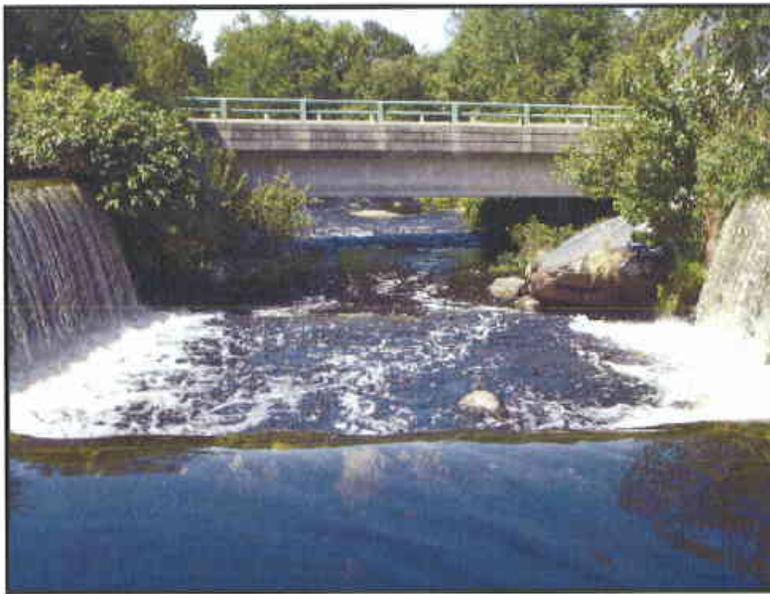


SHANNOCK FISH PASSAGE FEASIBILITY STUDY
PAWCATUCK RIVER
RICHMOND AND CHARLESTOWN, RHODE ISLAND

August 10, 2007

MMI #2989-01



Prepared for:

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EXECUTIVE SUMMARY

The Wood-Pawcatuck Watershed Association in partnership with the Town of Richmond has been awarded funding through the National Oceanic and Atmospheric Administration-American Rivers partnership and the Rhode Island Coastal Resources Management Council to conduct a Feasibility Study to assess anadromous fish passage and riverine habitat restoration at three dam sites on the Pawcatuck River in Richmond and Charlestown, Rhode Island. This document presents the detailed analysis of restoration alternatives. Figure ES-1 is a location plan of the project corridor identifying the three dams.

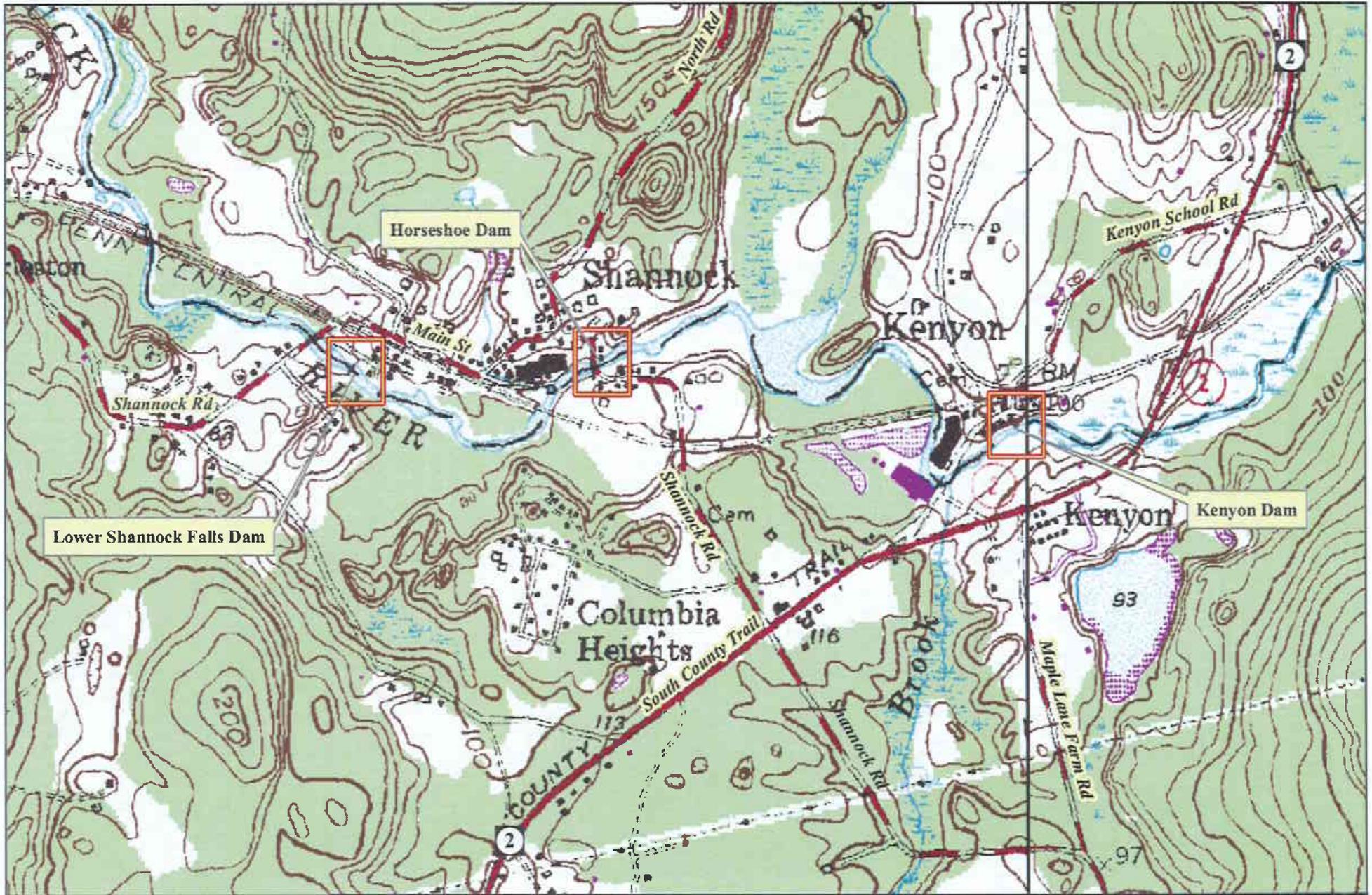
The Pawcatuck River watershed encompasses a total drainage area of 317 square miles. Approximately 260 square miles lie within Rhode Island; the remaining 57 square miles lie within Connecticut. The basin is approximately 25 miles long and 24 miles wide at its widest point. The upper and middle portions of the basin are characterized by gently rolling hills interspersed with wetlands and ponds. The Pawcatuck River meanders 33 miles through rural areas in Rhode Island before entering a more urban setting in the Westerly-Pawcatuck area. The lower five miles of the Pawcatuck River are tidal. The river flows in to the Narragansett Bay.

Historically, it is believed that the Pawcatuck River was of regional importance to diadromous fisheries, including Atlantic salmon and American shad. The system may have also supported a strong brook trout population. Over the last several centuries, the river has been physically and ecologically altered as a result of human activity. The many dams placed within the river have impacted the anadromous and resident fisheries habitat.

Three early run-of-the-river dams are located on the main stem of the Pawcatuck River, all of which currently block fish passage. From downstream to upstream, they are known as the Lower Shannock Falls Dam, the Upper Shannock Horseshoe Falls Dam, and the Kenyon Mill Dam. The Lower Shannock Falls Dam is located approximately 25 river miles above the estuary. The Upper Shannock Horseshoe Falls Dam is located approximately one-half mile above the Lower Shannock Falls Dam; the Kenyon Mill Dam is located an additional three-quarters of a mile upstream of the Upper Shannock Horseshoe Falls Dam. These three dams are currently the furthest upstream fish blockages to spawning and nursery habitat.

The following goals and objectives have been identified for the restoration of the Pawcatuck River:

- Achieve diadromous and resident fish passage;
- Improve riverine habitat conditions;
- Maintain or enhance aesthetics;
- Address dam safety;
- Minimize long-term dam maintenance;
- Consider and address cultural resources; and
- Identify cost-effective solutions.



Site Location Map

Location: **Richmond & Charlestown, RI**



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MMI#: 2989-01
MXD: H:\Site.mxd
Source: RIGIS



Shannock Fish Passage Feasibility Study

Date: April 2007
Scale: 1" = 1,000'

Sheet:
Figure ES-1



View of Lower Shannock Falls Dam from the right bank



View of Upper Shannock Horseshoe Falls Dam looking upstream



View of Kenyon Mill Dam from the right bank

RESTORATION ALTERNATIVES CONSIDERED

A total of 13 alternatives were evaluated at the Lower Shannock Falls, Upper Shannock Upper Shannock Horseshoe Falls, and Kenyon Mill dams. These are summarized in Table ES-1. Conceptual renderings for selected alternatives are included as figures in the body of this document. Conceptual design drawings for alternatives are appended, and show plan and profile views. Evaluated alternatives include installation of fish ladders, dam removal, high gradient riffles, and bypass channels.

**TABLE ES-1
Summary of Alternatives Considered**

| <i>Alternative</i> | <i>Description</i> |
|---|--|
| <i>Lower Shannock Falls Dam</i> | |
| S-1 | No Action |
| S-2 | Fish Ladder on Right Bank |
| S-3 | Full Dam Removal |
| S-4 | Bypass Channel Through Right Raceway |
| <i>Upper Shannock Horseshoe Falls Dam</i> | |
| H-1 | No Action |
| H-2a | High Gradient Riffles at Right Raceway |
| H-2b | Fish Ladders at Raceway |
| H-3 | Fish Ladder at Left Abutment |
| <i>Kenyon Mill Dam</i> | |
| K-1 | No Action |
| K-2 | Fish Ladder on Right Bank |
| K-3 | Bypass Channel through Existing Breach |
| K-4 | Full Dam Removal |
| K-5 | High Gradient Riffle |

Table ES-2 summarizes the above alternatives with regard to their ability to meet the project goals and objectives. Preliminary engineering opinions of costs were developed for the most feasible alternatives, as well as the no action alternative for each of the three dams. Table ES-3 presents costs for each of the alternatives.

**TABLE ES-2
Summary of Alternatives at Kenyon Mill Dam**

| <i>Alternative</i> | <i>Description</i> | <i>Achieves Fish Passage?</i> | <i>Improves Habitat Conditions?</i> | <i>Minimizes Long Term Dam Maintenance?</i> | <i>Potential for Impact to Historic Resources?</i> | <i>Prudent and Feasible Alternative?</i> |
|--------------------|-------------------------|-------------------------------|-------------------------------------|---|--|--|
| S-1 | No Action | No | No | No | No | No |
| S-2 | Fish Ladder | Yes | No | No | Yes | Maybe |
| S-3 | Full Dam Removal | Yes | Yes | Yes | Yes | Yes |
| S-4 | Bypass Channel | No | No | No | Yes | No |
| H-1 | No Action | No | No | No | No | No |
| H-2 | Ladder/Bypass Channel | Maybe | No | No | Yes | No |
| H-3 | Ladder -- Left Abutment | Yes | No | No | Yes | Yes |
| K-1 | No Action | No | No | No | No | No |
| K-2 | Fish Ladder | Yes | No | No | Yes | Yes |
| K-3 | Bypass Channel | Yes | No | No | Yes | Yes |
| K-4 | Full Dam Removal | Yes | Yes | Yes | Yes | Yes |
| K-5 | High Gradient Riffle | Yes | No | Yes | Yes | No |

**TABLE ES-3
Cost Summary of Individual Alternatives**

| <i>Alternative</i> | <i>Description</i> | <i>Total Cost</i> |
|--|--|-------------------|
| <i>Lower Shannock Falls Dam Alternatives</i> | | |
| S-1 | No Action | \$370,000 |
| S-2 | Fish Ladder on Right Bank | \$450,000 |
| S-3 | Full Dam Removal | \$413,000 |
| <i>Upper Shannock Horseshoe Falls Dam Alternatives</i> | | |
| H-1 | No Action | \$217,000 |
| H-2 | Fish Ladders at Right Raceway | \$421,000 |
| H-3 | Fish Ladder at Left Abutment | \$308,000 |
| <i>Kenyon Mill Dam Alternatives</i> | | |
| K-1 | No Action | \$132,000 |
| K-2 | Fish Ladder at Right Bank | \$169,000 |
| K-3 | Bypass Channel through Existing Breach | \$226,000 |
| K-4 | Full Dam Removal | \$384,000 |
| K-5 | High Gradient Riffle | \$288,000 |

As indicated in Table ES-3, cost opinions fall within a close range. The least costly "action" alternatives are full dam removal at the Shannock Dam, installation of a fish ladder at the left abutment at the Upper Shannock Horseshoe Falls Dam, and installation of a fish ladder at the right bank at the Kenyon Mill Dam. Recommended alternatives are summarized in Table ES-4.

**TABLE ES-4
Summary of Recommended Alternatives**

| <i>Location</i> | <i>Recommended Alternative</i> | | |
|------------------------------------|--------------------------------|------------------------------|-----------|
| Lower Shannock Falls Dam | S-3 | Full Dam Removal | \$413,000 |
| Upper Shannock Horseshoe Falls Dam | H-3 | Fish Ladder at Left Abutment | \$308,000 |
| Kenyon Mill Dam | K-4 | Full Dam Removal | \$384,000 |

It is important to note that the recommended alternatives are believed to meet the project goals and objectives, and are all believed to be technically feasible. However, the ultimate selection of preferred alternatives will depend upon a balance of cost, potential ecological benefits, and potentially public input. For example, while full dam removal is recommended at Kenyon Mill Dam, the fish ladder option is the least costly alternative.

In addition to the restoration elements involving fish passage, channel restoration should be considered as part of any future activities. The existing habitat upstream of the dams consists of wide pools with low velocities. Preferred habitat includes mixed pool, runs, and riffles, with intermediate velocities and increased cover. As part of any stream restoration effort, consideration should be given to creating in-stream channel enhancements to add stream features that will increase the habitat diversity. These types of stream improvements can be coupled with any of the selected alternatives.

Executive Summary.doc

1.0 INTRODUCTION

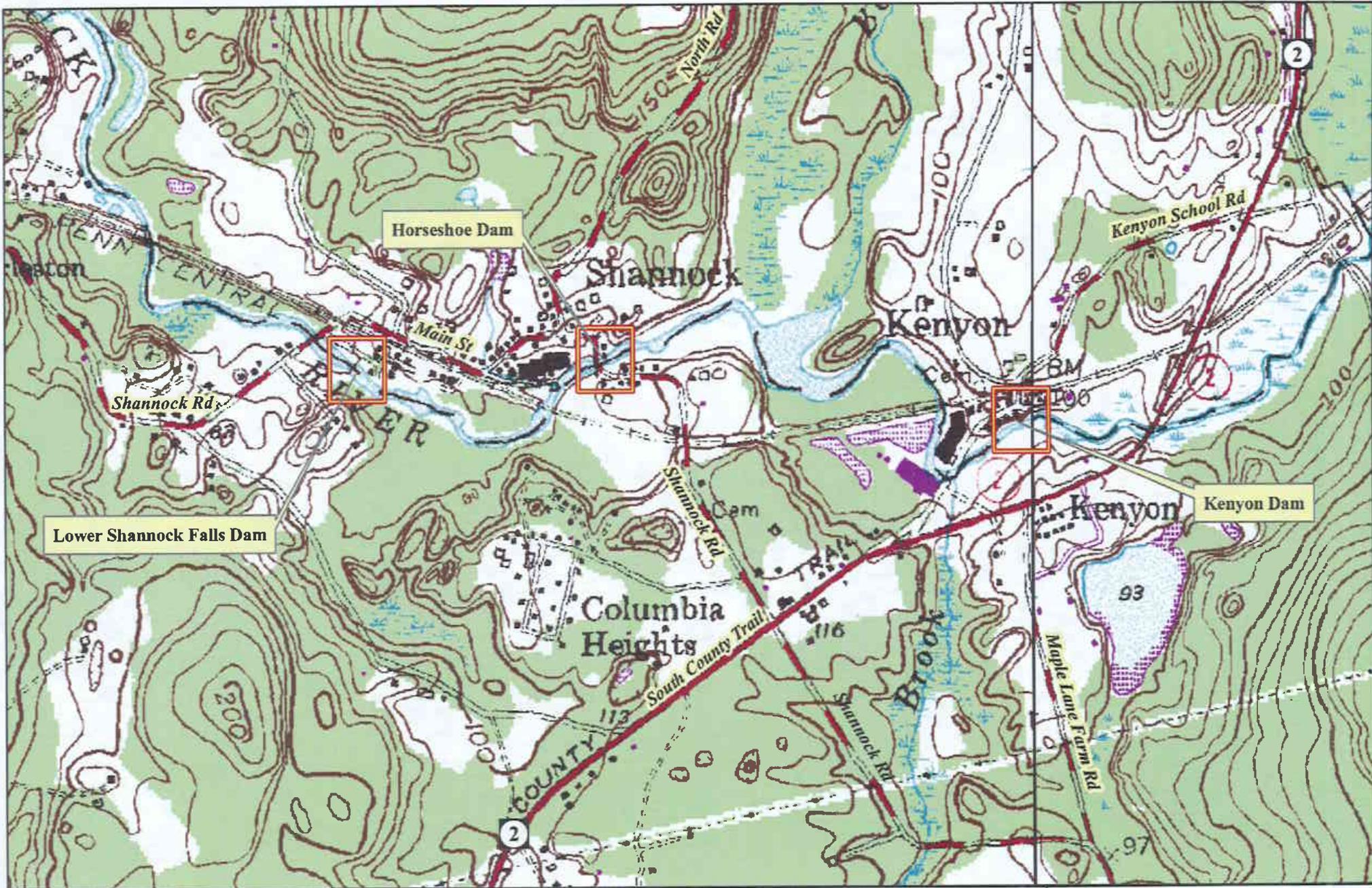
1.1 Project Background

The Wood-Pawcatuck Watershed Association (WPWA) in partnership with the Town of Richmond, has been awarded funding through the National Oceanic and Atmospheric Administration (NOAA) - American Rivers (AR) partnership and the Rhode Island Coastal Resources Management Council to conduct a Feasibility Study to assess diadromous fish passage and habitat restoration at three dam sites on the Pawcatuck River in Richmond and Charlestown, Rhode Island.

The subject study has been undertaken to assess the feasibility of providing diadromous fish passage past three dams to the upper Pawcatuck River, including the Beaver, Usquepaug, and Chipuxet tributaries. The dams are located on the main stem of the Pawcatuck River, and currently represent the furthest upstream fish blockages to upstream spawning and nursery habitat. From downstream to upstream, they are known as the Lower Shannock Falls Dam, the Upper Shannock Horseshoe Falls Dam and the Kenyon Mill Dam. Figure 1-1 is a location plan of the project corridor.

The WPWA retained Milone & MacBroom, Inc. (MMI) to evaluate various alternatives to restore access to historic upstream habitat for species including American shad, river herring, and American eel, as well as brook trout and other resident fish species. Various fish passage alternatives have been considered for each of the three dams, including structural fishways, bypass channels, high gradient riffles, and full or partial dam removal.

The following goals and objectives have been identified for the restoration of the subject reaches of the Pawcatuck River:



Engineering,
Landscape Architecture
and Environmental Science



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MMI#: 2989-01
MXD: H:\Site.mxd
Source: RIGIS

Site Location Map



Shannock Fish Passage Feasibility Study

Location: **Richmond &
Charlestown, RI**

Date: April 2007

Scale: 1" = 1,000'

Sheet:

Figure 1-1

- Achieve diadromous and resident fish passage;
- Improve riverine habitat conditions;
- Maintain or enhance aesthetics;
- Address dam safety;
- Minimize long-term dam maintenance;
- Consider and address cultural resources; and
- Identify cost-effective solutions.

1.2 Work Scope

The feasibility study work scope includes the following elements:

- Background Research;
- Field Assessment;
- Survey and Base Mapping;
- Evaluation of Restoration Alternatives;
- Hydrologic and Hydraulic Analysis;
- Preparation of Concept Design Drawings and Graphics;
- Planning Level Cost Opinions; and
- Public Outreach Meetings.

A number of reports and studies were reviewed during the data collection phase of the analysis. The review included information on file with the project stakeholders, the towns of Richmond and Charlestown, state agencies, U.S. Army Corps of Engineers, and other sources, including the following:

- River and Wetland Assessment, Pawcatuck River, Worden Pond to Lower Shannock Falls Dam performed by NOAA;
- Sediment reconnaissance and sampling for physical parameters performed by NOAA in collaboration with USFWS, WPWA, and URI;

- Technical Report, Cultural Resources Assessment Shannock Fish Passage Feasibility Study, Richmond and Charlestown, Rhode Island prepared by PAI, Inc.;
- Tax Assessor Information on file with the towns of Richmond and Charlestown;
- Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams prepared by Dennis E. Erkan, Rhode Island Department of Environmental Management;
- Interspecific Association, Diversity, and Population Analysis of Fish Species in the Wood-Pawcatuck Watershed by Saila et. al.;
- Assessing Habitat Requirements for Brook Trout (*Salvelinus fontinalis*) by Saila et. al.; and
- Small Dams and Habitat Quality in Low Order Streams by Saila et. al., 2005.

The following tasks were performed during field investigations of the site:

- Visual dam inspections were performed of the Lower Shannock Falls, Upper Shannock Horseshoe Falls Dam, and Kenyon Mill Dam;
- A survey was conducted of the wetland and vegetation habitats; and
- A field survey was conducted of the channel and impoundments.

1.3 Organization of Document

This document is organized as follows:

- Chapter 1 presents background information on the project, describes the project goals and objectives, and presents the project work scope.
- Chapter 2 documents information on the existing environment within the study area.
- Chapter 3 presents information on target fish species.

- Chapter 4 evaluates hydrology and hydraulics of the river under existing conditions.
- Chapter 5 presents an overview of fish passage restoration alternatives considered.
- Chapter 6 presents the alternatives analysis for Lower Shannock Falls Dam.
- Chapter 7 presents the alternatives analysis for the Upper Shannock Horseshoe Falls Dam.
- Chapter 8 presents alternatives analysis for the Kenyon Mill Dam.
- Chapter 9 provides recommendations on preferred alternatives.
- Chapter 10 presents estimates of probable constructions costs and likely permitting requirements.

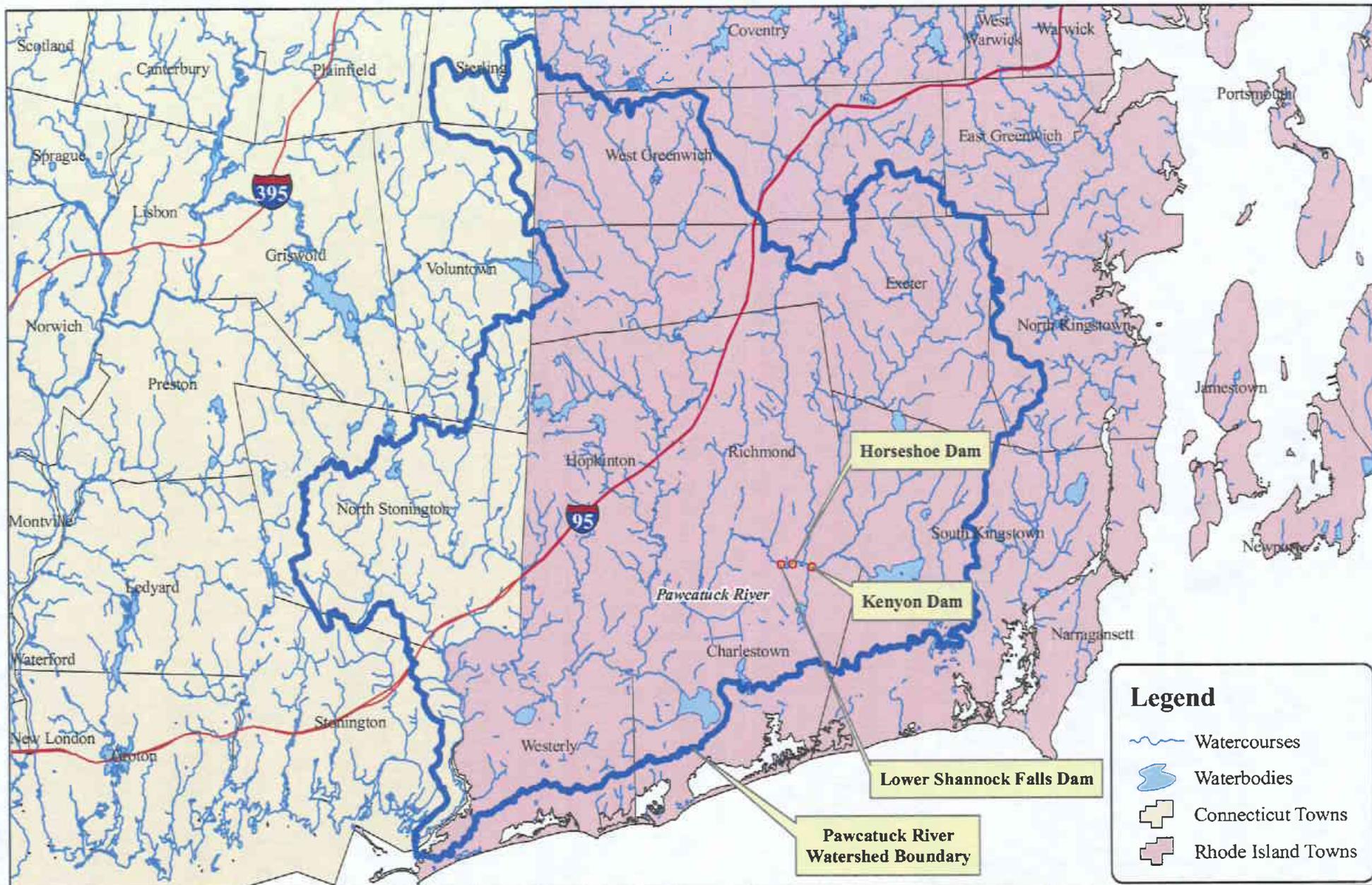
2.0 EXISTING CONDITIONS

2.1 Pawcatuck River Watershed

Figure 2-1 shows the Pawcatuck River watershed. The watershed is the largest river basin with land in Rhode Island, with a total drainage area of 303 square miles according to the 1986 Town of Charlestown FEMA Flood Insurance Study (FIS), and 317 square miles according to the Pawcatuck River Basin Plan prepared by the CT DEP in 1978. According to the Basin Plan, approximately 260 square miles lie within Rhode Island; the remaining 57 square miles lie within Connecticut. The basin is approximately 25 miles long and 24 miles wide at its widest point. The upper and middle portions of the basin are characterized by gently rolling hills interspersed with wetlands and ponds. The Pawcatuck River meanders 33 miles through rural areas in Rhode Island before entering a more urban setting in the Westerly-Pawcatuck area. The lower five miles of the Pawcatuck River are tidal. The river flows into the Little Narragansett Bay.

The Pawcatuck River and its major tributary, Wood River, drain much of southwestern Rhode Island. The lower Pawcatuck River watershed extends into portions of Connecticut and forms the border between the two states at some locations.

The project reach is situated in the northeast portion of the Pawcatuck River watershed. The watershed is relatively rural and the river is actively used for canoeing, fishing, and passive recreation. The low gradient watershed is characterized by extensive areas of pervious sand and gravel soils originating as glacial deposits and is home to numerous lakes and wetlands. As a result, peak flows are partially attenuated and summer low flows are maintained. Table 2-1 presents general characteristics of the Pawcatuck River.



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Source: RIGIS, CT DEP



Pawcatuck River Watershed

Shannock Fish Passage Feasibility Study

Location: **Connecticut &
Rhode Island**

Date: April 2007

Scale: 1" = 4 miles

Sheet:

Figure 2-1

**TABLE 2-1
Pawcatuck River Data**

| <i>Parameter</i> | <i>Value</i> |
|---------------------|--|
| Watershed Area | 303 SM ¹ |
| Bank Full Width | ±80 Feet |
| Alignment | Sinuuous |
| Gradient | Mild (0.001 Feet/Foot) to Moderate (0.005 Feet/Foot) |
| Substrate | Sand and gravel over bedrock |
| Banks | Glacial Outwash, Wooded |
| Bedload Transport | Low |
| Suspended Transport | Low |
| Stored Sediment | Low |

1986 FEMA FIS Town of Charlestown, Rhode Island

The topography of southern New England is the result of glacial, fluvial and coastal dynamics. Glaciation and subsequent deglaciation of Rhode Island eroded bedrock, realigned drainages, deposited till, created glacial swamps, kames, eskers, terraces, moraines, and outwash plains. Most notably, the retreating glaciers left ridges of material, forming the terminal moraine ridge of Charlestown, and meltwaters drained into the oceans, resulting in a gradual increase in mean sea level over the coast and outwash plain. The study area is located within the area of outwash deposits located between the Charlestown moraine to the south and the upland till plains to the north.

The Pawcatuck River through the project reach is moderately undisturbed. Woody vegetation shades the channel, creating high-quality habitat zones characterized by cool, well oxygenated water. The channel itself in the project reach varies between 45 and 130 feet wide. The slope through the project reach varies between 0.009 and 0.06 percent.

2.2 Description of Project Reach

According to the document *Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams* prepared by the Rhode Island Department of Environmental Management (RIDEM), eight dams remain on the main stem of the Pawcatuck River. The furthest downstream, the Stillman Mill Dam in Westerly, has

breached and is passable to diadromous fish. The White Rock Dam is located upstream of the Stillman Dam. Fish passage at this dam occurs via a raceway. The White Rock Dam is partially breached. The next two upstream dams, the Potter Hill Dam and the Bradford Dam, respectively located in Hopkinton and Westerly, are equipped with Denil fishways to provide passage to diadromous fish. The Route 91 USGS gauging station dam located in Richmond may need only minor work to be passable to shad and river herring.

The remaining obstructions to diadromous fish migration on the main stem of the Pawcatuck River are the Lower Shannock Falls Dam, Upper Shannock Horseshoe Falls Dam, and Kenyon Mill Dam. The Lower Shannock Falls Dam is located nearly 25 river miles upstream of the Pawcatuck River estuary. The Upper Shannock Horseshoe Falls Dam is located nearly half a mile upstream of the Lower Shannock Falls Dam. The Kenyon Mill Dam is located another nine-tenths of a mile upstream of the Upper Shannock Horseshoe Falls Dam. There are no dams located on the main stem of the Pawcatuck River upstream of the Kenyon Mill Dam.

Provisions for fish passage at these dams would open up the entire main stem of the Pawcatuck River to diadromous fish migration, for a total of 31 river miles downstream of the headwaters of the Pawcatuck River at Wordens Pond in South Kingston. According to the *Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams*, this would open up an additional 1,300 acres of habitat downstream of Wordens Pond.

2.3 Existing Channel Morphology

The Pawcatuck River through the project reach meanders through low relief terrain carved by glacial processes. The channel itself is primarily low gradient, with slopes averaging between 0.009 and 0.06 percent. The river is of irregular width, interspersed

with naturally formed, wider pooled areas and narrower, faster flowing areas. On average, channel width varies between 45 and 130 feet.

Low relief in the vicinity of the river creates access to a wide floodplain. Hydraulic modeling of the river under existing conditions predicts that the channel will flood over 100 feet outside its banks during the mean annual flood event.

In August 2006, NOAA measured various morphological parameters as presented in their *River and Wetland Assessment* report.

In the reach extending from the Upper Shannock Falls Horseshoe Dam to Lower Shannock Falls Dam, field estimates of bankfull width were determined to range from 90 to 160 feet, with bankfull depth ranging from seven to 16 feet. The width to



Pawcatuck River upstream of the Shannock Mill Pond Dam

depth ratio was calculated to be in the range of 10 to 13. Sinuosity was determined to be 1.38. Stream gradient was measured as typically less than 0.04% (1.0 ft/2376 ft).

The Rosgen channel classification is one means by which river sections can be classified. The Rosgen classification system is based upon visual inspection and field or map measurement, rather than geologic processes or numerical models.



Pawcatuck River upstream of the Horseshoe Dam

The river segment between the Lower Shannock Falls Dam and the Upper Shannock Horseshoe Dam can be classified as a Rosgen type C1c river. C1 stream types are slightly entrenched, meandering, alluvial channels with bedrock controlled beds that

occur on gentle gradients in broad valleys. They are characterized by well developed, alluvial floodplains. Alluvial floodplains are formed from sediment deposited from flowing water. The C1 stream types adjust laterally, and typically have high width to depth ratios (>12) due to the controlling influence of bedrock materials in the channel bed. Stream gradients of C1 channels are generally less than two percent. These channels have moderate sinuosity and are generally characterized by a riffle-pool configuration. Within the C1c designation, the "c" denotes a channel slope less than 0.001 feet per foot, or 0.1 percent.

Between the Upper Shannock Horseshoe Falls Dam and the Kenyon Mill Dam, the Pawcatuck River has a slightly lower stream gradient, on average less than 0.009% (0.38 ft/4,356 ft). Bankfull width was measured by NOAA from 45 to 130 feet, with bankfull depth ranging from eight to 11 feet. The width to depth ratio was calculated as between four and 16. Sinuosity was determined to be 1.43 (4,356 ft/3,036 ft). Much of this segment is impounded by the Upper Shannock Falls Horseshoe Dam under normal flow conditions.

The channel segment between the Upper Shannock Horseshoe Falls Dam and the Kenyon Mill Dam can be classified as a Rosgen type C5c river. As with C1 river segments, C5 river segments are also slightly entrenched, meandering channels with riffle-pool configurations within well-developed floodplains. C5 river sections are dominated by sandy substrates, as opposed to bedrock substrates. These stream types generally occur in broad valleys and plains areas; it is not uncommon to find the C5 stream type in glacial outwash. The C5c designation denotes a channel slope of less than 0.001 feet per foot, or 0.1 percent. The channel bed tends to be depositional, with a tendency toward lateral migration.

Upstream of the Kenyon Mill Dam, extending to New Biscuit City Road, bankfull width was estimated by NOAA to be between 70 and 120 feet, and bankfull depth was determined to be between seven and nine feet. The width to depth ratio was generally between eight and 17. Sinuosity was measured as 1.32. Average stream gradient was measured as less than 0.06% (0.24 ft/3828 ft). This river segment is classified as a Type C5c/C1c river.



Pawcatuck River upstream of the Kenyon Mill Dam

2.4 Utilities

Utility providers, as well as the Public Works Departments in the towns of Richmond and Charlestown, were contacted to verify the locations of utilities that could potentially be impacted under the proposed alternatives. The utility companies identified in Table 2-2 provide utilities in the area, as confirmed by DIG-SAFE.

**TABLE 2-2
Utility Providers in Project Area**

| <i>Utility Provider</i> | <i>Utility Provided</i> |
|-------------------------|-------------------------|
| Verizon | Phone, Cable |
| Cox Communications | Cable |
| Narragansett Electric | Electric, Gas |
| MCI | Phone |

Cox Communications indicated that their utilities do not extend to the dam sites. Narragansett Electric will stake the location of their utilities; this can be completed in conjunction with the design process. MCI indicated they do not have any infrastructure located in the project area. Verizon did not respond to a request for location of infrastructure. Relevant correspondence is included in Appendix A.

A 1.25-inch plastic water line, part of the Shannock Village Water District system, runs behind the Upper Shannock Horseshoe Falls Dam from the left bank (Leon Millis, Personal Communication). This line is served by wells off North Road and terminates its service on the western end at the post office (Sanford Neuschatz, personal communication). The water line can be accessed via a concrete manhole located on the left bank of the dam. It is anchored behind the dam with concrete blocks but line periodically comes loose and must be restabilized. This utility connection will need to be field located and protected during any project activities.

Water rights at the Upper Shannock Horseshoe Falls Dam raceway have recently been purchased to develop hydroelectric power. The owner of the water rights is allowed to divert up to half of the total flow past the dam. Head-gates to divert flow to the raceway could be installed as early as summer 2007 (Leon Millis, personal communication).

2.5 Natural Resources

2.5.1 Fisheries

Historically, it is believed that the Pawcatuck River was of regional importance to diadromous fisheries, including Atlantic salmon and American shad. The system may have also supported a strong brook trout population. One hypothesis is that the salter brook trout were mistaken for Atlantic salmon, leading some to question whether Atlantic salmon truly was a significant species in the Pawcatuck River watershed (WPWA, 2005). Other diadromous fish in this system include alewife, blueback herring, rainbow smelt, and sea-run brown trout, as well as the American eel, a catadromous species (U.S. FWS, 1991).

The first known users of the Pawcatuck River were the Native American Indian tribes of Niantic, Pequot, and Narragansett, who hunted and fished throughout the extensive watershed. With the introduction of European colonists in the 1600s, activities along the banks of Rhode Island's rivers shifted to residential and commercial uses. Water

powered mills were introduced. These mills were initially grist mills, used to grind grains for flour, but were eventually converted to textile mills for wool and cotton processing. Wastewater from these mills was often discharged directly into the river (Desbonnet and Schneider, 1992). The dams erected along the Pawcatuck River during this time decimated the diadromous fish populations.

A significant level of effort has been dedicated to the restoration of anadromous species in Rhode Island's coastal waters. River herring broodstock is transplanted by the Rhode Island Division of Fish and Wildlife (DFW) into areas where fish passage is already established. The Pawcatuck River watershed is stocked with hatchery-reared Atlantic salmon fry, parr, and smolts (Erkan, 2002).

In addition to these efforts, fish passage provisions have been made at several dams on the main stem of the Pawcatuck River, with varying success. Currently, passage past the Potter Hill Dam and Bradford Dam is compromised due to attraction flow issues. The USGS gauging station weir is passable to Atlantic salmon but needs minor work to pass species such as river herring.

The Pawcatuck River watershed has been identified in the *Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams* as having the potential for restoration of anadromous species (Erkan, 2002). In fact, the Pawcatuck River is the only watershed identified in the plan as having the potential for significant areas of salmon habitat. The plan acknowledges that the provision of fish passage work on the main stem of the Pawcatuck River would result in significant expansion of potential river herring and American shad spawning habitat.

A number of studies have been undertaken for the Wood-Pawcatuck Watershed Association. One such study on the temperature effects of small dams in low order streams indicates that small dams elevate downstream water temperatures and that channel temperature may remain elevated for miles downstream (*Maximum Stream*

Temperature Estimation from Air Temperature and its Relationship to Brook Trout, Saila, 2004). Supporting data was collected downstream of a small (four-foot) presumably run-of-river dam on the Beaver River, a tributary to the Pawcatuck River.

A separate study assessed habitat requirements for brook trout in low order streams. Data from that study indicate that the proximity of the sample site to dams was important in determining the relative proportion of brook trout in the sample. The report hypothesizes that the presence of dams not only obstructs seasonal movement but also increases suitable habitat for warm-water fish species. Competition from these warm-water species may result in the reduced growth and survival of brook trout (*Small Dams and Habitat Quality in Low Order Streams*, Saila, 2005).

A study of the interactions among fish species in the Pawcatuck watershed indicates that brook trout abundance is increased in situations where competition by other species is minimized. Data was collected from Locke Brook, Beaver River, Breakheart Brook, and Brushy Brook. Additionally, species composition was found to be influenced by altered environmental conditions in which warm-water species were associated with stream reaches in relative close proximity to impoundments (*Interspecific Association, Diversity, and Population Analysis of Fish Species in the Wood-Pawcatuck Watershed*, Saila, et. al., undated).

The above bodies of work indicate that in addition to obstructing fish migration, dams located within the Pawcatuck River watershed may alter environmental conditions such that fish species composition is affected. Aside from provision of fish passage, removal of one or more of the subject dams may be warranted where feasible, as this approach would significantly expand suitable habitat for resident species such as brook trout.

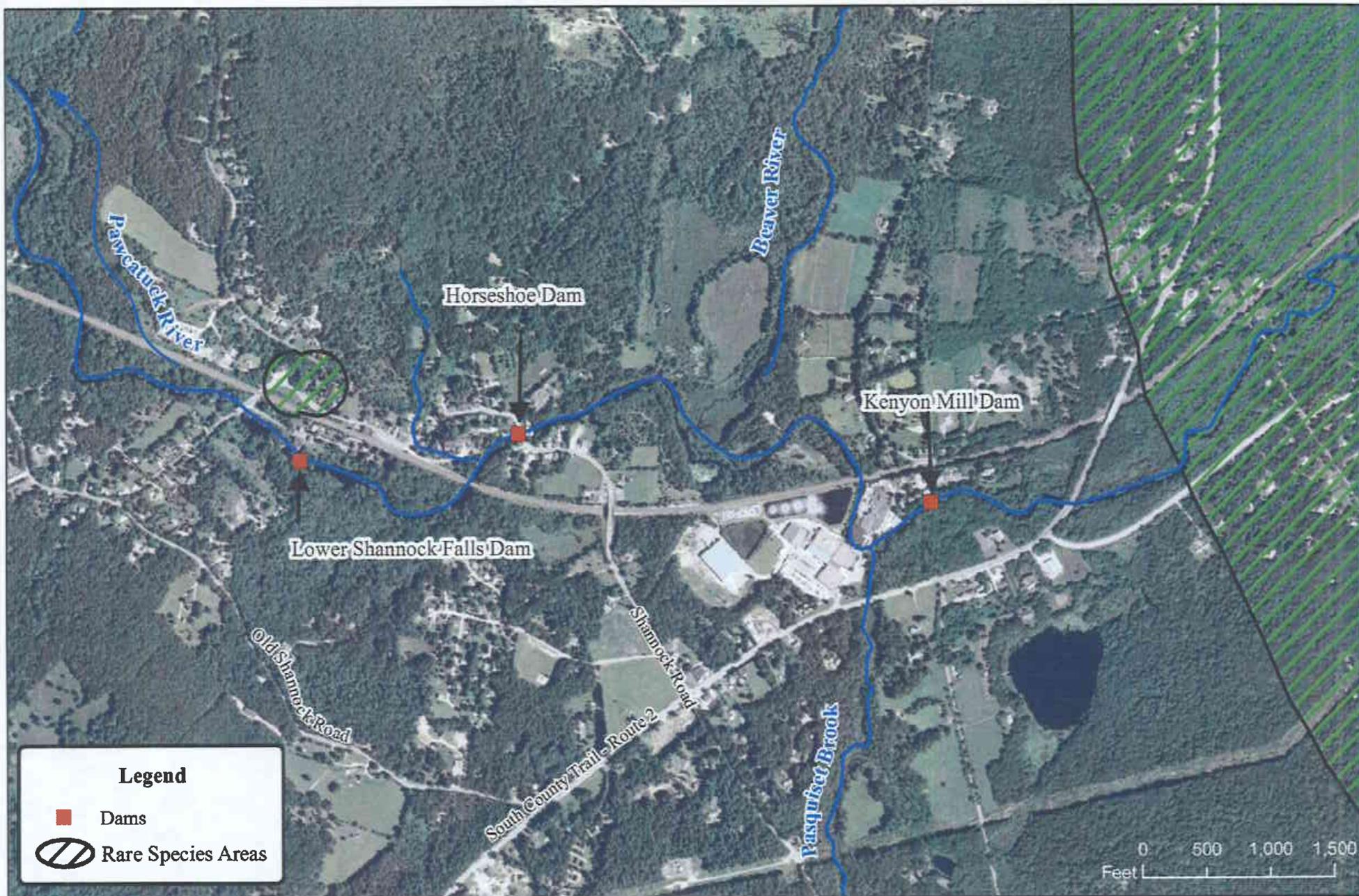
2.5.2 Endangered and Habitat Species

Watercourses offer desirable habitat for a variety of species. As such, it is vital that any impact on endangered or rare species from watercourse alteration be evaluated. To determine if any endangered or habitat species reside in the subject area, information was gathered from the Rhode Island Geographic Information System (RIGIS) online database, administered by the University of Rhode Island.

Delineation of rare species habitat is depicted in Figure 2-2. The mapping shows the estimated habitat and range of rare species as well as other noteworthy natural communities. According to the most recent database (1998), no documented rare species communities lie within the immediate river corridor between the three dams under study. Two polygons depicting the habitat regions of rare species are located within a few thousand feet of the project reach. The upstream polygon depicts the Great Swamp Wildlife Management Area maintained by RIDEM. If upstream water levels were to drop as a result of implementation of a fish passage alternative, it would be important to assess the impact to this habitat region.

2.5.3 Wetlands and Soils

Wetland soils were identified by NOAA in conjunction with their August 2006 *River and Wetland Assessment*. Hydric soil units including Carlisle muck (Co) and Adrian muck (Aa) are the predominant soils of the wetlands in the project area. Adrian mucks are very poorly drained organic soils up to 50 inches in thickness in outwash plains and topographic depressions, where the water table is at or near the surface for most of the year.



Legend

- Dams
- Rare Species Areas

MILONE & MACBROOM
*Engineering,
Landscape Architecture
and Environmental Science*
 99 Realty Drive
 Cheshire, CT 06410
 Phone: (203) 271-1773
 Fax: (203) 272-9733

Rare Species
 MMI#: 2989-01
 MXD: H:rare_species.mxd
 Source: RI GIS

**Shannock Fish Passage
Feasibility Study**

Location: **Richmond and
Charlestown, RI**
 Date: April 2007
 Scale: 1 : 12,000
 Sheet:
Figure 2-2

Carlisle mucks are similar to the Adrian series with very poorly drained organic soils often exceeding 50 inches in thickness and associated with depressions in glacial till and outwash plains and characterized by water at or near the surface for much of the year. Raypol (Rc) silt loams, Scarboro (Sb) mucky sandy loams, and Ridgebury extremely stony fine sandy loams (Rf) are less frequently occurring hydric soils mapped for this watershed area.

NOAA inventoried the wetlands within the project reach according to the National Wetlands Inventory (NWI) system. The NWI utilizes a system of letter and number codes that correspond to the classification nomenclature to describe the local habitat. The first letter describes the system of wetlands; the second letter/combination of letters describes the class; the third number describes the subclass; and the final letter is a modifier that describes the water regime, water chemistry, or soil properties. Table 2-3 describes the attributes associated with the referenced codes. A narrative by stream reach follows.

Lower Reach – Downstream of the Upper Shannock Horseshoe Falls Dam – Wetlands along this reach are relatively narrow but broaden to nearly 800 feet in one section. Forested (red maple and green ash) wetlands (PFO1C, PSS1C/E) dominate this reach. Water willow and buttonbush-dominated scrub-shrub wetlands are prevalent in the central portion of this reach in the vicinity of several Shannock Village residences on the north side of the river. Adrian mucks are the predominant hydric soil underlying the wetlands in this river reach. Urban fill soils (Ur - Udorthents) and upland soils including Canton-Urban very rocky, land complex (Cc), and Hinckley gravelly sandy loams (HkC) are also found in this area, forming gentle sloping to steep lands along the river.

**TABLE 2-3
Wetlands and Deepwater Habitats Classification Codes and Attributes**

| <i>Code</i> | <i>Attributes</i> |
|-------------------------------------|--|
| [P] Palustrine | <p>Non-tidal wetlands dominated by trees, shrubs, emergents, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics:</p> <ol style="list-style-type: none"> 1. are less than 8 hectares (20 acres); 2. do not have an active wave-formed or bedrock shoreline feature; 3. have at low water a depth less than 2 meters (6.6 feet) in the deepest part of the basin; 4. have salinity due to ocean-derived salts of less than 0.5 ppt. <p>The Palustrine System was developed to group the vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and prairie, which are found throughout the United States. It also includes the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers.</p> |
| [FO] Forested | Characterized by woody vegetation that is 6 m tall or taller |
| [EM] Emergent | Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed. |
| [SS] Scrub-Shrub | Areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees (saplings), and trees or shrubs that are small or stunted because of environmental conditions. |
| [I] Broad-Leaved Deciduous | Woody angiosperms (trees or shrubs) with relatively wide, flat leaves that are shed during the cold or dry season; e.g. black ash (<i>Fraxinus nigra</i>). |
| [C] Seasonally Flooded | Surface water is present for extended periods especially early in the growing season but is absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from saturated to the surface to a water table well below the ground surface. |
| [E] Seasonally Flooded/Saturated | Surface water is present for extended periods especially early in the growing season and when surface water is absent, substrate remains saturated near the surface for most of the growing season. |

Source: <http://wetlandsfws.er.usgs.gov/NWI/webatx/atx.html>

Wetlands and Deepwater Habitats Classification - National Wetlands Inventory Mapping Code

Attribute classification definitions derived from: Cowardin, L.M., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service. 103 pp.

Codes used: PFO1C, PFO1E, PEM5, PSS1C, PSS1E

Mid-Reach – Between the Upper Shannock Horseshoe Falls Dam and Kenyon Mill Dam –

Much of this segment is impounded by the Upper Shannock Horseshoe Falls Dam, although the river is free flowing immediately below the upstream Kenyon Mill Dam. This river section has been affected by urban development, particularly the Kenyon Industry buildings, dam, wastewater settling lagoons, and residential development. Along the river section bordering Kenyon Industries, the floodplain has been eliminated by construction of rock retaining walls. Below the walled reach, the river has been affected by lagoon construction but is well vegetated by a wetland complex.

The wetland border extends up to 250 feet along this river reach. Forested and scrub-shrub swamp (PFO1C/E, PSS1E) dominates this section of the river. Red maple and buttonbush (*Cephalanthus occidentalis*) dominate this region. NOAA noted invasive, non-native plants including common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*) along this reach of the river study area. Duckweed (*Lemna spp.*), a floating aquatic species, was also noted in this area and is an indicator of excess nutrients.

Adrian mucks are the predominant hydric soil underlying the wetlands in this river reach. Urban fill soils (Ur - Udorthents) and upland soils including Canton-Urban very rocky, land complex (Cc), Canton and Charlton fine sandy loams (CeC), Sutton extremely stony fine sandy loams (SvB), Sudbury sandy loams (Ss), and Hinckley gravelly sandy loams (HkC) were also found in this area, forming gentle sloping to steep lands along the river.

Upper Reach – Upstream of the Kenyon Mill Dam – The wetland cover along this river reach is relatively narrow but broadens to 600 feet in one section. This river reach is dominated by forested (PFO1C/E) and scrub-shrub (PFO1E) (red maple dominant) wetlands. The fringe emergent (PEM5) cover increases further downstream and is dominated by water willow, pickerel weed, and arrow arum, particularly in the vicinity of the Route 2 crossing. Adrian mucks are the predominant hydric soil underlying the wetlands in this river reach.

In the NWI system, class describes the general appearance of the habitat in terms of either the dominant life form of the vegetation or the physiography and composition of the substrate. Life forms (e.g., trees, shrubs, emergents) are used to define classes because they are easily recognizable, do not change distribution rapidly, and have traditionally been used to classify wetlands. Other forms of vegetation such as submerged or floating-leaved vascular plants are more difficult to detect. Substrates reflect regional and local variations in geology and the influence of wind, waves, and currents on erosion and deposition of substrate materials.

2.5.4 Cultural Resources

As an accessory to this report, a cultural resources assessment was conducted to determine the historic significance of the three dam sites and scenic values attached to the dams by the community. Conducted by Public Archeology Library, Inc. (PAL), the assessment consists of documenting the existing conditions and historical context/research value of each dam and making recommendations as to the need for additional historic and archaeological documentation that may be warranted prior to any proposed alterations. The cultural resources assessment was conducted in accordance with Section 106 of the National Historic Preservation Act (as amended) (26 CFR 800), which requires the lead federal agency, which is NOAA for this particular project, to take into account the effects of the proposed undertaking on cultural resources.

A combination of archival research and field investigations by PAL concluded that both Shannock Village dams, the Lower Shannock Falls Dam and the Upper Shannock Horseshoe Falls Dam, as well as the associated buildings and sites are considered contributing elements to the Shannock Village Historic District (the District). These features are integral components of the industrial development of Shannock Village in the nineteenth and early twentieth centuries. Additionally, these dam sites have also been assessed as containing shorelines that possess areas of moderate to high archaeological

sensitivity for Native American and early Euro-American cultural deposits. These conclusions were based on the following criteria that assessed properties:

- Associated with events that have made a significant contribution to the broad patterns of our history; or
- Associated with the lives of persons significant in our past; or
- Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or
- Have yielded, or may be likely to yield, information important to prehistory or history.

The Lower Falls and Upper Falls (Upper Shannock Horseshoe Falls Dam) dams are listed as contributing elements on the National Register Shannock Village Historic District. The waterpower infrastructure and mill remains have been recommended in the PAL report as having the eligibility to be listed as contributing elements in the District. Any proposed changes to these sites would require additional historical documentation prior to any structural modifications. This documentation would likely include a full written history and description, detailed site mapping, and photographic recordation of the mill remains, water control structures, and dam spillways. In addition, further investigations via Phase I(c) archaeological surveys would need to be undertaken to locate and identify any significant belowground Native American and/or Euro-American cultural deposits.

The integrity of the Kenyon Mill Dam currently disqualifies it for eligibility of a listing in the National Register of Historic Places; however, it could potentially be considered a contributing element in a Kenyon Village Historic District, if one were to be established.

At least two critical historic facets are of relevance to the historic significance of the project reach of the Pawcatuck River as noted below:

Native Americans – The Pawcatuck watershed was historically used by Native Americans including the Niantic, Pequot, and Narragansett tribes circa (ca.) 12,500 to 300 years before present (B.P.). The region provided hunting and fishing resources plus had a mild climate influenced by the sea. The immediate vicinity of the Lower Shannock Falls Dam is also identified as the site of a battle between the Narragansett and Pequot tribes for fishing rights at the falls.

Colonial Mills – The Pawcatuck watershed was first settled by European colonists in the mid 1600s and continued to play an important part in the development of the area throughout the 18th, 19th, and early to mid-20th centuries. The earliest mills were built at sites with water power potential for sawing timber and processing grain.

A grist mill, known as Clark Mills, is believed to have existed at Upper Shannock Falls (Upper Shannock Horseshoe Falls Dam) prior to 1747 with an undershot water wheel. The Village of Shannock changed rapidly after the Stonington-Providence railroad was built in 1837, allowing development of textile mills. The lower falls reportedly had a grist mill as of 1833; later a textile mill was built by John Knowles. Columbia Narrow Fabrics operated the upper mill until 1968.

Well before the Kenyon Station was built along the main line of the New York, Providence & Boston Railroad in 1889, a saw mill and an iron manufactory existed where the mills are now located. As early as 1772, the Village of Kenyon had a thriving industry base. In 1844, new mills were constructed and the community took on the name Kenyon's Mills (from Richmond Historic Society).

2.6 Riverbed Sediment

A thorough knowledge of sediment is required to understand the dynamics of both natural rivers and man-made channels. The status and character of sediment in the impoundments are key elements when considering the appropriate dam modification to provide fish passage. The specific concerns often include mobilization of potential pollutants, creation of downstream suspended sediment loads and turbidity, downstream sediment deposition that buries native substrate, and unstable incised channels ("headcutting") through existing impoundments.

Data collection efforts by both NOAA and MMI indicate that very little sediment accumulation has occurred behind any of the three subject dams. In general, sediment accumulation is limited to the quiet backwater areas. The physical composition of accumulated sediments is primarily sand and silt, with fractions of organics as a result of decaying vegetation. Chemical analyses of sediments in the vicinity of the Lower Shannock Falls Dam indicate that no chemical constituents exceed the Residential Direct Exposure Criteria as put forth in the RIDEM Solid Waste Regulation No. 1. These findings are explained in greater detail in the following sections.

Kenyon Industries maintains a wastewater discharge permit for discharges at its facilities. It is not clear at this time how such discharges may have affected the chemical composition of streambed sediments.

2.6.1 Physical Characterization

NOAA, in conjunction with volunteers from the University of Rhode Island (URI), and with assistance from the project partners, completed assessments to determine general distribution of and amount of sediments within each impoundment. They conducted both physical and chemical analyses of the sampled sediments. Sediment sampling was completed on August 16, 2006 with assistance from the U.S. Fish and Wildlife Service

(USFWS), Narragansett Bay Estuary Program (NBEP), URI, and WPWA. In addition, URI collected samples during a separate sampling event for physical analysis, including determination of bulk density. A copy of these sample results are included herein as Appendix II. Prior to completing field work, NOAA in collaboration with USFWS and the WPWA prepared a sediment sampling plan, which was submitted to and approved by the RIDEM Water Resources Division.

Sediment samples were collected from the Lower Shannock Falls Dam impoundment and the Kenyon Mill Dam impoundment. Sediment sample locations are graphically depicted in Figures 2-3 and 2-4. Sediment reconnaissance was completed with a metal probing rod and survey rod. Sediments were sampled with a MacCauley peat corer. Sample locations were located using a hand-held GPS.

Physical characterization of sediments downstream of the Lower Shannock Falls Dam was conducted by MMI. The channel was accessed both by boat and by foot. Sediment samples were located with a total station survey instrument in conjunction with topographic survey. Sediment samples were visually observed at the sample locations indicated in Figure 2-3. Downstream of the dam, a deeper, slower moving pool of water has developed. The northern (upstream) end of this pool contains coarse sediments such as sands and pebbles, while the southern (downstream) end had fine silts and very fine sands overlain by organics.

MMI also conducted visual assessments of the sediments upstream of the Lower Shannock Falls Dam. The MMI investigation supported the NOAA findings that sediment accumulation is limited to the quiet backwater and bank areas, and that sediment primarily consists of sand and silt overlain by a layer of organic muck. Bedrock and boulder was the dominant midstream substrate type.

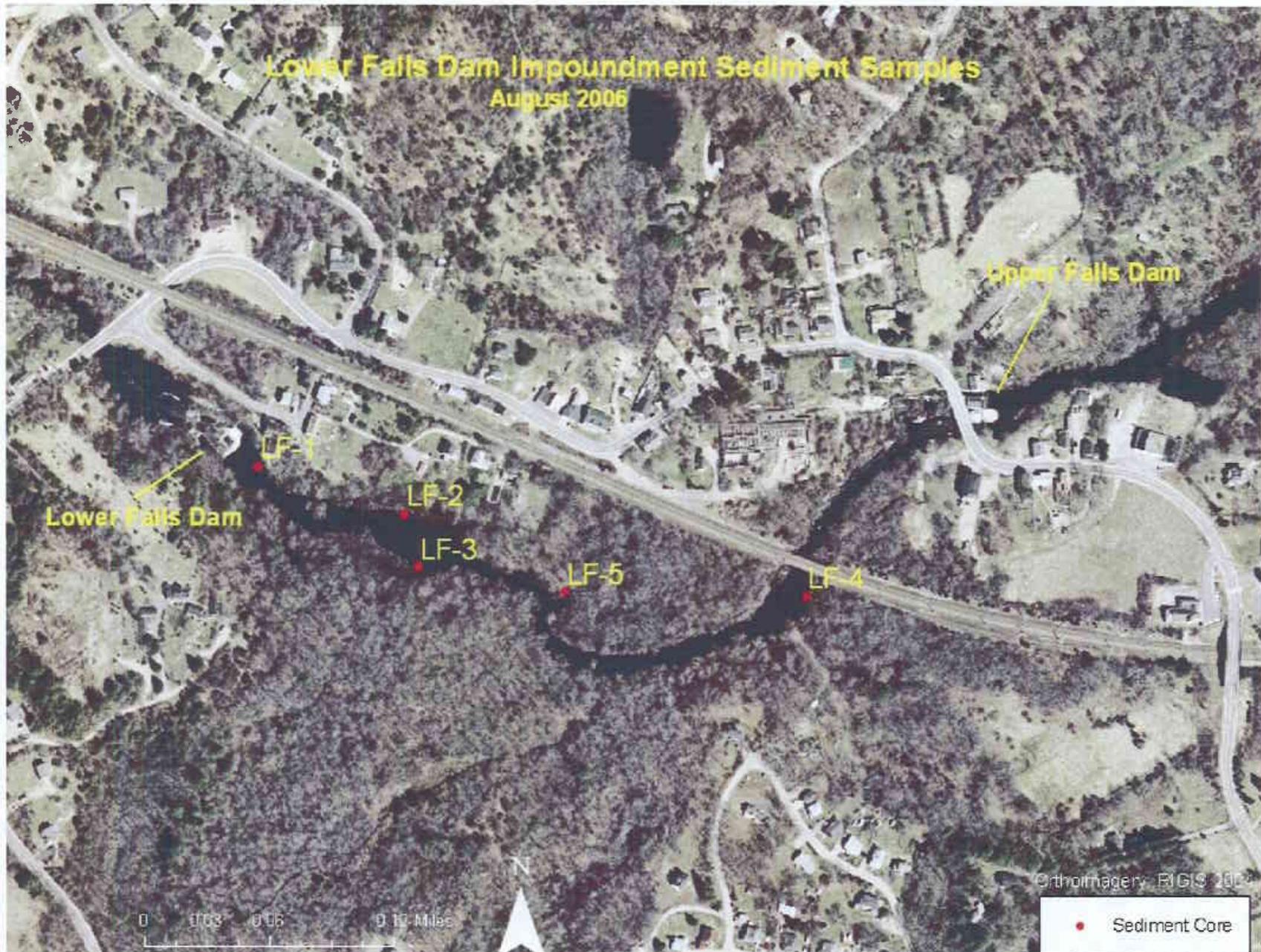




Figure 2-5 shows the MMI sediment sample locations. The results of the analysis conducted in the vicinity of the Lower Shannock Falls Dam are presented in Table 2-4. This table lists the location ID, approximate depth of water, location, and a description of the observed sediments.

Between the Lower Shannock Falls Dam and the upstream Upper Shannock Horseshoe Falls Dam, bedrock and boulder is the dominant bottom substrate type. Very fine sands and organic mucks were found in only limited depositional locations (inside channel meanders and small backwaters) to a maximum depth of three feet. The impoundment behind the Lower Shannock Falls Dam lacks sediment as the two upper dams likely minimize downstream transport of sediments. A bedrock/boulder substrate characterizes the area immediately upstream of the Lower Shannock Falls Dam.

Bedrock/boulder and sands and mucks are the dominant bottom substrate types between the Upper Shannock Horseshoe Falls Dam and the Kenyon Mill Dam. Sands and organic mucks were noted in depositional locations, such as inside channel meanders and backwaters, including in the vicinity of the lagoons.

Upstream of the Kenyon Mill Dam, the NOAA investigation identified bedrock and boulders as the dominant bottom substrate type. Sands and organic mucks were found in limited depositional locations, such as inside channel meanders and small backwaters, to a maximum depth of approximately two feet.

2.6.2 Chemical Characterization

A sediment analysis was performed by Premier Laboratory, LLC. for Fuss & O'Neill, Inc. on November 17, 2006. This data was collected in an independent analysis for an Environmental Assessment associated with the demolition of the Knowles Mill adjacent to the Lower Shannock Falls Dam.

TABLE 2-4
MMI Sediment Observations at Lower Shannock Falls Dam

| Survey Point # | Approx. Depth of Water (ft) | Depth of Sediment (in) | Location | Description of Sediments |
|----------------|-----------------------------|------------------------|--|--|
| 624 | 5.5 | 13 | Near right bank | Coarse sand |
| 625 | 6.0 | 0 | Midstream | Bedrock |
| 626 | 8.0 | 0 | Midstream | Bedrock |
| LEW | 2.0 | 14 | Left edge of water | Loose sand, silt, organic matter |
| 629 | 7.0 | 0 | Midstream | Bedrock |
| 631 | 7.0 | 1 | Midstream | Sand and gravel in bedrock |
| REW | 3.0 | 19 | Right edge of water | Consolidated sand, silt, and organic matter |
| 634 | 5.0 | 19 | Near right bank | Detritus over loose sand and silt |
| 635 | 6.0 | 8 | Midstream | Consolidated sand over bedrock |
| 636 | 5.0 | 0 | Midstream | Bedrock |
| 637 | 2.0 | 0 | Left edge of water | Coarse sand and gravel over bedrock |
| 638 | 4.0 | 0 | Right edge of water | Negligible silt over bedrock |
| 639 | 3.0 | 6 | Near right bank | Consolidated sand and gravel |
| 640 | 7.0 | 1 | Midstream | Thin layer of sand and gravel over bedrock |
| 641 | 7.0 | 4 | Midstream | Coarse sand and gravel over bedrock |
| 642 | 5.0 | 21 | Right edge of water | Detritus and sand over gravel |
| -- | 5.0 | 19 | Right edge of water, upstream of point 642 | Loose detritus and sand over consolidated detritus and sand |
| 643 | 5.0 | 6 | Midstream | Sand and silt |
| 644 | 10.0 | 0 | Midstream | Bedrock |
| 645 | 3.0 | 0 | Near left bank | Bedrock |
| LEW | 2.0 | 4 | Left edge of water | Very loose fine sand and silt with detritus |
| LEW | 4.0 | 4 | Left edge of water | Very loose fine sand and silt with detritus |
| 647 | 6.0 | 0 | Midstream | Bedrock |
| 648 | 6.0 | 0 | Midstream | Bedrock |
| 649 | 6.0 | 0 | Near island right bank | Bedrock |
| 653 | 2.0 | 10 | Near right bank | Loose, very fine to coarse sand, silt, detritus |
| REW | 2.0 | 5 | Right edge of water | Fine sand, silt, detritus |
| 657 | 6.0 | 0 | Midstream | Bedrock |
| 658 | 6.0 | 0 | Midstream | Bedrock |
| 659 | 2.0 | 6 | Left edge of water | Consolidated fine sand, silt, and detritus Fine sand and silt (0-45") over coarse sand (45-90") |
| 661 | 3.0 | 90 | Midstream | Detritus over sand and silt |
| 663 | 4.0 | 43 | Midstream | Detritus over sand and silt |
| 664 | 10.0+ | - | Midstream | Too deep for sediment observation |
| 665 | 10.0+ | - | Midstream | Too deep for sediment observation |
| 666 | 5.0 | 58 | Near left bank | Layer of detritus over sand and silt over gravel |
| 667 | 2.0 | 50 | Left edge of water | Loose sand and silt over consolidated sand and silt |
| 668 | 7.0 | - | Midstream | Too deep for sediment observation |
| 689 | 5.0 | 2 | Right edge of water | Consolidated fine and coarse sand with gravel |
| 690 | 3.0 | 14 | Left edge of water | Layer of detritus over consolidated sand and silt |
| 692 | 1.0 | 39 | Left edge of water | Detritus over consolidated sand and silt over gravel and bedrock |

The results of the Fuss & O'Neill analysis were compared by MMI to the maximum pollutant levels put forth by the RIDEM "Solid Waste Regulation No. 1, General Requirements," put in effect on January 1, 1997, and amended in April, 2001. These regulations were developed to regulate alternatives for disposal on land of sediment dredged or otherwise removed from any water body and offer guidelines for such operations.

The sediment samples were taken from upstream and downstream of the Lower Shannock Falls Dam. Sediment sample locations are included in Appendix E. All of the metals and compounds tested were well below the regulated levels per the RIDEM requirements, as shown in Table 2-5. This finding is consistent with the knowledge of the existing and historical land use and allows disposal of the materials at any residential, commercial, or industrial location.

TABLE 2-5
Results of Sediment Chemical Analysis by Fuss & O'Neill

| Constituent | Units | Residential Direct Exposure Criteria* | On-Site Sediment Test Locations | | | | | |
|---------------|-------|---------------------------------------|---------------------------------|-------|--------|--------|--------|--------|
| | | | SD-01 | SD-02 | SD-03 | SD-04 | SD-04A | SD-05 |
| TPH | µg/kg | 500,000 | 2,122.0 | 901.0 | 1314.0 | 6139.0 | 9599.0 | 2078.0 |
| PCB's | µg/kg | 10,000 | 48 | 26.0 | 18.0 | 21.0 | 17.0 | 16.0 |
| Arsenic (As) | mg/kg | 1.7 | - | - | - | - | - | - |
| Cadmium (Cd) | mg/kg | 39 | 0.7 | 0.3 | 0.1 | 0.2 | 0.2 | 0.1 |
| Chromium (Cr) | mg/kg | 390 | 11.0 | 5.2 | 2.0 | 3.6 | 2.5 | 1.7 |
| Copper (Cu) | mg/kg | 3,100 | 11.0 | 6.8 | 9.3 | 6.7 | 5.6 | 2.5 |
| Lead (Pb) | mg/kg | 150 | 37.0 | 25.0 | 47.0 | 37.0 | 48.0 | 10.0 |
| Mercury (Hg) | mg/kg | 23 | 0.10 | 0.07 | 0.03 | 0.03 | 0.05 | 0.03 |
| Nickel (ni) | mg/kg | 1,000 | 3.3 | 1.7 | 1.0 | 1.4 | 1.3 | 0.8 |
| Vanadium (V) | mg/kg | 550 | 8.4 | 5.0 | 2.5 | 3.3 | 3.0 | 5.0 |
| Zinc (Zn) | mg/kg | 6,000 | 56.0 | 28.0 | 47.0 | 44.0 | 31.0 | 9.5 |

* Table 1, Direct Exposure Criteria, State of Rhode Island and Providence Plantations, Department of Environmental Management, Office of Waste Management, Remediation Regulations as amended February 2004 DEM-DSR-01-93

2.6.3 Sediment Transport

Sediment transport occurs naturally and is a part of a healthy river. Rivers are considered to be in "dynamic equilibrium," actively undergoing erosion and deposition while maintaining essentially the same overall shape and form. The morphology or shape of a river is created largely according to sediment transport processes. One facet of a successful dam removal is to restore natural sediment transport processes without endangering channel stability.

The channel substrate in the project reach is primarily bedrock and boulder, with sand, silt, and organic muck in depositional areas and along the banks. Sediment transport in conjunction with various alternatives would impact these finer substrates. Alternatives such as fish ladders and high gradient riffles maintain the existing dams and, therefore, maintain dam impoundments. Under alternatives of this type, sediment transport would continue as under existing conditions. Other alternatives, such as full dam removals, narrow the existing channel as a free-flowing section of river is formed in the location of the existing impoundment. Under dam removal alternatives, sediments that have accumulated along the banks would be appropriately stabilized during the channel construction process and would then resume the natural erosion and deposition process.

3.0 TARGET FISH SPECIES

Fish passage projects have the potential to provide significant benefits to fisheries. It is important to have a good understanding of the fish in the system in order to design a project that will provide the potential benefits. This section presents the background information used in evaluation of the fish passage alternatives on the Pawcatuck River.

Fish that migrate between fresh water and marine environments are collectively called diadromous fish. The goal of this project is to provide upstream and downstream fish passage for diadromous and resident species. These include anadromous and catadromous fish. Anadromous fish lay their eggs and develop in fresh water. They then migrate to salt water where they remain until they are sexually mature. Once anadromous fish reach sexual maturity, they return to fresh water to spawn. The anadromous river herring have been targeted for restoration in the Pawcatuck River, and a number of other diadramous species may also benefit from restoration activities.

American shad, river herring (alewife and blueback herring), sea run brown trout and American eel have been identified as the primary target species for migratory passage in the Pawcatuck River. Adults of shad and river herring undertake upstream spawning migrations from May to July (depending on location). Juveniles migrate downstream during summer through fall.

The Wood-Pawcatuck Watershed Association (WPWA) has been engaged in brook trout habitat research in the Pawcatuck Watershed and has published several reports of findings relative to habitat conditions and stream temperature. WPWA scientists believe that brook trout was probably the most common native fish that were in the streams when the first colonists settled the area and remains an important species in the Pawcatuck River.

Habitat studies conducted in the Wood-Pawcatuck Watershed show that its local brook trout require a relatively cold water system, which involves canopy shading and sources

of ground water. They also require coarse sand or gravel substrate for successful reproduction. Relative to the continuity of low order streams in the Wood-Pawcatuck, where brook trout populations exist, small dams have essentially isolated the brook trout to localization in the upper reaches of the system (Saila, et. al 2004).

Sea run (salter) brook trout move from their freshwater habitat after reaching a size of about six inches. They remain in estuaries of the nearby sea and return to freshwater habitat to reproduce. Salter trout can reach sizes of several pounds, and they look very different from the freshwater trout. Their markings change to become more streamlined and their color a silvery green with no conspicuous colors or spots (Ryther 1999).

Three aspects of swimming speeds of fishes are relevant. They are:

- Cruising speed – the speed that can be maintained for hours.
- Sustained speed – the speed that can be maintained for minutes (200 minutes max).
- Burst speed – a single effort, not sustainable for more than five to 20 seconds.

Estimates of speed for brook trout and American shad are presented in Table 3-1.

**Table 3-1
Cruise, Sustained, and Burst Swimming Speeds for Brook Trout and Shad**

| <i>Speed Class</i> | <i>Swimming Speed (feet per second)</i> | |
|--------------------|---|----------------------|
| | <i>Brook Trout</i> | <i>American Shad</i> |
| Cruise Speed | 0 - 2 | 0 - 2.5 |
| Sustained Speed | 2 - 6 | 3 - 5 |
| Burst Speed | 6 - 13 | 5.5 - 14 |

Peake, et. al. (1997) provides a relatively recent evaluation of swimming performance of some salmonid fishes, including brook trout. They developed a multiple regression equation that estimates swimming speed based on fish size, water temperature and time. This equation can be applied in fishway design studies. Biologists at WPWA suggest a

maximum size of six inches for brook trout and also that passage facilities be designed to produce velocities well within the range of sustained swimming for the selected species.

It should be recognized that a Denil fishway and other fish passage structures such as the Alaska Steeppass fishway must be carefully engineered for width and depth relationships to provide the low velocity required in their design. Based on the information presented in Table 3-1, fish passage provisions capable of passing shad should also be capable of passing brook trout. A four-foot wide Denil fish ladder at a slope of 12.5% (1V:8H) is adequate to pass shad and larger brook trout (Alex Haro, personal communication). To optimize the passage of smaller brook trout, the slope of a traditional Denil fish ladder could be reduced. However, the best provision for fish passage that would provide optimal conditions for the widest range of species is full dam removal, where feasible.

Diadromous and freshwater fishes, listed in Vol. 2 of *The Biota of Rhode Island* include the following species, each of which may potentially benefit from the projected improvement in fish passage:

| | |
|------------------------|-------------------------------|
| Sea lamprey | <i>Petromyzon marinus</i> |
| Atlantic sturgeon | <i>Acipenser oxyrinchus</i> |
| American eel | <i>Anguilla rostrata</i> |
| Blueback herring | <i>Alosa aestivalis</i> |
| Hickory shad | <i>Alosa mediocris</i> |
| Alewife | <i>Alosa pseudoharengus</i> |
| American shad | <i>Alosa sapidissima</i> |
| Rainbow smelt | <i>Osmerus mordax</i> |
| Rainbow trout | <i>Oncorhynchus mykiss</i> |
| Atlantic salmon | <i>Salmo salar</i> |
| Brown trout | <i>Salmo trutta</i> |
| Brook trout | <i>Salvelinus fontinalis</i> |
| Atlantic tomcod | <i>Microgadus tomcod</i> |
| Threespine stickleback | <i>Gasterosteus aculeatus</i> |
| Ninespine stickleback | <i>Pungitius pungitius</i> |
| White perch | <i>Morone americana</i> |

Available information regarding swimming speeds suggests that most of the above species would successfully utilize fish passage facilities considered appropriate for brook trout of a minimum size of six inches.

Additional discussion of specific target fish species follows.

American Shad – American shad are the largest endemic member of the true herring family. They historically spawned in the Pawcatuck River basin; however, the construction of many dams on the river has obstructed upstream migration for centuries. American shad spawn in deep riffle areas of larger streams and rivers during the spring from mid May to late June. Spawning typically occurs at temperatures between 14.0 and 21.0°C (Eakins 2004). The eggs are pelagic and float downriver for a few days before hatching. Juveniles begin feeding and move slowly downriver as the fall progresses and may spend the winter in the estuary or in the ocean.

Shad return to spawn after three to six years. American shad are strong swimmers. Studies suggest that 99% of female American shad between 14 and 21 inches in length would be able to travel a distance of 65 feet against linear flows of 1.6 fps (Alex Haro, personal communication). Studies also suggested that the swimming performance for American shad is sex-specific. Male American shad typically exhibited better swimming performance over females of the same size.

River Herring – Alewives and blueback herring, collectively referred to as river herring, are common in Rhode Island and throughout New England. River herring are anadromous, meaning they spend most of their lives in the ocean, but return to fresh water to reproduce. Alewives, also known as graybacks, typically migrate first, followed by the bluebacks a few weeks later. Estimates of catch rates, spawning runs, and management goals are often grouped together due to the difficulty in distinguishing between the two species.

Alewife (*Alosa pseudoharengus*) – Alewife runs occur in many New England streams.

Alewife is an important commercial fish species on the Atlantic coast. Adults average 10 to 14 inches in length and weigh less than a pound. Although they can be caught on hook-and-line, the alewife is not a highly regarded game fish. Instead, people net it for use as bait in marine fisheries and, increasingly, as food fish. The alewife is an important forage species on which striped bass, bluefish, and other economically important fish prey.

Ideal alewife spawning habitat consists of lakes and ponds. The adult alewife spawning run occurs between April and June at water temperatures between 12.0° and 16.0°C. The juveniles descend the stream for the ocean during June through October of the same year. Adults travel at a cruising speed of 2.8 fps and can reach burst speeds of 6.8 fps. Alewife travel in schools and require a water depth of five inches or greater in order to travel (B. Kynard and other sources). The juveniles will return as adults in three to five years. Of the target species identified, alewives are the weakest swimmers. Laboratory studies suggest that only 67% of alewives between eight and 10 inches in length are able to travel a distance of 65 feet against linear flows of 1.6 fps (Alex Haro, personal communication).

Blueback Herring – Blueback herring are very similar in appearance to alewife. The blueback herring is not a highly regarded game fish. Instead, people net it for use as bait in marine fisheries and as food fish. The blueback herring is a very important forage species on which striped bass, bluefish, and other economically important fish prey.

Blueback herring begin their upstream migration from mid-May to June. Blueback herring spawn over hard substrates in areas with fast currents. Spawning typically occurs at temperatures above 14.0°C and ceases at temperatures above 27°C. Juvenile blueback herring migrate out to sea between September and November of the same year. Similar to alewife, they spend two to three years at sea before returning to their natal waters to spawn.

Adults travel at a cruising speed of 2.8 fps and can reach a burst speed of 6.8 fps. Blueback herring travel in schools and require a depth of five inches or greater in order to travel (B.

Kynard and other sources). Blueback herring appear to be stronger swimmers than alewife. Studies suggest that 83% to 95% of blueback herring between eight and 10 inches in length would be able to travel a distance of 65 feet against linear flows of 1.6 fps compared to only 67% for alewives under the same conditions (Alex Haro, personal communication). Swimming performance for blueback herring generally increases with fish length.

American Eel (Anguilla rostrata) – The American eel is a catadromous fish that spends its lifetime in rivers and migrates to the ocean to spawn. All adult American eels spawn in the Sargasso Sea located in the Atlantic Ocean, between the West Indies and the Azores. The larvae drift into the Gulf Stream where they mature into clear "glass eels" and then into elvers (immature eels) as they enter the estuaries and rivers during the winter months. Upstream migration occurs from May to October. American eel spend between eight and 25 years in freshwater rivers before migrating back to the Sargasso Sea during the winter, whereupon they spawn and die.

American eel adults reach a length of 30 inches. Adults descend Rhode Island rivers in the fall, and juveniles travel upstream in the spring. American eels travel at a cruising speed of 2.4 ft/s and can reach a burst speed of 6 to 7 ft/s. They are solitary travelers and travel near the bottom of the river.

Brook Trout (Salvelinus fontinalis) – Brook trout are distributed throughout small to medium sized streams in southern New England (Whitworth, 1996). Adults reach a length of 14 inches and travel upstream between April and July. Although the name commonly used for this fish is brook trout, it is actually a char (as opposed to a true trout, which is a salmo). It is more closely related to the lake trout and Arctic char than to brown trout or rainbow trout. Habitat destruction by dams, pollution, agricultural practices, and forestry are responsible for a significant decline in their local abundance.

Most brook trout found in Rhode Island streams are quite small, reaching a maximum of eight to 10 inches in length. However, some brook trout are diadromous, that is, they

spend several months in estuaries and then return to their home streams. These fish may grow to a relatively large size. They are commonly referred to as salters or sea run fish. While in the estuary, these trout change from a very colorful body to a very silvery-greenish color with no distinct pattern of markings. It is believed that salters were abundant prior to riverine habitat destruction, especially by the erection of dams that prevent successful return to freshwater breeding areas. Brook trout is not, relative to other salmonid species, either a strong swimmer or a good jumper.

4.0 HYDROLOGY AND HYDRAULIC ANALYSES

4.1 Introduction

Hydrologic and hydraulic analyses are important considerations in dam removal and fish passage projects. Hydrologic analyses are used to determine river flow rates, or discharge. River flow rates are used to predict water levels and velocities during fish migratory periods, to determine the potential for sediment migration, and to determine the hydraulic capacity of dams. As such, it is critical that the river conditions, including water surface elevations and flow velocities, are understood under a variety of flow rates.

In the case of the Pawcatuck River restoration, various structures are being considered for removal or alteration to accommodate fish passage and to improve stream habitat. In order to conduct a meaningful and multifaceted analysis, hydrology and hydraulics were evaluated for the Pawcatuck system under existing and proposed conditions. This assessment complements parallel evaluations of sediment and water quality, human infrastructure and investment, aesthetics, ecology and biology, and a host of other important factors.

4.2 Hydrology

The vast amount of wetland systems within the Pawcatuck River basin reduces flood peaks. USGS streamflow records collected in the vicinity indicate that annual peak flows can occur during any season of the year but occurs most frequently from December through April. Runoff from spring rains and snowmelt usually causes the highest peak flows to occur from March to April. High peaks can also occur during September and October due to runoff from tropical storms.

The Pawcatuck River basin is 317 square miles according to the Pawcatuck River Basin Plan (1978) and 303 square miles according to the Federal Emergency Management

Agency (FEMA) Flood Insurance Study (FIS) (1986). The discrepancy is likely due to differences in interpretation of drainage from the various wetland systems. The upper Pawcatuck River traverses a broad glacial outwash plain consisting of thick, sorted gravel, sand, silt, and clay deposits. Within the Village of Shannock, sloping upland and to a lesser extent wetland till soils are more prevalent. Bedrock outcrops become more frequent in this sloping topography. As a result of the existing topography and subsurface materials within the watershed, spring high flows are partially attenuated and summer flows are maintained.

The watershed contributing to the project area is rural in nature. Land use in the vicinity of the Lower Shannock Falls Dam is primarily residential. Near the Upper Shannock Horseshoe Falls Dam, land use is residential immediately adjacent to the dam, commercial toward the center of the Village of Shannock, and primarily rural and residential upstream. Land use is more industrial in nature in the immediate vicinity of the Kenyon Mill Dam in conjunction with Kenyon Industries and the sewage treatment lagoons. The greater surrounding area is residential.

Stream flows on the Pawcatuck River are measured at two USGS stream gauging stations (01117430 and 01117500). The former is located approximately 1,500 feet upstream of the Kenyon Mill Dam and the latter is located approximately 3.5 miles downstream of the Lower Shannock Falls Dam. Data from these gauges was analyzed to estimate flows, including the mean monthly April, May, June, and August flows, as well as the mean annual flow.

Additional hydrologic and hydraulic data for the Pawcatuck River is available in the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS). The 2006 FEMA FIS for the city of Charlestown provides flood flows for the 10-, 50-, and 100-year flow rates. A hydraulic model of the Pawcatuck River within the corporate limits was also completed by FEMA for the town of Charlestown in 1986. Additionally,

the Pawcatuck River was studied by approximate methods as part of the FIS for Richmond, Rhode Island.

The closest upstream tributary to the Kenyon Mill Dam is the Beaver River, whose junction with the Pawcatuck is approximately 1,900 feet upstream of the dam. According to the FEMA FIS, the Pawcatuck River watershed area above the confluence with the Beaver River is 79.8 square miles. The closest downstream tributary is Taney Brook, which joins the Pawcatuck River 4,500 feet downstream of the Lower Shannock Falls Dam. According to the FIS, the Pawcatuck River watershed area above the confluence with Taney Brook is 93.2 square miles. The FEMA peak discharges used in this study are those listed as above the confluence with Beaver River. FEMA peak flow rates are given in Table 4-1.

TABLE 4-1
FEMA Peak Flow Rates

| <i>Frequency (years)</i> | <i>Peak Flow (cfs)</i> |
|------------------------------|----------------------------|
| 10 | 850 |
| 50 | 1,200 |
| 100 | 1,350 |
| 500 | 1,850 |

Profiles of the project reach are located on Sheet 03P and 04P in the FEMA FIS. Lower Shannock Falls Dam is located at FEMA Cross Section T, Upper Shannock Horseshoe Falls Dam is located at FEMA Cross Section V, and Kenyon Mill Dam is located at FEMA Cross Section AA. In the model developed by MMI for the subject study, these cross sections correspond to River Station 529+40 at the Lower Shannock Falls Dam, 552+90 at the Upper Shannock Horseshoe Falls Dam, and 596+57 at the Kenyon Mill Dam. These locations are graphically depicted on plans contained in Appendix B.

Conditions during flood flows were analyzed to determine sediment stability and the potential for upstream flooding. Additionally, conditions during annual floods were

analyzed to assess channel forming conditions. A river channel constructed as part of a restoration project is typically designed to flood its banks every one to two years.

The FEMA study does not provide information on non-flood flow rates. Prediction of these flow rates is necessary to determine whether the designed channel is passable by fish under normal migration flows.

The flow rates encountered during upstream fish migration are those that occur during spring flow conditions. It is important that velocities and water depths are passable for fish under these conditions. These flows are approximated as the mean monthly April, May, and June flows.

Habitat quality is affected by water depths during low flow conditions. It is important that sufficient depths of flow are maintained during dryer times of the year such that fish populations are maintained. The mean monthly August flow is used for this analysis.

Flow data from the USGS gauging station #01117500 spans the years from 1942 to 2005; however, it is located downstream of the area of concern. Flow data from gauging station #01117430 is much more limited, including only the years 1957 to 1960 and the years 2002 to 2004. Five years of nonconsecutive data is not sufficient to accurately determine mean annual and monthly flows. Therefore, MMI determined the mean monthly flows by correlating downstream flow data (of which there is more available) with the desired location upstream of the Kenyon Dam.

Estimates for upstream flow values were calculated by mathematically comparing the ratios of measured flows to contributing drainage areas. By using the relationships $Q=A^n$ and the relationship $Q_1/Q_2 = (A_1/A_2)^n$, MMI was able to generate a regression equation according to the log of flow rate versus log of drainage basin area. The slope of this regression equation, n , was then used to accurately predict the mean monthly flows for

the desired months based on a ratio of watershed area. Flow rates of interest are presented in Table 4-2.

TABLE 4-2
Flow Rates Used in HEC-RAS Hydraulic Model

| <i>Flow Event</i> | <i>Flow Rate</i> |
|---------------------|------------------|
| Mean Monthly April | 273.3 cfs |
| Mean Monthly May | 186.6 cfs |
| Mean Monthly June | 140.2 cfs |
| Mean Monthly August | 64.9 cfs |
| Mean Annual Flood | 750 cfs |
| 100-Year Flood | 1,350 cfs |

4.3 Hydraulic Analysis

The Pawcatuck River has a low gradient, low velocity channel where changes in one dam could potentially affect water elevations and velocities at other dams or alter aquatic habitat between dams. A report on the Village of Shannock by the Richmond Historic Society (1977) states that raising the lower dam affected the water wheel operation at the upper dam. In order to assess the entire project site, MMI developed a continuous IIEC-RAS model that includes all three dams.

4.3.1 HEC-RAS Model Description

This section provides technical documentation of the HEC-RAS hydraulic model and, as such, specific technical terms are used. Effort has been made to clearly present model concepts. The reader is directed to the standard HEC-RAS reference manual, accessible at <http://www.hec.usace.army.mil/software/hecras/documents/hydrref/index.html> for further clarification.

The hydraulic analysis of the Pawcatuck River is based on the one-dimensional Hydraulic Engineering Center (HEC) River Analysis System (RAS) designed and maintained by the U.S. Army Corps of Engineers. The model is used to compute water surface profiles for

one-dimensional, steady-state, gradually varied flow. This system can accommodate a full network of channels, a dendritic system, or a single river reach. HEC-RAS is capable of modeling water surface profiles under subcritical, supercritical, and mixed-flow conditions. The precursor to HEC-RAS, HEC-2, was utilized in many older FIS studies.

The basic computation procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's Equation) and contraction/expansion (coefficient multiplies by the change in velocity head). The momentum equation is utilized in situations where the water surface profiles are rapidly varied. These situations include mixed flow regime calculations, hydraulics of dams and bridges, and evaluation of water surface profiles at river junctions.

4.3.2 Existing Conditions Modeling

The hydraulic computer of the Pawcatuck River begins downstream of the Lower Shannock Falls Dam, approximately 73 feet downstream of Townhouse Road/Route 112 and extends upstream to approximately 1,500 feet upstream of Biscuit City Road, nearly three-quarters of a mile upstream of the Kenyon Mill Dam. The upstream limit of the model is also the upstream limit of the FEMA hydraulic model.

Separate model runs were developed to forecast flow depths, velocities, and water surface profiles under existing conditions and for each proposed alternative. Output from these models were then used to assess sediment stability at the dams, resulting channel morphology, water depths in relation to fish passage, impact to upstream water levels, and ecological impacts given the predicted changes in water surface elevations.

The existing conditions HEC-RAS model of the Pawcatuck River has utilized data input from the FEMA Flood Insurance Study HEC-2 model completed in 1986 and was supplemented by new field survey conducted by MMI in 2006 and 2007. A graphical depiction of cross sections used for the project area is included in Appendix B. The

FEMA model included the Pawcatuck River within the corporate limits of Charlestown. An electronic copy of the HEC-2 data was not available; however, paper copies of the input data were obtained and manually input into the HEC-RAS model.

River stationing was synchronized to the stationing used in the FEMA FIS. Points representing the downstream face of each dam were taken at the point where a line connecting the headwall and the centerline of the river intersect. The river stationing at these points was set to correspond with FEMA stationing. Additional stationing data for MMI cross sections were derived from referencing these three points and interpolating along the river centerline between them.

After the initial input of the FEMA HEC-2 model data into HEC-RAS, additions and revisions were made to this outdated model based on supplemental survey as well as MMI field observations. Water surface profiles and velocities from the MMI existing conditions model were calculated and compared to the existing FEMA model. The results of this comparison can be found in Table 4-3.

The following modifications and refinements were made by MMI to the original FEMA HEC-2 model:

- The reach lengths between FEMA cross sections were adjusted to accommodate the addition of MMI surveyed cross sections.
- Two FEMA cross sections were removed from upstream and one cross section was removed from downstream of Shannock Road. Additionally, two FEMA cross sections were removed from upstream of the Lower Shannock Falls Dam. These were replaced with more accurate and detailed MMI surveyed cross sections.

- The portion of the Upper Shannock Horseshoe Falls Dam Raceway downstream of the stone wall outlet was simplified in the model to be a consistent shape with accurate invert elevations.
- The station of the FEMA cross section representing the Shannock Road crossing was adjusted to more accurately represent the distance between Shannock Road and Shannock Falls Dam. (FEMA gives this distance as 365 feet; MMI survey shows 425 feet.)
- The station of the upstream face of Shannock Falls Dam was adjusted to account for the width of the dam.
- Coefficients throughout the model such as Manning's roughness coefficient (n), and expansion/contraction coefficients were adjusted as necessary as the FEMA values did not appear to be reflective of the current channel conditions observed in the field.

A mixed flow analysis (that can calculate both subcritical and supercritical water surface profiles) was utilized. The velocity distribution was computed at cross sections. Both the downstream and upstream boundary conditions used the normal water surface elevation method. The mean monthly April, May, June, and August; the mean annual flood; and the 100-year flow events were modeled.

TABLE 4-3
Comparison of Model Predicted Water Surface Elevations (WSEL)
for the 100-Year Flow Event

| <i>Station</i> | <i>X-Sect.</i> | <i>Description</i> | <i>FEMA Existing Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>MMI Existing Conditions WSEL (feet, NGVD29)</i> | <i>Difference (feet)</i> |
|----------------|----------------|--|--|--|--------------------------|
| 526+26 | R | 20 feet upstream of Shannock Road | 62.2 | 62.05 | -0.15 |
| 528+66 | S | 68 feet downstream of Lower Shannock Falls Dam | 65 | 65.13 | 0.13 |
| 529+71 | T | 32 feet upstream of Lower Shannock Falls Dam | 72.8 | 71.63 | -1.17 |
| 547+04 | U | 32 feet upstream Shannock Road | 73.5 | 73.27 | -0.23 |
| 551+44 | V | downstream Shannock Road | 73.9 | 73.92 | 0.02 |
| 553+42 | W | 52 feet upstream Horseshoe Dam | 85.2 | 84.72 | -0.48 |
| 571+42 | X | 1,515 feet downstream of the Amtrak Railroad | 85.3 | 85.39 | 0.09 |
| 587+23 | Y | 1,007 feet downstream of the Sherman Avenue Bridge | 85.4 | 85.9 | 0.5 |
| 594+05 | Z | 117 feet upstream of the Sherman Avenue Bridge | 86.1 | 87.34 | 1.24 |
| 597+08 | AA | 43 feet upstream Kenyon Mill Dam | 88.8 | 88.85 | 0.05 |
| 611+68 | AB | 30 feet upstream of South County Trail | 89.3 | 89.4 | 0.1 |
| 633+83 | AC | 70 feet upstream of Biscuit City Road | 89.7 | 89.92 | 0.22 |
| 648+33 | AD | 1,520 feet upstream of Biscuit City Road | 90 | 90.15 | 0.15 |

For the most part, the two models (FEMA and MMI) are congruent, with water surface elevations in the MMI existing conditions model both slightly higher and lower than the FEMA model. The difference (at most cross sections in the 0.1 to 0.5 foot range) can be attributed to a combination of factors, including different boundary conditions and the application of coefficients.

The FEMA model used the downstream boundary condition at a starting water surface elevation of 54.81 feet NGVD29. The MMI model used the normal depth boundary method and specified boundary conditions at both the upstream and downstream. The slope used for the upstream boundary condition in the MMI model is 0.0006 feet per foot; a slope of 0.0004 feet per foot was used as the downstream FEMA boundary condition. The MMI existing conditions geometry also contains additional cross sections and a better representation of Manning's roughness coefficients throughout the river reach being modeled.

The over one foot difference in predicted water surface elevation at River Station 529+71, 32 feet upstream of the Lower Shannock Falls Dam, is likely due to the increased level of detail added to the model with the addition of the MMI surveyed cross sections. The FEMA model estimated the channel geometry in this location as a rectangular channel with straight sides and a flat bottom, with a consistent invert that is in some places higher than the existing invert. The actual channel bottom topography in this location shows variations of up to two feet. The simplification made by FEMA would cause the model to predict water surface elevations higher than would be expected.

The predicted water surface elevation at River Station 594+05, located 117 feet upstream of the Sherman Avenue Bridge and approximately 240 feet downstream of the Kenyon Mill Dam, is over one foot higher in the MMI model than that predicted by the FEMA model. Again, this is likely due to the level of detail added to the model with the addition of MMI cross sections in the immediate vicinity of the bridge. The FEMA channel in this location was approximated as a rectangular channel with a flat, 40-foot wide bottom. Based on MMI survey data, the actual channel geometry in this location is parabolic, with a bottom width of eight feet. The wider channel used in the FEMA model would cause water surface elevations to be computed erroneously low.

4.3.3 Proposed Conditions Model Runs

In order to assess the impact of the proposed dam modifications, hydraulic model runs were generated for a number of proposed alternatives to predict velocity and water surface elevation under proposed conditions. A description of the model results is described under the alternatives analysis in Sections 6.0, 7.0, and 8.0 of this document.

Prior to this analysis, MMI inspected the river with regard to its upstream and downstream morphology and plotted the original river bed profile through all three impoundments. Based on an analysis of anticipated flows and river morphology,

proposed conditions channel slope was calculated. MMI then developed proposed conditions cross sections and elevations. The previously described HEC-RAS model was revised with this geometry to determine water surface profiles and velocities under proposed conditions.

The water surface elevations calculated by the HEC-RAS model under differing alternatives were compared with the calculated existing water surface elevations to determine the potential impact on upstream water levels as well as to local ecology. The velocities and water depths calculated by the model under the different proposed alternatives were compared with the requirements of the target fish species.

5.0 OVERVIEW OF RESTORATION ALTERNATIVES

5.1 Overview of Fish Passage Restoration Alternatives

The following discussion provides general background relative to commonly applied fish passage restoration measures, including fish ladders, full and partial dam removal, high gradient riffles, and bypass channels. More specific descriptions of the alternatives considered in depth are presented in Chapter 6.0 for the Lower Shannock Falls Dam, Chapter 7.0 for the Upper Shannock Horseshoe Falls Dam, and Chapter 8.0 for the Kenyon Mill Dam.

5.1.1 Fish Ladders

Fish ladders are structures designed to allow fish to migrate upstream of an existing dam. They are typically narrow "chutes" with baffles or steps that enable fish to ascend to the upstream side of a dam, into the upstream pool. Basic types of fish ladders include pool-weir, vertical slot, Denil, and Alaskan Steeppass. Aesthetically, fish ladders are not always attractive features and often stand out in the surrounding landscape, particularly those constructed of metal or concrete. Smaller fishways can be made more attractive by utilizing native materials in their design, and some fish ladders can be sculpted directly into the surrounding landscape.

The primary advantage of fish ladders is their low cost. Fish ladders are also a good option when dam removal is not possible or when the excavation of highly contaminated sediments behind a dam is cost prohibitive. However, fish ladders are limited by the fact that they provide passage only for fish that are strong swimmers and only for certain life stages of fish. Therefore, their success rate as compared to free flowing channels is significantly lower.

Fish ladders require regular maintenance to clean out debris and maintain the structural integrity of the ladder. The most intensive maintenance occurs during the upstream migration season, between late March or early April through mid-June. During that time period, the primary concern is to keep the fishway clean from debris that can block passage. This is typically conducted twice each week; however, depending on the site, it could be more or less frequent. Some fish ladders are inspected and cleaned on a daily basis. This regular maintenance is normally done manually. Access to the fish ladder is imperative.

Fish ladders do not provide stream habitat improvements. Accordingly, the impoundment and the river corridor upstream of a dam remain, often with limited habitat for plant and animal species. Finally, the construction of a fish ladder implies that the dam will be left in place. Therefore, dam maintenance and safety are ongoing considerations as well.

5.1.2 Dam Removal

To wholly restore a stream to its natural condition, full dam removal is generally the most desirable approach. The benefits associated with this alternative include the restoration of fish migratory runs and aquatic habitat, improved conditions for sediment transport and natural flow regimes, elimination of debris that typically accumulates in impoundments, increased public safety, and the provision of recreational boat passage. Dam removal also eliminates maintenance of the structure.

In certain situations, dam removal may not be feasible due to the possibility of undermining upstream structures or negatively altering water surface elevations. In the case of flood control dams, downstream flooding can be a concern. Additionally, the capacity of the downstream structures and the quality of the downstream habitat can be diminished if significant volumes of sediment are released and deposited downstream during the dam removal process.

5.1.3 Partial Dam Removal

Where full dam removal is not possible or necessary, partial dam removal can be a viable option. Partial dam removal can occur in the vertical or horizontal direction. Partial *horizontal* removal is accomplished by breaching the dam along a portion of its length. In many instances, the natural river geomorphology is such that the restored river channel is much narrower than the full width of the dam, thus a partial horizontal removal is sufficient.

Partial *vertical* dam removal is achieved by lowering the dam crest. This approach might be desirable in combination with a downstream high gradient riffle or a fish ladder.

Partial vertical dam removal can provide a means of upstream sediment management to minimize the amount of sediment excavation that must occur. Lowering a dam is often accomplished in combination with fish passage mechanisms, such as a high gradient riffle, bypass channel, or fish ladder to provide fish passage.

Partial removal is not feasible if the remaining portion of the dam structure is unstable since removing a portion of the dam could cause a failure of the entire structure. This alternative is often less costly than full dam removal and can provide many of the same benefits. It may not, however, entirely restore the river to its natural geometry, flow regime, or sediment transport mechanisms. The remaining portion of the dam can be unsightly and may collect debris and backwater flood flows. It is important to determine the velocities through a partially breached dam under a variety of flow conditions to ensure the breach is large enough to prevent a velocity barrier to fish passage and/or recreational boating.

5.1.4 High Gradient Riffles

High gradient riffles are long, gradually sloping constructed riffles that make use of large roughness elements to establish adequate flow velocities that allow fish passage.

Construction of a high gradient riffle typically takes place at the face of an existing dam

and extends in the downstream direction, but they can be placed in other locations as well. They are used where a dam cannot be removed due to pool usage, sediment retention, flood control, at historic sites, and for a variety of other reasons. Typically constructed of various sized rocks and logs, these structures are designed to mimic natural stream riffles. They can extend across the entire length of a dam or can be limited to just a portion of the dam's length. Several types of high gradient riffles can be utilized, depending upon the method used to retard flow velocities and achieve fish passage, including random boulders, step pools, and protruding fixed obstacles.

5.1.5 Bypass Channels

Bypass channels are used to divert a portion of a river's flow around a dam that is to remain in place. Objectives associated with the implementation of a bypass channel include: (1) the creation of a seminatural channel that fish will use for upstream and downstream passage, (2) habitat that fish will use during the nonmigratory season, and (3) a natural, aesthetically pleasing area for people. In some cases, historically constructed channels, such as mill races, can be used as bypass channels.

One of the advantages of bypass channels is that they can be designed to emulate natural tributaries of the specific river where fish passage is being restored. In comparison to other fish passage structures, these natural looking channels often have lower construction costs and are easier to maintain. They can be aesthetically integrated into the landscape, providing passage for a wide variety of fish species. Additionally, they can increase the quantity of riverine habitat available for aquatic species. Large bypass channels can be designed for recreational boat passage as well, if enough water flow and depth is available.

For successful fish passage, bypass channels must be designed to convey sufficient water to attract fish into their entrance at the downstream end. Additionally, they have to be designed at an adequate width and depth to hold fish in resting areas. Experience has shown that the desired flow capacity of bypass channels is in the range of five to 10

percent or greater of the river's discharge during the migratory season, such that it provides attraction and conveyance. It is important to note that, unlike fish ladders, bypass channels are not limited to passage of a particular species.

5.2 Summary of Restoration Alternatives Considered

Various fish passage restoration measures were evaluated for their applicability at each dam. Restoration alternatives evaluated for the three dams are listed in Table 5-1. Conceptual design drawings for select alternatives are included in Appendix C, showing plan and profile views. They include the construction of fish ladders, dam removal, high gradient riffles, and bypass channels. Alternatives are discussed for each specific dam in Sections 6.0, 7.0, and 8.0 of this document.

TABLE 5-1
Summary of Alternatives Considered

| <i>Alternative</i> | <i>Description</i> |
|---|--|
| <i>Lower Shannock Falls Dam</i> | |
| S-1 | No Action |
| S-2 | Fish Ladder on Right Bank |
| S-3 | Full Dam Removal |
| S-4 | Bypass Channel Through Right Raceway |
| <i>Upper Shannock Horseshoe Falls Dam</i> | |
| H-1 | No Action |
| H-2a | High Gradient Riffles at Right Raceway |
| H-2b | Fish Ladders at Raceway |
| H-3 | Fish Ladder at Left Abutment |
| <i>Kenyon Mill Dam</i> | |
| K-1 | No Action |
| K-2 | Fish Ladder on Right Bank |
| K-3 | Bypass Channel Through Existing Breach |
| K-4 | Full Dam Removal |
| K-5 | High Gradient Riffle |

6.0 LOWER SHANNOCK FALLS DAM

6.1 Site Description



Shannock Mill Pond Dam, looking southwest from right bank

The Lower Shannock Falls Dam is the first of three dams within the project area. This dam is on file with the RIDEM, referenced as Dam ID #250, Shannock Mill Pond Dam. According to the RIDEM Active Inventory of February 2007, the dam is listed as having a low historical hazard classification and a low proposed hazard classification. Table 6-

1 provides baseline information on this dam. This timber and stone masonry structure is two to three feet high on the upstream side. The vertical difference between the crest (69.4 feet NGVD29) and the downstream channel invert is four feet. The total length of the dam is 133 feet.

**TABLE 6-1
Lower Shannock Falls Dam – Data Summary**

| | |
|-----------------------|---|
| Length | 133 Feet |
| Hydraulic Height | 4-5 Feet (under normal flow conditions) |
| Structural Height | ±8 Feet |
| Type | Run-of-River |
| Material | Stone masonry with timber cap over bedrock |
| Foundation | Rock / Bedrock |
| Sediment Accumulation | Little Sediment in Pool |
| Age | Mill in operation in 1828; part of operations for Columbia Narrow Fabrics Co. |
| Comments | Dam is in poor condition |

The Lower Shannock Falls Dam is a low-head run-of-river stone masonry dam with a rotting timber leveling cap. The dam appears to have been built atop existing native rock. Original plan sketches from 1892 on file with RIDEM indicate that the stone masonry dam structure was built 8.5 feet high above the downstream channel invert. Plans

sketches from 1940, also on file with RIDEM, indicate an eight-inch by eight-inch timber cap log topped by two-inch by 12-inch flashboards. The dam height from the downstream channel invert to the top of the timber cap log is given as seven feet on these plans. Both plans indicate that a triangular wedge of fill was placed behind the dam, extending approximately 10 feet upstream.

The Lower Shannock Falls Dam is in poor physical condition. The stone masonry face of the dam shows evidence of severe leakage and deterioration. Mortar is missing between the stone masonry, and a number of stones are missing. Water flows freely through the face of the dam. The timber cap log that forms the crest of the dam is rotting and deteriorated. This cap log supports grassy vegetation during low flow, encouraging continued rotting of the structure. Without repair, the severe nature of these deficiencies could cause a catastrophic failure of the dam.

The former adjacent Knowles Mill was a textile manufacturing site. The mill building was removed in 2006 through a Community Block Grant Program. The site is now intended for public access and open space. The rock cascade (low falls) at this location is reported to have been a Native American fishing area and was the site of a battle between the Narragansett and Pequot Indians. It was common for Native Americans to fish at falls or cascades where fish passage was blocked. Fish would also congregate waiting for appropriate flows for passage upstream.



Left Raceway at the Shannock Mill Pond Dam

The left raceway at the Lower Shannock Falls Dam historically supported hydroelectric activity. A deteriorated gate structure exists at the head of the raceway. The gate structure is nonfunctioning; the raceway itself is not in use and supports stagnant water.

The raceway is constrained by concrete walls, leading to a brick building with a nonfunctioning turbine.



Right raceway at Shannock Mill Pond Dam looking upstream

The right raceway at the Lower Shannock Falls Dam historically supported mill activity. The head of the raceway is constrained by a stone masonry culvert with a deteriorated concrete cap. Exposed rebar is visible in the concrete cap and severe leakage is evident through the stone masonry walls. The raceway is steep with

fast flowing water and is separated from the main channel by a vegetated island. The raceway is constrained by sections of deteriorated stone walls associated with the former mill buildings.

Shannock Village Road is located approximately 430 feet downstream of the Lower Shannock Falls Dam. The bridge has a concrete deck with two concrete piers.



Shannock Road, looking downstream from Shannock Mill Pond Dam

6.2 Restoration Alternatives

The following restoration alternatives were evaluated at the Lower Shannock Falls Dam:

- Alternative S-1 No Action
- Alternative S-2 Fish Ladder
- Alternative S-3 Full Dam Removal
- Alternative S-4 Bypass Channel

Each of these is described in detail in the ensuing narrative and are depicted graphically in plan and profile in appended plan sheet series "S." Sheet S-1 is an existing conditions plan for the Lower Shannock Falls Dam.

6.2.1 S-1 No Action

The No-Action alternative is graphically depicted in Figure 6-1. Under this alternative, no immediate action would be taken and the dam would be left in place. However, it is noted that the dam is deteriorating and would eventually fail without proper maintenance. A sudden failure would cause an uncontrolled release of impounded water, along with sudden channel morphological adjustments (i.e., loss of impoundment and return to channel). This alternative does not meet the basic project goals and objectives and is not pursued further.

6.2.2 S-2 Fish Ladder

Description of Alternative – Appended Sheets Alt S-2 (plan and profile) show this alternative in plan and profile views. A fish ladder at the Lower Shannock Falls Dam would need to extend approximately 40 feet downstream to overcome the four-plus feet of elevation difference between the downstream channel and the crest of the dam. A fish ladder could be placed on either the left or right bank, although construction access to the left bank would be more difficult. Under this alternative, the dam would be notched to elevation 68.4 feet NGVD29, providing 1.8 feet of flow under typical April flow conditions and 1.25 feet of flow under typical August conditions.

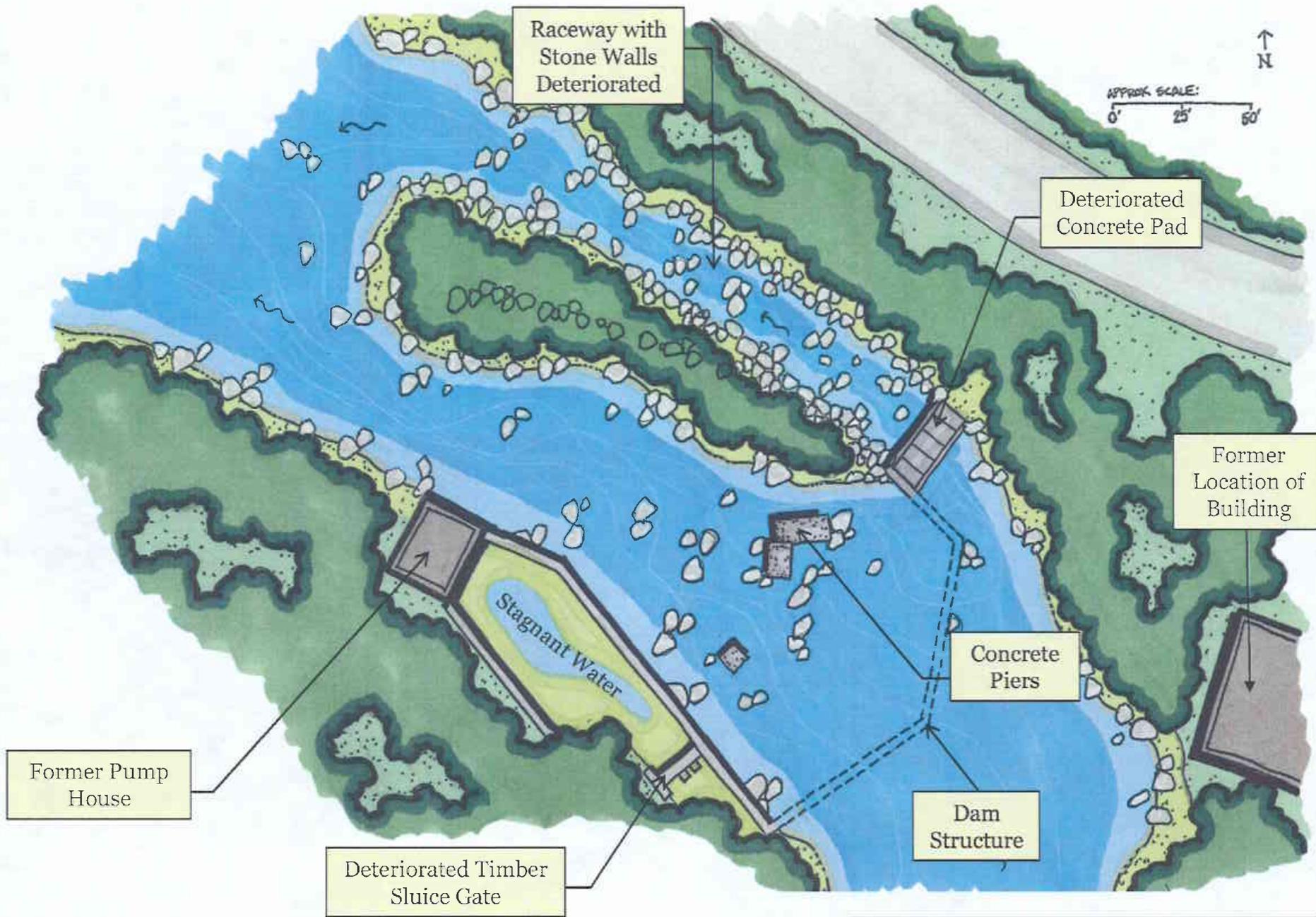


Figure 6-1
Alt. S-1 - Shannock Mill Pond Dam No Action

Ability to Meet Project Goals and Objectives - Fish ladders are often limited in their passage efficiency as compared to natural channel design. They need to be cleaned and maintained daily during fish migrations. Installation of a fish ladder would maintain the existing impoundment, which currently supports a scrub-shrub wetland. Sediment transport through the reach would remain unchanged as the dam and impoundment would remain in place. Likewise, flooding at the dam would not be impacted. It would be necessary to continue to maintain the structural integrity of the dam with a regular schedule of maintenance and repair. Initial repairs would be fairly extensive due to the degraded state of the structure.

Construction of a fish ladder is likely to have an impact on the historic mill raceway as well as potential impacts to archaeologically sensitive areas for 19th century mill remains on the right bank between the river channel and Railroad Street. No archaeological sensitivity is assigned in the river channel where the boulder diversion channel would be established because of previous scouring in the falls area and the documented presence of little sediment over rock/bedrock.

Preliminary Findings – While a fish ladder would provide a viable means for fish passage at the Lower Shannock Falls Dam, it would not provide for river continuity. Special attention would need to be given to the design of the fish ladder to maximize passage for species with different requirements, such as brook trout and shad. Extensive repairs and continued maintenance of the dam would be necessary. Stones would need to be replaced, and the downstream face of the dam would need to be remortared or capped in concrete or similar material. The timber leveling cap would also need to be replaced. Given the location of the fish ladder in proximity to the historic raceway, this alternative is likely to have a high degree of impact on historic resources.

6.2.3 S-3 Full Dam Removal

Description of Alternative – This alternative is graphically depicted in Figure 6-2, and on appended Sheets Alt S-3 (plan and profile). Removing the Lower Shannock Falls Dam would require removal of the existing stone masonry structure and timber crib as well as portions of the bedrock shelf on which the dam is built. Two large concrete piers located downstream of the dam would be removed as well. To provide fish passage at this location, the change in elevation between the existing bedrock shelf and the downstream channel invert would need to be addressed.

The potential exists to either excavate existing bedrock or to place material in the downstream channel. At an upper limit of 4%, fill material would need to extend approximately 100 feet downstream if the bedrock shelf were not removed. If the bedrock were to be excavated, the channel bottom in this location could be tied in the existing channel inverts upstream and downstream.

A channel slope of 4% has been known to successfully pass alewife and river herring in previously completed fish passage projects. A slope of 4% could limit the migration of brook trout based on navigable velocity under certain flow conditions. If the fill option were chosen, the slope of the channel would need to be optimized for successful migration of both diadromous and resident species. Lowering the slope of the channel would require excavation, and potentially blasting of bedrock, further upstream. The final selection of slope will require an analysis of cost versus benefit.

Under the bedrock shelf removal option, the dam would be removed and the channel excavated to elevation 62.7 feet NGVD29. The removal of approximately 125 cubic yards of material, composed of both sediment and bedrock, would be necessary. The relative percentages of existing sediment and bedrock would be determined during the design phase.

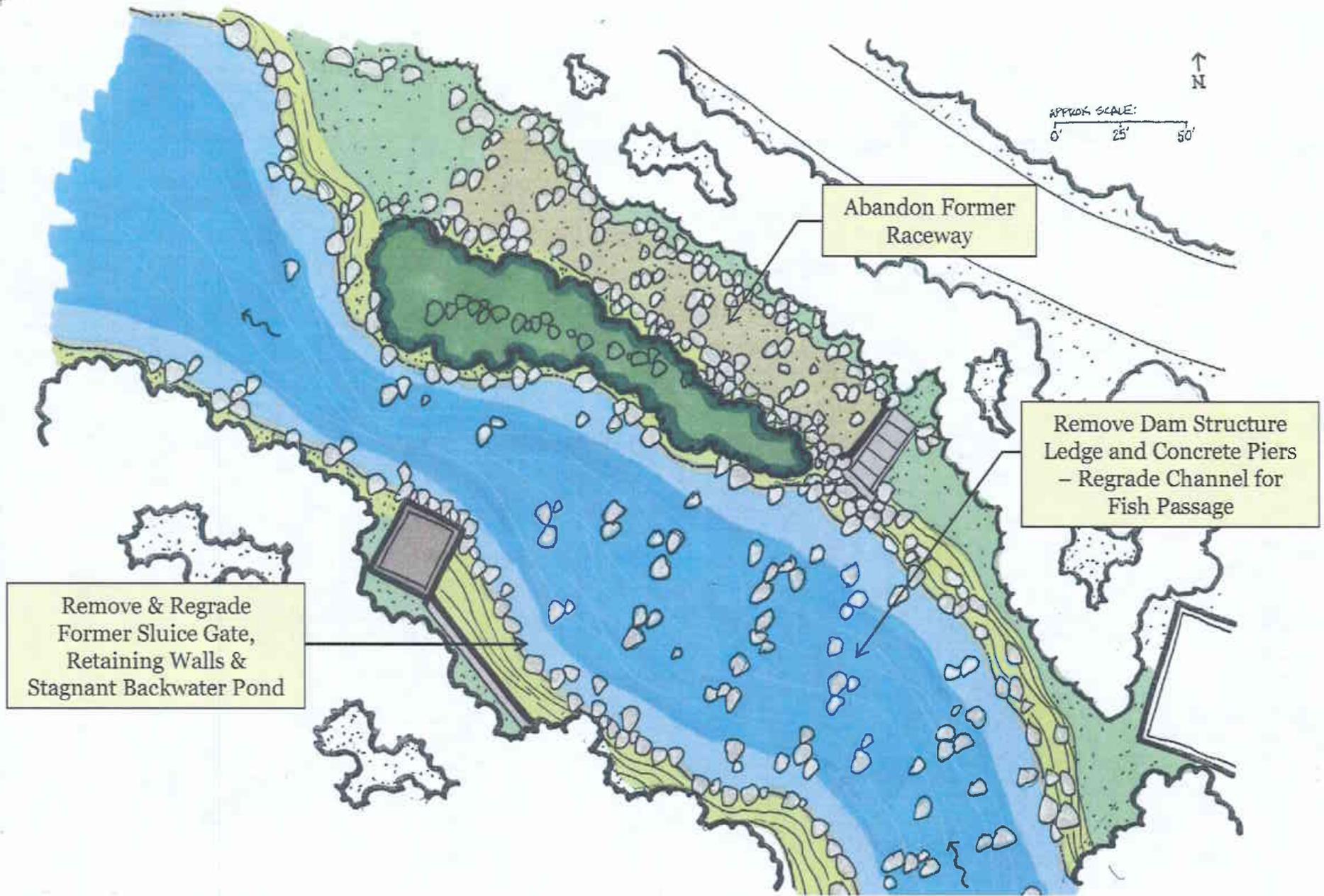


Figure 6-2
Alt. S-3 - Shannock Mill Pond Dam Full Dam Removal

In the vicinity of the dam, the channel would be graded at a 1.8 percent slope to tie into the existing channel invert elevation approximately 100 feet upstream, at elevation 64.4 feet NGVD29.

Ability to Meet Project Goals and Objectives - Removal of this dam would create a free-flowing channel through this reach. The impoundment, which is currently 90 to 110 feet wide, would not be maintained. After removal of the dam, the channel through this reach would be on the order of 30 to 45 feet wide. It is anticipated that the wetland fringe would encompass the newly exposed bank area, increasing the width of the wetland boundary in this location. It may be desirable to proactively plant this fringe to assist in the establishment of vegetation and to prevent the establishment of non-native and invasive plant species.

Sediment transport through the dam location would be restored to a natural condition. The majority of sediment accumulation was observed along the banks in this reach. As the channel would narrow under the full dam removal option, this sediment would remain in place under normal flow conditions. Sediment transport would resume its natural function after removal of the dam.

Habitat quality would be positively affected under this alternative. Impoundments are conducive to higher water temperatures due to increased residence times. Elevated temperatures, in conjunction with slow moving water, lead to decreased dissolved oxygen concentrations. Benthic species, such as insect nymphs, larvae and snails that are important food supplies to fish species, are negatively impacted by lower dissolved oxygen concentrations. Removal of the dam and establishment of free-flowing channel conditions would serve to cool the water, providing for higher concentrations of dissolved oxygen.

The backwater profile created by the Lower Shannock Falls Dam under existing conditions extends upstream to just downstream of Shannock Road. This means that

water surface elevations and flow regime are altered upstream due to the presence of the dam for a distance of nearly half a mile. Under the full dam removal alternative, water surface elevations would decrease through this distance. A comparison of existing and proposed water surface elevations for the April flow event for the full dam removal option is presented in Table 6-2.

TABLE 6-2
Comparison of Predicted Water Surface Elevations at Lower Shannock Falls Dam for the April Flow Event for Alt. S-3 Full Dam Removal

| <i>River Station</i> | <i>Description</i> | <i>Existing Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Proposed Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Difference (feet)</i> |
|----------------------|--|---|---|--------------------------|
| 529+05 | 19 feet downstream of Lower Shannock Falls Dam | 62.39 | 62.39 | 0.00 |
| 529+37 | 5 feet downstream of Lower Shannock Falls Dam | 63.8 | 63.50 | 0.30 |
| 529+41 | Crest of Lower Shannock Falls Dam | 70.20 | 62.77 | 7.43 |
| 529+73 | 32 feet upstream of Lower Shannock Falls Dam | 70.20 | 64.41 | 5.79 |
| 530+44 | 103 feet upstream of Lower Shannock Falls Dam | 70.20 | 65.15 | 5.05 |
| 552+17.48 | 1 foot downstream Shannock Road | 70.60 | 70.14 | 0.46 |
| 552+55.29 | 1 foot upstream of Shannock Road | 71.08 | 71.05 | 0.03 |
| 552+79 | 11 feet downstream of Horseshoe Dam | 73.70 | 73.69 | 0.01 |
| 552+84 | 6 feet downstream of Horseshoe Dam | 73.98 | 73.98 | 0.00 |

According to MMI surveyed cross sections, the Pawcatuck River appears to have a negative slope upstream of the Lower Shannock Falls Dam. As a result, the ponding effects of the dam propagate for some distance upstream as evidenced by existing conditions water surface elevations between cross sections 529+41 and 530+44, a distance of just over 100 feet.

The water surface elevation downstream of the dam is predicted to be slightly lower than it is under existing conditions. This is due to the proposed removal of the downstream concrete piers in conjunction with the removal of the dam. Under existing conditions, the presence of the concrete piers increases downstream water surface elevations.

The water surface elevation at the crest of the dam is predicted to be 7.43 feet lower than under existing conditions. The water surface elevation 100 feet upstream of the dam, at river station 530+44, is predicted to be over five feet lower than under existing conditions. By Shannock Road, approximately 2,000 feet upstream of the existing dam, predicted water surface elevations are less than half of a foot lower than under existing conditions. Upstream of Shannock Road, the difference between existing and proposed conditions water surface elevations are negligible.

Table 6-3 compares existing and proposed velocities for the project reach for the typical April flow regime. Channel velocities upstream of the dam are predicted to increase due to removal of the existing impoundment and restoration of a free-flowing channel condition. Velocity is predicted to increase by almost two feet per second downstream of Shannock Road; negligible velocity increases are predicted immediately upstream of Shannock Road.

TABLE 6-3
Comparison of Predicted Velocities at Lower Shannock Falls Dam
For the April Flow Event for Alt. S-3 Full Dam Removal

| <i>River Station</i> | <i>Description</i> | <i>Existing Conditions Velocity (feet per second)</i> | <i>Proposed Conditions Velocity (feet per second)</i> | <i>Difference (feet per second)</i> |
|----------------------|---|---|---|-------------------------------------|
| 529+05 | 19 feet downstream of Lower Shannock Falls Dm | 5.41 | 5.41 | 0.00 |
| 529+37 | 5 feet downstream of Lower Shannock Falls Dam | 4.65 | 5.99 | 1.34 |
| 529+41 | Crest of Lower Shannock Falls Dam | 0.72 | 1.42 | 0.7 |
| 529+73 | 32 feet upstream of Lower Shannock Falls Dam | 0.72 | 4.47 | 3.75 |
| 530+44 | 103 feet upstream of Lower Shannock Falls Dam | 0.78 | 6.10 | 5.32 |
| 552+17.48 | 1 foot downstream Shannock Road | 4.22 | 6.01 | 1.79 |
| 552+55.29 | 1 foot upstream of Shannock Road | 2.61 | 2.64 | 0.03 |
| 552+79 | 11 feet downstream of Horseshoe Dam | 4.31 | 4.31 | 0.00 |
| 552+84 | 6 feet downstream of Horseshoe Dam | 2.75 | 2.75 | 0.00 |

Predicted velocities are generally within the range of acceptable velocities for the target fish species (2.0 to 5.0 fps). In several areas, reduction of water surface elevations will expose rapids. Where present, high velocity zones can be reduced through the placement

of instream structures such as j-vanes and rock vortex weirs or preferably, removal in bedrock in these areas.

Lower Shannock Falls dam is a run-of-river structure and provides no flood protection. Its removal would eliminate an existing obstruction that results in the impoundment of water behind the dam. It would also eliminate the potential public safety hazard associated with a deteriorating dam.

An initial capital investment would be required to remove the dam and complete the associated channel improvements. However, long-term maintenance and repair of this decaying structure would no longer be necessary, saving time and labor in the long run.

The next upstream bridge is located at Shannock Road. Water surface elevations at this bridge are predicted to drop by approximately 0.03 to 0.46 feet upstream and downstream of the bridge, respectively. Predicted increases in velocity just downstream of the bridge are under two feet per second. This alternative would require further attention at this location to ensure that the bridge is appropriately protected from scour.

Based on the historic assessment conducted by PAL, this alternative will impact potentially eligible historic structures as well as archaeologically sensitive areas for Native American resource areas (fishing, habitation) and 19th century mill remains along both shorelines and in the river channel upstream of the dam where buried shorelines might be present. Accordingly, additional historical documentation would likely be required prior to any structural modifications. This documentation would include a full written history and description, detailed site mapping, and photographic recordation of the mill remains, water control structures, and dam spillways. In addition, further investigations via Phase I(c) archaeological surveys would need to be undertaken to locate and identify any significant belowground Native American and/or Euro-American cultural deposits.

Preliminary Findings - This alternative would provide full fish passage and river continuity. Natural erosion will also lead to long-term equilibrium of sediment transport in the system. The exposed banks could be replanted or allowed to naturally vegetate.

6.2.4 S-4 Bypass Channel Through Right Raceway

Description of Alternative – Flow to the right raceway currently passes through a concrete and stone masonry structure. The entrance provides the hydraulic control, limiting the amount of flow that enters the raceway. The tail end of the raceway, the last 35 feet before it rejoins the main channel, is at a slope of 12%. This section is characterized by fast moving, turbulent water under normal flow conditions, posing a barrier to fish passage. The remainder of the raceway is at an average slope of 7.5%.

To develop the right raceway as a bypass channel, it would be necessary to lessen the slope at the lower end of the raceway as well as to connect the channel invert at the head of the raceway to the upstream pool elevation in such a way as to create the velocities and flow depths necessary for fish passage during migration flows. The existing channel invert at the head of the raceway (66.5 feet NGVD29) is just below the elevation of the upstream impoundment invert (66.7 feet NGVD29). For an approximate flow depth of 1.5 feet during April flows, the upstream invert would need to be 68.7 feet NGVD29, creating a bypass channel slope of almost 9%.

Due to the upstream and downstream invert elevations, it is not possible to create fish passable slopes in the right raceway channel. Accordingly, this option was not explored further.

6.2.5 Summary of Alternatives at Lower Shannock Falls Dam

Table 6-4 summarizes the alternatives for the Lower Shannock Falls Dam.

**TABLE 6-4
Summary of Alternatives at Lower Shannock Falls Dam**

| <i>Alternative</i> | <i>Description</i> | <i>Achieves Fish Passage?</i> | <i>Improves Habitat Conditions?</i> | <i>Minimizes Long Term Dam Maintenance?</i> | <i>Potential for Impact to Historic Resources?</i> | <i>Prudent and Feasible Alternative?</i> |
|--------------------|--------------------|-------------------------------|-------------------------------------|---|--|--|
| S-1 | No Action | No | No | No | No | No |
| S-2 | Fish Ladder | Yes | No | No | Yes | Maybe |
| S-3 | Full Dam Removal | Yes | Yes | Yes | Yes | Yes |
| S-4 | Bypass Channel | No | No | No | Yes | No |

7.0 UPPER SHANNOCK HORSESHOE FALLS DAM

7.1 Site Description

Approximately one-half mile upstream of the Lower Shannock Falls Dam is the Upper Shannock Horseshoe Falls Dam. This unique dam has a horseshoe shaped spillway with conventional concrete nonoverflow segments. It is approximately 120 feet long and 12 feet high. The dam has significant cracks and seepage, with limited hydraulic capacity. Table 7-1 presents baseline information relative to this dam structure.



Upper Shannock Horseshoe Falls Dam spillway with rock ledge in foreground

**TABLE 7-1
Upper Shannock Horseshoe Falls Dam – Data Summary**

| | |
|-----------------------|--|
| Length | 120 Feet (Spillway: 97 feet) |
| Hydraulic Height | ±9 Feet |
| Structural Height | ±12 Feet |
| Type | Run-of-the-River |
| Material | Concrete and stone masonry with timber and steel flashboards |
| Foundation | Rock / Bedrock |
| Sediment Accumulation | N/A |
| Age | Two mills on site as early as 1771; first horseshoe dam structure built in early 1800s |
| Comments | Historic Context; built on vertical face of bedrock outcrop |

According to RIDEM files for dam #249, listed as the Horseshoe Falls Dam, the face of the dam spillway is comprised of four courses of cut and uncut mortared granite. The granite is capped by formed and poured concrete topped by wood and steel flashboards.



Leakage through left abutment at Upper Shannock Horseshoe Falls Dam

According to the 1984 RIDEM dam inspection report for the Upper Shannock Horseshoe Falls Dam, the structure was significantly repaired in 1945. At that time, the entire bank of gravel on the pond side of the dam was encased in six inches of concrete to stop seepage through the gravel.

Additional concrete was placed behind the retaining walls to stop leaks through the face of the dam. This same inspection report listed the dam in fair to good condition. According to the February 2007 RIDEM Active Inventory, the dam is listed as having a low historic hazard and a significant proposed hazard classification.

In its current condition, leakage occurs through the face and training walls of this dam. Stones and mortar are missing through the downstream face, causing gaps through which seepage and leakage occurs. Significant leakage was evident at the joint between the U-shaped dam and its left abutment.

The bridge over the downstream channel is a 1974 single span structure with prestressed concrete beams and vertical abutments. The upstream face of this bridge is located 32 feet downstream of the dam abutments.

A 1.25-inch plastic water line runs behind the dam from the left abutment. This line is held in place with concrete blocks. It serves two apartments on the right bank. The water line can be accessed via a manhole on the left abutment. It is part of the Shannock Village Water District system. The wells for this

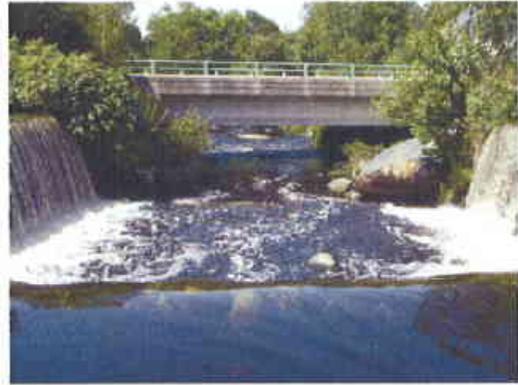


Left abutment at the Horseshoe Dam, with water line access manhole in foreground, and private residence in background

system are located off North Road, piping for this system runs through the village, and terminates at the post office on the western end of the village.



Head of right raceway at Horseshoe Dam, looking upstream



Shannock Road bridge, downstream of Horseshoe Falls Dam

The right abutment of the Upper Shannock Horseshoe Falls Dam has a historic "carpenter shop" and a private residence. These two buildings sit on either side of the historic raceway. The raceway is supported at its upstream end and separated from the main channel by timber logs, with a total of four feet of vertical rise. The stop logs are rotting and deteriorated. Significant seepage was evident through these logs, which supports the flow in the channel.

In the vicinity of the private residence, stone masonry and concrete walls constrain the channel and are integral to base structure of both the private residence and the garage. The stone masonry wall connects to the foundation of the residence. This wall has been repaired with surface concrete and plaster. Stones are missing from this wall, and significant leakage occurs from upstream through the wall in to the channel. A poured concrete wall forms the foundation for the garage building.

Further downstream, the channel is constrained by a low stone masonry wall on the right bank and a taller stone masonry wall on the left bank. Flow exits the raceway channel through an outlet in the left bank wall, 120 feet downstream of the timber logs. Average channel width is 15 feet. Channel substrate is primarily gravel and cobble.

A railroad bridge is located almost 600 feet downstream of the Upper Shannock Horseshoe Falls Dam. This bridge is a steel I-beam structure with a concrete deck.

7.2 Restoration Alternatives

The Upper Shannock Horseshoe Falls Dam is presently listed as a contributing element of the Shannock Village Historic District, listed on the State and National Registers of Historic Places. The dam is a unique and beautiful structure that is endeared by Shannock Village residents. The dam is built on a bedrock shelf that would require extensive excavation to make fish passage at this location feasible. For this reason, the full dam removal alternative was not pursued. The following restoration alternatives were evaluated at the Upper Shannock Horseshoe Falls Dam:

- Alternative H-1 No Action
- Alternative H-2 Fish Ladders/Bypass Channel or High Gradient Riffle
- Alternative H-3 Fish Ladder – Left Abutment

Each of these alternatives is described in detail in the ensuing narrative and are depicted graphically in plan and profile in appended plan sheet series "H."

7.2.1 H-1 No Action

Description of Alternative – Under this alternative, the Upper Shannock Horseshoe Falls Dam would remain in place and no restoration action would be taken. The dam would need to be repaired to maintain structural integrity and to meet dam safety requirements. Figure 7-1 depicts the No Action alternative.

Ability to Meet Project Goals and Objectives – This alternative does not meet the goals and objectives of this project. The Upper Shannock Horseshoe Falls Dam is a run-of-the-

river structure and, therefore, it provides no flood protection nor would it in the future. This structure is in need of rehabilitation and, if left alone, will become a public safety hazard.

Preliminary Findings – While this alternative is feasible (providing that private funds are put in place to maintain the Upper Shannock Horseshoe Falls Dam for public safety), it does not meet the basic goals and objectives of the project. As such, it is not a prudent alternative and no further consideration has been given to it.

7.2.2 H-2 Bypass Channel Through Right Raceway

Two alternatives were considered for use of the right raceway as a bypass channel. These include the installation of fish ladders at the upstream and downstream ends of the raceway and the installation of high gradient riffles at the upstream and downstream ends of the raceway.

H-2a Fish Ladders / Bypass Channel

Description of Alternative – This alternative is graphically depicted in plan and profile views on appended Sheets Alt. H-2 (plan and profile) and in Figure 7-2. Under this option, traditional Denil type fish ladders would be used to overcome the vertical difference between the main channel of the Pawcatuck River and the raceway at the upstream and downstream ends.

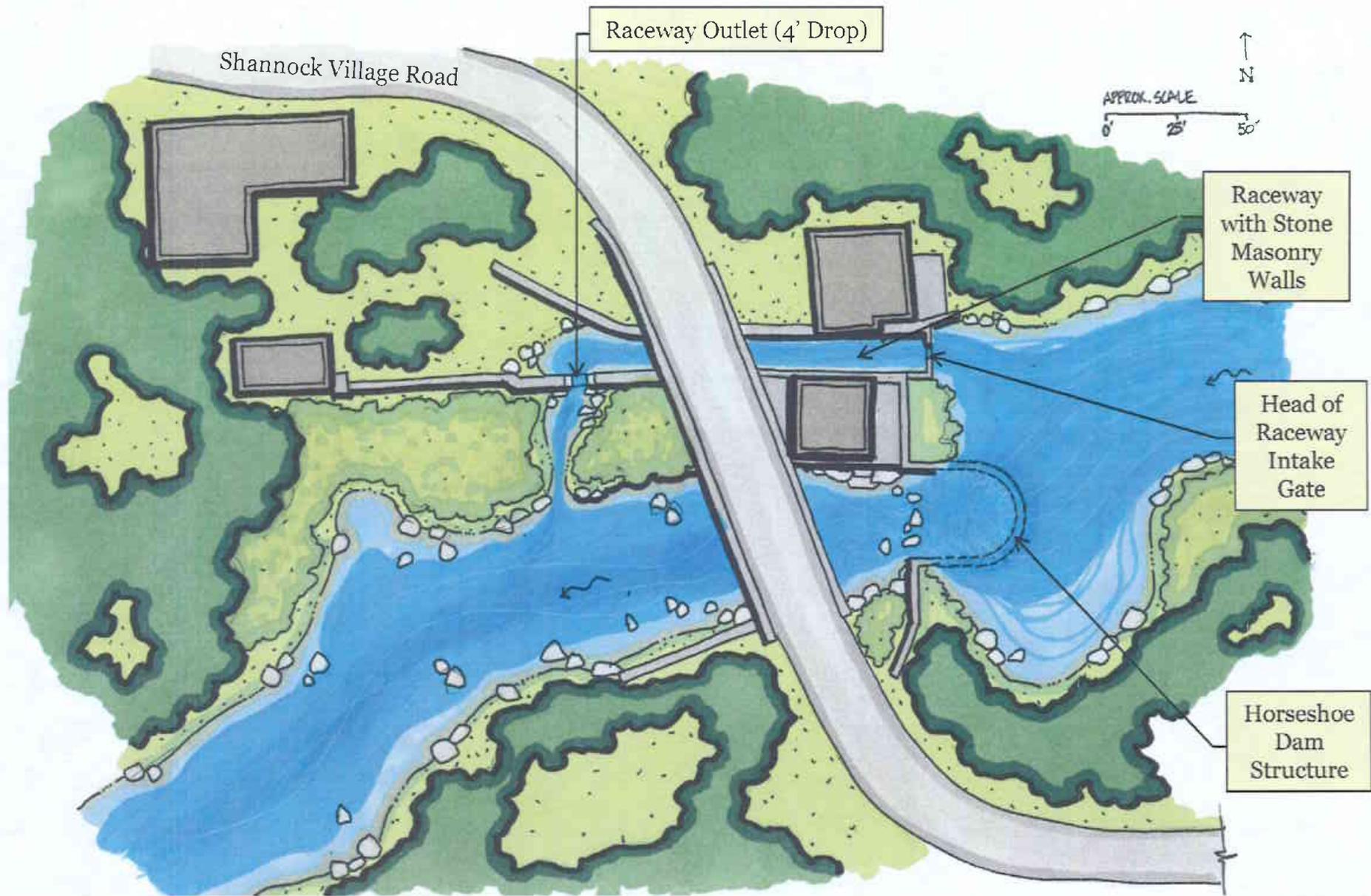


Figure 7-1
Alt. H-1 - Horseshoe Dam No Action

A: FISH LADDERS / BYPASS CHANNEL

APPROX. SCALE
0' 25' 50'

N

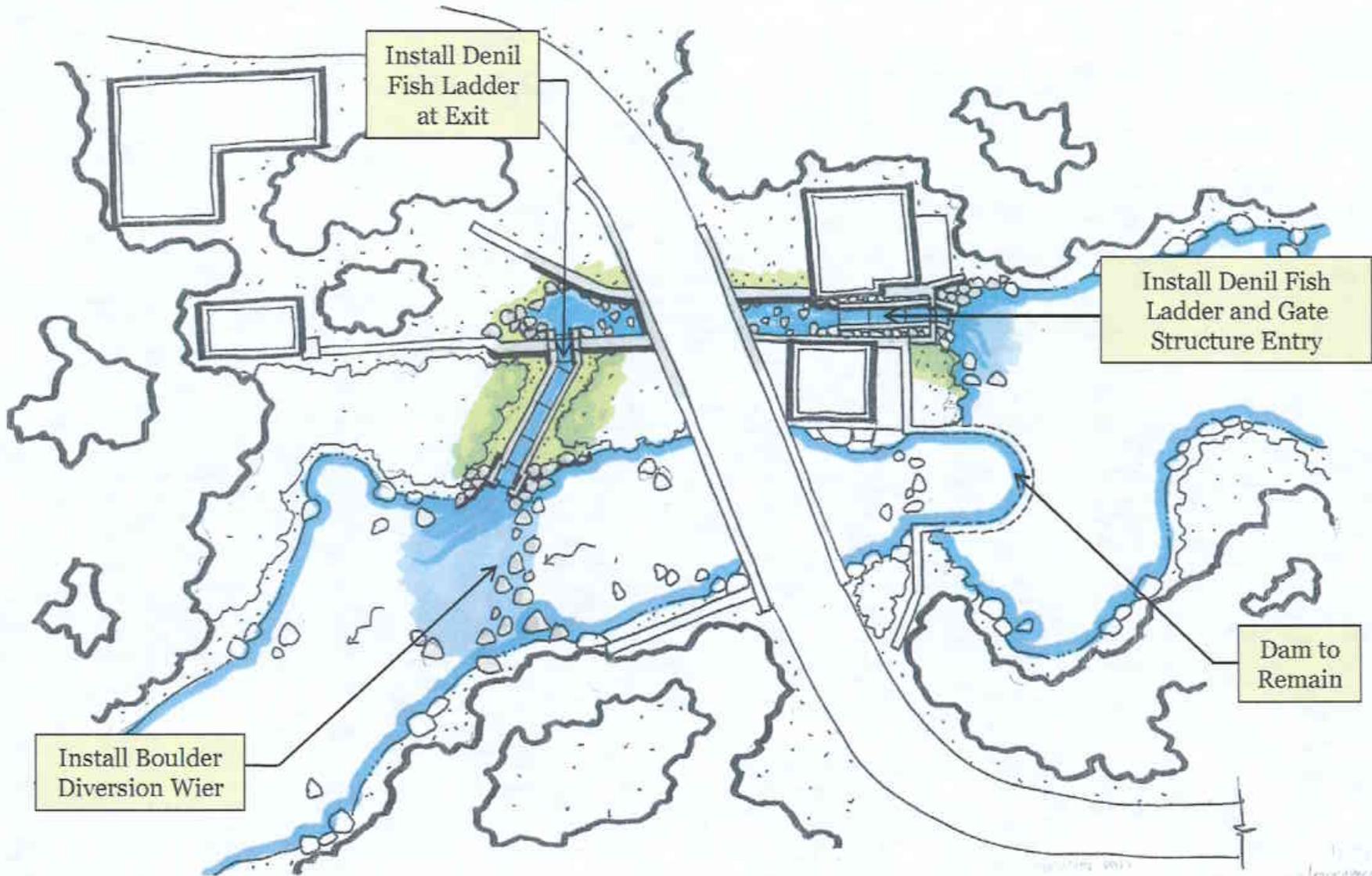


Figure 7-2
Alt. H-2 - Horseshoe Dam Fish Ladders Through Right Raceway

At the upstream end, the existing timber logs would be notched to elevation 81.3 feet NGVD29, providing 1.5 feet of flow during the April flow event and 0.9 feet of flow during the typical August event, according to existing conditions HEC-RAS modeling. The ladder would extend approximately 25 feet downstream of the existing timber logs, with an entrance pool at the downstream end, and a total vertical rise of four feet. Under this alternative, the rotting timber logs at the head of the raceway would need to be replaced with a sound structure.

At the downstream end, a fish ladder would extend from the outlet through the stone masonry wall, approximately 40 feet in to the main channel of the Pawcatuck River, with a total vertical rise of six feet. The existing outlet through the wall would be notched to elevation 75.0 feet NGVD29. Flow depths at the base of the fish ladder would be one foot deep during the typical April flow event, confirmed by HEC-RAS existing conditions modeling.

It would be necessary to place a boulder diversion weir within the main channel of the Pawcatuck River to divert migrating fish towards the bypass channel. The entrance at the base of the fish ladder to the bypass channel would be 150 feet downstream of the dam. Attraction flow may be an issue in that fish may simply not be persuaded to enter the bypass channel and may instead school at the base of the boulder diversion weir. Under this alternative, it would also be necessary to repair and maintain the dam structure.

Ability to Meet Project Goals and Objectives – Installation of fish ladders in the right raceway may provide a means for fish passage at the Upper Shannock Horseshoe Falls Dam; however, the distance of the entrance to the bypass channel diminishes the effectiveness of this option. This alternative would retain the historically significant and aesthetic dam structure, which may be seen as a positive benefit by many local residents.

Based on the historic assessment conducted by PAL, this alternative will impact potentially eligible historic structures as well as archaeologically sensitive areas. No

archeological sensitivity is assigned in the river channel where the boulder diversion weir would be established because of previous scouring in the falls area and the documented presence of little sediment over rock / bedrock.

Preliminary Findings – While fish ladders at the upstream and downstream ends of the existing raceway may provide a viable means of fish passage past the Upper Shannock Horseshoe Falls Dam, the location of the entry pool is a significant distance from the dam and may be confusing to fish, diminishing the effectiveness of the ladder. Additionally, access to this corridor would be very difficult, given the grades and location of surrounding historic buildings and structures.

H-2b High Gradient Riffles / Bypass Channel

Description of Alternative – The upstream end of the Upper Shannock Horseshoe Falls Dam raceway is separated from the main channel by a timber crib structure. The channel invert immediately downstream in the raceway channel is 8.5 feet below the crest of the timber logs and approximately one-half foot below the upstream pool invert. To maintain the pool at the dam, the invert of a high gradient riffle would need to be located just below the elevation of the dam crest, 82.7 feet NGVD29, for a total vertical rise of four feet. At a maximum slope of 4%, a high gradient riffle at the upstream end of the raceway channel would need to extend 100 feet, nearly the entire length of the raceway channel.

At the downstream end, the channel spills through the stone masonry wall. The original function of this wall in conjunction with the mill works was to support the mill pond. Weirboards were placed in the outlet to back water up into the mill pond area, and then water from the mill pond was used to power the mill works. There are no weirboards present at this time. Water currently exits the raceway channel directly through the outlet in the wall, at elevation 75.5 feet NGVD29 and plummets 8.5 feet to the channel below at elevation 67.0 feet NGVD29. The outlet channel flows approximately 55 feet before joining up with the main channel of the Pawcatuck River.

To overcome the six feet in elevation difference, at a maximum slope of 4%, a high gradient riffle at this location would need to be over 150 feet long. The riffle would require extensive infrastructure, including support and retaining walls as well as extensive amounts of fill. The riffle entrance would be over 250 feet downstream of the dam, such that attraction flow for fish may be a problem. Even if a boulder diversion weir were installed in the main channel at this location, fish may not be persuaded to enter the bypass channel.

Ability to Meet Project Goals and Objectives – While this alternative may provide fish passage past the Upper Shannock Horseshoe Falls Dam, the distance of the entrance to the bypass channel greatly diminishes the fish passage effectiveness of this option. Under this alternative, dam repair and maintenance would still be required to bring the dam to a safe structural condition.

Preliminary Findings – Due to the amount of fill required, the need for extensive infrastructure within the main channel of the Pawcatuck River, and the concern of attraction flow at a bypass channel entrance that would be located 250 feet downstream of the dam, this alternative is not believed to be prudent and, therefore, it was not considered further.

7.2.3 H-3 Fish Ladder at Left Abutment

Description of Alternative – Appended Sheets H-3 (plan and profile) and Figure 7-3 graphically depict this alternative. It consists of construction of a fish ladder at the left abutment of the Upper Shannock Horseshoe Falls Dam.

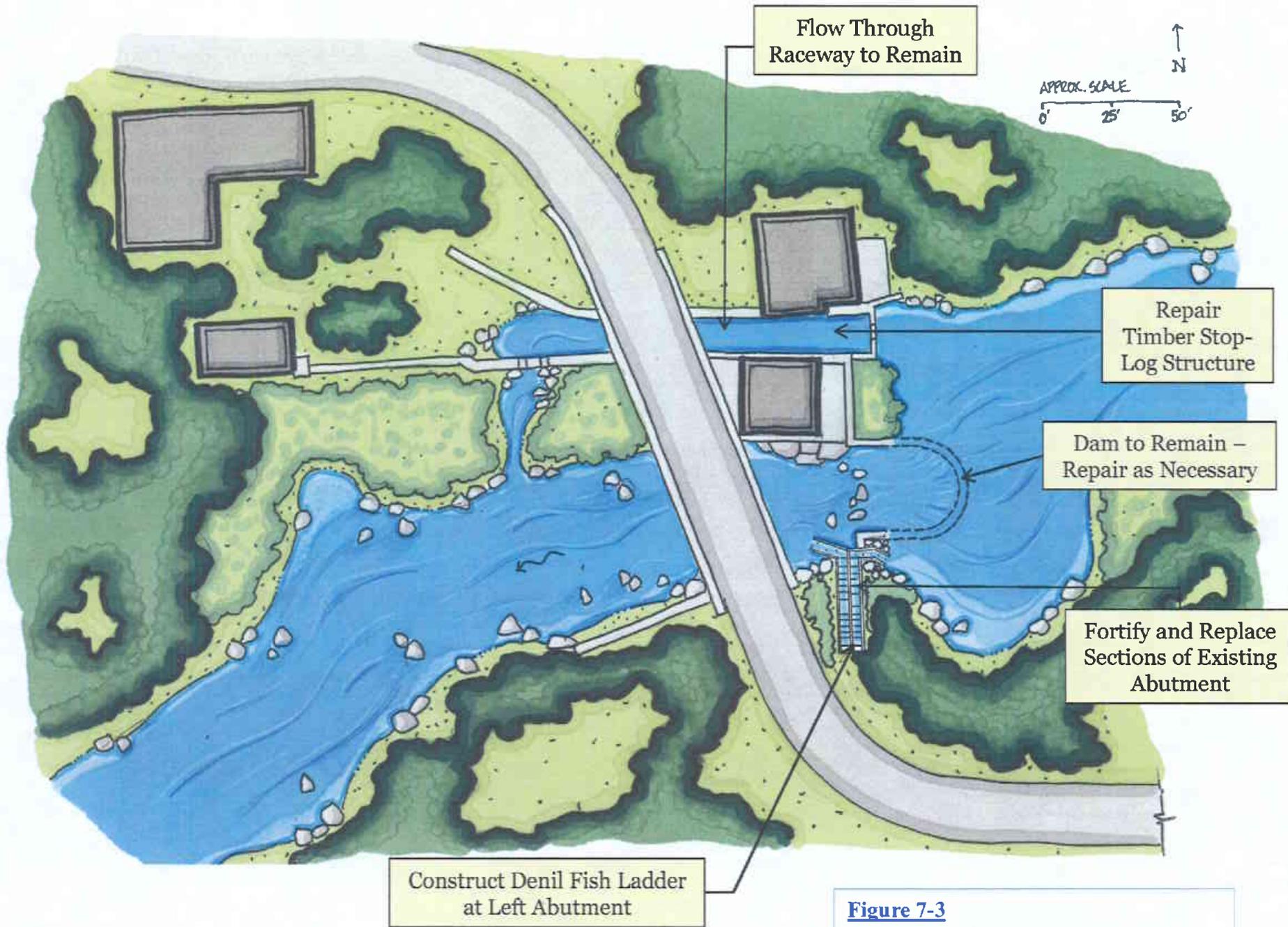


Figure 7-3
Alternate H-3 - Horseshoe Dam Fish Ladder at Left Abutment

This site is constrained by the Shannock Road Bridge, which is located just downstream of the dam. To fit a fish ladder of sufficient length to overcome the nine feet in elevation difference between the upstream pool and the downstream channel invert, a switchback configuration would be needed. Under this configuration, the exit pool would be located upstream of the left abutment. The fish ladder would extend approximately 20 feet to the face of the left abutment, where a 180° resting/turning pool would redirect flow to the right (east). Another 180° resting/turning pool would redirect flow back to the left (west), toward the channel.

Excavation of material from the left bank behind the left abutment would be necessary for placement of the fish ladder sections. In addition, repair and maintenance of the dam structure would be necessary. The fish ladder could be constructed, accessed, and maintained from the left bank. A boulder diversion weir would be required in the main channel to properly direct fish towards the ladder.

The entrance would be placed just downstream of the existing rock ledge across the main channel. This ledge could be utilized in conjunction with a boulder diversion weir and may, in fact, be sufficient to direct fish migration to the fish ladder. With the entrance located in such close proximity to the existing dam, fish would be more likely to choose to enter the fish ladder when unable to continue upstream. Water depth in the entrance pool is predicted by HEC-RAS modeling to be 1.8 feet for typical April flows and 1.2 feet for typical August flows.

Ability to Meet Project Goals and Objectives – A fish ladder at the left abutment would provide for fish passage past the Upper Shannock Horseshoe Falls Dam. Locating the entry pool close to the base of the dam would increase the likelihood that fish would utilize the fish ladder. Despite some of the shortcomings of fish ladders discussed previously, this alternative would provide fish passage while retaining the historic and aesthetic Upper Shannock Horseshoe Falls Dam structure. Access for construction, as well as regular maintenance of the fish ladder, can be accomplished from the left bank.

Based on the historic assessment conducted by PAL, this alternative will impact potentially eligible historic structures as well as archaeologically sensitive areas. Accordingly, additional historical documentation would likely be required prior to any structural modifications. This documentation would include a full written history and description, detailed site mapping, and photographic recordation of the mill remains, water control structures, and dam spillways. In addition, further investigations via Phase I(c) archaeological surveys would need to be undertaken to locate and identify any significant belowground cultural deposits. No archeological sensitivity is assigned in the river channel where the boulder diversion weir would be established because of previous scouring in the falls area and the documented presence of little sediment over rock / bedrock.

Preliminary Findings – A fish ladder at the left abutment would provide for fish passage past the Upper Shannock Horseshoe Falls Dam, while retaining the historic dam structure. This alternative appears to be feasible.

7.2.4 *Summary of Alternatives at the Upper Shannock Horseshoe Falls Dam*

Table 7-2 summarizes the alternatives for the Upper Shannock Horseshoe Falls Dam.

TABLE 7-2
Summary of Alternatives at Upper Shannock Horseshoe Falls Dam

| <i>Alternative</i> | <i>Description</i> | <i>Achieves Fish Passage?</i> | <i>Improves Habitat Conditions?</i> | <i>Minimizes Long Term Dam Maintenance?</i> | <i>Potential for Impact to Historic Resources?</i> | <i>Prudent and Feasible Alternative?</i> |
|--------------------|------------------------|-------------------------------|-------------------------------------|---|--|--|
| H-1 | No Action | No | No | No | No | No |
| H-2 | Ladder/Bypass Channel | Maybe | No | No | Yes | No |
| H-3 | Ladder – Left Abutment | Yes | No | No | Yes | Yes |

8.0 KENYON MILL DAM

8.1 Site Description

The Kenyon Mill Dam is the final structure within the project area. It is an approximately five foot high timber crib and concrete dam about 75 feet long, located adjacent to the active Kenyon Industries. During the initial field inspection, it was noted that the backwater pool inundates a broad floodplain area.



Kenyon Mill Dam, looking northeast

The Kenyon Mill Dam is located adjacent to the Kenyon Industries parking lot on the right bank and an inaccessible vegetated area on the left bank. Downstream of the dam, on the right bank, a retaining wall supporting the parking lot creates the right bank of the channel. Table 8-1 provides general information about the Kenyon Mill Dam.

**TABLE 8-1
Kenyon Mill Dam – Data Summary**

| | |
|-----------------------|--|
| Length | ±75 Feet |
| Hydraulic Height | ±3-4 Feet |
| Structural Height | ±5 Feet |
| Type | Run-of-the-River |
| Material | Timber crest and rock masonry |
| Foundation | Rock / Bedrock |
| Sediment Accumulation | 1-2 feet of fine sandy silt over boulder and bedrock |
| Age | First dam on site operating by 1840; currently owned by Kenyon Piece Die Works, Inc. |
| Comments | Spillway is in fair condition; pool and dam structure currently serve no function |

According to plan and cross section sketches from 1940 on file with RIDEM for dam #248, listed as the Kenyon Mill Dam, this structure is constructed of cement and stone

extending 10 linear feet from upstream to downstream. These drawings also indicate a wedge of earthen fill placed upstream of the dam, extending 10 to 15 feet upstream. The structural height of the dam is given at seven feet from the toe to the top of the crest. An eight-inch by eight-inch cap log is indicated as set into the spillway with stone and cement. The dam is listed in RIDEM Dams Active Inventory (February 2007) as having a low historical hazard and a low proposed hazard.

Visual observations confirmed that the dam is composed of concrete and stone with a timber cap log. The cap is significantly deteriorated and supporting vegetation. The face of the dam is eroded, with significant portions of the original stones and concrete missing. The toe of the dam appears to have been scoured during large flow events.

An historic breach was visible around the left abutment of the dam. A large fallen tree at the head of the breach blocked flow through the breach at the time of observation. This tree is evident in the photograph on the following page. Flow exits the breach under existing bushes at the base of the left abutment, visible as whitewater.

If the tree at the head of the breach were to be removed or displaced, a significant amount of flow would pass through the breached channel. It is likely that water levels in the upstream pool would drop considerably. As it exists, the breached area would be too steep and turbulent to provide effective fish passage past the Kenyon Mill Dam. Repair of this breached area, consisting of placement of a fortified structure at the head of the breach, will be necessary under alternatives in which the dam is to remain.



View of breach around left abutment

A fire suppression system at Kenyon Industries draws water directly from the river upstream of the Kenyon Mill Dam. A schematic of the fire suppression system indicates that the minimum head required to run the pump for the fire suppression system is only six inches below the crest of the dam. The system is used to run the fire sprinklers, and, when necessary, it can



Intake gate for fire suppression system at Kenyon Mill Dam

withdraw directly from the river at a maximum of 1,000 gallons per minute (gpm). If this system were to fail, a secondary pump is able to access a 75,000 gallon auxiliary tank.

Kenyon Industries is served by an on-site water supply well and does not have access to a public water supply. If full dam removal is determined to be the most appropriate course of action for the Kenyon Mill Dam, alternative design of the fire suppression system would need to be developed to serve the fire suppression needs of Kenyon Industries.



Sherman Avenue downstream of the Kenyon Mill Dam

The channel substrate upstream of the Kenyon Mill Dam is composed primarily of bedrock and boulder, with sands and organic mucks in depositional locations at depths of up to two feet. Sediment accumulation immediately behind the dam was verified by MMI during field investigations conducted in August, 2006. The bridge at Sherman Avenue, located approximately 360 feet

downstream of the dam crest, is a concrete arch culvert with a 40 foot bottom width.

8.2 Restoration Alternatives

The following restoration alternatives were evaluated at the Kenyon Mill Dam:

- Alternative K-1 No Action
- Alternative K-2 Fish Ladder
- Alternative K-3 Bypass Channel
- Alternative K-4 Full Dam Removal
- Alternative K-5 High Gradient Riffle

Each of these is described in detail in the ensuing narrative and are depicted graphically in plan and profile in appended plan sheet series "K."

8.2.1 K-1 No Action

This alternative is graphically depicted on Appended Sheets K-1 (plan and profile) and in Figure 8-1. The No Action alternative for the Kenyon Mill Dam is not a prudent alternative. The dam is in a deteriorated condition. Although its hazard potential is rated by RIDEM as low, failure of this dam could negatively impact the existing parking lot at Kenyon Industries and the Sherman Avenue Bridge, located 360 feet downstream. In addition, the fire suppression system at Kenyon Industries would be rendered useless by dam failure as water surface elevations in the dam would decrease and sufficient head would not be available for pump operation.

There is a significant breach on the left bank of the Kenyon Mill Dam. Currently, the breach is blocked by a large fallen tree, which limits flow through the breach channel. Should this tree become dislodged from its existing location, flow would likely circumvent the dam and carve a new channel through the location of the existing breach. This would lower water surface elevations upstream of the dam.

8.2.2 K-2 Fish Ladder

The left bank at the Kenyon Mill Dam is heavily vegetated and not easily accessible by equipment. Access to the left bank would require a river crossing, necessitating the temporary construction of an access road and significant water bypass infrastructure.

No benefits would be gained by locating a fish ladder on the left bank rather than the right bank. Due to the difficulties of construction, the option of a fish ladder on the left bank was not explored further. Discussion of a fish ladder on the right bank follows.

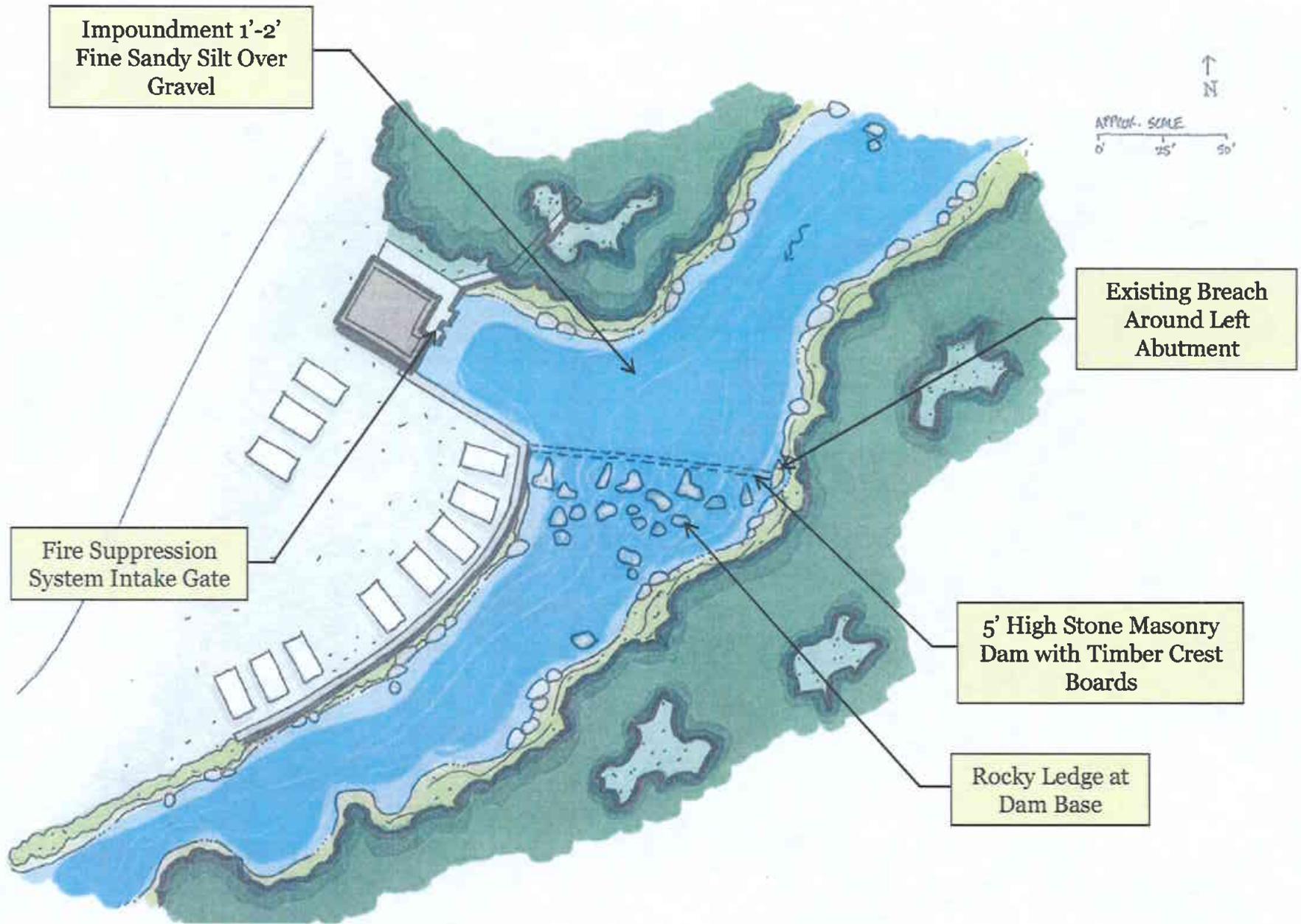


Figure 8-1
Alt. K-1 – Kenyon Mill Dam No Action

Description of Alternative – This alternative is graphically depicted on Appended Sheets K-2 (plan and profile) and in Figure 8-2. A fish ladder on the right bank would extend approximately 40 feet downstream from the dam structure. The dam would be notched to elevation 85.7 feet NGVD, providing 1.8 feet of flow depth during typical April flow conditions and one foot of flow depth during typical August flow conditions. The fish ladder could be made to conform to the existing retaining wall if necessary, providing increased support to the ladder structure. Construction access could be gained via the right bank at the existing parking lot. Flow could be diverted through the left half of the channel while work was completed and the fish ladder installed on the right half.

Ability to Meet Project Goals and Objectives – Hydraulics at this location would not be appreciably altered due to the installation of a fish ladder. Accordingly, no impact would be expected to the hydraulics of the dam.

Under this alternative, the upstream impoundment would remain. This would be a benefit to the fire suppression system in that sufficient head would exist to maintain the suppression system in its existing configuration. Retaining the impoundment would be negative from an ecological and river continuity perspective, however. Dissolved oxygen concentrations measured in the impoundment in August, 2006 were very low, both upstream and downstream of the dam. This indicates a degraded habitat condition with a limited ability to support benthic species, a basic fundamental link in the riverine food chain. In addition, river continuity, by which benthic as well as invertebrate and finfish species are able to move freely in search of appropriate temperature and shading zones, food sources, and resting habitats is fractured, further degrading habitat quality.

Preliminary Findings – A fish ladder at the Kenyon Mill Dam would provide a viable means for fish passage. The impoundment would remain, which would retain the functionality of the fire suppression system at Kenyon Industries, but would not benefit local ecology or river continuity.

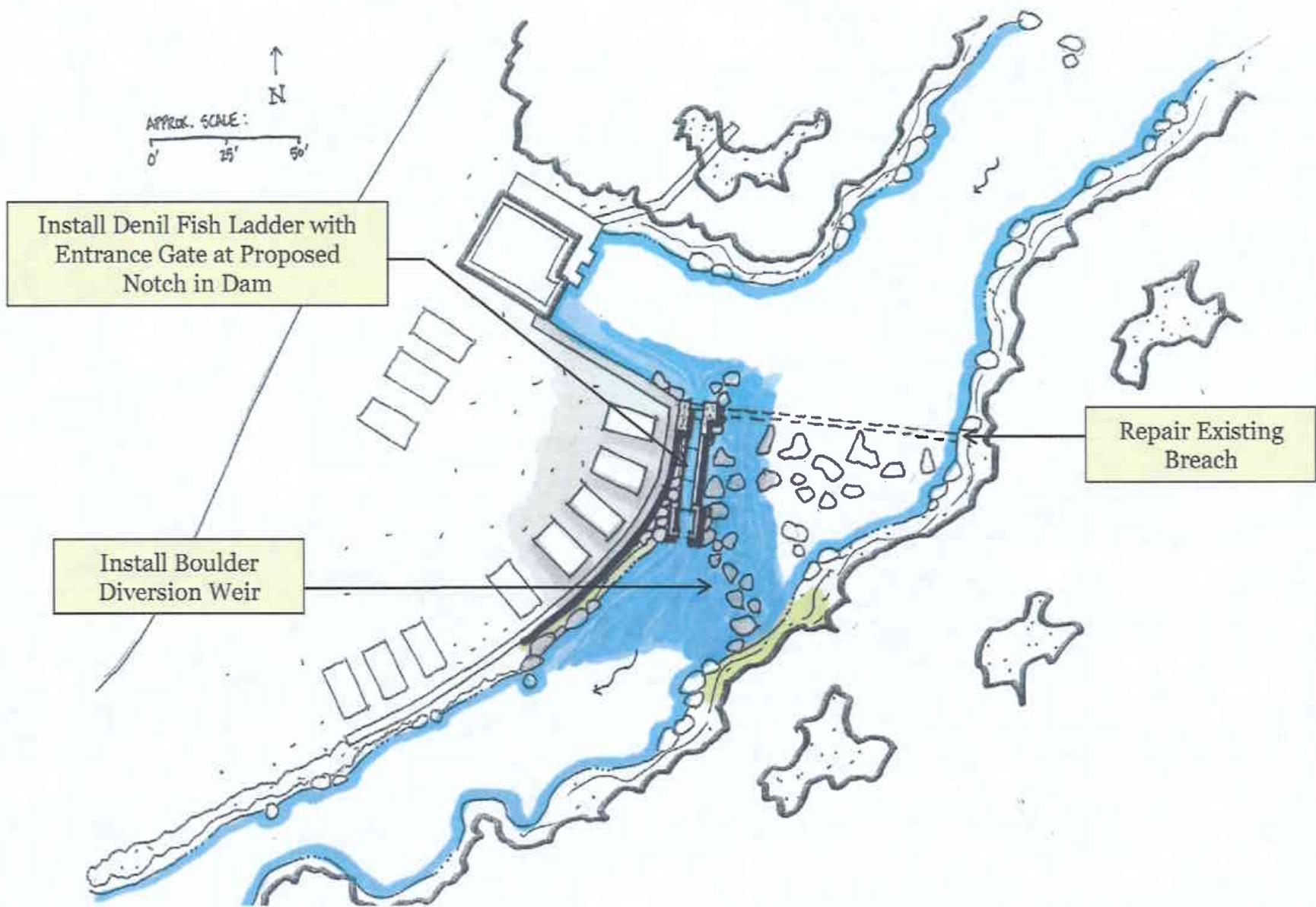


Figure 8-2
Alt. K-2 – Kenyon Mill Dam Fish Ladder on Right Bank

8.2.3 K-3 Bypass Channel at Existing Breach on River Left

Description of Alternative – This alternative is graphically depicted on Appended Sheets Alt. K-3 (plan and profile) and in Figure 8-3. The head of the breach at the Kenyon Mill Dam is currently at approximate elevation 86.0 feet NGVD29. The dam crest is at elevation 86.3 feet NGVD29, with predicted water surface elevations of 87.5 feet associated with typical April flows and 86.8 feet associated with typical August flows. Under existing conditions, if the dam were to fail at the location of the breach, a significantly wide or deep channel could be scoured. Under this scenario, the breach water surface elevations could be lowered significantly.

The proposed bypass channel would take advantage of the natural topography but constrain the diversion channel to a width of six feet. The downstream channel invert would be at elevation 82.2 feet NGVD29, and the upstream invert would be at elevation 85.9. This would provide 1.2 feet of flow depth during April flows and approximately eight inches of flow depth during August flow. The bypass channel drops 3.7 feet in elevation over 75 feet, for a channel slope of 5%.

At this high slope, velocities and channel conditions could be such that they are limiting to the migration of shad and brook trout. Provisions that would lessen the slope of the bypass channel would cause other complications. Making the channel longer in the downstream direction, and thus decreasing slope, would move the channel entrance further downstream of the dam. This would complicate attraction to the bypass channel, causing it to be less efficient and perhaps not functional for fish passage. Placement of the exit of the bypass channel further upstream would require extensive excavation on the left bank, which is heavily vegetated and difficult to access with excavation and construction equipment.

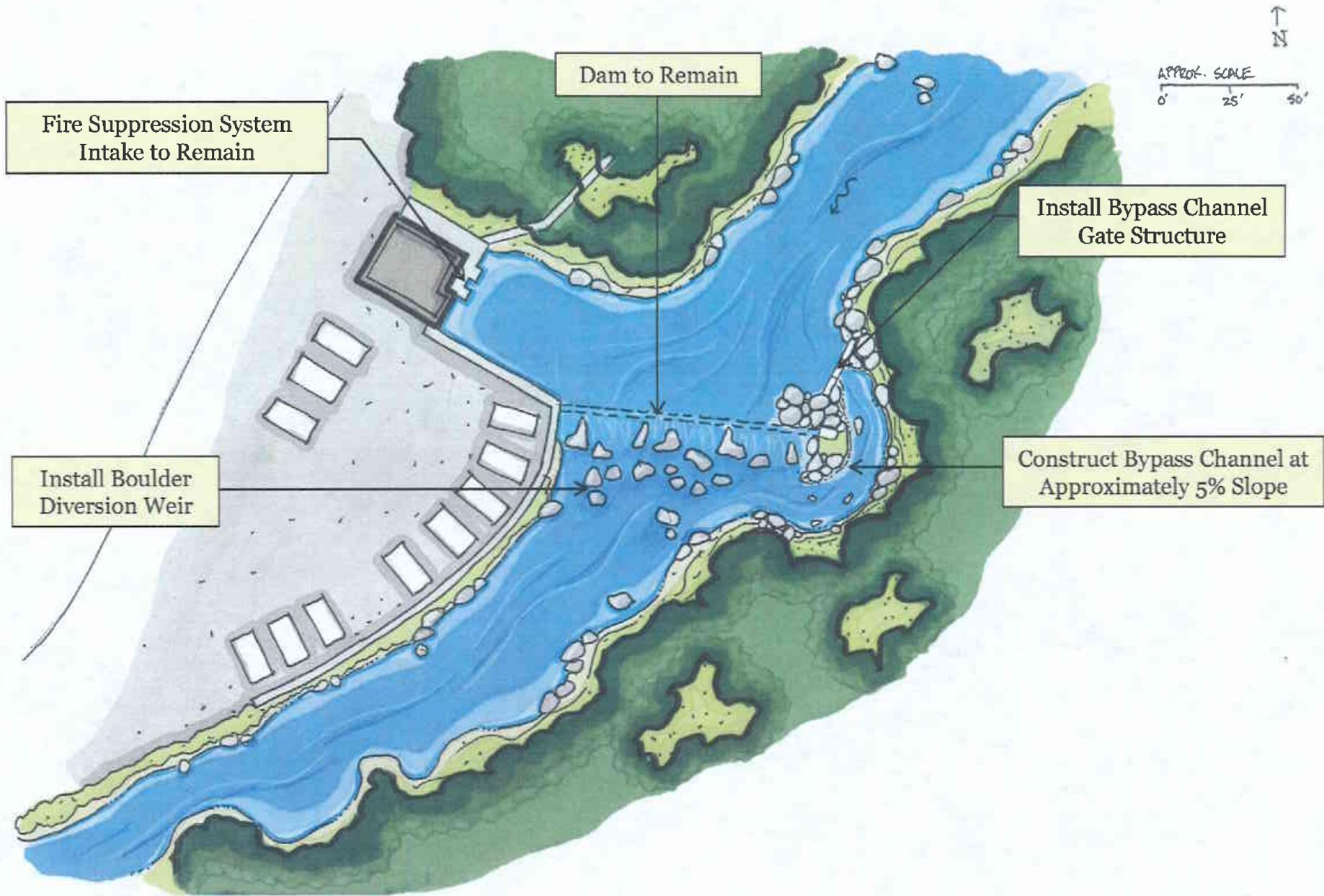


Figure 8-3
Alternate K-3 – Kenyon Mill Dam
Bypass Channel Through Existing Breach

Large roughness elements, such as boulders and large cobble, would be required to dampen the velocities through this very steep channel. Table 8-2 gives the flow depths and velocities predicted in the bypass channel for May and August flows.

TABLE 8-2
Predicted Water Depths and Velocities
for Alt. K-3 Bypass Channel at Kenyon Mill Dam

| <i>Bypass Channel Station</i> | <i>Description</i> | <i>Predicted Water Surface Elevation (feet, NGVD29)</i> | <i>Predicted Velocity (feet per second)</i> |
|-------------------------------|-------------------------------|---|---|
| 0+00 | <i>Head of bypass channel</i> | | |
| | April | 1.04 feet | 5.11 fps |
| | August | 0.54 feet | 3.52 fps |
| 0+75 | <i>Tail of bypass channel</i> | | |
| | April | 1.21 feet | 4.13 fps |
| | August | 0.71 feet | 2.39 fps |

Ability to Meet Project Goals and Objectives – A bypass channel at this location would provide fish passage to certain species. Although a slope of 5% is considerable, velocities are predicted to be within the envelope of sustained swimming speeds for the target species. An alternative to reduce the slope would be to lengthen the channel further landward on the left bank, carving sections of a new channel outside the existing breach channel.

Under this alternative, the dam would remain and repairs would be necessary. Habitat continuity would continue to be fractured, such that the reaches upstream and downstream of the dam would remain disconnected. Water surface elevations behind the dam are not predicted to appreciably change. Table 8-3 gives a comparison of predicted water surface elevations and velocities in the reach surrounding the Kenyon Mill Dam after installation of a bypass channel. In the impoundment created by the dam, indicated by cross section 596+64, located seven feet upstream of the dam, the water surface elevation is predicted to be drawn down by 0.2 feet under proposed conditions. Further upstream and downstream of the dam, water surface elevations would not be altered by installation of a bypass channel.

TABLE 8-3
Comparison of Predicted Water Surface Elevations at Kenyon Mill Dam
For Alt. K-3 Bypass Channel

| <i>River Station</i> | <i>Description</i> | <i>Existing Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Proposed Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Difference (feet)</i> |
|----------------------|----------------------------------|---|---|--------------------------|
| 596+46 | Toe of Kenyon Mill Dam | 82.9 | 82.9 | 0.0 |
| 596+57 | Crest of Kenyon Mill Dam | 86.8 | 86.8 | 0.0 |
| 596+64 | 7 feet upstream Kenyon Mill Dam | 87.3 | 87.1 | 0.2 |
| 597+00 | 56 feet upstream Kenyon Mill Dam | 87.4 | 87.4 | 0.00 |

As water surface elevations behind the dam will not be appreciably altered, no changes to existing ecology would be expected. This would mean that dissolved oxygen concentrations within the pool behind the dam would remain low during the summer months, a condition which negatively affects local invertebrate and benthic species.

This option would also be difficult to construct. Access to the right bank would require the construction of an access road across the river, through which culverts or other water control structures would need to be installed to convey channel flow during construction.

Based on the historic assessment conducted by PAL, this alternative could impact potentially contributing historic structures as well as archaeologically sensitive areas. As with other alternatives, additional historical documentation would likely be required prior to any structural modifications. In addition, further investigations via Phase I(c) archaeological surveys would need to be undertaken to locate and identify any significant belowground Native American and/or Euro-American cultural deposits.

No archaeological sensitivity was assigned in the river channel below the dam where the access road and water control structures and boulder diversion weir would be placed because of previous scouring and documented presence of little sediment over rock/bedrock.

Preliminary Findings – A bypass channel through the existing breach would be considerably steep, although predicted velocities are amenable to passage of target species. To create a channel of lesser slope, it would be necessary to excavate sections of a new channel on the left bank. Access to this bank by equipment is difficult and would require that a haul road and water diversion system be installed.

8.2.4 K-4 – Full Dam Removal

Description of Alternative – Appended Sheets Alt. K-4 (plan and profile) and Figure 8-4 depict this alternative. The Kenyon Mill Dam is a decaying structure, with a fully developed breach at its left abutment. Full removal of the dam would enable fish passage, which would benefit both diadromous as well as resident species. In addition, full dam removal would reconnect the river corridor, increasing habitat quality.

Under the full dam removal option, the dam structure would be removed to approximate elevation 80.0 feet NGVD29. A minor amount of excess sediment behind the dam may need to be removed for a distance of approximately 200 feet upstream, at which point the channel would meet the existing grade at approximate elevation 81.0 feet NGVD29. Preliminary estimates indicate approximately 600 cubic yards of material. It will also be necessary to verify the extent of bedrock and sediment behind the dam. If significant amounts of substrate other than bedrock are encountered, it will be necessary to place one or more hard points as grade controls within the channel. These grade control points would restrict the downstream migration of any moveable channel substrate.

Ability to Meet Project Goals and Objectives – Table 8-4 gives a comparison of predicted water surface elevations in the vicinity of the dam for existing and proposed conditions for April flow conditions. Water surface elevations are predicted to drop by over four feet at the crest of the dam. Downstream of the dam, water surface elevations are predicted to remain unchanged.

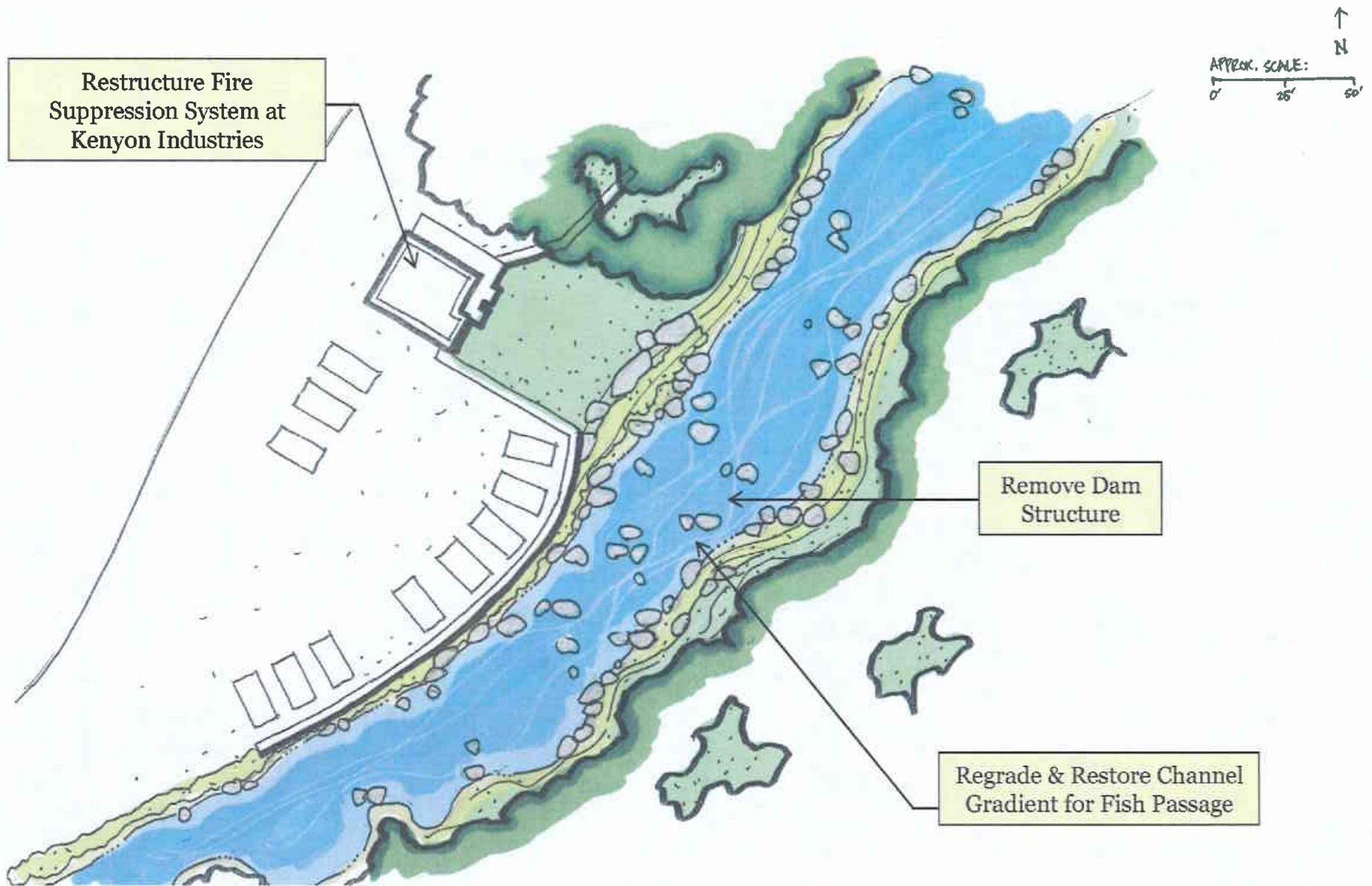


Figure 8-4
Alt. K-4 – Kenyon Mill Dam Full Dam Removal

TABLE 8-4
Comparison of Existing and Proposed Water Surface Elevations
Alt. K-4 Kenyon Mill Dam Full Dam Removal

| <i>River Station</i> | <i>Description</i> | <i>Existing Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Proposed Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Difference (feet)</i> |
|----------------------|--|---|---|--------------------------|
| 592+75 | Downstream Sherman Avenue | 83.04 | 83.04 | 0.00 |
| 593+25 | Upstream Sherman Avenue | 83.19 | 83.19 | 0.00 |
| 596+30 | 32 feet downstream Kenyon Mill Dam | 83.31 | 83.31 | 0.00 |
| 596+46 | Toe Kenyon Mill Dam | 83.31 | 83.31 | 0.00 |
| 596+57 | Crest Kenyon Mill Dam | 87.09 | 83.33 | 3.76 |
| 596+64 | 7 feet upstream Kenyon Mill Dam | 87.52 | 83.33 | 4.2 |
| 597+00 | 56 feet upstream Kenyon Mill Dam | 87.53 | 83.33 | 4.2 |
| 599+25 | 268 feet upstream Kenyon Mill Dam | 87.54 | 83.58 | 3.96 |
| 610+47 | Downstream South County Trail | 87.57 | 84.09 | 3.48 |
| 611+07 | Upstream South County Trail | 87.57 | 84.09 | 3.48 |
| 633+07 | Downstream Biscuit City Road | 87.61 | 84.51 | 3.10 |
| 633+22 | Upstream Biscuit City Road | 87.61 | 84.55 | 3.05 |
| 648+22 | Upstream limit of study, approximately 1,500 feet upstream of Biscuit City Road, 1 mile upstream Kenyon Mill Dam | 87.74 | 86.46 | 1.28 |

Due to the low gradient channel and low valley slope, the existing dam currently creates a backwater condition that extends upstream of Biscuit City Road and, in fact, to the upstream limit of the hydraulic model. Removal of the dam will decrease water surface elevations for a considerable distance upstream of the dam.

Water surface elevations are predicted to drop by over three feet at Biscuit City Road, located approximately three-quarters of a mile upstream of the Kenyon Mill Dam. Predicted water depths of one to two feet at the bridge under normal flow conditions should not limit canoe passage at this location. At the upstream limit of the hydraulic model, approximately one mile upstream of the Kenyon Mill Dam, water surface elevations are predicted to drop by over one foot.

Removal of the Kenyon Mill Dam would narrow the existing upstream channel. Immediately upstream of the dam, the channel is predicted to narrow by approximately 30 feet, nearly half its existing width during typical April flows. This exposed fringe

would revegetate, creating a wider riparian buffer through this section. In conjunction with removal of the dam, the channel banks would need to be appropriately graded.

It may be necessary to provide fortifications to the footings of the upstream bridges after dam removal. This could be accomplished through the selective placement of boulder and riprap. This would be determined as necessary during the design stages of the project.

Channel velocities will generally increase after removal of the Kenyon Mill Dam. Table 8-5 gives a comparison of existing and predicted velocities in the project reach. Increases in velocity are predicted to extend to the upstream limits of the hydraulic model. This is to be expected as the impoundment is to be replaced by a free-flowing channel section. Increases in velocity through this section will provide cooler, more oxygenated water that is of higher habitat quality than the existing impoundment.

TABLE 8-5
Comparison of Existing and Proposed Velocities
Alt. K-4 Kenyon Mill Dam Full Dam Removal

| <i>River Station</i> | <i>Description</i> | <i>Existing Conditions Velocity (feet per second)</i> | <i>Proposed Conditions Velocity (feet per second)</i> | <i>Difference (feet per second)</i> |
|----------------------|--|---|---|-------------------------------------|
| 592+75 | Downstream Sherman Avenue | 2.48 | 2.48 | 0.00 |
| 593+25 | Upstream Sherman Avenue | 1.10 | 1.10 | 0.00 |
| 596+30 | 32 feet downstream Kenyon Mill Dam | 1.26 | 1.20 | -0.06 |
| 596+46 | Toe Kenyon Mill Dam | 1.26 | 1.26 | 0.00 |
| 596+57 | Crest Kenyon Mill Dam | 4.27 | 1.11 | -3.16 |
| 596+64 | 7 feet upstream Kenyon Mill Dam | 0.82 | 1.12 | +0.30 |
| 597+00 | 56 feet upstream Kenyon Mill Dam | 0.66 | 1.74 | +1.08 |
| 599+25 | 268 feet upstream Kenyon Mill Dam | 1.14 | 4.79 | +3.65 |
| 610+47 | Downstream South County Trail | 0.59 | 0.95 | +0.36 |
| 611+07 | Upstream South County Trail | 0.59 | 0.95 | +0.36 |
| 633+07 | Downstream Biscuit City Road | 1.23 | 2.95 | +1.72 |
| 633+22 | Upstream Biscuit City Road | 1.23 | 2.90 | +1.67 |
| 648+22 | Upstream limit of study, approximately 1,500 feet upstream of Biscuit City Road, 1 mile upstream Kenyon Mill Dam | 0.83 | 1.90 | +1.07 |

At the crest of the existing dam, water currently sheets over the face of the dam under a high velocity condition. After removal of the dam, velocity through this section is predicted to be approximately one foot per second under typical April flows as opposed to over four feet per second with the dam in place. No increases in velocity are predicted downstream of the existing dam. The predicted velocities are within the envelope of acceptable velocities for passage of target species.

Table 8-6 gives flow depths predicted under the full dam removal option. Predicted water depths for both the April and August flow events support diadromous fish passage as well as habitat conditions for resident species.

TABLE 8-6
Predicted Water Depths
Alt. K-4 Kenyon Mill Dam Full Dam Removal

| <i>River Station</i> | <i>Description</i> | <i>Water Depth (feet)</i> | |
|----------------------|--|---------------------------|---------------|
| | | <i>April</i> | <i>August</i> |
| 592+75 | Downstream Sherman Avenue | 4.64 | 3.83 |
| 593+25 | Upstream Sherman Avenue | 6.19 | 5.24 |
| 596+30 | 32 feet downstream Kenyon Mill Dam | 3.84 | 2.78 |
| 596+46 | Toe Kenyon Mill Dam | 3.81 | 2.76 |
| 596+57 | Crest Kenyon Mill Dam | 3.33 | 2.76 |
| 596+64 | 7 feet upstream Kenyon Mill Dam | 2.93 | 1.86 |
| 597+00 | 56 feet upstream Kenyon Mill Dam | 3.45 | 2.38 |
| 599+25 | 268 feet upstream Kenyon Mill Dam | 2.75 | 1.6 |
| 610+47 | Downstream South County Trail | 6.19 | 4.69 |
| 611+07 | Upstream South County Trail | 6.2 | 4.69 |
| 633+07 | Downstream Biscuit City Road | 2.21 | 0.77 |
| 633+22 | Upstream Biscuit City Road | 2.25 | 0.84 |
| 648+22 | Upstream limit of study, approximately 1,500 feet upstream of Biscuit City Road, 1 mile upstream Kenyon Mill Dam | 3.46 | 1.58 |

Significant wetlands exist upstream of the Kenyon Mill Dam. Further development of this alternative would need to take in to account the effect on the upstream wetlands. One possibility would be to place low rock falls intermittently through the upstream

reach to incrementally raise water surface elevations without impacting fish passage. This approach could maintain upstream water levels close to existing conditions.

Based on the historic assessment conducted by PAL, this alternative could impact potentially contributing historic structures as well as archaeologically sensitive areas. As with other alternatives, additional historical documentation would likely be required prior to any structural modifications. In addition, further investigations via Phase I(c) archaeological surveys would need to be undertaken to locate and identify any significant belowground Native American and/or Euro-American cultural deposits.

Preliminary Findings – Full removal of the Kenyon Mill Dam will create fish passable flow depths and velocities. Dam removal has the extremely positive benefit of reconnecting riverine habitat zones, which benefits local macroinvertebrate and benthic species, increasing habitat quality and supporting local ecology. Natural erosion through this reach will lead to long-term equilibrium of sediment transport in the system. This alternative would require commitment by Kenyon Industries to develop alternatives to the existing fire suppression system.

8.2.5 K-5 – High Gradient Riffle

Description of Alternative – Appended Sheets K-5 (plan and profile) graphically depict this alternative. The riffle alternative consists of the placement of fill in the channel downstream of the dam. The maximum slope generally used for high gradient riffles is four percent. At this slope, large roughness elements such as large boulders will be necessary to create fish passable velocities. The vertical difference between the crest of the dam and the downstream channel is 6.3 feet. At 4% slope, a high gradient riffle would extend approximately 200 feet downstream from the crest of the existing dam, to tie into the existing channel elevation at 78.0 feet NGVD29.

Installation of a high gradient riffle would require the placement of approximately 1,500 cubic yards of fill in the channel. Due to the shallow overbank topography, installation of a riffle in this region would require the construction of a retaining wall along the left bank. The right bank is already constrained by a stone masonry retaining wall in conjunction with the parking lot at Kenyon Industries.

Ability to Meet Project Goals and Objectives – Table 8-7 compares the water surface elevations predicted for the high gradient riffle alternative with those computed for existing conditions. The influence of the riffle is evidenced at the dam crest and downstream of the existing dam. The water surface elevation at the crest of the dam is increased slightly. Water surface elevations are increased in excess of three feet at the toe of the existing dam, approximately 10 feet downstream of the crest. At a point 32 feet downstream of the crest of the existing dam, water surface elevations increase by over two feet. By Sherman Avenue, water surface elevations are the same as those calculated for existing conditions. Upstream of the dam, impacts to water surface elevations are negligible.

Increases in water surface elevation could also impact flooding. The flat topography along the left bank encourages flooding in this direction. The rock retaining wall supporting the parking lot on the right bank is not predicted to be overtopped even under the 100-year flood event.

Water velocities over the rock riffle will be greater than in the existing reach downstream of the dam, with increases generally in the range of two to three feet per second. The predicted velocities are within the range of acceptable velocities for target diadromous and resident fish species. Upstream and downstream of the proposed riffle, channel velocity will not be impacted. Table 8-8 gives a comparison of predicted velocities for the rock riffle alternative and existing conditions velocities.

TABLE 8-7
Comparison of Existing and Proposed Water Surface Elevations
Alt. K-5 Kenyon Mill Dam High Gradient Riffle

| <i>River Station</i> | <i>Description</i> | <i>Existing Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Proposed Conditions Water Surface Elevation (feet, NGVD29)</i> | <i>Difference (feet)</i> |
|----------------------|--|---|---|--------------------------|
| 592+75 | Downstream Sherman Avenue | 83.04 | 83.04 | 0.00 |
| 593+25 | Upstream Sherman Avenue | 83.19 | 83.19 | 0.00 |
| 596+30 | 32 feet downstream Kenyon Mill Dam | 83.31 | 85.44 | +2.13 |
| 596+46 | Toe Kenyon Mill Dam | 83.31 | 86.60 | +3.29 |
| 596+57 | Crest Kenyon Mill Dam | 87.09 | 87.36 | +0.27 |
| 596+64 | 7 feet upstream Kenyon Mill Dam | 87.52 | 87.50 | -0.02 |
| 597+00 | 56 feet upstream Kenyon Mill Dam | 87.53 | 87.50 | -0.03 |
| 599+25 | 268 feet upstream Kenyon Mill Dam | 87.54 | 87.51 | -0.03 |
| 610+47 | Downstream South County Trail | 87.57 | 87.55 | -0.02 |
| 611+07 | Upstream South County Trail | 87.57 | 87.55 | -0.02 |
| 633+07 | Downstream Biscuit City Road | 87.61 | 87.58 | -0.03 |
| 633+22 | Upstream Biscuit City Road | 87.61 | 87.59 | -0.02 |
| 648+22 | Upstream limit of study, approximately 1,500 feet upstream of Biscuit City Road, 1 mile upstream Kenyon Mill Dam | 87.74 | 87.72 | -0.02 |

TABLE 8-8
Comparison of Existing and Proposed Velocity
Alt. K-5 Kenyon Mill Dam Rock Riffle

| <i>River Station</i> | <i>Description</i> | <i>Existing Conditions Velocity (feet per second)</i> | <i>Proposed Conditions Velocity (feet per second)</i> | <i>Difference (feet per second)</i> |
|----------------------|--|---|---|-------------------------------------|
| 592+75 | Downstream Sherman Avenue | 2.48 | 2.48 | 0.00 |
| 593+25 | Upstream Sherman Avenue | 1.10 | 1.10 | 0.00 |
| 596+30 | 32 feet downstream Kenyon Mill Dam | 1.26 | 3.28 | +2.02 |
| 596+46 | Toe Kenyon Mill Dam | 1.26 | 4.80 | +3.54 |
| 596+57 | Crest Kenyon Mill Dam | 4.27 | 2.44 | -1.82 |
| 596+64 | 7 feet upstream Kenyon Mill Dam | 0.82 | 0.82 | 0.00 |
| 597+00 | 56 feet upstream Kenyon Mill Dam | 0.66 | 0.66 | 0.00 |
| 599+25 | 268 feet upstream Kenyon Mill Dam | 1.14 | 1.14 | 0.00 |
| 610+47 | Downstream South County Trail | 0.59 | 0.59 | 0.00 |
| 611+07 | Upstream South County Trail | 0.59 | 0.59 | 0.00 |
| 633+07 | Downstream Biscuit City Road | 1.23 | 1.23 | 0.00 |
| 633+22 | Upstream Biscuit City Road | 1.23 | 1.23 | 0.00 |
| 648+22 | Upstream limit of study, approximately 1,500 feet upstream of Biscuit City Road, 1 mile upstream Kenyon Mill Dam | 0.83 | 0.83 | 0.00 |

Predicted water depths for the rock riffle alternative are presented in Table 8-9. Water depths predicted by the model over the riffle are fairly shallow, in the range of one foot for April flows and 0.5 feet under August flows. In reality, the large roughness elements used to throttle velocities over the face of the riffle will create localized pooling and varied flow conditions, such that water depths will be greater than those predicted.

TABLE 8-9
Predicted Water Depths
Alt. K-5 Kenyon Mill Dam High Gradient Riffle

| <i>River Station</i> | <i>Description</i> | <i>Water Depth (feet)</i> | |
|----------------------|--|---------------------------|---------------|
| | | <i>April</i> | <i>August</i> |
| 59630 | 32 feet downstream of existing dam, on rock riffle | 1.08 | 0.51 |
| 59646 | 10 feet downstream of existing dam, on rock riffle | 0.87 | 0.43 |
| 59657 | Top of rock riffle | 1.31 | 0.68 |

High velocities and high channel slopes can create habitat fragmentation for local macroinvertebrate and benthic species. High velocity, high slope zones can inhibit the migration of these species in search of alternate food sources, appropriate temperature zones, and protective cover. Habitat fragmentation in general creates lower habitat quality zones, which ultimately affects the habitat quality of target fish species.

Based on the historic assessment conducted by PAL, this alternative could impact potentially contributing historic structures as well as archaeologically sensitive areas. As with other alternatives, additional historical documentation would likely be required prior to any structural modifications. In addition, further investigations via Phase I(c) archaeological surveys would need to be undertaken to locate and identify any significant belowground Native American and/or Euro-American cultural deposits.

Preliminary Findings – The high gradient riffle alternative would provide the necessary velocities and flow depths for migration of both diadromous and resident species. Overbank flooding would be increased in the region of the riffle along the left bank. A rock riffle in this location would propagate habitat fragmentation, reducing general

habitat quality in the Pawcatuck River. In addition, the amount to fill required to construct this 200-foot long riffle would be on the order of \$75,000 based on these preliminary findings.

8.2.6 Summary of Alternatives at the Kenyon Mill Dam

Table 8-10 summarizes the alternatives for the Kenyon Mill Dam.

**TABLE 8-10
Summary of Alternatives at Kenyon Mill Dam**

| <i>Alternative</i> | <i>Description</i> | <i>Achieves Fish Passage?</i> | <i>Improves Habitat Conditions?</i> | <i>Minimizes Long Term Dam Maintenance?</i> | <i>Potential for Impact to Historic Resources?</i> | <i>Prudent and Feasible Alternative?</i> |
|--------------------|----------------------|-------------------------------|-------------------------------------|---|--|--|
| K-1 | No Action | No | No | No | No | No |
| K-2 | Fish Ladder | Yes | No | No | Yes | Yes |
| K-3 | Bypass Channel | Yes | No | No | Yes | Yes |
| K-4 | Full Dam Removal | Yes | Yes | Yes | Yes | Yes |
| K-5 | High Gradient Riffle | Yes | No | Yes | Yes | No |

9.0 SELECTION OF RECOMMENDED PREFERRED ALTERNATIVES

Preliminary engineering opinions of costs were developed for the alternatives for each of the three dams. These are presented in Appendix D and summarized in Table 9-1.

TABLE 9-1
Cost Summary of Individual Alternatives

| <i>Alternative</i> | <i>Description</i> | <i>Total Cost</i> |
|--|--|-------------------|
| <i>Lower Shannock Falls Dam Alternatives</i> | | |
| S-1 | No Action | \$370,000 |
| S-2 | Fish Ladder on Right Bank | \$450,000 |
| S-3 | Full Dam Removal | \$413,000 |
| <i>Upper Shannock Horseshoe Falls Dam Alternatives</i> | | |
| H-1 | No Action | \$217,000 |
| H-2 | Fish Ladders at Right Raceway | \$421,000 |
| H-3 | Fish Ladder at Left Abutment | \$308,000 |
| <i>Kenyon Mill Dam Alternatives</i> | | |
| K-1 | No Action | \$132,000 |
| K-2 | Fish Ladder at Right Bank | \$169,000 |
| K-3 | Bypass Channel through Existing Breach | \$226,000 |
| K-4 | Full Dam Removal | \$384,000 |
| K-5 | High Gradient Riffle | \$288,000 |

In addition to the above capital costs, each alternative will have certain ongoing maintenance costs associated with it, as described below.

Dam Removal Maintenance – Alternatives S-3 and K-4 are full dam removal alternatives. Once a dam is physically removed and the channel and stream corridor vegetation is stable, the removal site and channel will not require a great deal of maintenance. Minor ongoing maintenance would include vegetation control on the banks of the river and maintenance of any public access areas. These costs would be relatively minor and could likely be accomplished by local public works department staff.

High Gradient Riffle Maintenance – Alternative K-5 involves a high gradient riffle structure. Similar to dam removal, high gradient riffles require little maintenance once

they are established. Periodic monitoring is recommended following large storms to identify any dislodged rocks or heavy deposition of upstream materials. In such situations, minor maintenance might be necessary; however, these costs would be relatively minor and could likely be accomplished by local public works department staff.

Fish Ladder – Alternatives S-2, H-2, H-3, and K-2 involve the installation of fish ladders. Fish ladders require regular maintenance to clean out debris and maintain the structural integrity of the ladder. The most intensive maintenance occurs during the upstream migration season, between late March or early April through mid-June. During that time period, the primary concern is to keep the fishway clean from debris that can block passage. This is typically conducted twice each week; however, depending on the site, it could be more or less frequent. Some fish ladders are inspected and cleaned on a daily basis. This regular maintenance is normally done manually. Access to the fish ladder is imperative. The major cost of fish ladder maintenance is in manual labor. The life expectancy of the structure itself would be on the order of 20 years, at which time it would need to be replaced.

Bypass Channel – Alternative K-3 involves a bypass channel. Bypass channels and relocated channels are fairly low maintenance following construction. Periodic inspection of the inlet to a bypass channel (i.e., downstream inlet for fish that are migrating upstream) as well as the channel itself is recommended to check for any obstructions that may be blocking passage. Occasionally, the flow patterns at the fish entrance to a bypass channel shift, requiring minor in-stream channel work to reestablish appropriate attraction flow. This could involve placement of boulders that have shifted during high storm events or removal of sediment that has deposited. Additionally, normal stream bank maintenance is recommended to control any invasive plant species and maintain public access. These costs would be relatively minor.

Full dam removal options are considered to be the most favorable relative to fish passage and restoration of a free-flowing "natural" channel. The high gradient riffle alternatives have a high degree of fish passage efficiency but are inferior with respect to upstream channel habitat restoration.

As indicated by Table 9-1, cost opinions at each dam are within the same order of magnitude for each of the viable alternatives. The least costly "action" alternatives are full dam removal at the Shannock Dam, installation of a fish ladder at the left abutment at the Upper Shannock Horseshoe Falls Dam, and installation of a fish ladder at the right bank at the Kenyon Mill Dam. Recommended alternatives are summarized in Table 9-2.

TABLE 9-2
Summary of Recommended Alternatives

| <i>Location</i> | <i>Recommended Alternative</i> | | |
|------------------------------------|--------------------------------|------------------------------|-----------|
| Lower Shannock Falls Dam | S-3 | Full Dam Removal | \$413,000 |
| Upper Shannock Horseshoe Falls Dam | H-3 | Fish Ladder at Left Abutment | \$308,000 |
| Kenyon Mill Dam | K-4 | Full Dam Removal | \$384,000 |

It is important to note that the listed recommended alternatives are believed to meet the project goals and objectives and are all believed to be technically feasible. However, the ultimate selection of preferred alternatives will depend upon a balance of cost, potential ecological benefits, and potentially public input. For example, while full dam removal is recommended at Kenyon Mill Dam, the fish ladder option is the least costly alternative.

In addition to the restoration elements involving fish passage, channel restoration should be considered as part of any future activities. The existing habitat upstream of the dams consists of wide pools with low velocities. Preferred habitat includes mixed pool, runs, and riffles, with intermediate velocities and increased cover. As part of any stream restoration effort, consideration should be given to creating in-stream channel enhancements to add stream features that will increase the habitat diversity. These types of stream improvements can be coupled with any of the selected alternatives.

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APPENDIX A
UTILITY CORRESPONDENCE



OSP National Support /
Investigations
Dept 42864 Loc 107
2400 North Glenville
Richardson, TX 75082

MCI Network Services, Inc.

02/21/2007

MILONE & MACBROOM
Elsa Loemann
99 Realty Drive
Cheshire, CT 06410

FEB 28 2007

RE: MMI #2989-01 – SHANNOCK FISH PASSAGE FEASIBILITY STUDY
– **RAILROAD STREET NEAR LOWER SHANNOCK FALLS DAM**
– **MAIN STREET NEAR THE HORSESHOE DAM**
– **SHERMAN AVENUE NEAR THE KENYON MILL DAM–**
Richmond/Charleston, Washington, Rhode Island

MCI ID: 1165-2007

Dear Sir or Madam:

MCI has been notified by your office regarding the above referenced project.

For your records, in reviewing the area in question, it has been determined that MCI does not have facilities within your project area. However, it will still be necessary for you to **contact the local One Call System at least 48 hours prior to any construction.**

You should address correspondence concerning any future projects to the attention of **OSP National Support/Investigations** at the above address.

If you need further assistance with this project, please do not hesitate to call me.

Sincerely,

John Bachelder
OSP National Support / Investigations
(972) 729-6016

*Engineering,
Landscape Architecture
and Environmental Science*



MILONE & MACBROOM®

February 15, 2007

MCI - Investigations
Department 42864, Location 107
2400 North Glenville
Richardson, TX 75082

**RE: Shannock Fish Passage Feasibility Study
Pawcatuck River
Richmond and Charleston, Rhode Island
MMI #2989-01**

Dear Investigations Unit:

Milone & MacBroom, Inc. has been retained by the Wood-Pawcatuck Watershed Association to perform a feasibility analysis in regard to restoring fish passage along the reach of the Pawcatuck River near the villages of Shannock and Kenyon, Rhode Island. As part of our analysis of alternatives, we are considering the alteration or removal of three dams along this reach of the river. Please see attached Figure 1 for a general location map of the affected dams.

We have learned that you are a utility provider in this area through DIGSAFE RI. In order to facilitate our design process, we ask that you provide our firm with maps of your utility lines near our proposed areas of impact. This information will enable our firm to design this project with a minimal impact to any of your utility lines. Please note that this project is still in the design phases and no excavation is proposed at this time.

The proposed areas of impact include the areas of the dams within the width of the Pawcatuck River and any overhead lines above the dams or on the roadways near the dam locations. Please see attached Figures 2 and 3 for a close-up of the dam locations. The nearby roadways we are most concerned with include:

- 1) Railroad Street near the Lower Shannock Falls Dam
- 2) Main Street near the Horseshoe Dam
- 3) Sherman Avenue near the Kenyon Mill Dam

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MCI - Investigations
February 15, 2007
Page 2

Any information you could provide our firm concerning your utilities would be most beneficial. Please fax or mail such information to the number or address listed on this letterhead.

If you have any questions, please do not hesitate to contact me.

Very truly yours,

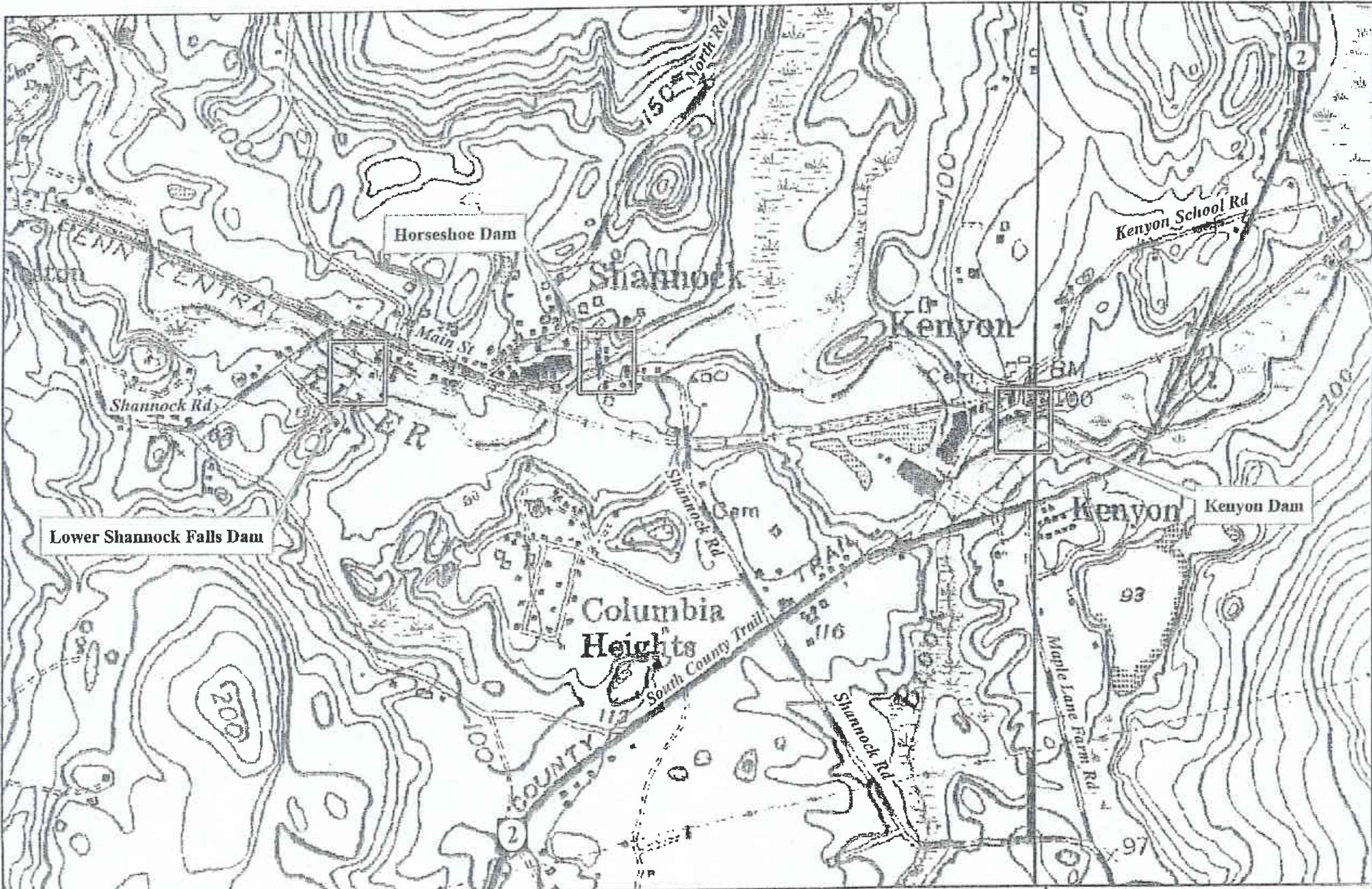
MILONE & MACBROOM, INC.



Elsa Loehmann, EIT
Water Resource Engineer

Enclosures

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MILONE & MACBROOM
 Engineering,
 Landscape Architecture
 and Environmental Science
 99 Realty Drive
 Cheshire, CT 06410
 Phone: (203) 271-1773

MMI#: 2989-01
 MXD: H:\Site.mxd



Site Location Map

**Shannock Fish Passage
Feasibility Study**

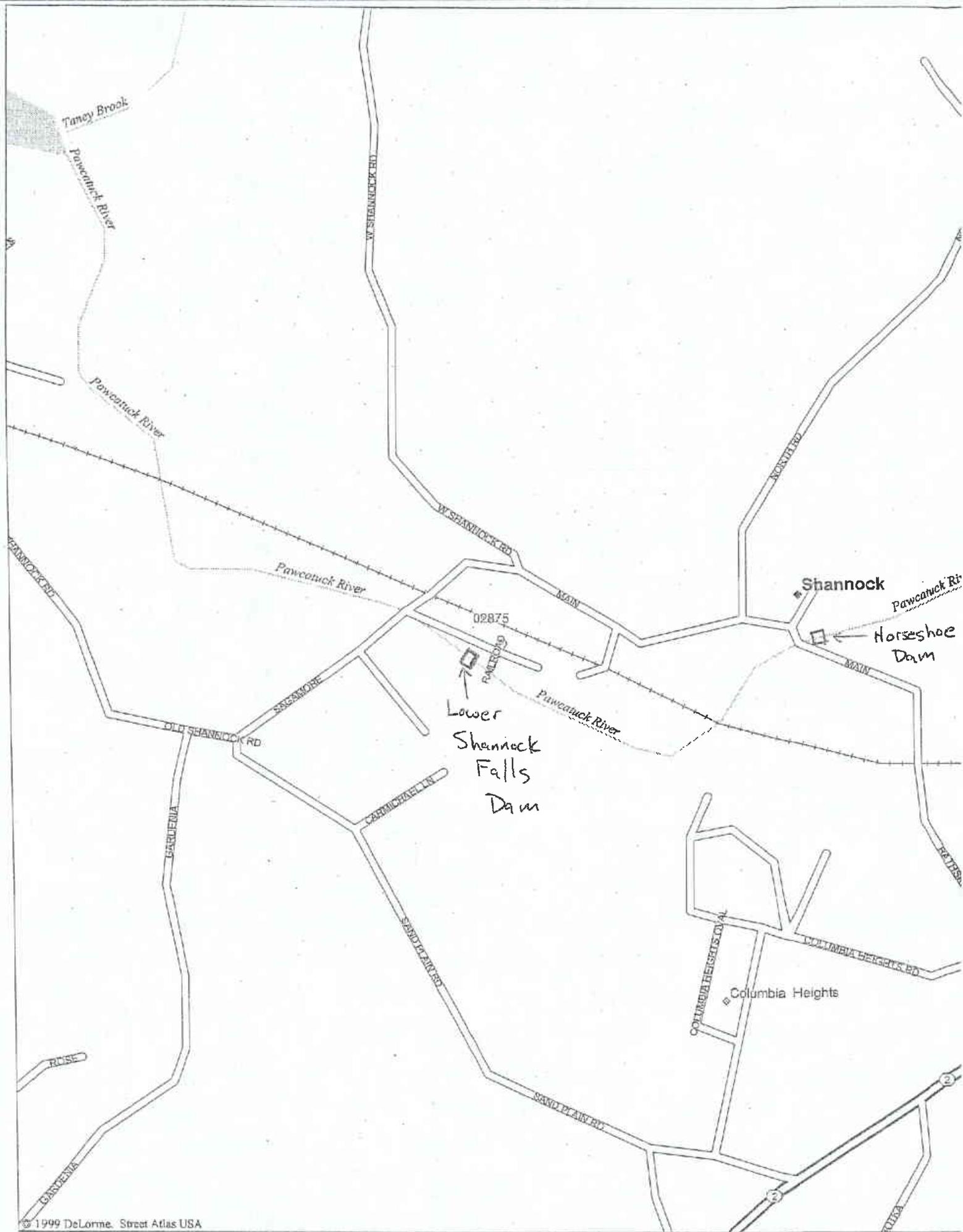
Location: **Richmond &
Charlestown, RI**

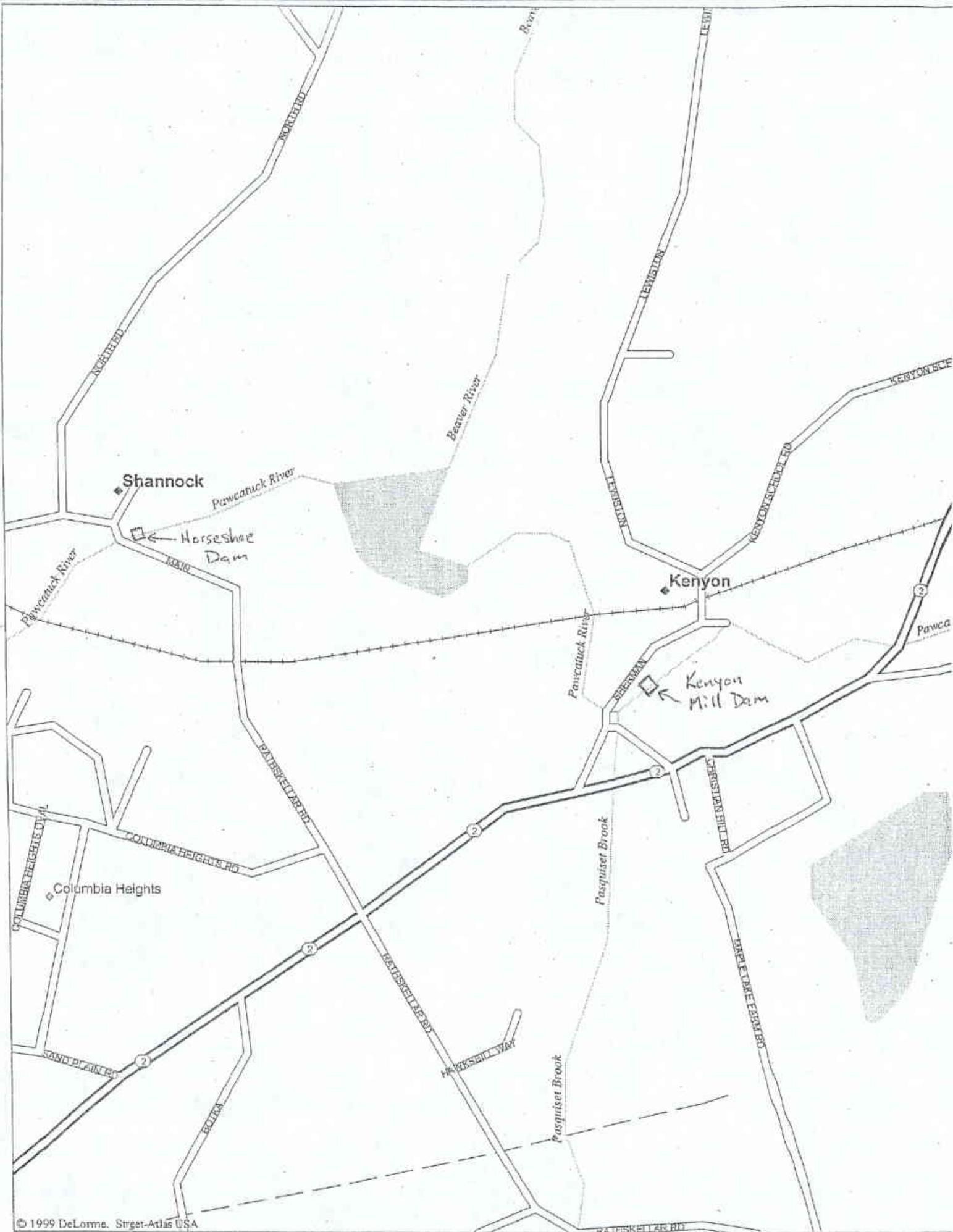
Date: Nov. 2006

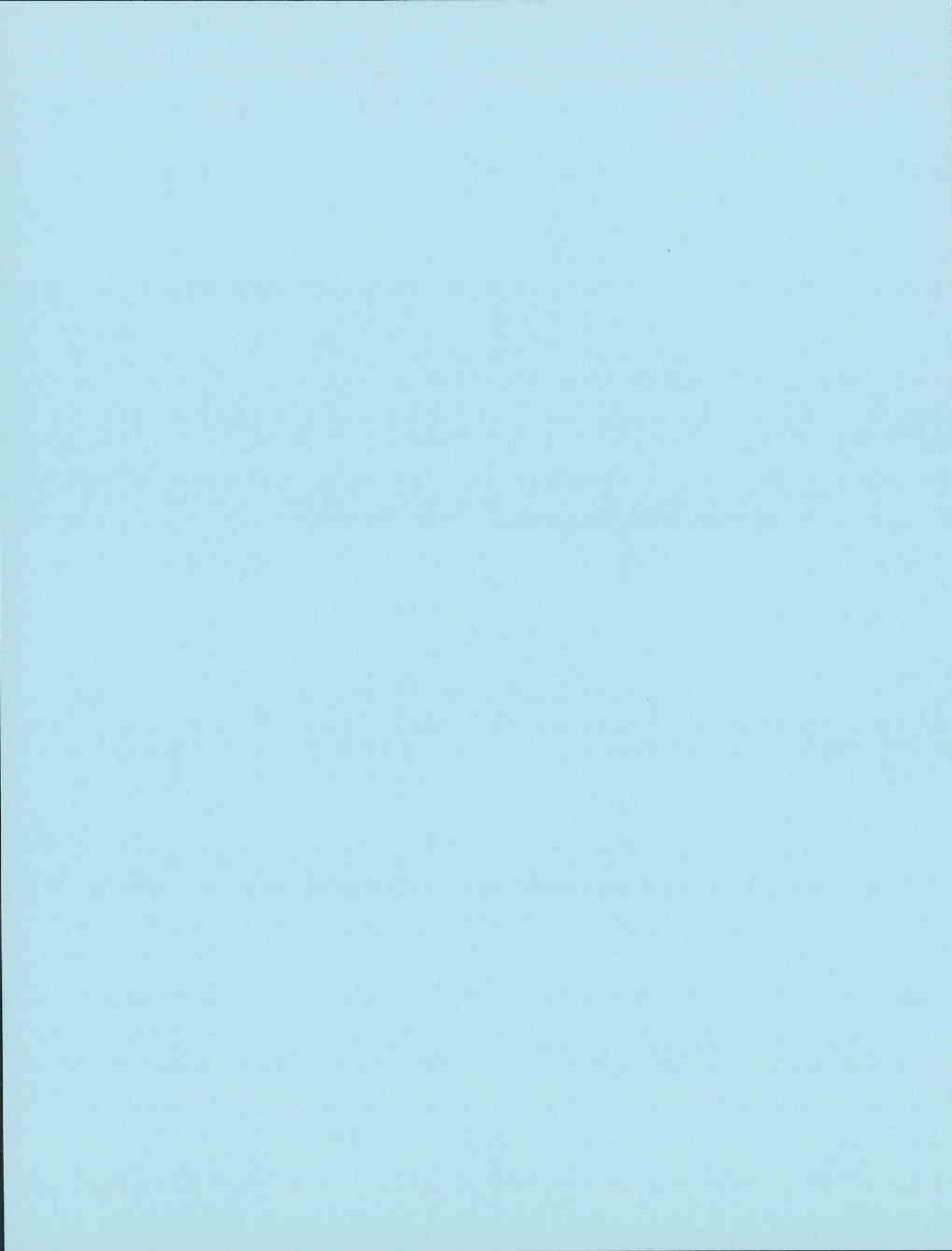
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Figure 1

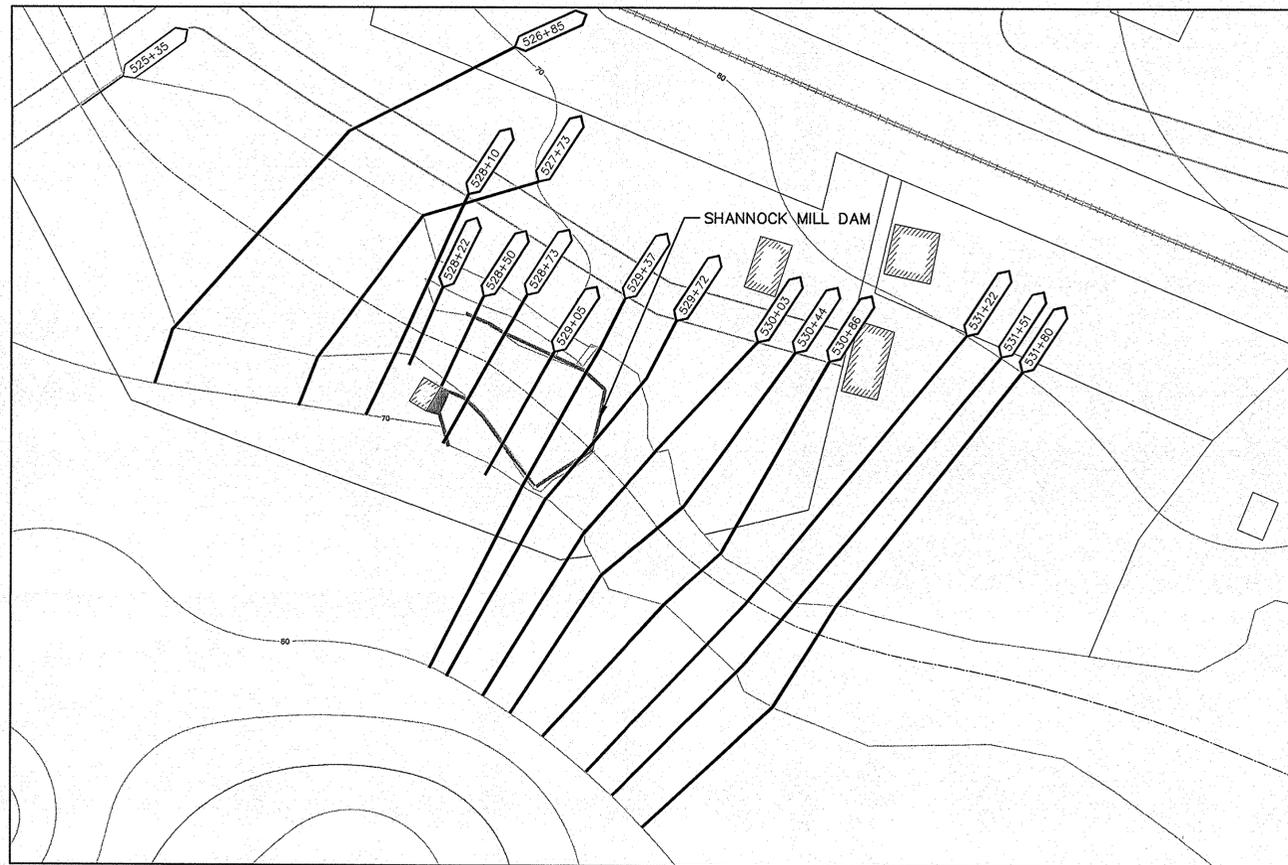




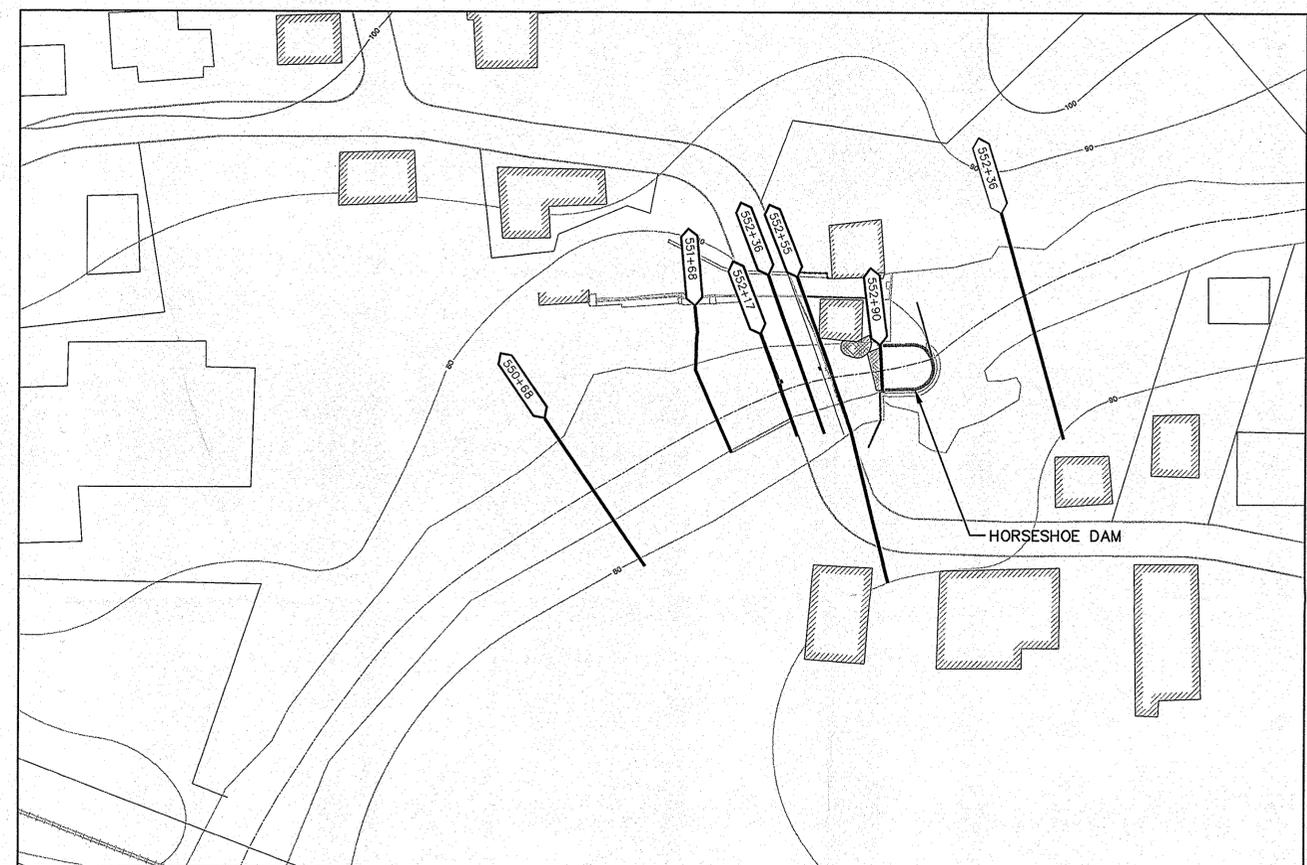


APPENDIX B

HYDRAULIC SECTIONS SHEET



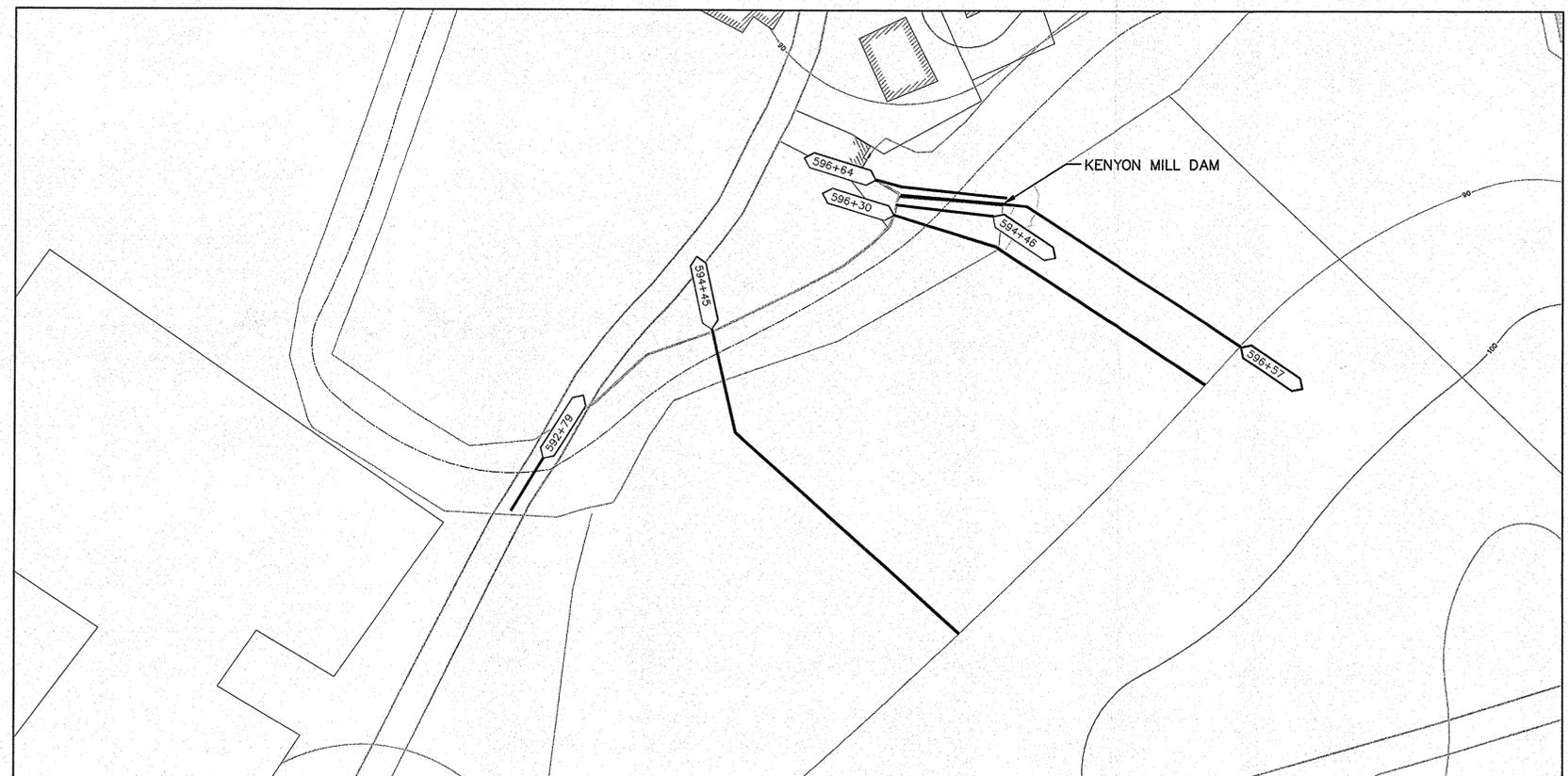
1. SHANNOCK MILL DAM - PLAN



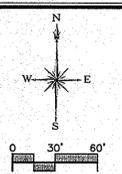
2. HORSESHOE DAM - PLAN



INDEX PLAN
N.T.S.



3. KENYON MILL DAM - PLAN



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SITE PLAN - HYDRAULIC MODEL CROSS SECTIONS
SHANNOCK FISH PASSAGE
FEASIBILITY STUDY
CHARLESTOWN / RICHMOND
RHODE ISLAND

| | | |
|---------------------|--------------|----------------|
| JCM DESIGNED | TMM DRAWN | EEL CHECKED |
| SCALE 1"=80' | | |
| DATE 3/28/2007 | | |
| PROJECT NO. 2989-01 | | |

APP. B

SHEET NO.

APPENDIX C
APPENDED SHEET SET

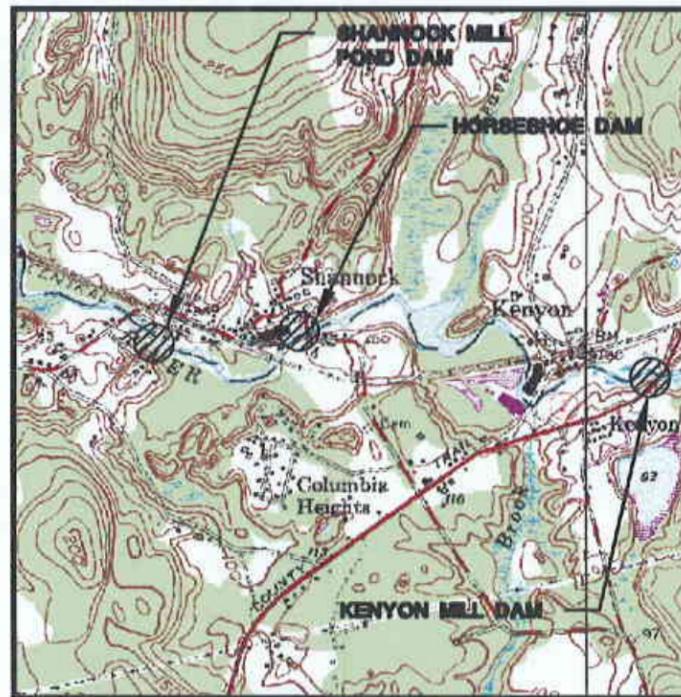
SHANNOCK FISH PASSAGE FEASIBILITY STUDY

PAWCATUCK RIVER CHARLESTOWN AND RICHMOND RHODE ISLAND

CONCEPTUAL ALTERNATIVES - NOT FOR CONSTRUCTION
AUGUST 2007

LEGEND

| | |
|--|------------------|
| | STREET LINE |
| | PROPERTY LINE |
| | CONTOUR |
| | SPOT GRADE |
| | WETLANDS |
| | TREE LINE |
| | TREES |
| | STONEWALL |
| | GUIDE RAIL |
| | WATERCOURSE EDGE |
| | EXISTING BEDROCK |



PROJECT SITE VICINITY MAP:

NOT TO SCALE
MMI # 2989-01

• **CIVIL ENGINEER - LANDSCAPE ARCHITECT
ENVIRONMENTAL SCIENCE**

Milone & MacBroom, Inc.
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LIST OF DRAWINGS

EX-1 EXISTING CONDITIONS AND VICINITY MAP

LOWER SHANNOCK FALLS DAM

S-1 EXISTING CONDITIONS
ALT S-2 FISH LADDER - PLAN
ALT S-2 FISH LADDER - PROFILE
ALT S-3 FULL DAM REMOVAL - PLAN
ALT S-3 FULL DAM REMOVAL - PROFILE

UPPER SHANNOCK HORSESHOE FALLS DAM

H-1 EXISTING CONDITIONS
ALT H-2 FISH LADDERS AT RACEWAY - PLAN
ALT H-2 FISH LADDERS AT RACEWAY - PROFILE
ALT H-3 FISH LADDER AT ABUTMENT - PLAN
ALT H-3 FISH LADDER AT ABUTMENT - PROFILE

KENYON MILL DAM

K-1 EXISTING CONDITIONS
ALT K-2 FISH LADDER - PLAN
ALT K-2 FISH LADDER - PROFILE
ALT K-3 BYPASS THROUGH BREACH - PLAN
ALT K-3 BYPASS THROUGH BREACH - PROFILE
ALT K-4 FULL DAM REMOVAL - PLAN
ALT K-4 FULL DAM REMOVAL - PROFILE
ALT K-5 HIGH GRADIENT RIFFLE - PLAN
ALT K-5 HIGH GRADIENT RIFFLE - PROFILE

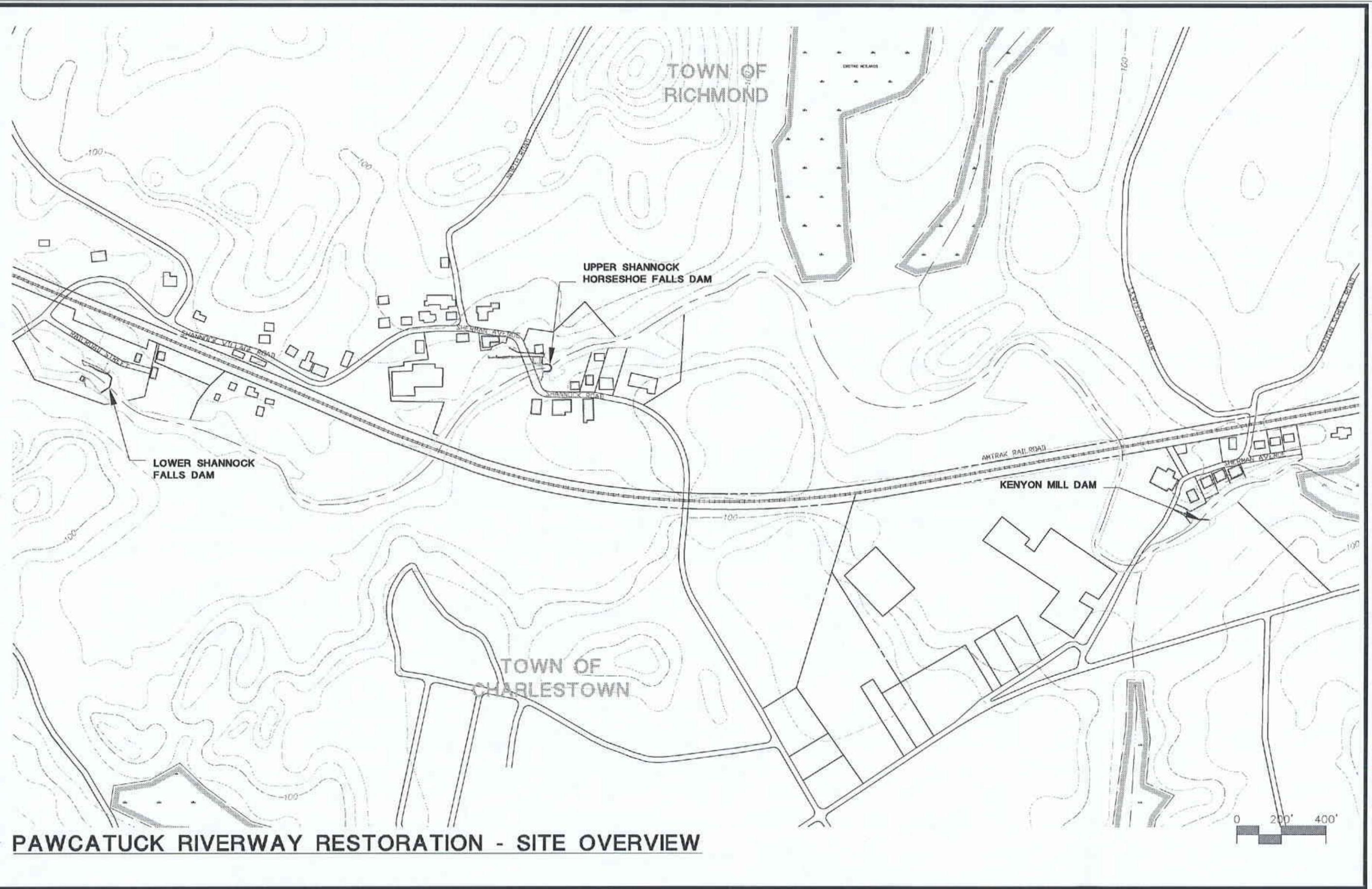
GENERAL NOTES:

1. RIVER CHANNEL ELEVATION INFORMATION FROM SURVEY CONDUCTED BY MMI IN NOVEMBER 2006, AND MARCH 2007.
2. 10' CONTOUR ELEVATION DATA DIGITIZED FROM UNITED STATES GEOLOGICAL SURVEY DATA.
3. BUILDING DATA, WATERCOURSE EDGE, AND ROAD DATA FROM RHODE ISLAND GIS (RIGIS) AND RIGIS 2003 AERIAL PHOTOGRAPHY, AND VERIFIED BY SUPPLEMENTAL SURVEY CONDUCTED BY MMI IN NOVEMBER 2006 AND MARCH 2007
4. ALL HORIZONTAL DATA IN RHODE ISLAND STATE PLANE NAD83, AND VERTICAL DATA IN NGVD29 PROJECTIONS.
5. PARCEL OWNER INFORMATION FROM TOWN OF RICHMOND AND TOWN OF CHARLESTOWN TAX ASSESSOR MAPPING. CHARLESTOWN MAPPING LAST REVISED 12/2005. RICHMOND MAPPING LAST UPDATED 06/2004, AND 09/2001.
6. DAMS ARE OF IRREGULAR WIDTH, AND ARE SHOWN ON THE PLANS AT AN APPROXIMATED AVERAGE WIDTH.

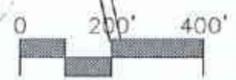
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Drawing: H:\Projects\2007\PAWCATUCK\PAWCATUCK.dwg
 Plotted by: JAM/SM On this date: Fri, 03/26/2007 August 10 - 3:03pm

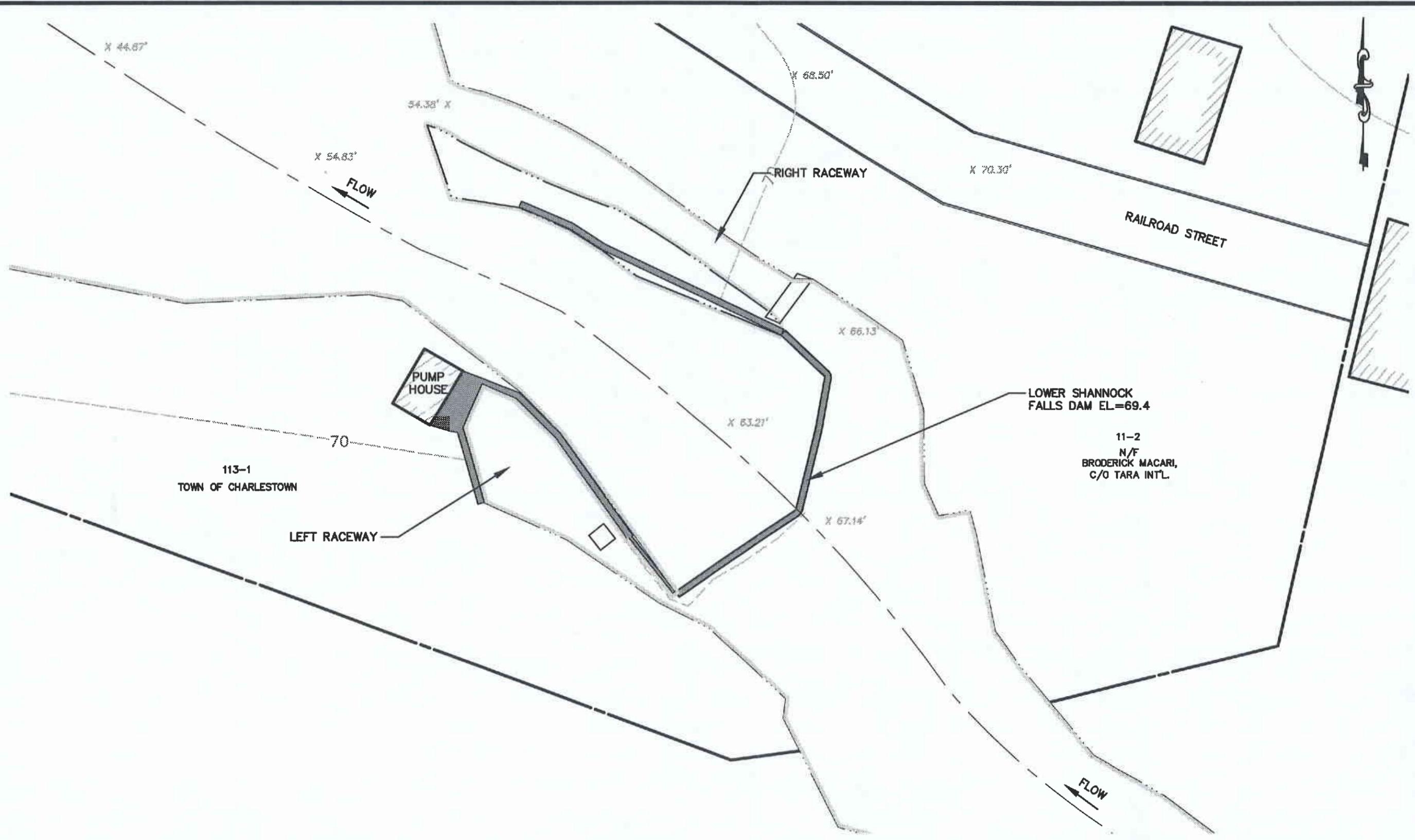


PAWCATUCK RIVERWAY RESTORATION - SITE OVERVIEW

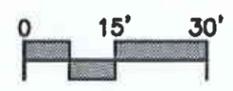


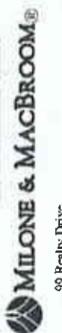
|  MILONE & MACBROOM® <small>Engineering, Architecture and Environmental Science</small> <small>99 Keeler Drive Charlestown, Rhode Island 02810 (401) 271-3773 Fax: (401) 271-9773 www.miloneandmacbroom.com</small> | | | | | | | | | | | | |
|--|-----------------|------------------------|----------------|------------------------|--|--|----------------------|--|--|----------------------------|--|--|
| <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">REVISIONS</th> </tr> </thead> <tbody> <tr> <td style="font-size: small;"># DATE DESCRIPTION</td> </tr> <tr> <td> </td> </tr> <tr> <td> </td> </tr> <tr> <td> </td> </tr> <tr> <td> </td> </tr> </tbody> </table> | REVISIONS | # DATE DESCRIPTION | | | | | | | | | | |
| REVISIONS | | | | | | | | | | | | |
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| <p>EXISTING CONDITIONS PLAN / VICINITY MAP</p> <p>SHANNOCK FISH PASSAGE FEASIBILITY STUDY</p> <p>CHARLESTOWN AND RICHMOND RHODE ISLAND</p> | | | | | | | | | | | | |
| <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="font-size: x-small;">EEL DESIGNED</td> <td style="font-size: x-small;">TMM DRAWN</td> <td style="font-size: x-small;">MRA CHECKED</td> </tr> <tr> <td colspan="3">SCALE 1" = 400'</td> </tr> <tr> <td colspan="3">DATE 03/26/07</td> </tr> <tr> <td colspan="3">PROJECT NO. 2989-01</td> </tr> </table> | EEL DESIGNED | TMM DRAWN | MRA CHECKED | SCALE 1" = 400' | | | DATE 03/26/07 | | | PROJECT NO. 2989-01 | | |
| EEL DESIGNED | TMM DRAWN | MRA CHECKED | | | | | | | | | | |
| SCALE 1" = 400' | | | | | | | | | | | | |
| DATE 03/26/07 | | | | | | | | | | | | |
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| EX-1 | | | | | | | | | | | | |

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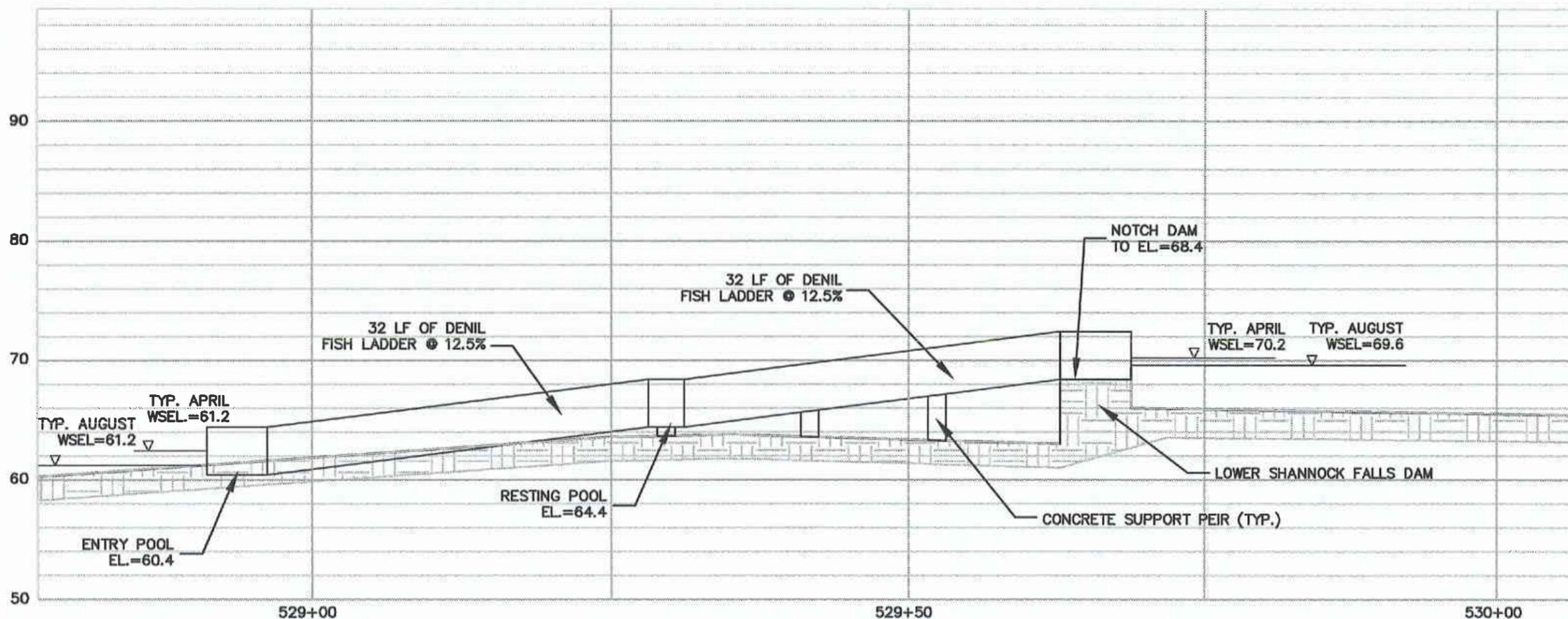
LOWER SHANNOCK FALLS DAM



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| REVISIONS AUGUST, 2007 | | |
| LOWER SHANNOCK FALLS DAM EXISTING CONDITIONS SHANNOCK FISH PASSAGE FEASIBILITY STUDY CHARLESTOWN AND RICHMOND, RHODE ISLAND | | |
| EEL <small>DESIGNED</small> | TMM <small>DRAWN</small> | MRA <small>CHECKED</small> |
| SCALE 1" = 30' | | |
| DATE 03/26/07 | | |
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| S-1 | | |

Design: I:\2009-01\Drawings\ALT S-2\DWG Layout Tool\ALT S-2-PROF

Printed by: JAMESW On: via dwt: Fri, 03/28/07 August 19 - 3:53pm



LOWER SHANNOCK FALLS DAM - PROFILE
 (SCALE: 1"=10'H, 1"=10'V)

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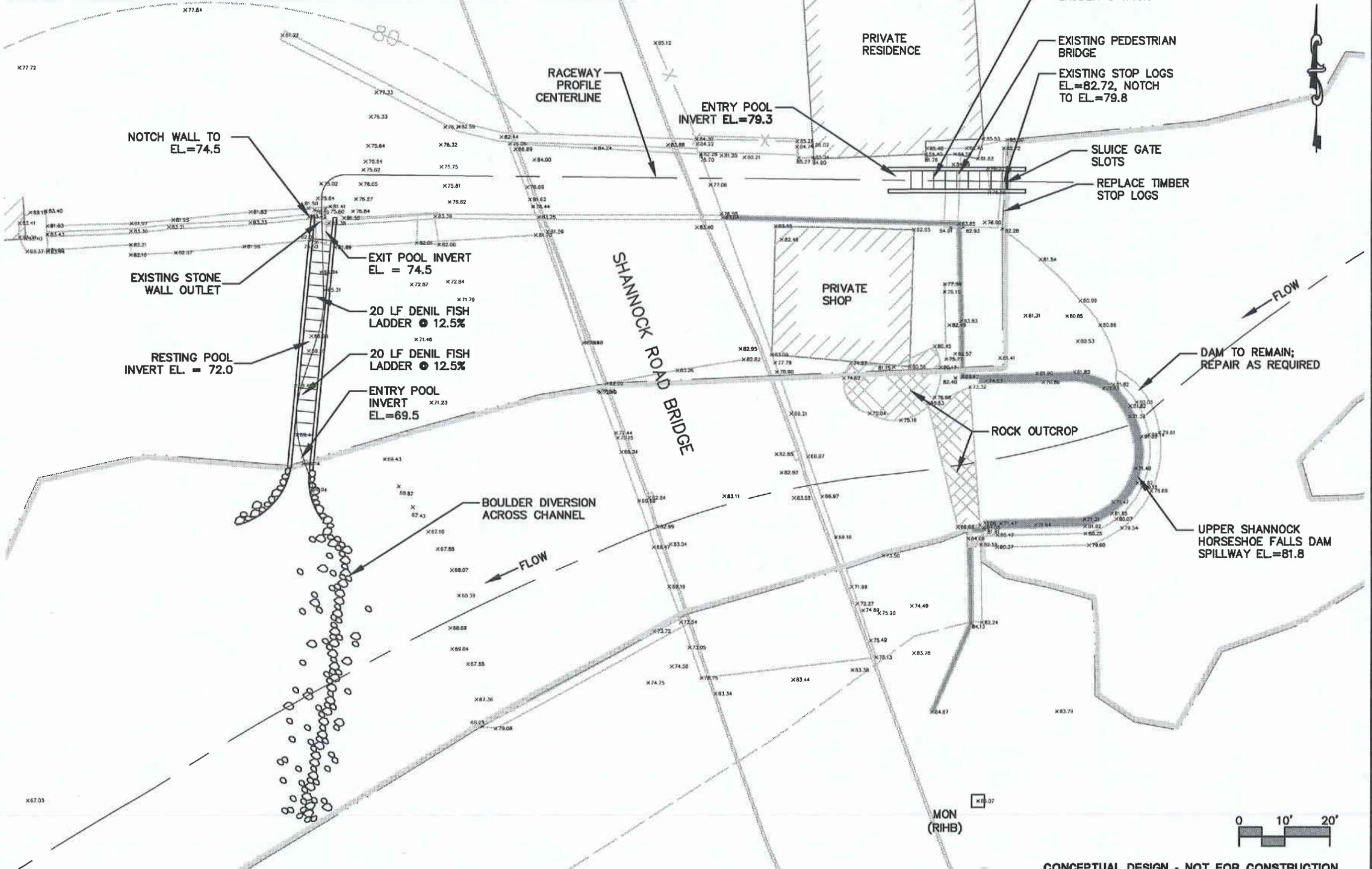
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| 1 | AUGUST, 2007 | |

LOWER SHANNOCK FALLS DAM - FISH LADDER
 SHANNOCK FISH PASSAGE
 FEASIBILITY STUDY
 CHARLESTOWN AND RICHMOND
 RHODE ISLAND

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| DESIGNED | DRAWN | CHECKED |
| SCALE: 1" = 10' | | |
| DATE: 03/28/07 | | |
| PROJECT NO: 2989-01 | | |

ALT S-2
 SHEET NO.

UPPER SHANNOCK HORSESHOE FALLS DAM - PLAN



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UPPER SHANNOCK HORSESHOE FALLS DAM
FISH LADDERS AT RACEWAY
SHANNOCK FISH PASSAGE
FEASIBILITY STUDY
CHARLESTOWN AND RICHMOND, RHODE ISLAND

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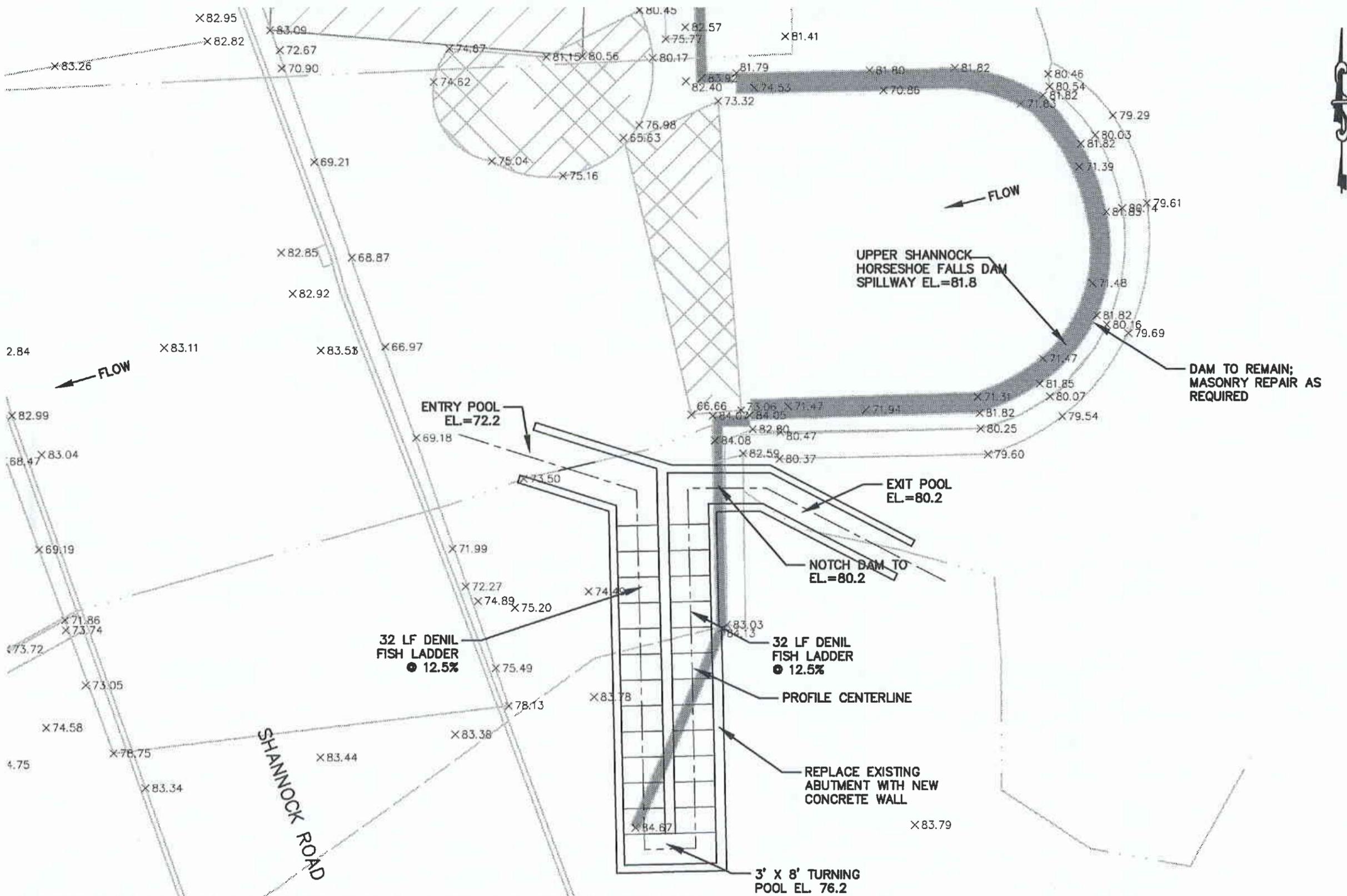
ALT H-2
SHEET NO.

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

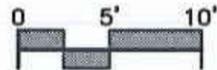
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Plotted by: JAMESM On this date: Fri, 2007 August 10 - 3:29pm



UPPER SHANNOCK HORSESHOE FALLS DAM - PLAN



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UPPER SHANNOCK HORSESHOE FALLS DAM
FISH LADDER AT ABUTMENT
SHANNOCK FISH PASSAGE
FEASIBILITY STUDY
 CHARLESTOWN AND RICHMOND, RHODE ISLAND

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ALT H-3

APPENDIX D

ENGINEER'S ESTIMATE OF PROBABLE COST SPREADSHEETS

**ALTERNATIVE S-1 SHANNOCK MILL POND DAM NO ACTION
Richmond and Charlestown, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|------|----------|--------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 1,000 | \$10.00 | \$10,000 |
| 3 | Construction Access | LS | 1 | \$20,000.00 | \$20,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$20,000.00 | \$20,000 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$150,000.00 | \$150,000 |
| Restoration | | | | | |
| 7 | Site Restoration | LS | 1 | \$15,000.00 | \$15,000 |
| SUBTOTAL | | | | | \$231,000 |
| Estimated Engineering Design and Permit Costs | | | | | \$65,000 |
| SUBTOTAL | | | | | \$296,000 |
| 25% Contingency | | | | | \$74,000 |
| Total | | | | | \$370,000 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$370,000 |

**ALTERNATIVE S-2 SHANNOCK MILL POND DAM FISH LADDER ON RIGHT BANK
Charlestown and Richmond, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|-------------|-----------------|--------------|---|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 1,000 | \$10.00 | \$10,000 |
| 3 | Construction Access | LS | 1 | \$20,000.00 | \$20,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$20,000.00 | \$20,000 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$150,000.00 | \$150,000 |
| Fish Ladder Installation | | | | | |
| 7 | Concrete | CY | 30 | \$1,000.00 | \$30,300 |
| 8 | Gate Hardware and Baffles (24) | LS | 1 | \$6,400.00 | \$6,400 |
| 9 | Bedrock Excavation | CY | 25 | \$500.00 | \$12,500 |
| Restoration | | | | | |
| 10 | Site Restoration | LS | 1 | \$15,000.00 | \$15,000 |
| SUBTOTAL | | | | | \$280,200 |
| Estimated Engineering Design and Permit Costs | | | | | \$80,000 |
| SUBTOTAL | | | | | \$360,200 |
| 25% Contingency | | | | | \$90,050 |
| Total | | | | | \$450,250 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$450,000 |

**ALT. S-3 SHANNOCK MILL POND DAM FULL DAM REMOVAL
Richmond and Charlestown, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|---|------|----------|--------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing/ Wire Mesh | LF | 1,000 | \$25.00 | \$25,000 |
| 3 | Construction Access, Signs & Traffic Control | LS | 1 | \$20,000.00 | \$20,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$10,000.00 | \$10,000 |
| Dam Removal | | | | | |
| 6 | Dam Removal / Channel Work | LS | 1 | \$110,000.00 | \$150,000 |
| 7 | Sediment Relocation/ In-channel | CY | 100 | \$20.00 | \$2,000 |
| 8 | Bedrock Excavation | CY | 25 | \$500.00 | \$12,500 |
| Restoration | | | | | |
| 9 | Site Restoration | LS | 1 | \$20,000.00 | \$20,000 |
| SUBTOTAL | | | | | \$255,500 |
| Estimated Engineering Design and Permit Costs | | | | | \$75,000 |
| SUBTOTAL | | | | | \$330,500 |
| 25% Contingency | | | | | \$82,625 |
| Total | | | | | \$413,125 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$413,000 |

**HORSESHOE DAM NO ACTION
Richmond and Charlestown, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|------|----------|-------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 1,000 | \$10.00 | \$10,000 |
| 3 | Construction Access | LS | 1 | \$5,000.00 | \$5,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$20,000.00 | \$20,000 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$75,000.00 | \$75,000 |
| Restoration | | | | | |
| 7 | Site Restoration | LS | 1 | \$7,500.00 | \$7,500 |
| SUBTOTAL | | | | | \$133,500 |
| Estimated Engineering Design and Permit Costs | | | | | \$40,000 |
| SUBTOTAL | | | | | \$173,500 |
| 25% Contingency | | | | | \$43,375 |
| Total | | | | | \$216,875 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$217,000 |

**ALTERNATIVE H-2 HORSESHOE DAM FISH LADDERS AT RIGHT RACEWAY
Charlestown and Richmond, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|-------------|-----------------|--------------|---|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$15,000.00 | \$15,000 |
| 2 | Temporary Construction Fencing | LF | 1,000 | \$10.00 | \$10,000 |
| 3 | Construction Access | LS | 1 | \$30,000.00 | \$30,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$30,000.00 | \$30,000 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$75,000.00 | \$75,000 |
| Fish Ladder and Channel Work | | | | | |
| 7 | Concrete | CY | 33 | \$1,000.00 | \$32,950 |
| 8 | Gate Hardware and Baffles (27) | LS | 1 | \$7,000.00 | \$7,000 |
| 9 | Structural Excavation | CY | 10 | \$100.00 | \$1,000 |
| 10 | Channel Improvements | LF | 300 | \$100.00 | \$30,000 |
| Restoration | | | | | |
| 11 | Site Restoration | LS | 1 | \$15,000.00 | \$15,000 |
| SUBTOTAL | | | | | \$251,950 |
| Estimated Engineering Design and Permit Costs | | | | | \$85,000 |
| SUBTOTAL | | | | | \$336,950 |
| 25% Contingency | | | | | \$84,238 |
| Total | | | | | \$421,188 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$421,000 |

**ALTERNATIVE H-2 HORSESHOE DAM FISH LADDER AT LEFT ABUTMENT
Charlestown and Richmond, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|------|----------|-------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 1,000 | \$10.00 | \$10,000 |
| 3 | Construction Access | LS | 1 | \$5,000.00 | \$5,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$25,000.00 | \$25,000 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$75,000.00 | \$75,000 |
| Fish Ladder Installation | | | | | |
| 7 | Concrete | CY | 37 | \$1,000.00 | \$37,300 |
| 8 | Gate Hardware and Baffles (26) | LS | 1 | \$6,800.00 | \$6,800 |
| 9 | Structural Excavation | CY | 10 | \$100.00 | \$1,000 |
| Restoration | | | | | |
| 10 | Site Restoration | LS | 1 | \$10,000.00 | \$10,000 |
| SUBTOTAL | | | | | \$186,100 |
| Estimated Engineering Design and Permit Costs | | | | | \$60,000 |
| SUBTOTAL | | | | | \$246,100 |
| 25% Contingency | | | | | \$61,525 |
| Total | | | | | \$307,625 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$308,000 |

**KENYON MILL DAM NO ACTION
Richmond and Charlestown, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|------|----------|-------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 200 | \$10.00 | \$2,000 |
| 3 | Construction Access | LS | 1 | \$7,500.00 | \$7,500 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$7,500.00 | \$7,500 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$40,000.00 | \$40,000 |
| Restoration | | | | | |
| 7 | Site Restoration | LS | 1 | \$7,500.00 | \$7,500 |
| SUBTOTAL | | | | | \$80,500 |
| Estimated Engineering Design and Permit Costs | | | | | \$25,000 |
| SUBTOTAL | | | | | \$105,500 |
| 25% Contingency | | | | | \$26,375 |
| Total | | | | | \$131,875 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$132,000 |

**ALTERNATIVE K-2 KENYON MILL DAM FISH LADDER ON RIGHT BANK
Charlestown and Richmond, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|------|----------|-------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 200 | \$10.00 | \$2,000 |
| 3 | Construction Access | LS | 1 | \$7,500.00 | \$7,500 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$7,500.00 | \$7,500 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$40,000.00 | \$40,000 |
| Fish Ladder Installation | | | | | |
| 7 | Concrete | CY | 21 | \$1,000.00 | \$21,000 |
| 8 | Gate Hardware and Baffles (17) | LS | 1 | \$5,000.00 | \$5,000 |
| 9 | Structural Excavation | CY | 10 | \$100.00 | \$1,000 |
| Restoration | | | | | |
| 10 | Site Restoration | LS | 1 | \$10,000.00 | \$10,000 |
| SUBTOTAL | | | | | \$100,000 |
| Estimated Engineering Design and Permit Costs | | | | | \$35,000 |
| SUBTOTAL | | | | | \$135,000 |
| 25% Contingency | | | | | \$33,750 |
| Total | | | | | \$168,750 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$169,000 |

**ALTERNATE K-3 KENYON MILL DAM BYPASS CHANNEL THROUGH BREACH
Richmond and Charlestown, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|------|----------|-------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 200 | \$10.00 | \$2,000 |
| 3 | Construction Access | LS | 1 | \$10,000.00 | \$10,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$7,500.00 | \$7,500 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$40,000.00 | \$40,000 |
| By-pass Channel | | | | | |
| 7 | Channel Work | LS | 1 | \$50,000.00 | \$50,000 |
| Restoration | | | | | |
| 8 | Site Restoration | LS | 1 | \$15,000.00 | \$15,000 |
| SUBTOTAL | | | | | \$140,500 |
| Estimated Engineering Design and Permit Costs | | | | | \$40,000 |
| SUBTOTAL | | | | | \$180,500 |
| 25% Contingency | | | | | \$45,125 |
| Total | | | | | \$225,625 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$226,000 |

**Alternative K-4 Kenyon Mill Pond Dam Full Dam Removal
Richmond and Charlestown, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|-----------------------------------|------|----------|--------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 200 | \$10.00 | \$2,000 |
| 3 | Construction Access | LS | 1 | \$10,000.00 | \$10,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$7,500.00 | \$7,500 |
| Dam Removal | | | | | |
| 6 | Dam Removal / Channel Work | LS | 1 | \$110,000.00 | \$125,000 |
| 7 | Sediment Relocation/ In-channel | CY | 100 | \$20.00 | \$2,000 |
| Alternate Fire Suppression at Kenyon Mill | | | | | |
| 8 | Alternate Fire Suppression System | LS | 1 | \$50,000.00 | \$50,000 |
| Restoration | | | | | |
| 9 | Site Restoration | LS | 1 | \$20,000.00 | \$20,000 |
| SUBTOTAL | | | | | \$232,500 |
| Estimated Engineering Design and Permit Costs | | | | | \$75,000 |
| SUBTOTAL | | | | | \$307,500 |
| 25% Contingency | | | | | \$76,875 |
| Total | | | | | \$384,375 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$384,000 |

**ALTERNATE K-5 KENYON MILL DAM HIGH GRADIENT RIFFLE
Richmond and Charlestown, Rhode Island**

ENGINEER'S PRELIMINARY ESTIMATE OF PROBABLE COST

| ITEM NO. | ITEM/DESCRIPTION | UNIT | QUANTITY | PRICE | DOLLAR AMOUNT (Nearest \$10) |
|--|--------------------------------|------|----------|-------------|---------------------------------|
| Site Preparation | | | | | |
| 1 | Mobilization | LS | 1 | \$10,000.00 | \$10,000 |
| 2 | Temporary Construction Fencing | LF | 200 | \$10.00 | \$2,000 |
| 3 | Construction Access | LS | 1 | \$10,000.00 | \$10,000 |
| 4 | Turbidity Curtain | LS | 1 | \$6,000.00 | \$6,000 |
| Water Handling | | | | | |
| 5 | Water Handling | LS | 1 | \$7,500.00 | \$7,500 |
| Dam Repair | | | | | |
| 6 | Dam Repair | LS | 1 | \$40,000.00 | \$40,000 |
| Rock Ramp | | | | | |
| 7 | Ramp Fill Material | CY | 1,500 | \$50.00 | \$75,000 |
| 8 | Rip-rap | SY | 200 | \$50.00 | \$10,000 |
| 9 | In-stream Features | SY | 200 | \$10.00 | \$2,000 |
| Restoration | | | | | |
| 10 | Site Restoration | LS | 1 | \$15,000.00 | \$15,000 |
| SUBTOTAL | | | | | \$165,500 |
| Estimated Engineering Design and Permit Costs | | | | | \$65,000 |
| SUBTOTAL | | | | | \$230,500 |
| 25% Contingency | | | | | \$57,625 |
| Total | | | | | \$288,125 |
| ESTIMATED CONSTRUCTION TOTAL (Nearest \$1000) | | | | | \$288,000 |

APPENDIX E
SEDIMENT ANALYSIS DATA



Table 7
Summary of Detected Parameters in Sediment Samples
Collected on November 16, 2006

Former Knowles Mill
Richmond, Rhode Island

Site Investigation Report
Prepared for RIDEM

February 2007

| | Location | SD-01 | SD-02 | SD-03 | SD-04 | SD-04 Duplicate | SD-05 |
|--|---------------|------------|------------|------------|------------|-----------------|------------|
| | Sample Number | 16-04 | 16-05 | 16-06 | 16-07 | 16-08 | 16-09 |
| | Sample Date | 11/16/2006 | 11/16/2006 | 11/16/2006 | 11/16/2006 | 11/16/2006 | 11/16/2006 |
| VOCs (via Method 8260) | | | | | | | |
| Acetone | µg/kg | ND<75 | ND<44 | ND<30 | ND<32 | 33 | ND<26 |
| SVOCs (via Method 8270) | | | | | | | |
| Acenaphthylene | µg/kg | ND<76 | ND<42 | ND<29 | 83 | 160 | ND<26 |
| Anthracene | µg/kg | ND<72 | ND<40 | 110 | 75 | 110 | 27 |
| Benzo(a)anthracene | µg/kg | 110 | ND<35 | 75 | 370 | 560 | 120 |
| Benzo(a)pyrene | µg/kg | ND<56 | ND<31 | 66 | 390 | 680 | 120 |
| Benzo(b)fluoranthene | µg/kg | 99 | 28 | 43 | 630 | 840 | 170 |
| Benzo(ghi)perylene | µg/kg | ND<56 | ND<31 | 39 | 120 | 240 | 57 |
| Benzo(k)fluoranthene | µg/kg | 83 | ND<35 | 76 | 350 | 870 | 140 |
| Bis(2-ethylhexyl)phthalate | µg/kg | ND<600 | ND<330 | ND<230 | ND<270 | 230 | ND<200 |
| Chrysene | µg/kg | 110 | ND<40 | 90 | 610 | 970 | 210 |
| Dibenzo(a,h)anthracene | µg/kg | ND<60 | ND<33 | ND<23 | 100 | 120 | ND<20 |
| Fluoranthene | µg/kg | 240 | 52 | 160 | 1,000 | 1,300 | 320 |
| Fluorene | µg/kg | ND<84 | ND<46 | ND<32 | ND<37 | 43 | ND<28 |
| Indeno(1,2,3-cd)pyrene | µg/kg | ND<48 | ND<27 | 31 | 180 | ND<220 | 64 |
| Naphthalene | µg/kg | ND<78 | ND<43 | ND<30 | ND<34 | 56 | ND<26 |
| Phenanthrene | µg/kg | 110 | ND<46 | 110 | 690 | 1,200 | 200 |
| Pyrene | µg/kg | 240 | 42 | 170 | 1,200 | 2,300 | 350 |
| Total Metals (via Method 6010/7471) | | | | | | | |
| Barium | mg/kg | 33 | 15 | 16 | 27 | 23 | 8.1 |
| Beryllium | mg/kg | 1.2 | 0.68 | 0.16 | 0.4 | 0.31 | 0.1 |
| Cadmium | mg/kg | 0.7 | 0.34 | ND<0.14 | ND<0.16 | 0.15 | ND<0.12 |
| Chromium | mg/kg | 11 | 5.2 | 2 | 3.6 | 2.5 | 1.7 |
| Copper | mg/kg | 11 | 6.8 | 9.3 | 6.7 | 5.6 | 2.5 |
| Lead | mg/kg | 37 | 25 | 47 | 37 | 48 | 10 |
| Manganese | mg/kg | 160 | 81 | 38 | 96 | 100 | 44 |
| Mercury | mg/kg | 0.12 | 0.074 | ND<0.028 | ND<0.032 | 0.049 | ND<0.025 |
| Nickel | mg/kg | 3.3 | 1.7 | 1 | 1.4 | 1.3 | 0.84 |
| Vanadium | mg/kg | 8.4 | 5 | 2.5 | 3.3 | 3 | 5 |
| Zinc | mg/kg | 56 | 28 | 47 | 44 | 31 | 9.5 |
| PCBs (via Method 8082) | µg/kg | ND<48 | ND<26 | ND<18 | ND<21 | ND<17 | ND<16 |
| Cyanide (via Method 9012) | mg/kg | ND<1.8 | ND<1.0 | ND<0.71 | ND<0.81 | ND<0.66 | ND<0.62 |
| Pesticides (via Method 8081) | µg/kg | ND<1.4 | ND<1.3 | ND<0.93 | ND<1.0 | ND<0.88 | ND<0.80 |

NOTES:

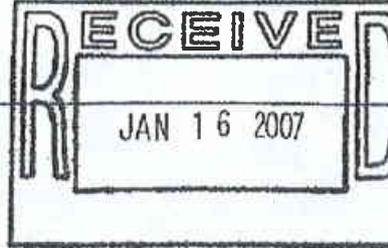
SD = sediment sample
 µg/kg = micrograms per kilogram
 mg/kg = milligrams per kilogram
 VOCs = volatile organic compounds
 SVOCs = semi-volatile organic compounds
 PCBs = polychlorinated biphenyls
 Only the last four digits of the sample number are listed
 ND<# = not detected above laboratory reporting limit
 | = concentration estimated to the method detection limit

Created by: HEK
 Reviewed by: LCK



**Premier
Laboratory, LLC**

61 Louisa Viens Drive
Dayville, CT 06241
FAX: 860-774-2889
860-774-8814 800-932-1150



ANALYTICAL DATA REPORT

Report Number: E611A38

Project: 20060089.A20/ Knowles Mill

prepared for:

Fuss & O'Neill, Inc.
275 Promenade Street
Suite 350
Providence, RI 02908
Attn: Brian Kortz

Received Date: 11/17/2006

Report Date: 1/11/2007

Premier Laboratory, LLC
Authorized Signature



Certifications:

CT (PH-0465), MA (M-CT008), ME (CT050), NH (2020), NJ (CT002), NY (11549), RI (RI246)



**Premier
Laboratory, LLC**

61 Louisa Viens Drive
Dayville, CT 06241
FAX: 860-774-2689
860-774-8814 800-932-1150

Report No: E611A38
Client: Fuss & O'Neill
Project: 20060089.A20/ Knowles Mill

CASE NARRATIVE / METHOD CONFORMANCE SUMMARY

Premier Laboratory received 12 samples from Fuss & O'Neill on 11/17/2006. The samples were analyzed from the following list of analyses:

Cyanide, Total, by 9012 in GW/SW
9012[9012]

Mercury by 7471 in SW
7471[7471]

Pesticides by 8081A in GW/SW
8081A[3500]

Trace Metals by 6010B
6010B[3000]

Mercury by 7470 in GW
7470A[245.1]

Moisture, Percent

PCB's by 8082 in GW/SW
8082[3500]

Semivolatiles by 8270C for GW/SW
8270C[3500]

Volatiles by 8260B in GW/SW
8260B

In order to meet requested detection limits, BDB results were estimated to Method Detection Limits for samples 841061109-04 and -05 for EPA method 8260B. For sample 841061109-04 through -09, PAH compounds and Hexachlorobenzene were estimated to their respective MDL values for EPA method 8270C. The estimation is represented by a "J" qualifier in the Detection Limit column.

Variations:

SDG:

Instrument QC failed to meet method criteria for EPA method 8081 due to matrix interference for sample fractions -5, -6, -7, -8, -9 and -12. The sample batch was rerun to confirm sample matrix interference.

Method:

Sample 12A, 841061116-12, Pesticides by 8081A: The holding time was exceeded prior to the extraction of this sample. The initial extraction failed to meet QC criteria.

Sample 12A, 841061116-12, Semivolatiles by SW-846 8270C: The holding time was exceeded prior to the extraction of this sample. The first extraction did not meet method QC limits.

QA/QC:

Sample 1A, 841061116-01, Semivolatiles by SW-846 8270C: One internal standard was outside quality control limits for the sample due to matrix interference.



Report No: E611A38
Client: Fuss & O'Neill
Project: 20060089.A20/ Knowles Mill

CASE NARRATIVE / METHOD CONFORMANCE SUMMARY
(continued)

QA/QC (continued):

Sample 2A, 841061116-02, Semivolatiles by SW-846 8270C: Two internal standard areas were outside quality control limits for the sample due to matrix interference.

Sample 2C, 841061116-02, Volatiles by 8260B: One internal standard was outside quality control limits for the sample due to matrix interference. The sample was re-analyzed and the internal standard was still outside the limits.

Sample 2C, 841061116-02, Volatiles by 8260B: Two surrogate spikes were outside quality control limits for the sample due to matrix interference. The sample was re-analyzed and the surrogate standard was still outside the limits.

Sample 5A, 841061116-05, Semivolatiles by SW-846 8270C: Two surrogate spikes were outside quality control limits for the sample, due to matrix interference.

Sample 6A, 841061116-06, Semivolatiles by SW-846 8270C: One surrogate spike was outside quality control limits for the sample, due to matrix interference.

Sample 7A, 841061116-07, Semivolatiles by SW-846 8270C: One internal standard was outside quality control limits for the sample due to matrix interference.

Sample 8A, 841061116-08, Semivolatiles by SW-846 8270C: One internal standard was outside quality control limits for the sample due to matrix interference.

INORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC
 PL Report No: B611A38
 Date Received: 11/17/2006

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill

| Parameter | Result | Qual | OL | MDL | Units | Started | | Completed | | Dilution |
|---------------------------------------|--------|------------------------|-------|--------|-------|----------|-----|-----------|-----|----------|
| | | | | | | Date | By | Date | By | |
| (3) 841061116-03 (continued) | | SS-03 (0.5'-1') | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 3.1 | | 0.52 | 0.28 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Barium | 22 | | 0.52 | 0.042 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Cadmium | 0.42 | | 0.10 | 0.055 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Chromium | 1.3 | | 0.52 | 0.10 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Lead | 24 | | 0.21 | 0.18 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Selenium | 0.52 | U | 0.52 | 0.35 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Silver | 0.10 | U | 0.10 | 0.070 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Zinc | 73 | | 0.52 | 0.70 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Vanadium | 2.2 | | 0.52 | 0.037 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Thallium | 0.26 | U | 0.26 | 0.19 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Nickel | 5.0 | | 0.52 | 0.069 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Manganese | 73 | | 0.52 | 0.033 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Copper | 8.4 | | 0.52 | 0.14 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Beryllium | 0.13 | | 0.052 | 0.012 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Antimony | 1.0 | U | 1.0 | 0.21 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Mercury by SW-846 7471 in SW | | | | | | | | | | |
| Mercury | 0.071 | | 0.021 | 0.0025 | mg/kg | 11/22/06 | BSZ | 11/22/06 | BSZ | |
| (4) 841061116-04 | | SD - CI | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Cyanide, Total, by SW-846 9012 | | | | | | | | | | |
| Cyanide | 1.8 | U | 1.8 | 0.55 | mg/kg | 11/20/06 | KAW | 11/27/06 | DDD | |

INORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC
 PL Report No: E611A38
 Date Received: 11/17/2006

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill

| Parameter | Result | Qual | QL | MDL | Units | Started | | Completed | | Dilution |
|-------------------------------------|--------|----------------------|-------|--------|-------|----------|-----|-----------|-----|----------|
| | | | | | | Date | By | Date | By | |
| (4) 841061116-04 (continued) | | SD-01 | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 1.8 | U | 1.8 | 0.97 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Barium | 33 | | 1.8 | 0.14 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Cadmium | 0.70 | | 0.37 | 0.19 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Chromium | 11 | | 1.8 | 0.36 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Lead | 37 | | 0.74 | 0.64 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Selenium | 1.8 | U | 1.8 | 1.2 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Silver | 0.37 | U | 0.37 | 0.24 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Zinc | 56 | | 1.8 | 0.37 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Vanadium | 8.4 | | 1.8 | 0.13 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Thallium | 0.92 | U | 0.92 | 0.65 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Nickel | 3.3 | | 1.8 | 0.24 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Manganese | 160 | | 1.8 | 0.12 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Copper | 11 | | 1.8 | 0.51 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Beryllium | 1.2 | | 0.18 | 0.040 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Antimony | 3.7 | U | 3.7 | 0.73 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Mercury by SW-846 7471 in SW | | | | | | | | | | |
| Mercury | 0.12 | | 0.074 | 0.0088 | mg/kg | 11/22/06 | BSZ | 11/22/06 | BSZ | |
| (5) 841061116-05 | | SD-02 | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Cyanide, Total, by SW-846 9012 | | | | | | | | | | |
| Cyanide | 1.0 | U | 1.0 | 0.30 | mg/kg | 11/21/06 | KAW | 11/27/06 | DDD | |

INORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC
 PL Report No: B611A38
 Date Received: 11/17/2006

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill

| Parameter | Result | Qual | QL | MDL | Units | Started Date | By | Completed Date | By | Dilution |
|---------------------------------------|--------|----------------------|-------|--------|-------|-----------------|-----|-------------------|-----|----------|
| (5) 841061116-05 (continued) | | SD-02 | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 1.0 | U | 1.0 | 0.53 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Barium | 15 | | 1.0 | 0.079 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Cadmium | 0.34 | | 0.20 | 0.10 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Chromium | 5.2 | | 1.0 | 0.20 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Lead | 25 | | 0.40 | 0.35 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Selenium | 1.0 | U | 1.0 | 0.67 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Silver | 0.20 | U | 0.20 | 0.13 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Zinc | 28 | | 1.0 | 0.20 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Vanadium | 5.0 | | 1.0 | 0.071 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Thallium | 0.50 | U | 0.50 | 0.35 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Nickel | 1.7 | | 1.0 | 0.13 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Manganese | 81 | | 1.0 | 0.063 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Copper | 6.8 | | 1.0 | 0.28 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Beryllium | 0.68 | | 0.10 | 0.022 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Antimony | 2.0 | U | 2.0 | 0.40 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Mercury by SW-846 7471 in SW | | | | | | | | | | |
| Mercury | 0.074 | | 0.040 | 0.0048 | mg/kg | 11/22/06 | BSZ | 11/22/06 | BSZ | |
| (6) 841061116-06 | | SD-03 | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Cyanide, Total, by SW-846 9012 | | | | | | | | | | |
| Cyanide | 0.71 | U | 0.71 | 0.21 | mg/kg | 11/21/06 | KAW | 11/27/06 | DDD | |

INORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC
 PL Report No: B611A38
 Date Received: 11/17/2006

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill

| Parameter | Result | Qual | QL | MDL | Units | Started | | Completed | | Dilution |
|-------------------------------------|--------|------|-------|--------|-------|----------------------|-----|-----------|-----|----------|
| | | | | | | Date | By | Date | By | |
| (6) 841061116-06 (continued) | | | | | | SD-03 | | | | |
| Date Collected: 11/16/2006 | | | | | | Matrix: Solid | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 0.71 | U | 0.71 | 0.37 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Barium | 16 | | 0.71 | 0.056 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Cadmium | 0.14 | U | 0.14 | 0.073 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Chromium | 2.0 | | 0.71 | 0.14 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Lead | 47 | | 0.28 | 0.25 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Selenium | 0.71 | U | 0.71 | 0.48 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Silver | 0.14 | U | 0.14 | 0.094 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Zinc | 47 | | 0.71 | 0.14 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Vanadium | 2.5 | | 0.71 | 0.050 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Thallium | 0.35 | U | 0.35 | 0.25 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Nickel | 1.0 | | 0.71 | 0.092 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Manganese | 38 | | 0.71 | 0.044 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Copper | 9.3 | | 0.71 | 0.20 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Beryllium | 0.16 | | 0.071 | 0.016 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Antimony | 1.4 | U | 1.4 | 0.28 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Mercury by SW-846 7471 in SW | | | | | | | | | | |
| Mercury | 0.028 | U | 0.028 | 0.0034 | mg/kg | 11/22/06 | BSZ | 11/22/06 | BSZ | |
| (7) 841061116-07 | | | | | | SD-04 | | | | |
| Date Collected: 11/16/2006 | | | | | | Matrix: Solid | | | | |
| Cyanide, Total, by SW-846 9012 | | | | | | | | | | |
| Cyanide | 0.81 | U | 0.81 | 0.24 | mg/kg | 11/21/06 | KAW | 11/27/06 | DDD | |

INORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC
 PL Report No: E611A38
 Date Received: 11/17/2006

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill

| Parameter | Result | Qual | QL | MDL | Units | Started Date | By | Completed Date | By | Dilution |
|---------------------------------------|--------|--------------------------------|-------|--------|-------|-----------------|-----|-------------------|-----|----------|
| (7) 841061116-07 (continued) | | SD-04 | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 0.81 | U | 0.81 | 0.43 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Barium | 27 | | 0.81 | 0.064 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Cadmium | 0.16 | U | 0.16 | 0.084 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Chromium | 3.6 | | 0.81 | 0.16 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Lead | 37 | | 0.32 | 0.28 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Selenium | 0.81 | U | 0.81 | 0.55 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Silver | 0.16 | U | 0.16 | 0.11 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Zinc | 44 | | 0.81 | 0.16 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Vanadium | 3.3 | | 0.81 | 0.057 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Thallium | 0.40 | U | 0.40 | 0.29 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Nickel | 1.4 | | 0.81 | 0.10 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Manganese | 96 | | 0.81 | 0.051 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Copper | 6.7 | | 0.81 | 0.22 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Beryllium | 0.40 | | 0.081 | 0.018 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Antimony | 1.6 | U | 1.6 | 0.32 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Mercury by SW-846 7471 in SW | | | | | | | | | | |
| Mercury | 0.032 | U | 0.032 | 0.0039 | mg/kg | 11/22/06 | BSZ | 11/22/06 | BSZ | |
| (8) 841061116-08 | | SD-04 (Field Duplicate) | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Cyanide, Total, by SW-846 9012 | | | | | | | | | | |
| Cyanide | 0.66 | U | 0.66 | 0.20 | mg/kg | 11/21/06 | KAW | 11/27/06 | DDD | |

INORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC
 PL Report No: E611A38
 Date Received: 11/17/2006

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill

| Parameter | Result | Qual | QL | MDL | Units | Started | | Completed | | Dilution |
|---------------------------------------|--------|------|-------|--------|-------|--------------------------------|-----|-----------|-----|----------|
| | | | | | | Date | By | Date | By | |
| (8) 841061116-08 (continued) | | | | | | SD-04 (Field Duplicate) | | | | |
| Date Collected: 11/16/2006 | | | | | | Matrix: Solid | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 0.66 | U | 0.66 | 0.35 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Barium | 23 | | 0.66 | 0.052 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Cadmium | 0.15 | | 0.13 | 0.068 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Chromium | 2.5 | | 0.66 | 0.13 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Lead | 48 | | 0.26 | 0.23 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Selenium | 0.66 | U | 0.66 | 0.44 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Silver | 0.13 | U | 0.13 | 0.088 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Zinc | 31 | | 0.66 | 0.13 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Vanadium | 3.0 | | 0.66 | 0.047 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Thallium | 0.33 | U | 0.33 | 0.23 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Nickel | 1.3 | | 0.66 | 0.086 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Manganese | 100 | | 0.66 | 0.041 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Copper | 5.6 | | 0.66 | 0.18 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Beryllium | 0.31 | | 0.066 | 0.014 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Antimony | 1.3 | U | 1.3 | 0.26 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Mercury by SW-846 7471 in SW | | | | | | | | | | |
| Mercury | 0.049 | | 0.026 | 0.0032 | mg/kg | 11/22/06 | BSZ | 11/22/06 | BSZ | |
| (9) 841061116-09 | | | | | | SD-05 | | | | |
| Date Collected: 11/16/2006 | | | | | | Matrix: Solid | | | | |
| Cyanide, Total, by SW-846 9012 | | | | | | | | | | |
| Cyanide | 0.62 | U | 0.62 | 0.18 | mg/kg | 11/21/06 | KAW | 11/27/06 | DDD | |

INORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC
 PL Report No: B611A38
 Date Received: 11/17/2006

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill

| Parameter | Result | Qual | QL | MDL | Units | Started Date | By | Completed Date | By | Dilution |
|-------------------------------------|--------|----------------------|-------|--------|-------|--------------|-----|----------------|-----|----------|
| (9) 841061116-09 (continued) | | SD-05 | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Solid | | | | | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 0.62 | U | 0.62 | 0.33 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Barium | 8.1 | | 0.62 | 0.049 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Cadmium | 0.12 | U | 0.12 | 0.064 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Chromium | 1.7 | | 0.62 | 0.12 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Lead | 10 | | 0.25 | 0.22 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Selenium | 0.62 | U | 0.62 | 0.42 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Silver | 0.12 | U | 0.12 | 0.082 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Zinc | 9.5 | | 0.62 | 0.12 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Vanadium | 5.0 | | 0.62 | 0.044 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Thallium | 0.31 | U | 0.31 | 0.22 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Nickel | 0.84 | | 0.62 | 0.081 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Manganese | 44 | | 0.62 | 0.039 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Copper | 2.5 | | 0.62 | 0.17 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Beryllium | 0.10 | | 0.062 | 0.014 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Antimony | 1.2 | U | 1.2 | 0.25 | mg/kg | 11/21/06 | AM | 11/21/06 | AM | |
| Mercury by SW-846 7471 in SW | | | | | | | | | | |
| Mercury | 0.025 | U | 0.025 | 0.0030 | mg/kg | 11/22/06 | BSZ | 11/22/06 | BSZ | |

| | | | | | | | | | | |
|-----------------------------------|--------|------------------------|--------|---------|------|----------|-----|----------|-----|--|
| (9) 841061116-11 | | Field Blank | | | | | | | | |
| Date Collected: 11/16/2006 | | Matrix: Aqueous | | | | | | | | |
| Trace Metals by 6010B | | | | | | | | | | |
| Arsenic | 0.010 | U | 0.010 | 0.0068 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Barium | 0.010 | U | 0.010 | 0.00042 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Cadmium | 0.0020 | U | 0.0020 | 0.00074 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Chromium | 0.010 | U | 0.010 | 0.0033 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Lead | 0.0040 | U | 0.0040 | 0.0038 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Selenium | 0.010 | U | 0.010 | 0.0043 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Silver | 0.0020 | U | 0.0020 | 0.0015 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Zinc | 0.010 | U | 0.010 | 0.0024 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Vanadium | 0.010 | U | 0.010 | 0.00066 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Thallium | 0.0050 | U | 0.0050 | 0.0047 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Nickel | 0.010 | U | 0.010 | 0.00093 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Manganese | 0.010 | U | 0.010 | 0.0021 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Copper | 0.010 | U | 0.010 | 0.0018 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Beryllium | 0.0010 | U | 0.0010 | 0.00042 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |
| Antimony | 0.010 | U | 0.010 | 0.0062 | mg/L | 11/21/06 | BSZ | 11/22/06 | AMM | |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 4

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-04

SD-01

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 72.8

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28310.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|------------------------------------|--------|------|-----|------|
| 67-64-1 | Acetone | 75 | U | 75 | 5.6 |
| 107-13-1 | Acrylonitrile | 94 | U | 94 | 3.5 |
| 71-43-2 | Benzene | 19 | U | 19 | 0.94 |
| 108-86-1 | Bromobenzene | 19 | U | 19 | 0.89 |
| 74-97-5 | Bromochloromethane | 19 | U | 19 | 1.3 |
| 75-27-4 | Bromodichloromethane | 19 | U | 19 | 0.89 |
| 75-25-2 | Bromoform | 19 | U | 19 | 0.66 |
| 74-83-9 | Bromomethane | 38 | U | 38 | 0.96 |
| 78-93-3 | 2-Butanone (MEK) | 38 | U | 38 | 5.7 |
| 104-51-8 | n-Butylbenzene | 19 | U | 19 | 0.88 |
| 135-98-8 | sec-Butylbenzene | 19 | U | 19 | 0.63 |
| 98-06-6 | tert-Butylbenzene | 19 | U | 19 | 1.8 |
| 75-15-0 | Carbon disulfide | 19 | U | 19 | 3.7 |
| 56-23-5 | Carbon tetrachloride | 19 | U | 19 | 1.8 |
| 108-90-7 | Chlorobenzene | 19 | U | 19 | 0.73 |
| 75-00-3 | Chloroethane | 38 | U | 38 | 1.8 |
| 67-66-3 | Chloroform | 19 | U | 19 | 1.4 |
| 74-87-3 | Chloromethane | 38 | U | 38 | 1.3 |
| 95-49-8 | 2-Chlorotoluene | 19 | U | 19 | 0.63 |
| 106-43-4 | 4-Chlorotoluene | 19 | U | 19 | 0.96 |
| 96-12-8 | 1,2-Dibromo-3-chloropropane (DBCP) | 19 | U | 19 | 1.7 |
| 124-48-1 | Dibromochloromethane | 19 | U | 19 | 0.80 |
| 106-93-4 | 1,2-Dibromoethane (EDB) | 1.0 | U | 1.0 | 1.0 |
| 74-95-3 | Dibromomethane | 19 | U | 19 | 0.96 |
| 95-50-1 | 1,2-Dichlorobenzene | 19 | U | 19 | 0.58 |
| 541-73-1 | 1,3-Dichlorobenzene | 19 | U | 19 | 0.96 |
| 106-46-7 | 1,4-Dichlorobenzene | 19 | U | 19 | 1.2 |
| 75-71-8 | Dichlorodifluoromethane | 38 | U | 38 | 0.59 |
| 75-34-3 | 1,1-Dichloroethane | 19 | U | 19 | 1.0 |
| 107-06-2 | 1,2-Dichloroethane | 19 | U | 19 | 1.8 |
| 75-35-4 | 1,1-Dichloroethene | 19 | U | 19 | 1.3 |
| 156-59-2 | cis-1,2-Dichloroethene | 19 | U | 19 | 1.6 |
| 156-60-5 | trans-1,2-Dichloroethene | 19 | U | 19 | 1.3 |
| 78-87-5 | 1,2-Dichloropropane | 19 | U | 19 | 1.3 |
| 142-28-9 | 1,3-Dichloropropane | 19 | U | 19 | 1.2 |
| 590-20-7 | 2,2-Dichloropropane | 19 | U | 19 | 0.81 |
| 563-58-6 | 1,1-Dichloropropene | 19 | U | 19 | 1.4 |
| 10061-01-5 | cis-1,3-Dichloropropene | 19 | U | 19 | 1.1 |
| 10061-02-6 | trans-1,3-Dichloropropene | 19 | U | 19 | 0.63 |
| 100-41-4 | Ethylbenzene | 19 | U | 19 | 1.1 |
| 87-68-3 | Hexachlorobutadiene | 19 | U | 19 | 0.69 |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 4 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-04

SD-01

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 72.8

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28310.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|--------------------------------|--------|------|----|------|
| 591-78-6 | 2-Hexanone | 38 | U | 38 | 4.2 |
| 98-82-8 | Isopropylbenzene | 19 | U | 19 | 0.86 |
| 99-87-6 | 4-Isopropyltoluene | 19 | U | 19 | 0.48 |
| 1634-04-4 | Methyl tert-butyl ether (MTBE) | 19 | U | 19 | 2.6 |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) | 38 | U | 38 | 5.6 |
| 75-09-2 | Methylene chloride | 19 | U | 19 | 1.9 |
| 91-20-3 | Naphthalene | 19 | U | 19 | 0.80 |
| 103-65-1 | n-Propylbenzene | 19 | U | 19 | 0.72 |
| 100-42-5 | Styrene | 19 | U | 19 | 0.59 |
| 96-18-4 | 1,2,3-Trichloropropane | 19 | U | 19 | 1.7 |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | 19 | U | 19 | 1.1 |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 19 | U | 19 | 0.86 |
| 127-18-4 | Tetrachloroethene (PCE) | 19 | U | 19 | 1.0 |
| 108-88-3 | Toluene | 19 | U | 19 | 1.0 |
| 87-61-6 | 1,2,3-Trichlorobenzene | 19 | U | 19 | 1.1 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 19 | U | 19 | 0.88 |
| 71-55-6 | 1,1,1-Trichloroethane | 19 | U | 19 | 0.94 |
| 79-00-5 | 1,1,2-Trichloroethane | 19 | U | 19 | 2.0 |
| 79-01-6 | Trichloroethene (TCE) | 19 | U | 19 | 0.79 |
| 75-69-4 | Trichlorofluoromethane | 38 | U | 38 | 0.86 |
| 95-63-6 | 1,2,4-Trimethylbenzene | 19 | U | 19 | 0.70 |
| 108-67-8 | 1,3,5-Trimethylbenzene | 19 | U | 19 | 0.93 |
| 75-01-4 | Vinyl chloride | 19 | U | 19 | 1.6 |
| 95-47-6 | o-Xylene | 19 | U | 19 | 0.72 |
| | m,p-Xylenes | 19 | U | 19 | 1.3 |

| Surrogate | Recovery | Limits |
|-----------------------|----------|----------|
| Bromofluorobenzene | 87% | 78%-111% |
| 1,2-Dichloroethane-d4 | 96% | 91%-114% |
| Toluene-d8 | 96% | 86%-115% |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 5

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-05 **SD-02**

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 49.9

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28317.D

| CAS No. | Parameter | Result | Qual | OL | MDL |
|------------|------------------------------------|--------|------|------|------|
| 67-64-1 | Acetone | 44 | U | 44 | 3.3 |
| 107-13-1 | Acrylonitrile | 55 | U | 55 | 2.0 |
| 71-43-2 | Benzene | 11 | U | 11 | 0.54 |
| 108-86-1 | Bromobenzene | 11 | U | 11 | 0.52 |
| 74-97-5 | Bromochloromethane | 11 | U | 11 | 0.76 |
| 75-27-4 | Bromodichloromethane | 11 | U | 11 | 0.52 |
| 75-25-2 | Bromoform | 11 | U | 11 | 0.38 |
| 74-83-9 | Bromomethane | 22 | U | 22 | 0.56 |
| 78-93-3 | 2-Butanone (MEK) | 22 | U | 22 | 3.3 |
| 104-51-8 | n-Butylbenzene | 11 | U | 11 | 0.51 |
| 135-98-8 | sec-Butylbenzene | 11 | U | 11 | 0.37 |
| 98-06-6 | tert-Butylbenzene | 11 | U | 11 | 1.0 |
| 75-15-0 | Carbon disulfide | 11 | U | 11 | 2.2 |
| 56-23-5 | Carbon tetrachloride | 11 | U | 11 | 1.0 |
| 108-90-7 | Chlorobenzene | 11 | U | 11 | 0.42 |
| 75-00-3 | Chloroethane | 22 | U | 22 | 1.0 |
| 67-66-3 | Chloroform | 11 | U | 11 | 0.82 |
| 74-87-3 | Chloromethane | 22 | U | 22 | 0.76 |
| 95-49-8 | 2-Chlorotoluene | 11 | U | 11 | 0.36 |
| 106-43-4 | 4-Chlorotoluene | 11 | U | 11 | 0.56 |
| 96-12-8 | 1,2-Dibromo-3-chloropropane (DBCP) | 11 | U | 11 | 0.99 |
| 124-48-1 | Dibromochloromethane | 11 | U | 11 | 0.47 |
| 106-93-4 | 1,2-Dibromoethane (EDB) | 0.60 | U | 0.60 | 0.60 |
| 74-95-3 | Dibromomethane | 11 | U | 11 | 0.56 |
| 95-50-1 | 1,2-Dichlorobenzene | 11 | U | 11 | 0.34 |
| 541-73-1 | 1,3-Dichlorobenzene | 11 | U | 11 | 0.56 |
| 106-46-7 | 1,4-Dichlorobenzene | 11 | U | 11 | 0.71 |
| 75-71-8 | Dichlorodifluoromethane | 22 | U | 22 | 0.34 |
| 75-34-3 | 1,1-Dichloroethane | 11 | U | 11 | 0.59 |
| 107-06-2 | 1,2-Dichloroethane | 11 | U | 11 | 1.0 |
| 75-35-4 | 1,1-Dichloroethene | 11 | U | 11 | 0.77 |
| 156-59-2 | cis-1,2-Dichloroethene | 11 | U | 11 | 0.92 |
| 156-60-5 | trans-1,2-Dichloroethene | 11 | U | 11 | 0.76 |
| 78-87-5 | 1,2-Dichloropropane | 11 | U | 11 | 0.74 |
| 142-28-9 | 1,3-Dichloropropane | 11 | U | 11 | 0.70 |
| 590-20-7 | 2,2-Dichloropropane | 11 | U | 11 | 0.48 |
| 563-58-6 | 1,1-Dichloropropene | 11 | U | 11 | 0.82 |
| 10061-01-5 | cis-1,3-Dichloropropene | 11 | U | 11 | 0.66 |
| 10061-02-6 | trans-1,3-Dichloropropene | 11 | U | 11 | 0.37 |
| 100-41-4 | Ethylbenzene | 11 | U | 11 | 0.63 |
| 87-68-3 | Hexachlorobutadiene | 11 | U | 11 | 0.40 |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: B611A38

Location: Richmond, RI

PL Sample No: 5 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-05 **SD-02**

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 49.9

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28317.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|--------------------------------|--------|------|----|------|
| 591-78-6 | 2-Hexanone | 22 | U | 22 | 2.4 |
| 98-82-8 | Isopropylbenzene | 11 | U | 11 | 0.50 |
| 99-87-6 | 4-Isopropyltoluene | 11 | U | 11 | 0.28 |
| 1634-04-4 | Methyl tert-butyl ether (MTBE) | 11 | U | 11 | 1.5 |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) | 22 | U | 22 | 3.2 |
| 75-09-2 | Methylene chloride | 11 | U | 11 | 1.1 |
| 91-20-3 | Naphthalene | 11 | U | 11 | 0.47 |
| 103-65-1 | n-Propylbenzene | 11 | U | 11 | 0.42 |
| 100-42-5 | Styrene | 11 | U | 11 | 0.34 |
| 96-18-4 | 1,2,3-Trichloropropane | 11 | U | 11 | 0.97 |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | 11 | U | 11 | 0.62 |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 11 | U | 11 | 0.50 |
| 127-18-4 | Tetrachloroethene (PCE) | 11 | U | 11 | 0.59 |
| 108-88-3 | Toluene | 11 | U | 11 | 0.59 |
| 87-61-6 | 1,2,3-Trichlorobenzene | 11 | U | 11 | 0.64 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 11 | U | 11 | 0.51 |
| 71-55-6 | 1,1,1-Trichloroethane | 11 | U | 11 | 0.55 |
| 79-00-5 | 1,1,2-Trichloroethane | 11 | U | 11 | 1.1 |
| 79-01-6 | Trichloroethene (TCE) | 11 | U | 11 | 0.46 |
| 75-69-4 | Trichlorofluoromethane | 22 | U | 22 | 0.50 |
| 95-63-6 | 1,2,4-Trimethylbenzene | 11 | U | 11 | 0.41 |
| 108-67-8 | 1,3,5-Trimethylbenzene | 11 | U | 11 | 0.54 |
| 75-01-4 | Vinyl chloride | 11 | U | 11 | 0.91 |
| 95-47-6 | o-Xylene | 11 | U | 11 | 0.42 |
| | m,p-Xylenes | 11 | U | 11 | 0.76 |

| Surrogate | Recovery | Limits |
|-----------------------|----------|----------|
| Bromofluorobenzene | 89% | 78%-111% |
| 1,2-Dichloroethane-d4 | 98% | 91%-114% |
| Toluene-d8 | 97% | 86%-115% |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 6

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-06 **SD-63**

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 29.2

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28312.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|------------------------------------|--------|------|-----|------|
| 67-64-1 | Acetone | 30 | U | 30 | 2.2 |
| 107-13-1 | Acrylonitrile | 37 | U | 37 | 1.4 |
| 71-43-2 | Benzene | 7.5 | U | 7.5 | 0.37 |
| 108-86-1 | Bromobenzene | 7.5 | U | 7.5 | 0.35 |
| 74-97-5 | Bromochloromethane | 7.5 | U | 7.5 | 0.52 |
| 75-27-4 | Bromodichloromethane | 7.5 | U | 7.5 | 0.35 |
| 75-25-2 | Bromoform | 7.5 | U | 7.5 | 0.26 |
| 74-83-9 | Bromomethane | 15 | U | 15 | 0.38 |
| 78-93-3 | 2-Butanone (MEK) | 15 | U | 15 | 2.3 |
| 104-51-8 | n-Butylbenzene | 7.5 | U | 7.5 | 0.35 |
| 135-98-8 | sec-Butylbenzene | 7.5 | U | 7.5 | 0.25 |
| 98-06-6 | tert-Butylbenzene | 7.5 | U | 7.5 | 0.70 |
| 75-15-0 | Carbon disulfide | 7.5 | U | 7.5 | 1.5 |
| 56-23-5 | Carbon tetrachloride | 7.5 | U | 7.5 | 0.71 |
| 108-90-7 | Chlorobenzene | 7.5 | U | 7.5 | 0.29 |
| 75-00-3 | Chloroethane | 15 | U | 15 | 0.71 |
| 67-66-3 | Chloroform | 7.5 | U | 7.5 | 0.56 |
| 74-87-3 | Chloromethane | 15 | U | 15 | 0.52 |
| 95-49-8 | 2-Chlorotoluene | 7.5 | U | 7.5 | 0.25 |
| 106-43-4 | 4-Chlorotoluene | 7.5 | U | 7.5 | 0.38 |
| 96-12-8 | 1,2-Dibromo-3-chloropropane (DBCP) | 7.5 | U | 7.5 | 0.67 |
| 124-48-1 | Dibromochloromethane | 7.5 | U | 7.5 | 0.32 |
| 106-93-4 | 1,2-Dibromoethane (EDB) | 7.5 | U | 7.5 | 0.41 |
| 74-95-3 | Dibromomethane | 7.5 | U | 7.5 | 0.38 |
| 95-50-1 | 1,2-Dichlorobenzene | 7.5 | U | 7.5 | 0.23 |
| 541-73-1 | 1,3-Dichlorobenzene | 7.5 | U | 7.5 | 0.38 |
| 106-46-7 | 1,4-Dichlorobenzene | 7.5 | U | 7.5 | 0.49 |
| 75-71-8 | Dichlorodifluoromethane | 15 | U | 15 | 0.24 |
| 75-34-3 | 1,1-Dichloroethane | 7.5 | U | 7.5 | 0.40 |
| 107-06-2 | 1,2-Dichloroethane | 7.5 | U | 7.5 | 0.71 |
| 75-35-4 | 1,1-Dichloroethene | 7.5 | U | 7.5 | 0.53 |
| 156-59-2 | cis-1,2-Dichloroethene | 7.5 | U | 7.5 | 0.62 |
| 156-60-5 | trans-1,2-Dichloroethene | 7.5 | U | 7.5 | 0.52 |
| 78-87-5 | 1,2-Dichloropropane | 7.5 | U | 7.5 | 0.50 |
| 142-28-9 | 1,3-Dichloropropane | 7.5 | U | 7.5 | 0.47 |
| 590-20-7 | 2,2-Dichloropropane | 7.5 | U | 7.5 | 0.32 |
| 563-58-6 | 1,1-Dichloropropene | 7.5 | U | 7.5 | 0.56 |
| 10061-01-5 | cis-1,3-Dichloropropene | 7.5 | U | 7.5 | 0.45 |
| 10061-02-6 | trans-1,3-Dichloropropene | 7.5 | U | 7.5 | 0.25 |
| 100-41-4 | Ethylbenzene | 7.5 | U | 7.5 | 0.43 |
| 87-68-3 | Hexachlorobutadiene | 7.5 | U | 7.5 | 0.27 |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 6 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-06 **SD-03**

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 29.2

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28312.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|--------------------------------|--------|------|-----|------|
| 591-78-6 | 2-Hexanone | 15 | U | 15 | 1.7 |
| 98-82-8 | Isopropylbenzene | 7.5 | U | 7.5 | 0.34 |
| 99-87-6 | 4-Isopropyltoluene | 7.5 | U | 7.5 | 0.19 |
| 1634-04-4 | Methyl tert-butyl ether (MTBE) | 7.5 | U | 7.5 | 1.0 |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) | 15 | U | 15 | 2.2 |
| 75-09-2 | Methylene chloride | 7.5 | U | 7.5 | 0.77 |
| 91-20-3 | Naphthalene | 7.5 | U | 7.5 | 0.32 |
| 103-65-1 | n-Propylbenzene | 7.5 | U | 7.5 | 0.29 |
| 100-42-5 | Styrene | 7.5 | U | 7.5 | 0.23 |
| 96-18-4 | 1,2,3-Trichloropropane | 7.5 | U | 7.5 | 0.66 |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | 7.5 | U | 7.5 | 0.42 |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 7.5 | U | 7.5 | 0.34 |
| 127-18-4 | Tetrachloroethene (PCB) | 7.5 | U | 7.5 | 0.40 |
| 108-88-3 | Toluene | 7.5 | U | 7.5 | 0.40 |
| 87-61-6 | 1,2,3-Trichlorobenzene | 7.5 | U | 7.5 | 0.43 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 7.5 | U | 7.5 | 0.35 |
| 71-55-6 | 1,1,1-Trichloroethane | 7.5 | U | 7.5 | 0.37 |
| 79-00-5 | 1,1,2-Trichloroethane | 7.5 | U | 7.5 | 0.78 |
| 79-01-6 | Trichloroethene (TCE) | 7.5 | U | 7.5 | 0.31 |
| 75-69-4 | Trichlorofluoromethane | 15 | U | 15 | 0.34 |
| 95-63-6 | 1,2,4-Trimethylbenzene | 7.5 | U | 7.5 | 0.28 |
| 108-67-8 | 1,3,5-Trimethylbenzene | 7.5 | U | 7.5 | 0.37 |
| 75-01-4 | Vinyl chloride | 7.5 | U | 7.5 | 0.62 |
| 95-47-6 | o-Xylene | 7.5 | U | 7.5 | 0.28 |
| | m,p-Xylenes | 7.5 | U | 7.5 | 0.52 |

| Surrogate | Recovery | Limits |
|-----------------------|----------|----------|
| Bromofluorobenzene | 96% | 78%-111% |
| 1,2-Dichloroethane-d4 | 104% | 91%-114% |
| Toluene-d8 | 93% | 86%-115% |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 7

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-07 **SD-04**

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 38.2

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28313.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|------------------------------------|--------|------|-----|------|
| 67-64-1 | Acetone | 32 | U | 32 | 2.4 |
| 107-13-1 | Acrylonitrile | 40 | U | 40 | 1.5 |
| 71-43-2 | Benzene | 8.0 | U | 8.0 | 0.40 |
| 108-86-1 | Bromobenzene | 8.0 | U | 8.0 | 0.38 |
| 74-97-5 | Bromochloromethane | 8.0 | U | 8.0 | 0.55 |
| 75-27-4 | Bromodichloromethane | 8.0 | U | 8.0 | 0.38 |
| 75-25-2 | Bromoform | 8.0 | U | 8.0 | 0.28 |
| 74-83-9 | Bromomethane | 16 | U | 16 | 0.41 |
| 78-93-3 | 2-Butanone (MEK) | 16 | U | 16 | 2.4 |
| 104-51-8 | n-Butylbenzene | 8.0 | U | 8.0 | 0.37 |
| 135-98-8 | sec-Butylbenzene | 8.0 | U | 8.0 | 0.27 |
| 98-06-6 | tert-Butylbenzene | 8.0 | U | 8.0 | 0.75 |
| 75-15-0 | Carbon disulfide | 8.0 | U | 8.0 | 1.6 |
| 56-23-5 | Carbon tetrachloride | 8.0 | U | 8.0 | 0.76 |
| 108-90-7 | Chlorobenzene | 8.0 | U | 8.0 | 0.31 |
| 75-00-3 | Chloroethane | 16 | U | 16 | 0.76 |
| 67-66-3 | Chloroform | 8.0 | U | 8.0 | 0.60 |
| 74-87-3 | Chloromethane | 16 | U | 16 | 0.55 |
| 95-49-8 | 2-Chlorotoluene | 8.0 | U | 8.0 | 0.26 |
| 106-43-4 | 4-Chlorotoluene | 8.0 | U | 8.0 | 0.41 |
| 96-12-8 | 1,2-Dibromo-3-chloropropane (DBCP) | 8.0 | U | 8.0 | 0.72 |
| 124-48-1 | Dibromochloromethane | 8.0 | U | 8.0 | 0.34 |
| 106-93-4 | 1,2-Dibromoethane (EDB) | 8.0 | U | 8.0 | 0.43 |
| 74-95-3 | Dibromomethane | 8.0 | U | 8.0 | 0.41 |
| 95-50-1 | 1,2-Dichlorobenzene | 8.0 | U | 8.0 | 0.24 |
| 541-73-1 | 1,3-Dichlorobenzene | 8.0 | U | 8.0 | 0.41 |
| 106-46-7 | 1,4-Dichlorobenzene | 8.0 | U | 8.0 | 0.52 |
| 75-71-8 | Dichlorodifluoromethane | 16 | U | 16 | 0.25 |
| 75-34-3 | 1,1-Dichloroethane | 8.0 | U | 8.0 | 0.43 |
| 107-06-2 | 1,2-Dichloroethane | 8.0 | U | 8.0 | 0.76 |
| 75-35-4 | 1,1-Dichloroethene | 8.0 | U | 8.0 | 0.56 |
| 156-59-2 | cis-1,2-Dichloroethene | 8.0 | U | 8.0 | 0.67 |
| 156-60-5 | trans-1,2-Dichloroethene | 8.0 | U | 8.0 | 0.55 |
| 78-87-5 | 1,2-Dichloropropane | 8.0 | U | 8.0 | 0.54 |
| 142-28-9 | 1,3-Dichloropropane | 8.0 | U | 8.0 | 0.50 |
| 590-20-7 | 2,2-Dichloropropane | 8.0 | U | 8.0 | 0.34 |
| 563-58-6 | 1,1-Dichloropropene | 8.0 | U | 8.0 | 0.59 |
| 10061-01-5 | cis-1,3-Dichloropropene | 8.0 | U | 8.0 | 0.48 |
| 10061-02-6 | trans-1,3-Dichloropropene | 8.0 | U | 8.0 | 0.27 |
| 100-41-4 | Ethylbenzene | 8.0 | U | 8.0 | 0.46 |
| 87-68-3 | Hexachlorobutadiene | 8.0 | U | 8.0 | 0.29 |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 7 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-07 **SD-04**

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 38.2

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28313.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|--------------------------------|--------|------|-----|------|
| 591-78-6 | 2-Hexanone | 16 | U | 16 | 1.8 |
| 98-82-8 | Isopropylbenzene | 8.0 | U | 8.0 | 0.36 |
| 99-87-6 | 4-Isopropyltoluene | 8.0 | U | 8.0 | 0.20 |
| 1634-04-4 | Methyl tert-butyl ether (MTBE) | 8.0 | U | 8.0 | 1.1 |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) | 16 | U | 16 | 2.4 |
| 75-09-2 | Methylene chloride | 8.0 | U | 8.0 | 0.82 |
| 91-20-3 | Naphthalene | 8.0 | U | 8.0 | 0.34 |
| 103-65-1 | n-Propylbenzene | 8.0 | U | 8.0 | 0.31 |
| 100-42-5 | Styrene | 8.0 | U | 8.0 | 0.25 |
| 96-18-4 | 1,2,3-Trichloropropane | 8.0 | U | 8.0 | 0.70 |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | 8.0 | U | 8.0 | 0.45 |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 8.0 | U | 8.0 | 0.36 |
| 127-18-4 | Tetrachloroethene (PCE) | 8.0 | U | 8.0 | 0.43 |
| 108-88-3 | Toluene | 8.0 | U | 8.0 | 0.43 |
| 87-61-6 | 1,2,3-Trichlorobenzene | 8.0 | U | 8.0 | 0.46 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 8.0 | U | 8.0 | 0.37 |
| 71-55-6 | 1,1,1-Trichloroethane | 8.0 | U | 8.0 | 0.40 |
| 79-00-5 | 1,1,2-Trichloroethane | 8.0 | U | 8.0 | 0.83 |
| 79-01-6 | Trichloroethene (TCE) | 8.0 | U | 8.0 | 0.34 |
| 75-69-4 | Trichlorofluoromethane | 16 | U | 16 | 0.36 |
| 95-63-6 | 1,2,4-Trimethylbenzene | 8.0 | U | 8.0 | 0.30 |
| 108-67-8 | 1,3,5-Trimethylbenzene | 8.0 | U | 8.0 | 0.39 |
| 75-01-4 | Vinyl chloride | 8.0 | U | 8.0 | 0.66 |
| 95-47-6 | o-Xylene | 8.0 | U | 8.0 | 0.30 |
| | m,p-Xylenes | 8.0 | U | 8.0 | 0.55 |

| Surrogate | Recovery | Limits |
|-----------------------|----------|----------|
| Bromofluorobenzene | 95% | 78%-111% |
| 1,2-Dichloroethane-d4 | 102% | 91%-114% |
| Toluene-d8 | 94% | 86%-115% |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 8

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-08

SD-04

Field Duplicate

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 24.0

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28314.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|------------------------------------|--------|------|-----|------|
| 67-64-1 | Acetone | 33 | | 27 | 2.0 |
| 107-13-1 | Acrylonitrile | 34 | U | 34 | 1.3 |
| 71-43-2 | Benzene | 6.8 | U | 6.8 | 0.34 |
| 108-86-1 | Bromobenzene | 6.8 | U | 6.8 | 0.32 |
| 74-97-5 | Bromochloromethane | 6.8 | U | 6.8 | 0.47 |
| 75-27-4 | Bromodichloromethane | 6.8 | U | 6.8 | 0.32 |
| 75-25-2 | Bromoform | 6.8 | U | 6.8 | 0.24 |
| 74-83-9 | Bromomethane | 14 | U | 14 | 0.34 |
| 78-93-3 | 2-Butanone (MEK) | 14 | U | 14 | 2.0 |
| 104-51-8 | n-Butylbenzene | 6.8 | U | 6.8 | 0.31 |
| 135-98-8 | sec-Butylbenzene | 6.8 | U | 6.8 | 0.23 |
| 98-06-6 | tert-Butylbenzene | 6.8 | U | 6.8 | 0.64 |
| 75-15-0 | Carbon disulfide | 6.8 | U | 6.8 | 1.3 |
| 56-23-5 | Carbon tetrachloride | 6.8 | U | 6.8 | 0.64 |
| 108-90-7 | Chlorobenzene | 6.8 | U | 6.8 | 0.26 |
| 75-00-3 | Chloroethane | 14 | U | 14 | 0.64 |
| 67-66-3 | Chloroform | 6.8 | U | 6.8 | 0.51 |
| 74-87-3 | Chloromethane | 14 | U | 14 | 0.47 |
| 95-49-8 | 2-Chlorotoluene | 6.8 | U | 6.8 | 0.22 |
| 106-43-4 | 4-Chlorotoluene | 6.8 | U | 6.8 | 0.34 |
| 96-12-8 | 1,2-Dibromo-3-chloropropane (DBCP) | 6.8 | U | 6.8 | 0.61 |
| 124-48-1 | Dibromochloromethane | 6.8 | U | 6.8 | 0.29 |
| 106-93-4 | 1,2-Dibromoethane (EDB) | 6.8 | U | 6.8 | 0.37 |
| 74-95-3 | Dibromomethane | 6.8 | U | 6.8 | 0.34 |
| 95-50-1 | 1,2-Dichlorobenzene | 6.8 | U | 6.8 | 0.21 |
| 541-73-1 | 1,3-Dichlorobenzene | 6.8 | U | 6.8 | 0.34 |
| 106-46-7 | 1,4-Dichlorobenzene | 6.8 | U | 6.8 | 0.44 |
| 75-71-8 | Dichlorodifluoromethane | 14 | U | 14 | 0.21 |
| 75-34-3 | 1,1-Dichloroethane | 6.8 | U | 6.8 | 0.36 |
| 107-06-2 | 1,2-Dichloroethane | 6.8 | U | 6.8 | 0.64 |
| 75-35-4 | 1,1-Dichloroethene | 6.8 | U | 6.8 | 0.48 |
| 156-59-2 | cis-1,2-Dichloroethene | 6.8 | U | 6.8 | 0.57 |
| 156-60-5 | trans-1,2-Dichloroethene | 6.8 | U | 6.8 | 0.47 |
| 78-87-5 | 1,2-Dichloropropane | 6.8 | U | 6.8 | 0.46 |
| 142-28-9 | 1,3-Dichloropropane | 6.8 | U | 6.8 | 0.43 |
| 590-20-7 | 2,2-Dichloropropane | 6.8 | U | 6.8 | 0.29 |
| 563-58-6 | 1,1-Dichloropropene | 6.8 | U | 6.8 | 0.50 |
| 10061-01-5 | cis-1,3-Dichloropropene | 6.8 | U | 6.8 | 0.41 |
| 10061-02-6 | trans-1,3-Dichloropropene | 6.8 | U | 6.8 | 0.23 |
| 100-41-4 | Ethylbenzene | 6.8 | U | 6.8 | 0.39 |
| 87-68-3 | Hexachlorobutadiene | 6.8 | U | 6.8 | 0.25 |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill
 Sample Description: 841061116-08

SD-04
 Field Duplicate

Date Collected: 11/16/2006
 Date Received: 11/17/2006
 Date Extracted: By:
 Date Analyzed: 11/20/06 By: GP
 Method: 8260B
 QC Batch#: 49859
 Units: ug/kg

Matrix: Solid
 Percent Moisture: 24.0
 Sample Weight/Volume:
 Dilution Factor: 1
 Soil Extract Volume:
 Lab Data File: J28314.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|--------------------------------|--------|------|-----|------|
| 591-78-6 | 2-Hexanone | 14 | U | 14 | 1.5 |
| 98-82-8 | Isopropylbenzene | 6.8 | U | 6.8 | 0.31 |
| 99-87-6 | 4-Isopropyltoluene | 6.8 | U | 6.8 | 0.17 |
| 1634-04-4 | Methyl tert-butyl ether (MTBE) | 6.8 | U | 6.8 | 0.94 |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) | 14 | U | 14 | 2.0 |
| 75-09-2 | Methylene chloride | 6.8 | U | 6.8 | 0.70 |
| 91-20-3 | Naphthalene | 6.8 | U | 6.8 | 0.29 |
| 103-65-1 | n-Propylbenzene | 6.8 | U | 6.8 | 0.26 |
| 100-42-5 | Styrene | 6.8 | U | 6.8 | 0.21 |
| 96-18-4 | 1,2,3-Trichloropropane | 6.8 | U | 6.8 | 0.60 |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | 6.8 | U | 6.8 | 0.38 |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 6.8 | U | 6.8 | 0.31 |
| 127-18-4 | Tetrachloroethene (PCE) | 6.8 | U | 6.8 | 0.36 |
| 108-88-3 | Toluene | 6.8 | U | 6.8 | 0.36 |
| 87-61-6 | 1,2,3-Trichlorobenzene | 6.8 | U | 6.8 | 0.39 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 6.8 | U | 6.8 | 0.32 |
| 71-55-6 | 1,1,1-Trichloroethane | 6.8 | U | 6.8 | 0.34 |
| 79-00-5 | 1,1,2-Trichloroethane | 6.8 | U | 6.8 | 0.71 |
| 79-01-6 | Trichloroethene (TCE) | 6.8 | U | 6.8 | 0.28 |
| 75-69-4 | Trichlorofluoromethane | 14 | U | 14 | 0.31 |
| 95-63-6 | 1,2,4-Trimethylbenzene | 6.8 | U | 6.8 | 0.25 |
| 108-67-8 | 1,3,5-Trimethylbenzene | 6.8 | U | 6.8 | 0.33 |
| 75-01-4 | Vinyl chloride | 6.8 | U | 6.8 | 0.56 |
| 95-47-6 | o-Xylene | 6.8 | U | 6.8 | 0.26 |
| | m,p-Xylenes | 6.8 | U | 6.8 | 0.47 |

| Surrogate | Recovery | Limits |
|-----------------------|----------|----------|
| Bromofluorobenzene | 93% | 78%-111% |
| 1,2-Dichloroethane-d4 | 101% | 91%-114% |
| Toluene-d8 | 97% | 86%-115% |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 9

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-09

SD-05

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 19.2

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28315.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|------------------------------------|--------|------|-----|------|
| 67-64-1 | Acetone | 26 | U | 26 | 1.9 |
| 107-13-1 | Acrylonitrile | 32 | U | 32 | 1.2 |
| 71-43-2 | Benzene | 6.4 | U | 6.4 | 0.32 |
| 108-86-1 | Bromobenzene | 6.4 | U | 6.4 | 0.30 |
| 74-97-5 | Bromochloromethane | 6.4 | U | 6.4 | 0.44 |
| 75-27-4 | Bromodichloromethane | 6.4 | U | 6.4 | 0.30 |
| 75-25-2 | Bromoform | 6.4 | U | 6.4 | 0.22 |
| 74-83-9 | Bromomethane | 13 | U | 13 | 0.33 |
| 78-93-3 | 2-Butanone (MEK) | 13 | U | 13 | 1.9 |
| 104-51-8 | n-Butylbenzene | 6.4 | U | 6.4 | 0.30 |
| 135-98-8 | sec-Butylbenzene | 6.4 | U | 6.4 | 0.22 |
| 98-06-6 | tert-Butylbenzene | 6.4 | U | 6.4 | 0.60 |
| 75-15-0 | Carbon disulfide | 6.4 | U | 6.4 | 1.3 |
| 56-23-5 | Carbon tetrachloride | 6.4 | U | 6.4 | 0.61 |
| 108-90-7 | Chlorobenzene | 6.4 | U | 6.4 | 0.25 |
| 75-00-3 | Chloroethane | 13 | U | 13 | 0.61 |
| 67-66-3 | Chloroform | 6.4 | U | 6.4 | 0.48 |
| 74-87-3 | Chloromethane | 13 | U | 13 | 0.44 |
| 95-49-8 | 2-Chlorotoluene | 6.4 | U | 6.4 | 0.21 |
| 106-43-4 | 4-Chlorotoluene | 6.4 | U | 6.4 | 0.33 |
| 96-12-8 | 1,2-Dibromo-3-chloropropane (DBCP) | 6.4 | U | 6.4 | 0.58 |
| 124-48-1 | Dibromochloromethane | 6.4 | U | 6.4 | 0.27 |
| 106-93-4 | 1,2-Dibromoethane (EDB) | 6.4 | U | 6.4 | 0.35 |
| 74-95-3 | Dibromomethane | 6.4 | U | 6.4 | 0.32 |
| 95-50-1 | 1,2-Dichlorobenzene | 6.4 | U | 6.4 | 0.20 |
| 541-73-1 | 1,3-Dichlorobenzene | 6.4 | U | 6.4 | 0.33 |
| 106-46-7 | 1,4-Dichlorobenzene | 6.4 | U | 6.4 | 0.42 |
| 75-71-8 | Dichlorodifluoromethane | 13 | U | 13 | 0.20 |
| 75-34-3 | 1,1-Dichloroethane | 6.4 | U | 6.4 | 0.34 |
| 107-06-2 | 1,2-Dichloroethane | 6.4 | U | 6.4 | 0.61 |
| 75-35-4 | 1,1-Dichloroethene | 6.4 | U | 6.4 | 0.45 |
| 156-59-2 | cis-1,2-Dichloroethene | 6.4 | U | 6.4 | 0.54 |
| 156-60-5 | trans-1,2-Dichloroethene | 6.4 | U | 6.4 | 0.44 |
| 78-87-5 | 1,2-Dichloropropane | 6.4 | U | 6.4 | 0.43 |
| 142-28-9 | 1,3-Dichloropropane | 6.4 | U | 6.4 | 0.40 |
| 590-20-7 | 2,2-Dichloropropane | 6.4 | U | 6.4 | 0.28 |
| 563-58-6 | 1,1-Dichloropropene | 6.4 | U | 6.4 | 0.48 |
| 10061-01-5 | cis-1,3-Dichloropropene | 6.4 | U | 6.4 | 0.38 |
| 10061-02-6 | trans-1,3-Dichloropropene | 6.4 | U | 6.4 | 0.21 |
| 100-41-4 | Ethylbenzene | 6.4 | U | 6.4 | 0.37 |
| 87-68-3 | Hexachlorobutadiene | 6.4 | U | 6.4 | 0.23 |

VOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: B611A38

Location: Richmond, RI

PL Sample No: 9 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-09 **SD-05**

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 19.2

Date Extracted: By:

Sample Weight/Volume:

Date Analyzed: 11/20/06 By: GP

Dilution Factor: 1

Method: 8260B

Soil Extract Volume:

QC Batch#: 49859

Lab Data File: J28315.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|--------------------------------|--------|------|-----|------|
| 591-78-6 | 2-Hexanone | 13 | U | 13 | 1.4 |
| 98-82-8 | Isopropylbenzene | 6.4 | U | 6.4 | 0.29 |
| 99-87-6 | 4-Isopropyltoluene | 6.4 | U | 6.4 | 0.16 |
| 1634-04-4 | Methyl tert-butyl ether (MTBE) | 6.4 | U | 6.4 | 0.89 |
| 108-10-1 | 4-Methyl-2-pentanone (MIBK) | 13 | U | 13 | 1.9 |
| 75-09-2 | Methylene chloride | 6.4 | U | 6.4 | 0.66 |
| 91-20-3 | Naphthalene | 6.4 | U | 6.4 | 0.27 |
| 103-65-1 | n-Propylbenzene | 6.4 | U | 6.4 | 0.25 |
| 100-42-5 | Styrene | 6.4 | U | 6.4 | 0.20 |
| 96-18-4 | 1,2,3-Trichloropropane | 6.4 | U | 6.4 | 0.56 |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | 6.4 | U | 6.4 | 0.36 |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 6.4 | U | 6.4 | 0.29 |
| 127-18-4 | Tetrachloroethene (PCE) | 6.4 | U | 6.4 | 0.34 |
| 108-88-3 | Toluene | 6.4 | U | 6.4 | 0.35 |
| 87-61-6 | 1,2,3-Trichlorobenzene | 6.4 | U | 6.4 | 0.37 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 6.4 | U | 6.4 | 0.30 |
| 71-55-6 | 1,1,1-Trichloroethane | 6.4 | U | 6.4 | 0.32 |
| 79-00-5 | 1,1,2-Trichloroethane | 6.4 | U | 6.4 | 0.67 |
| 79-01-6 | Trichloroethene (TCE) | 6.4 | U | 6.4 | 0.27 |
| 75-69-4 | Trichlorofluoromethane | 13 | U | 13 | 0.29 |
| 95-63-6 | 1,2,4-Trimethylbenzene | 6.4 | U | 6.4 | 0.24 |
| 108-67-8 | 1,3,5-Trimethylbenzene | 6.4 | U | 6.4 | 0.32 |
| 75-01-4 | Vinyl chloride | 6.4 | U | 6.4 | 0.53 |
| 95-47-6 | o-Xylene | 6.4 | U | 6.4 | 0.24 |
| | m,p-Xylenes | 6.4 | U | 6.4 | 0.44 |

| Surrogate | Recovery | Limits |
|-----------------------|----------|----------|
| Bromofluorobenzene | 98% | 78%-111% |
| 1,2-Dichloroethane-d4 | 101% | 91%-114% |
| Toluene-d8 | 92% | 86%-115% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 4

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-04

SD-01

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 72.8

Date Extracted: 11/20/06 By: BW

Sample Weight/Volume: 30.71 g

Date Analyzed: 11/21/06 By: MM

Dilution Factor: 1

Method: 8082

Extract Volume: 2

QC Batch#: 49868

Lab Data File: 4112125.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------------------|--------------|----------|----------|----|-----|
| 12674-11-2 | Aroclor 1016 | 48 | U | 48 | 36 |
| 11104-28-2 | Aroclor 1221 | 48 | U | 48 | 36 |
| 11141-16-5 | Aroclor 1232 | 48 | U | 48 | 36 |
| 53469-21-9 | Aroclor 1242 | 48 | U | 48 | 36 |
| 12672-29-6 | Aroclor 1248 | 48 | U | 48 | 36 |
| 11097-69-1 | Aroclor 1254 | 48 | U | 48 | 36 |
| 11096-82-5 | Aroclor 1260 | 48 | U | 48 | 36 |
| Surrogate | | Recovery | Limits | | |
| Tetrachloro-m-xylene | | 58% | 17%-129% | | |
| Decachlorobiphenyl | | 59% | 11%-123% | | |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 4

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-04

SD-01

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 72.8

Date Extracted: 11/20/06 By: BW

Sample Weight/Volume: 30.71 g

Date Analyzed: 11/20/06 By: LM

Dilution Factor: 1

Method: 8081A

Extract Volume: 2

QC Batch#: 49858

Lab Data File: 4112026.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|---------------------|--------|------|-----|-----|
| 309-00-2 | Aldrin | 2.4 | U | 2.4 | 1.3 |
| 319-84-6 | alpha-BHC | 2.4 | U | 2.4 | 1.2 |
| 319-85-7 | beta-BHC | 2.4 | U | 2.4 | 1.5 |
| 319-86-8 | delta-BHC | 2.4 | U | 2.4 | 1.2 |
| 59-89-9 | gamma-BHC (Lindane) | 1.2 | U | 1.2 | 1.2 |
| 5103-71-9 | alpha-Chlordane | 2.4 | U | 2.4 | 1.3 |
| 5103-74-2 | gamma-Chlordane | 2.4 | U | 2.4 | 1.8 |
| 72-54-8 | 4,4'-DDD | 2.4 | U | 2.4 | 1.6 |
| 72-55-9 | 4,4'-DDE | 2.4 | U | 2.4 | 1.3 |
| 50-29-3 | 4,4'-DDT | 2.4 | U | 2.4 | 2.2 |
| 60-57-1 | Dieldrin | 1.4 | U | 1.4 | 1.4 |
| 33213-65-9 | Endosulfan II | 2.4 | U | 2.4 | 1.3 |
| 7421-93-4 | Endrin aldehyde | 2.4 | U | 2.4 | 2.0 |
| 959-98-8 | Endosulfan I | 2.4 | U | 2.4 | 1.6 |
| 1031-07-8 | Endosulfan sulfate | 2.4 | U | 2.4 | 2.0 |
| 72-20-8 | Endrin | 1.8 | U | 1.8 | 1.8 |
| 53494-70-5 | Endrin ketone | 2.4 | U | 2.4 | 1.7 |
| 76-44-8 | Heptachlor | 2.4 | U | 2.4 | 1.5 |
| 1024-57-3 | Heptachlor epoxide | 2.4 | U | 2.4 | 1.4 |
| 72-43-5 | Methoxychlor | 2.4 | U | 2.4 | 2.1 |
| 8001-35-2 | Toxaphene | 120 | U | 120 | 34 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| Tetrachloro-m-xylene | 55% | 10%-135% |
| Decachlorobiphenyl | 39% | 10%-112% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 4

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-04

SD-01

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 72.8

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.39 g

Date Analyzed: 11/27/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49954

Lab Data File: L17814.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|-----------------------------|--------|------|------|-----|
| 103-33-3 | Azobenzene | 600 | U | 600 | 93 |
| 83-32-9 | Acenaphthene | 76 | U | 76 | 76 |
| 208-96-8 | Acenaphthylene | 76 | U | 76 | 76 |
| 62-53-3 | Aniline | 1200 | U | 1200 | 55 |
| 120-12-7 | Anthracene | 72 | U | 72 | 72 |
| 56-55-3 | Benzo[a]anthracene | 110 | | 64 J | 64 |
| 50-32-8 | Benzo[a]pyrene | 56 | U | 56 | 56 |
| 205-99-2 | Benzo[b]fluoranthene | 99 | | 51 J | 51 |
| 191-24-2 | Benzo[g,h,i]perylene | 56 | U | 56 | 56 |
| 207-08-9 | Benzo[k]fluoranthene | 83 | | 64 J | 64 |
| 65-85-0 | Benzoic acid | 3000 | U | 3000 | 21 |
| 100-51-6 | Benzyl alcohol | 1200 | U | 1200 | 67 |
| 85-68-7 | Benzyl butyl phthalate | 600 | U | 600 | 72 |
| 111-91-1 | Bis(2-chloroethoxy)methane | 600 | U | 600 | 79 |
| 111-44-4 | Bis(2-chloroethyl)ether | 600 | U | 600 | 91 |
| 108-60-1 | Bis(2-chloroisopropyl)ether | 1200 | U | 1200 | 91 |
| 117-81-7 | Bis(2-ethylhexyl)phthalate | 600 | U | 600 | 73 |
| 101-55-3 | 4-Bromophenyl phenyl ether | 600 | U | 600 | 49 |
| 59-50-7 | 4-Chloro-3-methylphenol | 600 | U | 600 | 63 |
| 106-47-8 | 4-Chloroaniline | 1200 | U | 1200 | 55 |
| 91-58-7 | 2-Chloronaphthalene | 600 | U | 600 | 75 |
| 95-57-8 | 2-Chlorophenol | 600 | U | 600 | 72 |
| 7005-72-3 | 4-Chlorophenyl phenyl ether | 600 | U | 600 | 73 |
| 218-01-9 | Chrysene | 110 | | 73 J | 73 |
| 53-70-3 | Dibenz[a,h]anthracene | 60 | U | 60 | 60 |
| 84-74-2 | Di-n-butyl phthalate | 600 | U | 600 | 87 |
| 117-84-0 | Di-n-octyl phthalate | 600 | U | 600 | 62 |
| 132-64-9 | Dibenzofuran | 1200 | U | 1200 | 80 |
| 95-50-1 | 1,2-Dichlorobenzene | 600 | U | 600 | 69 |
| 541-73-1 | 1,3-Dichlorobenzene | 600 | U | 600 | 64 |
| 106-46-7 | 1,4-Dichlorobenzene | 600 | U | 600 | 73 |
| 91-94-1 | 3,3-Dichlorobenzidine | 600 | U | 600 | 30 |
| 120-83-2 | 2,4-Dichlorophenol | 600 | U | 600 | 53 |
| 84-66-2 | Diethyl phthalate | 600 | U | 600 | 65 |
| 131-11-3 | Dimethyl phthalate | 600 | U | 600 | 59 |
| 105-67-9 | 2,4-Dimethylphenol | 600 | U | 600 | 66 |
| 51-28-5 | 2,4-Dinitrophenol | 600 | U | 600 | 120 |
| 121-14-2 | 2,4-Dinitrotoluene | 600 | U | 600 | 65 |
| 606-20-2 | 2,6-Dinitrotoluene | 600 | U | 600 | 58 |
| 206-44-0 | Fluoranthene | 240 | | 71 J | 71 |
| 86-73-7 | Fluorene | 84 | U | 84 | 84 |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 4 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-04

SD-01

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 72.8

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.39 g

Date Analyzed: 11/27/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49954

Lab Data File: L17814.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------|----------------------------|--------|------|------|-----|
| 118-74-1 | Hexachlorobenzene | 61 | U | 61 | 61 |
| 87-68-3 | Hexachlorobutadiene | 600 | U | 600 | 66 |
| 77-47-4 | Hexachlorocyclopentadiene | 600 | U | 600 | 92 |
| 67-72-1 | Hexachloroethane | 600 | U | 600 | 70 |
| 193-39-5 | Indeno[1,2,3-cd]pyrene | 48 | U | 48 | 48 |
| 78-59-1 | Isophorone | 600 | U | 600 | 67 |
| 534-52-1 | 2-Methyl-4,6-dinitrophenol | 600 | U | 600 | 35 |
| 91-57-6 | 2-Methylnaphthalene | 600 | U | 600 | 71 |
| 95-48-7 | 2-Methylphenol | 600 | U | 600 | 40 |
| | 3- & 4-Methylphenols | 600 | U | 600 | 78 |
| 91-20-3 | Naphthalene | 78 | U | 78 | 78 |
| 88-74-4 | 2-Nitroaniline | 1200 | U | 1200 | 69 |
| 99-09-2 | 3-Nitroaniline | 1200 | U | 1200 | 45 |
| 100-01-6 | 4-Nitroaniline | 1200 | U | 1200 | 45 |
| 98-95-3 | Nitrobenzene | 600 | U | 600 | 84 |
| 88-75-5 | 2-Nitrophenol | 600 | U | 600 | 36 |
| 100-02-1 | 4-Nitrophenol | 600 | U | 600 | 32 |
| 621-64-7 | N-Nitrosodi-n-propylamine | 600 | U | 600 | 92 |
| 62-75-9 | N-Nitrosodimethylamine | 600 | U | 600 | 76 |
| 86-30-6 | N-Nitrosodiphenylamine | 600 | U | 600 | 85 |
| 87-86-5 | Pentachlorophenol | 600 | U | 600 | 28 |
| 85-01-8 | Phenanthrene | 110 | | 85 J | 85 |
| 108-95-2 | Phenol | 600 | U | 600 | 69 |
| 129-00-0 | Pyrene | 240 | | 70 J | 70 |
| 95-95-4 | 2,4,5-Trichlorophenol | 600 | U | 600 | 48 |
| 88-06-2 | 2,4,6-Trichlorophenol | 600 | U | 600 | 49 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 600 | U | 600 | 60 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| 2,4,6-Tribromophenol | 59% | 19%-116% |
| 2-Fluorobiphenyl | 43% | 27%-105% |
| 2-Fluorophenol | 37% | 11%-94% |
| 4-Terphenyl-d14 | 69% | 20%-154% |
| Nitrobenzene-d5 | 38% | 15%-96% |
| Phenol-d6 | 40% | 12%-88% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 5

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-05

SD-62

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 49.9

Date Extracted: 11/20/06 By: BW

Sample Weight/Volume: 30.85 g

Date Analyzed: 11/21/06 By: MM

Dilution Factor: 1

Method: 8082

Extract Volume: 2

QC Batch#: 49868

Lab Data File: 4112128.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------------------|--------------|----------|----------|----|-----|
| 12674-11-2 | Aroclor 1016 | 26 | U | 26 | 19 |
| 11104-28-2 | Aroclor 1221 | 26 | U | 26 | 19 |
| 11141-16-5 | Aroclor 1232 | 26 | U | 26 | 19 |
| 53469-21-9 | Aroclor 1242 | 26 | U | 26 | 19 |
| 12672-29-6 | Aroclor 1248 | 26 | U | 26 | 19 |
| 11097-69-1 | Aroclor 1254 | 26 | U | 26 | 19 |
| 11096-82-5 | Aroclor 1260 | 26 | U | 26 | 19 |
| Surrogate | | Recovery | Limits | | |
| Tetrachloro-m-xylene | | 58% | 17%-129% | | |
| Decachlorobiphenyl | | 66% | 11%-123% | | |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: B611A38

Location: Richmond, RI

PL Sample No: 5

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-05

SD-02

Date Collected: 11/16/2006
 Date Received: 11/17/2006
 Date Extracted: 11/20/06 By: BW
 Date Analyzed: 11/20/06 By: LM
 Method: 8081A
 QC Batch#: 49858
 Units: ug/kg

Matrix: Solid
 Percent Moisture: 49.9
 Sample Weight/Volume: 30.85 g
 Dilution Factor: 1
 Extract Volume: 2
 Lab Data File: 4112027.D

| CAS No. | Parameter | Result | Qual | OL | MDL |
|----------------------|---------------------|----------|----------|-----|------|
| 309-00-2 | Aldrin | 1.3 | U | 1.3 | 0.69 |
| 319-84-6 | alpha-BHC | 1.3 | U | 1.3 | 0.66 |
| 319-85-7 | beta-BHC | 1.3 | U | 1.3 | 0.82 |
| 319-86-8 | delta-BHC | 1.3 | U | 1.3 | 0.66 |
| 59-89-9 | gamma-BHC (Lindane) | 1.3 | U | 1.3 | 0.68 |
| 5103-71-9 | alpha-Chlordane | 1.3 | U | 1.3 | 0.72 |
| 5103-74-2 | gamma-Chlordane | 1.3 | U | 1.3 | 1.0 |
| 72-54-8 | 4,4'-DDD | 1.3 | U | 1.3 | 0.87 |
| 72-55-9 | 4,4'-DDE | 1.3 | U | 1.3 | 0.72 |
| 50-29-3 | 4,4'-DDT | 1.3 | U | 1.3 | 1.2 |
| 60-57-1 | Dieldrin | 1.3 | U | 1.3 | 0.76 |
| 33213-65-9 | Endosulfan II | 1.3 | U | 1.3 | 0.72 |
| 7421-93-4 | Endrin aldehyde | 1.3 | U | 1.3 | 1.1 |
| 959-98-8 | Endosulfan I | 1.3 | U | 1.3 | 0.88 |
| 1031-07-8 | Endosulfan sulfate | 1.3 | U | 1.3 | 1.1 |
| 72-20-8 | Endrin | 1.3 | U | 1.3 | 0.97 |
| 53494-70-5 | Endrin ketone | 1.3 | U | 1.3 | 0.90 |
| 76-44-8 | Heptachlor | 1.3 | U | 1.3 | 0.82 |
| 1024-57-3 | Heptachlor epoxide | 1.3 | U | 1.3 | 0.74 |
| 72-43-5 | Methoxychlor | 1.3 | U | 1.3 | 1.1 |
| 8001-35-2 | Toxaphene | 65 | U | 65 | 18 |
| Surrogate | | Recovery | Limits | | |
| Tetrachloro-m-xylene | | 61% | 10%-135% | | |
| Decachlorobiphenyl | | 60% | 10%-112% | | |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 5

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-05

SD-02

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 49.9

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.02 g

Date Analyzed: 11/21/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49913

Lab Data File: L17804.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | OL | MDL |
|-----------|-----------------------------|--------|------|------|-----|
| 103-33-3 | Azobenzene | 330 | U | 330 | 51 |
| 83-32-9 | Acenaphthene | 42 | U | 42 | 42 |
| 208-96-8 | Acenaphthylene | 42 | U | 42 | 42 |
| 62-53-3 | Aniline | 660 | U | 660 | 30 |
| 120-12-7 | Anthracene | 40 | U | 40 | 40 |
| 56-55-3 | Benzo[a]anthracene | 35 | U | 35 | 35 |
| 50-32-8 | Benzo[a]pyrene | 31 | U | 31 | 31 |
| 205-99-2 | Benzo[b]fluoranthene | 28 | | 28 J | 28 |
| 191-24-2 | Benzo[g,h,i]perylene | 31 | U | 31 | 31 |
| 207-08-9 | Benzo[k]fluoranthene | 35 | U | 35 | 35 |
| 65-85-0 | Benzoic acid | 1700 | U | 1700 | 12 |
| 100-51-6 | Benzyl alcohol | 660 | U | 660 | 37 |
| 85-68-7 | Benzyl butyl phthalate | 330 | U | 330 | 40 |
| 111-91-1 | Bis(2-chloroethoxy)methane | 330 | U | 330 | 43 |
| 111-44-4 | Bis(2-chloroethyl)ether | 330 | U | 330 | 50 |
| 108-60-1 | Bis(2-chloroisopropyl)ether | 660 | U | 660 | 50 |
| 117-81-7 | Bis(2-ethylhexyl)phthalate | 330 | U | 330 | 40 |
| 101-55-3 | 4-Bromophenyl phenyl ether | 330 | U | 330 | 27 |
| 59-50-7 | 4-Chloro-3-methylphenol | 330 | U | 330 | 34 |
| 106-47-8 | 4-Chloroaniline | 660 | U | 660 | 30 |
| 91-58-7 | 2-Chloronaphthalene | 330 | U | 330 | 41 |
| 95-57-8 | 2-Chlorophenol | 330 | U | 330 | 40 |
| 7005-72-3 | 4-Chlorophenyl phenyl ether | 330 | U | 330 | 40 |
| 218-01-9 | Chrysene | 40 | U | 40 | 40 |
| 53-70-3 | Dibenz[a,h]anthracene | 33 | U | 33 | 33 |
| 84-74-2 | Di-n-butyl phthalate | 330 | U | 330 | 48 |
| 117-84-0 | Di-n-octyl phthalate | 330 | U | 330 | 34 |
| 132-64-9 | Dibenzofuran | 660 | U | 660 | 44 |
| 95-50-1 | 1,2-Dichlorobenzene | 330 | U | 330 | 38 |
| 541-73-1 | 1,3-Dichlorobenzene | 330 | U | 330 | 35 |
| 106-46-7 | 1,4-Dichlorobenzene | 330 | U | 330 | 40 |
| 91-94-1 | 3,3-Dichlorobenzidine | 330 | U | 330 | 16 |
| 120-83-2 | 2,4-Dichlorophenol | 330 | U | 330 | 29 |
| 84-66-2 | Diethyl phthalate | 330 | U | 330 | 36 |
| 131-11-3 | Dimethyl phthalate | 330 | U | 330 | 32 |
| 105-67-9 | 2,4-Dimethylphenol | 330 | U | 330 | 36 |
| 51-28-5 | 2,4-Dinitrophenol | 330 | U | 330 | 66 |
| 121-14-2 | 2,4-Dinitrotoluene | 330 | U | 330 | 36 |
| 606-20-2 | 2,6-Dinitrotoluene | 330 | U | 330 | 32 |
| 206-44-0 | Fluoranthene | 52 | | 39 J | 39 |
| 86-73-7 | Fluorene | 46 | U | 46 | 46 |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 5 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-05

SD-02

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 49.9

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.02 g

Date Analyzed: 11/21/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49913

Lab Data File: L17804.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------|----------------------------|--------|------|------|-----|
| 118-74-1 | Hexachlorobenzene | 330 | U | 330 | 33 |
| 87-68-3 | Hexachlorobutadiene | 330 | U | 330 | 36 |
| 77-47-4 | Hexachlorocyclopentadiene | 330 | U | 330 | 50 |
| 67-72-1 | Hexachloroethane | 330 | U | 330 | 38 |
| 193-39-5 | Indeno[1,2,3-cd]pyrene | 27 | U | 27 | 27 |
| 78-59-1 | Isophorone | 330 | U | 330 | 37 |
| 534-52-1 | 2-Methyl-4,6-dinitrophenol | 330 | U | 330 | 19 |
| 91-57-6 | 2-Methylnaphthalene | 330 | U | 330 | 39 |
| 95-48-7 | 2-Methylphenol | 330 | U | 330 | 22 |
| | 3- & 4-Methylphenols | 330 | U | 330 | 43 |
| 91-20-3 | Naphthalene | 43 | U | 43 | 43 |
| 88-74-4 | 2-Nitroaniline | 660 | U | 660 | 38 |
| 99-09-2 | 3-Nitroaniline | 660 | U | 660 | 25 |
| 100-01-6 | 4-Nitroaniline | 660 | U | 660 | 25 |
| 98-95-3 | Nitrobenzene | 330 | U | 330 | 46 |
| 88-75-5 | 2-Nitrophenol | 330 | U | 330 | 20 |
| 100-02-1 | 4-Nitrophenol | 330 | U | 330 | 18 |
| 621-64-7 | N-Nitrosodi-n-propylamine | 330 | U | 330 | 50 |
| 62-75-9 | N-Nitrosodimethylamine | 330 | U | 330 | 42 |
| 86-30-6 | N-Nitrosodiphenylamine | 330 | U | 330 | 46 |
| 87-86-5 | Pentachlorophenol | 330 | U | 330 | 16 |
| 85-01-8 | Phenanthrene | 46 | U | 46 | 46 |
| 108-95-2 | Phenol | 330 | U | 330 | 38 |
| 129-00-0 | Pyrene | 42 | | 39 J | 39 |
| 95-95-4 | 2,4,5-Trichlorophenol | 330 | U | 330 | 26 |
| 88-06-2 | 2,4,6-Trichlorophenol | 330 | U | 330 | 27 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 330 | U | 330 | 33 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| 2,4,6-Tribromophenol | 23% | 19%-116% |
| 2-Fluorobiphenyl | 16% | 27%-105% |
| 2-Fluorophenol | 15% | 11%-94% |
| 4-Terphenyl-d14 | 25% | 20%-154% |
| Nitrobenzene-d5 | 11% | 15%-96% |
| Phenol-d6 | 16% | 12%-88% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill
 Location: Richmond, RI
 Project: 20060089.A20/ Knowles Mill
 Sample Description: 841061116-06

SD-03

PL Report No: E611A38
 PL Sample No: 6

Date Collected: 11/16/2006
 Date Received: 11/17/2006
 Date Extracted: 11/20/06 By: BW
 Date Analyzed: 11/21/06 By: MM
 Method: 8082
 QC Batch#: 49868
 Units: ug/kg

Matrix: Solid
 Percent Moisture: 29.2
 Sample Weight/Volume: 30.38 g
 Dilution Factor: 1
 Extract Volume: 2
 Lab Data File: 4112129.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------------------|--------------|----------|----------|----|-----|
| 12674-11-2 | Aroclor 1016 | 18 | U | 18 | 14 |
| 11104-28-2 | Aroclor 1221 | 18 | U | 18 | 14 |
| 11141-16-5 | Aroclor 1232 | 18 | U | 18 | 14 |
| 53469-21-9 | Aroclor 1242 | 18 | U | 18 | 14 |
| 12672-29-6 | Aroclor 1248 | 18 | U | 18 | 14 |
| 11097-69-1 | Aroclor 1254 | 18 | U | 18 | 14 |
| 11096-82-5 | Aroclor 1260 | 18 | U | 18 | 14 |
| Surrogate | | Recovery | Limits | | |
| Tetrachloro-m-xylene | | 50% | 17%-129% | | |
| Decachlorobiphenyl | | 57% | 11%-123% | | |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 6

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-06

SD-03

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 29.2

Date Extracted: 11/20/06 By: BW

Sample Weight/Volume: 30.38 g

Date Analyzed: 11/22/06 By: LM

Dilution Factor: 1

Method: 8081A

Extract Volume: 2

QC Batch#: 49926

Lab Data File: 4112216.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|---------------------|--------|------|------|------|
| 309-00-2 | Aldrin | 0.93 | U | 0.93 | 0.50 |
| 319-84-6 | alpha-BHC | 0.93 | U | 0.93 | 0.47 |
| 319-85-7 | beta-BHC | 0.93 | U | 0.93 | 0.59 |
| 319-86-8 | delta-BHC | 0.93 | U | 0.93 | 0.47 |
| 59-89-9 | gamma-BHC (Lindane) | 0.93 | U | 0.93 | 0.49 |
| 5103-71-9 | alpha-Chlordane | 0.93 | U | 0.93 | 0.52 |
| 5103-74-2 | gamma-Chlordane | 0.93 | U | 0.93 | 0.72 |
| 72-54-8 | 4,4'-DDD | 0.93 | U | 0.93 | 0.63 |
| 72-55-9 | 4,4'-DDE | 0.93 | U | 0.93 | 0.52 |
| 50-29-3 | 4,4'-DDT | 0.93 | U | 0.93 | 0.84 |
| 60-57-1 | Dieldrin | 0.93 | U | 0.93 | 0.54 |
| 33213-65-9 | Endosulfan II | 0.93 | U | 0.93 | 0.52 |
| 7421-93-4 | Bndrin aldehyde | 0.93 | U | 0.93 | 0.80 |
| 959-98-8 | Endosulfan I | 0.93 | U | 0.93 | 0.63 |
| 1031-07-8 | Endosulfan sulfate | 0.93 | U | 0.93 | 0.76 |
| 72-20-8 | Bndrin | 0.93 | U | 0.93 | 0.70 |
| 53494-70-5 | Bndrin ketone | 0.93 | U | 0.93 | 0.65 |
| 76-44-8 | Heptachlor | 0.93 | U | 0.93 | 0.59 |
| 1024-57-3 | Heptachlor epoxide | 0.93 | U | 0.93 | 0.54 |
| 72-43-5 | Methoxychlor | 0.93 | U | 0.93 | 0.80 |
| 8001-35-2 | Toxaphene | 46 | U | 46 | 13 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| Tetrachloro-m-xylene | 111% | 10%-135% |
| Decachlorobiphenyl | 112% | 10%-112% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 6

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-06

SD-03

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 29.2

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.36 g

Date Analyzed: 11/21/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49913

Lab Data File: L17805.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|-----------------------------|--------|------|------|-----|
| 103-33-3 | Azobenzene | 230 | U | 230 | 36 |
| 83-32-9 | Acenaphthene | 29 | U | 29 | 29 |
| 208-96-8 | Acenaphthylene | 29 | U | 29 | 29 |
| 62-53-3 | Aniline | 460 | U | 460 | 21 |
| 120-12-7 | Anthracene | 110 | | 28 J | 28 |
| 56-55-3 | Benzo[a]anthracene | 75 | | 25 J | 25 |
| 50-32-8 | Benzo[a]pyrene | 66 | | 20 J | 22 |
| 205-99-2 | Benzo[b]fluoranthene | 43 | | 20 J | 20 |
| 191-24-2 | Benzo[g,h,i]perylene | 39 | | 21 J | 21 |
| 207-08-9 | Benzo[k]fluoranthene | 76 | | 25 J | 25 |
| 65-85-0 | Benzoic acid | 1200 | U | 1200 | 8.1 |
| 100-51-6 | Benzyl alcohol | 460 | U | 460 | 26 |
| 85-68-7 | Benzyl butyl phthalate | 230 | U | 230 | 28 |
| 111-91-1 | Bis(2-chloroethoxy)methane | 230 | U | 230 | 30 |
| 111-44-4 | Bis(2-chloroethyl)ether | 230 | U | 230 | 35 |
| 108-60-1 | Bis(2-chloroisopropyl)ether | 460 | U | 460 | 35 |
| 117-81-7 | Bis(2-ethylhexyl)phthalate | 230 | U | 230 | 28 |
| 101-55-3 | 4-Bromophenyl phenyl ether | 230 | U | 230 | 19 |
| 59-50-7 | 4-Chloro-3-methylphenol | 230 | U | 230 | 24 |
| 106-47-8 | 4-Chloroaniline | 460 | U | 460 | 21 |
| 91-58-7 | 2-Chloronaphthalene | 230 | U | 230 | 29 |
| 95-57-8 | 2-Chlorophenol | 230 | U | 230 | 28 |
| 7005-72-3 | 4-Chlorophenyl phenyl ether | 230 | U | 230 | 28 |
| 218-01-9 | Chrysene | 90 | | 28 J | 28 |
| 53-70-3 | Dibenz[a,h]anthracene | 23 | U | 23 | 23 |
| 84-74-2 | Di-n-butyl phthalate | 230 | U | 230 | 33 |
| 117-84-0 | Di-n-octyl phthalate | 230 | U | 230 | 24 |
| 132-64-9 | Dibenzofuran | 460 | U | 460 | 31 |
| 95-50-1 | 1,2-Dichlorobenzene | 230 | U | 230 | 26 |
| 541-73-1 | 1,3-Dichlorobenzene | 230 | U | 230 | 25 |
| 106-46-7 | 1,4-Dichlorobenzene | 230 | U | 230 | 28 |
| 91-94-1 | 3,3-Dichlorobenzidine | 230 | U | 230 | 11 |
| 120-83-2 | 2,4-Dichlorophenol | 230 | U | 230 | 20 |
| 84-66-2 | Diethyl phthalate | 230 | U | 230 | 25 |
| 131-11-3 | Dimethyl phthalate | 230 | U | 230 | 23 |
| 105-67-9 | 2,4-Dimethylphenol | 230 | U | 230 | 25 |
| 51-28-5 | 2,4-Dinitrophenol | 230 | U | 230 | 46 |
| 121-14-2 | 2,4-Dinitrotoluene | 230 | U | 230 | 25 |
| 606-20-2 | 2,6-Dinitrotoluene | 230 | U | 230 | 22 |
| 206-44-0 | Fluoranthene | 160 | | 27 J | 27 |
| 86-73-7 | Fluorene | 32 | U | 32 | 32 |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 6 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-06

SD-03

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 29.2

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.36 g

Date Analyzed: 11/21/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49913

Lab Data File: L17805.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------|----------------------------|--------|------|------|-----|
| 118-74-1 | Hexachlorobenzene | 230 | U | 230 | 23 |
| 87-68-3 | Hexachlorobutadiene | 230 | U | 230 | 25 |
| 77-47-4 | Hexachlorocyclopentadiene | 230 | U | 230 | 35 |
| 67-72-1 | Hexachloroethane | 230 | U | 230 | 27 |
| 193-39-5 | Indeno[1,2,3-cd]pyrene | 31 | | 19 J | 19 |
| 78-59-1 | Isophorone | 230 | U | 230 | 26 |
| 534-52-1 | 2-Methyl-4,6-dinitrophenol | 230 | U | 230 | 13 |
| 91-57-6 | 2-Methylnaphthalene | 230 | U | 230 | 27 |
| 95-48-7 | 2-Methylphenol | 230 | U | 230 | 15 |
| | 3- & 4-Methylphenols | 230 | U | 230 | 30 |
| 91-20-3 | Naphthalene | 30 | U | 30 | 30 |
| 88-74-4 | 2-Nitroaniline | 460 | U | 460 | 26 |
| 99-09-2 | 3-Nitroaniline | 460 | U | 460 | 17 |
| 100-01-6 | 4-Nitroaniline | 460 | U | 460 | 17 |
| 98-95-3 | Nitrobenzene | 230 | U | 230 | 32 |
| 88-75-5 | 2-Nitrophenol | 230 | U | 230 | 14 |
| 100-02-1 | 4-Nitrophenol | 230 | U | 230 | 12 |
| 621-64-7 | N-Nitrosodi-n-propylamine | 230 | U | 230 | 35 |
| 62-75-9 | N-Nitrosodimethylamine | 230 | U | 230 | 29 |
| 86-30-6 | N-Nitrosodiphenylamine | 230 | U | 230 | 32 |
| 87-86-5 | Pentachlorophenol | 230 | U | 230 | 11 |
| 85-01-8 | Phenanthrene | 110 | | 32 J | 32 |
| 108-95-2 | Phenol | 230 | U | 230 | 27 |
| 129-00-0 | Pyrene | 170 | | 27 J | 27 |
| 95-95-4 | 2,4,5-Trichlorophenol | 230 | U | 230 | 18 |
| 88-06-2 | 2,4,6-Trichlorophenol | 230 | U | 230 | 19 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 230 | U | 230 | 23 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| 2,4,6-Tribromophenol | 31% | 19%-116% |
| 2-Fluorobiphenyl | 26% | 27%-105% |
| 2-Fluorophenol | 24% | 11%-94% |
| 4-Terphenyl-d14 | 38% | 20%-154% |
| Nitrobenzene-d5 | 18% | 15%-96% |
| Phenol-d6 | 24% | 12%-88% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 7

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-07

SD-04

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 38.2

Date Extracted: 11/20/06 By: BW

Sample Weight/Volume: 30.64 g

Date Analyzed: 11/21/06 By: MM

Dilution Factor: 1

Method: 8082

Extract Volume: 2

QC Batch#: 49868

Lab Data File: 4112130.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | OL | MDL |
|----------------------|--------------|----------|----------|----|-----|
| 12674-11-2 | Aroclor 1016 | 21 | U | 21 | 16 |
| 11104-28-2 | Aroclor 1221 | 21 | U | 21 | 16 |
| 11141-16-5 | Aroclor 1232 | 21 | U | 21 | 16 |
| 53469-21-9 | Aroclor 1242 | 21 | U | 21 | 16 |
| 12672-29-6 | Aroclor 1248 | 21 | U | 21 | 16 |
| 11097-69-1 | Aroclor 1254 | 21 | U | 21 | 16 |
| 11096-82-5 | Aroclor 1260 | 21 | U | 21 | 16 |
| Surrogate | | Recovery | Limits | | |
| Tetrachloro-m-xylene | | 45% | 17%-129% | | |
| Decachlorobiphenyl | | 68% | 11%-123% | | |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: B611A38

Location: Richmond, RI

PL Sample No: 7

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-07

SD-04

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 38.2

Date Extracted: 11/20/06 By: BW

Sample Weight/Volume: 30.64 g

Date Analyzed: 11/22/06 By: LM

Dilution Factor: 1

Method: 8081A

Extract Volume: 2

QC Batch#: 49926

Lab Data File: 4112217.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------------------|---------------------|----------|----------|-----|------|
| 309-00-2 | Aldrin | 1.0 | U | 1.0 | 0.57 |
| 319-84-6 | alpha-BHC | 1.0 | U | 1.0 | 0.54 |
| 319-85-7 | beta-BHC | 1.0 | U | 1.0 | 0.67 |
| 319-86-8 | delta-BHC | 1.0 | U | 1.0 | 0.54 |
| 59-89-9 | gamma-BHC (Lindane) | 1.0 | U | 1.0 | 0.55 |
| 5103-71-9 | alpha-Chlordane | 1.0 | U | 1.0 | 0.58 |
| 5103-74-2 | gamma-Chlordane | 1.0 | U | 1.0 | 0.81 |
| 72-54-8 | 4,4'-DDD | 1.0 | U | 1.0 | 0.71 |
| 72-55-9 | 4,4'-DDE | 1.0 | U | 1.0 | 0.59 |
| 50-29-3 | 4,4'-DDT | 1.0 | U | 1.0 | 0.95 |
| 60-57-1 | Dieldrin | 1.0 | U | 1.0 | 0.62 |
| 33213-65-9 | Endosulfan II | 1.0 | U | 1.0 | 0.59 |
| 7421-93-4 | Endrin aldehyde | 1.0 | U | 1.0 | 0.91 |
| 959-98-8 | Endosulfan I | 1.0 | U | 1.0 | 0.72 |
| 1031-07-8 | Endosulfan sulfate | 1.0 | U | 1.0 | 0.87 |
| 72-20-8 | Endrin | 1.0 | U | 1.0 | 0.79 |
| 53494-70-5 | Endrin ketone | 1.0 | U | 1.0 | 0.73 |
| 76-44-8 | Heptachlor | 1.0 | U | 1.0 | 0.67 |
| 1024-57-3 | Heptachlor epoxide | 1.0 | U | 1.0 | 0.61 |
| 72-43-5 | Methoxychlor | 1.0 | U | 1.0 | 0.91 |
| 8001-35-2 | Toxaphene | 53 | U | 53 | 15 |
| Surrogate | | Recovery | Limits | | |
| Tetrachloro-m-xylene | | 68% | 10%-135% | | |
| Decachlorobiphenyl | | 112% | 10%-112% | | |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 7

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-07

SD-04

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 38.2

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.02 g

Date Analyzed: 11/21/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49913

Lab Data File: L17806.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|-----------------------------|--------|------|------|-----|
| 103-33-3 | Azobenzene | 270 | U | 270 | 42 |
| 83-32-9 | Acenaphthene | 34 | U | 34 | 34 |
| 208-96-8 | Acenaphthylene | 83 | | 34 J | 34 |
| 62-53-3 | Aniline | 540 | U | 540 | 24 |
| 120-12-7 | Anthracene | 75 | | 32 J | 32 |
| 56-55-3 | Benzo[a]anthracene | 370 | | 28 | 28 |
| 50-32-8 | Benzo[a]pyrene | 390 | | 25 | 25 |
| 205-99-2 | Benzo[b]fluoranthene | 630 | | 270 | 23 |
| 191-24-2 | Benzo[g,h,i]perylene | 120 | | 25 J | 25 |
| 207-08-9 | Benzo[k]fluoranthene | 350 | | 270 | 28 |
| 65-85-0 | Benzoic acid | 1300 | U | 1300 | 9.4 |
| 100-51-6 | Benzyl alcohol | 540 | U | 540 | 30 |
| 85-68-7 | Benzyl butyl phthalate | 270 | U | 270 | 32 |
| 111-91-1 | Bis(2-chloroethoxy)methane | 270 | U | 270 | 35 |
| 111-44-4 | Bis(2-chloroethyl)ether | 270 | U | 270 | 40 |
| 108-60-1 | Bis(2-chloroisopropyl)ether | 540 | U | 540 | 40 |
| 117-81-7 | Bis(2-ethylhexyl)phthalate | 270 | U | 270 | 32 |
| 101-55-3 | 4-Bromophenyl phenyl ether | 270 | U | 270 | 22 |
| 59-50-7 | 4-Chloro-3-methylphenol | 270 | U | 270 | 28 |
| 106-47-8 | 4-Chloroaniline | 540 | U | 540 | 24 |
| 91-58-7 | 2-Chloronaphthalene | 270 | U | 270 | 34 |
| 95-57-8 | 2-Chlorophenol | 270 | U | 270 | 32 |
| 7005-72-3 | 4-Chlorophenyl phenyl ether | 270 | U | 270 | 33 |
| 218-01-9 | Chrysene | 610 | | 33 | 33 |
| 53-70-3 | Dibenz[a,h]anthracene | 100 | | 27 J | 27 |
| 84-74-2 | Di-n-butyl phthalate | 270 | U | 270 | 39 |
| 117-84-0 | Di-n-octyl phthalate | 270 | U | 270 | 28 |
| 132-64-9 | Dibenzofuran | 540 | U | 540 | 36 |
| 95-50-1 | 1,2-Dichlorobenzene | 270 | U | 270 | 31 |
| 541-73-1 | 1,3-Dichlorobenzene | 270 | U | 270 | 29 |
| 106-46-7 | 1,4-Dichlorobenzene | 270 | U | 270 | 32 |
| 91-94-1 | 3,3-Dichlorobenzidine | 270 | U | 270 | 13 |
| 120-83-2 | 2,4-Dichlorophenol | 270 | U | 270 | 24 |
| 84-66-2 | Diethyl phthalate | 270 | U | 270 | 29 |
| 131-11-3 | Dimethyl phthalate | 270 | U | 270 | 26 |
| 105-67-9 | 2,4-Dimethylphenol | 270 | U | 270 | 30 |
| 51-28-5 | 2,4-Dinitrophenol | 270 | U | 270 | 54 |
| 121-14-2 | 2,4-Dinitrotoluene | 270 | U | 270 | 29 |
| 606-20-2 | 2,6-Dinitrotoluene | 270 | U | 270 | 26 |
| 206-44-0 | Fluoranthene | 1000 | | 270 | 32 |
| 86-73-7 | Fluorene | 37 | U | 37 | 37 |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 7 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-07

SD-04

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 38.2

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.02 g

Date Analyzed: 11/21/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49913

Lab Data File: L17806.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------|----------------------------|--------|------|------|-----|
| 118-74-1 | Hexachlorobenzene | 270 | U | 270 | 27 |
| 87-68-3 | Hexachlorobutadiene | 270 | U | 270 | 29 |
| 77-47-4 | Hexachlorocyclopentadiene | 270 | U | 270 | 41 |
| 67-72-1 | Hexachloroethane | 270 | U | 270 | 31 |
| 193-39-5 | Indeno[1,2,3-cd]pyrene | 180 | | 22 J | 22 |
| 78-59-1 | Isophorone | 270 | U | 270 | 30 |
| 534-52-1 | 2-Methyl-4,6-dinitrophenol | 270 | U | 270 | 16 |
| 91-57-6 | 2-Methylnaphthalene | 270 | U | 270 | 32 |
| 95-48-7 | 2-Methylphenol | 270 | U | 270 | 18 |
| | 3- & 4-Methylphenols | 270 | U | 270 | 34 |
| 91-20-3 | Naphthalene | 34 | U | 34 | 34 |
| 88-74-4 | 2-Nitroaniline | 540 | U | 540 | 31 |
| 99-09-2 | 3-Nitroaniline | 540 | U | 540 | 20 |
| 100-01-6 | 4-Nitroaniline | 540 | U | 540 | 20 |
| 98-95-3 | Nitrobenzene | 270 | U | 270 | 37 |
| 88-75-5 | 2-Nitrophenol | 270 | U | 270 | 16 |
| 100-02-1 | 4-Nitrophenol | 270 | U | 270 | 14 |
| 621-64-7 | N-Nitrosodi-n-propylamine | 270 | U | 270 | 41 |
| 62-75-9 | N-Nitrosodimethylamine | 270 | U | 270 | 34 |
| 86-30-6 | N-Nitrosodiphenylamine | 270 | U | 270 | 38 |
| 87-86-5 | Pentachlorophenol | 270 | U | 270 | 13 |
| 85-01-8 | Phenanthrene | 690 | | 38 | 38 |
| 108-95-2 | Phenol | 270 | U | 270 | 31 |
| 129-00-0 | Pyrene | 1200 | | 31 | 31 |
| 95-95-4 | 2,4,5-Trichlorophenol | 270 | U | 270 | 21 |
| 88-06-2 | 2,4,6-Trichlorophenol | 270 | U | 270 | 22 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 270 | U | 270 | 26 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| 2,4,6-Tribromophenol | 47% | 19%-116% |
| 2-Fluorobiphenyl | 30% | 27%-105% |
| 2-Fluorophenol | 23% | 11%-94% |
| 4-Terphenyl-d14 | 52% | 20%-154% |
| Nitrobenzene-d5 | 25% | 15%-96% |
| Phenol-d6 | 23% | 12%-88% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 8

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-08

SD-04
Field Duplicate

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 24.0

Date Extracted: 11/20/06 By: BW

Sample Weight/Volume: 30.29 g

Date Analyzed: 11/21/06 By: MM

Dilution Factor: 1

Method: 8082

Extract Volume: 2

QC Batch#: 49868

Lab Data File: 4112131.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|--------------|--------|------|----|-----|
| 12674-11-2 | Aroclor 1016 | 17 | U | 17 | 13 |
| 11104-28-2 | Aroclor 1221 | 17 | U | 17 | 13 |
| 11141-16-5 | Aroclor 1232 | 17 | U | 17 | 13 |
| 53469-21-9 | Aroclor 1242 | 17 | U | 17 | 13 |
| 12672-29-6 | Aroclor 1248 | 17 | U | 17 | 13 |
| 11097-69-1 | Aroclor 1254 | 17 | U | 17 | 13 |
| 11096-82-5 | Aroclor 1260 | 17 | U | 17 | 13 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| Tetrachloro-m-xylene | 45% | 17%-129% |
| Decachlorobiphenyl | 53% | 11%-123% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: B611A38

Location: Richmond, RI

PL Sample No: 8

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-08

SD-04
Field Duplicate

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 24.0

Date Extracted: 11/21/06 By: PZ

Sample Weight/Volume: 30.07 g

Date Analyzed: 11/22/06 By: LM

Dilution Factor: 1

Method: 8081A

Extract Volume: 2

QC Batch#: 49926

Lab Data File: 4112218.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|---------------------|--------|------|------|------|
| 309-00-2 | Aldrin | 0.88 | U | 0.88 | 0.47 |
| 319-84-6 | alpha-BHC | 0.88 | U | 0.88 | 0.45 |
| 319-85-7 | beta-BHC | 0.88 | U | 0.88 | 0.56 |
| 319-86-8 | delta-BHC | 0.88 | U | 0.88 | 0.45 |
| 59-89-9 | gamma-BHC (Lindane) | 0.88 | U | 0.88 | 0.46 |
| 5103-71-9 | alpha-Chlordane | 0.88 | U | 0.88 | 0.48 |
| 5103-74-2 | gamma-Chlordane | 0.88 | U | 0.88 | 0.67 |
| 72-54-8 | 4,4'-DDD | 0.88 | U | 0.88 | 0.59 |
| 72-55-9 | 4,4'-DDE | 0.88 | U | 0.88 | 0.49 |
| 50-29-3 | 4,4'-DDT | 0.88 | U | 0.88 | 0.79 |
| 60-57-1 | Dieldrin | 0.88 | U | 0.88 | 0.51 |
| 33213-65-9 | Endosulfan II | 0.88 | U | 0.88 | 0.49 |
| 7421-93-4 | Endrin aldehyde | 0.88 | U | 0.88 | 0.75 |
| 959-98-8 | Endosulfan I | 0.88 | U | 0.88 | 0.60 |
| 1031-07-8 | Endosulfan sulfate | 0.88 | U | 0.88 | 0.72 |
| 72-20-8 | Endrin | 0.88 | U | 0.88 | 0.65 |
| 53494-70-5 | Endrin ketone | 0.88 | U | 0.88 | 0.61 |
| 76-44-8 | Heptachlor | 0.88 | U | 0.88 | 0.55 |
| 1024-57-3 | Heptachlor epoxide | 0.88 | U | 0.88 | 0.50 |
| 72-43-5 | Methoxychlor | 0.88 | U | 0.88 | 0.76 |
| 8001-35-2 | Toxaphene | 44 | U | 44 | 12 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| Tetrachloro-m-xylene | 48% | 10%-135% |
| Decachlorobiphenyl | 106% | 10%-112% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 8

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-08

SD-04
Field Duplicate

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 24.0

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.01 g

Date Analyzed: 11/27/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49954

Lab Data File: L17817.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|-----------------------------|--------|------|------|-----|
| 103-33-3 | Azobenzene | 220 | U | 220 | 34 |
| 83-32-9 | Acenaphthene | 27 | U | 27 | 27 |
| 208-96-8 | Acenaphthylene | 160 | | 28 J | 28 |
| 62-53-3 | Aniline | 440 | U | 440 | 20 |
| 120-12-7 | Anthracene | 110 | | 26 J | 26 |
| 56-55-3 | Benzo[a]anthracene | 560 | | 23 | 23 |
| 50-32-8 | Benzo[a]pyrene | 680 | | 20 | 20 |
| 205-99-2 | Benzo[b]fluoranthene | 840 | | 220 | 18 |
| 191-24-2 | Benzo[g,h,i]perylene | 240 | | 220 | 20 |
| 207-08-9 | Benzo[k]fluoranthene | 870 | | 220 | 23 |
| 65-85-0 | Benzoic acid | 1100 | U | 1100 | 7.7 |
| 100-51-6 | Benzyl alcohol | 440 | U | 440 | 24 |
| 85-68-7 | Benzyl butyl phthalate | 220 | U | 220 | 26 |
| 111-91-1 | Bis(2-chloroethoxy)methane | 220 | U | 220 | 28 |
| 111-44-4 | Bis(2-chloroethyl)ether | 220 | U | 220 | 33 |
| 108-60-1 | Bis(2-chloroisopropyl)ether | 440 | U | 440 | 33 |
| 117-81-7 | Bis(2-ethylhexyl)phthalate | 230 | | 220 | 26 |
| 101-55-3 | 4-Bromophenyl phenyl ether | 220 | U | 220 | 18 |
| 59-50-7 | 4-Chloro-3-methylphenol | 220 | U | 220 | 23 |
| 106-47-8 | 4-Chloroaniline | 440 | U | 440 | 20 |
| 91-58-7 | 2-Chloronaphthalene | 220 | U | 220 | 27 |
| 95-57-8 | 2-Chlorophenol | 220 | U | 220 | 26 |
| 7005-72-3 | 4-Chlorophenyl phenyl ether | 220 | U | 220 | 27 |
| 218-01-9 | Chrysene | 970 | | 26 | 26 |
| 53-70-3 | Dibenz[a,h]anthracene | 120 | | 22 J | 22 |
| 84-74-2 | Di-n-butyl phthalate | 220 | U | 220 | 32 |
| 117-84-0 | Di-n-octyl phthalate | 220 | U | 220 | 23 |
| 132-64-9 | Dibenzofuran | 440 | U | 440 | 29 |
| 95-50-1 | 1,2-Dichlorobenzene | 220 | U | 220 | 25 |
| 541-73-1 | 1,3-Dichlorobenzene | 220 | U | 220 | 23 |
| 106-46-7 | 1,4-Dichlorobenzene | 220 | U | 220 | 26 |
| 91-94-1 | 3,3-Dichlorobenzidine | 220 | U | 220 | 11 |
| 120-83-2 | 2,4-Dichlorophenol | 220 | U | 220 | 19 |
| 84-66-2 | Diethyl phthalate | 220 | U | 220 | 23 |
| 131-11-3 | Dimethyl phthalate | 220 | U | 220 | 21 |
| 105-67-9 | 2,4-Dimethylphenol | 220 | U | 220 | 24 |
| 51-28-5 | 2,4-Dinitrophenol | 220 | U | 220 | 44 |
| 121-14-2 | 2,4-Dinitrotoluene | 220 | U | 220 | 24 |
| 606-20-2 | 2,6-Dinitrotoluene | 220 | U | 220 | 21 |
| 206-44-0 | Fluoranthene | 1300 | | 220 | 26 |
| 86-73-7 | Fluorene | 43 | | 30 J | 30 |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 8 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-08

SD-04

Field Duplicate

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 24.0

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.01 g

Date Analyzed: 11/27/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49954

Lab Data File: L17817.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------|----------------------------|--------|------|------|-----|
| 118-74-1 | Hexachlorobenzene | 220 | U | 220 | 22 |
| 87-68-3 | Hexachlorobutadiene | 220 | U | 220 | 24 |
| 77-47-4 | Hexachlorocyclopentadiene | 220 | U | 220 | 33 |
| 67-72-1 | Hexachloroethane | 220 | U | 220 | 25 |
| 193-39-5 | Indeno[1,2,3-cd]pyrene | 220 | U | 220 | 18 |
| 78-59-1 | Isophorone | 220 | U | 220 | 24 |
| 534-52-1 | 2-Methyl-4,6-dinitrophenol | 220 | U | 220 | 13 |
| 91-57-6 | 2-Methylnaphthalene | 220 | U | 220 | 26 |
| 95-48-7 | 2-Methylphenol | 220 | U | 220 | 15 |
| | 3- & 4-Methylphenols | 220 | U | 220 | 28 |
| 91-20-3 | Naphthalene | 56 | | 28 J | 28 |
| 88-74-4 | 2-Nitroaniline | 440 | U | 440 | 25 |
| 99-09-2 | 3-Nitroaniline | 440 | U | 440 | 16 |
| 100-01-6 | 4-Nitroaniline | 440 | U | 440 | 16 |
| 98-95-3 | Nitrobenzene | 220 | U | 220 | 30 |
| 88-75-5 | 2-Nitrophenol | 220 | U | 220 | 13 |
| 100-02-1 | 4-Nitrophenol | 220 | U | 220 | 12 |
| 621-64-7 | N-Nitrosodi-n-propylamine | 220 | U | 220 | 33 |
| 62-75-9 | N-Nitrosodimethylamine | 220 | U | 220 | 27 |
| 86-30-6 | N-Nitrosodiphenylamine | 220 | U | 220 | 31 |
| 87-86-5 | Pentachlorophenol | 220 | U | 220 | 10 |
| 85-01-8 | Phenanthrene | 1200 | | 31 | 31 |
| 108-95-2 | Phenol | 220 | U | 220 | 25 |
| 129-00-0 | Pyrene | 2300 | | 25 | 25 |
| 95-95-4 | 2,4,5-Trichlorophenol | 220 | U | 220 | 17 |
| 88-06-2 | 2,4,6-Trichlorophenol | 220 | U | 220 | 18 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 220 | U | 220 | 22 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| 2,4,6-Tribromophenol | 73% | 19%-116% |
| 2-Fluorobiphenyl | 58% | 27%-105% |
| 2-Fluorophenol | 34% | 11%-94% |
| 4-Terphenyl-d14 | 101% | 20%-154% |
| Nitrobenzene-d5 | 45% | 15%-96% |
| Phenol-d6 | 40% | 12%-88% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 9

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-09

SD-05

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 19.2

Date Extracted: 11/27/06 By: PZ

Sample Weight/Volume: 30.28 g

Date Analyzed: 11/28/06 By: MM

Dilution Factor: 1

Method: 8082

Extract Volume: 2

QC Batch#: 49868

Lab Data File: C112818.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-------------------------------|--------------|----------|----------|----|-----|
| 12674-11-2 | Aroclor 1016 | 16 | U | 16 | 12 |
| 11104-28-2 | Aroclor 1221 | 16 | U | 16 | 12 |
| 11141-16-5 | Aroclor 1232 | 16 | U | 16 | 12 |
| 53469-21-9 | Aroclor 1242 | 16 | U | 16 | 12 |
| 12672-29-6 | Aroclor 1248 | 16 | U | 16 | 12 |
| 11097-69-1 | Aroclor 1254 | 16 | U | 16 | 12 |
| 11096-82-5 | Aroclor 1260 | 16 | U | 16 | 12 |
| Surrogate | | Recovery | Limits | | |
| Tetrachloro- <i>m</i> -xylene | | 33% | 17%-129% | | |
| Decachlorobiphenyl | | 43% | 11%-123% | | |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 9

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-09

SD-05

Date Collected: 11/16/2006
 Date Received: 11/17/2006
 Date Extracted: 11/20/06 By: BW
 Date Analyzed: 11/22/06 By: LM
 Method: 8081A
 QC Batch#: 49926
 Units: ug/kg

Matrix: Solid
 Percent Moisture: 19.2
 Sample Weight/Volume: 30.85 g
 Dilution Factor: 1
 Extract Volume: 2
 Lab Data File: 4112219.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|------------|---------------------|--------|------|------|------|
| 309-00-2 | Aldrin | 0.80 | U | 0.80 | 0.43 |
| 319-84-6 | alpha-BHC | 0.80 | U | 0.80 | 0.41 |
| 319-85-7 | beta-BHC | 0.80 | U | 0.80 | 0.51 |
| 319-86-8 | delta-BHC | 0.80 | U | 0.80 | 0.41 |
| 59-89-9 | gamma-BHC (Lindane) | 0.80 | U | 0.80 | 0.42 |
| 5103-71-9 | alpha-Chlordane | 0.80 | U | 0.80 | 0.44 |
| 5103-74-2 | gamma-Chlordane | 0.80 | U | 0.80 | 0.62 |
| 72-54-8 | 4,4'-DDD | 0.80 | U | 0.80 | 0.54 |
| 72-55-9 | 4,4'-DDE | 0.80 | U | 0.80 | 0.45 |
| 50-29-3 | 4,4'-DDT | 0.80 | U | 0.80 | 0.72 |
| 60-57-1 | Dieldrin | 0.80 | U | 0.80 | 0.47 |
| 33213-65-9 | Endosulfan II | 0.80 | U | 0.80 | 0.45 |
| 7421-93-4 | Endrin aldehyde | 0.80 | U | 0.80 | 0.69 |
| 959-98-8 | Endosulfan I | 0.80 | U | 0.80 | 0.55 |
| 1031-07-8 | Endosulfan sulfate | 0.80 | U | 0.80 | 0.66 |
| 72-20-8 | Endrin | 0.80 | U | 0.80 | 0.60 |
| 53494-70-5 | Endrin ketone | 0.80 | U | 0.80 | 0.56 |
| 76-44-8 | Heptachlor | 0.80 | U | 0.80 | 0.51 |
| 1024-57-3 | Heptachlor epoxide | 0.80 | U | 0.80 | 0.46 |
| 72-43-5 | Methoxychlor | 0.80 | U | 0.80 | 0.69 |
| 8001-35-2 | Toxaphene | 40 | U | 40 | 11 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| Tetrachloro-m-xylene | 44% | 10%-135% |
| Decachlorobiphenyl | 101% | 10%-112% |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 9

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-09

SD-05

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 19.2

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.22 g

Date Analyzed: 11/27/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49954

Lab Data File: L17815.D

| CAS No. | Parameter | Result | Qual | QL | MDL |
|-----------|-----------------------------|--------|------|------|-----|
| 103-33-3 | Azobenzene | 200 | U | 200 | 32 |
| 83-32-9 | Acenaphthene | 26 | U | 26 | 26 |
| 208-96-8 | Acenaphthylene | 26 | U | 26 | 26 |
| 62-53-3 | Aniline | 410 | U | 410 | 19 |
| 120-12-7 | Anthracene | 27 | | 24 J | 24 |
| 56-55-3 | Benzo[a]anthracene | 120 | | 22 J | 22 |
| 50-32-8 | Benzo[a]pyrene | 120 | | 19 J | 19 |
| 205-99-2 | Benzo[b]fluoranthene | 170 | | 17 J | 17 |
| 191-24-2 | Benzo[g,h,i]perylene | 57 | | 19 J | 19 |
| 207-08-9 | Benzo[k]fluoranthene | 140 | | 22 J | 22 |
| 65-85-0 | Benzoic acid | 1000 | U | 1000 | 7.2 |
| 100-51-6 | Benzyl alcohol | 410 | U | 410 | 23 |
| 85-68-7 | Benzyl butyl phthalate | 200 | U | 200 | 24 |
| 111-91-1 | Bis(2-chloroethoxy)methane | 200 | U | 200 | 27 |
| 111-44-4 | Bis(2-chloroethyl)ether | 200 | U | 200 | 31 |
| 108-60-1 | Bis(2-chloroisopropyl)ether | 410 | U | 410 | 31 |
| 117-81-7 | Bis(2-ethylhexyl)phthalate | 200 | U | 200 | 25 |
| 101-55-3 | 4-Bromophenyl phenyl ether | 200 | U | 200 | 17 |
| 59-50-7 | 4-Chloro-3-methylphenol | 200 | U | 200 | 21 |
| 106-47-8 | 4-Chloroaniline | 410 | U | 410 | 19 |
| 91-58-7 | 2-Chloronaphthalene | 200 | U | 200 | 26 |
| 95-57-8 | 2-Chlorophenol | 200 | U | 200 | 24 |
| 7005-72-3 | 4-Chlorophenyl phenyl ether | 200 | U | 200 | 25 |
| 218-01-9 | Chrysene | 210 | | 25 | 25 |
| 53-70-3 | Dibenz[a,h]anthracene | 20 | U | 20 | 20 |
| 84-74-2 | Di-n-butyl phthalate | 200 | U | 200 | 29 |
| 117-84-0 | Di-n-octyl phthalate | 200 | U | 200 | 21 |
| 132-64-9 | Dibenzofuran | 410 | U | 410 | 27 |
| 95-50-1 | 1,2-Dichlorobenzene | 200 | U | 200 | 23 |
| 541-73-1 | 1,3-Dichlorobenzene | 200 | U | 200 | 22 |
| 106-46-7 | 1,4-Dichlorobenzene | 200 | U | 200 | 25 |
| 91-94-1 | 3,3-Dichlorobenzidine | 200 | U | 200 | 10 |
| 120-83-2 | 2,4-Dichlorophenol | 200 | U | 200 | 18 |
| 84-66-2 | Diethyl phthalate | 200 | U | 200 | 22 |
| 131-11-3 | Dimethyl phthalate | 200 | U | 200 | 20 |
| 105-67-9 | 2,4-Dimethylphenol | 200 | U | 200 | 22 |
| 51-28-5 | 2,4-Dinitrophenol | 200 | U | 200 | 41 |
| 121-14-2 | 2,4-Dinitrotoluene | 200 | U | 200 | 22 |
| 606-20-2 | 2,6-Dinitrotoluene | 200 | U | 200 | 20 |
| 206-44-0 | Fluoranthene | 320 | | 200 | 24 |
| 86-73-7 | Fluorene | 28 | U | 28 | 28 |

SEMIVOLATILE ORGANIC ANALYSIS DATA SHEET

Laboratory: Premier Laboratory, LLC

Customer: Fuss & O'Neill

PL Report No: E611A38

Location: Richmond, RI

PL Sample No: 9 (continued)

Project: 20060089.A20/ Knowles Mill

Sample Description: 841061116-09

SD-05

Date Collected: 11/16/2006

Matrix: Solid

Date Received: 11/17/2006

Percent Moisture: 19.2

Date Extracted: 11/20/06 By: PZ

Sample Weight/Volume: 30.22 g

Date Analyzed: 11/27/06 By: JD

Dilution Factor: 1

Method: 8270C

Extract Volume: 1

QC Batch#: 49954

Lab Data File: L17815.D

Units: ug/kg

| CAS No. | Parameter | Result | Qual | QL | MDL |
|----------|----------------------------|--------|------|------|-----|
| 118-74-1 | Hexachlorobenzene | 200 | U | 200 | 20 |
| 87-68-3 | Hexachlorobutadiene | 200 | U | 200 | 22 |
| 77-47-4 | Hexachlorocyclopentadiene | 200 | U | 200 | 31 |
| 67-72-1 | Hexachloroethane | 200 | U | 200 | 24 |
| 193-39-5 | Indeno[1,2,3-cd]pyrene | 64 | | 16 J | 16 |
| 78-59-1 | Isophorone | 200 | U | 200 | 23 |
| 534-52-1 | 2-Methyl-4,6-dinitrophenol | 200 | U | 200 | 12 |
| 91-57-6 | 2-Methylnaphthalene | 200 | U | 200 | 24 |
| 95-48-7 | 2-Methylphenol | 200 | U | 200 | 14 |
| | 3- & 4-Methylphenols | 200 | U | 200 | 26 |
| 91-20-3 | Naphthalene | 26 | U | 26 | 26 |
| 88-74-4 | 2-Nitroaniline | 410 | U | 410 | 23 |
| 99-09-2 | 3-Nitroaniline | 410 | U | 410 | 15 |
| 100-01-6 | 4-Nitroaniline | 410 | U | 410 | 15 |
| 98-95-3 | Nitrobenzene | 200 | U | 200 | 28 |
| 88-75-5 | 2-Nitrophenol | 200 | U | 200 | 12 |
| 100-02-1 | 4-Nitrophenol | 200 | U | 200 | 11 |
| 621-64-7 | N-Nitrosodi-n-propylamine | 200 | U | 200 | 31 |
| 62-75-9 | N-Nitrosodimethylamine | 200 | U | 200 | 26 |
| 86-30-6 | N-Nitrosodiphenylamine | 200 | U | 200 | 29 |
| 87-86-5 | Pentachlorophenol | 200 | U | 200 | 9.6 |
| 85-01-8 | Phenanthrene | 200 | | 29 J | 29 |
| 108-95-2 | Phenol | 200 | U | 200 | 24 |
| 129-00-0 | Pyrene | 350 | | 24 | 24 |
| 95-95-4 | 2,4,5-Trichlorophenol | 200 | U | 200 | 16 |
| 88-06-2 | 2,4,6-Trichlorophenol | 200 | U | 200 | 16 |
| 120-82-1 | 1,2,4-Trichlorobenzene | 200 | U | 200 | 20 |

| Surrogate | Recovery | Limits |
|----------------------|----------|----------|
| 2,4,6-Tribromophenol | 75% | 19%-116% |
| 2-Fluorobiphenyl | 54% | 27%-105% |
| 2-Fluorophenol | 38% | 11%-94% |
| 4-Terphenyl-d14 | 79% | 20%-154% |
| Nitrobenzene-d5 | 44% | 15%-96% |
| Phenol-d6 | 41% | 12%-88% |



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- 610 Lynnale Court, Suite E, Greenville, NC 27858
- 24 Madison Avenue Extension, Albany, NY 12203

- 275 Promenade Street, Suite 350, Providence, RI 02908
- 80 Washington Street, Suite 301, Poughkeepsie, NY 12601
- Other _____

E611A38

CHAIN-OF-CUSTODY RECORD 10897

PROJECT NAME:

Knowles Mill

PROJECT LOCATION:

Richmond, RI

PROJECT NUMBER:

2006.0089.A20

LABORATORY:

Premier

Containers

REPORT TO:

Brian Kortz

INVOICE TO:

Angela Shulman, RIDEM

P.O. No.:

8412006.0089.A20

Sampler's Signature:

[Signature]

Date: 11/16/06

Source Codes:

MW=Monitoring Well
SW=Surface Water

PW=Portable Water
TW=Treatment Facility

S=Soil

B=Bottom Sediment

W=Waste

A=Air

X=Other

Trip Blank

Analysis Request

1 Day* 3 Days* Other _____ (days)
 2 Days* Standard (____ days) *Surcharge Applies

VOCs by P-260B
 SVOCs by 8220C
 16 Metals by 8220C
 Cyanide by 9018
 PCBs by 8082
 Pesticides by 3081

Soil VOA Vol. 11 methanol / sodium bisulfite
 Glass Soil Container (4) or
 Other: VOA Pesticides
 Water VOA Vol. / As is / HCl
 Glass Amber () ml / As is / HCl
 Plastic - As is / 250 ml / 500 ml / 1000 ml
 Plastic - HSO₄ / 250 ml / 500 ml / 1000 ml
 Plastic - HNO₃ / 250 ml / 500 ml / 1000 ml
 Burette Bottle / Filtered

| Item No. | Transfer Check | | | | Sample Number | Source Code | Date Sampled | Time Sampled | Analysis Request | | | | | | | | | | Comments | | | | | |
|----------|----------------|---|---|---|---------------|-------------|--------------|--------------|------------------|-------|-----------|---------|------|------------|----------|----------------------|------------|-----------|----------|-------------|-----------------|----------------------------|----------------------------|----------------|
| | 1 | 2 | 3 | 4 | | | | | VOCs | SVOCs | 16 Metals | Cyanide | PCBs | Pesticides | Soil VOA | Glass Soil Container | Other: VOA | Water VOA | | Glass Amber | Plastic - As is | Plastic - HSO ₄ | Plastic - HNO ₃ | Burette Bottle |
| 1 | ✓ | | | | 84106116-01 | S | 11/16/06 | 1015 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 2 | | | | | -02 | S | | 1010 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 3 | | | | | -03 | S | | 1105 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 4 | | | | | -04 | B | | 1235 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 5 | | | | | -05 | B | | 1300 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 6 | | | | | -06 | B | | 1350 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 7 | | | | | -07 | D | | 1420 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 8 | | | | | -08 | B | | 1430 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 9 | | | | | -09 | B | | 1500 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 10 | ✓ | | | | -10 | X | | 1515 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Trip Blank |

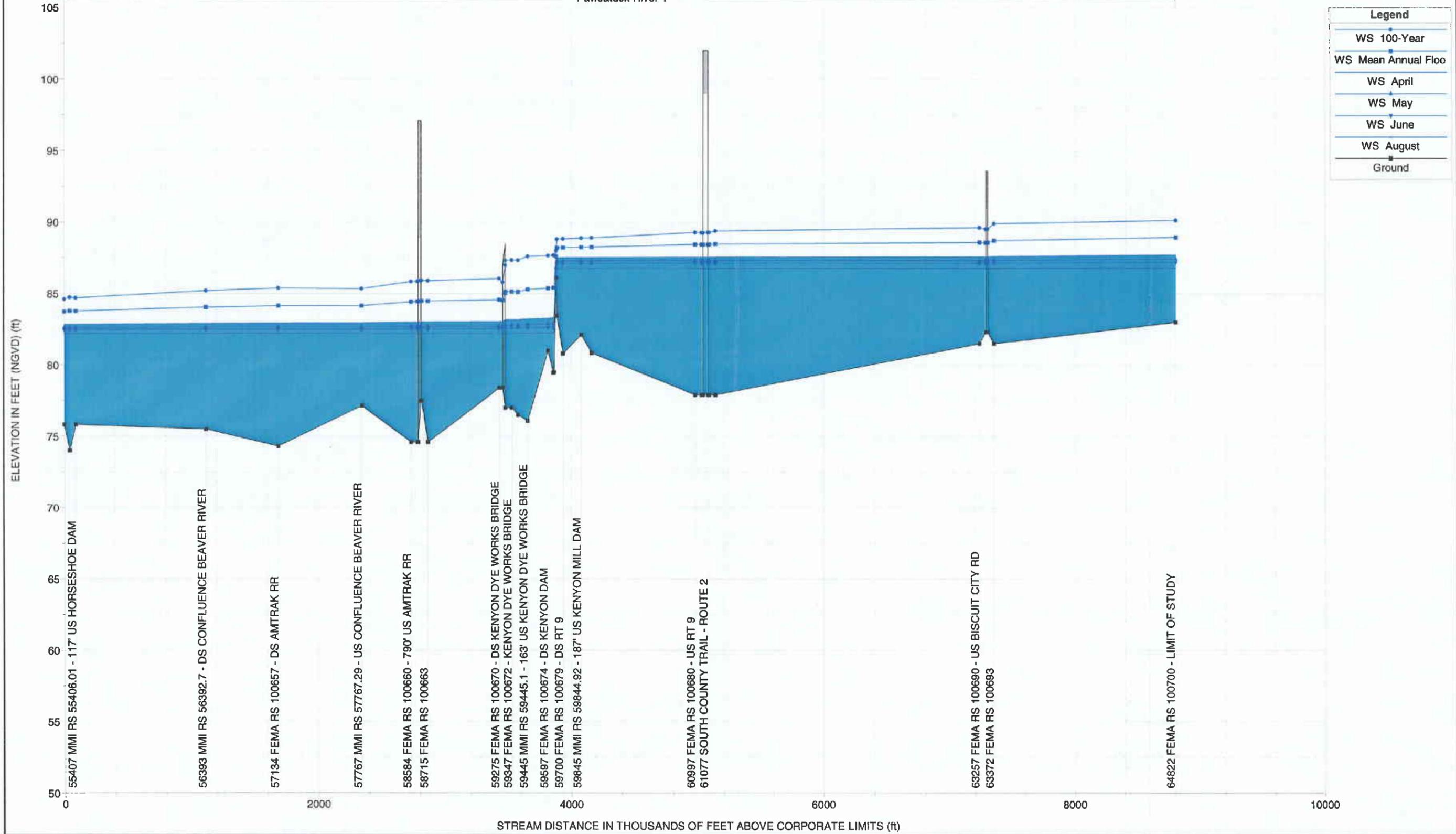
| Transfer Number | Relinquished By | Accepted By | Date | Time | Reporting and Detection Limit Requirements: |
|-----------------|--------------------|--------------------|----------|-------|---|
| 1 | <i>[Signature]</i> | E30 Fudge | 11/16/06 | 1210 | SEE attached memo |
| 2 | <i>[Signature]</i> | <i>[Signature]</i> | 11/17/06 | 0930 | |
| 3 | <i>[Signature]</i> | <i>[Signature]</i> | 11/17/06 | 0935 | |
| 4 | <i>[Signature]</i> | P. Lozano | 11/17/06 | 11:08 | |

Additional Comments:
 - 16 metals: Cadmium, arsenic, barium, beryllium, cobalt, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, zinc

APPENDIX F
HEC-RAS MODEL RESULTS

**APPENDIX F
HEC-RAS OUTPUT
EXISTING CONDITIONS**

Pawcatuck River 1



HEC-RAS Plan EC River Pawcatuck River Reach 1

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ftft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Crt |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 64822 | April | 273.30 | 83.00 | 87.74 | 84.24 | 87.75 | 0.000075 | 0.83 | 759.92 | 594.97 | 0.07 |
| 1 | 64822 | May | 186.60 | 83.00 | 87.43 | 83.97 | 87.44 | 0.000059 | 0.71 | 579.72 | 584.06 | 0.08 |
| 1 | 64822 | June | 140.20 | 83.00 | 87.21 | 83.80 | 87.22 | 0.000050 | 0.62 | 458.98 | 542.36 | 0.06 |
| 1 | 64822 | August | 64.90 | 83.00 | 86.61 | 83.48 | 86.61 | 0.000022 | 0.38 | 272.53 | 368.00 | 0.04 |
| 1 | 64822 | Mean Annual Floo | 750.00 | 83.00 | 88.96 | 85.38 | 88.97 | 0.000103 | 1.15 | 1568.88 | 716.56 | 0.09 |
| 1 | 64822 | 100-Year | 1350.00 | 83.00 | 90.15 | 87.05 | 90.16 | 0.000098 | 1.28 | 2451.21 | 753.95 | 0.09 |
| 1 | 63372 | April | 273.30 | 81.50 | 87.63 | | 87.64 | 0.000077 | 0.77 | 356.05 | 110.42 | 0.07 |
| 1 | 63372 | May | 186.60 | 81.50 | 87.36 | | 87.36 | 0.000046 | 0.57 | 327.58 | 97.04 | 0.05 |
| 1 | 63372 | June | 140.20 | 81.50 | 87.16 | | 87.16 | 0.000031 | 0.45 | 308.88 | 92.98 | 0.04 |
| 1 | 63372 | August | 64.90 | 81.50 | 86.79 | | 86.79 | 0.000008 | 0.24 | 275.17 | 89.79 | 0.02 |
| 1 | 63372 | Mean Annual Floo | 750.00 | 81.50 | 88.73 | | 88.77 | 0.000217 | 1.50 | 681.17 | 395.00 | 0.12 |
| 1 | 63372 | 100-Year | 1350.00 | 81.50 | 89.82 | | 89.96 | 0.000237 | 1.83 | 1189.58 | 444.47 | 0.13 |
| 1 | 63322 | April | 273.30 | 82.30 | 87.61 | 83.40 | 87.63 | 0.000138 | 1.23 | 222.60 | 50.65 | 0.09 |
| 1 | 63322 | May | 186.60 | 82.30 | 87.35 | 83.15 | 87.36 | 0.000076 | 0.88 | 211.56 | 58.77 | 0.07 |
| 1 | 63322 | June | 140.20 | 82.30 | 87.15 | 83.00 | 87.16 | 0.000048 | 0.69 | 203.43 | 58.12 | 0.06 |
| 1 | 63322 | August | 64.90 | 82.30 | 86.79 | 82.72 | 86.79 | 0.000013 | 0.34 | 188.19 | 56.91 | 0.03 |
| 1 | 63322 | Mean Annual Floo | 750.00 | 82.30 | 88.99 | 84.45 | 88.72 | 0.000066 | 2.84 | 263.95 | 62.95 | 0.20 |
| 1 | 63322 | 100-Year | 1350.00 | 82.30 | 89.55 | 85.48 | 89.86 | 0.001206 | 4.44 | 304.21 | 68.15 | 0.29 |
| 1 | 63314.5 | | Bridge | | | | | | | | | |
| 1 | 63307 | April | 273.30 | 82.30 | 87.61 | 83.40 | 87.63 | 0.000138 | 1.23 | 222.50 | 50.64 | 0.09 |
| 1 | 63307 | May | 186.60 | 82.30 | 87.34 | 83.15 | 87.36 | 0.000078 | 0.88 | 211.51 | 58.77 | 0.07 |
| 1 | 63307 | June | 140.20 | 82.30 | 87.15 | 83.00 | 87.16 | 0.000048 | 0.69 | 203.40 | 58.12 | 0.06 |
| 1 | 63307 | August | 64.90 | 82.30 | 86.79 | 82.72 | 86.79 | 0.000013 | 0.34 | 188.18 | 56.91 | 0.03 |
| 1 | 63307 | Mean Annual Floo | 750.00 | 82.30 | 88.98 | 84.45 | 88.71 | 0.0000610 | 2.85 | 263.47 | 62.91 | 0.20 |
| 1 | 63307 | 100-Year | 1350.00 | 82.30 | 89.53 | 85.48 | 89.84 | 0.001270 | 4.45 | 303.15 | 68.07 | 0.29 |
| 1 | 63257 | April | 273.30 | 81.50 | 87.61 | | 87.62 | 0.000079 | 0.78 | 353.41 | 109.25 | 0.07 |
| 1 | 63257 | May | 186.60 | 81.50 | 87.35 | | 87.35 | 0.000046 | 0.57 | 326.34 | 98.41 | 0.05 |
| 1 | 63257 | June | 140.20 | 81.50 | 87.15 | | 87.15 | 0.000031 | 0.45 | 306.13 | 92.91 | 0.04 |
| 1 | 63257 | August | 64.90 | 81.50 | 86.79 | | 86.79 | 0.000009 | 0.24 | 274.08 | 89.77 | 0.02 |
| 1 | 63257 | Mean Annual Floo | 750.00 | 81.50 | 88.61 | | 88.65 | 0.000245 | 1.57 | 633.21 | 388.12 | 0.13 |
| 1 | 63257 | 100-Year | 1350.00 | 81.50 | 89.63 | | 89.68 | 0.000304 | 2.00 | 1053.23 | 432.64 | 0.15 |
| 1 | 61157 | April | 273.30 | 77.90 | 87.58 | | 87.58 | 0.000007 | 0.33 | 652.52 | 250.68 | 0.02 |
| 1 | 61157 | May | 186.60 | 77.90 | 87.33 | | 87.33 | 0.000004 | 0.24 | 796.08 | 201.80 | 0.02 |
| 1 | 61157 | June | 140.20 | 77.90 | 87.14 | | 87.14 | 0.000002 | 0.18 | 761.68 | 164.65 | 0.01 |
| 1 | 61157 | August | 64.90 | 77.90 | 86.79 | | 86.79 | 0.000001 | 0.09 | 717.04 | 117.48 | 0.01 |
| 1 | 61157 | Mean Annual Floo | 750.00 | 77.90 | 88.48 | | 88.49 | 0.000032 | 0.78 | 1125.67 | 342.60 | 0.05 |
| 1 | 61157 | 100-Year | 1350.00 | 77.90 | 89.40 | | 89.42 | 0.000065 | 1.20 | 1495.51 | 448.77 | 0.07 |
| 1 | 61107 | April | 273.30 | 77.90 | 87.57 | 79.34 | 87.58 | 0.000013 | 0.59 | 460.68 | 249.63 | 0.03 |
| 1 | 61107 | May | 186.60 | 77.90 | 87.33 | 79.12 | 87.33 | 0.000007 | 0.42 | 448.34 | 201.09 | 0.02 |
| 1 | 61107 | June | 140.20 | 77.90 | 87.14 | 78.98 | 87.14 | 0.000004 | 0.32 | 438.90 | 164.36 | 0.02 |
| 1 | 61107 | August | 64.90 | 77.90 | 86.79 | 78.63 | 86.79 | 0.000001 | 0.15 | 421.28 | 117.47 | 0.01 |
| 1 | 61107 | Mean Annual Floo | 750.00 | 77.90 | 88.45 | 80.27 | 88.48 | 0.000074 | 1.49 | 504.37 | 339.56 | 0.08 |
| 1 | 61107 | 100-Year | 1350.00 | 77.90 | 89.30 | 81.19 | 89.39 | 0.000182 | 2.47 | 546.82 | 440.15 | 0.13 |
| 1 | 61077 | | Bridge | | | | | | | | | |
| 1 | 61047 | April | 273.30 | 77.90 | 87.57 | 79.34 | 87.58 | 0.000013 | 0.59 | 460.61 | 249.36 | 0.03 |
| 1 | 61047 | May | 186.60 | 77.90 | 87.33 | 79.12 | 87.33 | 0.000007 | 0.42 | 448.31 | 200.98 | 0.02 |
| 1 | 61047 | June | 140.20 | 77.90 | 87.14 | 78.98 | 87.14 | 0.000004 | 0.32 | 438.98 | 164.29 | 0.02 |
| 1 | 61047 | August | 64.90 | 77.90 | 86.79 | 78.63 | 86.79 | 0.000001 | 0.15 | 421.28 | 117.47 | 0.01 |
| 1 | 61047 | Mean Annual Floo | 750.00 | 77.90 | 88.44 | 80.27 | 88.47 | 0.000074 | 1.49 | 503.91 | 338.75 | 0.08 |
| 1 | 61047 | 100-Year | 1350.00 | 77.90 | 89.27 | 81.19 | 89.36 | 0.000184 | 2.48 | 545.43 | 437.74 | 0.13 |
| 1 | 60997 | April | 273.30 | 77.90 | 87.57 | | 87.58 | 0.000007 | 0.33 | 651.19 | 249.64 | 0.02 |
| 1 | 60997 | May | 186.60 | 77.90 | 87.33 | | 87.33 | 0.000004 | 0.24 | 795.55 | 201.09 | 0.02 |
| 1 | 60997 | June | 140.20 | 77.90 | 87.14 | | 87.14 | 0.000002 | 0.18 | 761.43 | 164.36 | 0.01 |
| 1 | 60997 | August | 64.90 | 77.90 | 86.79 | | 86.79 | 0.000001 | 0.09 | 718.99 | 117.47 | 0.01 |
| 1 | 60997 | Mean Annual Floo | 750.00 | 77.90 | 88.45 | | 88.46 | 0.000033 | 0.79 | 1114.04 | 339.63 | 0.05 |
| 1 | 60997 | 100-Year | 1350.00 | 77.90 | 89.36 | | 89.32 | 0.000088 | 1.22 | 1452.37 | 440.46 | 0.08 |
| 1 | 59825 | April | 273.30 | 80.83 | 87.54 | | 87.56 | 0.000130 | 1.14 | 249.77 | 87.30 | 0.09 |
| 1 | 59825 | May | 186.60 | 80.83 | 87.31 | | 87.32 | 0.000072 | 0.82 | 231.26 | 73.49 | 0.07 |
| 1 | 59825 | June | 140.20 | 80.83 | 87.13 | | 87.14 | 0.000047 | 0.64 | 219.02 | 62.71 | 0.06 |
| 1 | 59825 | August | 64.90 | 80.83 | 86.78 | | 86.78 | 0.000013 | 0.32 | 199.50 | 52.35 | 0.03 |
| 1 | 59825 | Mean Annual Floo | 750.00 | 80.83 | 88.27 | | 88.38 | 0.000067 | 2.82 | 332.84 | 139.79 | 0.20 |
| 1 | 59825 | 100-Year | 1350.00 | 80.83 | 89.92 | | 89.15 | 0.001158 | 4.04 | 437.45 | 186.67 | 0.29 |
| 1 | 59845 | April | 273.30 | 82.11 | 87.53 | | 87.55 | 0.000117 | 0.90 | 308.99 | 88.29 | 0.09 |
| 1 | 59845 | May | 186.60 | 82.11 | 87.31 | | 87.31 | 0.000059 | 0.66 | 284.84 | 95.50 | 0.07 |
| 1 | 59845 | June | 140.20 | 82.11 | 87.13 | | 87.13 | 0.000047 | 0.52 | 267.56 | 93.31 | 0.05 |
| 1 | 59845 | August | 64.90 | 82.11 | 86.78 | | 86.78 | 0.000015 | 0.27 | 236.51 | 86.67 | 0.03 |
| 1 | 59845 | Mean Annual Floo | 750.00 | 82.11 | 88.26 | | 88.32 | 0.000454 | 2.01 | 381.69 | 107.17 | 0.18 |

HEC-RAS Plan: EC River: Pawcatuck River Reach: 1 (Continued)

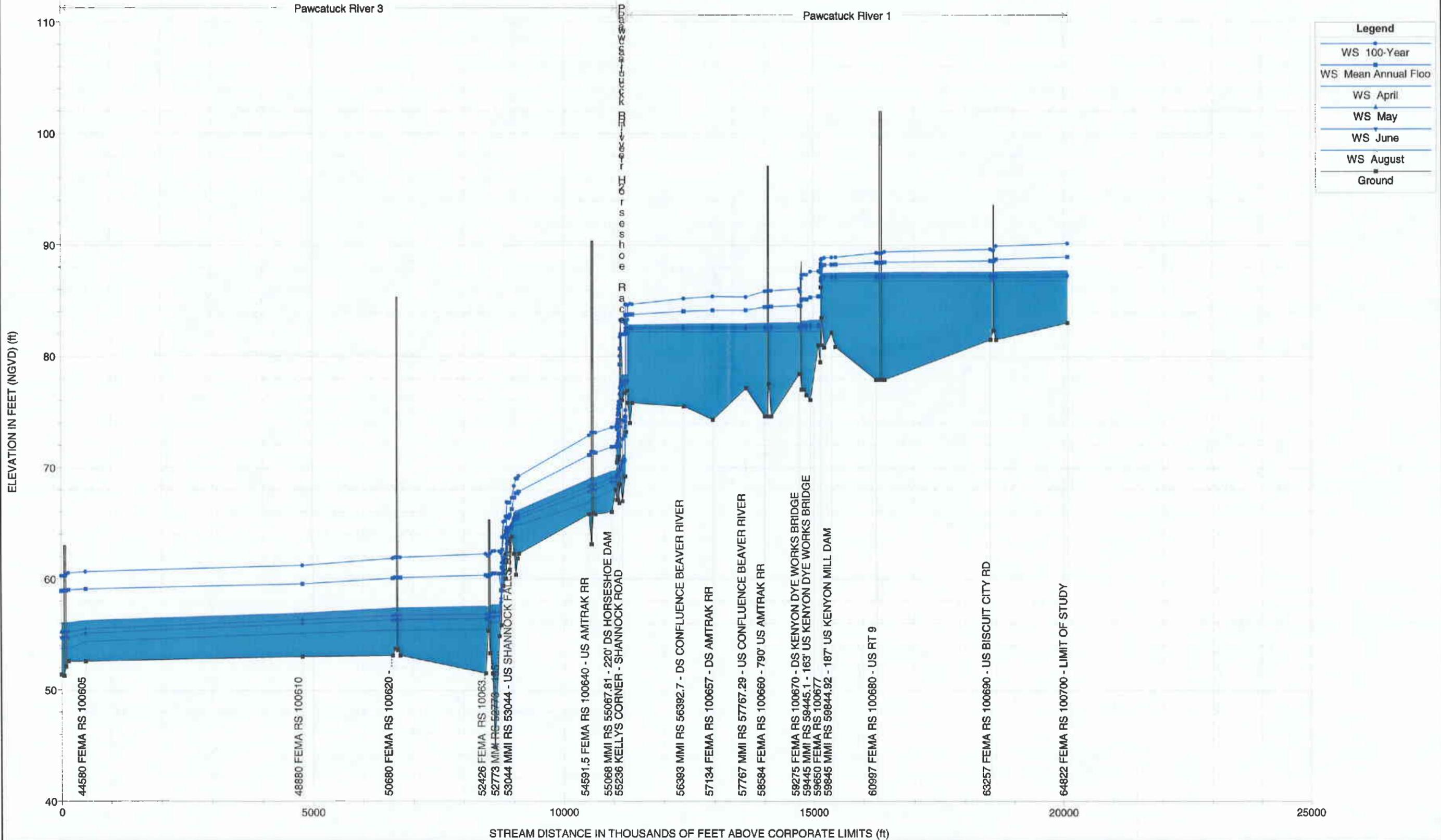
| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Crnt (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|-------------|
| 1 | 59845 | 100-Year | 1350.00 | 82.11 | 88.89 | | 89.04 | 0.000867 | 3.11 | 463.29 | 167.73 | 0.25 |
| 1 | 59700 | April | 273.30 | 80.60 | 87.53 | | 87.53 | 0.000946 | 0.66 | 415.12 | 102.94 | 0.06 |
| 1 | 59700 | May | 186.60 | 80.60 | 87.30 | | 87.31 | 0.000325 | 0.48 | 362.29 | 99.17 | 0.04 |
| 1 | 59700 | June | 140.20 | 80.60 | 87.12 | | 87.13 | 0.000317 | 0.37 | 374.93 | 96.21 | 0.03 |
| 1 | 59700 | August | 64.90 | 80.60 | 86.78 | | 86.78 | 0.000904 | 0.19 | 343.55 | 85.01 | 0.02 |
| 1 | 59700 | Mean Annual Floo | 750.00 | 80.60 | 86.24 | | 88.27 | 0.000209 | 1.54 | 530.11 | 208.26 | 0.12 |
| 1 | 59700 | 100-Year | 1350.00 | 80.60 | 88.85 | | 88.94 | 0.000435 | 2.40 | 867.27 | 240.70 | 0.18 |
| 1 | 59664 | April | 273.30 | 83.44 | 87.52 | | 87.53 | 0.000095 | 0.62 | 411.23 | 224.72 | 0.08 |
| 1 | 59664 | May | 186.60 | 83.44 | 87.30 | | 87.30 | 0.000057 | 0.61 | 362.69 | 215.08 | 0.06 |
| 1 | 59664 | June | 140.20 | 83.44 | 87.12 | | 87.12 | 0.000040 | 0.49 | 324.79 | 207.46 | 0.05 |
| 1 | 59664 | August | 64.90 | 83.44 | 86.78 | | 86.78 | 0.000013 | 0.26 | 260.14 | 160.91 | 0.03 |
| 1 | 59664 | Mean Annual Floo | 750.00 | 83.44 | 88.22 | | 88.26 | 0.000348 | 1.75 | 578.13 | 254.75 | 0.15 |
| 1 | 59664 | 100-Year | 1350.00 | 83.44 | 88.82 | | 88.91 | 0.000648 | 2.58 | 740.06 | 280.84 | 0.21 |
| 1 | 59657 | April | 273.30 | 86.10 | 87.09 | 87.09 | 87.37 | 0.017607 | 4.27 | 74.70 | 209.76 | 0.83 |
| 1 | 59657 | May | 186.60 | 86.10 | 86.84 | 86.84 | 87.13 | 0.029280 | 4.32 | 43.17 | 76.01 | 1.01 |
| 1 | 59657 | June | 140.20 | 86.10 | 86.74 | 86.74 | 86.98 | 0.031087 | 3.93 | 35.68 | 76.01 | 1.01 |
| 1 | 59657 | August | 64.90 | 86.10 | 86.56 | 86.56 | 86.70 | 0.035600 | 3.01 | 21.54 | 76.01 | 1.00 |
| 1 | 59657 | Mean Annual Floo | 750.00 | 86.10 | 87.61 | 87.61 | 88.03 | 0.019928 | 5.77 | 188.47 | 230.45 | 0.88 |
| 1 | 59657 | 100-Year | 1350.00 | 86.10 | 88.02 | 88.02 | 88.60 | 0.018188 | 7.12 | 285.45 | 246.72 | 0.95 |
| 1 | 59646 | April | 273.30 | 79.50 | 83.31 | 81.15 | 83.34 | 0.000308 | 1.26 | 216.54 | 76.24 | 0.13 |
| 1 | 59646 | May | 186.60 | 79.50 | 82.88 | 80.96 | 82.90 | 0.000243 | 1.01 | 183.99 | 75.80 | 0.11 |
| 1 | 59646 | June | 140.20 | 79.50 | 82.65 | 80.82 | 82.66 | 0.000190 | 0.84 | 166.41 | 75.57 | 0.10 |
| 1 | 59646 | August | 64.90 | 79.50 | 82.26 | 80.54 | 82.26 | 0.000677 | 0.47 | 136.94 | 75.17 | 0.06 |
| 1 | 59646 | Mean Annual Floo | 750.00 | 79.50 | 85.42 | 81.60 | 85.46 | 0.000388 | 1.98 | 379.28 | 78.37 | 0.16 |
| 1 | 59646 | 100-Year | 1350.00 | 79.50 | 87.69 | 82.69 | 87.77 | 0.000332 | 2.36 | 658.44 | 237.46 | 0.16 |
| 1 | 59630 | April | 273.30 | 79.47 | 83.31 | | 83.33 | 0.000258 | 1.20 | 227.78 | 79.06 | 0.12 |
| 1 | 59630 | May | 186.60 | 79.47 | 82.88 | | 82.90 | 0.000194 | 0.96 | 194.53 | 76.21 | 0.11 |
| 1 | 59630 | June | 140.20 | 79.47 | 82.65 | | 82.66 | 0.000146 | 0.79 | 177.00 | 74.69 | 0.09 |
| 1 | 59630 | August | 64.90 | 79.47 | 82.26 | | 82.26 | 0.000054 | 0.44 | 148.21 | 72.07 | 0.05 |
| 1 | 59630 | Mean Annual Floo | 750.00 | 79.47 | 85.42 | | 85.47 | 0.000312 | 1.89 | 396.79 | 82.24 | 0.15 |
| 1 | 59630 | 100-Year | 1350.00 | 79.47 | 87.69 | | 87.77 | 0.000265 | 2.24 | 722.53 | 213.59 | 0.15 |
| 1 | 59597 | April | 273.30 | 81.00 | 83.28 | | 83.32 | 0.000594 | 1.50 | 182.17 | 79.86 | 0.18 |
| 1 | 59597 | May | 186.60 | 81.00 | 82.66 | | 82.66 | 0.000532 | 1.26 | 148.42 | 79.85 | 0.16 |
| 1 | 59597 | June | 140.20 | 81.00 | 82.63 | | 82.65 | 0.000461 | 1.06 | 130.20 | 79.85 | 0.15 |
| 1 | 59597 | August | 64.90 | 81.00 | 82.25 | | 82.26 | 0.000237 | 0.85 | 96.84 | 79.83 | 0.10 |
| 1 | 59597 | Mean Annual Floo | 750.00 | 81.00 | 85.38 | | 85.46 | 0.000532 | 2.14 | 350.12 | 79.82 | 0.18 |
| 1 | 59597 | 100-Year | 1350.00 | 81.00 | 87.66 | | 87.75 | 0.000433 | 2.48 | 626.13 | 236.30 | 0.17 |
| 1 | 59445 | April | 273.30 | 76.06 | 83.25 | | 83.27 | 0.000145 | 1.29 | 212.56 | 38.79 | 0.10 |
| 1 | 59445 | May | 186.60 | 76.06 | 82.84 | | 82.85 | 0.000094 | 0.95 | 196.94 | 37.99 | 0.07 |
| 1 | 59445 | June | 140.20 | 76.06 | 82.62 | | 82.63 | 0.000054 | 0.74 | 188.65 | 37.52 | 0.06 |
| 1 | 59445 | August | 64.90 | 76.06 | 82.25 | | 82.25 | 0.000014 | 0.37 | 174.85 | 36.61 | 0.03 |
| 1 | 59445 | Mean Annual Floo | 750.00 | 76.06 | 85.30 | | 85.38 | 0.000365 | 2.39 | 401.78 | 149.23 | 0.16 |
| 1 | 59445 | 100-Year | 1350.00 | 76.06 | 87.61 | | 87.69 | 0.000320 | 2.62 | 858.74 | 229.41 | 0.15 |
| 1 | 59397 | April | 273.30 | 76.50 | 83.18 | | 83.25 | 0.000706 | 2.02 | 135.29 | 35.65 | 0.18 |
| 1 | 59397 | May | 186.60 | 76.50 | 82.80 | | 82.84 | 0.000440 | 1.53 | 121.83 | 34.48 | 0.14 |
| 1 | 59397 | June | 140.20 | 76.50 | 82.59 | | 82.62 | 0.000293 | 1.22 | 114.79 | 33.69 | 0.12 |
| 1 | 59397 | August | 64.90 | 76.50 | 82.24 | | 82.25 | 0.000085 | 0.63 | 103.12 | 32.33 | 0.06 |
| 1 | 59397 | Mean Annual Floo | 750.00 | 76.50 | 85.12 | | 85.32 | 0.001511 | 3.59 | 209.60 | 40.51 | 0.28 |
| 1 | 59397 | 100-Year | 1350.00 | 76.50 | 87.34 | | 87.62 | 0.001054 | 4.33 | 387.26 | 368.36 | 0.29 |
| 1 | 59347 | April | 273.30 | 77.00 | 83.19 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.75 | 40.08 | 0.08 |
| 1 | 59347 | May | 186.60 | 77.00 | 82.81 | 77.88 | 82.82 | 0.000068 | 0.89 | 232.30 | 40.07 | 0.06 |
| 1 | 59347 | June | 140.20 | 77.00 | 82.80 | 77.72 | 82.60 | 0.000043 | 0.63 | 223.96 | 40.07 | 0.05 |
| 1 | 59347 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.70 | 40.07 | 0.02 |
| 1 | 59347 | Mean Annual Floo | 750.00 | 77.00 | 85.15 | 79.22 | 85.23 | 0.000378 | 2.30 | 325.90 | 119.03 | 0.14 |
| 1 | 59347 | 100-Year | 1350.00 | 77.00 | 87.36 | 80.28 | 87.52 | 0.000350 | 3.26 | 414.28 | 119.47 | 0.18 |
| 1 | 59325 | April | 273.30 | 77.00 | 83.19 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.51 | 40.08 | 0.08 |
| 1 | 59325 | May | 186.60 | 77.00 | 82.90 | 77.88 | 82.81 | 0.000068 | 0.80 | 232.16 | 40.07 | 0.06 |
| 1 | 59325 | June | 140.20 | 77.00 | 82.90 | 77.73 | 82.60 | 0.000043 | 0.63 | 223.87 | 40.07 | 0.05 |
| 1 | 59325 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.67 | 40.07 | 0.02 |
| 1 | 59325 | Mean Annual Floo | 750.00 | 77.00 | 85.13 | 79.22 | 85.21 | 0.000361 | 2.31 | 325.12 | 119.03 | 0.14 |
| 1 | 59325 | 100-Year | 1350.00 | 77.00 | 87.33 | 80.28 | 87.49 | 0.000355 | 3.27 | 413.13 | 119.47 | 0.18 |
| 1 | 59280 | Bridge | | | | | | | | | | |
| 1 | 59275 | April | 273.30 | 78.40 | 83.04 | | 83.14 | 0.000585 | 2.48 | 110.33 | 35.42 | 0.25 |
| 1 | 59275 | May | 186.60 | 78.40 | 82.72 | | 82.78 | 0.000370 | 1.88 | 99.13 | 34.18 | 0.19 |
| 1 | 59275 | June | 140.20 | 78.40 | 82.54 | | 82.58 | 0.000250 | 1.51 | 93.11 | 33.50 | 0.16 |
| 1 | 59275 | August | 64.90 | 78.40 | 82.23 | | 82.24 | 0.000076 | 0.78 | 82.68 | 32.26 | 0.09 |
| 1 | 59275 | Mean Annual Floo | 750.00 | 78.40 | 84.56 | | 84.89 | 0.001296 | 4.47 | 167.67 | 39.29 | 0.38 |

HEC-RAS Plan EC River: Pawcatuck River Reach: 1 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev. (ft) | Crit W.S. (ft) | E.G. Elev. (ft) | E.G. Slope (ft/ft) | Vel Chrl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|-------|-----------|------------------|------------------|-------------------|--------------------|-------------------|--------------------|-----------------------|--------------------|----------------------|-------------------|-------------|
| 1 | 56275 | 100-Year | 1350.00 | 78.40 | 86.08 | | 86.60 | 0.001728 | 5.91 | 228.57 | 42.63 | 0.45 |
| 1 | 56715 | April | 273.30 | 74.60 | 83.02 | | 83.03 | 0.000667 | 0.91 | 301.29 | 54.49 | 0.07 |
| 1 | 56715 | May | 186.60 | 74.60 | 82.71 | | 82.72 | 0.000637 | 0.68 | 264.52 | 53.71 | 0.05 |
| 1 | 56715 | June | 140.20 | 74.60 | 82.54 | | 82.54 | 0.000623 | 0.51 | 275.31 | 53.27 | 0.04 |
| 1 | 56715 | August | 64.90 | 74.60 | 82.23 | | 82.23 | 0.000606 | 0.25 | 258.88 | 52.49 | 0.02 |
| 1 | 56715 | Mean Annual Floo | 750.00 | 74.60 | 84.48 | | 84.54 | 0.000250 | 1.06 | 383.27 | 57.20 | 0.13 |
| 1 | 56715 | 100-Year | 1350.00 | 74.60 | 85.90 | | 86.03 | 0.000459 | 2.90 | 466.23 | 59.79 | 0.18 |
| 1 | 56665 | April | 273.30 | 77.50 | 83.02 | 78.28 | 83.03 | 0.000042 | 0.69 | 366.42 | 73.87 | 0.05 |
| 1 | 56665 | May | 186.60 | 77.50 | 82.71 | 78.10 | 82.71 | 0.000024 | 0.50 | 373.54 | 73.64 | 0.04 |
| 1 | 56665 | June | 140.20 | 77.50 | 82.54 | 78.00 | 82.54 | 0.000015 | 0.39 | 360.87 | 73.51 | 0.03 |
| 1 | 56665 | August | 64.90 | 77.50 | 82.23 | 77.89 | 82.23 | 0.000004 | 0.19 | 338.07 | 73.28 | 0.02 |
| 1 | 56665 | Mean Annual Floo | 750.00 | 77.50 | 84.49 | 79.02 | 84.52 | 0.000147 | 1.48 | 505.62 | 74.85 | 0.10 |
| 1 | 56665 | 100-Year | 1350.00 | 77.50 | 85.91 | 79.76 | 85.99 | 0.000263 | 2.20 | 613.12 | 76.00 | 0.14 |
| 1 | 58649.5 | Bridge | | | | | | | | | | |
| 1 | 58634 | April | 273.30 | 74.60 | 83.01 | 77.06 | 83.02 | 0.000068 | 0.91 | 300.40 | 53.98 | 0.07 |
| 1 | 58634 | May | 186.60 | 74.60 | 82.70 | 76.66 | 82.71 | 0.000037 | 0.68 | 283.98 | 53.28 | 0.05 |
| 1 | 58634 | June | 140.20 | 74.60 | 82.53 | 76.41 | 82.54 | 0.000023 | 0.51 | 274.91 | 52.89 | 0.04 |
| 1 | 58634 | August | 64.90 | 74.60 | 82.22 | 75.88 | 82.23 | 0.000006 | 0.25 | 258.89 | 52.19 | 0.02 |
| 1 | 58634 | Mean Annual Floo | 750.00 | 74.60 | 84.45 | 78.49 | 84.51 | 0.000329 | 1.92 | 360.32 | 75.48 | 0.15 |
| 1 | 58634 | 100-Year | 1350.00 | 74.60 | 85.86 | 79.69 | 85.97 | 0.000527 | 2.65 | 503.49 | 386.60 | 0.19 |
| 1 | 58584 | April | 273.30 | 74.60 | 83.01 | | 83.02 | 0.000068 | 0.91 | 300.21 | 53.97 | 0.07 |
| 1 | 58584 | May | 186.60 | 74.60 | 82.70 | | 82.71 | 0.000037 | 0.66 | 283.67 | 53.28 | 0.05 |
| 1 | 58584 | June | 140.20 | 74.60 | 82.53 | | 82.54 | 0.000023 | 0.51 | 274.85 | 52.89 | 0.04 |
| 1 | 58584 | August | 64.90 | 74.60 | 82.22 | | 82.23 | 0.000006 | 0.25 | 258.87 | 52.19 | 0.02 |
| 1 | 58584 | Mean Annual Floo | 750.00 | 74.60 | 84.44 | | 84.49 | 0.000331 | 1.93 | 389.02 | 75.12 | 0.15 |
| 1 | 58584 | 100-Year | 1350.00 | 74.60 | 85.84 | | 85.93 | 0.000456 | 2.46 | 754.25 | 386.33 | 0.18 |
| 1 | 57767 | April | 273.30 | 77.13 | 82.94 | | 82.97 | 0.000320 | 1.40 | 195.20 | 52.38 | 0.13 |
| 1 | 57767 | May | 186.60 | 77.13 | 82.66 | | 82.68 | 0.000190 | 1.03 | 180.91 | 51.57 | 0.10 |
| 1 | 57767 | June | 140.20 | 77.13 | 82.51 | | 82.52 | 0.000123 | 0.81 | 172.53 | 51.02 | 0.06 |
| 1 | 57767 | August | 64.90 | 77.13 | 82.22 | | 82.22 | 0.000034 | 0.41 | 158.42 | 48.97 | 0.04 |
| 1 | 57767 | Mean Annual Floo | 750.00 | 77.13 | 84.15 | | 84.26 | 0.000582 | 2.90 | 260.83 | 55.95 | 0.23 |
| 1 | 57767 | 100-Year | 1350.00 | 77.13 | 85.34 | | 85.61 | 0.001512 | 4.14 | 353.87 | 116.82 | 0.30 |
| 1 | 57134 | April | 273.30 | 74.30 | 82.93 | | 82.94 | 0.000013 | 0.43 | 970.80 | 244.61 | 0.93 |
| 1 | 57134 | May | 186.60 | 74.30 | 82.66 | | 82.66 | 0.000007 | 0.31 | 904.12 | 243.12 | 0.82 |
| 1 | 57134 | June | 140.20 | 74.30 | 82.51 | | 82.51 | 0.000005 | 0.25 | 866.56 | 242.20 | 0.82 |
| 1 | 57134 | August | 64.90 | 74.30 | 82.22 | | 82.22 | 0.000001 | 0.12 | 796.85 | 240.70 | 0.91 |
| 1 | 57134 | Mean Annual Floo | 750.00 | 74.30 | 84.15 | | 84.16 | 0.000046 | 0.60 | 1368.08 | 397.07 | 0.95 |
| 1 | 57134 | 100-Year | 1350.00 | 74.30 | 85.39 | | 85.40 | 0.000074 | 1.24 | 1902.33 | 449.30 | 0.97 |
| 1 | 56393 | April | 273.30 | 75.50 | 82.91 | | 82.92 | 0.000072 | 0.79 | 347.04 | 72.38 | 0.06 |
| 1 | 56393 | May | 186.60 | 75.50 | 82.65 | | 82.65 | 0.000039 | 0.57 | 328.45 | 70.23 | 0.05 |
| 1 | 56393 | June | 140.20 | 75.50 | 82.50 | | 82.50 | 0.000024 | 0.44 | 318.01 | 68.46 | 0.04 |
| 1 | 56393 | August | 64.90 | 75.50 | 82.22 | | 82.22 | 0.000006 | 0.22 | 298.59 | 68.00 | 0.02 |
| 1 | 56393 | Mean Annual Floo | 750.00 | 75.50 | 84.05 | | 84.09 | 0.000261 | 1.72 | 478.34 | 154.11 | 0.12 |
| 1 | 56393 | 100-Year | 1350.00 | 75.50 | 85.20 | | 85.29 | 0.000423 | 2.46 | 687.52 | 208.94 | 0.16 |
| 1 | 55407 | April | 273.30 | 75.81 | 82.84 | | 82.85 | 0.000069 | 0.79 | 363.48 | 108.02 | 0.06 |
| 1 | 55407 | May | 186.60 | 75.81 | 82.61 | | 82.61 | 0.000038 | 0.57 | 330.89 | 106.62 | 0.05 |
| 1 | 55407 | June | 140.20 | 75.81 | 82.47 | | 82.48 | 0.000024 | 0.44 | 324.64 | 103.70 | 0.04 |
| 1 | 55407 | August | 64.90 | 75.81 | 82.21 | | 82.21 | 0.000006 | 0.22 | 301.02 | 78.22 | 0.02 |
| 1 | 55407 | Mean Annual Floo | 750.00 | 75.81 | 83.77 | | 83.82 | 0.000282 | 1.79 | 466.65 | 113.73 | 0.13 |
| 1 | 55407 | 100-Year | 1350.00 | 75.81 | 84.89 | | 84.80 | 0.000537 | 2.71 | 574.01 | 119.37 | 0.18 |
| 1 | 55334 | April | 273.30 | 74.00 | 82.84 | | 82.84 | 0.000008 | 0.34 | 793.27 | 131.96 | 0.92 |
| 1 | 55334 | May | 186.60 | 74.00 | 82.61 | | 82.61 | 0.000004 | 0.24 | 763.24 | 129.47 | 0.92 |
| 1 | 55334 | June | 140.20 | 74.00 | 82.47 | | 82.48 | 0.000003 | 0.19 | 745.81 | 128.54 | 0.91 |
| 1 | 55334 | August | 64.90 | 74.00 | 82.21 | | 82.21 | 0.000001 | 0.09 | 712.90 | 126.72 | 0.91 |
| 1 | 55334 | Mean Annual Floo | 750.00 | 74.00 | 83.78 | | 83.79 | 0.000039 | 0.82 | 919.94 | 137.53 | 0.96 |
| 1 | 55334 | 100-Year | 1350.00 | 74.00 | 84.72 | | 84.75 | 0.000086 | 1.28 | 1052.00 | 143.99 | 0.98 |
| 1 | 55300 | April | 273.30 | 75.81 | 82.83 | | 82.84 | 0.000055 | 0.79 | 366.15 | 107.97 | 0.06 |
| 1 | 55300 | May | 186.60 | 75.81 | 82.60 | | 82.61 | 0.000030 | 0.57 | 341.97 | 106.50 | 0.05 |
| 1 | 55300 | June | 140.20 | 75.81 | 82.47 | | 82.47 | 0.000019 | 0.44 | 327.87 | 105.78 | 0.04 |
| 1 | 55300 | August | 64.90 | 75.81 | 82.21 | | 82.21 | 0.000005 | 0.22 | 301.89 | 87.39 | 0.02 |
| 1 | 55300 | Mean Annual Floo | 750.00 | 75.81 | 83.73 | | 83.78 | 0.000229 | 1.80 | 485.79 | 113.46 | 0.13 |
| 1 | 55300 | 100-Year | 1350.00 | 75.81 | 84.60 | | 84.71 | 0.000448 | 2.76 | 567.15 | 118.84 | 0.19 |

APPENDIX F
HEC-RAS OUTPUT
SHANNOCK MILL POND DAM FULL DAM REMOVAL

Proposed - Lower Falls Removal Plan: Shannock Removal 8/27/2007



Legend

- WS 100-Year
- WS Mean Annual Flood
- WS April
- WS May
- WS June
- WS August
- Ground

HEC-RAS Plan: Shannock Rem

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elw (ft) | Crit W.S. (ft) | E.G. Elw (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|------------------|-------------------|------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 64822 | April | 273.30 | 83.00 | 87.71 | 84.24 | 87.72 | 0.000078 | 0.85 | 741.79 | 561.63 | 0.07 |
| 1 | 64822 | May | 186.60 | 83.00 | 87.38 | 83.97 | 87.38 | 0.000086 | 0.73 | 549.24 | 558.66 | 0.07 |
| 1 | 64822 | June | 140.20 | 83.00 | 87.18 | 83.80 | 87.18 | 0.000054 | 0.64 | 438.07 | 538.51 | 0.06 |
| 1 | 64822 | August | 64.90 | 83.00 | 86.80 | 83.48 | 86.80 | 0.000022 | 0.58 | 208.18 | 362.57 | 0.04 |
| 1 | 64822 | Mean Annual Floo | 750.00 | 83.00 | 88.95 | 85.38 | 89.99 | 0.000105 | 1.16 | 1560.92 | 716.04 | 0.09 |
| 1 | 64822 | 100-Year | 1350.00 | 83.00 | 90.15 | 87.06 | 90.16 | 0.000098 | 1.28 | 2440.92 | 763.80 | 0.08 |
| 1 | 63372 | April | 273.30 | 81.50 | 87.60 | | 87.61 | 0.000080 | 0.78 | 352.23 | 108.72 | 0.07 |
| 1 | 63372 | May | 186.60 | 81.50 | 87.30 | | 87.30 | 0.000048 | 0.58 | 321.85 | 94.19 | 0.06 |
| 1 | 63372 | June | 140.20 | 81.50 | 87.12 | | 87.12 | 0.000032 | 0.46 | 305.02 | 92.02 | 0.04 |
| 1 | 63372 | August | 64.90 | 81.50 | 86.78 | | 86.78 | 0.000009 | 0.24 | 274.08 | 86.88 | 0.02 |
| 1 | 63372 | Mean Annual Floo | 750.00 | 81.50 | 88.72 | | 88.75 | 0.000221 | 1.51 | 874.94 | 394.76 | 0.12 |
| 1 | 63372 | 100-Year | 1350.00 | 81.50 | 89.92 | | 89.90 | 0.000236 | 1.83 | 1170.57 | 444.38 | 0.13 |
| 1 | 63322 | April | 273.30 | 82.30 | 87.57 | 83.40 | 87.60 | 0.000141 | 1.24 | 221.12 | 59.53 | 0.09 |
| 1 | 63322 | May | 186.60 | 82.30 | 87.29 | 83.15 | 87.30 | 0.000079 | 0.89 | 209.04 | 58.57 | 0.07 |
| 1 | 63322 | June | 140.20 | 82.30 | 87.11 | 83.00 | 87.12 | 0.000050 | 0.70 | 201.88 | 57.98 | 0.05 |
| 1 | 63322 | August | 64.90 | 82.30 | 86.78 | 82.72 | 86.78 | 0.000013 | 0.35 | 187.68 | 56.87 | 0.03 |
| 1 | 63322 | Mean Annual Floo | 750.00 | 82.30 | 88.58 | 84.45 | 88.70 | 0.000511 | 2.85 | 203.26 | 62.89 | 0.20 |
| 1 | 63322 | 100-Year | 1350.00 | 82.30 | 89.55 | 85.48 | 89.96 | 0.001257 | 4.44 | 304.11 | 66.14 | 0.29 |
| 1 | 83314.5 | | Bridge | | | | | | | | | |
| 1 | 83307 | April | 273.30 | 82.30 | 87.57 | 83.40 | 87.60 | 0.000141 | 1.24 | 221.02 | 59.52 | 0.09 |
| 1 | 83307 | May | 186.60 | 82.30 | 87.28 | 83.15 | 87.30 | 0.000079 | 0.89 | 208.98 | 58.57 | 0.07 |
| 1 | 83307 | June | 140.20 | 82.30 | 87.11 | 83.00 | 87.12 | 0.000050 | 0.70 | 201.65 | 57.90 | 0.05 |
| 1 | 83307 | August | 64.90 | 82.30 | 86.78 | 82.72 | 86.78 | 0.000013 | 0.35 | 187.67 | 56.87 | 0.03 |
| 1 | 83307 | Mean Annual Floo | 750.00 | 82.30 | 88.57 | 84.45 | 88.86 | 0.000615 | 2.85 | 202.78 | 62.85 | 0.20 |
| 1 | 83307 | 100-Year | 1350.00 | 82.30 | 89.53 | 85.48 | 89.83 | 0.001271 | 4.45 | 303.04 | 66.00 | 0.29 |
| 1 | 83267 | April | 273.30 | 81.50 | 87.57 | | 87.58 | 0.000081 | 0.79 | 349.59 | 107.53 | 0.07 |
| 1 | 83267 | May | 186.60 | 81.50 | 87.20 | | 87.29 | 0.000049 | 0.59 | 320.61 | 94.07 | 0.06 |
| 1 | 83267 | June | 140.20 | 81.50 | 87.11 | | 87.11 | 0.000032 | 0.49 | 304.27 | 92.55 | 0.04 |
| 1 | 83267 | August | 64.90 | 81.50 | 86.78 | | 86.70 | 0.000009 | 0.24 | 273.89 | 89.89 | 0.02 |
| 1 | 83267 | Mean Annual Floo | 750.00 | 81.50 | 88.59 | | 88.63 | 0.000249 | 1.58 | 826.72 | 387.03 | 0.13 |
| 1 | 83267 | 100-Year | 1350.00 | 81.50 | 89.63 | | 89.68 | 0.000304 | 2.00 | 1062.16 | 432.53 | 0.15 |
| 1 | 81167 | April | 273.30 | 77.90 | 87.54 | | 87.55 | 0.000007 | 0.34 | 843.66 | 243.63 | 0.02 |
| 1 | 81167 | May | 186.60 | 77.90 | 87.27 | | 87.27 | 0.000004 | 0.24 | 784.18 | 189.03 | 0.02 |
| 1 | 81167 | June | 140.20 | 77.90 | 87.10 | | 87.10 | 0.000002 | 0.19 | 754.95 | 123.64 | 0.01 |
| 1 | 81167 | August | 64.90 | 77.90 | 86.77 | | 86.77 | 0.000001 | 0.09 | 715.61 | 117.20 | 0.01 |
| 1 | 81167 | Mean Annual Floo | 750.00 | 77.90 | 88.48 | | 88.47 | 0.000033 | 0.79 | 1119.45 | 341.02 | 0.05 |
| 1 | 81167 | 100-Year | 1350.00 | 77.90 | 89.39 | | 89.42 | 0.000065 | 1.20 | 1494.21 | 448.52 | 0.07 |
| 1 | 81107 | April | 273.30 | 77.90 | 87.54 | 79.34 | 87.54 | 0.000013 | 0.80 | 458.98 | 242.58 | 0.03 |
| 1 | 81107 | May | 186.60 | 77.90 | 87.27 | 79.12 | 87.27 | 0.000007 | 0.42 | 445.30 | 180.12 | 0.02 |
| 1 | 81107 | June | 140.20 | 77.90 | 87.10 | 78.98 | 87.10 | 0.000004 | 0.32 | 436.91 | 123.02 | 0.02 |
| 1 | 81107 | August | 64.90 | 77.90 | 86.77 | 78.63 | 86.77 | 0.000001 | 0.15 | 420.88 | 117.19 | 0.01 |
| 1 | 81107 | Mean Annual Floo | 750.00 | 77.90 | 88.43 | 80.27 | 88.48 | 0.000074 | 1.40 | 503.48 | 337.97 | 0.08 |
| 1 | 81107 | 100-Year | 1350.00 | 77.90 | 89.29 | 81.10 | 89.30 | 0.000183 | 2.47 | 546.57 | 436.96 | 0.13 |
| 1 | 81047 | | Bridge | | | | | | | | | |
| 1 | 81047 | April | 273.30 | 77.90 | 87.54 | 79.34 | 87.54 | 0.000013 | 0.80 | 458.82 | 242.31 | 0.03 |
| 1 | 81047 | May | 186.60 | 77.90 | 87.27 | 79.12 | 87.27 | 0.000007 | 0.42 | 445.26 | 189.96 | 0.02 |
| 1 | 81047 | June | 140.20 | 77.90 | 87.10 | 78.98 | 87.10 | 0.000004 | 0.32 | 436.89 | 123.02 | 0.02 |
| 1 | 81047 | August | 64.90 | 77.90 | 86.77 | 78.63 | 86.77 | 0.000001 | 0.15 | 420.87 | 117.19 | 0.01 |
| 1 | 81047 | Mean Annual Floo | 750.00 | 77.90 | 88.42 | 80.27 | 88.45 | 0.000074 | 1.40 | 502.99 | 337.19 | 0.08 |
| 1 | 81047 | 100-Year | 1350.00 | 77.90 | 89.27 | 81.10 | 89.36 | 0.000184 | 2.48 | 545.28 | 437.48 | 0.13 |
| 1 | 80967 | April | 273.30 | 77.90 | 87.54 | | 87.54 | 0.000007 | 0.34 | 842.36 | 242.58 | 0.02 |
| 1 | 80967 | May | 186.60 | 77.90 | 87.27 | | 87.27 | 0.000004 | 0.24 | 783.67 | 189.11 | 0.02 |
| 1 | 80967 | June | 140.20 | 77.90 | 87.10 | | 87.10 | 0.000002 | 0.19 | 754.70 | 123.62 | 0.01 |
| 1 | 80967 | August | 64.90 | 77.90 | 86.77 | | 86.77 | 0.000001 | 0.09 | 715.57 | 117.19 | 0.01 |
| 1 | 80967 | Mean Annual Floo | 750.00 | 77.90 | 88.43 | | 88.44 | 0.000033 | 0.79 | 1167.84 | 339.04 | 0.05 |
| 1 | 80967 | 100-Year | 1350.00 | 77.90 | 89.30 | | 89.32 | 0.000065 | 1.22 | 1481.08 | 440.21 | 0.08 |
| 1 | 59925 | April | 273.30 | 80.83 | 87.50 | | 87.52 | 0.000134 | 1.15 | 246.82 | 85.11 | 0.10 |
| 1 | 59925 | May | 186.60 | 80.83 | 87.25 | | 87.20 | 0.000078 | 0.83 | 225.85 | 69.80 | 0.07 |
| 1 | 59925 | June | 140.20 | 80.83 | 87.09 | | 87.09 | 0.000049 | 0.65 | 216.42 | 60.18 | 0.06 |
| 1 | 59925 | August | 64.90 | 80.83 | 86.77 | | 86.77 | 0.000014 | 0.33 | 199.28 | 52.30 | 0.03 |
| 1 | 59925 | Mean Annual Floo | 750.00 | 80.83 | 88.25 | | 88.36 | 0.000575 | 2.63 | 330.04 | 138.32 | 0.20 |
| 1 | 59925 | 100-Year | 1350.00 | 80.83 | 89.91 | | 89.15 | 0.001162 | 4.05 | 436.78 | 168.40 | 0.29 |
| 1 | 59845 | April | 273.30 | 82.11 | 87.50 | | 87.51 | 0.000121 | 0.91 | 303.38 | 97.94 | 0.09 |
| 1 | 59845 | May | 186.60 | 82.11 | 87.24 | | 87.25 | 0.000074 | 0.67 | 278.98 | 94.74 | 0.07 |
| 1 | 59845 | June | 140.20 | 82.11 | 87.00 | | 87.09 | 0.000050 | 0.53 | 264.01 | 92.70 | 0.05 |
| 1 | 59845 | August | 64.90 | 82.11 | 86.77 | | 86.77 | 0.000015 | 0.28 | 235.41 | 80.56 | 0.03 |
| 1 | 59845 | Mean Annual Floo | 750.00 | 82.11 | 88.24 | | 88.39 | 0.000482 | 2.02 | 379.49 | 106.92 | 0.18 |
| 1 | 59845 | 100-Year | 1350.00 | 82.11 | 89.89 | | 89.04 | 0.000890 | 3.12 | 487.66 | 167.36 | 0.25 |

HEC-RAS Plan: Shannon Rem (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 59700 | April | 273.30 | 80.80 | 87.49 | | 87.50 | 0.000047 | 0.67 | 411.32 | 102.32 | 0.08 |
| 1 | 59700 | May | 188.60 | 80.80 | 87.24 | | 87.24 | 0.000027 | 0.49 | 306.17 | 98.14 | 0.04 |
| 1 | 59700 | June | 140.20 | 80.80 | 87.08 | | 87.08 | 0.000017 | 0.39 | 370.86 | 95.50 | 0.03 |
| 1 | 59700 | August | 64.60 | 80.80 | 86.77 | | 86.77 | 0.000004 | 0.19 | 342.52 | 84.50 | 0.02 |
| 1 | 59700 | Mean Annual Floe | 750.00 | 80.80 | 88.22 | | 88.25 | 0.000212 | 1.55 | 525.75 | 207.22 | 0.12 |
| 1 | 59700 | 100-Year | 1350.00 | 80.80 | 88.84 | | 88.83 | 0.000436 | 2.40 | 666.32 | 240.46 | 0.18 |
| 1 | 59664 | April | 273.30 | 83.44 | 87.48 | 84.45 | 87.49 | 0.000109 | 0.87 | 340.78 | 140.14 | 0.09 |
| 1 | 59664 | May | 188.60 | 83.44 | 87.23 | 84.26 | 87.24 | 0.000065 | 0.64 | 305.62 | 135.14 | 0.06 |
| 1 | 59664 | June | 140.20 | 83.44 | 87.08 | 84.15 | 87.08 | 0.000043 | 0.51 | 285.17 | 126.28 | 0.05 |
| 1 | 59664 | August | 64.60 | 83.44 | 86.77 | 83.93 | 86.77 | 0.000013 | 0.28 | 248.75 | 108.74 | 0.03 |
| 1 | 59664 | Mean Annual Floe | 750.00 | 83.44 | 88.18 | 85.19 | 88.24 | 0.000423 | 1.92 | 458.97 | 188.74 | 0.17 |
| 1 | 59664 | 100-Year | 1350.00 | 83.44 | 88.78 | 85.88 | 88.90 | 0.000827 | 2.90 | 581.57 | 222.49 | 0.24 |
| 1 | 59657 | | Inf Struct | | | | | | | | | |
| 1 | 59651 | April | 273.30 | 81.00 | 87.44 | | 87.45 | 0.000020 | 0.52 | 575.94 | 227.62 | 0.04 |
| 1 | 59651 | May | 188.60 | 81.00 | 87.21 | | 87.21 | 0.000011 | 0.39 | 523.30 | 218.19 | 0.03 |
| 1 | 59651 | June | 140.20 | 81.00 | 87.06 | | 87.06 | 0.000007 | 0.29 | 480.41 | 211.88 | 0.02 |
| 1 | 59651 | August | 64.90 | 81.00 | 86.75 | | 86.75 | 0.000002 | 0.14 | 459.18 | 79.99 | 0.01 |
| 1 | 59651 | Mean Annual Floe | 750.00 | 81.00 | 88.11 | | 88.14 | 0.000102 | 1.26 | 737.64 | 264.48 | 0.08 |
| 1 | 59651 | 100-Year | 1350.00 | 81.00 | 88.69 | | 88.75 | 0.000238 | 2.01 | 892.48 | 277.76 | 0.13 |
| 1 | 59650 | April | 273.30 | 86.20 | 87.29 | 87.02 | 87.41 | 0.006205 | 2.97 | 121.36 | 221.33 | 0.52 |
| 1 | 59650 | May | 188.60 | 86.20 | 87.03 | 86.80 | 87.17 | 0.006288 | 2.99 | 65.90 | 211.66 | 0.60 |
| 1 | 59650 | June | 140.20 | 86.20 | 86.60 | 86.71 | 87.02 | 0.006386 | 2.68 | 62.24 | 79.00 | 0.58 |
| 1 | 59650 | August | 64.90 | 86.20 | 86.67 | 86.52 | 86.73 | 0.006415 | 1.91 | 33.92 | 79.87 | 0.52 |
| 1 | 59650 | Mean Annual Floe | 750.00 | 86.20 | 87.84 | | 88.07 | 0.007846 | 4.40 | 260.09 | 243.60 | 0.62 |
| 1 | 59650 | 100-Year | 1350.00 | 86.20 | 88.34 | | 88.67 | 0.008260 | 5.40 | 378.20 | 263.72 | 0.66 |
| 1 | 59647 | April | 273.30 | 86.20 | 87.02 | 87.02 | 87.32 | 0.021043 | 4.46 | 63.34 | 210.58 | 0.90 |
| 1 | 59647 | May | 188.60 | 86.20 | 86.80 | 86.80 | 87.08 | 0.026902 | 4.22 | 44.21 | 79.89 | 1.00 |
| 1 | 59647 | June | 140.20 | 86.20 | 86.71 | 86.71 | 86.94 | 0.030784 | 3.84 | 36.51 | 79.87 | 1.00 |
| 1 | 59647 | August | 64.90 | 86.20 | 86.52 | 86.52 | 86.86 | 0.036381 | 2.97 | 21.84 | 79.84 | 1.00 |
| 1 | 59647 | Mean Annual Floe | 750.00 | 86.20 | 87.58 | 87.58 | 87.98 | 0.018541 | 5.88 | 188.01 | 233.07 | 0.87 |
| 1 | 59647 | 100-Year | 1350.00 | 86.20 | 87.98 | 87.98 | 88.56 | 0.017813 | 7.01 | 285.47 | 249.25 | 0.94 |
| 1 | 59646 | April | 273.30 | 81.00 | 83.31 | 81.71 | 83.34 | 0.000085 | 1.48 | 184.07 | 79.86 | 0.17 |
| 1 | 59646 | May | 188.60 | 81.00 | 82.88 | 81.55 | 82.90 | 0.000054 | 1.24 | 149.96 | 79.85 | 0.16 |
| 1 | 59646 | June | 140.20 | 81.00 | 82.65 | 81.46 | 82.86 | 0.000447 | 1.07 | 131.48 | 79.85 | 0.18 |
| 1 | 59646 | August | 64.90 | 81.00 | 82.26 | 81.27 | 82.26 | 0.000233 | 0.65 | 100.34 | 79.83 | 0.10 |
| 1 | 59646 | Mean Annual Floe | 750.00 | 81.00 | 85.41 | 82.40 | 85.48 | 0.000522 | 2.13 | 352.19 | 79.82 | 0.18 |
| 1 | 59646 | 100-Year | 1350.00 | 81.00 | 87.68 | 83.06 | 87.77 | 0.000428 | 2.47 | 630.47 | 237.03 | 0.17 |
| 1 | 59630 | April | 273.30 | 79.47 | 83.31 | | 83.33 | 0.000258 | 1.20 | 227.78 | 79.08 | 0.12 |
| 1 | 59630 | May | 188.60 | 79.47 | 82.88 | | 82.90 | 0.000194 | 0.98 | 194.53 | 78.21 | 0.11 |
| 1 | 59630 | June | 140.20 | 79.47 | 82.65 | | 82.88 | 0.000146 | 0.79 | 177.00 | 74.89 | 0.09 |
| 1 | 59630 | August | 64.90 | 79.47 | 82.26 | | 82.26 | 0.000054 | 0.44 | 148.21 | 72.07 | 0.05 |
| 1 | 59630 | Mean Annual Floe | 750.00 | 79.47 | 85.42 | | 85.47 | 0.000312 | 1.89 | 398.74 | 82.24 | 0.15 |
| 1 | 59630 | 100-Year | 1350.00 | 79.47 | 87.68 | | 87.78 | 0.000277 | 2.26 | 656.95 | 162.42 | 0.15 |
| 1 | 59597 | April | 273.30 | 81.00 | 83.28 | | 83.32 | 0.000584 | 1.50 | 182.17 | 79.86 | 0.18 |
| 1 | 59597 | May | 188.60 | 81.00 | 82.86 | | 82.88 | 0.000532 | 1.28 | 148.42 | 79.85 | 0.16 |
| 1 | 59597 | June | 140.20 | 81.00 | 82.63 | | 82.65 | 0.000481 | 1.08 | 130.20 | 79.85 | 0.15 |
| 1 | 59597 | August | 64.90 | 81.00 | 82.25 | | 82.26 | 0.000237 | 0.65 | 99.84 | 79.83 | 0.10 |
| 1 | 59597 | Mean Annual Floe | 750.00 | 81.00 | 85.38 | | 85.45 | 0.000532 | 2.14 | 350.07 | 79.82 | 0.18 |
| 1 | 59597 | 100-Year | 1350.00 | 81.00 | 87.65 | | 87.75 | 0.000434 | 2.48 | 625.03 | 236.11 | 0.17 |
| 1 | 59445 | April | 273.30 | 76.08 | 83.25 | | 83.27 | 0.000145 | 1.29 | 212.58 | 38.79 | 0.10 |
| 1 | 59445 | May | 188.60 | 76.08 | 82.84 | | 82.85 | 0.000094 | 0.95 | 186.94 | 37.66 | 0.07 |
| 1 | 59445 | June | 140.20 | 76.08 | 82.62 | | 82.63 | 0.000054 | 0.74 | 188.05 | 37.52 | 0.08 |
| 1 | 59445 | August | 64.90 | 76.08 | 82.25 | | 82.25 | 0.000014 | 0.37 | 174.85 | 36.81 | 0.03 |
| 1 | 59445 | Mean Annual Floe | 750.00 | 76.08 | 85.30 | | 85.38 | 0.000362 | 2.40 | 396.37 | 160.13 | 0.16 |
| 1 | 59445 | 100-Year | 1350.00 | 76.08 | 87.61 | | 87.69 | 0.000289 | 2.59 | 973.97 | 338.02 | 0.15 |
| 1 | 59397 | April | 273.30 | 78.50 | 83.18 | | 83.25 | 0.000708 | 2.02 | 135.29 | 35.95 | 0.18 |
| 1 | 59397 | May | 188.60 | 78.50 | 82.80 | | 82.84 | 0.000440 | 1.53 | 121.83 | 34.48 | 0.14 |
| 1 | 59397 | June | 140.20 | 78.50 | 82.59 | | 82.62 | 0.000293 | 1.22 | 114.79 | 33.69 | 0.12 |
| 1 | 59397 | August | 64.90 | 78.50 | 82.24 | | 82.25 | 0.000085 | 0.63 | 103.12 | 32.33 | 0.08 |
| 1 | 59397 | Mean Annual Floe | 750.00 | 78.50 | 85.12 | | 85.32 | 0.001511 | 3.58 | 290.80 | 40.51 | 0.29 |
| 1 | 59397 | 100-Year | 1350.00 | 78.50 | 87.34 | | 87.62 | 0.001554 | 4.33 | 387.26 | 308.36 | 0.29 |
| 1 | 59347 | April | 273.30 | 77.00 | 83.19 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.75 | 40.06 | 0.08 |
| 1 | 59347 | May | 188.60 | 77.00 | 82.81 | 77.89 | 82.82 | 0.000088 | 0.89 | 232.30 | 40.07 | 0.08 |
| 1 | 59347 | June | 140.20 | 77.00 | 82.60 | 77.72 | 82.60 | 0.000043 | 0.63 | 223.96 | 40.07 | 0.05 |
| 1 | 59347 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.70 | 40.07 | 0.02 |
| 1 | 59347 | Mean Annual Floe | 750.00 | 77.00 | 85.15 | 79.22 | 85.23 | 0.000378 | 2.30 | 326.90 | 116.03 | 0.14 |
| 1 | 59347 | 100-Year | 1350.00 | 77.00 | 87.36 | 80.28 | 87.52 | 0.000550 | 3.26 | 414.28 | 116.47 | 0.18 |
| 1 | 59325 | April | 273.30 | 77.00 | 83.19 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.51 | 40.08 | 0.08 |
| 1 | 59325 | May | 188.60 | 77.00 | 82.80 | 77.89 | 82.81 | 0.000088 | 0.89 | 232.16 | 40.07 | 0.08 |

HEC-RAS Plan: Shennock Rem (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch Elev (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Cntl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|-------|-----------|------------------|------------------|---------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|-------------|
| 1 | 59325 | June | 140.20 | 77.00 | 82.60 | 77.73 | 82.60 | 0.000043 | 0.63 | 223.87 | 40.07 | 0.05 |
| 1 | 59325 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.67 | 40.07 | 0.02 |
| 1 | 59325 | Mean Annual Floe | 750.00 | 77.00 | 85.13 | 79.22 | 85.21 | 0.000381 | 2.31 | 325.12 | 119.03 | 0.14 |
| 1 | 59325 | 100-Year | 1350.00 | 77.00 | 87.33 | 80.28 | 87.49 | 0.000580 | 3.27 | 413.13 | 119.47 | 0.18 |
| 1 | 59280 | Bridge | | | | | | | | | | |
| 1 | 59275 | April | 273.30 | 78.40 | 83.04 | | 83.14 | 0.000585 | 2.48 | 110.33 | 35.42 | 0.25 |
| 1 | 59275 | May | 186.60 | 78.40 | 82.72 | | 82.78 | 0.000370 | 1.88 | 89.13 | 34.18 | 0.19 |
| 1 | 59275 | June | 140.20 | 78.40 | 82.54 | | 82.59 | 0.000290 | 1.51 | 93.11 | 33.50 | 0.16 |
| 1 | 59275 | August | 64.90 | 78.40 | 82.23 | | 82.24 | 0.000078 | 0.78 | 82.68 | 32.28 | 0.09 |
| 1 | 59275 | Mean Annual Floe | 750.00 | 78.40 | 84.58 | | 84.89 | 0.001258 | 4.47 | 167.87 | 39.29 | 0.38 |
| 1 | 59275 | 100-Year | 1350.00 | 78.40 | 86.06 | | 86.60 | 0.001728 | 5.91 | 228.57 | 42.63 | 0.45 |
| 1 | 58715 | April | 273.30 | 74.80 | 83.02 | | 83.03 | 0.000067 | 0.91 | 301.29 | 54.49 | 0.07 |
| 1 | 58715 | May | 186.60 | 74.80 | 82.71 | | 82.72 | 0.000037 | 0.88 | 284.52 | 53.71 | 0.05 |
| 1 | 58715 | June | 140.20 | 74.80 | 82.54 | | 82.54 | 0.000023 | 0.51 | 275.31 | 53.27 | 0.04 |
| 1 | 58715 | August | 64.90 | 74.80 | 82.23 | | 82.23 | 0.000008 | 0.25 | 258.88 | 52.49 | 0.02 |
| 1 | 58715 | Mean Annual Floe | 750.00 | 74.80 | 84.48 | | 84.54 | 0.000250 | 1.98 | 383.27 | 57.29 | 0.13 |
| 1 | 58715 | 100-Year | 1350.00 | 74.80 | 85.90 | | 86.03 | 0.000459 | 2.90 | 486.23 | 59.79 | 0.18 |
| 1 | 58865 | April | 273.30 | 77.50 | 83.02 | 78.28 | 83.03 | 0.000042 | 0.69 | 396.42 | 73.87 | 0.05 |
| 1 | 58865 | May | 186.60 | 77.50 | 82.71 | 78.10 | 82.71 | 0.000024 | 0.50 | 373.54 | 73.04 | 0.04 |
| 1 | 58865 | June | 140.20 | 77.50 | 82.54 | 78.00 | 82.54 | 0.000015 | 0.39 | 380.87 | 73.51 | 0.03 |
| 1 | 58865 | August | 64.90 | 77.50 | 82.23 | 77.80 | 82.23 | 0.000004 | 0.19 | 336.07 | 73.28 | 0.02 |
| 1 | 58865 | Mean Annual Floe | 750.00 | 77.50 | 84.49 | 79.02 | 84.52 | 0.000147 | 1.48 | 506.02 | 74.86 | 0.10 |
| 1 | 58865 | 100-Year | 1350.00 | 77.50 | 85.91 | 79.76 | 85.99 | 0.000283 | 2.20 | 613.12 | 76.00 | 0.14 |
| 1 | 58640.5 | Bridge | | | | | | | | | | |
| 1 | 58634 | April | 273.30 | 74.80 | 83.01 | 77.06 | 83.02 | 0.000068 | 0.91 | 300.40 | 53.68 | 0.07 |
| 1 | 58634 | May | 186.60 | 74.80 | 82.70 | 76.66 | 82.71 | 0.000037 | 0.66 | 283.96 | 53.28 | 0.05 |
| 1 | 58634 | June | 140.20 | 74.80 | 82.53 | 76.41 | 82.54 | 0.000023 | 0.51 | 274.91 | 52.89 | 0.04 |
| 1 | 58634 | August | 64.90 | 74.80 | 82.22 | 76.88 | 82.23 | 0.000008 | 0.25 | 258.69 | 52.19 | 0.02 |
| 1 | 58634 | Mean Annual Floe | 750.00 | 74.80 | 84.45 | 78.49 | 84.51 | 0.000329 | 1.92 | 390.32 | 56.48 | 0.10 |
| 1 | 58634 | 100-Year | 1350.00 | 74.80 | 85.86 | 79.89 | 85.87 | 0.000527 | 2.85 | 506.48 | 58.80 | 0.19 |
| 1 | 58584 | April | 273.30 | 74.80 | 83.01 | | 83.02 | 0.000068 | 0.91 | 300.21 | 53.67 | 0.07 |
| 1 | 58584 | May | 186.60 | 74.80 | 82.70 | | 82.71 | 0.000037 | 0.66 | 283.87 | 53.28 | 0.05 |
| 1 | 58584 | June | 140.20 | 74.80 | 82.53 | | 82.54 | 0.000023 | 0.51 | 274.85 | 52.89 | 0.04 |
| 1 | 58584 | August | 64.90 | 74.80 | 82.22 | | 82.23 | 0.000008 | 0.25 | 258.67 | 52.19 | 0.02 |
| 1 | 58584 | Mean Annual Floe | 750.00 | 74.80 | 84.44 | | 84.49 | 0.000331 | 1.93 | 389.02 | 55.12 | 0.15 |
| 1 | 58584 | 100-Year | 1350.00 | 74.80 | 85.84 | | 85.93 | 0.000456 | 2.48 | 474.26 | 58.33 | 0.18 |
| 1 | 57767 | April | 273.30 | 77.13 | 82.94 | | 82.97 | 0.000320 | 1.40 | 196.20 | 52.38 | 0.13 |
| 1 | 57767 | May | 186.60 | 77.13 | 82.68 | | 82.68 | 0.000190 | 1.03 | 190.91 | 51.57 | 0.10 |
| 1 | 57767 | June | 140.20 | 77.13 | 82.51 | | 82.52 | 0.000123 | 0.81 | 172.93 | 51.62 | 0.08 |
| 1 | 57767 | August | 64.90 | 77.13 | 82.22 | | 82.22 | 0.000034 | 0.41 | 158.42 | 48.07 | 0.04 |
| 1 | 57767 | Mean Annual Floe | 750.00 | 77.13 | 84.15 | | 84.28 | 0.000982 | 2.90 | 290.83 | 55.95 | 0.23 |
| 1 | 57767 | 100-Year | 1350.00 | 77.13 | 85.34 | | 85.81 | 0.001612 | 4.14 | 353.87 | 118.82 | 0.30 |
| 1 | 57134 | April | 273.30 | 74.30 | 82.93 | | 82.94 | 0.000013 | 0.43 | 970.80 | 244.61 | 0.03 |
| 1 | 57134 | May | 186.60 | 74.30 | 82.68 | | 82.68 | 0.000007 | 0.31 | 994.12 | 243.12 | 0.02 |
| 1 | 57134 | June | 140.20 | 74.30 | 82.51 | | 82.51 | 0.000005 | 0.25 | 886.56 | 242.20 | 0.02 |
| 1 | 57134 | August | 64.90 | 74.30 | 82.22 | | 82.22 | 0.000001 | 0.12 | 798.85 | 240.70 | 0.01 |
| 1 | 57134 | Mean Annual Floe | 750.00 | 74.30 | 84.15 | | 84.16 | 0.000046 | 0.90 | 1388.08 | 397.07 | 0.05 |
| 1 | 57134 | 100-Year | 1350.00 | 74.30 | 85.39 | | 85.40 | 0.000074 | 1.24 | 1902.33 | 449.30 | 0.07 |
| 1 | 56393 | April | 273.30 | 75.50 | 82.91 | | 82.92 | 0.000072 | 0.79 | 347.04 | 72.30 | 0.08 |
| 1 | 56393 | May | 186.60 | 75.50 | 82.65 | | 82.65 | 0.000036 | 0.67 | 328.45 | 70.23 | 0.06 |
| 1 | 56393 | June | 140.20 | 75.50 | 82.50 | | 82.50 | 0.000024 | 0.44 | 318.01 | 69.46 | 0.04 |
| 1 | 56393 | August | 64.90 | 75.50 | 82.22 | | 82.22 | 0.000006 | 0.22 | 298.58 | 68.00 | 0.02 |
| 1 | 56393 | Mean Annual Floe | 750.00 | 75.50 | 84.05 | | 84.06 | 0.000261 | 1.72 | 478.34 | 154.11 | 0.12 |
| 1 | 56393 | 100-Year | 1350.00 | 75.50 | 85.20 | | 85.29 | 0.000423 | 2.40 | 687.52 | 208.94 | 0.16 |
| 1 | 55407 | April | 273.30 | 75.81 | 82.84 | | 82.85 | 0.000089 | 0.79 | 363.48 | 108.02 | 0.08 |
| 1 | 55407 | May | 186.60 | 75.81 | 82.61 | | 82.61 | 0.000038 | 0.67 | 338.80 | 106.82 | 0.06 |
| 1 | 55407 | June | 140.20 | 75.81 | 82.47 | | 82.48 | 0.000024 | 0.44 | 324.84 | 103.70 | 0.04 |
| 1 | 55407 | August | 64.90 | 75.81 | 82.21 | | 82.21 | 0.000006 | 0.22 | 301.02 | 78.22 | 0.02 |
| 1 | 55407 | Mean Annual Floe | 750.00 | 75.81 | 83.77 | | 83.82 | 0.000282 | 1.79 | 486.85 | 113.73 | 0.13 |
| 1 | 55407 | 100-Year | 1350.00 | 75.81 | 84.69 | | 84.90 | 0.000537 | 2.71 | 574.91 | 119.37 | 0.18 |
| 1 | 56334 | April | 273.30 | 74.00 | 82.84 | | 82.84 | 0.000008 | 0.34 | 793.27 | 131.06 | 0.02 |
| 1 | 56334 | May | 186.60 | 74.00 | 82.61 | | 82.61 | 0.000004 | 0.24 | 783.24 | 129.47 | 0.02 |
| 1 | 56334 | June | 140.20 | 74.00 | 82.47 | | 82.48 | 0.000003 | 0.19 | 745.81 | 126.84 | 0.01 |
| 1 | 56334 | August | 64.90 | 74.00 | 82.21 | | 82.21 | 0.000001 | 0.09 | 712.00 | 126.72 | 0.01 |
| 1 | 56334 | Mean Annual Floe | 750.00 | 74.00 | 83.78 | | 83.79 | 0.000036 | 0.82 | 819.84 | 137.53 | 0.06 |
| 1 | 56334 | 100-Year | 1350.00 | 74.00 | 84.72 | | 84.75 | 0.000086 | 1.28 | 1052.00 | 143.99 | 0.08 |
| 1 | 56300 | April | 273.30 | 75.81 | 82.83 | | 82.84 | 0.000055 | 0.79 | 366.15 | 107.97 | 0.06 |
| 1 | 56300 | May | 186.60 | 75.81 | 82.60 | | 82.61 | 0.000030 | 0.57 | 341.97 | 106.59 | 0.05 |

HEC-RAS Plan: Shannock Rem (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Cntrl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|----------------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|---------------------|----------------------|-------------------|--------------|
| 1 | 55300 | June | 140.20 | 75.81 | 82.47 | | 82.47 | 0.000019 | 0.44 | 327.87 | 105.78 | 0.04 |
| 1 | 55300 | August | 64.90 | 75.81 | 82.21 | | 82.21 | 0.000005 | 0.22 | 301.89 | 87.39 | 0.02 |
| 1 | 55300 | Mean Annual Floo | 750.00 | 75.81 | 83.73 | | 83.78 | 0.000229 | 1.80 | 465.79 | 113.40 | 0.13 |
| 1 | 55300 | 100-Year | 1350.00 | 75.81 | 84.80 | | 84.71 | 0.000448 | 2.78 | 567.15 | 118.84 | 0.19 |
| Horseshoe Race | 218 | April | 27.30 | 76.90 | 78.41 | | 78.43 | 0.000717 | 1.05 | 26.08 | 17.24 | 0.15 |
| Horseshoe Race | 218 | May | 18.70 | 76.90 | 77.92 | | 77.94 | 0.001178 | 1.07 | 17.55 | 17.23 | 0.19 |
| Horseshoe Race | 218 | June | 14.00 | 76.90 | 77.70 | | 77.71 | 0.001462 | 1.02 | 13.70 | 17.22 | 0.20 |
| Horseshoe Race | 218 | August | 6.50 | 76.90 | 77.46 | | 77.46 | 0.001004 | 0.68 | 9.58 | 17.22 | 0.16 |
| Horseshoe Race | 218 | Mean Annual Floo | 102.00 | 76.90 | 82.02 | | 82.04 | 0.000257 | 1.15 | 88.41 | 17.30 | 0.08 |
| Horseshoe Race | 218 | 100-Year | 135.00 | 76.90 | 83.30 | | 83.32 | 0.000223 | 1.19 | 117.67 | 42.49 | 0.08 |
| Horseshoe Race | 155.82 | April | 27.30 | 76.70 | 78.33 | | 78.37 | 0.001622 | 1.45 | 18.82 | 13.51 | 0.22 |
| Horseshoe Race | 155.82 | May | 18.70 | 76.70 | 77.77 | | 77.81 | 0.003891 | 1.67 | 11.21 | 13.50 | 0.32 |
| Horseshoe Race | 155.82 | June | 14.00 | 76.70 | 77.46 | | 77.52 | 0.009914 | 2.00 | 7.00 | 13.50 | 0.49 |
| Horseshoe Race | 155.82 | August | 6.50 | 76.70 | 77.30 | | 77.33 | 0.006719 | 1.32 | 4.92 | 13.50 | 0.38 |
| Horseshoe Race | 155.82 | Mean Annual Floo | 102.00 | 76.70 | 81.90 | | 82.02 | 0.000502 | 1.49 | 68.29 | 13.58 | 0.12 |
| Horseshoe Race | 155.82 | 100-Year | 135.00 | 76.70 | 83.26 | | 83.29 | 0.000475 | 1.58 | 85.55 | 13.80 | 0.11 |
| Horseshoe Race | 107.54 | April | 27.30 | 76.06 | 78.30 | | 78.32 | 0.000593 | 1.04 | 26.23 | 14.24 | 0.14 |
| Horseshoe Race | 107.54 | May | 18.70 | 76.06 | 77.72 | | 77.73 | 0.000903 | 1.04 | 17.92 | 14.06 | 0.16 |
| Horseshoe Race | 107.54 | June | 14.00 | 76.06 | 77.36 | | 77.38 | 0.001436 | 1.09 | 12.88 | 13.95 | 0.20 |
| Horseshoe Race | 107.54 | August | 6.50 | 76.06 | 76.65 | | 76.72 | 0.002151 | 2.14 | 3.03 | 13.21 | 0.78 |
| Horseshoe Race | 107.54 | Mean Annual Floo | 102.00 | 76.06 | 81.88 | | 82.00 | 0.000312 | 1.27 | 80.61 | 15.37 | 0.10 |
| Horseshoe Race | 107.54 | 100-Year | 135.00 | 76.06 | 83.25 | | 83.28 | 0.000300 | 1.34 | 100.38 | 15.88 | 0.09 |
| Horseshoe Race | 78.0 | April | 27.30 | 75.54 | 78.31 | | 78.32 | 0.000094 | 0.48 | 57.14 | 26.16 | 0.06 |
| Horseshoe Race | 78.0 | May | 18.70 | 75.54 | 77.72 | | 77.73 | 0.000106 | 0.45 | 41.74 | 26.16 | 0.06 |
| Horseshoe Race | 78.0 | June | 14.00 | 75.54 | 77.38 | | 77.37 | 0.000135 | 0.43 | 32.29 | 28.15 | 0.07 |
| Horseshoe Race | 78.0 | August | 6.50 | 75.54 | 76.68 | | 76.69 | 0.000254 | 0.42 | 15.84 | 22.11 | 0.09 |
| Horseshoe Race | 78.0 | Mean Annual Floo | 102.00 | 75.54 | 81.89 | | 82.00 | 0.000058 | 0.66 | 164.07 | 27.80 | 0.05 |
| Horseshoe Race | 78.0 | 100-Year | 135.00 | 75.54 | 83.27 | | 83.27 | 0.000053 | 0.71 | 190.58 | 28.80 | 0.05 |
| Horseshoe Race | 82.61 | April | 27.30 | 75.59 | 77.80 | 77.18 | 78.18 | 0.031935 | 5.05 | 5.41 | 2.48 | 0.80 |
| Horseshoe Race | 82.61 | May | 18.70 | 75.59 | 77.33 | 76.82 | 77.63 | 0.027487 | 4.40 | 4.25 | 2.46 | 0.59 |
| Horseshoe Race | 82.61 | June | 14.00 | 75.59 | 77.04 | 76.60 | 77.29 | 0.024716 | 3.96 | 3.54 | 2.46 | 0.58 |
| Horseshoe Race | 82.61 | August | 6.50 | 75.59 | 76.50 | 76.20 | 76.63 | 0.019132 | 2.95 | 2.20 | 2.45 | 0.55 |
| Horseshoe Race | 82.61 | Mean Annual Floo | 102.00 | 75.59 | 80.71 | 79.36 | 81.70 | 0.057572 | 7.88 | 12.78 | 2.56 | 0.63 |
| Horseshoe Race | 82.61 | 100-Year | 135.00 | 75.59 | 81.72 | 80.13 | 82.92 | 0.066030 | 8.76 | 15.40 | 2.80 | 0.63 |
| Horseshoe Race | 55.33 | April | 27.30 | 75.50 | 77.07 | 77.07 | 77.08 | 0.075638 | 7.10 | 3.85 | 2.47 | 1.00 |
| Horseshoe Race | 55.33 | May | 18.70 | 75.50 | 76.72 | 76.72 | 77.33 | 0.069590 | 6.28 | 2.96 | 2.46 | 1.01 |
| Horseshoe Race | 55.33 | June | 14.00 | 75.50 | 76.51 | 76.51 | 77.01 | 0.065682 | 5.70 | 2.45 | 2.45 | 1.00 |
| Horseshoe Race | 55.33 | August | 6.50 | 75.50 | 76.11 | 76.11 | 76.41 | 0.059700 | 4.42 | 1.47 | 2.44 | 1.00 |
| Horseshoe Race | 55.33 | Mean Annual Floo | 102.00 | 75.50 | 79.27 | 79.27 | 81.12 | 0.119377 | 10.93 | 9.33 | 2.53 | 1.00 |
| Horseshoe Race | 55.33 | 100-Year | 135.00 | 75.50 | 80.03 | 80.03 | 82.26 | 0.134827 | 11.98 | 11.27 | 2.56 | 1.01 |
| Horseshoe Race | 48.89 | April | 27.30 | 68.44 | 73.55 | 70.29 | 73.56 | 0.000216 | 1.20 | 44.22 | 18.86 | 0.10 |
| Horseshoe Race | 48.89 | May | 18.70 | 68.44 | 73.17 | 69.98 | 73.17 | 0.000147 | 1.01 | 37.97 | 15.73 | 0.08 |
| Horseshoe Race | 48.89 | June | 14.00 | 68.44 | 72.91 | 69.76 | 72.82 | 0.000107 | 0.83 | 34.07 | 14.81 | 0.07 |
| Horseshoe Race | 48.89 | August | 6.50 | 68.44 | 72.38 | 69.38 | 72.38 | 0.000042 | 0.48 | 26.54 | 13.16 | 0.04 |
| Horseshoe Race | 48.89 | Mean Annual Floo | 102.00 | 68.44 | 75.42 | 71.81 | 75.47 | 0.000854 | 2.79 | 81.41 | 22.10 | 0.19 |
| Horseshoe Race | 48.89 | 100-Year | 135.00 | 68.44 | 75.96 | 72.24 | 76.02 | 0.000798 | 3.25 | 93.34 | 22.78 | 0.21 |
| Horseshoe Race | 45.18 | April | 27.30 | 66.81 | 73.55 | | 73.56 | 0.000066 | 0.80 | 78.28 | 21.81 | 0.06 |
| Horseshoe Race | 45.18 | May | 18.70 | 66.81 | 73.17 | | 73.17 | 0.000035 | 0.61 | 68.02 | 21.04 | 0.04 |
| Horseshoe Race | 45.18 | June | 14.00 | 66.81 | 72.91 | | 72.92 | 0.000024 | 0.49 | 62.74 | 20.21 | 0.04 |
| Horseshoe Race | 45.18 | August | 6.50 | 66.81 | 72.38 | | 72.38 | 0.000008 | 0.27 | 52.34 | 18.48 | 0.02 |
| Horseshoe Race | 45.18 | Mean Annual Floo | 102.00 | 66.81 | 75.44 | | 75.46 | 0.000238 | 1.84 | 119.55 | 24.00 | 0.12 |
| Horseshoe Race | 45.18 | 100-Year | 135.00 | 66.81 | 75.97 | | 76.01 | 0.000313 | 2.33 | 132.41 | 24.00 | 0.14 |
| Horseshoe Race | 35.07 | April | 27.30 | 68.48 | 73.54 | | 73.56 | 0.000225 | 1.31 | 43.47 | 18.83 | 0.11 |
| Horseshoe Race | 35.07 | May | 18.70 | 68.48 | 73.18 | | 73.17 | 0.000154 | 1.03 | 37.30 | 15.59 | 0.09 |
| Horseshoe Race | 35.07 | June | 14.00 | 68.48 | 72.91 | | 72.92 | 0.000112 | 0.84 | 33.44 | 14.77 | 0.07 |
| Horseshoe Race | 35.07 | August | 6.50 | 68.48 | 72.37 | | 72.38 | 0.000045 | 0.48 | 26.01 | 13.03 | 0.04 |
| Horseshoe Race | 35.07 | Mean Annual Floo | 102.00 | 68.48 | 75.40 | | 75.46 | 0.000681 | 2.84 | 80.10 | 22.03 | 0.19 |
| Horseshoe Race | 35.07 | 100-Year | 135.00 | 68.48 | 75.93 | | 76.00 | 0.000830 | 3.29 | 91.07 | 22.89 | 0.22 |
| Horseshoe Race | 31.39 | April | 27.30 | 70.66 | 73.42 | | 73.56 | 0.003954 | 3.58 | 13.32 | 9.34 | 0.40 |
| Horseshoe Race | 31.39 | May | 18.70 | 70.66 | 73.07 | | 73.17 | 0.003500 | 3.03 | 10.22 | 8.20 | 0.36 |
| Horseshoe Race | 31.39 | June | 14.00 | 70.66 | 72.83 | | 72.91 | 0.003182 | 2.88 | 8.38 | 7.43 | 0.34 |
| Horseshoe Race | 31.39 | August | 6.50 | 70.66 | 72.33 | | 72.39 | 0.002274 | 1.85 | 5.08 | 5.81 | 0.27 |
| Horseshoe Race | 31.39 | Mean Annual Floo | 102.00 | 70.66 | 76.14 | | 75.45 | 0.005656 | 6.03 | 34.18 | 14.93 | 0.52 |
| Horseshoe Race | 31.39 | 100-Year | 135.00 | 70.66 | 75.63 | | 76.00 | 0.006635 | 6.70 | 41.88 | 16.52 | 0.54 |
| Horseshoe Race | 23.53 | April | 27.30 | 70.99 | 73.22 | | 73.51 | 0.010652 | 4.98 | 8.81 | 7.62 | 0.82 |
| Horseshoe Race | 23.53 | May | 18.70 | 70.99 | 72.89 | | 73.13 | 0.010376 | 4.36 | 6.50 | 6.56 | 0.80 |
| Horseshoe Race | 23.53 | June | 14.00 | 70.99 | 72.68 | | 72.87 | 0.010137 | 3.93 | 5.18 | 5.96 | 0.58 |
| Horseshoe Race | 23.53 | August | 6.50 | 70.99 | 72.22 | | 72.34 | 0.009372 | 2.94 | 2.84 | 4.38 | 0.52 |
| Horseshoe Race | 23.53 | Mean Annual Floo | 102.00 | 70.99 | 74.82 | | 75.39 | 0.011818 | 7.81 | 25.24 | 12.84 | 0.73 |
| Horseshoe Race | 23.53 | 100-Year | 135.00 | 70.99 | 75.29 | | 76.03 | 0.012082 | 8.55 | 31.53 | 14.34 | 0.75 |

HEC-RAS Plan: Shamook Ram (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|----------------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| Horseshoe Race | 12.73 | April | 27.30 | 70.94 | 72.79 | 72.79 | 73.34 | 0.025434 | 6.67 | 6.13 | 6.37 | 0.93 |
| Horseshoe Race | 12.73 | May | 18.70 | 70.94 | 72.48 | 72.48 | 72.06 | 0.027153 | 6.00 | 4.36 | 5.40 | 0.93 |
| Horseshoe Race | 12.73 | June | 14.00 | 70.94 | 72.29 | 72.29 | 72.70 | 0.028749 | 5.53 | 3.36 | 4.76 | 0.93 |
| Horseshoe Race | 12.73 | August | 6.50 | 70.94 | 71.88 | 71.88 | 72.17 | 0.034832 | 4.40 | 1.69 | 3.43 | 0.95 |
| Horseshoe Race | 12.73 | Mean Annual Floo | 102.00 | 70.94 | 74.31 | 74.31 | 75.22 | 0.021656 | 9.64 | 16.66 | 11.33 | 0.96 |
| Horseshoe Race | 12.73 | 100-Year | 135.00 | 70.94 | 74.74 | 74.74 | 75.79 | 0.021693 | 10.50 | 24.77 | 12.72 | 0.96 |
| Horseshoe Race | 6.21 | April | 27.30 | 70.94 | 72.25 | 72.49 | 73.13 | 0.047373 | 8.20 | 4.74 | 5.62 | 1.24 |
| Horseshoe Race | 6.21 | May | 18.70 | 70.94 | 71.90 | 72.18 | 72.73 | 0.050519 | 7.35 | 3.38 | 4.77 | 1.23 |
| Horseshoe Race | 6.21 | June | 14.00 | 70.94 | 71.93 | 71.90 | 72.40 | 0.051203 | 6.66 | 2.66 | 4.25 | 1.21 |
| Horseshoe Race | 6.21 | August | 6.50 | 70.94 | 71.50 | 71.58 | 71.89 | 0.054400 | 5.13 | 1.42 | 3.16 | 1.16 |
| Horseshoe Race | 6.21 | Mean Annual Floo | 102.00 | 70.94 | 73.83 | 74.01 | 75.05 | 0.038274 | 11.73 | 15.51 | 10.08 | 1.25 |
| Horseshoe Race | 6.21 | 100-Year | 135.00 | 70.94 | 74.04 | 74.44 | 75.59 | 0.038498 | 12.58 | 19.96 | 11.47 | 1.25 |
| Horseshoe Race | 0.55 | April | 27.30 | 70.44 | 72.12 | 72.20 | 72.89 | 0.039040 | 7.60 | 5.13 | 5.84 | 1.13 |
| Horseshoe Race | 0.55 | May | 18.70 | 70.44 | 71.87 | 71.98 | 72.48 | 0.038688 | 6.74 | 3.77 | 5.03 | 1.09 |
| Horseshoe Race | 0.55 | June | 14.00 | 70.44 | 71.73 | 71.78 | 72.21 | 0.035607 | 5.92 | 3.09 | 4.56 | 1.02 |
| Horseshoe Race | 0.55 | August | 6.50 | 70.44 | 71.35 | 71.38 | 71.67 | 0.040794 | 4.60 | 1.59 | 3.33 | 1.02 |
| Horseshoe Race | 0.55 | Mean Annual Floo | 102.00 | 70.44 | 73.46 | 73.80 | 74.83 | 0.038172 | 11.50 | 15.88 | 10.20 | 1.22 |
| Horseshoe Race | 0.55 | 100-Year | 135.00 | 70.44 | 73.85 | 74.24 | 75.38 | 0.035861 | 12.51 | 20.11 | 11.47 | 1.24 |
| 2 | 55295 | April | 246.00 | 73.20 | 82.83 | 73.70 | 82.63 | 0.000002 | 0.23 | 1273.11 | 134.40 | 0.91 |
| 2 | 55296 | May | 167.90 | 73.20 | 82.91 | 73.58 | 82.61 | 0.000001 | 0.16 | 1242.54 | 134.29 | 0.91 |
| 2 | 55295 | June | 126.20 | 73.20 | 82.47 | 73.62 | 82.47 | 0.000001 | 0.12 | 1224.59 | 134.23 | 0.91 |
| 2 | 55295 | August | 58.40 | 73.20 | 82.21 | 73.39 | 82.21 | 0.000000 | 0.06 | 1189.25 | 134.11 | 0.90 |
| 2 | 55295 | Mean Annual Floo | 648.00 | 73.20 | 83.75 | 74.15 | 83.78 | 0.000012 | 0.55 | 1386.61 | 134.83 | 0.93 |
| 2 | 55295 | 100-Year | 1215.00 | 73.20 | 84.85 | 74.64 | 84.68 | 0.000035 | 0.99 | 1532.31 | 167.22 | 0.96 |
| 2 | 55290 | | Inf Struct | | | | | | | | | |
| 2 | 55284 | April | 246.00 | 73.20 | 73.98 | 73.70 | 74.08 | 0.009675 | 2.75 | 101.16 | 130.26 | 0.55 |
| 2 | 55284 | May | 167.90 | 73.20 | 73.83 | 73.58 | 73.90 | 0.009681 | 2.31 | 81.83 | 130.19 | 0.51 |
| 2 | 55284 | June | 126.20 | 73.20 | 73.74 | 73.52 | 73.80 | 0.008554 | 2.03 | 70.25 | 130.15 | 0.49 |
| 2 | 55284 | August | 58.40 | 73.20 | 73.56 | 73.39 | 73.59 | 0.007194 | 1.41 | 46.56 | 130.07 | 0.42 |
| 2 | 55284 | Mean Annual Floo | 648.00 | 73.20 | 74.55 | 74.14 | 74.79 | 0.010728 | 4.18 | 175.88 | 130.53 | 0.63 |
| 2 | 55284 | 100-Year | 1215.00 | 73.20 | 75.16 | 74.84 | 75.55 | 0.011028 | 5.42 | 255.04 | 130.81 | 0.68 |
| 2 | 55279 | April | 246.00 | 73.20 | 73.89 | 73.86 | 73.95 | 0.043498 | 4.31 | 64.38 | 130.13 | 1.08 |
| 2 | 55279 | May | 167.90 | 73.20 | 73.58 | 73.58 | 73.78 | 0.047330 | 3.70 | 49.86 | 130.08 | 1.06 |
| 2 | 55279 | June | 126.20 | 73.20 | 73.52 | 73.52 | 73.08 | 0.050255 | 3.44 | 41.25 | 130.05 | 1.09 |
| 2 | 55279 | August | 58.40 | 73.20 | 73.39 | 73.36 | 73.40 | 0.059815 | 2.87 | 24.64 | 129.99 | 1.08 |
| 2 | 55279 | Mean Annual Floo | 648.00 | 73.20 | 74.14 | 74.14 | 74.62 | 0.035205 | 5.96 | 122.88 | 130.34 | 1.08 |
| 2 | 55279 | 100-Year | 1215.00 | 73.20 | 74.84 | 74.84 | 75.37 | 0.030712 | 7.37 | 187.11 | 130.57 | 1.08 |
| 2 | 55274 | April | 246.00 | 69.20 | 71.23 | 69.96 | 71.28 | 0.001350 | 1.87 | 131.73 | 64.93 | 0.23 |
| 2 | 55274 | May | 167.90 | 69.20 | 70.86 | 69.79 | 70.84 | 0.001370 | 1.62 | 103.75 | 64.82 | 0.23 |
| 2 | 55274 | June | 126.20 | 69.20 | 70.52 | 69.69 | 70.50 | 0.001443 | 1.47 | 85.77 | 64.82 | 0.23 |
| 2 | 55274 | August | 58.40 | 69.20 | 69.27 | 69.40 | 71.79 | 5.695825 | 12.73 | 4.59 | 64.90 | 8.44 |
| 2 | 55274 | Mean Annual Floo | 648.00 | 69.20 | 72.85 | 70.85 | 72.98 | 0.001410 | 2.74 | 236.77 | 64.86 | 0.26 |
| 2 | 55274 | 100-Year | 1215.00 | 69.20 | 74.57 | 71.41 | 74.70 | 0.001454 | 3.49 | 349.49 | 64.97 | 0.27 |
| 2 | 55256.29 | April | 246.00 | 66.97 | 71.05 | 69.70 | 71.16 | 0.003816 | 2.84 | 93.07 | 45.80 | 0.33 |
| 2 | 55256.29 | May | 167.90 | 66.97 | 70.65 | 69.30 | 70.73 | 0.003279 | 2.23 | 75.18 | 42.58 | 0.30 |
| 2 | 55256.29 | June | 126.20 | 66.97 | 70.39 | 69.20 | 70.45 | 0.002854 | 1.96 | 64.40 | 40.00 | 0.27 |
| 2 | 55256.29 | August | 58.40 | 66.97 | 69.85 | 69.56 | 69.87 | 0.001774 | 1.32 | 44.17 | 34.68 | 0.21 |
| 2 | 55256.29 | Mean Annual Floo | 648.00 | 66.97 | 72.59 | 70.84 | 72.82 | 0.004280 | 3.83 | 179.59 | 55.18 | 0.37 |
| 2 | 55256.29 | 100-Year | 1215.00 | 66.97 | 74.26 | 71.80 | 74.90 | 0.003768 | 4.72 | 263.10 | 55.79 | 0.37 |
| 2 | 55236 | | Bridge | | | | | | | | | |
| 2 | 55217.48 | April | 246.00 | 68.47 | 70.14 | 70.14 | 70.70 | 0.043801 | 6.01 | 40.92 | 37.01 | 1.01 |
| 2 | 55217.48 | May | 167.90 | 68.47 | 69.87 | 69.87 | 70.32 | 0.047492 | 5.40 | 31.08 | 35.13 | 1.01 |
| 2 | 55217.48 | June | 126.20 | 68.47 | 69.70 | 69.70 | 70.08 | 0.050296 | 4.97 | 25.39 | 34.01 | 1.01 |
| 2 | 55217.48 | August | 58.40 | 68.47 | 69.28 | 69.36 | 69.62 | 0.059376 | 3.95 | 14.80 | 31.79 | 1.02 |
| 2 | 55217.48 | Mean Annual Floo | 648.00 | 68.47 | 71.93 | 72.44 | 72.44 | 0.012583 | 5.78 | 113.63 | 41.48 | 0.82 |
| 2 | 55217.48 | 100-Year | 1215.00 | 68.47 | 73.67 | | 74.29 | 0.007912 | 6.40 | 260.76 | 63.88 | 0.84 |
| 2 | 55168 | April | 246.00 | 67.10 | 69.97 | 68.24 | 70.00 | 0.000753 | 1.53 | 200.60 | 110.39 | 0.20 |
| 2 | 55168 | May | 167.90 | 67.10 | 69.44 | 68.02 | 69.47 | 0.001086 | 1.40 | 142.42 | 110.18 | 0.22 |
| 2 | 55168 | June | 126.20 | 67.10 | 69.19 | 67.86 | 69.21 | 0.000900 | 1.20 | 117.34 | 87.13 | 0.20 |
| 2 | 55168 | August | 58.40 | 67.10 | 68.73 | 67.50 | 68.74 | 0.000563 | 0.78 | 89.85 | 73.95 | 0.15 |
| 2 | 55168 | Mean Annual Floo | 648.00 | 67.10 | 72.10 | | 72.15 | 0.000401 | 1.80 | 437.49 | 111.24 | 0.18 |
| 2 | 55168 | 100-Year | 1215.00 | 67.10 | 73.89 | | 73.96 | 0.000413 | 2.41 | 638.31 | 111.05 | 0.18 |
| 3 | 55152.41 | April | 273.30 | 67.10 | 69.98 | 68.36 | 69.98 | 0.000767 | 1.38 | 198.74 | 110.38 | 0.18 |
| 3 | 55152.41 | May | 186.80 | 67.10 | 69.42 | 68.12 | 69.44 | 0.000962 | 1.21 | 139.75 | 108.78 | 0.19 |
| 3 | 55152.41 | June | 140.20 | 67.10 | 69.16 | 67.86 | 69.18 | 0.000883 | 1.04 | 115.05 | 84.63 | 0.17 |
| 3 | 55152.41 | August | 94.90 | 67.10 | 69.71 | 67.63 | 68.73 | 0.000517 | 0.86 | 79.71 | 73.68 | 0.13 |
| 3 | 55152.41 | Mean Annual Floo | 750.00 | 67.10 | 72.09 | 69.27 | 72.14 | 0.000517 | 1.67 | 435.69 | 111.23 | 0.17 |
| 3 | 55152.41 | 100-Year | 1350.00 | 67.10 | 73.87 | 69.83 | 73.96 | 0.000505 | 2.37 | 634.87 | 111.95 | 0.17 |

HEC-RAS Plan: Sharnook Rem (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 55124 | April | 273.30 | 88.00 | 88.73 | | 89.89 | 0.005737 | 3.25 | 84.16 | 56.32 | 0.47 |
| 3 | 55124 | May | 186.60 | 88.00 | 89.12 | | 89.33 | 0.011836 | 3.81 | 51.70 | 50.90 | 0.63 |
| 3 | 55124 | June | 140.20 | 88.00 | 88.89 | 88.89 | 89.02 | 0.034717 | 4.59 | 36.53 | 47.14 | 1.01 |
| 3 | 55124 | August | 64.90 | 88.00 | 88.42 | 86.42 | 86.82 | 0.040624 | 3.02 | 17.86 | 44.71 | 1.01 |
| 3 | 55124 | Mean Annual Flow | 750.00 | 88.00 | 71.86 | | 72.07 | 0.002132 | 3.43 | 230.11 | 70.21 | 0.33 |
| 3 | 55124 | 100-Year | 1350.00 | 88.00 | 73.66 | | 73.88 | 0.001883 | 3.89 | 386.76 | 66.33 | 0.31 |
| 3 | 55068 | April | 273.30 | 86.02 | 86.88 | | 89.73 | 0.008909 | 1.71 | 159.84 | 64.68 | 0.19 |
| 3 | 55068 | May | 186.60 | 86.02 | 86.06 | | 89.12 | 0.008821 | 1.52 | 122.86 | 59.56 | 0.19 |
| 3 | 55068 | June | 140.20 | 86.02 | 88.70 | 87.33 | 88.73 | 0.009840 | 1.39 | 100.73 | 56.68 | 0.18 |
| 3 | 55068 | August | 64.90 | 86.02 | 87.87 | 87.87 | 87.99 | 0.008821 | 1.06 | 61.25 | 51.13 | 0.17 |
| 3 | 55068 | Mean Annual Flow | 750.00 | 86.02 | 71.86 | | 71.95 | 0.007749 | 2.42 | 312.18 | 73.69 | 0.20 |
| 3 | 55068 | 100-Year | 1350.00 | 86.02 | 73.82 | | 73.77 | 0.007993 | 3.11 | 445.85 | 78.66 | 0.22 |
| 3 | 54724 | April | 273.30 | 85.80 | 89.12 | | 89.25 | 0.003270 | 2.91 | 93.79 | 48.21 | 0.37 |
| 3 | 54724 | May | 186.60 | 85.80 | 88.47 | | 88.80 | 0.004294 | 2.90 | 64.36 | 41.94 | 0.41 |
| 3 | 54724 | June | 140.20 | 85.80 | 88.02 | | 88.16 | 0.005489 | 2.95 | 47.41 | 35.32 | 0.45 |
| 3 | 54724 | August | 64.90 | 85.80 | 87.25 | | 87.38 | 0.008265 | 2.76 | 23.50 | 26.42 | 0.52 |
| 3 | 54724 | Mean Annual Flow | 750.00 | 85.80 | 71.34 | | 71.53 | 0.002570 | 3.48 | 215.28 | 68.19 | 0.35 |
| 3 | 54724 | 100-Year | 1350.00 | 85.80 | 73.14 | | 73.25 | 0.002371 | 3.68 | 373.63 | 129.87 | 0.34 |
| 3 | 54674 | April | 273.30 | 85.90 | 89.18 | | 89.52 | 0.000139 | 0.88 | 319.45 | 98.10 | 0.08 |
| 3 | 54674 | May | 186.60 | 85.90 | 88.51 | 88.38 | 88.52 | 0.000139 | 0.73 | 255.64 | 98.08 | 0.08 |
| 3 | 54674 | June | 140.20 | 85.90 | 88.07 | 88.30 | 88.07 | 0.000143 | 0.60 | 212.33 | 98.07 | 0.08 |
| 3 | 54674 | August | 64.90 | 85.90 | 87.28 | 86.14 | 87.28 | 0.000137 | 0.48 | 135.38 | 98.04 | 0.07 |
| 3 | 54674 | Mean Annual Flow | 750.00 | 85.90 | 71.40 | 67.12 | 71.43 | 0.000183 | 1.39 | 539.12 | 98.17 | 0.10 |
| 3 | 54674 | 100-Year | 1350.00 | 85.90 | 73.19 | 67.70 | 73.25 | 0.000232 | 1.89 | 714.47 | 138.73 | 0.12 |
| 3 | 54672 | Bridgs | | | | | | | | | | |
| 3 | 54641.5 | April | 273.30 | 83.10 | 89.18 | 83.72 | 89.16 | 0.000018 | 0.48 | 593.85 | 98.13 | 0.03 |
| 3 | 54641.5 | May | 186.60 | 83.10 | 88.51 | 83.58 | 88.51 | 0.000012 | 0.35 | 530.04 | 98.12 | 0.03 |
| 3 | 54641.5 | June | 140.20 | 83.10 | 88.07 | 83.50 | 88.07 | 0.000006 | 0.29 | 488.73 | 98.11 | 0.02 |
| 3 | 54641.5 | August | 64.90 | 83.10 | 87.28 | 83.34 | 87.28 | 0.000003 | 0.16 | 409.78 | 98.09 | 0.01 |
| 3 | 54641.5 | Mean Annual Flow | 750.00 | 83.10 | 71.40 | 64.31 | 71.41 | 0.000046 | 0.92 | 813.52 | 98.16 | 0.06 |
| 3 | 54641.5 | 100-Year | 1350.00 | 83.10 | 73.19 | 64.90 | 73.22 | 0.000078 | 1.37 | 988.87 | 138.73 | 0.08 |
| 3 | 54591.5 | April | 273.30 | 85.00 | 89.08 | | 89.11 | 0.004256 | 3.18 | 88.03 | 47.51 | 0.42 |
| 3 | 54591.5 | May | 186.60 | 85.00 | 88.30 | | 88.46 | 0.005790 | 3.24 | 57.55 | 38.84 | 0.47 |
| 3 | 54591.5 | June | 140.20 | 85.00 | 87.83 | 87.32 | 88.01 | 0.008231 | 3.44 | 40.76 | 32.79 | 0.54 |
| 3 | 54591.5 | August | 64.90 | 85.00 | 86.85 | 86.85 | 87.18 | 0.034943 | 4.65 | 13.97 | 21.24 | 1.01 |
| 3 | 54591.5 | Mean Annual Flow | 750.00 | 85.00 | 71.13 | | 71.35 | 0.003021 | 3.73 | 206.96 | 64.86 | 0.37 |
| 3 | 54591.5 | 100-Year | 1350.00 | 85.00 | 72.90 | | 73.14 | 0.002956 | 3.95 | 344.48 | 116.28 | 0.38 |
| 3 | 53180 | April | 273.30 | 82.25 | 86.17 | | 86.24 | 0.001181 | 2.07 | 132.05 | 52.00 | 0.23 |
| 3 | 53180 | May | 186.60 | 82.25 | 85.73 | | 85.77 | 0.006907 | 1.70 | 106.85 | 48.23 | 0.20 |
| 3 | 53180 | June | 140.20 | 82.25 | 85.44 | | 85.48 | 0.006734 | 1.45 | 96.36 | 45.79 | 0.18 |
| 3 | 53180 | August | 64.90 | 82.25 | 84.85 | 83.19 | 84.86 | 0.003370 | 0.92 | 70.53 | 40.64 | 0.12 |
| 3 | 53180 | Mean Annual Flow | 750.00 | 82.25 | 67.84 | | 68.00 | 0.001391 | 3.25 | 230.80 | 66.41 | 0.31 |
| 3 | 53180 | 100-Year | 1350.00 | 82.25 | 69.23 | | 69.46 | 0.002285 | 4.07 | 331.43 | 78.41 | 0.35 |
| 3 | 53151 | April | 273.30 | 81.82 | 86.11 | | 86.20 | 0.001580 | 2.45 | 111.36 | 42.37 | 0.27 |
| 3 | 53151 | May | 186.60 | 81.82 | 85.98 | | 85.74 | 0.001194 | 1.99 | 83.85 | 39.56 | 0.23 |
| 3 | 53151 | June | 140.20 | 81.82 | 85.41 | | 85.45 | 0.009940 | 1.88 | 83.34 | 37.78 | 0.20 |
| 3 | 53151 | August | 64.90 | 81.82 | 84.83 | | 84.86 | 0.006453 | 1.94 | 62.50 | 33.97 | 0.13 |
| 3 | 53151 | Mean Annual Flow | 750.00 | 81.82 | 67.89 | | 67.94 | 0.002894 | 4.02 | 186.37 | 52.74 | 0.38 |
| 3 | 53151 | 100-Year | 1350.00 | 81.82 | 68.98 | | 69.41 | 0.003749 | 5.18 | 280.86 | 61.32 | 0.44 |
| 3 | 53122 | April | 273.30 | 80.36 | 86.13 | | 86.18 | 0.006535 | 1.76 | 155.38 | 42.36 | 0.16 |
| 3 | 53122 | May | 186.60 | 80.36 | 85.70 | | 85.73 | 0.003348 | 1.36 | 137.52 | 40.12 | 0.13 |
| 3 | 53122 | June | 140.20 | 80.36 | 85.42 | | 85.44 | 0.002465 | 1.11 | 126.87 | 38.70 | 0.11 |
| 3 | 53122 | August | 64.90 | 80.36 | 84.84 | | 84.84 | 0.006888 | 0.82 | 104.89 | 35.68 | 0.06 |
| 3 | 53122 | Mean Annual Flow | 750.00 | 80.36 | 67.72 | | 67.88 | 0.001404 | 3.27 | 220.09 | 50.54 | 0.27 |
| 3 | 53122 | 100-Year | 1350.00 | 80.36 | 69.01 | | 69.33 | 0.002218 | 4.52 | 298.94 | 57.23 | 0.35 |
| 3 | 53086 | April | 273.30 | 82.25 | 85.95 | | 85.14 | 0.004428 | 3.50 | 78.02 | 37.81 | 0.43 |
| 3 | 53086 | May | 186.60 | 82.25 | 85.57 | | 85.70 | 0.003708 | 2.02 | 63.99 | 35.83 | 0.38 |
| 3 | 53086 | June | 140.20 | 82.25 | 85.32 | | 85.42 | 0.003219 | 2.53 | 55.29 | 34.68 | 0.35 |
| 3 | 53086 | August | 64.90 | 82.25 | 84.79 | | 84.83 | 0.001963 | 1.71 | 38.01 | 29.94 | 0.27 |
| 3 | 53086 | Mean Annual Flow | 750.00 | 82.25 | 67.30 | | 67.79 | 0.008967 | 5.60 | 134.02 | 44.38 | 0.57 |
| 3 | 53086 | 100-Year | 1350.00 | 82.25 | 68.35 | | 69.19 | 0.009217 | 7.34 | 183.89 | 50.31 | 0.68 |
| 3 | 53044 | April | 273.30 | 83.80 | 85.15 | | 85.15 | 0.028761 | 6.10 | 44.80 | 39.07 | 1.00 |
| 3 | 53044 | May | 186.60 | 83.80 | 84.87 | 84.87 | 85.34 | 0.030594 | 5.48 | 34.07 | 36.95 | 1.00 |
| 3 | 53044 | June | 140.20 | 83.80 | 84.69 | 84.69 | 85.09 | 0.032627 | 5.07 | 27.87 | 35.12 | 1.01 |
| 3 | 53044 | August | 64.90 | 83.80 | 84.35 | 84.35 | 84.60 | 0.038574 | 4.08 | 15.99 | 32.14 | 1.01 |
| 3 | 53044 | Mean Annual Flow | 750.00 | 83.80 | 68.28 | 68.28 | 67.26 | 0.024424 | 7.85 | 94.34 | 48.73 | 1.01 |
| 3 | 53044 | 100-Year | 1350.00 | 83.80 | 67.30 | 67.30 | 68.59 | 0.021970 | 9.12 | 148.09 | 57.40 | 1.00 |
| 3 | 53003 | April | 273.30 | 80.82 | 84.84 | 83.42 | 84.84 | 0.002683 | 2.82 | 108.52 | 58.35 | 0.33 |

HEC-RAS Plan: Shamook Rem (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | M in Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft) | Vel Cntrl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chi |
|-------|-----------|------------------|------------------|--------------------|-------------------|-------------------|-------------------|--------------------|---------------------|----------------------|-------------------|--------------|
| 3 | 53003 | May | 186.60 | 60.82 | 64.62 | 63.04 | 64.68 | 0.001834 | 1.94 | 86.96 | 58.21 | 0.27 |
| 3 | 53003 | June | 140.20 | 60.82 | 64.49 | 62.90 | 64.53 | 0.001329 | 1.59 | 86.14 | 56.78 | 0.22 |
| 3 | 53003 | August | 64.90 | 60.82 | 64.20 | 62.27 | 64.22 | 0.000436 | 0.89 | 73.10 | 46.76 | 0.13 |
| 3 | 53003 | Mean Annual Floo | 750.00 | 60.82 | 65.74 | 64.71 | 66.07 | 0.005943 | 4.56 | 164.43 | 64.17 | 0.50 |
| 3 | 53003 | 100-Year | 1350.00 | 60.82 | 66.85 | 65.55 | 67.35 | 0.005969 | 5.80 | 236.67 | 70.05 | 0.54 |
| 3 | 52961.5 | April | 273.30 | 63.60 | 64.72 | | 64.89 | 0.006739 | 3.26 | 85.82 | 76.55 | 0.55 |
| 3 | 52961.5 | May | 186.60 | 63.60 | 64.53 | | 64.65 | 0.007490 | 2.68 | 89.58 | 75.97 | 0.49 |
| 3 | 52961.5 | June | 140.20 | 63.60 | 64.42 | | 64.50 | 0.006610 | 2.31 | 60.69 | 75.61 | 0.45 |
| 3 | 52961.5 | August | 64.90 | 63.60 | 64.17 | | 64.20 | 0.004777 | 1.56 | 41.95 | 74.85 | 0.38 |
| 3 | 52961.5 | Mean Annual Floo | 750.00 | 63.60 | 65.01 | | 65.98 | 0.005282 | 4.89 | 153.38 | 70.29 | 0.62 |
| 3 | 52961.5 | 100-Year | 1350.00 | 63.60 | 66.83 | | 67.26 | 0.006149 | 5.35 | 252.34 | 83.05 | 0.54 |
| 3 | 52976.5 | April | 273.30 | 63.30 | 64.70 | | 64.77 | 0.002600 | 2.07 | 131.82 | 93.92 | 0.31 |
| 3 | 52976.5 | May | 186.60 | 63.30 | 64.52 | | 64.56 | 0.001948 | 1.63 | 114.31 | 93.91 | 0.26 |
| 3 | 52976.5 | June | 140.20 | 63.30 | 64.40 | | 64.43 | 0.001528 | 1.36 | 163.43 | 93.91 | 0.23 |
| 3 | 52976.5 | August | 64.90 | 63.30 | 64.16 | | 64.17 | 0.000749 | 0.81 | 89.53 | 93.91 | 0.15 |
| 3 | 52976.5 | Mean Annual Floo | 750.00 | 63.30 | 65.62 | | 65.81 | 0.003762 | 3.44 | 218.07 | 93.93 | 0.40 |
| 3 | 52976.5 | 100-Year | 1350.00 | 63.30 | 66.87 | | 67.12 | 0.003016 | 4.03 | 334.86 | 93.94 | 0.38 |
| 3 | 52973 | April | 273.30 | 63.20 | 64.41 | 64.41 | 64.72 | 0.037053 | 4.47 | 61.11 | 103.16 | 1.02 |
| 3 | 52973 | May | 186.60 | 63.20 | 64.28 | 64.28 | 64.52 | 0.040547 | 3.55 | 47.19 | 102.60 | 1.03 |
| 3 | 52973 | June | 140.20 | 63.20 | 64.20 | 64.20 | 64.40 | 0.042114 | 3.61 | 38.88 | 99.88 | 1.02 |
| 3 | 52973 | August | 64.90 | 63.20 | 64.00 | 64.00 | 64.15 | 0.047960 | 3.05 | 21.25 | 77.23 | 1.03 |
| 3 | 52973 | Mean Annual Floo | 750.00 | 63.20 | 65.49 | | 65.78 | 0.008978 | 4.29 | 174.74 | 107.77 | 0.59 |
| 3 | 52973 | 100-Year | 1350.00 | 63.20 | 66.83 | | 67.10 | 0.004039 | 4.18 | 323.32 | 113.49 | 0.44 |
| 3 | 52941 | April | 273.30 | 61.85 | 64.08 | 62.77 | 64.11 | 0.000842 | 1.42 | 163.11 | 107.02 | 0.10 |
| 3 | 52941 | May | 186.60 | 61.85 | 63.71 | 62.82 | 63.73 | 0.000832 | 1.22 | 153.25 | 105.64 | 0.18 |
| 3 | 52941 | June | 140.20 | 61.85 | 63.47 | 62.52 | 63.46 | 0.000816 | 1.09 | 128.78 | 103.53 | 0.17 |
| 3 | 52941 | August | 64.90 | 61.85 | 62.95 | 62.35 | 62.96 | 0.000821 | 0.85 | 76.03 | 96.60 | 0.17 |
| 3 | 52941 | Mean Annual Floo | 750.00 | 61.85 | 65.58 | | 65.84 | 0.000880 | 2.10 | 367.31 | 112.53 | 0.21 |
| 3 | 52941 | 100-Year | 1350.00 | 61.85 | 66.80 | | 67.00 | 0.000938 | 2.66 | 568.47 | 117.37 | 0.22 |
| 3 | 52937 | April | 273.30 | 61.50 | 63.50 | 63.50 | 64.05 | 0.031481 | 5.59 | 45.89 | 42.10 | 1.01 |
| 3 | 52937 | May | 186.60 | 61.50 | 63.23 | 63.23 | 63.68 | 0.034391 | 5.37 | 34.73 | 40.43 | 1.02 |
| 3 | 52937 | June | 140.20 | 61.50 | 63.05 | 63.05 | 63.45 | 0.034955 | 5.05 | 27.77 | 35.92 | 1.01 |
| 3 | 52937 | August | 64.90 | 61.50 | 62.63 | 62.63 | 62.92 | 0.038556 | 4.32 | 15.04 | 26.54 | 1.01 |
| 3 | 52937 | Mean Annual Floo | 750.00 | 61.50 | 64.58 | 64.58 | 65.55 | 0.025867 | 7.91 | 94.87 | 48.85 | 1.00 |
| 3 | 52937 | 100-Year | 1350.00 | 61.50 | 65.80 | 65.80 | 66.88 | 0.023844 | 9.09 | 148.95 | 58.65 | 1.00 |
| 3 | 52922 | April | 273.30 | 60.00 | 62.76 | 62.15 | 63.06 | 0.008328 | 4.22 | 64.82 | 37.60 | 0.57 |
| 3 | 52922 | May | 186.60 | 60.00 | 62.40 | 61.83 | 62.81 | 0.007920 | 3.68 | 59.71 | 35.06 | 0.54 |
| 3 | 52922 | June | 140.20 | 60.00 | 62.16 | 61.64 | 62.33 | 0.007463 | 3.29 | 42.61 | 33.51 | 0.51 |
| 3 | 52922 | August | 64.90 | 60.00 | 61.96 | 61.22 | 61.76 | 0.006182 | 2.39 | 27.14 | 39.34 | 0.45 |
| 3 | 52922 | Mean Annual Floo | 750.00 | 60.00 | 64.29 | 63.42 | 64.82 | 0.008964 | 5.84 | 128.41 | 47.11 | 0.62 |
| 3 | 52922 | 100-Year | 1350.00 | 60.00 | 65.61 | 64.53 | 66.34 | 0.009473 | 6.85 | 195.87 | 58.89 | 0.66 |
| 3 | 52905 | April | 273.30 | 60.00 | 62.36 | | 62.85 | 0.017202 | 5.41 | 50.50 | 35.02 | 0.79 |
| 3 | 52905 | May | 186.60 | 60.00 | 61.96 | | 62.36 | 0.020397 | 5.07 | 36.62 | 32.36 | 0.84 |
| 3 | 52905 | June | 140.20 | 60.00 | 61.72 | 61.64 | 62.10 | 0.024601 | 4.91 | 28.57 | 30.64 | 0.90 |
| 3 | 52905 | August | 64.90 | 60.00 | 61.22 | 61.22 | 61.53 | 0.036147 | 4.49 | 14.44 | 23.72 | 1.01 |
| 3 | 52905 | Mean Annual Floo | 750.00 | 60.00 | 63.86 | | 64.61 | 0.013781 | 6.81 | 110.17 | 44.59 | 0.76 |
| 3 | 52905 | 100-Year | 1350.00 | 60.00 | 65.19 | | 66.13 | 0.012538 | 7.77 | 173.70 | 52.85 | 0.76 |
| 3 | 52873 | April | 273.30 | 59.37 | 62.23 | | 62.44 | 0.006807 | 3.71 | 73.75 | 40.01 | 0.48 |
| 3 | 52873 | May | 186.60 | 59.37 | 61.91 | | 61.97 | 0.006587 | 3.24 | 57.58 | 36.59 | 0.45 |
| 3 | 52873 | June | 140.20 | 59.37 | 61.54 | | 61.67 | 0.006230 | 2.92 | 48.07 | 34.28 | 0.43 |
| 3 | 52873 | August | 64.90 | 59.37 | 60.03 | 60.38 | 61.01 | 0.006885 | 2.25 | 28.78 | 29.04 | 0.40 |
| 3 | 52873 | Mean Annual Floo | 750.00 | 59.37 | 63.77 | | 64.20 | 0.007672 | 5.30 | 146.07 | 54.18 | 0.54 |
| 3 | 52873 | 100-Year | 1350.00 | 59.37 | 65.13 | | 65.72 | 0.007369 | 6.28 | 228.50 | 68.29 | 0.58 |
| 3 | 52850 | April | 273.30 | 59.37 | 61.36 | 61.36 | 62.01 | 0.034841 | 6.49 | 42.11 | 32.69 | 1.01 |
| 3 | 52850 | May | 186.60 | 59.37 | 61.04 | 61.04 | 61.57 | 0.035744 | 5.83 | 32.00 | 29.07 | 0.99 |
| 3 | 52850 | June | 140.20 | 59.37 | 60.82 | 60.82 | 61.28 | 0.038158 | 5.44 | 25.75 | 28.12 | 1.00 |
| 3 | 52850 | August | 64.90 | 59.37 | 60.57 | | 60.76 | 0.010418 | 3.41 | 19.04 | 26.31 | 0.89 |
| 3 | 52850 | Mean Annual Floo | 750.00 | 59.37 | 62.62 | | 63.71 | 0.025767 | 6.44 | 92.99 | 46.94 | 0.96 |
| 3 | 52850 | 100-Year | 1350.00 | 59.37 | 63.74 | 63.74 | 65.20 | 0.021338 | 9.93 | 162.11 | 58.57 | 0.93 |
| 3 | 52822 | April | 273.30 | 58.96 | 60.56 | 60.82 | 61.38 | 0.122837 | 7.24 | 37.74 | 64.84 | 1.67 |
| 3 | 52822 | May | 186.60 | 58.96 | 60.47 | 60.62 | 61.01 | 0.100237 | 5.89 | 31.69 | 63.78 | 1.47 |
| 3 | 52822 | June | 140.20 | 58.96 | 60.51 | 60.51 | 60.77 | 0.095088 | 4.12 | 34.01 | 64.19 | 1.00 |
| 3 | 52822 | August | 64.90 | 58.96 | 60.27 | 60.27 | 60.45 | 0.053208 | 3.37 | 19.28 | 55.83 | 1.01 |
| 3 | 52822 | Mean Annual Floo | 750.00 | 58.96 | 61.00 | 61.58 | 62.93 | 0.148965 | 11.15 | 67.24 | 69.62 | 2.00 |
| 3 | 52822 | 100-Year | 1350.00 | 58.96 | 61.44 | 62.30 | 64.32 | 0.143072 | 13.61 | 99.19 | 74.84 | 2.07 |
| 3 | 52811 | April | 273.30 | 55.82 | 58.55 | 58.85 | 59.02 | 0.224155 | 9.29 | 33.07 | 72.58 | 2.16 |
| 3 | 52811 | May | 186.60 | 55.82 | 58.30 | 58.67 | 59.03 | 0.068081 | 10.28 | 18.20 | 74.78 | 1.62 |
| 3 | 52811 | June | 140.20 | 55.82 | 57.84 | 58.57 | 59.92 | 0.160600 | 11.58 | 12.11 | 11.07 | 2.93 |
| 3 | 52811 | August | 64.90 | 55.82 | 57.19 | 57.79 | 59.33 | 0.280164 | 11.76 | 5.52 | 8.08 | 2.51 |
| 3 | 52811 | Mean Annual Floo | 750.00 | 55.82 | 58.98 | 59.58 | 61.00 | 0.195207 | 11.67 | 64.25 | 75.67 | 2.23 |

HEC-RAS Plan: Sharnock Rem (Continued)

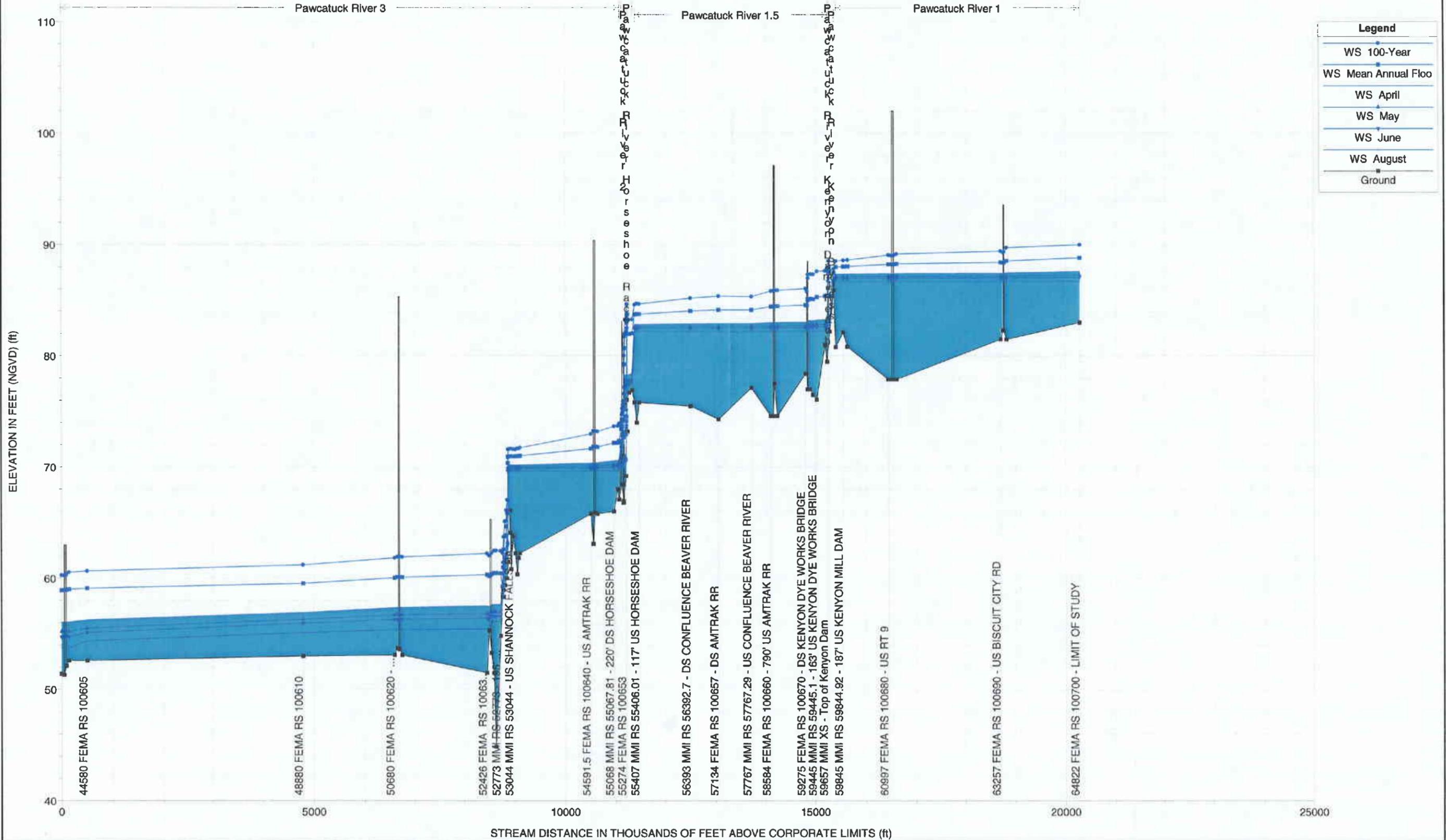
| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/l) | Vel Cntf (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Cfl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 62811 | 100-Year | 1350.00 | 55.82 | 62.32 | 60.28 | 62.58 | 0.002770 | 4.01 | 358.17 | 100.17 | 0.35 |
| 3 | 62773 | April | 273.30 | 54.83 | 57.64 | 55.98 | 57.60 | 0.000511 | 1.09 | 250.50 | 120.57 | 0.13 |
| 3 | 62773 | May | 186.60 | 54.83 | 56.97 | 55.84 | 56.90 | 0.000769 | 1.09 | 170.71 | 114.70 | 0.16 |
| 3 | 62773 | June | 140.20 | 54.83 | 56.59 | 55.79 | 56.60 | 0.001141 | 1.10 | 127.69 | 111.40 | 0.18 |
| 3 | 62773 | August | 64.90 | 54.83 | 56.10 | 55.53 | 56.11 | 0.001395 | 0.87 | 74.44 | 106.81 | 0.18 |
| 3 | 62773 | Mean Annual Floe | 750.00 | 54.83 | 60.47 | 58.55 | 60.49 | 0.000210 | 1.22 | 636.00 | 161.37 | 0.10 |
| 3 | 62773 | 100-Year | 1350.00 | 54.83 | 62.47 | | 62.51 | 0.000202 | 1.51 | 960.69 | 172.14 | 0.10 |
| 3 | 52686 | April | 273.30 | 44.87 | 57.66 | | 57.66 | 0.000904 | 0.24 | 1116.39 | 139.43 | 0.02 |
| 3 | 52686 | May | 186.60 | 44.87 | 56.99 | | 56.99 | 0.000902 | 0.18 | 1023.39 | 135.15 | 0.01 |
| 3 | 52686 | June | 140.20 | 44.87 | 56.60 | | 56.60 | 0.000901 | 0.14 | 972.49 | 132.74 | 0.01 |
| 3 | 52686 | August | 64.90 | 44.87 | 56.11 | | 56.11 | 0.000900 | 0.07 | 907.73 | 129.62 | 0.00 |
| 3 | 52686 | Mean Annual Floe | 750.00 | 44.87 | 60.48 | | 60.49 | 0.000910 | 0.49 | 1636.72 | 158.47 | 0.03 |
| 3 | 52686 | 100-Year | 1350.00 | 44.87 | 62.50 | | 62.51 | 0.000918 | 0.74 | 1872.02 | 175.43 | 0.04 |
| 3 | 52646.5 | April | 273.30 | 51.50 | 57.66 | | 57.66 | 0.000030 | 0.40 | 560.75 | 127.69 | 0.04 |
| 3 | 52646.5 | May | 186.60 | 51.50 | 56.96 | | 56.96 | 0.000023 | 0.30 | 475.26 | 124.58 | 0.04 |
| 3 | 52646.5 | June | 140.20 | 51.50 | 56.60 | | 56.60 | 0.000018 | 0.33 | 426.44 | 122.31 | 0.03 |
| 3 | 52646.5 | August | 64.90 | 51.50 | 56.11 | | 56.11 | 0.000008 | 0.18 | 368.93 | 119.35 | 0.02 |
| 3 | 52646.5 | Mean Annual Floe | 750.00 | 51.50 | 60.48 | | 60.49 | 0.000045 | 0.81 | 929.06 | 136.95 | 0.05 |
| 3 | 52646.5 | 100-Year | 1350.00 | 51.50 | 62.48 | | 62.50 | 0.000053 | 1.12 | 1221.13 | 170.58 | 0.07 |
| 3 | 52537.75 | April | 273.30 | 53.30 | 57.62 | 54.33 | 57.65 | 0.000247 | 1.38 | 198.01 | 45.87 | 0.12 |
| 3 | 52537.75 | May | 186.60 | 53.30 | 56.96 | 54.10 | 56.98 | 0.000194 | 1.11 | 167.56 | 45.86 | 0.10 |
| 3 | 52537.75 | June | 140.20 | 53.30 | 56.58 | 53.97 | 56.60 | 0.000154 | 0.93 | 150.50 | 45.86 | 0.06 |
| 3 | 52537.75 | August | 64.90 | 53.30 | 56.10 | 53.69 | 56.11 | 0.000065 | 0.61 | 128.47 | 45.85 | 0.05 |
| 3 | 52537.75 | Mean Annual Floe | 750.00 | 53.30 | 60.38 | 55.33 | 60.46 | 0.000407 | 2.31 | 324.52 | 45.92 | 0.15 |
| 3 | 52537.75 | 100-Year | 1350.00 | 53.30 | 62.28 | 56.30 | 62.45 | 0.000948 | 3.28 | 412.15 | 45.95 | 0.19 |
| 3 | 62517 | Bridge | | | | | | | | | | |
| 3 | 52496.25 | April | 273.30 | 55.30 | 57.45 | 56.33 | 57.57 | 0.002252 | 2.77 | 68.67 | 45.84 | 0.33 |
| 3 | 52496.25 | May | 186.60 | 55.30 | 56.76 | 56.10 | 56.88 | 0.003733 | 2.80 | 68.68 | 45.83 | 0.41 |
| 3 | 52496.25 | June | 140.20 | 55.30 | 56.32 | 55.68 | 56.46 | 0.006759 | 3.00 | 46.68 | 45.82 | 0.52 |
| 3 | 52496.25 | August | 64.90 | 55.30 | 56.70 | 55.70 | 56.89 | 0.032119 | 3.56 | 18.23 | 45.81 | 0.99 |
| 3 | 52496.25 | Mean Annual Floe | 750.00 | 55.30 | 60.22 | 57.33 | 60.30 | 0.001740 | 3.33 | 225.52 | 45.90 | 0.29 |
| 3 | 52496.25 | 100-Year | 1350.00 | 55.30 | 62.08 | 56.30 | 62.35 | 0.001516 | 4.30 | 309.65 | 45.94 | 0.30 |
| 3 | 52426 | April | 273.30 | 51.50 | 57.53 | | 57.53 | 0.000027 | 0.51 | 638.67 | 124.51 | 0.04 |
| 3 | 52426 | May | 186.60 | 51.50 | 56.84 | | 56.84 | 0.000022 | 0.41 | 453.26 | 121.17 | 0.04 |
| 3 | 52426 | June | 140.20 | 51.50 | 56.41 | | 56.41 | 0.000016 | 0.36 | 402.40 | 118.97 | 0.03 |
| 3 | 52426 | August | 64.90 | 51.50 | 56.45 | 52.50 | 56.45 | 0.000011 | 0.22 | 290.68 | 114.00 | 0.02 |
| 3 | 52426 | Mean Annual Floe | 750.00 | 51.50 | 60.33 | | 60.34 | 0.000041 | 0.83 | 869.51 | 134.52 | 0.06 |
| 3 | 52426 | 100-Year | 1350.00 | 51.50 | 62.24 | | 62.26 | 0.000058 | 1.17 | 1173.56 | 154.38 | 0.07 |
| 3 | 50905 | April | 273.30 | 53.10 | 57.39 | | 57.42 | 0.000293 | 1.41 | 193.27 | 56.09 | 0.13 |
| 3 | 50905 | May | 186.60 | 53.10 | 56.73 | | 56.75 | 0.000280 | 1.19 | 156.58 | 54.02 | 0.12 |
| 3 | 50905 | June | 140.20 | 53.10 | 56.32 | | 56.34 | 0.000232 | 1.04 | 136.02 | 52.77 | 0.11 |
| 3 | 50905 | August | 64.90 | 53.10 | 56.40 | | 56.41 | 0.000187 | 0.74 | 87.70 | 49.03 | 0.10 |
| 3 | 50905 | Mean Annual Floe | 750.00 | 53.10 | 60.10 | | 60.17 | 0.000396 | 2.00 | 358.23 | 71.28 | 0.16 |
| 3 | 50905 | 100-Year | 1350.00 | 53.10 | 61.93 | | 62.03 | 0.000519 | 2.58 | 573.26 | 105.23 | 0.19 |
| 3 | 50755 | April | 273.30 | 53.60 | 57.40 | 54.21 | 57.41 | 0.000693 | 0.72 | 379.72 | 100.90 | 0.07 |
| 3 | 50755 | May | 186.60 | 53.60 | 56.73 | 54.08 | 56.73 | 0.000656 | 0.60 | 312.82 | 100.79 | 0.06 |
| 3 | 50755 | June | 140.20 | 53.60 | 56.32 | 54.00 | 56.33 | 0.00061 | 0.51 | 272.30 | 100.69 | 0.05 |
| 3 | 50755 | August | 64.90 | 53.60 | 56.40 | 53.83 | 56.40 | 0.000443 | 0.39 | 179.96 | 100.45 | 0.05 |
| 3 | 50755 | Mean Annual Floe | 750.00 | 53.60 | 60.12 | 54.00 | 60.14 | 0.000719 | 1.15 | 652.06 | 101.85 | 0.08 |
| 3 | 50755 | 100-Year | 1350.00 | 53.60 | 61.95 | 55.38 | 61.99 | 0.000112 | 1.62 | 635.14 | 102.11 | 0.10 |
| 3 | 50742.6 | Bridge | | | | | | | | | | |
| 3 | 50730 | April | 273.30 | 53.70 | 57.39 | 54.32 | 57.40 | 0.000070 | 0.74 | 369.12 | 100.93 | 0.07 |
| 3 | 50730 | May | 186.60 | 53.70 | 56.72 | 54.17 | 56.73 | 0.000063 | 0.62 | 302.32 | 100.77 | 0.06 |
| 3 | 50730 | June | 140.20 | 53.70 | 56.32 | 54.09 | 56.32 | 0.000058 | 0.54 | 261.87 | 100.66 | 0.06 |
| 3 | 50730 | August | 64.90 | 53.70 | 56.39 | 53.64 | 56.40 | 0.000053 | 0.38 | 169.30 | 100.43 | 0.05 |
| 3 | 50730 | Mean Annual Floe | 750.00 | 53.70 | 60.11 | 54.91 | 60.13 | 0.000063 | 1.17 | 641.13 | 101.62 | 0.08 |
| 3 | 50730 | 100-Year | 1350.00 | 53.70 | 61.94 | 55.49 | 61.98 | 0.000117 | 1.64 | 823.62 | 102.09 | 0.10 |
| 3 | 50680 | April | 273.30 | 53.10 | 57.35 | | 57.39 | 0.000303 | 1.45 | 161.20 | 55.98 | 0.14 |
| 3 | 50680 | May | 186.60 | 53.10 | 56.70 | | 56.72 | 0.000289 | 1.20 | 155.00 | 53.93 | 0.13 |
| 3 | 50680 | June | 140.20 | 53.10 | 56.30 | | 56.31 | 0.000239 | 1.05 | 133.74 | 52.69 | 0.12 |
| 3 | 50680 | August | 64.90 | 53.10 | 56.36 | | 56.38 | 0.000193 | 0.78 | 86.65 | 48.99 | 0.10 |
| 3 | 50680 | Mean Annual Floe | 750.00 | 53.10 | 60.04 | | 60.11 | 0.000494 | 2.12 | 353.70 | 70.01 | 0.17 |
| 3 | 50680 | 100-Year | 1350.00 | 53.10 | 61.94 | | 61.95 | 0.000550 | 2.63 | 557.00 | 178.10 | 0.20 |
| 3 | 48890 | April | 273.30 | 53.00 | 56.92 | | 56.94 | 0.000204 | 1.24 | 240.80 | 86.85 | 0.12 |
| 3 | 48890 | May | 186.60 | 53.00 | 56.31 | | 56.32 | 0.000182 | 1.03 | 190.28 | 79.28 | 0.11 |
| 3 | 48890 | June | 140.20 | 53.00 | 55.95 | | 55.97 | 0.000156 | 0.80 | 163.64 | 73.38 | 0.10 |
| 3 | 48890 | August | 64.90 | 53.00 | 55.10 | | 55.11 | 0.000127 | 0.61 | 106.26 | 61.46 | 0.08 |
| 3 | 48890 | Mean Annual Floe | 750.00 | 53.00 | 59.55 | | 59.59 | 0.000206 | 1.81 | 517.54 | 123.66 | 0.13 |

HEC-RAS Plan: Shannock Ram (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|-------|-----------|-----------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|-------------|
| 3 | 44880 | 100-Year | 1350.00 | 53.00 | 61.21 | | 61.28 | 0.000269 | 2.38 | 808.59 | 252.94 | 0.15 |
| 3 | 44560 | April | 273.30 | 52.60 | 58.25 | | 58.26 | 0.000125 | 0.77 | 399.29 | 107.51 | 0.09 |
| 3 | 44560 | May | 189.60 | 52.60 | 55.51 | | 55.52 | 0.000189 | 0.75 | 251.69 | 151.28 | 0.10 |
| 3 | 44560 | June | 140.20 | 52.60 | 55.11 | | 55.11 | 0.000255 | 0.73 | 192.01 | 142.34 | 0.11 |
| 3 | 44560 | August | 64.90 | 52.60 | 54.39 | | 54.37 | 0.000263 | 0.63 | 102.63 | 92.57 | 0.11 |
| 3 | 44560 | Mean Annual Fbo | 750.00 | 52.60 | 59.10 | | 59.12 | 0.000097 | 0.93 | 936.57 | 230.26 | 0.07 |
| 3 | 44560 | 100-Year | 1350.00 | 52.60 | 60.65 | | 60.68 | 0.000085 | 1.24 | 1315.44 | 260.00 | 0.08 |
| 3 | 44230 | April | 273.30 | 52.60 | 58.06 | | 58.16 | 0.001361 | 2.43 | 138.42 | 111.40 | 0.28 |
| 3 | 44230 | May | 189.60 | 52.60 | 55.23 | | 55.34 | 0.002838 | 2.69 | 70.79 | 51.20 | 0.38 |
| 3 | 44230 | June | 140.20 | 52.60 | 54.73 | | 54.86 | 0.006062 | 2.93 | 47.91 | 40.78 | 0.46 |
| 3 | 44230 | August | 64.90 | 52.60 | 53.74 | 53.74 | 54.04 | 0.028823 | 4.41 | 14.73 | 25.06 | 1.01 |
| 3 | 44230 | Mean Annual Fbo | 750.00 | 52.60 | 59.01 | | 59.07 | 0.003369 | 2.17 | 551.52 | 168.60 | 0.17 |
| 3 | 44230 | 100-Year | 1350.00 | 52.60 | 60.63 | | 60.81 | 0.000430 | 2.77 | 830.51 | 211.23 | 0.19 |
| 3 | 44180 | April | 273.30 | 52.10 | 58.07 | 53.05 | 58.10 | 0.000203 | 1.33 | 206.12 | 53.58 | 0.12 |
| 3 | 44180 | May | 189.60 | 52.10 | 55.25 | 52.84 | 55.27 | 0.000204 | 1.14 | 163.82 | 53.23 | 0.11 |
| 3 | 44180 | June | 140.20 | 52.10 | 54.78 | 52.71 | 54.78 | 0.000202 | 1.01 | 138.14 | 53.03 | 0.11 |
| 3 | 44180 | August | 64.90 | 52.10 | 53.80 | 52.47 | 53.81 | 0.000193 | 0.74 | 88.20 | 52.82 | 0.10 |
| 3 | 44180 | Mean Annual Fbo | 750.00 | 52.10 | 58.98 | 53.97 | 59.05 | 0.000245 | 2.10 | 356.97 | 54.81 | 0.14 |
| 3 | 44180 | 100-Year | 1350.00 | 52.10 | 60.42 | 54.86 | 60.57 | 0.000420 | 3.13 | 431.78 | 55.42 | 0.19 |
| 3 | 44168.7 | Bridge | | | | | | | | | | |
| 3 | 44133.4 | April | 273.30 | 51.30 | 58.08 | 52.26 | 58.07 | 0.000111 | 1.11 | 246.79 | 53.78 | 0.09 |
| 3 | 44133.4 | May | 189.60 | 51.30 | 55.24 | 52.04 | 55.25 | 0.000097 | 0.91 | 204.45 | 53.48 | 0.08 |
| 3 | 44133.4 | June | 140.20 | 51.30 | 54.75 | 51.91 | 54.78 | 0.000085 | 0.78 | 179.07 | 53.26 | 0.07 |
| 3 | 44133.4 | August | 64.90 | 51.30 | 53.79 | 51.68 | 53.80 | 0.000054 | 0.50 | 129.34 | 52.88 | 0.06 |
| 3 | 44133.4 | Mean Annual Fbo | 750.00 | 51.30 | 58.94 | 53.17 | 59.00 | 0.000172 | 1.80 | 396.71 | 54.92 | 0.12 |
| 3 | 44133.4 | 100-Year | 1350.00 | 51.30 | 60.27 | 54.06 | 60.40 | 0.000327 | 2.90 | 485.66 | 55.44 | 0.17 |
| 3 | 44083.4 | April | 273.30 | 51.40 | 58.02 | 53.26 | 58.00 | 0.000400 | 1.58 | 172.63 | 50.14 | 0.15 |
| 3 | 44083.4 | May | 189.60 | 51.40 | 55.21 | 53.02 | 55.24 | 0.000400 | 1.40 | 133.19 | 47.01 | 0.15 |
| 3 | 44083.4 | June | 140.20 | 51.40 | 54.72 | 52.86 | 54.75 | 0.000400 | 1.27 | 110.88 | 45.87 | 0.14 |
| 3 | 44083.4 | August | 64.90 | 51.40 | 53.77 | 52.57 | 53.79 | 0.000400 | 0.95 | 87.99 | 44.03 | 0.14 |
| 3 | 44083.4 | Mean Annual Fbo | 750.00 | 51.40 | 58.91 | 54.31 | 58.98 | 0.000400 | 2.22 | 413.13 | 395.92 | 0.16 |
| 3 | 44083.4 | 100-Year | 1350.00 | 51.40 | 60.23 | 55.33 | 60.30 | 0.000400 | 2.55 | 644.23 | 386.79 | 0.17 |

**APPENDIX F
HEC-RAS OUTPUT
KENYON MILL DAM BYPASS CHANNEL**

Proposed - Kenyon Bypass Plan: Plan 02 3/27/2007



| Legend | |
|---------------------|------------------------|
| WS 100-Year | (Blue line with dots) |
| WS Mean Annual Floo | (Blue line with dots) |
| WS April | (Blue line with dots) |
| WS May | (Blue line with dots) |
| WS June | (Blue line with dots) |
| WS August | (Blue line with dots) |
| Ground | (Black line with dots) |

HEC-RAS Plan Plan 02

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W S Elev (ft) | Crit W S (ft) | E.G Elev (ft) | E.G Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|------------------|------------------|------------------|----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 84822 | April | 273.30 | 83.00 | 87.81 | 84.24 | 87.82 | 0.000093 | 0.91 | 884.17 | 582.18 | 0.08 |
| 1 | 84822 | May | 186.60 | 83.00 | 87.28 | 83.97 | 87.29 | 0.000078 | 0.79 | 494.78 | 548.88 | 0.07 |
| 1 | 84822 | June | 140.20 | 83.00 | 87.08 | 83.80 | 87.09 | 0.000063 | 0.68 | 387.95 | 484.35 | 0.06 |
| 1 | 84822 | August | 64.90 | 83.00 | 86.72 | 83.48 | 86.72 | 0.000025 | 0.40 | 242.31 | 321.42 | 0.04 |
| 1 | 84822 | Mean Annual Floo | 750.00 | 83.00 | 88.83 | 85.38 | 88.84 | 0.000121 | 1.23 | 1475.70 | 711.18 | 0.09 |
| 1 | 84822 | 100-Year | 1350.00 | 83.00 | 90.02 | 87.08 | 90.03 | 0.000111 | 1.34 | 2347.82 | 751.20 | 0.09 |
| 1 | 83372 | April | 273.30 | 81.50 | 87.48 | | 87.49 | 0.000088 | 0.80 | 340.22 | 103.10 | 0.08 |
| 1 | 83372 | May | 186.60 | 81.50 | 87.19 | | 87.19 | 0.000053 | 0.60 | 311.59 | 93.24 | 0.06 |
| 1 | 83372 | June | 140.20 | 81.50 | 87.02 | | 87.02 | 0.000035 | 0.47 | 295.50 | 81.73 | 0.05 |
| 1 | 83372 | August | 64.90 | 81.50 | 86.70 | | 86.70 | 0.000010 | 0.24 | 267.16 | 80.01 | 0.02 |
| 1 | 83372 | Mean Annual Floo | 750.00 | 81.50 | 88.56 | | 88.60 | 0.000257 | 1.59 | 614.50 | 384.77 | 0.13 |
| 1 | 83372 | 100-Year | 1350.00 | 81.50 | 89.75 | | 89.80 | 0.000274 | 1.92 | 1105.88 | 437.51 | 0.14 |
| 1 | 83322 | April | 273.30 | 82.30 | 87.46 | 83.40 | 87.48 | 0.000151 | 1.28 | 216.32 | 59.15 | 0.10 |
| 1 | 83322 | May | 186.60 | 82.30 | 87.18 | 83.15 | 87.19 | 0.000084 | 0.91 | 204.42 | 58.20 | 0.07 |
| 1 | 83322 | June | 140.20 | 82.30 | 87.01 | 83.00 | 87.02 | 0.000053 | 0.71 | 197.36 | 57.64 | 0.06 |
| 1 | 83322 | August | 64.90 | 82.30 | 86.70 | 82.72 | 86.70 | 0.000014 | 0.35 | 184.43 | 56.81 | 0.03 |
| 1 | 83322 | Mean Annual Floo | 750.00 | 82.30 | 88.42 | 84.45 | 88.55 | 0.000663 | 2.92 | 256.54 | 62.36 | 0.21 |
| 1 | 83322 | 100-Year | 1350.00 | 82.30 | 89.37 | 86.48 | 89.69 | 0.001383 | 4.68 | 298.37 | 85.53 | 0.30 |
| 1 | 83314.5 | Bridge | | | | | | | | | | |
| 1 | 83307 | April | 273.30 | 82.30 | 87.46 | 83.40 | 87.48 | 0.000152 | 1.26 | 216.21 | 59.14 | 0.10 |
| 1 | 83307 | May | 186.60 | 82.30 | 87.17 | 83.15 | 87.19 | 0.000085 | 0.91 | 204.36 | 58.20 | 0.07 |
| 1 | 83307 | June | 140.20 | 82.30 | 87.01 | 83.00 | 87.01 | 0.000053 | 0.71 | 197.33 | 57.64 | 0.06 |
| 1 | 83307 | August | 64.90 | 82.30 | 86.70 | 82.72 | 86.70 | 0.000014 | 0.35 | 184.42 | 56.81 | 0.03 |
| 1 | 83307 | Mean Annual Floo | 750.00 | 82.30 | 88.41 | 84.45 | 88.54 | 0.000667 | 2.93 | 256.02 | 62.31 | 0.21 |
| 1 | 83307 | 100-Year | 1350.00 | 82.30 | 89.34 | 85.48 | 89.66 | 0.001380 | 4.57 | 295.21 | 65.44 | 0.30 |
| 1 | 83257 | April | 273.30 | 81.50 | 87.46 | | 87.47 | 0.000090 | 0.91 | 337.56 | 101.93 | 0.08 |
| 1 | 83257 | May | 186.60 | 81.50 | 87.17 | | 87.18 | 0.000054 | 0.60 | 310.29 | 93.12 | 0.06 |
| 1 | 83257 | June | 140.20 | 81.50 | 87.01 | | 87.01 | 0.000035 | 0.48 | 294.76 | 91.66 | 0.05 |
| 1 | 83257 | August | 64.90 | 81.50 | 86.70 | | 86.70 | 0.000010 | 0.24 | 286.97 | 88.96 | 0.02 |
| 1 | 83257 | Mean Annual Floo | 750.00 | 81.50 | 88.43 | | 88.47 | 0.000292 | 1.67 | 564.71 | 373.38 | 0.14 |
| 1 | 83257 | 100-Year | 1350.00 | 81.50 | 89.44 | | 89.50 | 0.000359 | 2.12 | 972.32 | 424.93 | 0.16 |
| 1 | 81157 | April | 273.30 | 77.90 | 87.43 | | 87.43 | 0.000006 | 0.34 | 616.53 | 220.65 | 0.02 |
| 1 | 81157 | May | 186.60 | 77.90 | 87.16 | | 87.16 | 0.000004 | 0.24 | 784.28 | 187.74 | 0.02 |
| 1 | 81157 | June | 140.20 | 77.90 | 87.00 | | 87.00 | 0.000002 | 0.19 | 742.20 | 122.30 | 0.01 |
| 1 | 81157 | August | 64.90 | 77.90 | 86.70 | | 86.70 | 0.000001 | 0.09 | 706.59 | 115.42 | 0.01 |
| 1 | 81157 | Mean Annual Floo | 750.00 | 77.90 | 88.20 | | 88.30 | 0.000036 | 0.81 | 1080.41 | 325.50 | 0.05 |
| 1 | 81157 | 100-Year | 1350.00 | 77.90 | 89.18 | | 89.20 | 0.000073 | 1.25 | 1390.62 | 429.57 | 0.08 |
| 1 | 81107 | April | 273.30 | 77.90 | 87.42 | 79.34 | 87.43 | 0.000014 | 0.60 | 453.04 | 219.57 | 0.04 |
| 1 | 81107 | May | 186.60 | 77.90 | 87.15 | 79.12 | 87.16 | 0.000007 | 0.42 | 439.73 | 167.21 | 0.03 |
| 1 | 81107 | June | 140.20 | 77.90 | 86.98 | 78.98 | 87.00 | 0.000004 | 0.32 | 431.72 | 122.27 | 0.02 |
| 1 | 81107 | August | 64.90 | 77.90 | 86.70 | 78.83 | 86.70 | 0.000001 | 0.16 | 416.80 | 115.41 | 0.01 |
| 1 | 81107 | Mean Annual Floo | 750.00 | 77.90 | 88.25 | 80.27 | 88.29 | 0.000079 | 1.52 | 494.55 | 322.45 | 0.08 |
| 1 | 81107 | 100-Year | 1350.00 | 77.90 | 89.07 | 81.18 | 89.17 | 0.000195 | 2.52 | 535.63 | 420.76 | 0.14 |
| 1 | 81077 | Bridge | | | | | | | | | | |
| 1 | 81047 | April | 273.30 | 77.90 | 87.42 | 79.34 | 87.43 | 0.000014 | 0.60 | 452.97 | 219.20 | 0.04 |
| 1 | 81047 | May | 186.60 | 77.90 | 87.15 | 79.12 | 87.16 | 0.000007 | 0.42 | 439.69 | 167.08 | 0.03 |
| 1 | 81047 | June | 140.20 | 77.90 | 86.98 | 78.98 | 87.00 | 0.000004 | 0.32 | 431.70 | 122.26 | 0.02 |
| 1 | 81047 | August | 64.90 | 77.90 | 86.70 | 78.63 | 86.70 | 0.000001 | 0.16 | 416.79 | 115.41 | 0.01 |
| 1 | 81047 | Mean Annual Floo | 750.00 | 77.90 | 88.24 | 80.27 | 88.28 | 0.000079 | 1.52 | 494.07 | 321.62 | 0.09 |
| 1 | 81047 | 100-Year | 1350.00 | 77.90 | 89.04 | 81.10 | 89.14 | 0.000197 | 2.53 | 534.21 | 418.30 | 0.14 |
| 1 | 80987 | April | 273.30 | 77.90 | 87.42 | | 87.42 | 0.000008 | 0.34 | 815.32 | 219.67 | 0.02 |
| 1 | 80987 | May | 186.60 | 77.90 | 87.15 | | 87.16 | 0.000004 | 0.24 | 763.83 | 167.21 | 0.02 |
| 1 | 80987 | June | 140.20 | 77.90 | 86.98 | | 87.00 | 0.000002 | 0.19 | 742.00 | 122.27 | 0.01 |
| 1 | 80987 | August | 64.90 | 77.90 | 86.70 | | 86.70 | 0.000001 | 0.09 | 706.54 | 115.41 | 0.01 |
| 1 | 80987 | Mean Annual Floo | 750.00 | 77.90 | 88.25 | | 88.26 | 0.000037 | 0.82 | 1048.97 | 322.51 | 0.05 |
| 1 | 80987 | 100-Year | 1350.00 | 77.90 | 89.08 | | 89.10 | 0.000077 | 1.27 | 1355.89 | 421.08 | 0.08 |
| 1 | 59925 | April | 273.30 | 80.83 | 87.38 | | 87.40 | 0.000147 | 1.18 | 236.90 | 77.98 | 0.10 |
| 1 | 59925 | May | 186.60 | 80.83 | 87.13 | | 87.15 | 0.000083 | 0.86 | 210.38 | 83.05 | 0.07 |
| 1 | 59925 | June | 140.20 | 80.83 | 86.98 | | 86.98 | 0.000053 | 0.67 | 210.47 | 54.26 | 0.06 |
| 1 | 59925 | August | 64.90 | 80.83 | 86.60 | | 86.60 | 0.000014 | 0.33 | 105.21 | 51.05 | 0.03 |
| 1 | 59925 | Mean Annual Floo | 750.00 | 80.83 | 88.06 | | 88.17 | 0.000655 | 2.76 | 304.14 | 123.86 | 0.22 |
| 1 | 59925 | 100-Year | 1350.00 | 80.83 | 88.83 | | 88.91 | 0.001421 | 4.33 | 388.97 | 165.71 | 0.32 |
| 1 | 59845 | April | 273.30 | 82.11 | 87.38 | | 87.39 | 0.000137 | 0.94 | 291.69 | 96.37 | 0.09 |
| 1 | 59845 | May | 186.60 | 82.11 | 87.13 | | 87.14 | 0.000084 | 0.70 | 268.32 | 93.38 | 0.07 |
| 1 | 59845 | June | 140.20 | 82.11 | 86.98 | | 86.98 | 0.000058 | 0.55 | 254.35 | 91.51 | 0.06 |
| 1 | 59845 | August | 64.90 | 82.11 | 86.69 | | 86.69 | 0.000017 | 0.28 | 228.49 | 88.55 | 0.03 |
| 1 | 59845 | Mean Annual Floo | 750.00 | 82.11 | 88.04 | | 88.11 | 0.000549 | 2.13 | 358.14 | 104.45 | 0.19 |
| 1 | 59845 | 100-Year | 1350.00 | 82.11 | 88.80 | | 88.77 | 0.001124 | 3.34 | 423.14 | 130.17 | 0.28 |

HEC-RAS Plan: Plan 02 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.O. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|------------------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 59700 | April | 273.30 | 80.90 | 87.37 | | 87.38 | 0.000052 | 0.59 | 399.06 | 100.30 | 0.06 |
| 1 | 59700 | May | 186.60 | 80.80 | 87.13 | | 87.13 | 0.000029 | 0.50 | 375.13 | 96.24 | 0.04 |
| 1 | 59700 | June | 140.20 | 80.80 | 86.68 | | 86.68 | 0.000018 | 0.39 | 360.92 | 93.16 | 0.03 |
| 1 | 59700 | August | 64.00 | 80.80 | 86.69 | | 86.69 | 0.000004 | 0.19 | 336.07 | 81.53 | 0.02 |
| 1 | 59700 | Mean Annual Floo | 750.00 | 80.80 | 88.01 | | 88.05 | 0.000248 | 1.63 | 483.83 | 196.98 | 0.13 |
| 1 | 59700 | 100-Year | 1350.00 | 80.90 | 89.54 | | 88.64 | 0.000642 | 2.58 | 595.36 | 223.65 | 0.20 |
| Keryon Bypass | 75 | April | 26.12 | 85.90 | 87.05 | 86.98 | 87.39 | 0.040699 | 4.62 | 5.86 | 7.31 | 0.85 |
| Keryon Bypass | 75 | May | 17.91 | 85.90 | 86.89 | 86.79 | 87.13 | 0.038355 | 3.92 | 4.60 | 6.83 | 0.70 |
| Keryon Bypass | 75 | June | 14.14 | 85.00 | 86.80 | 86.69 | 86.99 | 0.036948 | 3.53 | 4.04 | 6.57 | 0.76 |
| Keryon Bypass | 75 | August | 7.48 | 85.90 | 86.60 | 86.47 | 86.71 | 0.034392 | 2.69 | 2.79 | 5.90 | 0.69 |
| Keryon Bypass | 75 | Mean Annual Floo | 53.08 | 85.00 | 87.47 | 87.47 | 88.06 | 0.045986 | 6.29 | 9.09 | 8.00 | 0.90 |
| Keryon Bypass | 75 | 100-Year | 80.30 | 85.90 | 87.84 | 87.84 | 88.83 | 0.045222 | 7.33 | 12.03 | 8.00 | 0.99 |
| Keryon Bypass | 0 | April | 26.12 | 82.20 | 83.27 | 83.27 | 83.89 | 0.059327 | 5.21 | 5.05 | 8.28 | 1.01 |
| Keryon Bypass | 0 | May | 17.91 | 82.20 | 83.08 | 83.08 | 83.41 | 0.054677 | 4.60 | 3.91 | 6.13 | 1.01 |
| Keryon Bypass | 0 | June | 14.14 | 82.20 | 82.90 | 82.99 | 83.27 | 0.058154 | 4.25 | 3.33 | 6.09 | 1.01 |
| Keryon Bypass | 0 | August | 7.48 | 82.20 | 82.77 | 82.77 | 82.97 | 0.076201 | 3.59 | 2.98 | 5.27 | 1.01 |
| Keryon Bypass | 0 | Mean Annual Floo | 53.08 | 82.20 | 85.40 | 83.77 | 85.53 | 0.033373 | 2.89 | 20.04 | 7.79 | 0.30 |
| Keryon Bypass | 0 | 100-Year | 80.30 | 82.20 | 87.70 | 84.20 | 87.70 | 0.001100 | 2.42 | 38.41 | 8.00 | 0.19 |
| Keryon Dam Reach | 59604 | April | 247.18 | 83.44 | 87.37 | | 87.38 | 0.000091 | 0.79 | 377.20 | 218.09 | 0.09 |
| Keryon Dam Reach | 59604 | May | 168.69 | 83.44 | 87.12 | | 87.13 | 0.000057 | 0.59 | 325.48 | 207.60 | 0.06 |
| Keryon Dam Reach | 59604 | June | 126.06 | 83.44 | 86.80 | | 86.98 | 0.000039 | 0.47 | 295.03 | 197.58 | 0.05 |
| Keryon Dam Reach | 59604 | August | 57.42 | 83.44 | 86.99 | | 86.69 | 0.000011 | 0.24 | 246.50 | 144.06 | 0.03 |
| Keryon Dam Reach | 59604 | Mean Annual Floo | 697.32 | 83.44 | 88.00 | | 88.05 | 0.000360 | 1.78 | 524.98 | 245.59 | 0.16 |
| Keryon Dam Reach | 59604 | 100-Year | 1269.71 | 83.44 | 88.54 | | 88.64 | 0.000707 | 2.68 | 682.91 | 288.73 | 0.22 |
| Keryon Dam Reach | 59657 | April | 247.18 | 86.10 | 88.97 | 88.97 | 87.31 | 0.028536 | 4.69 | 52.70 | 78.02 | 0.99 |
| Keryon Dam Reach | 59657 | May | 168.69 | 86.10 | 88.80 | 88.80 | 87.08 | 0.029821 | 4.18 | 40.40 | 76.91 | 1.01 |
| Keryon Dam Reach | 59657 | June | 126.06 | 86.10 | 88.71 | 88.71 | 86.93 | 0.031807 | 3.70 | 33.24 | 76.01 | 1.01 |
| Keryon Dam Reach | 59657 | August | 57.42 | 86.10 | 88.53 | 88.53 | 88.68 | 0.040207 | 2.98 | 19.26 | 78.01 | 1.04 |
| Keryon Dam Reach | 59657 | Mean Annual Floo | 697.32 | 86.10 | 87.50 | 87.56 | 87.97 | 0.017057 | 5.86 | 177.53 | 228.54 | 0.88 |
| Keryon Dam Reach | 59657 | 100-Year | 1269.71 | 86.10 | 87.97 | 87.97 | 88.53 | 0.019060 | 6.96 | 273.56 | 244.76 | 0.94 |
| Keryon Dam Reach | 59646 | April | 247.18 | 79.50 | 83.32 | 81.09 | 83.34 | 0.000251 | 1.14 | 218.79 | 78.24 | 0.12 |
| Keryon Dam Reach | 59646 | May | 168.69 | 79.50 | 82.89 | 80.90 | 82.90 | 0.000198 | 0.92 | 184.14 | 75.81 | 0.10 |
| Keryon Dam Reach | 59646 | June | 126.06 | 79.50 | 82.05 | 80.78 | 82.66 | 0.000153 | 0.76 | 168.51 | 75.57 | 0.09 |
| Keryon Dam Reach | 59646 | August | 57.42 | 79.50 | 82.26 | 80.49 | 82.26 | 0.000060 | 0.42 | 135.67 | 75.17 | 0.08 |
| Keryon Dam Reach | 59646 | Mean Annual Floo | 697.32 | 79.50 | 85.42 | 81.81 | 85.48 | 0.000334 | 1.84 | 379.78 | 78.37 | 0.15 |
| Keryon Dam Reach | 59646 | 100-Year | 1269.71 | 79.50 | 87.69 | 82.50 | 87.77 | 0.000311 | 2.22 | 659.81 | 237.71 | 0.15 |
| 1.5 | 59830 | April | 273.30 | 79.47 | 83.31 | 80.82 | 83.33 | 0.000259 | 1.20 | 227.78 | 79.05 | 0.12 |
| 1.5 | 59830 | May | 186.60 | 79.47 | 82.88 | 80.61 | 82.90 | 0.000194 | 0.96 | 194.53 | 76.21 | 0.11 |
| 1.5 | 59830 | June | 140.20 | 79.47 | 82.05 | 80.48 | 82.86 | 0.000146 | 0.79 | 177.00 | 74.69 | 0.09 |
| 1.5 | 59830 | August | 64.90 | 79.47 | 82.26 | 80.22 | 82.26 | 0.000054 | 0.44 | 148.21 | 72.07 | 0.05 |
| 1.5 | 59830 | Mean Annual Floo | 750.00 | 79.47 | 85.42 | 85.47 | 85.47 | 0.000312 | 1.89 | 398.78 | 82.24 | 0.15 |
| 1.5 | 59830 | 100-Year | 1350.00 | 79.47 | 87.96 | 87.77 | 87.77 | 0.000266 | 2.24 | 722.48 | 213.59 | 0.15 |
| 1.5 | 59597 | April | 273.30 | 81.00 | 83.26 | | 83.32 | 0.000584 | 1.50 | 182.16 | 79.88 | 0.18 |
| 1.5 | 59597 | May | 186.60 | 81.00 | 82.86 | | 82.89 | 0.000532 | 1.26 | 148.42 | 79.85 | 0.16 |
| 1.5 | 59597 | June | 140.20 | 81.00 | 82.83 | | 82.68 | 0.000461 | 1.08 | 130.26 | 79.85 | 0.15 |
| 1.5 | 59597 | August | 64.00 | 81.00 | 82.25 | | 82.26 | 0.000237 | 0.65 | 98.94 | 79.63 | 0.10 |
| 1.5 | 59597 | Mean Annual Floo | 750.00 | 81.00 | 85.38 | | 85.49 | 0.000532 | 2.14 | 350.11 | 79.92 | 0.18 |
| 1.5 | 59597 | 100-Year | 1350.00 | 81.00 | 87.66 | | 87.75 | 0.000433 | 2.48 | 626.00 | 236.29 | 0.17 |
| 1.5 | 59445 | April | 273.30 | 76.08 | 83.25 | | 83.27 | 0.000145 | 1.29 | 212.58 | 36.79 | 0.10 |
| 1.5 | 59445 | May | 186.60 | 76.08 | 82.84 | | 82.85 | 0.000084 | 0.95 | 190.93 | 37.90 | 0.07 |
| 1.5 | 59445 | June | 140.20 | 76.08 | 82.67 | | 82.63 | 0.000054 | 0.74 | 168.65 | 37.52 | 0.06 |
| 1.5 | 59445 | August | 64.00 | 76.08 | 82.25 | | 82.25 | 0.000014 | 0.37 | 174.85 | 36.81 | 0.03 |
| 1.5 | 59445 | Mean Annual Floo | 750.00 | 76.08 | 85.30 | | 85.38 | 0.000365 | 2.36 | 401.78 | 149.23 | 0.16 |
| 1.5 | 59445 | 100-Year | 1350.00 | 76.08 | 87.61 | | 87.69 | 0.000320 | 2.82 | 858.69 | 229.41 | 0.16 |
| 1.5 | 59397 | April | 273.30 | 76.50 | 83.18 | | 83.25 | 0.000706 | 2.02 | 135.29 | 35.95 | 0.18 |
| 1.5 | 59397 | May | 186.60 | 76.50 | 82.80 | | 82.84 | 0.000440 | 1.53 | 121.83 | 34.48 | 0.14 |
| 1.5 | 59397 | June | 140.20 | 76.50 | 82.59 | | 82.62 | 0.000293 | 1.22 | 114.79 | 35.89 | 0.12 |
| 1.5 | 59397 | August | 64.00 | 76.50 | 82.24 | | 82.25 | 0.000086 | 0.63 | 103.12 | 32.33 | 0.06 |
| 1.5 | 59397 | Mean Annual Floo | 750.00 | 76.50 | 85.12 | | 85.32 | 0.001512 | 3.58 | 209.59 | 40.51 | 0.28 |
| 1.5 | 59397 | 100-Year | 1350.00 | 76.50 | 87.34 | | 87.62 | 0.001554 | 4.33 | 387.18 | 308.32 | 0.29 |
| 1.5 | 59347 | April | 273.30 | 77.00 | 83.10 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.75 | 40.08 | 0.08 |
| 1.5 | 59347 | May | 186.60 | 77.00 | 82.81 | 77.88 | 82.82 | 0.000088 | 0.80 | 232.30 | 40.07 | 0.06 |
| 1.5 | 59347 | June | 140.20 | 77.00 | 82.80 | 77.72 | 82.80 | 0.000043 | 0.63 | 223.96 | 40.07 | 0.05 |
| 1.5 | 59347 | August | 64.00 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 206.70 | 40.07 | 0.02 |
| 1.5 | 59347 | Mean Annual Floo | 750.00 | 77.00 | 85.15 | 79.22 | 85.23 | 0.000378 | 2.30 | 325.80 | 119.03 | 0.14 |
| 1.5 | 59347 | 100-Year | 1350.00 | 77.00 | 87.36 | 80.28 | 87.52 | 0.000550 | 3.26 | 414.27 | 119.47 | 0.18 |
| 1.5 | 59325 | April | 273.30 | 77.00 | 83.10 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.51 | 40.08 | 0.08 |
| 1.5 | 59325 | May | 186.60 | 77.00 | 82.80 | 77.88 | 82.81 | 0.000068 | 0.80 | 232.16 | 40.07 | 0.06 |
| 1.5 | 59325 | June | 140.20 | 77.00 | 82.80 | 77.73 | 82.60 | 0.000043 | 0.63 | 223.87 | 40.07 | 0.05 |
| 1.5 | 59325 | August | 64.00 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.67 | 40.07 | 0.02 |

HEC-RAS Plan: Plan 02 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 1.5 | 59325 | Mean Annual Floo | 750.00 | 77.00 | 85.13 | 79.22 | 85.21 | 0.000381 | 2.31 | 325.11 | 119.63 | 0.14 |
| 1.5 | 59325 | 100-Year | 1350.00 | 77.00 | 87.33 | 80.28 | 87.49 | 0.000555 | 3.27 | 413.11 | 119.47 | 0.18 |
| 1.5 | 59260 | Bridge | | | | | | | | | | |
| 1.5 | 59275 | April | 273.30 | 74.40 | 83.04 | | 83.14 | 0.000585 | 2.48 | 110.33 | 35.42 | 0.25 |
| 1.5 | 59275 | May | 186.60 | 74.40 | 82.72 | | 82.78 | 0.000370 | 1.88 | 96.13 | 34.18 | 0.19 |
| 1.5 | 59275 | June | 140.20 | 74.40 | 82.54 | | 82.58 | 0.000250 | 1.51 | 93.11 | 33.50 | 0.16 |
| 1.5 | 59275 | August | 64.00 | 74.40 | 82.23 | | 82.24 | 0.000078 | 0.76 | 82.88 | 32.28 | 0.09 |
| 1.5 | 59275 | Mean Annual Floo | 750.00 | 74.40 | 84.58 | | 84.89 | 0.001299 | 4.47 | 167.86 | 39.28 | 0.38 |
| 1.5 | 59275 | 100-Year | 1350.00 | 74.40 | 86.06 | | 86.60 | 0.001729 | 5.91 | 228.58 | 42.63 | 0.45 |
| 1.5 | 58715 | April | 273.30 | 74.60 | 83.02 | | 83.03 | 0.000067 | 0.91 | 301.29 | 54.49 | 0.07 |
| 1.5 | 58715 | May | 186.60 | 74.60 | 82.71 | | 82.72 | 0.000037 | 0.66 | 294.52 | 53.71 | 0.06 |
| 1.5 | 58715 | June | 140.20 | 74.60 | 82.54 | | 82.54 | 0.000023 | 0.51 | 275.31 | 53.27 | 0.04 |
| 1.5 | 58715 | August | 64.00 | 74.60 | 82.23 | | 82.23 | 0.000008 | 0.26 | 268.88 | 52.49 | 0.02 |
| 1.5 | 58715 | Mean Annual Floo | 750.00 | 74.60 | 84.48 | | 84.54 | 0.000250 | 1.96 | 393.25 | 57.20 | 0.13 |
| 1.5 | 58715 | 100-Year | 1350.00 | 74.60 | 85.96 | | 86.03 | 0.000459 | 2.90 | 496.20 | 59.79 | 0.10 |
| 1.5 | 58865 | April | 273.30 | 77.50 | 83.02 | 78.28 | 83.03 | 0.000042 | 0.69 | 396.41 | 73.87 | 0.06 |
| 1.5 | 58865 | May | 186.60 | 77.50 | 82.71 | 78.10 | 82.71 | 0.000024 | 0.50 | 373.54 | 73.64 | 0.04 |
| 1.5 | 58865 | June | 140.20 | 77.50 | 82.54 | 78.00 | 82.54 | 0.000015 | 0.39 | 360.87 | 73.51 | 0.03 |
| 1.5 | 58865 | August | 64.00 | 77.50 | 82.23 | 77.80 | 82.23 | 0.000004 | 0.19 | 338.07 | 73.20 | 0.02 |
| 1.5 | 58865 | Mean Annual Floo | 750.00 | 77.50 | 84.49 | 79.62 | 84.52 | 0.000147 | 1.48 | 505.80 | 74.05 | 0.10 |
| 1.5 | 58865 | 100-Year | 1350.00 | 77.50 | 85.91 | 79.78 | 85.99 | 0.000263 | 2.20 | 613.09 | 76.00 | 0.14 |
| 1.5 | 58849.5 | Bridge | | | | | | | | | | |
| 1.5 | 58834 | April | 273.30 | 74.60 | 83.01 | 77.06 | 83.02 | 0.000068 | 0.91 | 300.39 | 53.88 | 0.07 |
| 1.5 | 58834 | May | 186.60 | 74.60 | 82.70 | 76.60 | 82.71 | 0.000037 | 0.66 | 293.96 | 53.26 | 0.06 |
| 1.5 | 58834 | June | 140.20 | 74.60 | 82.53 | 76.41 | 82.54 | 0.000023 | 0.51 | 274.31 | 52.89 | 0.04 |
| 1.5 | 58834 | August | 64.00 | 74.60 | 82.22 | 75.88 | 82.23 | 0.000006 | 0.25 | 258.89 | 52.19 | 0.02 |
| 1.5 | 58834 | Mean Annual Floo | 750.00 | 74.60 | 84.45 | 78.49 | 84.51 | 0.000329 | 1.92 | 390.30 | 75.48 | 0.15 |
| 1.5 | 58834 | 100-Year | 1350.00 | 74.60 | 85.96 | 79.69 | 85.97 | 0.000527 | 2.85 | 500.46 | 388.59 | 0.19 |
| 1.5 | 58584 | April | 273.30 | 74.60 | 83.01 | | 83.02 | 0.000068 | 0.91 | 300.21 | 53.67 | 0.07 |
| 1.5 | 58584 | May | 186.60 | 74.60 | 82.70 | | 82.71 | 0.000037 | 0.66 | 293.86 | 53.28 | 0.06 |
| 1.5 | 58584 | June | 140.20 | 74.60 | 82.53 | | 82.54 | 0.000023 | 0.51 | 274.34 | 52.89 | 0.04 |
| 1.5 | 58584 | August | 64.00 | 74.60 | 82.22 | | 82.23 | 0.000006 | 0.25 | 258.67 | 52.19 | 0.02 |
| 1.5 | 58584 | Mean Annual Floo | 750.00 | 74.60 | 84.44 | | 84.49 | 0.000331 | 1.93 | 389.01 | 75.12 | 0.15 |
| 1.5 | 58584 | 100-Year | 1350.00 | 74.60 | 85.94 | | 85.93 | 0.000458 | 2.46 | 764.00 | 388.32 | 0.18 |
| 1.5 | 57767 | April | 273.30 | 77.13 | 82.94 | | 82.97 | 0.000320 | 1.40 | 195.19 | 52.38 | 0.13 |
| 1.5 | 57767 | May | 186.60 | 77.13 | 82.66 | | 82.68 | 0.000190 | 1.03 | 180.91 | 51.57 | 0.10 |
| 1.5 | 57767 | June | 140.20 | 77.13 | 82.51 | | 82.52 | 0.000123 | 0.81 | 172.92 | 51.02 | 0.08 |
| 1.5 | 57767 | August | 64.00 | 77.13 | 82.22 | | 82.22 | 0.000034 | 0.41 | 158.42 | 48.67 | 0.04 |
| 1.5 | 57767 | Mean Annual Floo | 750.00 | 77.13 | 84.15 | | 84.28 | 0.000982 | 2.90 | 280.81 | 55.95 | 0.23 |
| 1.5 | 57767 | 100-Year | 1350.00 | 77.13 | 85.34 | | 85.61 | 0.001512 | 4.14 | 363.80 | 118.77 | 0.30 |
| 1.5 | 57134 | April | 273.30 | 74.30 | 82.93 | | 82.94 | 0.000013 | 0.43 | 970.78 | 244.61 | 0.03 |
| 1.5 | 57134 | May | 186.60 | 74.30 | 82.66 | | 82.66 | 0.000007 | 0.31 | 904.11 | 243.12 | 0.02 |
| 1.5 | 57134 | June | 140.20 | 74.30 | 82.51 | | 82.51 | 0.000005 | 0.25 | 898.55 | 242.28 | 0.02 |
| 1.5 | 57134 | August | 64.00 | 74.30 | 82.22 | | 82.22 | 0.000001 | 0.12 | 796.85 | 240.70 | 0.01 |
| 1.5 | 57134 | Mean Annual Floo | 750.00 | 74.30 | 84.15 | | 84.18 | 0.000046 | 0.90 | 1387.98 | 397.05 | 0.05 |
| 1.5 | 57134 | 100-Year | 1350.00 | 74.30 | 85.30 | | 85.40 | 0.000074 | 1.24 | 1502.99 | 449.29 | 0.07 |
| 1.5 | 56393 | April | 273.30 | 75.50 | 82.91 | | 82.92 | 0.000072 | 0.79 | 347.94 | 72.38 | 0.06 |
| 1.5 | 56393 | May | 186.60 | 75.50 | 82.65 | | 82.65 | 0.000039 | 0.57 | 328.45 | 70.23 | 0.06 |
| 1.5 | 56393 | June | 140.20 | 75.50 | 82.50 | | 82.50 | 0.000024 | 0.44 | 318.00 | 69.46 | 0.04 |
| 1.5 | 56393 | August | 64.00 | 75.50 | 82.22 | | 82.22 | 0.000006 | 0.22 | 298.59 | 68.00 | 0.02 |
| 1.5 | 56393 | Mean Annual Floo | 750.00 | 75.50 | 84.05 | | 84.09 | 0.000261 | 1.72 | 478.30 | 154.69 | 0.12 |
| 1.5 | 56393 | 100-Year | 1350.00 | 75.50 | 85.20 | | 85.29 | 0.000423 | 2.40 | 697.40 | 268.82 | 0.16 |
| 1.5 | 55407 | April | 273.30 | 75.81 | 82.84 | | 82.85 | 0.000069 | 0.79 | 363.47 | 108.02 | 0.06 |
| 1.5 | 55407 | May | 186.60 | 75.81 | 82.61 | | 82.61 | 0.000038 | 0.57 | 338.80 | 108.82 | 0.06 |
| 1.5 | 55407 | June | 140.20 | 75.81 | 82.47 | | 82.48 | 0.000024 | 0.44 | 324.64 | 103.70 | 0.04 |
| 1.5 | 55407 | August | 64.00 | 75.81 | 82.21 | | 82.21 | 0.000006 | 0.22 | 301.02 | 78.22 | 0.02 |
| 1.5 | 55407 | Mean Annual Floo | 750.00 | 75.81 | 83.77 | | 83.82 | 0.000283 | 1.70 | 466.62 | 113.72 | 0.13 |
| 1.5 | 55407 | 100-Year | 1350.00 | 75.81 | 84.99 | | 84.00 | 0.000537 | 2.71 | 573.91 | 119.37 | 0.18 |
| 1.5 | 55334 | April | 273.30 | 74.00 | 82.84 | | 82.84 | 0.000008 | 0.34 | 793.27 | 131.06 | 0.02 |
| 1.5 | 55334 | May | 186.60 | 74.00 | 82.61 | | 82.61 | 0.000004 | 0.24 | 793.23 | 129.47 | 0.02 |
| 1.5 | 55334 | June | 140.20 | 74.00 | 82.47 | | 82.48 | 0.000003 | 0.19 | 745.81 | 128.54 | 0.01 |
| 1.5 | 55334 | August | 64.00 | 74.00 | 82.21 | | 82.21 | 0.000001 | 0.09 | 712.00 | 126.72 | 0.01 |
| 1.5 | 55334 | Mean Annual Floo | 750.00 | 74.00 | 83.78 | | 83.79 | 0.000039 | 0.82 | 619.80 | 137.53 | 0.06 |
| 1.5 | 55334 | 100-Year | 1350.00 | 74.00 | 84.72 | | 84.75 | 0.000088 | 1.26 | 1051.89 | 143.59 | 0.08 |
| 1.5 | 55300 | April | 273.30 | 75.81 | 82.83 | | 82.84 | 0.000055 | 0.79 | 386.14 | 107.97 | 0.06 |
| 1.5 | 55300 | May | 186.60 | 75.81 | 82.60 | | 82.61 | 0.000030 | 0.57 | 341.97 | 108.59 | 0.06 |
| 1.5 | 55300 | June | 140.20 | 75.81 | 82.47 | | 82.47 | 0.000019 | 0.44 | 327.87 | 105.78 | 0.04 |
| 1.5 | 55300 | August | 64.00 | 75.81 | 82.21 | | 82.21 | 0.000005 | 0.22 | 301.89 | 87.39 | 0.02 |

HEC-RAS Plan: Plan 02 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W S Elev (ft) | Crit W S (ft) | E G Elev (ft) | E G Slope (ft/m) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|----------------|-----------|------------------|------------------|-------------------|------------------|------------------|------------------|---------------------|--------------------|----------------------|-------------------|--------------|
| 1.5 | 55300 | Mean Annual Floo | 750.00 | 75.81 | 83.73 | | 83.70 | 0.000229 | 1.80 | 485.76 | 113.49 | 0.13 |
| 1.5 | 55300 | 100-Year | 1350.00 | 75.81 | 84.80 | | 84.71 | 0.000448 | 2.78 | 587.05 | 118.83 | 0.19 |
| Horseshoe Race | 216 | April | 27.30 | 76.90 | 78.41 | | 78.43 | 0.000716 | 1.05 | 26.09 | 17.24 | 0.15 |
| Horseshoe Race | 216 | May | 18.70 | 76.90 | 77.92 | | 77.94 | 0.001178 | 1.07 | 17.55 | 17.23 | 0.19 |
| Horseshoe Race | 216 | June | 14.00 | 76.90 | 77.70 | | 77.71 | 0.001462 | 1.02 | 13.70 | 17.22 | 0.20 |
| Horseshoe Race | 216 | August | 6.50 | 76.90 | 77.46 | | 77.46 | 0.001004 | 0.68 | 9.50 | 17.22 | 0.16 |
| Horseshoe Race | 216 | Mean Annual Floo | 102.00 | 76.90 | 82.02 | | 82.04 | 0.000257 | 1.15 | 88.42 | 17.30 | 0.09 |
| Horseshoe Race | 216 | 100-Year | 135.00 | 76.90 | 83.30 | | 83.32 | 0.000223 | 1.19 | 117.67 | 42.48 | 0.08 |
| Horseshoe Race | 155.82 | April | 27.30 | 76.70 | 78.33 | | 78.37 | 0.001621 | 1.45 | 18.82 | 13.51 | 0.22 |
| Horseshoe Race | 155.82 | May | 18.70 | 76.70 | 77.77 | | 77.81 | 0.003882 | 1.07 | 11.21 | 13.50 | 0.32 |
| Horseshoe Race | 155.82 | June | 14.00 | 76.70 | 77.48 | | 77.52 | 0.009922 | 2.00 | 7.00 | 13.50 | 0.48 |
| Horseshoe Race | 155.82 | August | 6.50 | 76.70 | 77.30 | | 77.33 | 0.006719 | 1.32 | 4.92 | 13.50 | 0.39 |
| Horseshoe Race | 155.82 | Mean Annual Floo | 102.00 | 76.70 | 81.99 | | 82.02 | 0.000502 | 1.49 | 68.30 | 13.58 | 0.12 |
| Horseshoe Race | 155.82 | 100-Year | 135.00 | 76.70 | 83.26 | | 83.28 | 0.000475 | 1.58 | 85.55 | 13.60 | 0.11 |
| Horseshoe Race | 107.54 | April | 27.30 | 76.06 | 78.30 | | 78.32 | 0.000592 | 1.04 | 26.24 | 14.24 | 0.14 |
| Horseshoe Race | 107.54 | May | 18.70 | 76.06 | 77.72 | | 77.73 | 0.000903 | 1.04 | 17.92 | 14.06 | 0.16 |
| Horseshoe Race | 107.54 | June | 14.00 | 76.06 | 77.36 | | 77.37 | 0.001438 | 1.00 | 12.87 | 13.95 | 0.20 |
| Horseshoe Race | 107.54 | August | 6.50 | 76.06 | 76.85 | | 76.72 | 0.032151 | 2.14 | 3.03 | 13.21 | 0.70 |
| Horseshoe Race | 107.54 | Mean Annual Floo | 102.00 | 76.06 | 81.98 | | 82.00 | 0.000312 | 1.27 | 80.82 | 15.37 | 0.10 |
| Horseshoe Race | 107.54 | 100-Year | 135.00 | 76.06 | 83.25 | | 83.26 | 0.000300 | 1.34 | 100.38 | 15.68 | 0.09 |
| Horseshoe Race | 76.0 | April | 27.30 | 75.54 | 78.31 | | 78.32 | 0.000084 | 0.48 | 67.15 | 28.18 | 0.08 |
| Horseshoe Race | 76.0 | May | 18.70 | 75.54 | 77.72 | | 77.73 | 0.000106 | 0.45 | 41.74 | 28.18 | 0.08 |
| Horseshoe Race | 76.0 | June | 14.00 | 75.54 | 77.36 | | 77.36 | 0.000136 | 0.43 | 32.28 | 26.15 | 0.07 |
| Horseshoe Race | 76.0 | August | 6.50 | 75.54 | 76.88 | | 76.89 | 0.000254 | 0.42 | 15.64 | 22.11 | 0.09 |
| Horseshoe Race | 76.0 | Mean Annual Floo | 102.00 | 75.54 | 81.99 | | 82.00 | 0.000058 | 0.60 | 154.08 | 27.60 | 0.05 |
| Horseshoe Race | 76.0 | 100-Year | 135.00 | 75.54 | 83.27 | | 83.27 | 0.000053 | 0.71 | 100.67 | 29.00 | 0.05 |
| Horseshoe Race | 82.61 | April | 27.30 | 75.59 | 77.80 | 77.18 | 78.19 | 0.031906 | 5.05 | 5.41 | 2.49 | 0.60 |
| Horseshoe Race | 82.61 | May | 18.70 | 75.59 | 77.33 | 78.82 | 77.63 | 0.027491 | 4.40 | 4.25 | 2.47 | 0.59 |
| Horseshoe Race | 82.61 | June | 14.00 | 75.59 | 77.04 | 76.60 | 77.29 | 0.024743 | 3.66 | 3.54 | 2.46 | 0.58 |
| Horseshoe Race | 82.61 | August | 6.50 | 75.59 | 76.50 | 76.20 | 76.63 | 0.019132 | 2.95 | 2.20 | 2.45 | 0.55 |
| Horseshoe Race | 82.61 | Mean Annual Floo | 102.00 | 75.59 | 80.71 | 78.36 | 81.70 | 0.057542 | 7.98 | 12.79 | 2.58 | 0.63 |
| Horseshoe Race | 82.61 | 100-Year | 135.00 | 75.59 | 81.72 | 80.13 | 82.92 | 0.066036 | 8.76 | 16.40 | 2.60 | 0.63 |
| Horseshoe Race | 55.33 | April | 27.30 | 75.50 | 77.07 | 77.07 | 77.88 | 0.076061 | 7.11 | 3.84 | 2.47 | 1.00 |
| Horseshoe Race | 55.33 | May | 18.70 | 75.50 | 76.72 | 76.72 | 77.33 | 0.069546 | 6.28 | 2.98 | 2.46 | 1.01 |
| Horseshoe Race | 55.33 | June | 14.00 | 75.50 | 76.51 | 76.51 | 77.01 | 0.085339 | 5.69 | 2.46 | 2.45 | 1.00 |
| Horseshoe Race | 55.33 | August | 6.50 | 75.50 | 76.11 | 76.11 | 76.41 | 0.059700 | 4.42 | 1.47 | 2.44 | 1.00 |
| Horseshoe Race | 55.33 | Mean Annual Floo | 102.00 | 75.50 | 79.25 | 79.28 | 81.12 | 0.119778 | 10.94 | 9.32 | 2.53 | 1.01 |
| Horseshoe Race | 55.33 | 100-Year | 135.00 | 75.50 | 80.03 | 80.03 | 82.26 | 0.134748 | 11.97 | 11.27 | 2.56 | 1.00 |
| Horseshoe Race | 48.89 | April | 27.30 | 68.44 | 73.55 | 70.29 | 73.56 | 0.000218 | 1.29 | 44.22 | 16.90 | 0.10 |
| Horseshoe Race | 48.89 | May | 18.70 | 68.44 | 73.17 | 69.88 | 73.17 | 0.000147 | 1.01 | 37.97 | 15.73 | 0.08 |
| Horseshoe Race | 48.89 | June | 14.00 | 68.44 | 72.91 | 69.70 | 72.92 | 0.000107 | 0.93 | 34.07 | 14.91 | 0.07 |
| Horseshoe Race | 48.89 | August | 6.50 | 68.44 | 72.39 | 69.39 | 72.38 | 0.000042 | 0.48 | 20.54 | 13.16 | 0.04 |
| Horseshoe Race | 48.89 | Mean Annual Floo | 102.00 | 68.44 | 75.42 | 71.81 | 75.47 | 0.000654 | 2.76 | 81.41 | 22.10 | 0.19 |
| Horseshoe Race | 48.89 | 100-Year | 135.00 | 68.44 | 75.95 | 72.24 | 76.02 | 0.000768 | 3.25 | 93.34 | 22.78 | 0.21 |
| Horseshoe Race | 45.18 | April | 27.30 | 66.81 | 73.55 | | 73.56 | 0.000058 | 0.80 | 76.28 | 21.81 | 0.06 |
| Horseshoe Race | 45.18 | May | 18.70 | 66.81 | 73.17 | | 73.17 | 0.000035 | 0.81 | 68.02 | 21.04 | 0.04 |
| Horseshoe Race | 45.18 | June | 14.00 | 66.81 | 72.91 | | 72.92 | 0.000024 | 0.49 | 62.74 | 20.21 | 0.04 |
| Horseshoe Race | 45.18 | August | 6.50 | 66.81 | 72.38 | | 72.38 | 0.000008 | 0.27 | 52.34 | 18.46 | 0.02 |
| Horseshoe Race | 45.18 | Mean Annual Floo | 102.00 | 66.81 | 75.44 | | 75.46 | 0.000236 | 1.94 | 119.55 | 24.00 | 0.12 |
| Horseshoe Race | 45.18 | 100-Year | 135.00 | 66.81 | 75.97 | | 76.01 | 0.000313 | 2.33 | 132.41 | 24.00 | 0.14 |
| Horseshoe Race | 35.07 | April | 27.30 | 68.48 | 73.54 | | 73.56 | 0.000225 | 1.31 | 43.47 | 16.83 | 0.11 |
| Horseshoe Race | 35.07 | May | 18.70 | 68.48 | 73.16 | | 73.17 | 0.000154 | 1.03 | 37.30 | 15.58 | 0.09 |
| Horseshoe Race | 35.07 | June | 14.00 | 68.48 | 72.91 | | 72.92 | 0.000112 | 0.84 | 33.44 | 14.77 | 0.07 |
| Horseshoe Race | 35.07 | August | 6.50 | 68.48 | 72.37 | | 72.38 | 0.000045 | 0.48 | 26.01 | 13.03 | 0.04 |
| Horseshoe Race | 35.07 | Mean Annual Floo | 102.00 | 68.48 | 75.40 | | 75.46 | 0.000681 | 2.84 | 80.18 | 22.03 | 0.19 |
| Horseshoe Race | 35.07 | 100-Year | 135.00 | 68.48 | 75.93 | | 76.00 | 0.000830 | 3.29 | 91.97 | 22.66 | 0.22 |
| Horseshoe Race | 31.39 | April | 27.30 | 70.66 | 73.42 | | 73.56 | 0.000954 | 3.56 | 13.32 | 9.34 | 0.40 |
| Horseshoe Race | 31.39 | May | 18.70 | 70.66 | 73.07 | | 73.17 | 0.003600 | 3.03 | 10.22 | 8.20 | 0.36 |
| Horseshoe Race | 31.39 | June | 14.00 | 70.66 | 72.83 | | 72.91 | 0.003162 | 2.66 | 8.38 | 7.43 | 0.34 |
| Horseshoe Race | 31.39 | August | 6.50 | 70.66 | 72.33 | | 72.38 | 0.002274 | 1.80 | 5.08 | 5.81 | 0.27 |
| Horseshoe Race | 31.39 | Mean Annual Floo | 102.00 | 70.66 | 75.14 | | 75.45 | 0.006856 | 6.03 | 34.18 | 14.93 | 0.52 |
| Horseshoe Race | 31.39 | 100-Year | 135.00 | 70.66 | 76.83 | | 76.00 | 0.006035 | 6.70 | 41.88 | 16.52 | 0.54 |
| Horseshoe Race | 23.53 | April | 27.30 | 70.99 | 73.22 | | 73.51 | 0.010652 | 4.99 | 8.81 | 7.82 | 0.82 |
| Horseshoe Race | 23.53 | May | 18.70 | 70.99 | 72.89 | | 73.13 | 0.010376 | 4.39 | 6.50 | 6.56 | 0.60 |
| Horseshoe Race | 23.53 | June | 14.00 | 70.99 | 72.68 | | 72.87 | 0.010137 | 3.93 | 5.18 | 5.86 | 0.58 |
| Horseshoe Race | 23.53 | August | 6.50 | 70.99 | 72.22 | | 72.34 | 0.009372 | 2.94 | 2.84 | 4.38 | 0.52 |
| Horseshoe Race | 23.53 | Mean Annual Floo | 102.00 | 70.99 | 74.82 | | 75.39 | 0.011818 | 7.81 | 25.24 | 12.84 | 0.73 |
| Horseshoe Race | 23.53 | 100-Year | 135.00 | 70.99 | 76.20 | | 75.93 | 0.012062 | 8.55 | 31.53 | 14.34 | 0.75 |
| Horseshoe Race | 12.73 | April | 27.30 | 70.94 | 72.79 | 72.79 | 73.34 | 0.025434 | 6.67 | 8.13 | 6.37 | 0.93 |

HEC-RAS Plan: Plan 02 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Ch1 (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch1 |
|----------------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|-------------------|----------------------|-------------------|--------------|
| Horseshoe Race | 12.73 | May | 18.70 | 70.64 | 72.48 | 72.48 | 72.96 | 0.027153 | 6.00 | 4.36 | 5.40 | 0.93 |
| Horseshoe Race | 12.73 | June | 14.00 | 70.64 | 72.29 | 72.29 | 72.70 | 0.028748 | 5.53 | 3.98 | 4.75 | 0.93 |
| Horseshoe Race | 12.73 | August | 8.50 | 70.64 | 71.88 | 71.88 | 72.17 | 0.034632 | 4.46 | 1.69 | 3.43 | 0.66 |
| Horseshoe Race | 12.73 | Mean Annual Floo | 102.00 | 70.64 | 74.31 | 74.31 | 75.22 | 0.021856 | 9.61 | 19.65 | 11.33 | 0.96 |
| Horseshoe Race | 12.73 | 100-Year | 135.00 | 70.64 | 74.74 | 74.74 | 75.76 | 0.021683 | 10.50 | 24.77 | 12.72 | 0.88 |
| Horseshoe Race | 6.21 | April | 27.30 | 70.64 | 72.25 | 72.49 | 73.13 | 0.047373 | 8.20 | 4.74 | 5.62 | 1.24 |
| Horseshoe Race | 6.21 | May | 18.70 | 70.64 | 71.95 | 72.18 | 72.73 | 0.050519 | 7.35 | 3.38 | 4.77 | 1.23 |
| Horseshoe Race | 6.21 | June | 14.00 | 70.64 | 71.83 | 71.99 | 72.46 | 0.051203 | 6.68 | 2.86 | 4.25 | 1.21 |
| Horseshoe Race | 6.21 | August | 6.50 | 70.64 | 71.50 | 71.59 | 71.86 | 0.054400 | 5.13 | 1.42 | 3.16 | 1.18 |
| Horseshoe Race | 6.21 | Mean Annual Floo | 102.00 | 70.64 | 73.83 | 74.01 | 75.06 | 0.038274 | 11.73 | 15.51 | 10.09 | 1.25 |
| Horseshoe Race | 6.21 | 100-Year | 135.00 | 70.64 | 74.04 | 74.44 | 75.59 | 0.036488 | 12.58 | 19.98 | 11.42 | 1.25 |
| Horseshoe Race | 0.55 | April | 27.30 | 70.44 | 72.12 | 72.29 | 72.88 | 0.039040 | 7.69 | 5.13 | 5.84 | 1.13 |
| Horseshoe Race | 0.55 | May | 18.70 | 70.44 | 71.87 | 71.98 | 72.48 | 0.038888 | 6.74 | 3.77 | 5.03 | 1.09 |
| Horseshoe Race | 0.55 | June | 14.00 | 70.44 | 71.73 | 71.79 | 72.21 | 0.035607 | 6.02 | 3.00 | 4.58 | 1.02 |
| Horseshoe Race | 0.55 | August | 6.50 | 70.44 | 71.35 | 71.38 | 71.67 | 0.040794 | 4.69 | 1.50 | 3.33 | 1.02 |
| Horseshoe Race | 0.55 | Mean Annual Floo | 102.00 | 70.44 | 73.46 | 73.80 | 74.83 | 0.036172 | 11.50 | 15.88 | 10.20 | 1.22 |
| Horseshoe Race | 0.55 | 100-Year | 135.00 | 70.44 | 73.85 | 74.24 | 75.38 | 0.035881 | 12.51 | 20.11 | 11.47 | 1.24 |
| 2 | 55295 | April | 246.00 | 73.20 | 82.83 | 73.70 | 82.83 | 0.000002 | 0.23 | 1273.11 | 134.40 | 0.01 |
| 2 | 55295 | May | 167.90 | 73.20 | 82.81 | 73.58 | 82.81 | 0.000001 | 0.16 | 1242.54 | 134.29 | 0.01 |
| 2 | 55295 | June | 126.20 | 73.20 | 82.47 | 73.52 | 82.47 | 0.000001 | 0.12 | 1224.59 | 134.23 | 0.01 |
| 2 | 55295 | August | 58.40 | 73.20 | 82.21 | 73.39 | 82.21 | 0.000000 | 0.06 | 1186.25 | 134.11 | 0.00 |
| 2 | 55295 | Mean Annual Floo | 648.00 | 73.20 | 83.75 | 74.15 | 83.76 | 0.000012 | 0.55 | 1396.61 | 134.83 | 0.03 |
| 2 | 55295 | 100-Year | 1215.00 | 73.20 | 84.85 | 74.64 | 84.86 | 0.000036 | 0.99 | 1632.31 | 167.22 | 0.05 |
| 2 | 55290 | In Struct | | | | | | | | | | |
| 2 | 55264 | April | 246.00 | 73.20 | 73.98 | 73.70 | 74.08 | 0.005970 | 2.75 | 101.16 | 130.26 | 0.55 |
| 2 | 55264 | May | 167.90 | 73.20 | 73.83 | 73.58 | 73.90 | 0.006081 | 2.31 | 81.93 | 130.10 | 0.51 |
| 2 | 55264 | June | 126.20 | 73.20 | 73.74 | 73.52 | 73.80 | 0.006553 | 2.03 | 70.25 | 130.15 | 0.49 |
| 2 | 55264 | August | 58.40 | 73.20 | 73.56 | 73.39 | 73.50 | 0.007201 | 1.41 | 46.55 | 130.07 | 0.42 |
| 2 | 55264 | Mean Annual Floo | 648.00 | 73.20 | 74.55 | 74.14 | 74.79 | 0.010728 | 4.18 | 175.86 | 130.53 | 0.63 |
| 2 | 55264 | 100-Year | 1215.00 | 73.20 | 75.16 | 74.64 | 75.55 | 0.011029 | 5.42 | 255.04 | 130.61 | 0.68 |
| 2 | 55279 | April | 246.00 | 73.20 | 73.70 | 73.70 | 73.95 | 0.043473 | 4.31 | 64.36 | 130.13 | 1.08 |
| 2 | 55279 | May | 167.90 | 73.20 | 73.58 | 73.58 | 73.78 | 0.047330 | 3.78 | 46.86 | 130.08 | 1.08 |
| 2 | 55279 | June | 126.20 | 73.20 | 73.52 | 73.52 | 73.68 | 0.050255 | 3.44 | 41.25 | 130.05 | 1.08 |
| 2 | 55279 | August | 58.40 | 73.20 | 73.30 | 73.39 | 73.49 | 0.056931 | 2.67 | 24.64 | 129.99 | 1.08 |
| 2 | 55279 | Mean Annual Floo | 648.00 | 73.20 | 74.14 | 74.14 | 74.62 | 0.036205 | 5.06 | 122.88 | 130.34 | 1.08 |
| 2 | 55279 | 100-Year | 1215.00 | 73.20 | 74.84 | 74.64 | 75.37 | 0.030712 | 7.37 | 187.11 | 130.57 | 1.08 |
| 2 | 55274 | April | 246.00 | 69.20 | 71.25 | 69.96 | 71.30 | 0.001305 | 1.05 | 133.08 | 64.93 | 0.23 |
| 2 | 55274 | May | 167.90 | 69.20 | 70.81 | 69.79 | 70.85 | 0.001330 | 1.01 | 104.55 | 64.92 | 0.22 |
| 2 | 55274 | June | 126.20 | 69.20 | 70.53 | 69.69 | 70.57 | 0.001367 | 1.46 | 80.84 | 64.92 | 0.22 |
| 2 | 55274 | August | 58.40 | 69.20 | 69.27 | 69.49 | 71.70 | 5.005825 | 12.73 | 4.59 | 64.90 | 8.44 |
| 2 | 55274 | Mean Annual Floo | 648.00 | 69.20 | 72.96 | 70.65 | 73.07 | 0.001280 | 2.88 | 244.05 | 64.95 | 0.24 |
| 2 | 55274 | 100-Year | 1215.00 | 69.20 | 74.59 | 71.41 | 74.70 | 0.001434 | 3.47 | 350.02 | 64.97 | 0.26 |
| 2 | 55255.29 | April | 246.00 | 66.97 | 71.00 | 69.72 | 71.19 | 0.003865 | 2.61 | 94.33 | 45.94 | 0.32 |
| 2 | 55255.29 | May | 167.90 | 66.97 | 70.86 | 69.40 | 70.74 | 0.003199 | 2.21 | 75.84 | 42.72 | 0.29 |
| 2 | 55255.29 | June | 126.20 | 66.97 | 70.41 | 69.22 | 70.46 | 0.002770 | 1.94 | 65.09 | 40.17 | 0.27 |
| 2 | 55255.29 | August | 58.40 | 66.97 | 69.90 | 68.56 | 69.92 | 0.001584 | 1.27 | 45.96 | 35.18 | 0.20 |
| 2 | 55255.29 | Mean Annual Floo | 648.00 | 66.97 | 72.73 | 70.84 | 72.94 | 0.003731 | 3.67 | 178.21 | 55.28 | 0.35 |
| 2 | 55255.29 | 100-Year | 1215.00 | 66.97 | 74.29 | 71.85 | 74.62 | 0.003865 | 4.69 | 264.70 | 55.80 | 0.37 |
| 2 | 55238 | Bridge | | | | | | | | | | |
| 2 | 55217.48 | April | 246.00 | 68.47 | 70.59 | | 70.87 | 0.014388 | 4.24 | 58.07 | 38.87 | 0.81 |
| 2 | 55217.48 | May | 167.90 | 68.47 | 70.22 | | 70.45 | 0.016063 | 3.91 | 44.10 | 37.36 | 0.82 |
| 2 | 55217.48 | June | 126.20 | 68.47 | 70.01 | | 70.20 | 0.016838 | 3.48 | 36.29 | 36.14 | 0.81 |
| 2 | 55217.48 | August | 58.40 | 68.47 | 69.68 | | 69.77 | 0.011803 | 2.36 | 24.80 | 33.88 | 0.40 |
| 2 | 55217.48 | Mean Annual Floo | 648.00 | 68.47 | 72.24 | | 72.65 | 0.008854 | 5.16 | 127.87 | 46.85 | 0.53 |
| 2 | 55217.48 | 100-Year | 1215.00 | 68.47 | 73.72 | | 74.32 | 0.007864 | 6.33 | 203.47 | 54.00 | 0.53 |
| 2 | 55168 | April | 246.00 | 67.10 | 70.68 | | 70.70 | 0.000251 | 1.10 | 279.75 | 110.98 | 0.12 |
| 2 | 55168 | May | 167.90 | 67.10 | 70.30 | | 70.31 | 0.000202 | 0.88 | 237.23 | 110.52 | 0.11 |
| 2 | 55168 | June | 126.20 | 67.10 | 70.07 | | 70.08 | 0.000164 | 0.74 | 212.51 | 110.43 | 0.09 |
| 2 | 55168 | August | 58.40 | 67.10 | 69.71 | | 69.72 | 0.000070 | 0.42 | 172.58 | 110.29 | 0.06 |
| 2 | 55168 | Mean Annual Floo | 648.00 | 67.10 | 72.36 | | 72.42 | 0.000321 | 1.74 | 466.16 | 111.35 | 0.15 |
| 2 | 55168 | 100-Year | 1215.00 | 67.10 | 73.03 | | 74.00 | 0.000462 | 2.39 | 641.31 | 111.97 | 0.17 |
| 3 | 55152.41 | April | 273.30 | 67.10 | 70.89 | | 68.31 | 0.000368 | 1.18 | 279.37 | 110.97 | 0.13 |
| 3 | 55152.41 | May | 186.60 | 67.10 | 70.30 | | 68.08 | 0.000295 | 0.95 | 236.98 | 110.52 | 0.11 |
| 3 | 55152.41 | June | 140.20 | 67.10 | 70.07 | | 67.93 | 0.000239 | 0.79 | 212.33 | 110.43 | 0.10 |
| 3 | 55152.41 | August | 64.00 | 67.10 | 69.71 | | 67.61 | 0.000162 | 0.45 | 172.50 | 110.29 | 0.06 |
| 3 | 55152.41 | Mean Annual Floo | 750.00 | 67.10 | 72.37 | | 69.11 | 0.000512 | 1.95 | 466.69 | 111.35 | 0.17 |
| 3 | 55152.41 | 100-Year | 1350.00 | 67.10 | 73.02 | | 69.90 | 0.000591 | 2.57 | 638.57 | 111.96 | 0.19 |
| 3 | 55124 | April | 273.30 | 68.00 | 70.80 | | 70.67 | 0.001273 | 2.01 | 137.09 | 85.26 | 0.24 |

HEC-RAS Plan: Plan 02 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/m) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 55124 | May | 188.00 | 68.00 | 70.24 | | 70.28 | 0.001040 | 1.84 | 114.29 | 61.36 | 0.21 |
| 3 | 55124 | June | 140.20 | 68.00 | 70.03 | | 70.00 | 0.000852 | 1.38 | 101.70 | 59.08 | 0.18 |
| 3 | 55124 | August | 64.90 | 68.00 | 69.70 | | 69.71 | 0.000345 | 0.79 | 62.41 | 56.04 | 0.11 |
| 3 | 55124 | Mean Annual Floo | 750.00 | 68.00 | 72.21 | | 72.36 | 0.001561 | 3.12 | 256.24 | 62.70 | 0.28 |
| 3 | 55124 | 100-Year | 1350.00 | 68.00 | 73.71 | | 73.93 | 0.001619 | 3.84 | 302.52 | 68.69 | 0.30 |
| 3 | 55068 | April | 273.30 | 66.02 | 70.59 | | 70.61 | 0.000305 | 1.24 | 220.98 | 69.63 | 0.12 |
| 3 | 55068 | May | 198.00 | 66.02 | 70.23 | | 70.25 | 0.000207 | 0.95 | 198.32 | 68.25 | 0.10 |
| 3 | 55068 | June | 140.20 | 66.02 | 70.03 | | 70.03 | 0.000145 | 0.77 | 162.11 | 66.70 | 0.08 |
| 3 | 55068 | August | 64.90 | 66.02 | 69.70 | | 69.70 | 0.000045 | 0.40 | 160.84 | 64.20 | 0.04 |
| 3 | 55068 | Mean Annual Floo | 750.00 | 66.02 | 72.19 | | 72.27 | 0.000590 | 2.25 | 336.58 | 74.45 | 0.18 |
| 3 | 55068 | 100-Year | 1350.00 | 66.02 | 73.68 | | 73.82 | 0.000768 | 3.08 | 460.50 | 78.73 | 0.22 |
| 3 | 54724 | April | 273.30 | 65.80 | 70.41 | | 70.46 | 0.000771 | 1.74 | 157.15 | 57.73 | 0.19 |
| 3 | 54724 | May | 188.00 | 65.80 | 70.13 | | 70.15 | 0.000398 | 1.31 | 142.89 | 49.10 | 0.14 |
| 3 | 54724 | June | 140.20 | 65.80 | 69.99 | | 69.97 | 0.000273 | 1.04 | 134.40 | 48.96 | 0.11 |
| 3 | 54724 | August | 64.90 | 65.80 | 69.67 | | 69.68 | 0.000082 | 0.54 | 126.73 | 48.71 | 0.06 |
| 3 | 54724 | Mean Annual Floo | 750.00 | 65.80 | 71.82 | | 71.96 | 0.001702 | 3.02 | 246.49 | 71.58 | 0.29 |
| 3 | 54724 | 100-Year | 1350.00 | 65.80 | 73.23 | | 73.43 | 0.002193 | 3.59 | 385.18 | 135.73 | 0.33 |
| 3 | 54674 | April | 273.30 | 65.90 | 70.43 | 66.52 | 70.43 | 0.000046 | 0.62 | 443.77 | 96.14 | 0.05 |
| 3 | 54674 | May | 188.00 | 65.90 | 70.14 | 66.38 | 70.14 | 0.000027 | 0.45 | 416.09 | 98.13 | 0.04 |
| 3 | 54674 | June | 140.20 | 65.90 | 69.99 | 66.30 | 69.96 | 0.000018 | 0.35 | 397.84 | 98.13 | 0.03 |
| 3 | 54674 | August | 64.90 | 65.90 | 69.68 | 66.14 | 69.68 | 0.000005 | 0.18 | 370.04 | 98.12 | 0.02 |
| 3 | 54674 | Mean Annual Floo | 750.00 | 65.90 | 71.05 | 67.12 | 71.89 | 0.000140 | 1.28 | 584.11 | 98.10 | 0.09 |
| 3 | 54674 | 100-Year | 1350.00 | 65.90 | 73.27 | 67.70 | 73.33 | 0.000273 | 1.87 | 722.67 | 144.22 | 0.12 |
| 3 | 54672 | Bridge | | | | | | | | | | |
| 3 | 54641.5 | April | 273.30 | 63.10 | 70.43 | 63.72 | 70.43 | 0.000009 | 0.38 | 718.17 | 96.16 | 0.02 |
| 3 | 54641.5 | May | 188.00 | 63.10 | 70.14 | 63.58 | 70.14 | 0.000005 | 0.27 | 689.49 | 98.15 | 0.02 |
| 3 | 54641.5 | June | 140.20 | 63.10 | 69.96 | 63.50 | 69.98 | 0.000003 | 0.21 | 672.24 | 98.15 | 0.01 |
| 3 | 54641.5 | August | 64.90 | 63.10 | 69.68 | 63.34 | 69.68 | 0.000001 | 0.10 | 644.44 | 98.14 | 0.01 |
| 3 | 54641.5 | Mean Annual Floo | 750.00 | 63.10 | 71.86 | 64.31 | 71.87 | 0.000039 | 0.87 | 858.51 | 98.19 | 0.05 |
| 3 | 54641.5 | 100-Year | 1350.00 | 63.10 | 73.27 | 64.90 | 73.30 | 0.000078 | 1.35 | 997.07 | 144.22 | 0.07 |
| 3 | 54591.5 | April | 273.30 | 65.80 | 70.37 | | 70.42 | 0.000807 | 1.77 | 154.70 | 49.54 | 0.18 |
| 3 | 54591.5 | May | 188.00 | 65.80 | 70.10 | | 70.13 | 0.000411 | 1.30 | 141.80 | 49.15 | 0.14 |
| 3 | 54591.5 | June | 140.20 | 65.80 | 69.94 | | 69.95 | 0.000279 | 1.05 | 133.58 | 48.95 | 0.11 |
| 3 | 54591.5 | August | 64.90 | 65.80 | 69.67 | | 69.67 | 0.000083 | 0.54 | 120.52 | 48.71 | 0.06 |
| 3 | 54591.5 | Mean Annual Floo | 750.00 | 65.80 | 71.87 | | 71.82 | 0.001931 | 3.16 | 237.82 | 70.49 | 0.30 |
| 3 | 54591.5 | 100-Year | 1350.00 | 65.80 | 73.00 | | 73.23 | 0.002685 | 3.83 | 356.57 | 120.70 | 0.36 |
| 3 | 53180 | April | 273.30 | 62.25 | 70.21 | | 70.22 | 0.000050 | 0.68 | 414.88 | 94.57 | 0.05 |
| 3 | 53180 | May | 188.00 | 62.25 | 70.02 | | 70.02 | 0.000027 | 0.47 | 386.14 | 88.02 | 0.04 |
| 3 | 53180 | June | 140.20 | 62.25 | 69.89 | | 69.89 | 0.000016 | 0.36 | 384.76 | 84.15 | 0.03 |
| 3 | 53180 | August | 64.90 | 62.25 | 69.68 | | 69.68 | 0.000004 | 0.18 | 365.80 | 82.10 | 0.01 |
| 3 | 53180 | Mean Annual Floo | 750.00 | 62.25 | 71.03 | | 71.07 | 0.000221 | 1.55 | 622.44 | 121.81 | 0.11 |
| 3 | 53180 | 100-Year | 1350.00 | 62.25 | 71.76 | | 71.84 | 0.000471 | 2.45 | 596.65 | 145.80 | 0.17 |
| 3 | 53151 | April | 273.30 | 61.82 | 70.21 | | 70.22 | 0.000086 | 0.80 | 347.40 | 88.82 | 0.05 |
| 3 | 53151 | May | 188.00 | 61.82 | 70.02 | | 70.02 | 0.000036 | 0.57 | 336.78 | 82.33 | 0.04 |
| 3 | 53151 | June | 140.20 | 61.82 | 69.89 | | 69.89 | 0.000022 | 0.44 | 320.25 | 77.94 | 0.04 |
| 3 | 53151 | August | 64.90 | 61.82 | 69.68 | | 69.68 | 0.000006 | 0.21 | 303.41 | 70.35 | 0.02 |
| 3 | 53151 | Mean Annual Floo | 750.00 | 61.82 | 71.01 | | 71.06 | 0.000314 | 1.80 | 429.77 | 115.44 | 0.14 |
| 3 | 53151 | 100-Year | 1350.00 | 61.82 | 71.69 | | 71.83 | 0.000683 | 3.00 | 516.70 | 138.34 | 0.20 |
| 3 | 53122 | April | 273.30 | 60.36 | 70.21 | | 70.22 | 0.000046 | 0.74 | 375.25 | 78.54 | 0.05 |
| 3 | 53122 | May | 188.00 | 60.36 | 70.02 | | 70.02 | 0.000025 | 0.52 | 360.63 | 71.97 | 0.04 |
| 3 | 53122 | June | 140.20 | 60.36 | 69.89 | | 69.89 | 0.000015 | 0.40 | 351.47 | 67.52 | 0.03 |
| 3 | 53122 | August | 64.90 | 60.36 | 69.68 | | 69.68 | 0.000004 | 0.19 | 336.88 | 62.06 | 0.01 |
| 3 | 53122 | Mean Annual Floo | 750.00 | 60.36 | 71.00 | | 71.05 | 0.000236 | 1.78 | 448.43 | 105.47 | 0.12 |
| 3 | 53122 | 100-Year | 1350.00 | 60.36 | 71.68 | | 71.81 | 0.000542 | 2.87 | 527.05 | 128.48 | 0.18 |
| 3 | 53086 | April | 273.30 | 62.25 | 70.20 | | 70.22 | 0.000087 | 0.85 | 368.81 | 81.15 | 0.07 |
| 3 | 53086 | May | 188.00 | 62.25 | 70.01 | | 70.02 | 0.000052 | 0.68 | 299.04 | 84.08 | 0.05 |
| 3 | 53086 | June | 140.20 | 62.25 | 69.88 | | 69.89 | 0.000032 | 0.52 | 279.28 | 80.78 | 0.04 |
| 3 | 53086 | August | 64.90 | 62.25 | 69.68 | | 69.68 | 0.000008 | 0.26 | 261.91 | 73.48 | 0.02 |
| 3 | 53086 | Mean Annual Floo | 750.00 | 62.25 | 70.97 | | 71.04 | 0.000443 | 2.23 | 386.16 | 115.98 | 0.16 |
| 3 | 53086 | 100-Year | 1350.00 | 62.25 | 71.80 | | 71.78 | 0.000970 | 3.53 | 486.20 | 136.52 | 0.24 |
| 3 | 53044 | April | 273.30 | 63.89 | 70.20 | | 70.21 | 0.000078 | 0.78 | 358.60 | 101.10 | 0.06 |
| 3 | 53044 | May | 188.00 | 63.89 | 70.01 | | 70.02 | 0.000041 | 0.56 | 339.94 | 94.30 | 0.05 |
| 3 | 53044 | June | 140.20 | 63.89 | 69.88 | | 69.88 | 0.000028 | 0.43 | 327.97 | 89.82 | 0.04 |
| 3 | 53044 | August | 64.90 | 63.89 | 69.68 | | 69.68 | 0.000006 | 0.21 | 308.42 | 83.78 | 0.02 |
| 3 | 53044 | Mean Annual Floo | 750.00 | 63.89 | 70.98 | | 71.02 | 0.000330 | 1.81 | 447.24 | 128.26 | 0.14 |
| 3 | 53044 | 100-Year | 1350.00 | 63.89 | 71.63 | | 71.75 | 0.000701 | 2.85 | 538.06 | 151.11 | 0.21 |
| 3 | 53003 | April | 273.30 | 60.82 | 70.21 | | 70.21 | 0.000026 | 0.54 | 506.78 | 102.18 | 0.04 |
| 3 | 53003 | May | 188.00 | 60.82 | 70.01 | | 70.02 | 0.000014 | 0.38 | 496.74 | 95.72 | 0.03 |
| 3 | 53003 | June | 140.20 | 60.82 | 69.88 | | 69.88 | 0.000008 | 0.29 | 478.52 | 91.33 | 0.02 |

HEC-RAS Plan Plan 02 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.C. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|-------------|
| 3 | 53003 | August | 64.00 | 60.82 | 69.66 | | 60.86 | 0.000002 | 0.14 | 456.45 | 86.80 | 0.01 |
| 3 | 53003 | Mean Annual Floo | 750.00 | 60.82 | 70.99 | | 71.02 | 0.000130 | 1.30 | 600.36 | 128.57 | 0.06 |
| 3 | 53003 | 100-Year | 1350.00 | 60.82 | 71.66 | | 71.73 | 0.000269 | 2.11 | 694.13 | 151.00 | 0.14 |
| 3 | 52991.5 | April | 273.30 | 64.10 | 70.21 | | 70.21 | 0.000029 | 0.54 | 508.45 | 04.59 | 0.04 |
| 3 | 52991.5 | May | 186.60 | 64.10 | 70.01 | | 70.01 | 0.000615 | 0.38 | 490.46 | 92.91 | 0.03 |
| 3 | 52991.5 | June | 140.20 | 64.10 | 69.88 | | 69.88 | 0.000609 | 0.26 | 478.39 | 92.37 | 0.02 |
| 3 | 52991.5 | August | 64.00 | 64.10 | 60.66 | | 60.66 | 0.000002 | 0.14 | 457.60 | 01.62 | 0.01 |
| 3 | 52991.5 | Mean Annual Floo | 750.00 | 64.10 | 70.99 | | 71.02 | 0.000159 | 1.28 | 587.03 | 105.70 | 0.10 |
| 3 | 52991.5 | 100-Year | 1350.00 | 64.10 | 71.66 | | 71.72 | 0.000388 | 2.04 | 661.68 | 115.20 | 0.15 |
| 3 | 52976.5 | April | 273.30 | 64.10 | 70.21 | | 70.21 | 0.000022 | 0.48 | 573.52 | 93.89 | 0.03 |
| 3 | 52976.5 | May | 196.60 | 64.10 | 70.01 | | 70.01 | 0.000011 | 0.34 | 555.44 | 93.98 | 0.02 |
| 3 | 52976.5 | June | 140.20 | 64.10 | 69.88 | | 69.88 | 0.000007 | 0.26 | 543.17 | 93.98 | 0.02 |
| 3 | 52976.5 | August | 64.00 | 64.10 | 60.66 | | 60.66 | 0.000032 | 0.12 | 521.93 | 93.89 | 0.01 |
| 3 | 52976.5 | Mean Annual Floo | 750.00 | 64.10 | 70.99 | | 71.01 | 0.000113 | 1.16 | 617.28 | 93.99 | 0.09 |
| 3 | 52976.5 | 100-Year | 1350.00 | 64.10 | 71.66 | | 71.72 | 0.000272 | 1.00 | 710.30 | 95.00 | 0.12 |
| 3 | 52973 | April | 273.30 | 66.07 | 70.20 | | 70.21 | 0.000106 | 0.72 | 409.47 | 159.03 | 0.07 |
| 3 | 52973 | May | 186.60 | 66.07 | 70.01 | | 70.01 | 0.000064 | 0.52 | 379.54 | 165.83 | 0.05 |
| 3 | 52973 | June | 140.20 | 66.07 | 69.86 | | 69.88 | 0.000042 | 0.41 | 369.53 | 153.14 | 0.04 |
| 3 | 52973 | August | 64.00 | 66.07 | 60.66 | | 60.66 | 0.000012 | 0.21 | 325.58 | 149.00 | 0.02 |
| 3 | 52973 | Mean Annual Floo | 750.00 | 66.07 | 70.97 | | 71.01 | 0.000373 | 1.54 | 537.97 | 173.28 | 0.14 |
| 3 | 52973 | 100-Year | 1350.00 | 66.07 | 71.63 | | 71.71 | 0.000687 | 2.32 | 656.27 | 165.43 | 0.19 |
| 3 | 52941 | April | 273.30 | 66.07 | 70.20 | 67.68 | 70.20 | 0.000110 | 0.72 | 408.91 | 159.97 | 0.07 |
| 3 | 52941 | May | 186.60 | 66.07 | 70.01 | 67.51 | 70.01 | 0.000064 | 0.52 | 379.22 | 165.49 | 0.05 |
| 3 | 52941 | June | 140.20 | 66.07 | 69.86 | 67.42 | 69.88 | 0.000042 | 0.41 | 369.32 | 153.11 | 0.04 |
| 3 | 52941 | August | 64.00 | 66.07 | 60.66 | 67.15 | 60.66 | 0.000012 | 0.21 | 325.52 | 148.98 | 0.02 |
| 3 | 52941 | Mean Annual Floo | 750.00 | 66.07 | 70.96 | 68.20 | 71.00 | 0.000377 | 1.54 | 535.94 | 173.06 | 0.14 |
| 3 | 52941 | 100-Year | 1350.00 | 66.07 | 71.61 | 68.72 | 71.69 | 0.000700 | 2.34 | 651.96 | 185.00 | 0.19 |
| 3 | 52640 | | | | | | | | | | | |
| 3 | 52937 | April | 273.30 | 61.50 | 63.80 | | 64.13 | 0.014529 | 4.05 | 58.74 | 44.03 | 0.71 |
| 3 | 52937 | May | 186.60 | 61.50 | 63.23 | 63.23 | 63.68 | 0.034359 | 5.37 | 34.74 | 40.43 | 1.02 |
| 3 | 52937 | June | 140.20 | 61.50 | 63.05 | 63.06 | 63.44 | 0.031740 | 5.04 | 27.84 | 35.98 | 1.01 |
| 3 | 52937 | August | 64.00 | 61.50 | 62.63 | 62.63 | 62.92 | 0.038818 | 4.32 | 16.03 | 26.53 | 1.01 |
| 3 | 52937 | Mean Annual Floo | 750.00 | 61.50 | 65.87 | | 66.19 | 0.005805 | 4.55 | 165.03 | 62.81 | 0.49 |
| 3 | 52937 | 100-Year | 1350.00 | 61.50 | 67.02 | | 67.50 | 0.006858 | 5.59 | 243.52 | 71.87 | 0.52 |
| 3 | 52922 | April | 273.30 | 60.00 | 63.61 | 62.16 | 64.00 | 0.001762 | 2.46 | 119.88 | 44.71 | 0.28 |
| 3 | 52922 | May | 186.60 | 60.00 | 63.25 | 61.83 | 63.33 | 0.001907 | 2.25 | 82.07 | 40.55 | 0.28 |
| 3 | 52922 | June | 140.20 | 60.00 | 62.83 | 61.64 | 62.90 | 0.002039 | 2.11 | 66.45 | 37.88 | 0.28 |
| 3 | 52922 | August | 64.00 | 60.00 | 62.01 | 61.22 | 62.06 | 0.002306 | 1.72 | 37.66 | 32.53 | 0.28 |
| 3 | 52922 | Mean Annual Floo | 750.00 | 60.00 | 65.90 | 63.42 | 66.09 | 0.002391 | 3.49 | 215.07 | 63.88 | 0.33 |
| 3 | 52922 | 100-Year | 1350.00 | 60.00 | 67.07 | 64.52 | 67.36 | 0.003671 | 4.58 | 309.28 | 67.50 | 0.39 |
| 3 | 52921 | | | | | | | | | | | |
| 3 | 52905 | April | 273.30 | 60.00 | 62.30 | | 62.85 | 0.017192 | 5.41 | 50.51 | 35.02 | 0.79 |
| 3 | 52905 | May | 186.60 | 60.00 | 61.99 | | 62.38 | 0.020207 | 5.06 | 36.93 | 32.38 | 0.83 |
| 3 | 52905 | June | 140.20 | 60.00 | 61.72 | 61.64 | 62.10 | 0.024738 | 4.91 | 28.55 | 30.64 | 0.90 |
| 3 | 52905 | August | 64.00 | 60.00 | 61.22 | 61.22 | 61.53 | 0.036117 | 4.49 | 14.44 | 23.72 | 1.01 |
| 3 | 52905 | Mean Annual Floo | 750.00 | 60.00 | 63.89 | | 64.61 | 0.013782 | 6.81 | 110.16 | 41.59 | 0.76 |
| 3 | 52905 | 100-Year | 1350.00 | 60.00 | 65.10 | | 66.13 | 0.012538 | 7.77 | 173.70 | 52.65 | 0.76 |
| 3 | 52873 | April | 273.30 | 59.37 | 62.23 | | 62.45 | 0.006802 | 3.71 | 73.77 | 40.01 | 0.48 |
| 3 | 52873 | May | 186.60 | 59.37 | 61.81 | | 61.67 | 0.006506 | 3.23 | 57.82 | 36.55 | 0.45 |
| 3 | 52873 | June | 140.20 | 59.37 | 61.54 | | 61.67 | 0.006251 | 2.92 | 48.02 | 34.27 | 0.43 |
| 3 | 52873 | August | 64.00 | 59.37 | 60.93 | 60.38 | 61.01 | 0.005895 | 2.25 | 28.78 | 29.04 | 0.40 |
| 3 | 52873 | Mean Annual Floo | 750.00 | 59.37 | 63.77 | | 64.20 | 0.007672 | 5.30 | 146.07 | 54.16 | 0.54 |
| 3 | 52873 | 100-Year | 1350.00 | 59.37 | 65.13 | | 65.72 | 0.007396 | 6.28 | 228.50 | 66.25 | 0.56 |
| 3 | 52850 | April | 273.30 | 59.37 | 61.36 | 61.36 | 62.01 | 0.034604 | 6.60 | 42.08 | 32.98 | 1.01 |
| 3 | 52850 | May | 186.60 | 59.37 | 61.02 | 61.02 | 61.57 | 0.037071 | 5.90 | 31.60 | 29.86 | 1.01 |
| 3 | 52850 | June | 140.20 | 59.37 | 60.83 | 60.82 | 61.28 | 0.037847 | 5.43 | 25.82 | 28.14 | 1.00 |
| 3 | 52850 | August | 64.00 | 59.37 | 60.57 | | 60.75 | 0.019301 | 3.41 | 10.06 | 25.31 | 0.99 |
| 3 | 52850 | Mean Annual Floo | 750.00 | 59.37 | 62.62 | 62.62 | 63.71 | 0.025782 | 8.43 | 92.99 | 46.94 | 0.96 |
| 3 | 52850 | 100-Year | 1350.00 | 59.37 | 63.74 | 63.74 | 65.20 | 0.021336 | 9.93 | 152.11 | 58.57 | 0.93 |
| 3 | 52822 | April | 273.30 | 58.96 | 60.56 | 60.79 | 61.38 | 0.123167 | 7.25 | 37.70 | 64.64 | 1.66 |
| 3 | 52822 | May | 186.60 | 58.96 | 60.40 | 60.62 | 61.00 | 0.092961 | 5.75 | 32.44 | 63.91 | 1.42 |
| 3 | 52822 | June | 140.20 | 58.96 | 60.50 | 60.50 | 60.77 | 0.048275 | 4.16 | 33.74 | 64.14 | 1.01 |
| 3 | 52822 | August | 64.00 | 58.96 | 60.27 | 60.27 | 60.45 | 0.052346 | 3.34 | 19.43 | 56.26 | 1.00 |
| 3 | 52822 | Mean Annual Floo | 750.00 | 58.96 | 61.00 | 61.56 | 62.93 | 0.148999 | 11.15 | 67.24 | 60.82 | 2.00 |
| 3 | 52822 | 100-Year | 1350.00 | 58.96 | 61.44 | 62.30 | 64.32 | 0.143072 | 13.81 | 99.19 | 74.84 | 2.07 |
| 3 | 52811 | April | 273.30 | 58.32 | 59.65 | 59.12 | 59.77 | 0.181053 | 7.86 | 35.53 | 74.76 | 1.97 |
| 3 | 52811 | May | 186.60 | 58.32 | 59.73 | 59.96 | 59.50 | 0.221409 | 7.05 | 26.47 | 73.67 | 2.06 |
| 3 | 52811 | June | 140.20 | 58.32 | 59.61 | 59.85 | 59.59 | 0.177594 | 7.96 | 17.62 | 72.98 | 2.85 |

HEC-RAS Plan: Plan 02 (Continued)

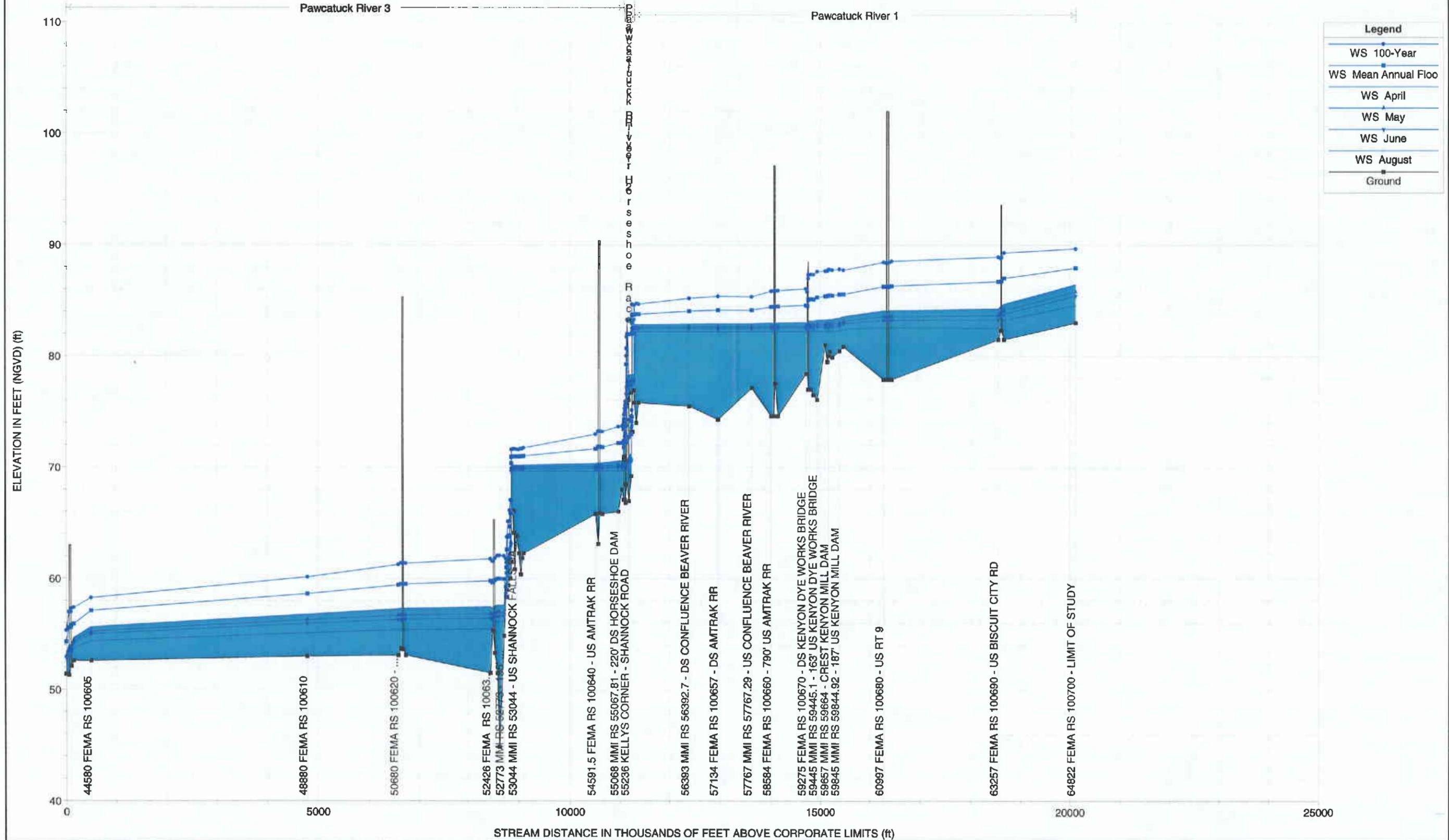
| Reach | Rever Sta | Profile | Q Total (cfs) | Min Ch Elev (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Cntrl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Cntrl |
|-------|-----------|------------------|------------------|---------------------|-------------------|-------------------|-------------------|-----------------------|---------------------|----------------------|-------------------|----------------|
| 3 | 52811 | August | 64.90 | 58.32 | 58.51 | 58.00 | 59.11 | 0.067711 | 6.18 | 10.49 | 72.27 | 2.86 |
| 3 | 52811 | Mean Annual Floo | 750.00 | 58.32 | 59.27 | 59.83 | 61.20 | 0.171454 | 11.15 | 67.28 | 77.81 | 2.11 |
| 3 | 52811 | 100-Year | 1350.00 | 58.32 | 62.29 | 60.51 | 62.57 | 0.003412 | 4.28 | 339.01 | 99.90 | 0.38 |
| 3 | 52773 | April | 273.30 | 54.83 | 57.84 | 56.98 | 57.68 | 0.000511 | 1.09 | 250.50 | 120.57 | 0.13 |
| 3 | 52773 | May | 186.60 | 54.83 | 56.97 | 56.84 | 56.99 | 0.000799 | 1.09 | 170.71 | 114.70 | 0.16 |
| 3 | 52773 | June | 140.20 | 54.83 | 56.59 | 56.76 | 56.80 | 0.001141 | 1.10 | 127.69 | 111.40 | 0.18 |
| 3 | 52773 | August | 64.90 | 54.83 | 56.10 | 55.53 | 56.11 | 0.001306 | 0.87 | 74.44 | 108.81 | 0.18 |
| 3 | 52773 | Mean Annual Floo | 750.00 | 54.83 | 60.47 | 58.55 | 60.49 | 0.000210 | 1.22 | 636.91 | 161.37 | 0.10 |
| 3 | 52773 | 100-Year | 1350.00 | 54.83 | 62.47 | | 62.51 | 0.000202 | 1.51 | 960.68 | 172.14 | 0.10 |
| 3 | 52888 | April | 273.30 | 44.87 | 57.66 | | 57.96 | 0.000004 | 0.24 | 1116.39 | 139.43 | 0.02 |
| 3 | 52888 | May | 186.60 | 44.87 | 56.98 | | 56.98 | 0.000002 | 0.18 | 1023.30 | 135.15 | 0.01 |
| 3 | 52888 | June | 140.20 | 44.87 | 56.80 | | 56.90 | 0.000001 | 0.14 | 972.49 | 132.74 | 0.01 |
| 3 | 52888 | August | 64.90 | 44.87 | 56.11 | | 56.11 | 0.000000 | 0.07 | 907.73 | 129.62 | 0.00 |
| 3 | 52888 | Mean Annual Floo | 750.00 | 44.87 | 60.48 | | 60.49 | 0.000010 | 0.49 | 1536.73 | 158.42 | 0.03 |
| 3 | 52888 | 100-Year | 1350.00 | 44.87 | 62.50 | | 62.51 | 0.000018 | 0.74 | 1872.02 | 175.43 | 0.04 |
| 3 | 52646.5 | April | 273.30 | 51.50 | 57.86 | | 57.86 | 0.000030 | 0.49 | 560.75 | 127.60 | 0.04 |
| 3 | 52646.5 | May | 186.60 | 51.50 | 56.99 | | 56.98 | 0.000023 | 0.39 | 475.20 | 124.58 | 0.04 |
| 3 | 52646.5 | June | 140.20 | 51.50 | 56.60 | | 56.60 | 0.000016 | 0.33 | 428.44 | 122.31 | 0.03 |
| 3 | 52646.5 | August | 64.90 | 51.50 | 56.11 | | 56.11 | 0.000006 | 0.18 | 369.93 | 119.35 | 0.02 |
| 3 | 52646.5 | Mean Annual Floo | 750.00 | 51.50 | 60.48 | | 60.49 | 0.000045 | 0.81 | 929.08 | 135.95 | 0.05 |
| 3 | 52646.5 | 100-Year | 1350.00 | 51.50 | 62.48 | | 62.50 | 0.000063 | 1.12 | 1221.13 | 170.68 | 0.07 |
| 3 | 52537.75 | April | 273.30 | 53.30 | 57.82 | 54.33 | 57.65 | 0.000247 | 1.38 | 108.01 | 45.87 | 0.12 |
| 3 | 52537.75 | May | 186.60 | 53.30 | 56.98 | 54.10 | 56.88 | 0.000194 | 1.11 | 167.59 | 45.86 | 0.10 |
| 3 | 52537.75 | June | 140.20 | 53.30 | 56.58 | 53.97 | 56.60 | 0.000154 | 0.93 | 150.50 | 45.85 | 0.09 |
| 3 | 52537.75 | August | 64.90 | 53.30 | 56.10 | 53.89 | 56.11 | 0.000055 | 0.51 | 128.47 | 45.85 | 0.05 |
| 3 | 52537.75 | Mean Annual Floo | 750.00 | 53.30 | 60.39 | 55.33 | 60.48 | 0.000402 | 2.31 | 324.52 | 45.92 | 0.15 |
| 3 | 52537.75 | 100-Year | 1350.00 | 53.30 | 62.28 | 56.30 | 62.45 | 0.000646 | 3.28 | 412.15 | 45.95 | 0.19 |
| 3 | 52517 | Bridge | | | | | | | | | | |
| 3 | 52496.25 | April | 273.30 | 56.30 | 57.45 | 56.33 | 57.57 | 0.002252 | 2.77 | 98.67 | 45.84 | 0.33 |
| 3 | 52496.25 | May | 186.60 | 56.30 | 56.78 | 56.10 | 56.88 | 0.003733 | 2.80 | 66.68 | 45.83 | 0.41 |
| 3 | 52496.25 | June | 140.20 | 56.30 | 56.32 | 56.98 | 56.46 | 0.008759 | 3.00 | 46.69 | 45.82 | 0.52 |
| 3 | 52496.25 | August | 64.90 | 56.30 | 55.70 | 55.70 | 55.69 | 0.032116 | 3.56 | 18.23 | 45.81 | 0.99 |
| 3 | 52496.25 | Mean Annual Floo | 750.00 | 56.30 | 60.22 | 57.33 | 60.39 | 0.001240 | 3.33 | 225.52 | 45.90 | 0.26 |
| 3 | 52496.25 | 100-Year | 1350.00 | 56.30 | 62.06 | 58.30 | 62.35 | 0.001516 | 4.36 | 308.95 | 45.94 | 0.30 |
| 3 | 52426 | April | 273.30 | 51.50 | 57.53 | | 57.53 | 0.000027 | 0.51 | 538.67 | 124.51 | 0.04 |
| 3 | 52426 | May | 186.60 | 51.50 | 56.84 | | 56.84 | 0.000022 | 0.41 | 463.26 | 121.17 | 0.04 |
| 3 | 52426 | June | 140.20 | 51.50 | 56.41 | | 56.41 | 0.000018 | 0.35 | 402.40 | 118.97 | 0.03 |
| 3 | 52426 | August | 64.90 | 51.50 | 55.45 | 52.50 | 55.45 | 0.000011 | 0.22 | 296.88 | 114.09 | 0.02 |
| 3 | 52426 | Mean Annual Floo | 750.00 | 51.50 | 60.34 | | 60.34 | 0.000041 | 0.83 | 699.52 | 134.92 | 0.06 |
| 3 | 52426 | 100-Year | 1350.00 | 51.50 | 62.24 | | 62.26 | 0.000058 | 1.17 | 1172.58 | 154.38 | 0.07 |
| 3 | 50805 | April | 273.30 | 53.10 | 57.39 | | 57.42 | 0.000293 | 1.41 | 193.27 | 58.09 | 0.13 |
| 3 | 50805 | May | 186.60 | 53.10 | 56.73 | | 56.75 | 0.000260 | 1.19 | 156.58 | 54.02 | 0.12 |
| 3 | 50805 | June | 140.20 | 53.10 | 56.32 | | 56.34 | 0.000232 | 1.04 | 135.02 | 52.77 | 0.11 |
| 3 | 50805 | August | 64.90 | 53.10 | 55.40 | | 55.41 | 0.000187 | 0.74 | 87.79 | 49.08 | 0.10 |
| 3 | 50805 | Mean Annual Floo | 750.00 | 53.10 | 60.10 | | 60.17 | 0.000390 | 2.09 | 356.24 | 71.20 | 0.18 |
| 3 | 50805 | 100-Year | 1350.00 | 53.10 | 61.93 | | 62.03 | 0.000610 | 2.68 | 573.25 | 105.23 | 0.19 |
| 3 | 50755 | April | 273.30 | 53.60 | 57.40 | 54.21 | 57.41 | 0.000063 | 0.72 | 379.72 | 100.96 | 0.07 |
| 3 | 50755 | May | 186.60 | 53.60 | 56.73 | 54.08 | 56.73 | 0.000056 | 0.60 | 312.82 | 100.79 | 0.06 |
| 3 | 50755 | June | 140.20 | 53.60 | 56.32 | 54.00 | 56.33 | 0.000051 | 0.51 | 272.30 | 100.69 | 0.05 |
| 3 | 50755 | August | 64.90 | 53.60 | 55.40 | 53.83 | 55.40 | 0.000043 | 0.36 | 179.68 | 100.45 | 0.05 |
| 3 | 50755 | Mean Annual Floo | 750.00 | 53.60 | 60.12 | 54.80 | 60.14 | 0.000079 | 1.15 | 652.06 | 101.85 | 0.08 |
| 3 | 50755 | 100-Year | 1350.00 | 53.60 | 61.95 | 55.38 | 61.99 | 0.000112 | 1.62 | 836.14 | 102.11 | 0.10 |
| 3 | 50742.5 | Bridge | | | | | | | | | | |
| 3 | 50730 | April | 273.30 | 53.70 | 57.39 | 54.32 | 57.40 | 0.000070 | 0.74 | 369.12 | 100.93 | 0.07 |
| 3 | 50730 | May | 186.60 | 53.70 | 56.72 | 54.17 | 56.73 | 0.000063 | 0.62 | 302.32 | 100.77 | 0.06 |
| 3 | 50730 | June | 140.20 | 53.70 | 56.32 | 54.09 | 56.32 | 0.000059 | 0.54 | 261.67 | 100.66 | 0.06 |
| 3 | 50730 | August | 64.90 | 53.70 | 55.39 | 53.94 | 55.40 | 0.000053 | 0.36 | 169.30 | 100.43 | 0.05 |
| 3 | 50730 | Mean Annual Floo | 750.00 | 53.70 | 60.11 | 54.91 | 60.13 | 0.000063 | 1.17 | 841.14 | 101.02 | 0.08 |
| 3 | 50730 | 100-Year | 1350.00 | 53.70 | 61.94 | 55.48 | 61.99 | 0.000117 | 1.64 | 823.61 | 102.09 | 0.10 |
| 3 | 50680 | April | 273.30 | 53.10 | 57.39 | | 57.39 | 0.000303 | 1.43 | 191.20 | 56.98 | 0.14 |
| 3 | 50680 | May | 186.60 | 53.10 | 56.70 | | 56.72 | 0.000269 | 1.20 | 155.00 | 53.03 | 0.13 |
| 3 | 50680 | June | 140.20 | 53.10 | 56.30 | | 56.31 | 0.000230 | 1.05 | 133.74 | 52.69 | 0.12 |
| 3 | 50680 | August | 64.90 | 53.10 | 55.38 | | 55.39 | 0.000193 | 0.75 | 86.95 | 48.69 | 0.10 |
| 3 | 50680 | Mean Annual Floo | 750.00 | 53.10 | 60.04 | | 60.11 | 0.000404 | 2.12 | 353.71 | 70.01 | 0.17 |
| 3 | 50680 | 100-Year | 1350.00 | 53.10 | 61.84 | | 61.95 | 0.000650 | 2.83 | 567.00 | 178.10 | 0.20 |
| 3 | 48860 | April | 273.30 | 53.00 | 56.92 | | 56.94 | 0.000204 | 1.24 | 240.80 | 89.85 | 0.12 |
| 3 | 48860 | May | 186.60 | 53.00 | 56.31 | | 56.32 | 0.000182 | 1.03 | 190.28 | 78.28 | 0.11 |
| 3 | 48860 | June | 140.20 | 53.00 | 55.95 | | 55.97 | 0.000158 | 0.88 | 163.94 | 73.30 | 0.10 |

HEC-RAS Plan: Plan 02 (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chf (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chf |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|-------------------|----------------------|-------------------|--------------|
| 3 | 48880 | August | 84.90 | 53.00 | 55.10 | | 55.11 | 0.000127 | 0.81 | 105.35 | 81.46 | 0.08 |
| 3 | 48880 | Mean Annual Floo | 750.00 | 53.00 | 59.55 | | 59.59 | 0.000209 | 1.81 | 517.55 | 123.86 | 0.13 |
| 3 | 48880 | 100-Year | 1350.00 | 53.00 | 61.21 | | 61.28 | 0.000259 | 2.36 | 868.59 | 252.94 | 0.16 |
| 3 | 44580 | April | 273.30 | 52.60 | 58.25 | | 58.26 | 0.000125 | 0.77 | 269.28 | 167.51 | 0.09 |
| 3 | 44580 | May | 186.60 | 52.60 | 55.51 | | 55.52 | 0.000189 | 0.75 | 261.70 | 151.28 | 0.10 |
| 3 | 44580 | June | 140.20 | 52.60 | 55.11 | | 55.11 | 0.000255 | 0.73 | 192.61 | 142.34 | 0.11 |
| 3 | 44580 | August | 84.90 | 52.60 | 54.38 | | 54.37 | 0.000253 | 0.63 | 102.63 | 92.57 | 0.11 |
| 3 | 44580 | Mean Annual Floo | 750.00 | 52.60 | 59.10 | | 59.12 | 0.000367 | 0.93 | 638.60 | 230.27 | 0.07 |
| 3 | 44580 | 100-Year | 1350.00 | 52.60 | 60.85 | | 60.88 | 0.000386 | 1.24 | 1315.43 | 250.00 | 0.08 |
| 3 | 44230 | April | 273.30 | 52.60 | 56.06 | | 56.15 | 0.001351 | 2.43 | 138.42 | 111.40 | 0.28 |
| 3 | 44230 | May | 186.60 | 52.60 | 55.23 | | 55.34 | 0.002838 | 2.69 | 79.79 | 51.20 | 0.30 |
| 3 | 44230 | June | 140.20 | 52.60 | 54.73 | | 54.86 | 0.005052 | 2.93 | 47.91 | 40.78 | 0.48 |
| 3 | 44230 | August | 84.90 | 52.60 | 53.74 | 53.74 | 54.04 | 0.028825 | 4.41 | 14.73 | 25.09 | 1.01 |
| 3 | 44230 | Mean Annual Floo | 750.00 | 52.60 | 59.01 | | 59.07 | 0.000380 | 2.17 | 561.54 | 168.80 | 0.17 |
| 3 | 44230 | 100-Year | 1350.00 | 52.60 | 60.53 | | 60.61 | 0.000430 | 2.77 | 830.51 | 211.23 | 0.19 |
| 3 | 44180 | April | 273.30 | 52.10 | 56.97 | 53.05 | 56.10 | 0.000203 | 1.33 | 206.12 | 53.58 | 0.12 |
| 3 | 44180 | May | 186.60 | 52.10 | 55.25 | 52.84 | 55.27 | 0.000204 | 1.14 | 193.62 | 53.23 | 0.11 |
| 3 | 44180 | June | 140.20 | 52.10 | 54.76 | 52.71 | 54.76 | 0.000202 | 1.01 | 138.14 | 53.03 | 0.11 |
| 3 | 44180 | August | 84.90 | 52.10 | 53.80 | 52.47 | 53.81 | 0.000180 | 0.74 | 88.20 | 52.62 | 0.10 |
| 3 | 44180 | Mean Annual Floo | 750.00 | 52.10 | 56.98 | 53.97 | 56.05 | 0.000245 | 2.10 | 356.98 | 54.81 | 0.14 |
| 3 | 44180 | 100-Year | 1350.00 | 52.10 | 60.42 | 54.88 | 60.57 | 0.000420 | 3.13 | 431.76 | 55.42 | 0.19 |
| 3 | 44158.7 | Bridge | | | | | | | | | | |
| 3 | 44133.4 | April | 273.30 | 51.30 | 56.06 | 52.25 | 56.07 | 0.000111 | 1.11 | 246.70 | 53.78 | 0.09 |
| 3 | 44133.4 | May | 186.60 | 51.30 | 55.24 | 52.04 | 55.25 | 0.000097 | 0.91 | 204.45 | 53.48 | 0.08 |
| 3 | 44133.4 | June | 140.20 | 51.30 | 54.78 | 51.01 | 54.78 | 0.000085 | 0.78 | 178.07 | 53.28 | 0.07 |
| 3 | 44133.4 | August | 84.90 | 51.30 | 53.79 | 51.66 | 53.80 | 0.000054 | 0.65 | 120.34 | 52.88 | 0.06 |
| 3 | 44133.4 | Mean Annual Floo | 750.00 | 51.30 | 58.94 | 53.17 | 59.00 | 0.000172 | 1.09 | 396.72 | 54.92 | 0.12 |
| 3 | 44133.4 | 100-Year | 1350.00 | 51.30 | 60.27 | 54.06 | 60.40 | 0.000327 | 2.90 | 485.86 | 55.44 | 0.17 |
| 3 | 44083.4 | April | 273.30 | 51.40 | 56.02 | 53.26 | 56.08 | 0.000400 | 1.98 | 172.63 | 50.14 | 0.15 |
| 3 | 44083.4 | May | 186.60 | 51.40 | 55.21 | 53.01 | 55.24 | 0.000400 | 1.40 | 133.16 | 47.01 | 0.15 |
| 3 | 44083.4 | June | 140.20 | 51.40 | 54.72 | 52.86 | 54.75 | 0.000400 | 1.27 | 116.80 | 45.87 | 0.14 |
| 3 | 44083.4 | August | 84.90 | 51.40 | 53.77 | 52.57 | 53.79 | 0.000400 | 0.95 | 87.99 | 44.03 | 0.14 |
| 3 | 44083.4 | Mean Annual Floo | 750.00 | 51.40 | 58.81 | 54.31 | 58.88 | 0.000400 | 2.22 | 413.13 | 385.92 | 0.16 |
| 3 | 44083.4 | 100-Year | 1350.00 | 51.40 | 60.28 | 55.33 | 60.38 | 0.000400 | 2.55 | 944.23 | 398.70 | 0.17 |

APPENDIX F
HEC-RAS OUTPUT
KENYON MILL DAM REMOVAL

Proposed - Kenyon Removal Plan: Kenyon Dam Removal 8/27/2007



| Legend | |
|----------------------|--------------------------------|
| WS 100-Year | Blue line with square markers |
| WS Mean Annual Flood | Blue line with square markers |
| WS April | Blue line with square markers |
| WS May | Blue line with square markers |
| WS June | Blue line with square markers |
| WS August | Blue line with square markers |
| Ground | Black line with square markers |

HEC-RAS Plan: Canyon reman

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch E1 (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch1 |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 64822 | April | 273.30 | 83.00 | 86.46 | 84.24 | 86.52 | 0.000620 | 1.90 | 177.00 | 191.12 | 0.19 |
| 1 | 64822 | May | 186.60 | 83.00 | 85.03 | 83.97 | 85.87 | 0.000650 | 1.70 | 110.00 | 47.92 | 0.19 |
| 1 | 64822 | June | 140.20 | 83.00 | 85.43 | 83.80 | 86.47 | 0.00015 | 1.51 | 92.71 | 42.86 | 0.18 |
| 1 | 64822 | August | 64.90 | 83.00 | 84.58 | 83.48 | 84.60 | 0.000567 | 1.12 | 57.78 | 36.58 | 0.16 |
| 1 | 64822 | Mean Annual Floe | 750.00 | 83.00 | 87.95 | 85.38 | 87.98 | 0.000405 | 2.00 | 884.15 | 615.30 | 0.17 |
| 1 | 64822 | 100-Year | 1350.00 | 83.00 | 89.69 | 87.13 | 89.70 | 0.00152 | 1.52 | 2100.16 | 744.82 | 0.11 |
| 1 | 63372 | April | 273.30 | 81.50 | 84.71 | | 81.81 | 0.002822 | 2.03 | 103.94 | 88.57 | 0.38 |
| 1 | 63372 | May | 186.60 | 81.50 | 84.13 | | 84.24 | 0.002382 | 2.57 | 72.72 | 42.58 | 0.35 |
| 1 | 63372 | June | 140.20 | 81.50 | 83.83 | | 83.81 | 0.002291 | 2.33 | 60.06 | 36.36 | 0.33 |
| 1 | 63372 | August | 64.90 | 81.50 | 83.26 | | 83.20 | 0.001500 | 1.64 | 39.54 | 33.40 | 0.27 |
| 1 | 63372 | Mean Annual Floe | 750.00 | 81.50 | 87.02 | | 87.12 | 0.000984 | 2.53 | 296.30 | 91.86 | 0.25 |
| 1 | 63372 | 100-Year | 1350.00 | 81.50 | 89.31 | | 89.37 | 0.000405 | 2.22 | 915.82 | 418.26 | 0.17 |
| 1 | 63322 | April | 273.30 | 82.30 | 84.55 | 83.40 | 84.69 | 0.002212 | 2.90 | 94.31 | 49.42 | 0.34 |
| 1 | 63322 | May | 186.60 | 82.30 | 84.01 | 83.15 | 84.11 | 0.002552 | 2.61 | 71.51 | 47.86 | 0.35 |
| 1 | 63322 | June | 140.20 | 82.30 | 83.69 | 83.00 | 83.78 | 0.002015 | 2.40 | 58.32 | 46.55 | 0.36 |
| 1 | 63322 | August | 64.90 | 82.30 | 83.14 | 82.72 | 83.19 | 0.003211 | 1.85 | 35.13 | 44.70 | 0.36 |
| 1 | 63322 | Mean Annual Floe | 750.00 | 82.30 | 86.76 | 84.45 | 87.01 | 0.001813 | 4.01 | 187.09 | 56.82 | 0.33 |
| 1 | 63322 | 100-Year | 1350.00 | 82.30 | 88.87 | 85.48 | 89.24 | 0.001714 | 4.00 | 275.58 | 83.87 | 0.34 |
| 1 | 63314.5 | Bridge | | | | | | | | | | |
| 1 | 63307 | April | 273.30 | 82.30 | 84.51 | 83.40 | 84.65 | 0.002345 | 2.95 | 92.64 | 49.29 | 0.35 |
| 1 | 63307 | May | 186.60 | 82.30 | 83.98 | 83.15 | 84.07 | 0.002809 | 2.68 | 69.52 | 47.45 | 0.37 |
| 1 | 63307 | June | 140.20 | 82.30 | 83.64 | 83.00 | 83.73 | 0.003208 | 2.50 | 56.05 | 46.37 | 0.38 |
| 1 | 63307 | August | 64.90 | 82.30 | 83.07 | 82.72 | 83.13 | 0.004241 | 2.01 | 32.30 | 44.48 | 0.40 |
| 1 | 63307 | Mean Annual Floe | 750.00 | 82.30 | 86.73 | 84.45 | 86.98 | 0.001854 | 4.04 | 185.77 | 56.72 | 0.34 |
| 1 | 63307 | 100-Year | 1350.00 | 82.30 | 88.84 | 85.48 | 89.21 | 0.001743 | 4.93 | 274.11 | 83.75 | 0.34 |
| 1 | 63257 | April | 273.30 | 81.50 | 84.29 | | 84.47 | 0.004390 | 3.43 | 79.78 | 47.90 | 0.47 |
| 1 | 63257 | May | 186.60 | 81.50 | 83.68 | | 83.80 | 0.005385 | 3.43 | 54.37 | 37.87 | 0.50 |
| 1 | 63257 | June | 140.20 | 81.50 | 83.30 | | 83.48 | 0.008803 | 3.44 | 40.78 | 33.90 | 0.55 |
| 1 | 63257 | August | 64.90 | 81.50 | 82.53 | | 82.73 | 0.015189 | 3.81 | 17.99 | 25.48 | 0.76 |
| 1 | 63257 | Mean Annual Floe | 750.00 | 81.50 | 86.72 | | 86.84 | 0.001322 | 2.79 | 288.70 | 86.17 | 0.28 |
| 1 | 63257 | 100-Year | 1350.00 | 81.50 | 88.93 | | 89.02 | 0.000577 | 2.52 | 762.12 | 406.16 | 0.20 |
| 1 | 61157 | April | 273.30 | 77.90 | 84.11 | | 84.11 | 0.000044 | 0.64 | 429.90 | 102.21 | 0.05 |
| 1 | 61157 | May | 186.60 | 77.90 | 83.58 | | 83.58 | 0.000031 | 0.50 | 376.12 | 99.95 | 0.05 |
| 1 | 61157 | June | 140.20 | 77.90 | 83.25 | | 83.25 | 0.000023 | 0.41 | 343.77 | 98.67 | 0.04 |
| 1 | 61157 | August | 64.90 | 77.90 | 82.59 | | 82.59 | 0.000009 | 0.23 | 270.95 | 95.71 | 0.02 |
| 1 | 61157 | Mean Annual Floe | 750.00 | 77.90 | 86.33 | | 86.35 | 0.000067 | 1.13 | 695.13 | 110.20 | 0.08 |
| 1 | 61157 | 100-Year | 1350.00 | 77.90 | 88.55 | | 88.59 | 0.000101 | 1.39 | 1150.81 | 353.74 | 0.09 |
| 1 | 61107 | April | 273.30 | 77.90 | 84.10 | 79.34 | 84.11 | 0.000064 | 0.95 | 286.77 | 102.15 | 0.07 |
| 1 | 61107 | May | 186.60 | 77.90 | 83.57 | 79.12 | 83.58 | 0.000041 | 0.72 | 260.45 | 99.92 | 0.06 |
| 1 | 61107 | June | 140.20 | 77.90 | 83.25 | 78.98 | 83.25 | 0.000029 | 0.57 | 244.28 | 98.55 | 0.05 |
| 1 | 61107 | August | 64.90 | 77.90 | 82.59 | 78.63 | 82.59 | 0.000010 | 0.31 | 211.81 | 95.80 | 0.03 |
| 1 | 61107 | Mean Annual Floe | 750.00 | 77.90 | 86.27 | 80.27 | 86.33 | 0.000165 | 1.90 | 395.86 | 109.99 | 0.12 |
| 1 | 61107 | 100-Year | 1350.00 | 77.90 | 88.44 | 81.19 | 88.58 | 0.000230 | 2.68 | 504.01 | 338.94 | 0.15 |
| 1 | 61077 | Bridge | | | | | | | | | | |
| 1 | 61047 | April | 273.30 | 77.90 | 84.09 | 79.34 | 84.11 | 0.000064 | 0.95 | 286.57 | 102.14 | 0.07 |
| 1 | 61047 | May | 186.60 | 77.90 | 83.57 | 79.12 | 83.57 | 0.000041 | 0.72 | 260.32 | 99.91 | 0.06 |
| 1 | 61047 | June | 140.20 | 77.90 | 83.24 | 78.98 | 83.25 | 0.000029 | 0.57 | 244.20 | 98.54 | 0.05 |
| 1 | 61047 | August | 64.90 | 77.90 | 82.59 | 78.63 | 82.59 | 0.000010 | 0.31 | 211.58 | 95.88 | 0.03 |
| 1 | 61047 | Mean Annual Floe | 750.00 | 77.90 | 86.26 | 80.27 | 86.32 | 0.000168 | 1.90 | 394.97 | 109.93 | 0.12 |
| 1 | 61047 | 100-Year | 1350.00 | 77.90 | 88.41 | 81.19 | 88.52 | 0.000242 | 2.69 | 502.48 | 338.27 | 0.15 |
| 1 | 60997 | April | 273.30 | 77.90 | 84.09 | | 84.10 | 0.000045 | 0.64 | 428.30 | 102.14 | 0.05 |
| 1 | 60997 | May | 186.60 | 77.90 | 83.57 | | 83.57 | 0.000031 | 0.50 | 375.17 | 99.91 | 0.05 |
| 1 | 60997 | June | 140.20 | 77.90 | 83.24 | | 83.25 | 0.000023 | 0.41 | 343.14 | 98.54 | 0.04 |
| 1 | 60997 | August | 64.90 | 77.90 | 82.59 | | 82.59 | 0.000010 | 0.23 | 270.75 | 96.67 | 0.02 |
| 1 | 60997 | Mean Annual Floe | 750.00 | 77.90 | 86.27 | | 86.29 | 0.000060 | 1.14 | 659.12 | 109.98 | 0.08 |
| 1 | 60997 | 100-Year | 1350.00 | 77.90 | 88.44 | | 88.47 | 0.000107 | 1.42 | 1112.16 | 339.15 | 0.09 |
| 1 | 59925 | April | 273.30 | 80.83 | 83.58 | | 83.94 | 0.008560 | 4.77 | 57.25 | 34.40 | 0.65 |
| 1 | 59925 | May | 186.60 | 80.83 | 83.17 | | 83.45 | 0.008574 | 4.28 | 43.84 | 31.03 | 0.64 |
| 1 | 59925 | June | 140.20 | 80.83 | 82.92 | | 83.16 | 0.008184 | 3.86 | 36.29 | 29.05 | 0.61 |
| 1 | 59925 | August | 64.90 | 80.83 | 82.43 | | 82.56 | 0.006705 | 2.84 | 22.83 | 25.02 | 0.52 |
| 1 | 59925 | Mean Annual Floe | 750.00 | 80.83 | 86.58 | | 86.02 | 0.006013 | 5.36 | 140.01 | 46.90 | 0.55 |
| 1 | 59925 | 100-Year | 1350.00 | 80.83 | 87.75 | | 88.19 | 0.002704 | 5.34 | 289.58 | 101.40 | 0.43 |
| 1 | 59845 | April | 273.30 | 80.45 | 83.45 | | 83.55 | 0.002063 | 2.61 | 104.74 | 53.87 | 0.33 |
| 1 | 59845 | May | 186.60 | 80.45 | 83.00 | | 83.08 | 0.002088 | 2.30 | 81.26 | 50.80 | 0.32 |
| 1 | 59845 | June | 140.20 | 80.45 | 82.75 | | 82.81 | 0.001953 | 2.04 | 68.62 | 49.06 | 0.30 |
| 1 | 59845 | August | 64.90 | 80.45 | 82.30 | | 82.33 | 0.001165 | 1.38 | 47.84 | 42.90 | 0.23 |
| 1 | 59845 | Mean Annual Floe | 750.00 | 80.45 | 85.57 | | 85.72 | 0.001582 | 3.14 | 238.55 | 75.08 | 0.31 |
| 1 | 59845 | 100-Year | 1350.00 | 80.45 | 87.83 | | 87.98 | 0.000884 | 3.11 | 439.13 | 101.94 | 0.25 |

HEC-RAS Plan: Kenyon remov (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 59700 | April | 273.30 | 79.99 | 83.34 | | 83.39 | 0.000914 | 1.73 | 157.81 | 60.13 | 0.19 |
| 1 | 59700 | May | 186.00 | 79.99 | 82.91 | | 82.94 | 0.000485 | 1.41 | 132.14 | 57.59 | 0.18 |
| 1 | 59700 | June | 140.20 | 79.99 | 82.87 | | 82.89 | 0.000379 | 1.18 | 118.96 | 56.20 | 0.14 |
| 1 | 59700 | August | 64.90 | 79.99 | 82.27 | | 82.28 | 0.000152 | 0.57 | 96.45 | 53.83 | 0.09 |
| 1 | 59700 | Mean Annual Floe | 750.00 | 79.99 | 85.46 | | 85.56 | 0.000715 | 2.52 | 297.84 | 72.25 | 0.22 |
| 1 | 59700 | 100-Year | 1350.00 | 79.99 | 87.75 | | 87.86 | 0.000839 | 2.75 | 494.93 | 126.10 | 0.21 |
| 1 | 59964 | April | 273.30 | 80.40 | 83.33 | | 83.39 | 0.000383 | 1.30 | 210.12 | 87.21 | 0.15 |
| 1 | 59964 | May | 186.00 | 80.40 | 82.90 | | 82.92 | 0.000328 | 1.08 | 172.85 | 84.55 | 0.13 |
| 1 | 59964 | June | 140.20 | 80.40 | 82.86 | | 82.88 | 0.000271 | 0.92 | 153.07 | 83.11 | 0.12 |
| 1 | 59964 | August | 64.90 | 80.40 | 82.26 | | 82.27 | 0.000124 | 0.54 | 120.36 | 80.67 | 0.08 |
| 1 | 59964 | Mean Annual Floe | 750.00 | 80.40 | 85.48 | | 85.52 | 0.000261 | 1.58 | 356.11 | 267.98 | 0.13 |
| 1 | 59964 | 100-Year | 1350.00 | 80.40 | 87.80 | | 87.82 | 0.000141 | 1.41 | 1520.51 | 450.09 | 0.10 |
| 1 | 59967 | April | 273.30 | 80.00 | 83.33 | | 83.35 | 0.000233 | 1.11 | 257.07 | 168.35 | 0.12 |
| 1 | 59967 | May | 186.00 | 80.00 | 82.89 | | 82.91 | 0.000189 | 0.90 | 206.77 | 166.97 | 0.10 |
| 1 | 59967 | June | 140.20 | 80.00 | 82.86 | | 82.87 | 0.000148 | 0.76 | 180.49 | 165.54 | 0.09 |
| 1 | 59967 | August | 64.90 | 80.00 | 82.26 | | 82.29 | 0.000059 | 0.42 | 153.01 | 163.10 | 0.06 |
| 1 | 59967 | Mean Annual Floe | 750.00 | 80.00 | 85.48 | | 85.51 | 0.000184 | 1.39 | 767.77 | 285.06 | 0.11 |
| 1 | 59967 | 100-Year | 1350.00 | 80.00 | 87.80 | | 87.82 | 0.000105 | 1.26 | 1700.58 | 464.87 | 0.09 |
| 1 | 59946 | April | 273.30 | 79.50 | 83.31 | | 83.34 | 0.000308 | 1.26 | 218.54 | 78.24 | 0.13 |
| 1 | 59946 | May | 186.00 | 79.50 | 82.88 | | 82.90 | 0.000243 | 1.01 | 183.99 | 75.80 | 0.11 |
| 1 | 59946 | June | 140.20 | 79.50 | 82.85 | | 82.86 | 0.000190 | 0.84 | 166.41 | 75.57 | 0.10 |
| 1 | 59946 | August | 64.90 | 79.50 | 82.26 | | 82.29 | 0.000077 | 0.47 | 136.84 | 75.17 | 0.06 |
| 1 | 59946 | Mean Annual Floe | 750.00 | 79.50 | 85.42 | | 85.48 | 0.000388 | 1.98 | 379.28 | 78.37 | 0.16 |
| 1 | 59946 | 100-Year | 1350.00 | 79.50 | 87.69 | | 87.77 | 0.000353 | 2.36 | 888.44 | 237.48 | 0.16 |
| 1 | 59630 | April | 273.30 | 79.47 | 83.31 | | 83.33 | 0.000288 | 1.20 | 227.78 | 79.00 | 0.12 |
| 1 | 59630 | May | 186.00 | 79.47 | 82.88 | | 82.90 | 0.000194 | 0.96 | 194.53 | 76.21 | 0.11 |
| 1 | 59630 | June | 140.20 | 79.47 | 82.85 | | 82.86 | 0.000148 | 0.79 | 177.00 | 74.99 | 0.09 |
| 1 | 59630 | August | 64.90 | 79.47 | 82.26 | | 82.26 | 0.000054 | 0.44 | 148.21 | 72.07 | 0.06 |
| 1 | 59630 | Mean Annual Floe | 750.00 | 79.47 | 85.42 | | 85.47 | 0.000312 | 1.69 | 398.79 | 82.24 | 0.15 |
| 1 | 59630 | 100-Year | 1350.00 | 79.47 | 87.69 | | 87.77 | 0.000265 | 2.24 | 722.53 | 213.59 | 0.15 |
| 1 | 59597 | April | 273.30 | 81.00 | 83.28 | | 83.32 | 0.000684 | 1.50 | 182.17 | 79.80 | 0.18 |
| 1 | 59597 | May | 186.00 | 81.00 | 82.86 | | 82.88 | 0.000532 | 1.26 | 148.42 | 79.85 | 0.16 |
| 1 | 59597 | June | 140.20 | 81.00 | 82.83 | | 82.85 | 0.000481 | 1.08 | 130.26 | 79.85 | 0.15 |
| 1 | 59597 | August | 64.90 | 81.00 | 82.25 | | 82.26 | 0.000237 | 0.65 | 99.84 | 79.83 | 0.10 |
| 1 | 59597 | Mean Annual Floe | 750.00 | 81.00 | 85.38 | | 85.46 | 0.000532 | 2.14 | 350.12 | 79.92 | 0.18 |
| 1 | 59597 | 100-Year | 1350.00 | 81.00 | 87.66 | | 87.75 | 0.000433 | 2.48 | 626.13 | 236.30 | 0.17 |
| 1 | 59445 | April | 273.30 | 78.08 | 83.25 | | 83.27 | 0.000145 | 1.29 | 212.58 | 36.79 | 0.10 |
| 1 | 59445 | May | 186.00 | 78.08 | 82.84 | | 82.85 | 0.000084 | 0.95 | 196.94 | 37.06 | 0.07 |
| 1 | 59445 | June | 140.20 | 78.08 | 82.82 | | 82.83 | 0.000054 | 0.74 | 188.95 | 37.52 | 0.05 |
| 1 | 59445 | August | 64.90 | 78.08 | 82.25 | | 82.25 | 0.000014 | 0.37 | 174.86 | 36.81 | 0.03 |
| 1 | 59445 | Mean Annual Floe | 750.00 | 78.08 | 85.39 | | 85.38 | 0.000385 | 2.39 | 401.78 | 149.23 | 0.16 |
| 1 | 59445 | 100-Year | 1350.00 | 78.08 | 87.61 | | 87.60 | 0.000320 | 2.62 | 858.74 | 229.41 | 0.15 |
| 1 | 59397 | April | 273.30 | 78.50 | 83.18 | | 83.26 | 0.000708 | 2.02 | 135.29 | 35.85 | 0.19 |
| 1 | 59397 | May | 186.00 | 78.50 | 82.80 | | 82.84 | 0.000440 | 1.53 | 121.83 | 34.48 | 0.14 |
| 1 | 59397 | June | 140.20 | 78.50 | 82.80 | | 82.82 | 0.000293 | 1.22 | 114.79 | 33.69 | 0.12 |
| 1 | 59397 | August | 64.90 | 78.50 | 82.24 | | 82.26 | 0.000085 | 0.83 | 103.12 | 32.33 | 0.06 |
| 1 | 59397 | Mean Annual Floe | 750.00 | 78.50 | 85.12 | | 85.32 | 0.001511 | 3.58 | 200.60 | 40.51 | 0.28 |
| 1 | 59397 | 100-Year | 1350.00 | 78.50 | 87.34 | | 87.82 | 0.001554 | 4.33 | 387.26 | 368.26 | 0.29 |
| 1 | 59347 | April | 273.30 | 77.00 | 83.10 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.75 | 40.08 | 0.08 |
| 1 | 59347 | May | 186.00 | 77.00 | 82.61 | 77.86 | 82.82 | 0.000068 | 0.80 | 232.30 | 40.07 | 0.06 |
| 1 | 59347 | June | 140.20 | 77.00 | 82.60 | 77.72 | 82.80 | 0.000043 | 0.63 | 223.96 | 40.07 | 0.05 |
| 1 | 59347 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.70 | 40.07 | 0.02 |
| 1 | 59347 | Mean Annual Floe | 750.00 | 77.00 | 85.15 | 79.22 | 85.23 | 0.000378 | 2.30 | 326.90 | 119.03 | 0.14 |
| 1 | 59347 | 100-Year | 1350.00 | 77.00 | 87.38 | 80.28 | 87.52 | 0.000559 | 3.26 | 414.28 | 119.47 | 0.18 |
| 1 | 59325 | April | 273.30 | 77.00 | 83.19 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.51 | 40.08 | 0.08 |
| 1 | 59325 | May | 186.00 | 77.00 | 82.60 | 77.88 | 82.81 | 0.000068 | 0.80 | 232.18 | 40.07 | 0.06 |
| 1 | 59325 | June | 140.20 | 77.00 | 82.60 | 77.73 | 82.80 | 0.000043 | 0.63 | 223.87 | 40.07 | 0.05 |
| 1 | 59325 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.67 | 40.07 | 0.02 |
| 1 | 59325 | Mean Annual Floe | 750.00 | 77.00 | 85.13 | 79.22 | 85.21 | 0.000381 | 2.31 | 326.12 | 119.03 | 0.14 |
| 1 | 59325 | 100-Year | 1350.00 | 77.00 | 87.35 | 80.28 | 87.49 | 0.000555 | 3.27 | 413.13 | 119.47 | 0.18 |
| 1 | 59280 | Bridge | | | | | | | | | | |
| 1 | 59275 | April | 273.30 | 78.40 | 83.04 | | 83.14 | 0.000585 | 2.48 | 110.33 | 35.42 | 0.25 |
| 1 | 59275 | May | 186.00 | 78.40 | 82.72 | | 82.78 | 0.000370 | 1.89 | 99.13 | 34.18 | 0.19 |
| 1 | 59275 | June | 140.20 | 78.40 | 82.54 | | 82.58 | 0.000250 | 1.51 | 93.11 | 33.50 | 0.16 |
| 1 | 59275 | August | 64.90 | 78.40 | 82.23 | | 82.24 | 0.000078 | 0.79 | 82.68 | 32.28 | 0.09 |
| 1 | 59275 | Mean Annual Floe | 750.00 | 78.40 | 84.58 | | 84.89 | 0.001298 | 4.47 | 167.87 | 39.29 | 0.38 |
| 1 | 59275 | 100-Year | 1350.00 | 78.40 | 86.06 | | 86.60 | 0.001728 | 5.61 | 228.57 | 42.93 | 0.45 |
| 1 | 59715 | April | 273.30 | 74.60 | 83.02 | | 83.03 | 0.000067 | 0.91 | 301.29 | 64.49 | 0.07 |
| 1 | 59715 | May | 186.00 | 74.60 | 82.71 | | 82.72 | 0.000037 | 0.69 | 284.52 | 63.71 | 0.05 |

HEC-RAS Plan: Kanyon runw (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crp W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|----------------|-----------|------------------|------------------|-------------------|-------------------|------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 58715 | June | 140.20 | 74.60 | 82.54 | | 82.54 | 0.000023 | 0.51 | 275.31 | 53.27 | 0.04 |
| 1 | 58715 | August | 64.90 | 74.60 | 82.23 | | 82.23 | 0.000009 | 0.25 | 258.88 | 52.49 | 0.02 |
| 1 | 58715 | Mean Annual Floo | 750.00 | 74.60 | 84.48 | | 84.54 | 0.000260 | 1.96 | 383.27 | 57.29 | 0.13 |
| 1 | 58715 | 100-Year | 1350.00 | 74.60 | 85.90 | | 86.03 | 0.000459 | 2.90 | 468.23 | 59.79 | 0.18 |
| 1 | 58865 | April | 273.30 | 77.50 | 83.02 | 78.26 | 83.03 | 0.000042 | 0.69 | 366.42 | 73.67 | 0.05 |
| 1 | 58865 | May | 186.60 | 77.50 | 82.71 | 78.10 | 82.71 | 0.000024 | 0.50 | 373.54 | 73.64 | 0.04 |
| 1 | 58865 | June | 140.20 | 77.50 | 82.54 | 78.00 | 82.54 | 0.000015 | 0.39 | 369.67 | 73.51 | 0.03 |
| 1 | 58865 | August | 64.90 | 77.50 | 82.23 | 77.80 | 82.23 | 0.000004 | 0.19 | 338.07 | 73.20 | 0.02 |
| 1 | 58865 | Mean Annual Floo | 750.00 | 77.50 | 84.49 | 78.02 | 84.52 | 0.000147 | 1.48 | 505.62 | 74.95 | 0.10 |
| 1 | 58865 | 100-Year | 1350.00 | 77.50 | 85.91 | 78.76 | 85.96 | 0.000263 | 2.20 | 613.12 | 76.00 | 0.14 |
| 1 | 58949.5 | Bridge | | | | | | | | | | |
| 1 | 58934 | April | 273.30 | 74.60 | 83.01 | 77.06 | 83.02 | 0.000068 | 0.91 | 300.40 | 53.68 | 0.07 |
| 1 | 58934 | May | 186.60 | 74.60 | 82.70 | 76.66 | 82.71 | 0.000037 | 0.66 | 283.06 | 53.28 | 0.05 |
| 1 | 58934 | June | 140.20 | 74.60 | 82.53 | 76.41 | 82.54 | 0.000023 | 0.51 | 274.91 | 52.89 | 0.04 |
| 1 | 58934 | August | 64.90 | 74.60 | 82.22 | 75.88 | 82.23 | 0.000008 | 0.25 | 258.69 | 52.19 | 0.02 |
| 1 | 58934 | Mean Annual Floo | 750.00 | 74.60 | 84.45 | 78.48 | 84.51 | 0.000329 | 1.92 | 390.32 | 75.48 | 0.15 |
| 1 | 58934 | 100-Year | 1350.00 | 74.60 | 85.86 | 78.66 | 85.97 | 0.000527 | 2.65 | 609.49 | 386.80 | 0.19 |
| 1 | 58584 | April | 273.30 | 74.60 | 83.01 | | 83.02 | 0.000068 | 0.91 | 300.21 | 53.97 | 0.07 |
| 1 | 58584 | May | 186.60 | 74.60 | 82.70 | | 82.71 | 0.000037 | 0.66 | 283.87 | 53.28 | 0.05 |
| 1 | 58584 | June | 140.20 | 74.60 | 82.53 | | 82.54 | 0.000023 | 0.51 | 274.85 | 52.89 | 0.04 |
| 1 | 58584 | August | 64.90 | 74.60 | 82.22 | | 82.23 | 0.000008 | 0.25 | 258.67 | 52.19 | 0.02 |
| 1 | 58584 | Mean Annual Floo | 750.00 | 74.60 | 84.44 | | 84.49 | 0.000331 | 1.93 | 389.02 | 75.12 | 0.15 |
| 1 | 58584 | 100-Year | 1350.00 | 74.60 | 85.84 | | 85.93 | 0.000456 | 2.46 | 754.25 | 386.33 | 0.18 |
| 1 | 57767 | April | 273.30 | 77.13 | 82.94 | | 82.97 | 0.000320 | 1.40 | 195.20 | 52.38 | 0.13 |
| 1 | 57767 | May | 186.60 | 77.13 | 82.68 | | 82.68 | 0.000190 | 1.03 | 180.91 | 51.57 | 0.10 |
| 1 | 57767 | June | 140.20 | 77.13 | 82.51 | | 82.52 | 0.000123 | 0.81 | 172.93 | 51.02 | 0.08 |
| 1 | 57767 | August | 64.90 | 77.13 | 82.22 | | 82.22 | 0.000034 | 0.41 | 158.42 | 48.97 | 0.04 |
| 1 | 57767 | Mean Annual Floo | 750.00 | 77.13 | 84.15 | | 84.28 | 0.000982 | 2.90 | 280.83 | 55.95 | 0.23 |
| 1 | 57767 | 100-Year | 1350.00 | 77.13 | 85.34 | | 85.61 | 0.001512 | 4.14 | 353.87 | 118.82 | 0.30 |
| 1 | 57134 | April | 273.30 | 74.30 | 82.93 | | 82.94 | 0.000013 | 0.43 | 970.80 | 244.01 | 0.03 |
| 1 | 57134 | May | 186.60 | 74.30 | 82.68 | | 82.68 | 0.000007 | 0.31 | 904.12 | 243.12 | 0.02 |
| 1 | 57134 | June | 140.20 | 74.30 | 82.51 | | 82.51 | 0.000005 | 0.25 | 866.58 | 242.28 | 0.02 |
| 1 | 57134 | August | 64.90 | 74.30 | 82.22 | | 82.22 | 0.000001 | 0.12 | 798.85 | 240.70 | 0.01 |
| 1 | 57134 | Mean Annual Floo | 750.00 | 74.30 | 84.15 | | 84.16 | 0.000046 | 0.90 | 1368.08 | 397.07 | 0.05 |
| 1 | 57134 | 100-Year | 1350.00 | 74.30 | 85.39 | | 85.40 | 0.000074 | 1.24 | 1902.33 | 449.30 | 0.07 |
| 1 | 56363 | April | 273.30 | 75.50 | 82.91 | | 82.92 | 0.000072 | 0.79 | 347.04 | 72.38 | 0.06 |
| 1 | 56363 | May | 186.60 | 75.50 | 82.65 | | 82.65 | 0.000039 | 0.57 | 328.45 | 70.23 | 0.05 |
| 1 | 56363 | June | 140.20 | 75.50 | 82.50 | | 82.50 | 0.000024 | 0.44 | 318.01 | 69.40 | 0.04 |
| 1 | 56363 | August | 64.90 | 75.50 | 82.22 | | 82.22 | 0.000008 | 0.22 | 298.59 | 68.00 | 0.02 |
| 1 | 56363 | Mean Annual Floo | 750.00 | 75.50 | 84.05 | | 84.09 | 0.000261 | 1.72 | 478.34 | 154.11 | 0.12 |
| 1 | 56363 | 100-Year | 1350.00 | 75.50 | 85.20 | | 85.29 | 0.000423 | 2.40 | 667.52 | 208.91 | 0.16 |
| 1 | 55407 | April | 273.30 | 75.81 | 82.84 | | 82.85 | 0.000009 | 0.79 | 363.48 | 108.02 | 0.06 |
| 1 | 55407 | May | 186.60 | 75.81 | 82.61 | | 82.61 | 0.000038 | 0.57 | 338.69 | 106.67 | 0.05 |
| 1 | 55407 | June | 140.20 | 75.81 | 82.47 | | 82.48 | 0.000024 | 0.44 | 324.64 | 103.79 | 0.04 |
| 1 | 55407 | August | 64.90 | 75.81 | 82.21 | | 82.21 | 0.000008 | 0.22 | 301.02 | 79.22 | 0.02 |
| 1 | 55407 | Mean Annual Floo | 750.00 | 75.81 | 83.77 | | 83.82 | 0.000262 | 1.79 | 465.65 | 113.73 | 0.13 |
| 1 | 55407 | 100-Year | 1350.00 | 75.81 | 84.69 | | 84.80 | 0.000537 | 2.71 | 574.01 | 119.37 | 0.18 |
| 1 | 55334 | April | 273.30 | 74.00 | 82.84 | | 82.84 | 0.000008 | 0.34 | 793.27 | 131.06 | 0.02 |
| 1 | 55334 | May | 186.60 | 74.00 | 82.61 | | 82.61 | 0.000004 | 0.24 | 763.24 | 129.47 | 0.02 |
| 1 | 55334 | June | 140.20 | 74.00 | 82.47 | | 82.48 | 0.000003 | 0.19 | 745.81 | 128.54 | 0.01 |
| 1 | 55334 | August | 64.90 | 74.00 | 82.21 | | 82.21 | 0.000001 | 0.09 | 712.00 | 126.72 | 0.01 |
| 1 | 55334 | Mean Annual Floo | 750.00 | 74.00 | 83.78 | | 83.70 | 0.000039 | 0.82 | 919.84 | 137.53 | 0.06 |
| 1 | 55334 | 100-Year | 1350.00 | 74.00 | 84.72 | | 84.75 | 0.000066 | 1.28 | 1052.00 | 143.99 | 0.08 |
| 1 | 55300 | April | 273.30 | 75.81 | 82.83 | | 82.84 | 0.000066 | 0.79 | 366.15 | 107.97 | 0.06 |
| 1 | 55300 | May | 186.60 | 75.81 | 82.60 | | 82.61 | 0.000030 | 0.57 | 341.97 | 106.59 | 0.05 |
| 1 | 55300 | June | 140.20 | 75.81 | 82.47 | | 82.47 | 0.000019 | 0.44 | 327.87 | 105.78 | 0.04 |
| 1 | 55300 | August | 64.90 | 75.81 | 82.21 | | 82.21 | 0.000005 | 0.22 | 301.89 | 87.39 | 0.02 |
| 1 | 55300 | Mean Annual Floo | 750.00 | 75.81 | 83.73 | | 83.78 | 0.000229 | 1.80 | 465.76 | 113.49 | 0.13 |
| 1 | 55300 | 100-Year | 1350.00 | 75.81 | 84.60 | | 84.71 | 0.000448 | 2.76 | 567.15 | 118.84 | 0.19 |
| Horseshoe Race | 216 | April | 27.30 | 76.90 | 78.41 | | 78.43 | 0.000717 | 1.05 | 26.08 | 17.24 | 0.15 |
| Horseshoe Race | 216 | May | 18.70 | 76.90 | 77.92 | | 77.94 | 0.001178 | 1.07 | 17.55 | 17.23 | 0.19 |
| Horseshoe Race | 216 | June | 14.00 | 76.90 | 77.70 | | 77.71 | 0.001462 | 1.02 | 15.70 | 17.22 | 0.20 |
| Horseshoe Race | 216 | August | 6.50 | 76.90 | 77.48 | | 77.46 | 0.001004 | 0.68 | 9.58 | 17.22 | 0.18 |
| Horseshoe Race | 216 | Mean Annual Floo | 102.00 | 76.90 | 82.02 | | 82.04 | 0.000257 | 1.15 | 86.41 | 17.30 | 0.09 |
| Horseshoe Race | 216 | 100-Year | 135.00 | 76.90 | 83.30 | | 83.32 | 0.000223 | 1.19 | 117.87 | 42.40 | 0.08 |
| Horseshoe Race | 155.82 | April | 27.30 | 76.70 | 78.33 | | 78.37 | 0.001922 | 1.46 | 18.82 | 13.51 | 0.22 |
| Horseshoe Race | 155.82 | May | 18.70 | 76.70 | 77.77 | | 77.81 | 0.003891 | 1.67 | 11.21 | 13.50 | 0.32 |
| Horseshoe Race | 155.82 | June | 14.00 | 76.70 | 77.46 | | 77.52 | 0.006914 | 2.00 | 7.00 | 13.50 | 0.49 |
| Horseshoe Race | 155.82 | August | 6.50 | 76.70 | 77.30 | | 77.33 | 0.006710 | 1.32 | 4.02 | 13.50 | 0.39 |

HEC-RAS Plan: Kanyon remov (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W S Elev (ft) | Crit W.S (ft) | E G Elev (ft) | E.G. Slope (ft/ft) | Vel Cntl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Fronda # Cnt |
|----------------|-----------|------------------|------------------|-------------------|------------------|------------------|------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| Horseshoe Race | 155.82 | Mean Annual Floo | 102.00 | 76.70 | 81.09 | | 82.02 | 0.000502 | 1.49 | 88.29 | 13.58 | 0.12 |
| Horseshoe Race | 155.82 | 100-Year | 135.00 | 76.70 | 83.26 | | 83.28 | 0.000476 | 1.58 | 85.55 | 13.80 | 0.11 |
| Horseshoe Race | 107.54 | April | 27.30 | 76.06 | 78.30 | | 78.32 | 0.000593 | 1.04 | 26.23 | 14.24 | 0.14 |
| Horseshoe Race | 107.54 | May | 18.70 | 76.08 | 77.72 | | 77.73 | 0.000903 | 1.04 | 17.92 | 14.06 | 0.16 |
| Horseshoe Race | 107.54 | June | 14.00 | 76.06 | 77.36 | | 77.38 | 0.001436 | 1.09 | 12.88 | 13.95 | 0.20 |
| Horseshoe Race | 107.54 | August | 6.50 | 76.06 | 76.05 | | 76.72 | 0.032151 | 2.14 | 3.03 | 13.21 | 0.78 |
| Horseshoe Race | 107.54 | Mean Annual Floo | 102.00 | 76.06 | 81.08 | | 82.00 | 0.000312 | 1.27 | 80.61 | 15.37 | 0.10 |
| Horseshoe Race | 107.54 | 100-Year | 135.00 | 76.06 | 83.25 | | 83.28 | 0.000300 | 1.34 | 190.38 | 15.88 | 0.09 |
| Horseshoe Race | 76.0 | April | 27.30 | 75.54 | 78.31 | | 78.32 | 0.000084 | 0.48 | 57.14 | 26.10 | 0.06 |
| Horseshoe Race | 76.0 | May | 18.70 | 75.54 | 77.72 | | 77.73 | 0.000106 | 0.45 | 41.74 | 26.16 | 0.08 |
| Horseshoe Race | 76.0 | June | 14.00 | 75.54 | 77.36 | | 77.37 | 0.000135 | 0.43 | 32.29 | 26.15 | 0.07 |
| Horseshoe Race | 76.0 | August | 6.50 | 75.54 | 76.68 | | 76.68 | 0.000254 | 0.42 | 15.64 | 22.11 | 0.09 |
| Horseshoe Race | 76.0 | Mean Annual Floo | 102.00 | 75.54 | 81.98 | | 82.00 | 0.000058 | 0.88 | 154.07 | 27.60 | 0.05 |
| Horseshoe Race | 76.0 | 100-Year | 135.00 | 75.54 | 83.27 | | 83.27 | 0.000053 | 0.71 | 190.58 | 29.60 | 0.05 |
| Horseshoe Race | 82.61 | April | 27.30 | 75.50 | 77.80 | 77.10 | 78.18 | 0.031935 | 5.05 | 5.41 | 2.49 | 0.60 |
| Horseshoe Race | 82.61 | May | 18.70 | 75.50 | 77.33 | 76.82 | 77.83 | 0.027487 | 4.40 | 4.25 | 2.47 | 0.59 |
| Horseshoe Race | 82.61 | June | 14.00 | 75.50 | 77.04 | 76.60 | 77.26 | 0.024716 | 3.98 | 3.54 | 2.48 | 0.58 |
| Horseshoe Race | 82.61 | August | 6.50 | 75.59 | 76.50 | 76.20 | 76.83 | 0.019132 | 2.95 | 2.20 | 2.45 | 0.55 |
| Horseshoe Race | 82.61 | Mean Annual Floo | 102.00 | 75.59 | 80.71 | 79.36 | 81.70 | 0.057672 | 7.98 | 12.79 | 2.58 | 0.63 |
| Horseshoe Race | 82.61 | 100-Year | 135.00 | 75.59 | 81.72 | 80.13 | 82.92 | 0.066030 | 8.76 | 15.40 | 2.60 | 0.63 |
| Horseshoe Race | 55.33 | April | 27.30 | 76.50 | 77.07 | 77.07 | 77.86 | 0.075536 | 7.10 | 3.85 | 2.47 | 1.00 |
| Horseshoe Race | 55.33 | May | 18.70 | 76.50 | 76.72 | 76.72 | 77.33 | 0.069590 | 6.28 | 2.98 | 2.48 | 1.01 |
| Horseshoe Race | 55.33 | June | 14.00 | 76.50 | 76.51 | 76.51 | 77.01 | 0.065882 | 5.70 | 2.45 | 2.45 | 1.00 |
| Horseshoe Race | 55.33 | August | 6.50 | 76.50 | 76.11 | 76.11 | 76.41 | 0.059700 | 4.42 | 1.47 | 2.44 | 1.00 |
| Horseshoe Race | 55.33 | Mean Annual Floo | 102.00 | 76.50 | 79.27 | 79.27 | 81.12 | 0.119377 | 10.83 | 9.33 | 2.53 | 1.00 |
| Horseshoe Race | 55.33 | 100-Year | 135.00 | 76.50 | 80.03 | 80.03 | 82.26 | 0.134827 | 11.98 | 11.27 | 2.56 | 1.01 |
| Horseshoe Race | 48.89 | April | 27.30 | 68.44 | 73.55 | 70.29 | 73.56 | 0.000218 | 1.29 | 44.22 | 16.96 | 0.10 |
| Horseshoe Race | 48.89 | May | 18.70 | 68.44 | 73.17 | 69.98 | 73.17 | 0.000147 | 1.01 | 37.97 | 15.73 | 0.08 |
| Horseshoe Race | 48.89 | June | 14.00 | 68.44 | 72.91 | 69.79 | 72.92 | 0.000107 | 0.93 | 34.07 | 14.91 | 0.07 |
| Horseshoe Race | 48.89 | August | 6.50 | 68.44 | 72.38 | 69.38 | 72.38 | 0.000042 | 0.48 | 26.54 | 13.16 | 0.04 |
| Horseshoe Race | 48.89 | Mean Annual Floo | 102.00 | 68.44 | 75.42 | 71.81 | 75.47 | 0.000654 | 2.79 | 81.41 | 22.10 | 0.18 |
| Horseshoe Race | 48.89 | 100-Year | 135.00 | 68.44 | 75.95 | 72.24 | 76.02 | 0.000798 | 3.25 | 83.34 | 22.76 | 0.21 |
| Horseshoe Race | 45.18 | April | 27.30 | 66.81 | 73.55 | | 73.56 | 0.000056 | 0.80 | 76.20 | 21.81 | 0.06 |
| Horseshoe Race | 45.18 | May | 18.70 | 66.81 | 73.17 | | 73.17 | 0.000035 | 0.61 | 68.02 | 21.04 | 0.04 |
| Horseshoe Race | 45.18 | June | 14.00 | 66.81 | 72.91 | | 72.92 | 0.000024 | 0.49 | 62.74 | 20.21 | 0.04 |
| Horseshoe Race | 45.18 | August | 6.50 | 66.81 | 72.38 | | 72.38 | 0.000008 | 0.27 | 52.34 | 18.46 | 0.02 |
| Horseshoe Race | 45.18 | Mean Annual Floo | 102.00 | 66.81 | 75.44 | | 75.46 | 0.000236 | 1.94 | 119.55 | 24.00 | 0.12 |
| Horseshoe Race | 45.18 | 100-Year | 135.00 | 66.81 | 75.97 | | 76.01 | 0.000313 | 2.33 | 132.41 | 24.00 | 0.14 |
| Horseshoe Race | 35.07 | April | 27.30 | 68.48 | 73.54 | | 73.56 | 0.000225 | 1.31 | 43.47 | 16.83 | 0.11 |
| Horseshoe Race | 35.07 | May | 18.70 | 68.48 | 73.16 | | 73.17 | 0.000154 | 1.03 | 37.30 | 15.59 | 0.09 |
| Horseshoe Race | 35.07 | June | 14.00 | 68.48 | 72.91 | | 72.92 | 0.000112 | 0.84 | 33.44 | 14.77 | 0.07 |
| Horseshoe Race | 35.07 | August | 6.50 | 68.48 | 72.37 | | 72.38 | 0.000045 | 0.48 | 26.01 | 13.03 | 0.04 |
| Horseshoe Race | 35.07 | Mean Annual Floo | 102.00 | 68.48 | 76.40 | | 76.46 | 0.000681 | 2.84 | 80.18 | 22.03 | 0.19 |
| Horseshoe Race | 35.07 | 100-Year | 135.00 | 68.48 | 75.93 | | 76.00 | 0.000830 | 3.29 | 91.97 | 22.69 | 0.22 |
| Horseshoe Race | 31.39 | April | 27.30 | 70.66 | 73.42 | | 73.56 | 0.003954 | 3.56 | 13.32 | 0.34 | 0.40 |
| Horseshoe Race | 31.39 | May | 18.70 | 70.66 | 73.07 | | 73.17 | 0.003500 | 3.03 | 10.22 | 0.20 | 0.36 |
| Horseshoe Race | 31.39 | June | 14.00 | 70.66 | 72.83 | | 72.91 | 0.003162 | 2.66 | 8.38 | 7.43 | 0.34 |
| Horseshoe Race | 31.39 | August | 6.50 | 70.66 | 72.33 | | 72.38 | 0.002274 | 1.85 | 5.08 | 5.81 | 0.27 |
| Horseshoe Race | 31.39 | Mean Annual Floo | 102.00 | 70.66 | 76.14 | | 76.45 | 0.005858 | 6.03 | 34.18 | 14.93 | 0.52 |
| Horseshoe Race | 31.39 | 100-Year | 135.00 | 70.66 | 75.63 | | 76.00 | 0.000035 | 6.70 | 41.88 | 16.52 | 0.64 |
| Horseshoe Race | 23.53 | April | 27.30 | 70.99 | 73.22 | | 73.51 | 0.010652 | 4.99 | 8.81 | 7.82 | 0.82 |
| Horseshoe Race | 23.53 | May | 18.70 | 70.99 | 72.89 | | 73.13 | 0.010378 | 4.39 | 6.50 | 6.56 | 0.80 |
| Horseshoe Race | 23.53 | June | 14.00 | 70.99 | 72.68 | | 72.87 | 0.010137 | 3.93 | 5.16 | 5.86 | 0.58 |
| Horseshoe Race | 23.53 | August | 6.50 | 70.99 | 72.22 | | 72.34 | 0.009372 | 2.94 | 2.84 | 4.38 | 0.52 |
| Horseshoe Race | 23.53 | Mean Annual Floo | 102.00 | 70.99 | 74.82 | | 75.39 | 0.011818 | 7.81 | 25.24 | 12.84 | 0.73 |
| Horseshoe Race | 23.53 | 100-Year | 135.00 | 70.99 | 75.29 | | 75.93 | 0.012082 | 8.55 | 31.53 | 14.34 | 0.76 |
| Horseshoe Race | 12.73 | April | 27.30 | 70.94 | 72.70 | 72.70 | 73.34 | 0.025434 | 6.87 | 6.13 | 6.37 | 0.93 |
| Horseshoe Race | 12.73 | May | 18.70 | 70.94 | 72.48 | 72.48 | 72.96 | 0.027163 | 6.00 | 4.36 | 5.40 | 0.93 |
| Horseshoe Race | 12.73 | June | 14.00 | 70.94 | 72.20 | 72.20 | 72.70 | 0.028749 | 5.53 | 3.36 | 4.75 | 0.93 |
| Horseshoe Race | 12.73 | August | 6.50 | 70.94 | 71.88 | 71.88 | 72.17 | 0.034832 | 4.46 | 1.69 | 3.43 | 0.96 |
| Horseshoe Race | 12.73 | Mean Annual Floo | 102.00 | 70.94 | 74.31 | 74.31 | 75.22 | 0.021656 | 6.84 | 19.65 | 11.33 | 0.86 |
| Horseshoe Race | 12.73 | 100-Year | 135.00 | 70.94 | 74.74 | 74.74 | 75.76 | 0.021663 | 10.50 | 24.77 | 12.72 | 0.89 |
| Horseshoe Race | 6.21 | April | 27.30 | 70.84 | 72.25 | 72.49 | 73.13 | 0.047373 | 8.20 | 4.74 | 5.02 | 1.24 |
| Horseshoe Race | 6.21 | May | 18.70 | 70.84 | 71.89 | 72.18 | 72.73 | 0.050519 | 7.35 | 3.38 | 4.77 | 1.23 |
| Horseshoe Race | 6.21 | June | 14.00 | 70.84 | 71.83 | 71.99 | 72.46 | 0.051203 | 6.86 | 2.69 | 4.25 | 1.21 |
| Horseshoe Race | 6.21 | August | 6.50 | 70.84 | 71.50 | 71.58 | 71.88 | 0.054400 | 5.13 | 1.42 | 3.18 | 1.10 |
| Horseshoe Race | 6.21 | Mean Annual Floo | 102.00 | 70.84 | 73.63 | 74.01 | 76.05 | 0.038274 | 11.73 | 15.51 | 10.98 | 1.25 |
| Horseshoe Race | 6.21 | 100-Year | 135.00 | 70.84 | 74.04 | 74.44 | 75.59 | 0.036408 | 12.58 | 19.98 | 11.42 | 1.25 |
| Horseshoe Race | 0.56 | April | 27.30 | 70.44 | 72.12 | 72.29 | 72.88 | 0.036040 | 7.69 | 5.13 | 5.84 | 1.13 |

HEC-RAS Plan: Kenyon remov (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|----------------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|-------------|
| Horseshoe Race | 0.55 | May | 10.70 | 70.44 | 71.07 | 71.08 | 72.48 | 0.038889 | 6.74 | 3.77 | 5.03 | 1.09 |
| Horseshoe Race | 0.55 | June | 14.00 | 70.44 | 71.73 | 71.79 | 72.21 | 0.035507 | 5.02 | 3.06 | 4.50 | 1.02 |
| Horseshoe Race | 0.55 | August | 6.50 | 70.44 | 71.36 | 71.38 | 71.67 | 0.040764 | 4.89 | 1.59 | 3.33 | 1.02 |
| Horseshoe Race | 0.55 | Mean Annual Floo | 102.00 | 70.44 | 73.46 | 73.80 | 74.83 | 0.036172 | 11.50 | 16.88 | 10.20 | 1.22 |
| Horseshoe Race | 0.55 | 100-Year | 135.00 | 70.44 | 73.86 | 74.24 | 75.30 | 0.035861 | 12.51 | 20.11 | 11.47 | 1.24 |
| 2 | 55266 | April | 246.00 | 73.20 | 82.83 | 73.70 | 82.83 | 0.000002 | 0.23 | 1273.11 | 134.40 | 0.01 |
| 2 | 55295 | May | 167.90 | 73.20 | 82.64 | 73.58 | 82.61 | 0.000001 | 0.10 | 1242.54 | 134.29 | 0.01 |
| 2 | 55266 | June | 126.20 | 73.20 | 82.47 | 73.52 | 82.47 | 0.000001 | 0.12 | 1224.59 | 134.23 | 0.01 |
| 2 | 55266 | August | 58.40 | 73.20 | 82.21 | 73.39 | 82.21 | 0.000000 | 0.06 | 1189.26 | 134.11 | 0.00 |
| 2 | 55295 | Mean Annual Floo | 648.00 | 73.20 | 83.75 | 74.15 | 83.78 | 0.000012 | 0.55 | 1386.81 | 134.83 | 0.03 |
| 2 | 55266 | 100-Year | 1215.00 | 73.20 | 84.86 | 74.64 | 84.69 | 0.000035 | 0.99 | 1532.31 | 167.22 | 0.06 |
| 2 | 55290 | | Int Struct | | | | | | | | | |
| 2 | 55284 | April | 246.00 | 73.20 | 73.98 | 73.70 | 74.08 | 0.009678 | 2.75 | 101.18 | 130.26 | 0.55 |
| 2 | 55284 | May | 167.90 | 73.20 | 73.83 | 73.58 | 73.90 | 0.009081 | 2.31 | 81.93 | 130.19 | 0.51 |
| 2 | 55284 | June | 126.20 | 73.20 | 73.74 | 73.52 | 73.80 | 0.008553 | 2.63 | 70.25 | 130.15 | 0.49 |
| 2 | 55284 | August | 58.40 | 73.20 | 73.56 | 73.39 | 73.59 | 0.007201 | 1.41 | 46.56 | 130.07 | 0.42 |
| 2 | 55284 | Mean Annual Floo | 648.00 | 73.20 | 74.58 | 74.14 | 74.79 | 0.010728 | 4.18 | 176.86 | 130.53 | 0.63 |
| 2 | 55284 | 100-Year | 1215.00 | 73.20 | 75.16 | 74.64 | 75.55 | 0.011028 | 6.42 | 255.04 | 130.81 | 0.68 |
| 2 | 55279 | April | 246.00 | 73.20 | 73.70 | 73.70 | 73.05 | 0.043473 | 4.31 | 64.30 | 130.13 | 1.00 |
| 2 | 55279 | May | 167.90 | 73.20 | 73.58 | 73.58 | 73.78 | 0.047330 | 3.79 | 49.86 | 130.08 | 1.06 |
| 2 | 55279 | June | 126.20 | 73.20 | 73.52 | 73.52 | 73.88 | 0.050255 | 3.44 | 41.25 | 130.05 | 1.08 |
| 2 | 55279 | August | 58.40 | 73.20 | 73.39 | 73.39 | 73.49 | 0.058815 | 2.67 | 24.64 | 129.99 | 1.08 |
| 2 | 55279 | Mean Annual Floo | 648.00 | 73.20 | 74.14 | 74.14 | 74.62 | 0.035205 | 5.98 | 122.88 | 130.34 | 1.08 |
| 2 | 55279 | 100-Year | 1215.00 | 73.20 | 74.64 | 74.64 | 75.37 | 0.030712 | 7.37 | 187.11 | 130.57 | 1.08 |
| 2 | 55274 | April | 246.00 | 69.20 | 71.26 | 69.68 | 71.30 | 0.001302 | 1.85 | 133.19 | 64.93 | 0.23 |
| 2 | 55274 | May | 167.90 | 69.20 | 70.81 | 69.79 | 70.05 | 0.001333 | 1.60 | 104.62 | 64.92 | 0.22 |
| 2 | 55274 | June | 126.20 | 69.20 | 70.54 | 69.69 | 70.57 | 0.001394 | 1.48 | 86.70 | 64.92 | 0.22 |
| 2 | 55274 | August | 58.40 | 69.20 | 69.27 | 69.49 | 71.79 | 0.096826 | 12.73 | 4.69 | 64.90 | 0.44 |
| 2 | 55274 | Mean Annual Floo | 648.00 | 69.20 | 72.98 | 70.65 | 73.07 | 0.001275 | 2.65 | 244.31 | 64.95 | 0.24 |
| 2 | 55274 | 100-Year | 1215.00 | 69.20 | 74.60 | 71.41 | 74.78 | 0.001430 | 3.47 | 350.37 | 64.97 | 0.26 |
| 2 | 55255.29 | April | 246.00 | 66.97 | 71.08 | 69.72 | 71.19 | 0.003654 | 2.61 | 94.42 | 45.98 | 0.32 |
| 2 | 55255.29 | May | 167.90 | 66.97 | 70.67 | 69.40 | 70.74 | 0.003102 | 2.21 | 75.89 | 42.73 | 0.29 |
| 2 | 55255.29 | June | 126.20 | 66.97 | 70.41 | 69.22 | 70.47 | 0.002785 | 1.94 | 65.13 | 40.16 | 0.27 |
| 2 | 55255.29 | August | 58.40 | 66.97 | 69.90 | 68.66 | 68.82 | 0.001682 | 1.27 | 45.99 | 35.19 | 0.20 |
| 2 | 55255.29 | Mean Annual Floo | 648.00 | 66.97 | 72.73 | 70.94 | 72.94 | 0.003713 | 3.67 | 178.48 | 56.28 | 0.36 |
| 2 | 55255.29 | 100-Year | 1215.00 | 66.97 | 74.29 | 71.85 | 74.83 | 0.003879 | 4.89 | 295.96 | 55.80 | 0.37 |
| 2 | 55236 | | Bridge | | | | | | | | | |
| 2 | 55217.48 | April | 246.00 | 68.47 | 70.00 | | 70.87 | 0.014175 | 4.22 | 58.36 | 38.90 | 0.60 |
| 2 | 55217.48 | May | 167.90 | 68.47 | 70.23 | | 70.46 | 0.015917 | 3.76 | 44.32 | 37.41 | 0.61 |
| 2 | 55217.48 | June | 126.20 | 68.47 | 70.02 | | 70.20 | 0.016405 | 3.46 | 36.46 | 36.17 | 0.61 |
| 2 | 55217.48 | August | 58.40 | 68.47 | 69.69 | | 69.77 | 0.011532 | 2.36 | 24.84 | 33.89 | 0.49 |
| 2 | 55217.48 | Mean Annual Floo | 648.00 | 68.47 | 72.25 | | 72.86 | 0.008585 | 5.14 | 128.26 | 46.72 | 0.52 |
| 2 | 55217.48 | 100-Year | 1215.00 | 68.47 | 73.73 | | 74.33 | 0.007530 | 6.31 | 204.07 | 54.03 | 0.53 |
| 2 | 55188 | April | 246.00 | 67.10 | 70.09 | | 70.70 | 0.000249 | 1.08 | 280.44 | 110.83 | 0.12 |
| 2 | 55188 | May | 167.90 | 67.10 | 70.30 | | 70.31 | 0.000200 | 0.88 | 237.78 | 110.52 | 0.10 |
| 2 | 55188 | June | 126.20 | 67.10 | 70.08 | | 70.09 | 0.000163 | 0.74 | 212.85 | 110.43 | 0.09 |
| 2 | 55188 | August | 58.40 | 67.10 | 69.71 | | 69.72 | 0.000079 | 0.42 | 172.70 | 110.29 | 0.06 |
| 2 | 55188 | Mean Annual Floo | 648.00 | 67.10 | 72.39 | | 72.43 | 0.000319 | 1.73 | 488.08 | 111.35 | 0.15 |
| 2 | 55188 | 100-Year | 1215.00 | 67.10 | 73.94 | | 74.01 | 0.000400 | 2.36 | 642.42 | 111.87 | 0.17 |
| 3 | 55152.41 | April | 273.30 | 67.10 | 70.68 | 68.31 | 70.70 | 0.000368 | 1.18 | 279.37 | 110.67 | 0.13 |
| 3 | 55152.41 | May | 186.80 | 67.10 | 70.30 | 68.08 | 70.31 | 0.000295 | 0.95 | 236.96 | 110.52 | 0.11 |
| 3 | 55152.41 | June | 140.20 | 67.10 | 70.07 | 67.93 | 70.08 | 0.000239 | 0.79 | 212.33 | 110.43 | 0.10 |
| 3 | 55152.41 | August | 64.90 | 67.10 | 69.71 | 67.81 | 69.71 | 0.000102 | 0.45 | 172.46 | 110.29 | 0.08 |
| 3 | 55152.41 | Mean Annual Floo | 750.00 | 67.10 | 72.37 | 69.11 | 72.41 | 0.000512 | 1.96 | 488.89 | 111.35 | 0.17 |
| 3 | 55152.41 | 100-Year | 1350.00 | 67.10 | 73.92 | 69.90 | 74.00 | 0.000591 | 2.57 | 639.57 | 111.98 | 0.19 |
| 3 | 55124 | April | 273.30 | 68.00 | 70.60 | | 70.67 | 0.001273 | 2.01 | 137.09 | 65.25 | 0.24 |
| 3 | 55124 | May | 186.80 | 68.00 | 70.24 | | 70.28 | 0.001040 | 1.64 | 114.29 | 61.35 | 0.21 |
| 3 | 55124 | June | 140.20 | 68.00 | 70.03 | | 70.06 | 0.000852 | 1.38 | 101.70 | 59.88 | 0.18 |
| 3 | 55124 | August | 64.90 | 68.00 | 69.70 | | 69.71 | 0.000345 | 0.79 | 82.39 | 58.04 | 0.11 |
| 3 | 55124 | Mean Annual Floo | 750.00 | 68.00 | 72.21 | | 72.36 | 0.001581 | 3.12 | 256.24 | 62.70 | 0.26 |
| 3 | 55124 | 100-Year | 1350.00 | 68.00 | 73.71 | | 73.93 | 0.001619 | 3.84 | 362.52 | 68.98 | 0.30 |
| 3 | 55068 | April | 273.30 | 66.02 | 70.59 | | 70.61 | 0.000305 | 1.24 | 220.99 | 69.83 | 0.12 |
| 3 | 55068 | May | 186.80 | 66.02 | 70.23 | | 70.25 | 0.000297 | 0.95 | 196.32 | 68.25 | 0.10 |
| 3 | 55068 | June | 140.20 | 66.02 | 70.03 | | 70.03 | 0.000145 | 0.77 | 182.41 | 66.70 | 0.08 |
| 3 | 55068 | August | 64.90 | 66.02 | 69.70 | | 69.70 | 0.000045 | 0.40 | 160.81 | 64.20 | 0.04 |
| 3 | 55068 | Mean Annual Floo | 750.00 | 66.02 | 72.19 | | 72.27 | 0.000590 | 2.25 | 336.58 | 74.45 | 0.18 |
| 3 | 55068 | 100-Year | 1350.00 | 66.02 | 73.88 | | 73.82 | 0.000788 | 3.08 | 450.50 | 78.73 | 0.22 |
| 3 | 54724 | April | 273.30 | 65.80 | 70.41 | | 70.48 | 0.000771 | 1.74 | 157.15 | 57.73 | 0.19 |

HEC-RAS Plan: Canyon ramon (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 54724 | May | 188.00 | 65.00 | 70.13 | | 70.15 | 0.000399 | 1.31 | 142.89 | 49.19 | 0.14 |
| 3 | 54724 | June | 140.20 | 65.80 | 69.05 | | 69.97 | 0.000273 | 1.04 | 134.40 | 48.98 | 0.11 |
| 3 | 54724 | August | 64.90 | 65.00 | 69.67 | | 69.68 | 0.000082 | 0.54 | 120.71 | 48.71 | 0.06 |
| 3 | 54724 | Mean Annual Floo | 750.00 | 65.80 | 71.82 | | 71.96 | 0.001702 | 3.02 | 248.49 | 71.58 | 0.29 |
| 3 | 54724 | 100-Year | 1350.00 | 65.00 | 73.23 | | 73.43 | 0.002193 | 3.59 | 385.16 | 135.73 | 0.33 |
| 3 | 54674 | April | 273.30 | 65.00 | 70.43 | 68.62 | 70.43 | 0.000048 | 0.62 | 443.77 | 98.14 | 0.05 |
| 3 | 54674 | May | 188.00 | 65.90 | 70.14 | 68.38 | 70.14 | 0.000027 | 0.45 | 415.09 | 98.13 | 0.04 |
| 3 | 54674 | June | 140.20 | 65.90 | 69.98 | 68.30 | 69.98 | 0.000018 | 0.35 | 397.84 | 98.13 | 0.03 |
| 3 | 54674 | August | 64.90 | 65.90 | 69.68 | 68.14 | 69.68 | 0.000005 | 0.18 | 370.00 | 98.12 | 0.02 |
| 3 | 54674 | Mean Annual Floo | 750.00 | 65.90 | 71.96 | 67.12 | 71.89 | 0.000140 | 1.28 | 584.11 | 98.19 | 0.06 |
| 3 | 54674 | 100-Year | 1350.00 | 65.90 | 73.27 | 67.70 | 73.33 | 0.000223 | 1.87 | 722.67 | 144.22 | 0.12 |
| 3 | 54672 | Bridge | | | | | | | | | | |
| 3 | 54641.5 | April | 273.30 | 63.10 | 70.43 | 63.72 | 70.43 | 0.000006 | 0.38 | 718.17 | 98.16 | 0.02 |
| 3 | 54641.5 | May | 186.60 | 63.10 | 70.14 | 63.58 | 70.14 | 0.000005 | 0.27 | 689.49 | 98.15 | 0.02 |
| 3 | 54641.5 | June | 140.20 | 63.10 | 69.96 | 63.50 | 69.96 | 0.000003 | 0.21 | 672.24 | 98.15 | 0.01 |
| 3 | 54641.5 | August | 64.90 | 63.10 | 69.68 | 63.34 | 69.68 | 0.000001 | 0.10 | 644.40 | 98.14 | 0.01 |
| 3 | 54641.5 | Mean Annual Floo | 750.00 | 63.10 | 71.86 | 64.31 | 71.87 | 0.000039 | 0.87 | 856.51 | 98.10 | 0.05 |
| 3 | 54641.5 | 100-Year | 1350.00 | 63.10 | 73.27 | 64.90 | 73.30 | 0.000076 | 1.35 | 997.07 | 144.22 | 0.07 |
| 3 | 54591.5 | April | 273.30 | 65.80 | 70.37 | | 70.42 | 0.000887 | 1.77 | 154.70 | 49.54 | 0.18 |
| 3 | 54591.5 | May | 186.60 | 65.80 | 70.10 | | 70.13 | 0.000411 | 1.32 | 141.60 | 49.15 | 0.14 |
| 3 | 54591.5 | June | 140.20 | 65.80 | 69.94 | | 69.95 | 0.000279 | 1.05 | 135.58 | 49.95 | 0.11 |
| 3 | 54591.5 | August | 64.90 | 65.80 | 69.67 | | 69.67 | 0.000083 | 0.54 | 120.50 | 48.71 | 0.08 |
| 3 | 54591.5 | Mean Annual Floo | 750.00 | 65.80 | 71.67 | | 71.82 | 0.001931 | 3.15 | 237.82 | 70.49 | 0.30 |
| 3 | 54591.5 | 100-Year | 1350.00 | 65.80 | 73.00 | | 73.23 | 0.002685 | 3.83 | 358.57 | 120.70 | 0.36 |
| 3 | 53180 | April | 273.30 | 62.25 | 70.21 | | 70.22 | 0.000050 | 0.69 | 414.03 | 94.57 | 0.05 |
| 3 | 53180 | May | 186.60 | 62.25 | 70.02 | | 70.02 | 0.000027 | 0.47 | 388.14 | 88.02 | 0.04 |
| 3 | 53180 | June | 140.20 | 62.25 | 69.89 | | 69.89 | 0.000018 | 0.30 | 384.78 | 84.15 | 0.03 |
| 3 | 53180 | August | 64.90 | 62.25 | 69.66 | | 69.66 | 0.000004 | 0.18 | 365.78 | 82.10 | 0.01 |
| 3 | 53180 | Mean Annual Floo | 750.00 | 62.25 | 71.03 | | 71.07 | 0.000221 | 1.55 | 562.44 | 121.81 | 0.11 |
| 3 | 53180 | 100-Year | 1350.00 | 62.25 | 71.75 | | 71.94 | 0.000471 | 2.45 | 568.69 | 145.60 | 0.17 |
| 3 | 53151 | April | 273.30 | 61.82 | 70.21 | | 70.25 | 0.000069 | 0.80 | 347.49 | 88.62 | 0.06 |
| 3 | 53151 | May | 186.60 | 61.82 | 70.02 | | 70.02 | 0.000038 | 0.57 | 339.78 | 82.33 | 0.04 |
| 3 | 53151 | June | 140.20 | 61.82 | 69.88 | | 69.89 | 0.000022 | 0.44 | 320.25 | 77.94 | 0.04 |
| 3 | 53151 | August | 64.90 | 61.82 | 69.69 | | 69.66 | 0.000006 | 0.21 | 303.38 | 70.34 | 0.02 |
| 3 | 53151 | Mean Annual Floo | 750.00 | 61.82 | 71.01 | | 71.06 | 0.000314 | 1.69 | 428.77 | 115.44 | 0.14 |
| 3 | 53151 | 100-Year | 1350.00 | 61.82 | 71.69 | | 71.83 | 0.000683 | 3.00 | 515.70 | 138.34 | 0.20 |
| 3 | 53122 | April | 273.30 | 60.36 | 70.21 | | 70.22 | 0.000048 | 0.74 | 375.25 | 78.54 | 0.06 |
| 3 | 53122 | May | 186.60 | 60.36 | 70.02 | | 70.02 | 0.000025 | 0.52 | 360.63 | 71.97 | 0.04 |
| 3 | 53122 | June | 140.20 | 60.36 | 69.88 | | 69.89 | 0.000015 | 0.40 | 351.47 | 67.52 | 0.03 |
| 3 | 53122 | August | 64.90 | 60.36 | 69.68 | | 69.68 | 0.000004 | 0.19 | 336.95 | 62.05 | 0.01 |
| 3 | 53122 | Mean Annual Floo | 750.00 | 60.36 | 71.00 | | 71.05 | 0.000236 | 1.78 | 448.43 | 105.47 | 0.12 |
| 3 | 53122 | 100-Year | 1350.00 | 60.36 | 71.68 | | 71.81 | 0.000542 | 2.87 | 527.95 | 128.48 | 0.18 |
| 3 | 53086 | April | 273.30 | 62.25 | 70.20 | | 70.22 | 0.000097 | 0.95 | 306.81 | 91.15 | 0.07 |
| 3 | 53086 | May | 186.60 | 62.25 | 70.01 | | 70.02 | 0.000052 | 0.68 | 290.04 | 84.96 | 0.05 |
| 3 | 53086 | June | 140.20 | 62.25 | 69.88 | | 69.89 | 0.000032 | 0.52 | 270.28 | 80.78 | 0.04 |
| 3 | 53086 | August | 64.90 | 62.25 | 69.66 | | 69.66 | 0.000006 | 0.26 | 281.88 | 73.46 | 0.02 |
| 3 | 53086 | Mean Annual Floo | 750.00 | 62.25 | 70.97 | | 71.04 | 0.000443 | 2.23 | 380.16 | 115.90 | 0.16 |
| 3 | 53086 | 100-Year | 1350.00 | 62.25 | 71.60 | | 71.78 | 0.000970 | 3.53 | 486.20 | 136.52 | 0.24 |
| 3 | 53044 | April | 273.30 | 63.80 | 70.20 | | 70.21 | 0.000078 | 0.78 | 358.60 | 101.10 | 0.09 |
| 3 | 53044 | May | 186.60 | 63.80 | 70.01 | | 70.02 | 0.000041 | 0.56 | 339.94 | 94.39 | 0.05 |
| 3 | 53044 | June | 140.20 | 63.80 | 69.88 | | 69.88 | 0.000026 | 0.43 | 327.57 | 89.82 | 0.04 |
| 3 | 53044 | August | 64.90 | 63.80 | 69.66 | | 69.66 | 0.000006 | 0.21 | 308.38 | 83.74 | 0.02 |
| 3 | 53044 | Mean Annual Floo | 750.00 | 63.80 | 70.98 | | 71.02 | 0.000330 | 1.81 | 447.24 | 128.26 | 0.14 |
| 3 | 53044 | 100-Year | 1350.00 | 63.80 | 71.63 | | 71.75 | 0.000701 | 2.85 | 538.09 | 151.11 | 0.21 |
| 3 | 53003 | April | 273.30 | 60.82 | 70.21 | | 70.21 | 0.000026 | 0.54 | 509.78 | 102.18 | 0.04 |
| 3 | 53003 | May | 186.60 | 60.82 | 70.01 | | 70.02 | 0.000014 | 0.39 | 490.74 | 95.72 | 0.03 |
| 3 | 53003 | June | 140.20 | 60.82 | 69.88 | | 69.88 | 0.000008 | 0.29 | 473.52 | 91.33 | 0.02 |
| 3 | 53003 | August | 64.90 | 60.82 | 69.66 | | 69.66 | 0.000002 | 0.14 | 458.42 | 86.79 | 0.01 |
| 3 | 53003 | Mean Annual Floo | 750.00 | 60.82 | 70.99 | | 71.02 | 0.000130 | 1.30 | 600.38 | 128.57 | 0.09 |
| 3 | 53003 | 100-Year | 1350.00 | 60.82 | 71.86 | | 71.73 | 0.000259 | 2.11 | 664.13 | 151.09 | 0.14 |
| 3 | 52991.5 | April | 273.30 | 64.10 | 70.21 | | 70.21 | 0.000029 | 0.64 | 508.45 | 94.59 | 0.04 |
| 3 | 52991.5 | May | 186.60 | 64.10 | 70.01 | | 70.01 | 0.000015 | 0.39 | 490.48 | 92.81 | 0.03 |
| 3 | 52991.5 | June | 140.20 | 64.10 | 69.88 | | 69.88 | 0.000009 | 0.29 | 478.39 | 92.37 | 0.02 |
| 3 | 52991.5 | August | 64.90 | 64.10 | 69.68 | | 69.66 | 0.000002 | 0.14 | 457.57 | 91.02 | 0.01 |
| 3 | 52991.5 | Mean Annual Floo | 750.00 | 64.10 | 70.59 | | 71.02 | 0.000159 | 1.28 | 567.03 | 105.78 | 0.10 |
| 3 | 52991.5 | 100-Year | 1350.00 | 64.10 | 71.66 | | 71.72 | 0.000388 | 2.04 | 661.08 | 115.20 | 0.15 |
| 3 | 52976.5 | April | 273.30 | 64.10 | 70.21 | | 70.21 | 0.000022 | 0.48 | 573.52 | 93.98 | 0.03 |
| 3 | 52976.5 | May | 186.60 | 64.10 | 70.01 | | 70.01 | 0.000011 | 0.34 | 555.44 | 93.98 | 0.02 |
| 3 | 52976.5 | June | 140.20 | 64.10 | 69.88 | | 69.88 | 0.000007 | 0.26 | 543.17 | 93.98 | 0.02 |

HEC-RAS Plan: Kenyon remov (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/l) | Vel Chrl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Cfl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 52976.5 | August | 64.90 | 64.10 | 69.96 | | 69.96 | 0.000002 | 0.12 | 521.89 | 93.98 | 0.01 |
| 3 | 52976.5 | Mean Annual Floo | 750.00 | 64.10 | 70.99 | | 71.01 | 0.000113 | 1.18 | 647.26 | 93.99 | 0.08 |
| 3 | 52976.5 | 100-Year | 1350.00 | 64.10 | 71.96 | | 71.72 | 0.000272 | 1.00 | 710.30 | 95.00 | 0.12 |
| 3 | 52973 | April | 273.30 | 66.07 | 70.20 | | 70.21 | 0.000106 | 0.72 | 409.47 | 159.03 | 0.07 |
| 3 | 52973 | May | 186.60 | 66.07 | 70.01 | | 70.01 | 0.000064 | 0.52 | 376.54 | 156.53 | 0.05 |
| 3 | 52973 | June | 140.20 | 66.07 | 69.88 | | 69.88 | 0.000042 | 0.41 | 359.53 | 153.14 | 0.04 |
| 3 | 52973 | August | 64.90 | 66.07 | 69.96 | | 69.96 | 0.000012 | 0.21 | 325.52 | 149.99 | 0.02 |
| 3 | 52973 | Mean Annual Floo | 750.00 | 66.07 | 70.97 | | 71.01 | 0.000373 | 1.54 | 637.97 | 173.28 | 0.14 |
| 3 | 52973 | 100-Year | 1350.00 | 66.07 | 71.83 | | 71.71 | 0.000687 | 2.32 | 656.27 | 165.43 | 0.19 |
| 3 | 52941 | April | 273.30 | 66.07 | 70.20 | 67.68 | 70.20 | 0.000110 | 0.72 | 408.91 | 158.97 | 0.07 |
| 3 | 52941 | May | 186.60 | 66.07 | 70.01 | 67.51 | 70.01 | 0.000064 | 0.52 | 379.22 | 155.49 | 0.05 |
| 3 | 52941 | June | 140.20 | 66.07 | 69.88 | 67.42 | 69.88 | 0.000042 | 0.41 | 359.32 | 153.11 | 0.04 |
| 3 | 52941 | August | 64.90 | 66.07 | 69.65 | 67.15 | 69.66 | 0.000012 | 0.21 | 325.49 | 148.98 | 0.02 |
| 3 | 52941 | Mean Annual Floo | 750.00 | 66.07 | 70.96 | 68.20 | 71.00 | 0.000377 | 1.54 | 635.64 | 173.95 | 0.14 |
| 3 | 52941 | 100-Year | 1350.00 | 66.07 | 71.61 | 68.72 | 71.69 | 0.000700 | 2.34 | 651.66 | 165.00 | 0.19 |
| 3 | 52940 | | | | | | | | | | | |
| 3 | 52937 | April | 273.30 | 61.50 | 63.80 | | 61.13 | 0.014529 | 4.65 | 68.74 | 44.03 | 0.71 |
| 3 | 52937 | May | 186.60 | 61.50 | 63.23 | 63.23 | 63.68 | 0.034288 | 6.37 | 34.77 | 40.43 | 1.02 |
| 3 | 52937 | June | 140.20 | 61.50 | 63.05 | 63.05 | 63.45 | 0.034088 | 6.05 | 27.77 | 36.92 | 1.01 |
| 3 | 52937 | August | 64.90 | 61.50 | 62.64 | 62.64 | 62.92 | 0.037809 | 4.28 | 15.15 | 26.84 | 1.00 |
| 3 | 52937 | Mean Annual Floo | 750.00 | 61.50 | 65.07 | | 65.19 | 0.005685 | 4.55 | 165.02 | 62.80 | 0.49 |
| 3 | 52937 | 100-Year | 1350.00 | 61.50 | 67.02 | | 67.60 | 0.005834 | 5.59 | 245.91 | 77.19 | 0.52 |
| 3 | 52922 | April | 273.30 | 60.00 | 63.01 | 62.15 | 64.00 | 0.001792 | 2.46 | 110.98 | 44.71 | 0.26 |
| 3 | 52922 | May | 186.60 | 60.00 | 63.25 | 61.83 | 63.33 | 0.001807 | 2.25 | 82.96 | 40.55 | 0.28 |
| 3 | 52922 | June | 140.20 | 60.00 | 62.83 | 61.64 | 62.90 | 0.002036 | 2.11 | 66.45 | 37.80 | 0.26 |
| 3 | 52922 | August | 64.90 | 60.00 | 62.01 | 61.22 | 62.08 | 0.002306 | 1.72 | 37.66 | 32.53 | 0.26 |
| 3 | 52922 | Mean Annual Floo | 750.00 | 60.00 | 65.90 | 63.42 | 66.09 | 0.002391 | 3.49 | 215.06 | 63.89 | 0.33 |
| 3 | 52922 | 100-Year | 1350.00 | 60.00 | 67.07 | 64.53 | 67.39 | 0.003071 | 4.58 | 306.26 | 87.50 | 0.39 |
| 3 | 52921 | | | | | | | | | | | |
| 3 | 52906 | April | 273.30 | 60.00 | 62.39 | | 62.85 | 0.017210 | 5.41 | 50.49 | 35.02 | 0.79 |
| 3 | 52906 | May | 186.60 | 60.00 | 61.99 | | 62.38 | 0.020207 | 5.05 | 36.93 | 32.38 | 0.83 |
| 3 | 52906 | June | 140.20 | 60.00 | 61.72 | 61.64 | 62.16 | 0.024736 | 4.91 | 26.55 | 30.64 | 0.90 |
| 3 | 52906 | August | 64.90 | 60.00 | 61.22 | 61.22 | 61.53 | 0.036147 | 4.46 | 14.44 | 23.72 | 1.01 |
| 3 | 52906 | Mean Annual Floo | 750.00 | 60.00 | 63.89 | | 64.61 | 0.013781 | 6.81 | 110.17 | 44.59 | 0.76 |
| 3 | 52906 | 100-Year | 1350.00 | 60.00 | 65.18 | | 66.13 | 0.012636 | 7.77 | 173.70 | 52.85 | 0.78 |
| 3 | 52873 | April | 273.30 | 59.37 | 62.23 | | 62.44 | 0.006811 | 3.71 | 73.74 | 40.00 | 0.48 |
| 3 | 52873 | May | 186.60 | 59.37 | 61.81 | | 61.97 | 0.006508 | 3.23 | 67.82 | 38.55 | 0.45 |
| 3 | 52873 | June | 140.20 | 59.37 | 61.54 | | 61.67 | 0.006251 | 2.82 | 48.02 | 34.27 | 0.43 |
| 3 | 52873 | August | 64.90 | 59.37 | 60.93 | 60.39 | 61.01 | 0.006965 | 2.26 | 28.78 | 29.04 | 0.40 |
| 3 | 52873 | Mean Annual Floo | 750.00 | 59.37 | 63.77 | | 64.20 | 0.007072 | 5.30 | 146.07 | 54.18 | 0.54 |
| 3 | 52873 | 100-Year | 1350.00 | 59.37 | 65.13 | | 65.72 | 0.007309 | 6.28 | 228.50 | 66.29 | 0.58 |
| 3 | 52850 | April | 273.30 | 59.37 | 61.36 | 61.36 | 62.01 | 0.034578 | 6.49 | 42.13 | 33.00 | 1.01 |
| 3 | 52850 | May | 186.60 | 59.37 | 61.02 | 61.02 | 61.57 | 0.037071 | 5.90 | 31.60 | 29.86 | 1.01 |
| 3 | 52850 | June | 140.20 | 59.37 | 60.85 | 60.82 | 61.28 | 0.037847 | 5.43 | 25.82 | 28.14 | 1.00 |
| 3 | 52850 | August | 64.90 | 59.37 | 60.57 | 60.57 | 60.75 | 0.019301 | 3.41 | 19.05 | 25.31 | 0.99 |
| 3 | 52850 | Mean Annual Floo | 750.00 | 59.37 | 62.62 | 62.62 | 63.71 | 0.025707 | 6.44 | 92.99 | 46.94 | 0.96 |
| 3 | 52850 | 100-Year | 1350.00 | 59.37 | 63.74 | 63.74 | 65.20 | 0.021358 | 9.63 | 152.11 | 56.57 | 0.93 |
| 3 | 52822 | April | 273.30 | 58.96 | 60.66 | 60.79 | 61.38 | 0.123154 | 7.25 | 37.70 | 64.84 | 1.68 |
| 3 | 52822 | May | 186.60 | 58.96 | 60.49 | 60.62 | 61.09 | 0.062661 | 5.75 | 32.44 | 63.91 | 1.42 |
| 3 | 52822 | June | 140.20 | 58.96 | 60.50 | 60.50 | 60.77 | 0.046275 | 4.16 | 33.74 | 64.14 | 1.01 |
| 3 | 52822 | August | 64.90 | 58.96 | 60.27 | 60.27 | 60.45 | 0.062348 | 3.34 | 19.43 | 56.26 | 1.00 |
| 3 | 52822 | Mean Annual Floo | 750.00 | 58.96 | 61.00 | 61.68 | 62.93 | 0.148694 | 11.15 | 67.25 | 69.82 | 2.00 |
| 3 | 52822 | 100-Year | 1350.00 | 58.96 | 61.44 | 62.30 | 64.32 | 0.143072 | 13.61 | 99.19 | 74.84 | 2.07 |
| 3 | 52811 | April | 273.30 | 58.32 | 58.65 | 58.12 | 58.77 | 0.181062 | 7.89 | 35.53 | 74.76 | 1.97 |
| 3 | 52811 | May | 186.60 | 58.32 | 58.73 | 58.96 | 59.50 | 0.271408 | 7.05 | 26.17 | 73.87 | 2.09 |
| 3 | 52811 | June | 140.20 | 58.32 | 58.61 | 58.85 | 59.59 | 0.477594 | 7.96 | 17.62 | 72.68 | 2.85 |
| 3 | 52811 | August | 64.90 | 58.32 | 58.51 | 58.66 | 59.11 | 0.567711 | 6.18 | 10.49 | 72.27 | 2.86 |
| 3 | 52811 | Mean Annual Floo | 750.00 | 58.32 | 59.27 | 58.93 | 61.20 | 0.171464 | 11.15 | 67.28 | 77.81 | 2.11 |
| 3 | 52811 | 100-Year | 1350.00 | 58.32 | 61.79 | 60.51 | 62.16 | 0.035527 | 4.97 | 286.43 | 66.27 | 0.48 |
| 3 | 52773 | April | 273.30 | 54.83 | 67.68 | 55.88 | 57.90 | 0.000560 | 1.12 | 243.27 | 120.05 | 0.14 |
| 3 | 52773 | May | 186.60 | 54.83 | 66.96 | 55.84 | 58.07 | 0.000916 | 1.10 | 189.57 | 114.61 | 0.16 |
| 3 | 52773 | June | 140.20 | 54.83 | 66.68 | 55.70 | 58.80 | 0.001143 | 1.16 | 127.62 | 111.40 | 0.18 |
| 3 | 52773 | August | 64.90 | 54.83 | 66.10 | 55.53 | 56.11 | 0.001265 | 0.87 | 74.44 | 106.81 | 0.18 |
| 3 | 52773 | Mean Annual Floo | 750.00 | 54.83 | 69.97 | 56.55 | 59.96 | 0.000307 | 1.37 | 561.32 | 149.18 | 0.12 |
| 3 | 52773 | 100-Year | 1350.00 | 54.83 | 82.94 | | 82.08 | 0.000255 | 1.62 | 886.76 | 167.64 | 0.11 |
| 3 | 52886 | April | 273.30 | 44.87 | 57.80 | | 57.80 | 0.000004 | 0.26 | 1168.18 | 139.98 | 0.02 |
| 3 | 52886 | May | 186.60 | 44.87 | 56.97 | | 56.97 | 0.000002 | 0.16 | 1022.08 | 135.06 | 0.01 |
| 3 | 52886 | June | 140.20 | 44.87 | 56.80 | | 56.80 | 0.000001 | 0.14 | 972.41 | 132.74 | 0.01 |

HEC-RAS Plan: Kenyon remov (Continued)

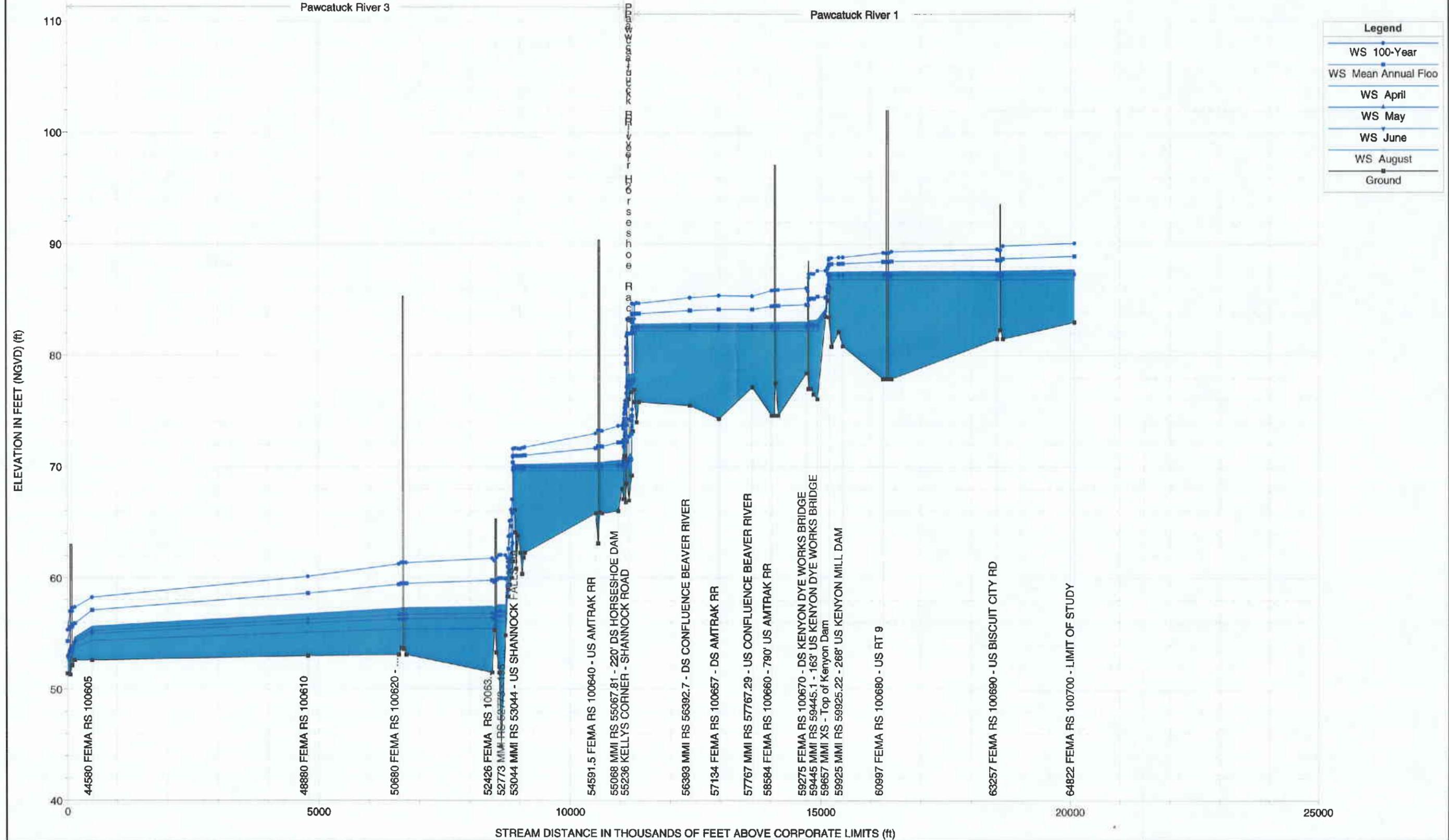
| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 52686 | August | 64.90 | 44.87 | 56.11 | | 56.11 | 0.000000 | 0.07 | 907.73 | 129.62 | 0.00 |
| 3 | 52686 | Mean Annual Floo | 750.00 | 44.87 | 59.99 | | 59.99 | 0.000012 | 0.52 | 1458.86 | 155.06 | 0.03 |
| 3 | 52686 | 100-Year | 1350.00 | 44.87 | 62.07 | | 62.08 | 0.000020 | 0.77 | 1797.27 | 171.82 | 0.04 |
| 3 | 52646.5 | April | 273.30 | 51.50 | 57.60 | | 57.00 | 0.000031 | 0.49 | 553.21 | 127.46 | 0.04 |
| 3 | 52646.5 | May | 186.60 | 51.50 | 56.97 | | 56.97 | 0.000023 | 0.39 | 474.05 | 124.53 | 0.04 |
| 3 | 52646.5 | June | 140.20 | 51.50 | 56.60 | | 56.60 | 0.000010 | 0.33 | 428.37 | 122.30 | 0.03 |
| 3 | 52646.5 | August | 64.90 | 51.50 | 56.11 | | 56.11 | 0.000000 | 0.18 | 308.93 | 119.35 | 0.02 |
| 3 | 52646.5 | Mean Annual Floo | 750.00 | 51.50 | 59.98 | | 59.99 | 0.000057 | 0.87 | 862.17 | 132.52 | 0.06 |
| 3 | 52646.5 | 100-Year | 1350.00 | 51.50 | 62.06 | | 62.07 | 0.000074 | 1.16 | 1153.24 | 156.83 | 0.07 |
| 3 | 52537.75 | April | 273.30 | 53.30 | 57.66 | 54.33 | 57.59 | 0.000253 | 1.40 | 195.25 | 45.87 | 0.12 |
| 3 | 52537.75 | May | 186.60 | 53.30 | 56.95 | 54.10 | 56.97 | 0.000199 | 1.12 | 167.11 | 45.86 | 0.10 |
| 3 | 52537.75 | June | 140.20 | 53.30 | 56.58 | 53.97 | 56.60 | 0.000154 | 0.93 | 150.47 | 45.85 | 0.09 |
| 3 | 52537.75 | August | 64.90 | 53.30 | 56.10 | 53.88 | 56.11 | 0.000055 | 0.51 | 126.47 | 45.85 | 0.05 |
| 3 | 52537.75 | Mean Annual Floo | 750.00 | 53.30 | 59.86 | 55.33 | 59.96 | 0.000512 | 2.40 | 300.86 | 45.91 | 0.17 |
| 3 | 52537.75 | 100-Year | 1350.00 | 53.30 | 61.83 | 56.30 | 62.01 | 0.000754 | 3.45 | 391.24 | 45.84 | 0.21 |
| 3 | 52617 | Bridge | | | | | | | | | | |
| 3 | 52496.25 | April | 273.30 | 55.30 | 57.38 | 56.33 | 57.51 | 0.002525 | 2.87 | 85.23 | 45.84 | 0.35 |
| 3 | 52496.25 | May | 186.60 | 55.30 | 56.74 | 56.10 | 56.86 | 0.003859 | 2.83 | 66.01 | 45.83 | 0.42 |
| 3 | 52496.25 | June | 140.20 | 55.30 | 56.32 | 55.96 | 56.46 | 0.000702 | 3.01 | 46.00 | 45.82 | 0.53 |
| 3 | 52496.25 | August | 64.90 | 55.30 | 55.70 | 55.70 | 55.89 | 0.002119 | 3.56 | 18.23 | 45.81 | 0.99 |
| 3 | 52496.25 | Mean Annual Floo | 750.00 | 55.30 | 59.64 | 57.33 | 59.86 | 0.001829 | 3.77 | 199.13 | 45.89 | 0.32 |
| 3 | 52496.25 | 100-Year | 1350.00 | 55.30 | 61.55 | 58.30 | 61.89 | 0.001023 | 4.71 | 286.64 | 45.83 | 0.33 |
| 3 | 52426 | April | 273.30 | 51.50 | 57.46 | | 57.47 | 0.000029 | 0.52 | 539.05 | 124.29 | 0.04 |
| 3 | 52426 | May | 186.60 | 51.50 | 56.82 | | 56.83 | 0.000022 | 0.41 | 451.68 | 121.10 | 0.04 |
| 3 | 52426 | June | 140.20 | 51.50 | 56.41 | | 56.41 | 0.000018 | 0.35 | 402.26 | 119.97 | 0.03 |
| 3 | 52426 | August | 64.90 | 51.50 | 55.45 | 52.50 | 55.46 | 0.000011 | 0.22 | 269.89 | 114.01 | 0.02 |
| 3 | 52426 | Mean Annual Floo | 750.00 | 51.50 | 59.78 | | 59.80 | 0.000053 | 0.91 | 827.09 | 131.62 | 0.06 |
| 3 | 52426 | 100-Year | 1350.00 | 51.50 | 61.77 | | 61.79 | 0.000070 | 1.24 | 1101.84 | 147.09 | 0.08 |
| 3 | 50805 | April | 273.30 | 53.10 | 57.31 | | 57.36 | 0.000314 | 1.46 | 189.97 | 55.85 | 0.14 |
| 3 | 50805 | May | 186.60 | 53.10 | 56.71 | | 56.73 | 0.000264 | 1.29 | 158.81 | 53.88 | 0.12 |
| 3 | 50805 | June | 140.20 | 53.10 | 56.32 | | 56.34 | 0.000232 | 1.04 | 134.55 | 52.76 | 0.11 |
| 3 | 50805 | August | 64.90 | 53.10 | 55.40 | | 55.41 | 0.000187 | 0.74 | 87.89 | 49.09 | 0.10 |
| 3 | 50805 | Mean Annual Floo | 750.00 | 53.10 | 59.50 | | 59.59 | 0.000497 | 2.38 | 313.14 | 62.63 | 0.18 |
| 3 | 50805 | 100-Year | 1350.00 | 53.10 | 61.37 | | 61.50 | 0.000764 | 2.90 | 481.55 | 140.42 | 0.23 |
| 3 | 50755 | April | 273.30 | 53.60 | 57.32 | 54.21 | 57.33 | 0.000098 | 0.73 | 372.04 | 100.94 | 0.07 |
| 3 | 50755 | May | 186.60 | 53.60 | 56.71 | 54.08 | 56.72 | 0.000067 | 0.60 | 311.39 | 100.79 | 0.06 |
| 3 | 50755 | June | 140.20 | 53.60 | 56.32 | 54.00 | 56.33 | 0.000051 | 0.52 | 272.18 | 100.69 | 0.06 |
| 3 | 50755 | August | 64.90 | 53.60 | 55.40 | 53.83 | 55.40 | 0.000043 | 0.38 | 179.88 | 100.45 | 0.05 |
| 3 | 50755 | Mean Annual Floo | 750.00 | 53.60 | 59.52 | 54.80 | 59.54 | 0.000109 | 1.27 | 591.57 | 101.40 | 0.06 |
| 3 | 50755 | 100-Year | 1350.00 | 53.60 | 61.40 | 55.30 | 61.44 | 0.000141 | 1.73 | 779.61 | 101.97 | 0.11 |
| 3 | 50742.5 | Bridge | | | | | | | | | | |
| 3 | 50730 | April | 273.30 | 53.70 | 57.31 | 54.32 | 57.32 | 0.000075 | 0.76 | 361.41 | 100.92 | 0.07 |
| 3 | 50730 | May | 186.60 | 53.70 | 56.71 | 54.17 | 56.71 | 0.000064 | 0.62 | 309.88 | 100.76 | 0.06 |
| 3 | 50730 | June | 140.20 | 53.70 | 56.32 | 54.09 | 56.32 | 0.000058 | 0.54 | 261.74 | 100.66 | 0.06 |
| 3 | 50730 | August | 64.90 | 53.70 | 55.40 | 53.04 | 55.40 | 0.000053 | 0.38 | 169.00 | 100.43 | 0.05 |
| 3 | 50730 | Mean Annual Floo | 750.00 | 53.70 | 59.50 | 54.91 | 59.53 | 0.000116 | 1.29 | 580.34 | 101.47 | 0.06 |
| 3 | 50730 | 100-Year | 1350.00 | 53.70 | 61.38 | 55.49 | 61.43 | 0.000148 | 1.76 | 787.77 | 101.94 | 0.11 |
| 3 | 50660 | April | 273.30 | 53.10 | 57.28 | | 57.31 | 0.000326 | 1.46 | 186.79 | 55.73 | 0.14 |
| 3 | 50660 | May | 186.60 | 53.10 | 56.68 | | 56.70 | 0.000273 | 1.21 | 154.21 | 53.99 | 0.13 |
| 3 | 50660 | June | 140.20 | 53.10 | 56.30 | | 56.31 | 0.000239 | 1.05 | 133.67 | 52.89 | 0.12 |
| 3 | 50660 | August | 64.90 | 53.10 | 55.38 | | 55.39 | 0.000192 | 0.75 | 87.05 | 49.90 | 0.10 |
| 3 | 50660 | Mean Annual Floo | 750.00 | 53.10 | 59.41 | | 59.50 | 0.000522 | 2.40 | 312.84 | 62.36 | 0.19 |
| 3 | 50660 | 100-Year | 1350.00 | 53.10 | 61.25 | | 61.38 | 0.000801 | 2.98 | 485.12 | 131.26 | 0.24 |
| 3 | 48880 | April | 273.30 | 53.00 | 58.79 | | 58.02 | 0.000231 | 1.28 | 230.96 | 85.10 | 0.12 |
| 3 | 48880 | May | 186.60 | 53.00 | 58.28 | | 58.30 | 0.000187 | 1.04 | 198.59 | 77.96 | 0.11 |
| 3 | 48880 | June | 140.20 | 53.00 | 58.95 | | 58.96 | 0.000159 | 0.89 | 163.44 | 73.32 | 0.10 |
| 3 | 48880 | August | 64.90 | 53.00 | 56.11 | | 56.11 | 0.000126 | 0.61 | 106.57 | 61.51 | 0.08 |
| 3 | 48880 | Mean Annual Floo | 750.00 | 53.00 | 58.63 | | 58.70 | 0.000378 | 2.18 | 409.94 | 110.81 | 0.17 |
| 3 | 48880 | 100-Year | 1350.00 | 53.00 | 60.13 | | 60.25 | 0.000502 | 2.97 | 604.42 | 232.42 | 0.20 |
| 3 | 44580 | April | 273.30 | 52.60 | 55.64 | | 55.65 | 0.000325 | 1.02 | 270.36 | 153.97 | 0.13 |
| 3 | 44580 | May | 186.60 | 52.60 | 55.24 | | 55.29 | 0.000330 | 0.86 | 211.47 | 145.32 | 0.13 |
| 3 | 44580 | June | 140.20 | 52.60 | 55.00 | | 55.01 | 0.000336 | 0.78 | 176.39 | 139.88 | 0.12 |
| 3 | 44580 | August | 64.90 | 52.60 | 54.38 | | 54.37 | 0.000252 | 0.63 | 102.82 | 92.71 | 0.11 |
| 3 | 44580 | Mean Annual Floo | 750.00 | 52.60 | 57.10 | | 57.13 | 0.000348 | 1.55 | 518.93 | 196.13 | 0.15 |
| 3 | 44580 | 100-Year | 1350.00 | 52.60 | 58.25 | | 58.31 | 0.000402 | 2.03 | 747.83 | 211.44 | 0.17 |
| 3 | 44230 | April | 273.30 | 52.60 | 54.65 | 54.65 | 55.23 | 0.023178 | 6.10 | 44.80 | 39.74 | 1.01 |
| 3 | 44230 | May | 186.60 | 52.60 | 54.35 | 54.35 | 54.84 | 0.024648 | 5.57 | 33.50 | 35.68 | 1.01 |
| 3 | 44230 | June | 140.20 | 52.60 | 54.18 | 54.18 | 54.68 | 0.025809 | 5.22 | 26.85 | 32.64 | 1.01 |

HEC-RAS Plan: Canyon remov (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/l) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ch |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|----------------------|--------------------|----------------------|-------------------|-------------|
| 3 | 44230 | August | 94.00 | 52.60 | 53.74 | 53.74 | 54.04 | 0.028823 | 4.41 | 14.73 | 25.00 | 1.01 |
| 3 | 44230 | Mean Annual Floo | 750.00 | 52.60 | 55.91 | 55.91 | 56.70 | 0.013300 | 7.29 | 121.20 | 108.36 | 0.60 |
| 3 | 44230 | 100-Year | 1350.00 | 52.60 | 67.38 | | 57.92 | 0.005430 | 6.53 | 301.81 | 136.91 | 0.60 |
| 3 | 44180 | April | 273.30 | 52.10 | 54.13 | 53.06 | 54.22 | 0.001937 | 2.61 | 104.80 | 52.76 | 0.32 |
| 3 | 44180 | May | 186.60 | 52.10 | 53.70 | 52.84 | 53.78 | 0.001947 | 2.24 | 83.14 | 52.58 | 0.31 |
| 3 | 44180 | June | 140.20 | 52.10 | 53.45 | 52.71 | 53.51 | 0.001954 | 2.00 | 69.96 | 52.47 | 0.30 |
| 3 | 44180 | August | 94.00 | 52.10 | 52.94 | 52.47 | 52.97 | 0.002029 | 1.49 | 43.58 | 52.26 | 0.29 |
| 3 | 44180 | Mean Annual Floo | 750.00 | 52.10 | 55.78 | 53.97 | 56.02 | 0.001969 | 3.93 | 190.92 | 53.46 | 0.30 |
| 3 | 44180 | 100-Year | 1350.00 | 52.10 | 67.30 | 54.86 | 57.80 | 0.002013 | 5.00 | 266.87 | 54.10 | 0.39 |
| 3 | 44156.7 | Bridge | | | | | | | | | | |
| 3 | 44133.4 | April | 273.30 | 51.30 | 54.01 | 52.25 | 54.07 | 0.000724 | 1.94 | 140.86 | 52.97 | 0.21 |
| 3 | 44133.4 | May | 186.60 | 51.30 | 53.62 | 52.04 | 53.86 | 0.000570 | 1.55 | 120.10 | 52.81 | 0.18 |
| 3 | 44133.4 | June | 140.20 | 51.30 | 53.38 | 51.91 | 53.40 | 0.000464 | 1.30 | 107.70 | 52.72 | 0.18 |
| 3 | 44133.4 | August | 94.00 | 51.30 | 52.89 | 51.60 | 52.90 | 0.000240 | 0.79 | 62.65 | 52.53 | 0.11 |
| 3 | 44133.4 | Mean Annual Floo | 750.00 | 51.30 | 55.56 | 53.17 | 55.78 | 0.001189 | 3.38 | 222.11 | 53.59 | 0.29 |
| 3 | 44133.4 | 100-Year | 1350.00 | 51.30 | 67.00 | 54.06 | 57.32 | 0.001484 | 4.57 | 288.72 | 54.15 | 0.34 |
| 3 | 44083.4 | April | 273.30 | 51.40 | 53.26 | 53.26 | 53.81 | 0.026040 | 5.06 | 46.82 | 42.75 | 1.02 |
| 3 | 44083.4 | May | 186.60 | 51.40 | 53.02 | 53.02 | 53.46 | 0.026759 | 5.27 | 35.43 | 42.14 | 1.01 |
| 3 | 44083.4 | June | 140.20 | 51.40 | 52.86 | 52.86 | 53.23 | 0.020064 | 4.84 | 28.99 | 41.76 | 1.02 |
| 3 | 44083.4 | August | 94.00 | 51.40 | 52.57 | 52.57 | 52.89 | 0.032365 | 3.83 | 16.62 | 37.67 | 1.01 |
| 3 | 44083.4 | Mean Annual Floo | 750.00 | 51.40 | 54.31 | 54.31 | 55.34 | 0.020660 | 6.18 | 91.73 | 45.07 | 1.01 |
| 3 | 44083.4 | 100-Year | 1350.00 | 51.40 | 56.32 | 55.32 | 56.89 | 0.018648 | 9.74 | 138.54 | 47.45 | 1.01 |

APPENDIX F
HEC-RAS OUTPUT
KENYON MILL DAM ROCK RAMP

Proposed - Kenyon Rock Ramp Plan: kenyon rock ramp 8/27/2007



| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W S Elev (ft) | Crit W S (ft) | E G Elev (ft) | E G Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|-------------------|------------------|------------------|------------------|----------------------|--------------------|----------------------|-------------------|--------------|
| | 84822 | April | 273.30 | 83.00 | 87.74 | 84.24 | 87.74 | 0.000075 | 0.83 | 756.55 | 594.41 | 0.07 |
| 1 | 84822 | May | 186.60 | 83.00 | 87.44 | 83.97 | 87.45 | 0.000058 | 0.70 | 586.52 | 585.25 | 0.06 |
| 1 | 84822 | June | 140.20 | 83.00 | 87.27 | 83.80 | 87.28 | 0.000045 | 0.60 | 490.01 | 548.02 | 0.05 |
| 1 | 84822 | August | 64.90 | 83.00 | 86.88 | 83.48 | 86.88 | 0.000019 | 0.36 | 297.63 | 396.59 | 0.03 |
| 1 | 84822 | Mean Annual Floo | 750.00 | 83.00 | 86.95 | 85.38 | 86.96 | 0.000104 | 1.16 | 1564.03 | 716.28 | 0.09 |
| 1 | 84822 | 100-Year | 1350.00 | 83.00 | 90.12 | 87.13 | 90.13 | 0.000101 | 1.30 | 2422.42 | 753.17 | 0.09 |
| | 83372 | April | 273.30 | 81.50 | 87.03 | | 87.64 | 0.000078 | 0.77 | 355.33 | 110.10 | 0.07 |
| 1 | 83372 | May | 186.60 | 81.50 | 87.37 | | 87.38 | 0.000045 | 0.57 | 328.86 | 97.98 | 0.05 |
| 1 | 83372 | June | 140.20 | 81.50 | 87.22 | | 87.22 | 0.000029 | 0.45 | 314.55 | 93.51 | 0.04 |
| 1 | 83372 | August | 64.90 | 81.50 | 86.88 | | 86.88 | 0.000009 | 0.23 | 281.21 | 90.37 | 0.02 |
| 1 | 83372 | Mean Annual Floo | 750.00 | 81.50 | 86.72 | | 86.78 | 0.000210 | 1.51 | 677.75 | 395.24 | 0.12 |
| 1 | 83372 | 100-Year | 1350.00 | 81.50 | 89.07 | | 89.92 | 0.000247 | 1.85 | 1159.77 | 442.54 | 0.14 |
| | 83322 | April | 273.30 | 82.30 | 87.60 | 83.40 | 87.63 | 0.000136 | 1.23 | 222.33 | 59.63 | 0.00 |
| 1 | 83322 | May | 186.60 | 82.30 | 87.38 | 83.15 | 87.37 | 0.000075 | 0.88 | 212.12 | 58.82 | 0.07 |
| 1 | 83322 | June | 140.20 | 82.30 | 87.21 | 83.00 | 87.22 | 0.000047 | 0.68 | 205.96 | 58.33 | 0.05 |
| 1 | 83322 | August | 64.90 | 82.30 | 86.88 | 82.72 | 86.88 | 0.000013 | 0.34 | 191.01 | 57.13 | 0.03 |
| 1 | 83322 | Mean Annual Floo | 750.00 | 82.30 | 86.60 | 84.45 | 86.71 | 0.000006 | 2.85 | 283.57 | 62.92 | 0.20 |
| 1 | 83322 | 100-Year | 1350.00 | 82.30 | 89.50 | 85.48 | 89.81 | 0.001284 | 4.47 | 302.05 | 65.86 | 0.29 |
| | 83314.5 | Bridge | | | | | | | | | | |
| | 83307 | April | 273.30 | 82.30 | 87.60 | 83.40 | 87.62 | 0.000136 | 1.23 | 222.22 | 59.62 | 0.00 |
| 1 | 83307 | May | 186.60 | 82.30 | 87.38 | 83.15 | 87.37 | 0.000075 | 0.88 | 212.06 | 58.81 | 0.07 |
| 1 | 83307 | June | 140.20 | 82.30 | 87.21 | 83.00 | 87.22 | 0.000047 | 0.68 | 205.96 | 58.32 | 0.05 |
| 1 | 83307 | August | 64.90 | 82.30 | 86.88 | 82.72 | 86.88 | 0.000013 | 0.34 | 191.00 | 57.13 | 0.03 |
| 1 | 83307 | Mean Annual Floo | 750.00 | 82.30 | 86.57 | 84.45 | 86.70 | 0.000612 | 2.85 | 263.10 | 62.88 | 0.20 |
| 1 | 83307 | 100-Year | 1350.00 | 82.30 | 89.48 | 85.48 | 89.79 | 0.001296 | 4.40 | 300.96 | 65.89 | 0.30 |
| | 83257 | April | 273.30 | 81.60 | 87.60 | | 87.61 | 0.000078 | 0.78 | 352.70 | 108.93 | 0.07 |
| 1 | 83257 | May | 186.60 | 81.60 | 87.38 | | 87.38 | 0.000046 | 0.57 | 327.63 | 97.06 | 0.05 |
| 1 | 83257 | June | 140.20 | 81.60 | 87.21 | | 87.22 | 0.000029 | 0.45 | 313.82 | 93.44 | 0.04 |
| 1 | 83257 | August | 64.90 | 81.60 | 86.88 | | 86.88 | 0.000006 | 0.23 | 281.03 | 90.36 | 0.02 |
| 1 | 83257 | Mean Annual Floo | 750.00 | 81.60 | 86.80 | | 86.84 | 0.000247 | 1.57 | 629.70 | 387.53 | 0.13 |
| 1 | 83257 | 100-Year | 1350.00 | 81.60 | 89.58 | | 89.63 | 0.000318 | 2.03 | 1030.78 | 430.51 | 0.15 |
| | 81157 | April | 273.30 | 77.90 | 87.67 | | 87.67 | 0.000007 | 0.33 | 850.86 | 249.38 | 0.02 |
| 1 | 81157 | May | 186.60 | 77.90 | 87.34 | | 87.34 | 0.000004 | 0.24 | 798.80 | 204.24 | 0.02 |
| 1 | 81157 | June | 140.20 | 77.90 | 87.20 | | 87.20 | 0.000002 | 0.18 | 772.16 | 176.73 | 0.01 |
| 1 | 81157 | August | 64.90 | 77.90 | 86.85 | | 86.85 | 0.000001 | 0.09 | 724.96 | 119.02 | 0.01 |
| 1 | 81157 | Mean Annual Floo | 750.00 | 77.90 | 86.77 | | 86.88 | 0.000033 | 0.78 | 1122.31 | 341.75 | 0.05 |
| 1 | 81157 | 100-Year | 1350.00 | 77.90 | 89.34 | | 89.36 | 0.000087 | 1.21 | 1468.69 | 443.52 | 0.07 |
| | 81107 | April | 273.30 | 77.90 | 87.67 | 79.34 | 87.67 | 0.000013 | 0.59 | 460.35 | 248.33 | 0.03 |
| 1 | 81107 | May | 186.60 | 77.90 | 87.34 | 79.12 | 87.34 | 0.000007 | 0.42 | 449.01 | 203.73 | 0.02 |
| 1 | 81107 | June | 140.20 | 77.90 | 87.20 | 78.88 | 87.20 | 0.000004 | 0.32 | 442.07 | 176.41 | 0.02 |
| 1 | 81107 | August | 64.90 | 77.90 | 86.85 | 78.63 | 86.85 | 0.000001 | 0.15 | 424.65 | 119.02 | 0.01 |
| 1 | 81107 | Mean Annual Floo | 750.00 | 77.90 | 86.44 | 80.27 | 86.47 | 0.000074 | 1.49 | 503.88 | 338.70 | 0.08 |
| 1 | 81107 | 100-Year | 1350.00 | 77.90 | 89.24 | 81.19 | 89.33 | 0.000186 | 2.48 | 543.76 | 434.85 | 0.13 |
| | 81077 | Bridge | | | | | | | | | | |
| | 81047 | April | 273.30 | 77.90 | 87.57 | 79.34 | 87.57 | 0.000013 | 0.59 | 460.28 | 248.05 | 0.03 |
| 1 | 81047 | May | 186.60 | 77.90 | 87.34 | 79.12 | 87.34 | 0.000007 | 0.42 | 448.98 | 203.59 | 0.02 |
| 1 | 81047 | June | 140.20 | 77.90 | 87.20 | 78.88 | 87.20 | 0.000004 | 0.32 | 442.05 | 176.36 | 0.02 |
| 1 | 81047 | August | 64.90 | 77.90 | 86.85 | 78.63 | 86.85 | 0.000001 | 0.15 | 424.64 | 119.01 | 0.01 |
| 1 | 81047 | Mean Annual Floo | 750.00 | 77.90 | 86.43 | 80.27 | 86.46 | 0.000074 | 1.49 | 503.41 | 337.89 | 0.08 |
| 1 | 81047 | 100-Year | 1350.00 | 77.90 | 89.21 | 81.19 | 89.30 | 0.000197 | 2.49 | 542.36 | 432.42 | 0.13 |
| | 80997 | April | 273.30 | 77.90 | 87.57 | | 87.57 | 0.000007 | 0.33 | 849.53 | 248.33 | 0.02 |
| 1 | 80997 | May | 186.60 | 77.90 | 87.34 | | 87.34 | 0.000004 | 0.24 | 798.27 | 203.73 | 0.02 |
| 1 | 80997 | June | 140.20 | 77.90 | 87.20 | | 87.20 | 0.000002 | 0.18 | 771.89 | 176.43 | 0.01 |
| 1 | 80997 | August | 64.90 | 77.90 | 86.85 | | 86.85 | 0.000001 | 0.09 | 724.95 | 119.02 | 0.01 |
| 1 | 80997 | Mean Annual Floo | 750.00 | 77.90 | 86.44 | | 86.46 | 0.000033 | 0.79 | 1110.69 | 338.77 | 0.05 |
| 1 | 80997 | 100-Year | 1350.00 | 77.90 | 89.24 | | 89.26 | 0.000071 | 1.23 | 1425.57 | 435.16 | 0.08 |
| | 59825 | April | 273.30 | 80.83 | 87.53 | | 87.55 | 0.000131 | 1.14 | 249.18 | 86.89 | 0.09 |
| 1 | 59825 | May | 186.60 | 80.83 | 87.32 | | 87.33 | 0.000072 | 0.82 | 232.26 | 74.30 | 0.07 |
| 1 | 59825 | June | 140.20 | 80.83 | 87.19 | | 87.20 | 0.000045 | 0.63 | 223.00 | 68.41 | 0.05 |
| 1 | 59825 | August | 64.90 | 80.83 | 86.65 | | 86.65 | 0.000013 | 0.32 | 203.44 | 52.66 | 0.03 |
| 1 | 59825 | Mean Annual Floo | 750.00 | 80.83 | 86.28 | | 86.37 | 0.000571 | 2.63 | 331.33 | 138.98 | 0.20 |
| 1 | 59825 | 100-Year | 1350.00 | 80.83 | 88.84 | | 89.09 | 0.001224 | 4.12 | 423.24 | 181.02 | 0.30 |
| | 59846 | April | 273.30 | 82.11 | 87.53 | | 87.54 | 0.000118 | 0.90 | 306.32 | 98.20 | 0.09 |
| 1 | 59846 | May | 186.60 | 82.11 | 87.32 | | 87.33 | 0.000068 | 0.65 | 286.14 | 95.66 | 0.07 |
| 1 | 59846 | June | 140.20 | 82.11 | 87.19 | | 87.19 | 0.000044 | 0.51 | 273.76 | 94.07 | 0.05 |
| 1 | 59846 | August | 64.90 | 82.11 | 86.85 | | 86.85 | 0.000014 | 0.27 | 242.57 | 90.28 | 0.03 |
| 1 | 59846 | Mean Annual Floo | 750.00 | 82.11 | 86.25 | | 86.31 | 0.000458 | 2.02 | 380.50 | 107.03 | 0.18 |
| 1 | 59846 | 100-Year | 1350.00 | 82.11 | 88.81 | | 88.97 | 0.000952 | 3.17 | 455.31 | 160.04 | 0.26 |

HEC-RAS Plan: Keryan ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch Elev (ft) | W.S Elev (ft) | Crit W.S (ft) | E.G. Elev (ft) | E.G. Slope (ft/l) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|---------------------|------------------|------------------|-------------------|----------------------|--------------------|----------------------|-------------------|--------------|
| 1 | 56700 | April | 273.30 | 80.80 | 87.52 | | 87.53 | 0.000046 | 0.66 | 414.42 | 102.83 | 0.06 |
| 1 | 56700 | May | 186.60 | 80.80 | 87.32 | | 87.32 | 0.000025 | 0.47 | 393.85 | 80.40 | 0.04 |
| 1 | 56700 | June | 140.20 | 80.80 | 87.19 | | 87.19 | 0.000016 | 0.37 | 380.93 | 97.24 | 0.03 |
| 1 | 56700 | August | 64.90 | 80.80 | 86.85 | | 86.85 | 0.000004 | 0.19 | 349.38 | 87.83 | 0.02 |
| 1 | 56700 | Mean Annual Floe | 750.00 | 80.80 | 86.23 | | 86.26 | 0.000210 | 1.54 | 527.75 | 207.70 | 0.12 |
| 1 | 56700 | 100-Year | 1350.00 | 80.80 | 80.77 | | 86.86 | 0.000481 | 2.45 | 647.50 | 235.71 | 0.18 |
| 1 | 59664 | April | 273.30 | 83.44 | 87.51 | | 87.52 | 0.000096 | 0.82 | 409.69 | 224.42 | 0.08 |
| 1 | 59664 | May | 186.60 | 83.44 | 87.31 | | 87.32 | 0.000056 | 0.61 | 365.05 | 215.67 | 0.09 |
| 1 | 59664 | June | 140.20 | 83.44 | 87.18 | | 87.19 | 0.000037 | 0.48 | 337.81 | 210.15 | 0.05 |
| 1 | 59664 | August | 64.90 | 83.44 | 86.85 | | 86.85 | 0.000012 | 0.26 | 271.43 | 173.62 | 0.03 |
| 1 | 59664 | Mean Annual Floe | 750.00 | 83.44 | 86.21 | | 86.26 | 0.000352 | 1.75 | 575.13 | 254.24 | 0.15 |
| 1 | 59664 | 100-Year | 1350.00 | 83.44 | 88.74 | | 86.83 | 0.000668 | 2.65 | 715.89 | 277.10 | 0.22 |
| 1 | 59657 | April | 273.30 | 88.10 | 87.41 | | 87.48 | 0.000948 | 2.44 | 142.34 | 222.29 | 0.40 |
| 1 | 59657 | May | 186.60 | 88.10 | 87.19 | | 87.27 | 0.012659 | 2.40 | 95.06 | 213.91 | 0.44 |
| 1 | 59657 | June | 140.20 | 88.10 | 87.09 | | 87.14 | 0.014135 | 2.29 | 67.81 | 208.44 | 0.45 |
| 1 | 59657 | August | 64.90 | 88.10 | 86.78 | | 86.82 | 0.013762 | 1.69 | 38.42 | 76.01 | 0.42 |
| 1 | 59657 | Mean Annual Floe | 750.00 | 88.10 | 88.09 | | 88.20 | 0.008828 | 3.13 | 302.93 | 240.64 | 0.41 |
| 1 | 59657 | 100-Year | 1350.00 | 88.10 | 88.60 | | 88.77 | 0.009818 | 3.88 | 436.59 | 270.13 | 0.45 |
| 1 | 59646 | April | 273.30 | 85.73 | 86.60 | 86.60 | 86.66 | 0.081285 | 4.89 | 56.89 | 70.80 | 1.00 |
| 1 | 59646 | May | 186.60 | 85.73 | 86.44 | 86.44 | 86.72 | 0.080600 | 4.25 | 43.86 | 70.43 | 1.01 |
| 1 | 59646 | June | 140.20 | 85.73 | 86.34 | 86.34 | 86.67 | 0.095512 | 3.87 | 36.20 | 70.35 | 1.01 |
| 1 | 59646 | August | 64.90 | 85.73 | 86.16 | 86.16 | 86.30 | 0.108608 | 2.97 | 21.84 | 76.87 | 0.90 |
| 1 | 59646 | Mean Annual Floe | 750.00 | 85.73 | 87.38 | 87.38 | 87.77 | 0.038248 | 5.34 | 172.37 | 225.39 | 0.77 |
| 1 | 59646 | 100-Year | 1350.00 | 85.73 | 87.79 | | 88.29 | 0.030690 | 6.36 | 286.27 | 241.46 | 0.81 |
| 1 | 59630 | April | 273.30 | 84.93 | 86.01 | 86.70 | 86.18 | 0.021531 | 3.28 | 83.37 | 86.89 | 0.58 |
| 1 | 59630 | May | 186.60 | 84.93 | 85.81 | 85.54 | 85.93 | 0.020717 | 2.81 | 66.43 | 83.30 | 0.55 |
| 1 | 59630 | June | 140.20 | 84.93 | 85.68 | 85.46 | 85.78 | 0.020059 | 2.50 | 56.15 | 82.20 | 0.53 |
| 1 | 59630 | August | 64.90 | 84.93 | 85.44 | 85.27 | 85.40 | 0.018452 | 1.79 | 36.18 | 82.06 | 0.48 |
| 1 | 59630 | Mean Annual Floe | 750.00 | 84.93 | 86.08 | 86.43 | 87.32 | 0.0179147 | 9.28 | 80.84 | 85.07 | 1.68 |
| 1 | 59630 | 100-Year | 1350.00 | 84.93 | 87.91 | | 88.12 | 0.008287 | 4.12 | 403.96 | 222.02 | 0.43 |
| 1 | 59597 | April | 273.30 | 83.50 | 84.21 | 84.21 | 84.57 | 0.071208 | 4.61 | 56.84 | 79.83 | 1.00 |
| 1 | 59597 | May | 186.60 | 83.50 | 84.05 | 84.05 | 84.33 | 0.077336 | 4.24 | 44.03 | 79.82 | 1.01 |
| 1 | 59597 | June | 140.20 | 83.50 | 83.98 | 83.98 | 84.19 | 0.081896 | 3.85 | 36.43 | 79.82 | 1.00 |
| 1 | 59597 | August | 64.90 | 83.50 | 83.77 | 83.77 | 83.91 | 0.086603 | 2.87 | 21.87 | 79.81 | 1.00 |
| 1 | 59597 | Mean Annual Floe | 750.00 | 83.50 | 85.23 | 84.69 | 85.89 | 0.028856 | 5.44 | 137.04 | 79.88 | 0.73 |
| 1 | 59597 | 100-Year | 1350.00 | 83.50 | 87.64 | | 87.85 | 0.004681 | 3.60 | 422.49 | 235.82 | 0.33 |
| 1 | 59445 | April | 273.30 | 76.08 | 83.25 | 78.13 | 83.27 | 0.000145 | 1.29 | 212.58 | 38.78 | 0.10 |
| 1 | 59445 | May | 186.60 | 76.08 | 82.84 | 77.79 | 82.85 | 0.000084 | 0.95 | 198.94 | 37.96 | 0.07 |
| 1 | 59445 | June | 140.20 | 76.08 | 82.62 | 77.52 | 82.63 | 0.000054 | 0.74 | 188.65 | 37.52 | 0.06 |
| 1 | 59445 | August | 64.90 | 76.08 | 82.25 | 77.02 | 82.26 | 0.000014 | 0.37 | 174.85 | 36.81 | 0.03 |
| 1 | 59445 | Mean Annual Floe | 750.00 | 76.08 | 85.30 | | 85.38 | 0.000365 | 2.39 | 401.78 | 149.23 | 0.10 |
| 1 | 59445 | 100-Year | 1350.00 | 76.08 | 87.61 | | 87.69 | 0.000320 | 2.62 | 858.74 | 229.41 | 0.15 |
| 1 | 59397 | April | 273.30 | 76.50 | 83.18 | | 83.25 | 0.060708 | 2.02 | 135.28 | 35.86 | 0.18 |
| 1 | 59397 | May | 186.60 | 76.50 | 82.80 | | 82.84 | 0.060440 | 1.53 | 121.83 | 34.48 | 0.14 |
| 1 | 59397 | June | 140.20 | 76.50 | 82.58 | | 82.62 | 0.060293 | 1.22 | 114.78 | 33.89 | 0.12 |
| 1 | 59397 | August | 64.90 | 76.50 | 82.24 | | 82.25 | 0.060035 | 0.63 | 103.12 | 32.33 | 0.06 |
| 1 | 59397 | Mean Annual Floe | 750.00 | 76.50 | 85.12 | | 85.32 | 0.001511 | 3.68 | 206.80 | 40.51 | 0.28 |
| 1 | 59397 | 100-Year | 1350.00 | 76.50 | 87.34 | | 87.02 | 0.001554 | 4.33 | 387.26 | 308.36 | 0.29 |
| 1 | 59347 | April | 273.30 | 77.00 | 83.16 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.75 | 40.08 | 0.08 |
| 1 | 59347 | May | 186.60 | 77.00 | 82.81 | 77.88 | 82.82 | 0.000088 | 0.80 | 232.30 | 40.67 | 0.06 |
| 1 | 59347 | June | 140.20 | 77.00 | 82.60 | 77.72 | 82.60 | 0.000043 | 0.63 | 223.96 | 40.67 | 0.05 |
| 1 | 59347 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.70 | 40.67 | 0.02 |
| 1 | 59347 | Mean Annual Floe | 750.00 | 77.00 | 85.15 | 79.22 | 85.23 | 0.000378 | 2.30 | 325.90 | 119.03 | 0.14 |
| 1 | 59347 | 100-Year | 1350.00 | 77.00 | 87.36 | 80.26 | 87.52 | 0.000550 | 3.26 | 414.28 | 119.47 | 0.18 |
| 1 | 59325 | April | 273.30 | 77.00 | 83.10 | 78.13 | 83.21 | 0.000119 | 1.10 | 247.51 | 40.08 | 0.08 |
| 1 | 59325 | May | 186.60 | 77.00 | 82.80 | 77.85 | 82.81 | 0.000088 | 0.80 | 232.16 | 40.07 | 0.08 |
| 1 | 59325 | June | 140.20 | 77.00 | 82.60 | 77.73 | 82.60 | 0.000043 | 0.63 | 223.87 | 40.07 | 0.05 |
| 1 | 59325 | August | 64.90 | 77.00 | 82.24 | 77.43 | 82.24 | 0.000011 | 0.31 | 209.67 | 40.07 | 0.02 |
| 1 | 59325 | Mean Annual Floe | 750.00 | 77.00 | 85.13 | 79.22 | 85.21 | 0.000381 | 2.31 | 325.12 | 119.03 | 0.14 |
| 1 | 59325 | 100-Year | 1350.00 | 77.00 | 87.33 | 80.28 | 87.49 | 0.000555 | 3.27 | 413.13 | 119.47 | 0.18 |
| 1 | 59290 | Bridge | | | | | | | | | | |
| 1 | 59275 | April | 273.30 | 78.40 | 83.04 | | 83.14 | 0.000565 | 2.40 | 119.33 | 35.42 | 0.25 |
| 1 | 59275 | May | 186.60 | 78.40 | 82.72 | | 82.78 | 0.000370 | 1.88 | 99.13 | 34.18 | 0.19 |
| 1 | 59275 | June | 140.20 | 78.40 | 82.54 | | 82.58 | 0.000250 | 1.51 | 93.11 | 33.50 | 0.16 |
| 1 | 59275 | August | 64.90 | 78.40 | 82.23 | | 82.24 | 0.000076 | 0.78 | 82.68 | 32.28 | 0.09 |
| 1 | 59275 | Mean Annual Floe | 750.00 | 78.40 | 84.58 | | 84.89 | 0.001296 | 4.47 | 187.87 | 39.29 | 0.38 |
| 1 | 59275 | 100-Year | 1350.00 | 78.40 | 86.06 | | 86.60 | 0.001728 | 5.91 | 228.57 | 42.63 | 0.45 |
| 1 | 58715 | April | 273.30 | 74.60 | 83.02 | | 83.03 | 0.000097 | 0.91 | 301.29 | 54.49 | 0.07 |
| 1 | 58715 | May | 186.60 | 74.60 | 82.71 | | 82.72 | 0.000037 | 0.66 | 284.52 | 53.71 | 0.05 |

HEC-RAS Plan: Kenyon ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | I.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Ctr'l (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Ctr |
|----------------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|---------------------|----------------------|-------------------|--------------|
| 1 | 59715 | June | 140.20 | 74.60 | 82.54 | | 82.54 | 0.000023 | 0.51 | 275.31 | 53.27 | 0.04 |
| 1 | 59715 | August | 94.90 | 74.60 | 82.23 | | 82.23 | 0.000006 | 0.25 | 258.89 | 52.49 | 0.02 |
| 1 | 59715 | Mean Annual Floo | 750.00 | 74.60 | 84.48 | | 84.54 | 0.000250 | 1.96 | 363.27 | 57.20 | 0.13 |
| 1 | 59715 | 100-Year | 1350.00 | 74.60 | 85.90 | | 86.03 | 0.000459 | 2.90 | 408.23 | 50.70 | 0.18 |
| 1 | 59665 | April | 273.30 | 77.50 | 83.02 | 78.28 | 83.03 | 0.000042 | 0.69 | 396.42 | 73.97 | 0.06 |
| 1 | 59665 | May | 186.60 | 77.50 | 82.71 | 78.10 | 82.71 | 0.000024 | 0.50 | 373.54 | 73.64 | 0.04 |
| 1 | 59665 | June | 140.20 | 77.50 | 82.54 | 78.00 | 82.54 | 0.000015 | 0.39 | 360.87 | 73.51 | 0.03 |
| 1 | 59665 | August | 94.90 | 77.50 | 82.23 | 77.90 | 82.23 | 0.000064 | 0.19 | 338.07 | 73.26 | 0.02 |
| 1 | 59665 | Mean Annual Floo | 750.00 | 77.50 | 84.40 | 79.02 | 84.52 | 0.000147 | 1.48 | 505.62 | 74.95 | 0.10 |
| 1 | 59665 | 100-Year | 1350.00 | 77.50 | 85.91 | 79.76 | 85.90 | 0.000263 | 2.20 | 613.12 | 76.00 | 0.14 |
| 1 | 58649.5 | Bridge | | | | | | | | | | |
| 1 | 58634 | April | 273.30 | 74.60 | 83.01 | 77.06 | 83.02 | 0.000069 | 0.91 | 300.40 | 53.69 | 0.07 |
| 1 | 58634 | May | 186.60 | 74.60 | 82.70 | 76.66 | 82.71 | 0.000037 | 0.66 | 283.96 | 53.23 | 0.05 |
| 1 | 58634 | June | 140.20 | 74.60 | 82.53 | 76.41 | 82.54 | 0.000023 | 0.51 | 274.91 | 52.89 | 0.04 |
| 1 | 58634 | August | 94.90 | 74.60 | 82.22 | 75.89 | 82.23 | 0.000009 | 0.25 | 256.89 | 52.19 | 0.02 |
| 1 | 58634 | Mean Annual Floo | 750.00 | 74.60 | 84.45 | 78.49 | 84.51 | 0.000329 | 1.92 | 389.32 | 75.49 | 0.15 |
| 1 | 58634 | 100-Year | 1350.00 | 74.60 | 85.86 | 79.69 | 85.67 | 0.000527 | 2.65 | 509.49 | 386.60 | 0.19 |
| 1 | 58584 | April | 273.30 | 74.60 | 83.01 | | 83.02 | 0.000069 | 0.91 | 300.21 | 53.97 | 0.07 |
| 1 | 58584 | May | 186.60 | 74.60 | 82.70 | | 82.71 | 0.000037 | 0.66 | 283.67 | 53.28 | 0.05 |
| 1 | 58584 | June | 140.20 | 74.60 | 82.53 | | 82.54 | 0.000023 | 0.51 | 274.85 | 52.89 | 0.04 |
| 1 | 58584 | August | 94.90 | 74.60 | 82.22 | | 82.23 | 0.000008 | 0.25 | 258.67 | 52.10 | 0.02 |
| 1 | 58584 | Mean Annual Floo | 750.00 | 74.60 | 84.44 | | 84.49 | 0.000331 | 1.93 | 389.02 | 75.12 | 0.15 |
| 1 | 58584 | 100-Year | 1350.00 | 74.60 | 85.84 | | 85.93 | 0.000456 | 2.46 | 754.25 | 386.33 | 0.18 |
| 1 | 57767 | April | 273.30 | 77.13 | 82.94 | | 82.97 | 0.000320 | 1.40 | 195.20 | 52.38 | 0.13 |
| 1 | 57767 | May | 186.60 | 77.13 | 82.66 | | 82.68 | 0.000190 | 1.03 | 189.91 | 51.57 | 0.10 |
| 1 | 57767 | June | 140.20 | 77.13 | 82.51 | | 82.52 | 0.000123 | 0.81 | 172.93 | 51.02 | 0.08 |
| 1 | 57767 | August | 94.90 | 77.13 | 82.22 | | 82.22 | 0.000034 | 0.41 | 168.42 | 48.97 | 0.04 |
| 1 | 57767 | Mean Annual Floo | 750.00 | 77.13 | 84.15 | | 84.28 | 0.000382 | 2.90 | 280.83 | 55.95 | 0.23 |
| 1 | 57767 | 100-Year | 1350.00 | 77.13 | 85.34 | | 85.61 | 0.001512 | 4.14 | 353.87 | 116.82 | 0.30 |
| 1 | 57134 | April | 273.30 | 74.30 | 82.93 | | 82.94 | 0.000013 | 0.43 | 970.80 | 244.61 | 0.03 |
| 1 | 57134 | May | 186.60 | 74.30 | 82.66 | | 82.68 | 0.000007 | 0.31 | 904.12 | 243.12 | 0.02 |
| 1 | 57134 | June | 140.20 | 74.30 | 82.51 | | 82.51 | 0.000005 | 0.26 | 896.56 | 242.29 | 0.02 |
| 1 | 57134 | August | 94.90 | 74.30 | 82.22 | | 82.22 | 0.000001 | 0.12 | 796.85 | 240.70 | 0.01 |
| 1 | 57134 | Mean Annual Floo | 750.00 | 74.30 | 84.15 | | 84.16 | 0.000046 | 0.90 | 1368.06 | 397.07 | 0.05 |
| 1 | 57134 | 100-Year | 1350.00 | 74.30 | 85.36 | | 85.40 | 0.000074 | 1.24 | 1002.33 | 449.20 | 0.07 |
| 1 | 56393 | April | 273.30 | 75.50 | 82.91 | | 82.92 | 0.000072 | 0.79 | 347.04 | 72.30 | 0.06 |
| 1 | 56393 | May | 186.60 | 75.50 | 82.65 | | 82.65 | 0.000039 | 0.57 | 328.45 | 70.23 | 0.05 |
| 1 | 56393 | June | 140.20 | 75.50 | 82.50 | | 82.50 | 0.000024 | 0.44 | 310.01 | 69.46 | 0.04 |
| 1 | 56393 | August | 94.90 | 75.50 | 82.22 | | 82.22 | 0.000006 | 0.22 | 298.59 | 68.00 | 0.02 |
| 1 | 56393 | Mean Annual Floo | 750.00 | 75.50 | 84.05 | | 84.09 | 0.000261 | 1.72 | 470.34 | 154.11 | 0.12 |
| 1 | 56393 | 100-Year | 1350.00 | 75.50 | 85.20 | | 85.29 | 0.000423 | 2.46 | 687.52 | 208.94 | 0.16 |
| 1 | 55407 | April | 273.30 | 75.81 | 82.84 | | 82.85 | 0.000069 | 0.79 | 363.49 | 108.02 | 0.06 |
| 1 | 55407 | May | 186.60 | 75.81 | 82.61 | | 82.61 | 0.000038 | 0.57 | 338.89 | 106.62 | 0.05 |
| 1 | 55407 | June | 140.20 | 75.81 | 82.47 | | 82.48 | 0.000024 | 0.44 | 324.64 | 103.70 | 0.04 |
| 1 | 55407 | August | 94.90 | 75.81 | 82.21 | | 82.21 | 0.000006 | 0.22 | 301.62 | 78.22 | 0.02 |
| 1 | 55407 | Mean Annual Floo | 750.00 | 75.81 | 83.77 | | 83.82 | 0.000282 | 1.79 | 466.65 | 113.73 | 0.13 |
| 1 | 55407 | 100-Year | 1350.00 | 75.81 | 84.69 | | 84.80 | 0.000537 | 2.71 | 574.01 | 119.37 | 0.18 |
| 1 | 55334 | April | 273.30 | 74.00 | 82.84 | | 82.84 | 0.000008 | 0.34 | 793.27 | 131.06 | 0.02 |
| 1 | 55334 | May | 186.60 | 74.00 | 82.61 | | 82.61 | 0.000004 | 0.24 | 783.24 | 129.47 | 0.02 |
| 1 | 55334 | June | 140.20 | 74.00 | 82.47 | | 82.48 | 0.000003 | 0.19 | 745.81 | 128.54 | 0.01 |
| 1 | 55334 | August | 94.90 | 74.00 | 82.21 | | 82.21 | 0.000001 | 0.09 | 712.00 | 126.72 | 0.01 |
| 1 | 55334 | Mean Annual Floo | 750.00 | 74.00 | 83.78 | | 83.79 | 0.000039 | 0.32 | 919.84 | 137.53 | 0.08 |
| 1 | 55334 | 100-Year | 1350.00 | 74.00 | 84.72 | | 84.75 | 0.000086 | 1.28 | 1052.90 | 143.99 | 0.08 |
| 1 | 55300 | April | 273.30 | 75.81 | 82.83 | | 82.84 | 0.000055 | 0.79 | 366.15 | 107.97 | 0.06 |
| 1 | 55300 | May | 186.60 | 75.81 | 82.60 | | 82.61 | 0.000030 | 0.57 | 341.07 | 106.59 | 0.05 |
| 1 | 55300 | June | 140.20 | 75.81 | 82.47 | | 82.47 | 0.000019 | 0.44 | 327.87 | 105.78 | 0.04 |
| 1 | 55300 | August | 94.90 | 75.81 | 82.21 | | 82.21 | 0.000005 | 0.22 | 301.80 | 87.39 | 0.02 |
| 1 | 55300 | Mean Annual Floo | 750.00 | 75.81 | 83.73 | | 83.78 | 0.000229 | 1.80 | 465.79 | 113.49 | 0.13 |
| 1 | 55300 | 100-Year | 1350.00 | 75.81 | 84.60 | | 84.71 | 0.000445 | 2.70 | 567.15 | 118.64 | 0.19 |
| Horseshoe Race | 216 | April | 27.30 | 76.90 | 78.41 | | 78.43 | 0.000717 | 1.05 | 26.08 | 17.24 | 0.15 |
| Horseshoe Race | 216 | May | 18.70 | 76.90 | 77.92 | | 77.94 | 0.001178 | 1.67 | 17.56 | 17.23 | 0.19 |
| Horseshoe Race | 216 | June | 14.00 | 76.90 | 77.70 | | 77.71 | 0.001462 | 1.62 | 13.70 | 17.22 | 0.20 |
| Horseshoe Race | 216 | August | 8.50 | 76.90 | 77.46 | | 77.48 | 0.001604 | 0.69 | 9.50 | 17.22 | 0.16 |
| Horseshoe Race | 216 | Mean Annual Floo | 102.00 | 76.90 | 82.02 | | 82.04 | 0.000257 | 1.15 | 88.41 | 17.30 | 0.09 |
| Horseshoe Race | 216 | 100-Year | 135.00 | 76.90 | 83.30 | | 83.32 | 0.000223 | 1.19 | 117.67 | 42.48 | 0.08 |
| Horseshoe Race | 155.82 | April | 27.30 | 76.70 | 77.33 | | 77.37 | 0.001022 | 1.45 | 18.82 | 13.51 | 0.22 |
| Horseshoe Race | 155.82 | May | 18.70 | 76.70 | 77.77 | | 77.81 | 0.003891 | 1.67 | 11.21 | 13.50 | 0.32 |
| Horseshoe Race | 155.82 | June | 14.00 | 76.70 | 77.46 | | 77.52 | 0.009914 | 2.00 | 7.00 | 13.50 | 0.49 |
| Horseshoe Race | 155.82 | August | 8.50 | 76.70 | 77.30 | | 77.33 | 0.006710 | 1.32 | 4.92 | 13.50 | 0.39 |

HEC-RAS Plan: Kanyon ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W S Elev (ft) | Crit W S (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|----------------|-----------|------------------|------------------|-------------------|------------------|------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| Horseshoe Race | 155.82 | Mean Annual Floo | 102.00 | 76.70 | 81.99 | | 82.02 | 0.000502 | 1.49 | 68.20 | 13.56 | 0.12 |
| Horseshoe Race | 155.82 | 100-Year | 135.00 | 76.70 | 83.26 | | 83.29 | 0.000475 | 1.58 | 85.55 | 13.60 | 0.11 |
| Horseshoe Race | 107.54 | April | 27.30 | 76.06 | 78.30 | | 76.32 | 0.000503 | 1.04 | 26.23 | 14.24 | 0.14 |
| Horseshoe Race | 107.54 | May | 18.70 | 76.06 | 77.72 | | 77.73 | 0.000903 | 1.04 | 17.82 | 14.06 | 0.16 |
| Horseshoe Race | 107.54 | June | 14.00 | 76.06 | 77.30 | | 77.38 | 0.001430 | 1.09 | 12.88 | 13.95 | 0.20 |
| Horseshoe Race | 107.54 | August | 6.50 | 76.06 | 76.65 | | 76.72 | 0.032151 | 2.14 | 3.03 | 13.21 | 0.70 |
| Horseshoe Race | 107.54 | Mean Annual Floo | 102.00 | 76.06 | 81.99 | | 82.00 | 0.000312 | 1.27 | 80.61 | 15.37 | 0.10 |
| Horseshoe Race | 107.54 | 100-Year | 135.00 | 76.06 | 83.26 | | 83.28 | 0.000300 | 1.34 | 100.38 | 15.68 | 0.09 |
| Horseshoe Race | 76.0 | April | 27.30 | 75.54 | 78.31 | | 78.32 | 0.000084 | 0.48 | 57.14 | 26.16 | 0.06 |
| Horseshoe Race | 76.0 | May | 18.70 | 75.54 | 77.72 | | 77.73 | 0.000106 | 0.45 | 41.74 | 26.16 | 0.06 |
| Horseshoe Race | 76.0 | June | 14.00 | 75.54 | 77.36 | | 77.37 | 0.000135 | 0.43 | 32.20 | 26.15 | 0.07 |
| Horseshoe Race | 76.0 | August | 6.50 | 75.54 | 76.68 | | 76.69 | 0.000254 | 0.42 | 15.64 | 22.11 | 0.09 |
| Horseshoe Race | 76.0 | Mean Annual Floo | 102.00 | 75.54 | 81.99 | | 82.00 | 0.000058 | 0.66 | 154.07 | 27.60 | 0.05 |
| Horseshoe Race | 76.0 | 100-Year | 135.00 | 75.54 | 83.27 | | 83.27 | 0.000053 | 0.71 | 190.58 | 29.60 | 0.05 |
| Horseshoe Race | 82.01 | April | 27.30 | 75.50 | 77.80 | 77.16 | 78.10 | 0.031936 | 5.05 | 5.41 | 2.46 | 0.60 |
| Horseshoe Race | 82.01 | May | 18.70 | 75.50 | 77.33 | 76.82 | 77.63 | 0.027487 | 4.40 | 4.25 | 2.47 | 0.59 |
| Horseshoe Race | 82.01 | June | 14.00 | 75.50 | 77.04 | 76.60 | 77.29 | 0.024716 | 3.98 | 3.54 | 2.46 | 0.50 |
| Horseshoe Race | 82.01 | August | 6.50 | 75.50 | 76.50 | 76.20 | 76.63 | 0.019132 | 2.85 | 2.20 | 2.45 | 0.55 |
| Horseshoe Race | 82.01 | Mean Annual Floo | 102.00 | 75.50 | 80.71 | 79.36 | 81.70 | 0.057572 | 7.98 | 12.79 | 2.58 | 0.63 |
| Horseshoe Race | 82.01 | 100-Year | 135.00 | 75.50 | 81.72 | 80.13 | 82.92 | 0.068030 | 8.76 | 15.40 | 2.60 | 0.63 |
| Horseshoe Race | 55.33 | April | 27.30 | 75.50 | 77.07 | 77.07 | 77.86 | 0.075836 | 7.10 | 3.85 | 2.47 | 1.00 |
| Horseshoe Race | 55.33 | May | 18.70 | 75.50 | 76.72 | 76.72 | 77.33 | 0.069500 | 6.28 | 2.98 | 2.46 | 1.01 |
| Horseshoe Race | 55.33 | June | 14.00 | 75.50 | 76.51 | 76.51 | 77.01 | 0.065602 | 5.70 | 2.45 | 2.45 | 1.00 |
| Horseshoe Race | 55.33 | August | 6.50 | 75.50 | 76.11 | 76.11 | 76.41 | 0.059700 | 4.42 | 1.47 | 2.44 | 1.00 |
| Horseshoe Race | 55.33 | Mean Annual Floo | 102.00 | 75.50 | 79.27 | 79.27 | 81.12 | 0.119377 | 10.93 | 9.33 | 2.53 | 1.00 |
| Horseshoe Race | 55.33 | 100-Year | 135.00 | 75.50 | 80.03 | 80.03 | 82.26 | 0.134827 | 11.98 | 11.27 | 2.58 | 1.01 |
| Horseshoe Race | 48.89 | April | 27.30 | 68.44 | 73.55 | 70.29 | 73.58 | 0.000216 | 1.29 | 44.22 | 16.98 | 0.10 |
| Horseshoe Race | 48.89 | May | 18.70 | 68.44 | 73.17 | 69.98 | 73.17 | 0.000147 | 1.01 | 37.97 | 15.73 | 0.08 |
| Horseshoe Race | 48.89 | June | 14.00 | 68.44 | 72.91 | 69.79 | 72.92 | 0.000107 | 0.83 | 34.07 | 14.91 | 0.07 |
| Horseshoe Race | 48.89 | August | 6.50 | 68.44 | 72.38 | 69.38 | 72.38 | 0.000042 | 0.40 | 26.54 | 13.16 | 0.04 |
| Horseshoe Race | 48.89 | Mean Annual Floo | 102.00 | 68.44 | 75.42 | 71.81 | 75.47 | 0.000654 | 2.70 | 81.11 | 22.10 | 0.19 |
| Horseshoe Race | 48.89 | 100-Year | 135.00 | 68.44 | 75.95 | 72.24 | 78.02 | 0.000798 | 3.25 | 93.34 | 22.76 | 0.21 |
| Horseshoe Race | 45.18 | April | 27.30 | 66.81 | 73.55 | | 73.56 | 0.000056 | 0.80 | 76.28 | 21.81 | 0.06 |
| Horseshoe Race | 45.18 | May | 18.70 | 66.81 | 73.17 | | 73.17 | 0.000035 | 0.61 | 68.02 | 21.04 | 0.04 |
| Horseshoe Race | 45.18 | June | 14.00 | 66.81 | 72.91 | | 72.92 | 0.000024 | 0.40 | 62.74 | 20.21 | 0.04 |
| Horseshoe Race | 45.18 | August | 6.50 | 66.81 | 72.38 | | 72.38 | 0.000008 | 0.27 | 52.34 | 18.48 | 0.02 |
| Horseshoe Race | 45.18 | Mean Annual Floo | 102.00 | 66.81 | 75.44 | | 75.46 | 0.000238 | 1.84 | 119.55 | 24.00 | 0.12 |
| Horseshoe Race | 45.18 | 100-Year | 135.00 | 66.81 | 75.97 | | 76.01 | 0.000313 | 2.33 | 132.41 | 24.00 | 0.14 |
| Horseshoe Race | 35.07 | April | 27.30 | 68.48 | 73.54 | | 73.56 | 0.000225 | 1.31 | 43.47 | 16.83 | 0.11 |
| Horseshoe Race | 35.07 | May | 18.70 | 68.48 | 73.16 | | 73.17 | 0.000154 | 1.03 | 37.30 | 15.59 | 0.09 |
| Horseshoe Race | 35.07 | June | 14.00 | 68.48 | 72.91 | | 72.92 | 0.000112 | 0.84 | 33.44 | 14.77 | 0.07 |
| Horseshoe Race | 35.07 | August | 6.50 | 68.48 | 72.37 | | 72.38 | 0.000045 | 0.48 | 28.01 | 13.03 | 0.04 |
| Horseshoe Race | 35.07 | Mean Annual Floo | 102.00 | 68.48 | 75.40 | | 75.46 | 0.000681 | 2.04 | 80.18 | 22.03 | 0.18 |
| Horseshoe Race | 35.07 | 100-Year | 135.00 | 68.48 | 75.93 | | 76.00 | 0.000630 | 3.20 | 91.97 | 22.69 | 0.22 |
| Horseshoe Race | 31.39 | April | 27.30 | 70.66 | 73.42 | | 73.56 | 0.003054 | 3.58 | 13.32 | 9.34 | 0.40 |
| Horseshoe Race | 31.39 | May | 18.70 | 70.66 | 73.07 | | 73.17 | 0.003500 | 3.03 | 10.22 | 8.20 | 0.36 |
| Horseshoe Race | 31.39 | June | 14.00 | 70.66 | 72.83 | | 72.91 | 0.003182 | 2.86 | 8.38 | 7.43 | 0.34 |
| Horseshoe Race | 31.39 | August | 6.50 | 70.66 | 72.33 | | 72.38 | 0.002274 | 1.85 | 5.08 | 5.81 | 0.27 |
| Horseshoe Race | 31.39 | Mean Annual Floo | 102.00 | 70.66 | 75.14 | | 75.45 | 0.036050 | 6.03 | 34.18 | 14.93 | 0.52 |
| Horseshoe Race | 31.39 | 100-Year | 135.00 | 70.66 | 75.63 | | 76.00 | 0.036035 | 6.70 | 41.88 | 16.52 | 0.54 |
| Horseshoe Race | 23.53 | April | 27.30 | 70.99 | 73.22 | | 73.51 | 0.010852 | 4.99 | 8.81 | 7.82 | 0.62 |
| Horseshoe Race | 23.53 | May | 18.70 | 70.99 | 72.89 | | 73.13 | 0.010376 | 4.36 | 6.50 | 6.50 | 0.60 |
| Horseshoe Race | 23.53 | June | 14.00 | 70.99 | 72.68 | | 72.87 | 0.010137 | 3.93 | 5.16 | 5.86 | 0.58 |
| Horseshoe Race | 23.53 | August | 6.50 | 70.99 | 72.22 | | 72.34 | 0.009372 | 2.94 | 2.84 | 4.39 | 0.52 |
| Horseshoe Race | 23.53 | Mean Annual Floo | 102.00 | 70.99 | 74.82 | | 75.30 | 0.011818 | 7.01 | 25.24 | 12.84 | 0.73 |
| Horseshoe Race | 23.53 | 100-Year | 135.00 | 70.99 | 75.20 | | 75.93 | 0.012062 | 8.55 | 31.53 | 14.34 | 0.75 |
| Horseshoe Race | 12.73 | April | 27.30 | 70.94 | 72.79 | 72.79 | 73.34 | 0.025434 | 8.67 | 6.13 | 6.37 | 0.93 |
| Horseshoe Race | 12.73 | May | 18.70 | 70.94 | 72.48 | 72.48 | 72.86 | 0.027153 | 6.00 | 4.36 | 5.40 | 0.93 |
| Horseshoe Race | 12.73 | June | 14.00 | 70.94 | 72.29 | 72.29 | 72.70 | 0.028749 | 5.53 | 3.36 | 4.75 | 0.93 |
| Horseshoe Race | 12.73 | August | 6.50 | 70.94 | 71.88 | 71.88 | 72.17 | 0.034832 | 4.48 | 1.69 | 3.43 | 0.95 |
| Horseshoe Race | 12.73 | Mean Annual Floo | 102.00 | 70.94 | 74.31 | 74.31 | 75.22 | 0.021656 | 9.64 | 19.65 | 11.33 | 0.96 |
| Horseshoe Race | 12.73 | 100-Year | 135.00 | 70.94 | 74.74 | 74.74 | 75.76 | 0.021683 | 10.50 | 24.77 | 12.72 | 0.98 |
| Horseshoe Race | 8.21 | April | 27.30 | 70.64 | 72.25 | 72.49 | 73.13 | 0.047373 | 8.20 | 4.74 | 5.62 | 1.24 |
| Horseshoe Race | 8.21 | May | 18.70 | 70.64 | 71.09 | 72.18 | 72.73 | 0.050519 | 7.35 | 3.38 | 4.77 | 1.23 |
| Horseshoe Race | 8.21 | June | 14.00 | 70.64 | 71.83 | 71.99 | 72.48 | 0.051203 | 6.66 | 2.86 | 4.25 | 1.21 |
| Horseshoe Race | 8.21 | August | 6.50 | 70.64 | 71.50 | 71.58 | 71.89 | 0.054400 | 5.13 | 1.42 | 3.16 | 1.16 |
| Horseshoe Race | 8.21 | Mean Annual Floo | 102.00 | 70.64 | 73.63 | 74.01 | 75.05 | 0.038274 | 11.73 | 15.51 | 10.08 | 1.25 |
| Horseshoe Race | 8.21 | 100-Year | 135.00 | 70.64 | 74.04 | 74.44 | 75.59 | 0.038408 | 12.58 | 18.96 | 11.42 | 1.25 |
| Horseshoe Race | 0.55 | April | 27.30 | 70.44 | 72.12 | 72.20 | 72.88 | 0.038940 | 7.69 | 5.13 | 5.84 | 1.13 |

HEC-RAS Plan: Kenyon ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chrs (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chs |
|----------------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| Horseshoe Race | 0.55 | May | 16.70 | 70.44 | 71.87 | 71.98 | 72.48 | 0.038886 | 6.74 | 3.77 | 5.03 | 1.09 |
| Horseshoe Race | 0.55 | June | 14.00 | 70.44 | 71.73 | 71.79 | 72.21 | 0.035507 | 5.92 | 3.09 | 4.56 | 1.02 |
| Horseshoe Race | 0.55 | August | 6.50 | 70.44 | 71.35 | 71.38 | 71.67 | 0.040794 | 4.69 | 1.59 | 3.33 | 1.02 |
| Horseshoe Race | 0.55 | Mean Annual Floo | 102.00 | 70.44 | 73.46 | 73.80 | 74.83 | 0.036172 | 11.50 | 15.88 | 10.20 | 1.22 |
| Horseshoe Race | 0.55 | 100-Year | 135.00 | 70.44 | 73.85 | 74.24 | 75.36 | 0.035981 | 12.51 | 20.11 | 11.47 | 1.24 |
| 2 | 55296 | April | 246.00 | 73.20 | 82.83 | 73.70 | 82.83 | 0.000002 | 0.23 | 1273.11 | 134.40 | 0.01 |
| 2 | 55296 | May | 167.90 | 73.20 | 82.81 | 73.58 | 82.81 | 0.000001 | 0.16 | 1242.54 | 134.29 | 0.01 |
| 2 | 55296 | June | 126.20 | 73.20 | 82.47 | 73.52 | 82.47 | 0.000001 | 0.12 | 1224.59 | 134.23 | 0.01 |
| 2 | 55296 | August | 58.40 | 73.20 | 82.21 | 73.39 | 82.21 | 0.000000 | 0.06 | 1169.25 | 134.11 | 0.00 |
| 2 | 55296 | Mean Annual Floo | 640.60 | 73.20 | 83.75 | 74.15 | 83.70 | 0.000012 | 0.55 | 1308.61 | 134.83 | 0.03 |
| 2 | 55296 | 100-Year | 1215.00 | 73.20 | 84.65 | 74.64 | 84.68 | 0.000035 | 0.99 | 1532.31 | 167.22 | 0.05 |
| 2 | 55290 | | Int Struct | | | | | | | | | |
| 2 | 55284 | April | 246.00 | 73.20 | 73.98 | 73.70 | 74.08 | 0.009070 | 2.75 | 101.16 | 130.26 | 0.55 |
| 2 | 55284 | May | 167.90 | 73.20 | 73.03 | 73.58 | 73.50 | 0.009081 | 2.31 | 81.93 | 130.19 | 0.51 |
| 2 | 55284 | June | 126.20 | 73.20 | 73.74 | 73.52 | 73.60 | 0.008553 | 2.03 | 70.25 | 130.15 | 0.49 |
| 2 | 55284 | August | 58.40 | 73.20 | 73.56 | 73.30 | 73.59 | 0.007201 | 1.41 | 46.55 | 130.07 | 0.42 |
| 2 | 55284 | Mean Annual Floo | 648.00 | 73.20 | 74.55 | 74.14 | 74.79 | 0.010728 | 4.18 | 175.86 | 130.53 | 0.63 |
| 2 | 55284 | 100-Year | 1215.00 | 73.20 | 75.16 | 74.64 | 75.55 | 0.011028 | 5.42 | 255.04 | 130.81 | 0.68 |
| 2 | 55279 | April | 246.00 | 73.20 | 73.70 | 73.70 | 73.95 | 0.043473 | 4.31 | 64.36 | 130.15 | 1.08 |
| 2 | 55279 | May | 167.90 | 73.20 | 73.58 | 73.58 | 73.78 | 0.047330 | 3.79 | 49.96 | 130.08 | 1.08 |
| 2 | 55279 | June | 126.20 | 73.20 | 73.52 | 73.52 | 73.68 | 0.050255 | 3.44 | 41.25 | 130.05 | 1.06 |
| 2 | 55279 | August | 58.40 | 73.20 | 73.30 | 73.30 | 73.49 | 0.059815 | 2.67 | 24.84 | 129.99 | 1.08 |
| 2 | 55279 | Mean Annual Floo | 648.00 | 73.20 | 74.14 | 74.14 | 74.62 | 0.035205 | 5.98 | 122.88 | 130.34 | 1.08 |
| 2 | 55279 | 100-Year | 1215.00 | 73.20 | 74.84 | 74.84 | 75.37 | 0.030712 | 7.37 | 187.11 | 130.67 | 1.08 |
| 2 | 55274 | April | 246.00 | 69.20 | 71.25 | 69.96 | 71.30 | 0.001302 | 1.85 | 133.19 | 64.93 | 0.23 |
| 2 | 55274 | May | 167.90 | 69.20 | 70.81 | 69.70 | 70.85 | 0.001333 | 1.80 | 104.62 | 64.62 | 0.22 |
| 2 | 55274 | June | 126.20 | 69.20 | 70.54 | 69.89 | 70.57 | 0.001304 | 1.48 | 86.70 | 64.32 | 0.22 |
| 2 | 55274 | August | 58.40 | 69.20 | 69.27 | 69.49 | 71.29 | 5.095825 | 12.73 | 4.59 | 64.50 | 8.44 |
| 2 | 55274 | Mean Annual Floo | 648.00 | 69.20 | 72.90 | 70.85 | 73.97 | 0.01275 | 2.85 | 244.31 | 64.95 | 0.24 |
| 2 | 55274 | 100-Year | 1215.00 | 69.20 | 74.86 | 71.41 | 74.28 | 0.001430 | 3.47 | 350.37 | 64.97 | 0.26 |
| 2 | 55255.29 | April | 246.00 | 66.97 | 71.08 | 69.72 | 71.19 | 0.003654 | 2.61 | 94.42 | 45.95 | 0.32 |
| 2 | 55255.29 | May | 167.90 | 66.97 | 70.67 | 69.40 | 70.74 | 0.003182 | 2.21 | 75.89 | 42.73 | 0.29 |
| 2 | 55255.29 | June | 126.20 | 66.97 | 70.41 | 69.22 | 70.47 | 0.002785 | 1.94 | 65.13 | 40.18 | 0.27 |
| 2 | 55255.29 | August | 58.40 | 66.97 | 69.90 | 68.58 | 69.92 | 0.001582 | 1.27 | 45.99 | 35.10 | 0.20 |
| 2 | 55255.29 | Mean Annual Floo | 648.00 | 66.97 | 72.73 | 70.64 | 72.94 | 0.003713 | 3.87 | 173.49 | 55.28 | 0.35 |
| 2 | 55255.29 | 100-Year | 1215.00 | 66.97 | 74.29 | 71.85 | 74.63 | 0.003679 | 4.69 | 265.06 | 55.80 | 0.37 |
| 2 | 55238 | | Bridge | | | | | | | | | |
| 2 | 55217.48 | April | 246.00 | 68.47 | 70.60 | | 70.87 | 0.014175 | 4.22 | 58.35 | 36.90 | 0.60 |
| 2 | 55217.48 | May | 167.90 | 68.47 | 70.23 | | 70.45 | 0.015817 | 3.79 | 44.32 | 37.41 | 0.61 |
| 2 | 55217.48 | June | 126.20 | 68.47 | 70.02 | | 70.20 | 0.018465 | 3.40 | 36.48 | 36.17 | 0.61 |
| 2 | 55217.48 | August | 58.40 | 68.47 | 69.69 | | 69.77 | 0.011532 | 2.35 | 24.84 | 33.90 | 0.48 |
| 2 | 55217.48 | Mean Annual Floo | 648.00 | 68.47 | 72.25 | | 72.68 | 0.008665 | 5.14 | 128.29 | 46.72 | 0.62 |
| 2 | 55217.48 | 100-Year | 1215.00 | 68.47 | 73.73 | | 74.33 | 0.007538 | 6.31 | 204.07 | 54.03 | 0.53 |
| 2 | 55188 | April | 246.00 | 67.10 | 70.69 | | 70.70 | 0.002449 | 1.09 | 280.44 | 110.60 | 0.12 |
| 2 | 55188 | May | 167.90 | 67.10 | 70.30 | | 70.31 | 0.002200 | 0.88 | 237.78 | 110.52 | 0.10 |
| 2 | 55188 | June | 126.20 | 67.10 | 70.08 | | 70.09 | 0.001453 | 0.74 | 212.95 | 110.43 | 0.09 |
| 2 | 55188 | August | 58.40 | 67.10 | 69.71 | | 69.72 | 0.000070 | 0.42 | 172.70 | 110.29 | 0.06 |
| 2 | 55188 | Mean Annual Floo | 648.00 | 67.10 | 72.39 | | 72.43 | 0.000319 | 1.73 | 489.08 | 111.26 | 0.15 |
| 2 | 55188 | 100-Year | 1215.00 | 67.10 | 73.94 | | 74.91 | 0.000400 | 2.39 | 642.42 | 111.97 | 0.17 |
| 3 | 55152.41 | April | 273.30 | 67.10 | 70.68 | 68.31 | 70.70 | 0.000368 | 1.19 | 279.37 | 110.67 | 0.13 |
| 3 | 55152.41 | May | 188.60 | 67.10 | 70.30 | 68.06 | 70.31 | 0.000295 | 0.95 | 236.98 | 110.52 | 0.11 |
| 3 | 55152.41 | June | 140.20 | 67.10 | 70.07 | 67.93 | 70.08 | 0.000239 | 0.79 | 212.33 | 110.43 | 0.10 |
| 3 | 55152.41 | August | 64.90 | 67.10 | 69.71 | 67.81 | 69.71 | 0.000102 | 0.45 | 172.40 | 110.29 | 0.06 |
| 3 | 55152.41 | Mean Annual Floo | 750.00 | 67.10 | 72.37 | 69.11 | 72.41 | 0.000512 | 1.95 | 468.69 | 111.25 | 0.17 |
| 3 | 55152.41 | 100-Year | 1350.00 | 67.10 | 73.92 | 69.90 | 74.90 | 0.000591 | 2.57 | 639.57 | 111.95 | 0.19 |
| 3 | 55124 | April | 273.30 | 68.00 | 70.60 | | 70.87 | 0.001273 | 2.01 | 137.09 | 65.25 | 0.24 |
| 3 | 55124 | May | 188.60 | 68.00 | 70.24 | | 70.26 | 0.001040 | 1.84 | 114.29 | 61.35 | 0.21 |
| 3 | 55124 | June | 140.20 | 68.00 | 70.03 | | 70.06 | 0.000952 | 1.38 | 101.70 | 59.08 | 0.18 |
| 3 | 55124 | August | 64.90 | 68.00 | 69.70 | | 69.71 | 0.000345 | 0.79 | 82.39 | 56.04 | 0.11 |
| 3 | 55124 | Mean Annual Floo | 750.00 | 68.00 | 72.21 | | 72.36 | 0.001581 | 3.12 | 258.24 | 82.70 | 0.28 |
| 3 | 55124 | 100-Year | 1350.00 | 68.00 | 73.71 | | 73.93 | 0.001819 | 3.84 | 362.52 | 98.96 | 0.30 |
| 3 | 55068 | April | 273.30 | 66.02 | 70.59 | | 70.61 | 0.000305 | 1.24 | 220.99 | 69.83 | 0.12 |
| 3 | 55068 | May | 188.60 | 66.02 | 70.23 | | 70.25 | 0.000267 | 0.95 | 195.32 | 68.25 | 0.10 |
| 3 | 55068 | June | 140.20 | 66.02 | 70.03 | | 70.03 | 0.000145 | 0.77 | 162.41 | 66.70 | 0.08 |
| 3 | 55068 | August | 64.90 | 66.02 | 69.79 | | 69.70 | 0.000046 | 0.40 | 160.81 | 64.20 | 0.04 |
| 3 | 55068 | Mean Annual Floo | 750.00 | 66.02 | 72.19 | | 72.27 | 0.000590 | 2.25 | 338.58 | 74.45 | 0.18 |
| 3 | 55068 | 100-Year | 1350.00 | 66.02 | 73.68 | | 73.82 | 0.000768 | 3.03 | 450.50 | 78.73 | 0.22 |
| 3 | 54724 | April | 273.30 | 65.80 | 70.41 | | 70.46 | 0.000771 | 1.74 | 167.15 | 57.73 | 0.19 |

HEC-RAS Plan: Kenyon ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch Elev (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|---------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 54724 | May | 186.60 | 65.80 | 70.13 | | 70.15 | 0.000359 | 1.31 | 142.80 | 49.19 | 0.14 |
| 3 | 54724 | June | 140.20 | 65.80 | 69.96 | | 69.97 | 0.000273 | 1.04 | 134.40 | 48.56 | 0.11 |
| 3 | 54724 | August | 64.90 | 65.80 | 69.67 | | 69.68 | 0.000082 | 0.54 | 120.71 | 48.71 | 0.06 |
| 3 | 54724 | Mean Annual Floo | 750.00 | 65.80 | 71.82 | | 71.90 | 0.001702 | 3.02 | 246.49 | 71.58 | 0.29 |
| 3 | 54724 | 100-Year | 1350.00 | 65.80 | 73.23 | | 73.43 | 0.002163 | 3.59 | 386.10 | 135.73 | 0.33 |
| 3 | 54674 | April | 273.30 | 65.90 | 70.43 | 66.52 | 70.43 | 0.000046 | 0.62 | 443.77 | 98.14 | 0.05 |
| 3 | 54674 | May | 186.60 | 65.90 | 70.14 | 66.39 | 70.14 | 0.000027 | 0.45 | 415.09 | 98.13 | 0.04 |
| 3 | 54674 | June | 140.20 | 65.90 | 69.96 | 66.30 | 69.96 | 0.000018 | 0.35 | 397.84 | 98.13 | 0.03 |
| 3 | 54674 | August | 64.90 | 65.90 | 69.68 | 66.14 | 69.68 | 0.000005 | 0.18 | 370.00 | 98.12 | 0.02 |
| 3 | 54674 | Mean Annual Floo | 750.00 | 65.90 | 71.86 | 67.12 | 71.89 | 0.000140 | 1.28 | 584.11 | 98.19 | 0.06 |
| 3 | 54674 | 100-Year | 1350.00 | 65.90 | 73.27 | 67.70 | 73.33 | 0.000223 | 1.67 | 722.67 | 144.22 | 0.12 |
| 3 | 54672 | Bridge | | | | | | | | | | |
| 3 | 54641.5 | April | 273.30 | 63.10 | 70.43 | 63.72 | 70.43 | 0.000009 | 0.38 | 718.17 | 98.16 | 0.02 |
| 3 | 54641.5 | May | 186.60 | 63.10 | 70.14 | 63.58 | 70.14 | 0.000005 | 0.27 | 689.49 | 98.15 | 0.02 |
| 3 | 54641.5 | June | 140.20 | 63.10 | 69.96 | 63.50 | 69.96 | 0.000003 | 0.21 | 672.24 | 98.15 | 0.01 |
| 3 | 54641.5 | August | 64.90 | 63.10 | 69.68 | 63.34 | 69.68 | 0.000001 | 0.19 | 644.40 | 98.14 | 0.01 |
| 3 | 54641.5 | Mean Annual Floo | 750.00 | 63.10 | 71.86 | 64.31 | 71.87 | 0.000039 | 0.67 | 858.51 | 98.19 | 0.05 |
| 3 | 54641.5 | 100-Year | 1350.00 | 63.10 | 73.27 | 64.90 | 73.30 | 0.000076 | 1.35 | 997.07 | 144.22 | 0.07 |
| 3 | 54591.5 | April | 273.30 | 65.80 | 70.37 | | 70.42 | 0.000667 | 1.77 | 154.70 | 49.54 | 0.18 |
| 3 | 54591.5 | May | 186.60 | 65.80 | 70.10 | | 70.13 | 0.000411 | 1.32 | 141.60 | 49.15 | 0.14 |
| 3 | 54591.5 | June | 140.20 | 65.80 | 69.94 | | 69.95 | 0.000279 | 1.05 | 133.58 | 48.96 | 0.11 |
| 3 | 54591.5 | August | 64.90 | 65.80 | 69.67 | | 69.67 | 0.000083 | 0.54 | 120.50 | 48.71 | 0.06 |
| 3 | 54591.5 | Mean Annual Floo | 750.00 | 65.80 | 71.67 | | 71.82 | 0.001931 | 3.15 | 237.82 | 70.49 | 0.30 |
| 3 | 54591.5 | 100-Year | 1350.00 | 65.80 | 73.00 | | 73.23 | 0.002685 | 3.83 | 356.57 | 120.70 | 0.36 |
| 3 | 53180 | April | 273.30 | 62.25 | 70.21 | | 70.22 | 0.000050 | 0.66 | 414.88 | 94.57 | 0.05 |
| 3 | 53180 | May | 186.60 | 62.25 | 70.02 | | 70.02 | 0.000027 | 0.47 | 396.14 | 94.02 | 0.04 |
| 3 | 53180 | June | 140.20 | 62.25 | 69.99 | | 69.99 | 0.000016 | 0.36 | 394.76 | 94.15 | 0.03 |
| 3 | 53180 | August | 64.90 | 62.25 | 69.68 | | 69.66 | 0.000004 | 0.16 | 365.76 | 92.10 | 0.01 |
| 3 | 53180 | Mean Annual Floo | 750.00 | 62.25 | 71.03 | | 71.07 | 0.000221 | 1.55 | 502.44 | 121.81 | 0.11 |
| 3 | 53180 | 100-Year | 1350.00 | 62.25 | 71.75 | | 71.84 | 0.000471 | 2.45 | 698.85 | 145.80 | 0.17 |
| 3 | 53151 | April | 273.30 | 61.82 | 70.21 | | 70.22 | 0.000069 | 0.80 | 347.40 | 86.82 | 0.06 |
| 3 | 53151 | May | 186.60 | 61.82 | 70.02 | | 70.02 | 0.000036 | 0.57 | 330.78 | 82.33 | 0.04 |
| 3 | 53151 | June | 140.20 | 61.82 | 69.98 | | 69.99 | 0.000022 | 0.44 | 320.25 | 77.94 | 0.04 |
| 3 | 53151 | August | 64.90 | 61.82 | 69.68 | | 69.66 | 0.000006 | 0.21 | 303.36 | 70.34 | 0.02 |
| 3 | 53151 | Mean Annual Floo | 750.00 | 61.82 | 71.01 | | 71.06 | 0.000314 | 1.89 | 428.77 | 115.44 | 0.14 |
| 3 | 53151 | 100-Year | 1350.00 | 61.82 | 71.89 | | 71.83 | 0.000683 | 3.00 | 515.70 | 138.34 | 0.20 |
| 3 | 53122 | April | 273.30 | 60.36 | 70.21 | | 70.22 | 0.000048 | 0.74 | 375.25 | 78.54 | 0.05 |
| 3 | 53122 | May | 186.60 | 60.36 | 70.02 | | 70.02 | 0.000025 | 0.52 | 360.63 | 71.67 | 0.04 |
| 3 | 53122 | June | 140.20 | 60.36 | 69.98 | | 69.99 | 0.000015 | 0.40 | 351.47 | 67.52 | 0.03 |
| 3 | 53122 | August | 64.90 | 60.36 | 69.66 | | 69.66 | 0.000004 | 0.19 | 336.85 | 62.05 | 0.01 |
| 3 | 53122 | Mean Annual Floo | 750.00 | 60.36 | 71.00 | | 71.05 | 0.000256 | 1.70 | 448.43 | 105.47 | 0.12 |
| 3 | 53122 | 100-Year | 1350.00 | 60.36 | 71.68 | | 71.81 | 0.000542 | 2.87 | 527.95 | 128.49 | 0.18 |
| 3 | 53086 | April | 273.30 | 62.25 | 70.20 | | 70.22 | 0.000097 | 0.95 | 306.81 | 61.15 | 0.07 |
| 3 | 53086 | May | 186.60 | 62.25 | 70.01 | | 70.02 | 0.000052 | 0.69 | 290.04 | 64.98 | 0.05 |
| 3 | 53086 | June | 140.20 | 62.25 | 69.98 | | 69.99 | 0.000032 | 0.52 | 279.20 | 60.79 | 0.04 |
| 3 | 53086 | August | 64.90 | 62.25 | 69.66 | | 69.66 | 0.000008 | 0.26 | 261.88 | 73.49 | 0.02 |
| 3 | 53086 | Mean Annual Floo | 750.00 | 62.25 | 70.97 | | 71.04 | 0.000443 | 2.23 | 388.16 | 115.98 | 0.16 |
| 3 | 53086 | 100-Year | 1350.00 | 62.25 | 71.60 | | 71.78 | 0.000970 | 3.53 | 468.20 | 138.52 | 0.24 |
| 3 | 53044 | April | 273.30 | 63.80 | 70.20 | | 70.21 | 0.000078 | 0.78 | 358.60 | 101.10 | 0.06 |
| 3 | 53044 | May | 186.60 | 63.80 | 70.01 | | 70.02 | 0.000041 | 0.59 | 339.94 | 94.38 | 0.05 |
| 3 | 53044 | June | 140.20 | 63.80 | 69.98 | | 69.99 | 0.000020 | 0.43 | 327.97 | 89.82 | 0.04 |
| 3 | 53044 | August | 64.90 | 63.80 | 69.66 | | 69.66 | 0.000006 | 0.21 | 308.39 | 83.74 | 0.02 |
| 3 | 53044 | Mean Annual Floo | 750.00 | 63.80 | 70.98 | | 71.02 | 0.000330 | 1.81 | 447.24 | 128.26 | 0.14 |
| 3 | 53044 | 100-Year | 1350.00 | 63.80 | 71.63 | | 71.75 | 0.000791 | 2.85 | 538.09 | 151.11 | 0.21 |
| 3 | 53003 | April | 273.30 | 60.82 | 70.21 | | 70.21 | 0.000026 | 0.54 | 509.78 | 102.18 | 0.04 |
| 3 | 53003 | May | 186.60 | 60.82 | 70.01 | | 70.02 | 0.000014 | 0.38 | 490.74 | 95.72 | 0.03 |
| 3 | 53003 | June | 140.20 | 60.82 | 69.98 | | 69.99 | 0.000006 | 0.29 | 478.52 | 91.33 | 0.02 |
| 3 | 53003 | August | 64.90 | 60.82 | 69.66 | | 69.66 | 0.000002 | 0.14 | 458.42 | 86.70 | 0.01 |
| 3 | 53003 | Mean Annual Floo | 750.00 | 60.82 | 70.99 | | 71.02 | 0.000130 | 1.30 | 600.38 | 128.57 | 0.09 |
| 3 | 53003 | 100-Year | 1350.00 | 60.82 | 71.66 | | 71.73 | 0.000289 | 2.11 | 694.13 | 151.09 | 0.14 |
| 3 | 52991.5 | April | 273.30 | 64.10 | 70.21 | | 70.21 | 0.000029 | 0.54 | 509.45 | 94.50 | 0.04 |
| 3 | 52991.5 | May | 186.60 | 64.10 | 70.01 | | 70.01 | 0.000015 | 0.38 | 490.48 | 92.81 | 0.03 |
| 3 | 52991.5 | June | 140.20 | 64.10 | 69.98 | | 69.99 | 0.000009 | 0.29 | 478.30 | 92.37 | 0.02 |
| 3 | 52991.5 | August | 64.90 | 64.10 | 69.66 | | 69.66 | 0.000002 | 0.14 | 457.57 | 91.62 | 0.01 |
| 3 | 52991.5 | Mean Annual Floo | 750.00 | 64.10 | 70.99 | | 71.02 | 0.000159 | 1.28 | 587.03 | 105.70 | 0.10 |
| 3 | 52991.5 | 100-Year | 1350.00 | 64.10 | 71.68 | | 71.72 | 0.000389 | 2.04 | 681.06 | 115.26 | 0.15 |
| 3 | 52976.5 | April | 273.30 | 64.10 | 70.21 | | 70.21 | 0.000022 | 0.46 | 573.52 | 93.98 | 0.03 |
| 3 | 52976.5 | May | 186.60 | 64.10 | 70.01 | | 70.01 | 0.000011 | 0.34 | 555.44 | 93.98 | 0.02 |
| 3 | 52976.5 | June | 140.20 | 64.10 | 69.98 | | 69.98 | 0.000007 | 0.26 | 543.17 | 93.98 | 0.02 |

HEC-RAS Plan: Kenyon ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch Elev (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Chl |
|-------|-----------|------------------|------------------|---------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|--------------|
| 3 | 52976.5 | August | 64.90 | 64.10 | 69.89 | | 69.86 | 0.000002 | 0.12 | 521.89 | 93.99 | 0.01 |
| 3 | 52976.5 | Mean Annual Floe | 750.00 | 64.10 | 70.99 | | 71.01 | 0.000113 | 1.16 | 647.28 | 93.99 | 0.08 |
| 3 | 52976.5 | 100-Year | 1350.00 | 64.10 | 71.68 | | 71.72 | 0.000272 | 1.60 | 710.30 | 95.00 | 0.12 |
| 3 | 52973 | April | 273.30 | 66.07 | 70.20 | | 70.21 | 0.000109 | 0.72 | 409.47 | 159.03 | 0.07 |
| 3 | 52973 | May | 186.60 | 66.07 | 70.01 | | 70.01 | 0.000094 | 0.52 | 379.54 | 155.53 | 0.05 |
| 3 | 52973 | June | 140.20 | 66.07 | 69.89 | | 69.88 | 0.000042 | 0.41 | 359.53 | 153.14 | 0.04 |
| 3 | 52973 | August | 64.90 | 66.07 | 69.88 | | 69.88 | 0.000012 | 0.21 | 325.52 | 148.99 | 0.02 |
| 3 | 52973 | Mean Annual Floe | 750.00 | 66.07 | 70.97 | | 71.01 | 0.000373 | 1.54 | 537.97 | 173.28 | 0.14 |
| 3 | 52973 | 100-Year | 1350.00 | 66.07 | 71.03 | | 71.71 | 0.000687 | 2.32 | 656.27 | 185.43 | 0.10 |
| 3 | 52941 | April | 273.30 | 66.07 | 70.20 | 67.68 | 70.20 | 0.000110 | 0.72 | 406.91 | 158.97 | 0.07 |
| 3 | 52941 | May | 186.60 | 66.07 | 70.01 | 67.51 | 70.01 | 0.000094 | 0.52 | 379.22 | 155.49 | 0.05 |
| 3 | 52941 | June | 140.20 | 66.07 | 69.88 | 67.42 | 69.88 | 0.000042 | 0.41 | 360.32 | 153.11 | 0.04 |
| 3 | 52941 | August | 64.90 | 66.07 | 69.85 | 67.15 | 69.86 | 0.000012 | 0.21 | 325.40 | 148.98 | 0.02 |
| 3 | 52941 | Mean Annual Floe | 750.00 | 66.07 | 70.96 | 68.20 | 71.00 | 0.000377 | 1.54 | 536.84 | 173.05 | 0.14 |
| 3 | 52941 | 100-Year | 1350.00 | 66.07 | 71.01 | 68.72 | 71.69 | 0.000700 | 2.34 | 651.96 | 185.00 | 0.19 |
| 3 | 52940 | | | | | | | | | | | |
| 3 | 52937 | April | 273.30 | 61.50 | 63.80 | | 64.13 | 0.014529 | 4.65 | 68.74 | 44.03 | 0.71 |
| 3 | 52937 | May | 186.60 | 61.50 | 63.23 | 63.23 | 63.68 | 0.034286 | 5.37 | 34.77 | 40.43 | 1.02 |
| 3 | 52937 | June | 140.20 | 61.50 | 63.05 | 63.05 | 63.45 | 0.034966 | 6.05 | 27.77 | 35.92 | 1.01 |
| 3 | 52937 | August | 64.90 | 61.50 | 62.64 | 62.64 | 62.92 | 0.037909 | 4.29 | 16.15 | 28.64 | 1.00 |
| 3 | 52937 | Mean Annual Floe | 750.00 | 61.50 | 66.87 | | 66.19 | 0.005885 | 4.56 | 160.02 | 62.00 | 0.49 |
| 3 | 52937 | 100-Year | 1350.00 | 61.50 | 67.02 | | 67.50 | 0.005834 | 5.59 | 245.01 | 77.19 | 0.52 |
| 3 | 52922 | April | 273.30 | 60.00 | 63.91 | 62.15 | 64.00 | 0.001792 | 2.46 | 110.98 | 44.71 | 0.20 |
| 3 | 52922 | May | 186.60 | 60.00 | 63.25 | 61.83 | 63.33 | 0.001907 | 2.25 | 62.98 | 40.85 | 0.28 |
| 3 | 52922 | June | 140.20 | 60.00 | 62.83 | 61.64 | 62.90 | 0.002039 | 2.11 | 69.45 | 37.88 | 0.28 |
| 3 | 52922 | August | 64.90 | 60.00 | 62.01 | 61.22 | 62.00 | 0.002306 | 1.72 | 37.66 | 32.53 | 0.28 |
| 3 | 52922 | Mean Annual Floe | 750.00 | 60.00 | 65.90 | 63.42 | 66.09 | 0.002391 | 3.49 | 215.06 | 63.88 | 0.33 |
| 3 | 52922 | 100-Year | 1350.00 | 60.00 | 67.07 | 64.53 | 67.39 | 0.003071 | 4.58 | 306.28 | 87.50 | 0.39 |
| 3 | 52921 | | | | | | | | | | | |
| 3 | 52905 | April | 273.30 | 60.00 | 62.39 | | 62.85 | 0.017210 | 5.41 | 50.49 | 35.02 | 0.76 |
| 3 | 52905 | May | 186.60 | 60.00 | 61.99 | | 62.38 | 0.020207 | 5.05 | 36.93 | 32.38 | 0.83 |
| 3 | 52905 | June | 140.20 | 60.00 | 61.72 | 61.64 | 62.10 | 0.024738 | 4.91 | 28.55 | 30.64 | 0.90 |
| 3 | 52905 | August | 64.90 | 60.00 | 61.22 | 61.22 | 61.53 | 0.036147 | 4.46 | 14.44 | 23.72 | 1.01 |
| 3 | 52905 | Mean Annual Floe | 750.00 | 60.00 | 63.69 | | 64.61 | 0.013781 | 6.91 | 110.17 | 44.50 | 0.76 |
| 3 | 52905 | 100-Year | 1350.00 | 60.00 | 65.19 | | 66.13 | 0.012538 | 7.77 | 173.76 | 52.85 | 0.76 |
| 3 | 52873 | April | 273.30 | 59.37 | 62.23 | | 62.44 | 0.006811 | 3.71 | 73.74 | 40.00 | 0.48 |
| 3 | 52873 | May | 186.60 | 59.37 | 61.81 | | 61.97 | 0.006508 | 3.23 | 57.82 | 36.55 | 0.45 |
| 3 | 52873 | June | 140.20 | 59.37 | 61.54 | | 61.67 | 0.006251 | 2.92 | 48.02 | 34.27 | 0.43 |
| 3 | 52873 | August | 64.90 | 59.37 | 60.93 | 60.38 | 61.01 | 0.005886 | 2.26 | 28.78 | 29.04 | 0.40 |
| 3 | 52873 | Mean Annual Floe | 750.00 | 59.37 | 63.77 | | 64.20 | 0.007672 | 5.30 | 146.07 | 54.18 | 0.54 |
| 3 | 52873 | 100-Year | 1350.00 | 59.37 | 65.13 | | 65.72 | 0.007369 | 6.28 | 228.50 | 68.29 | 0.55 |
| 3 | 52850 | April | 273.30 | 59.37 | 61.36 | 61.36 | 62.01 | 0.034679 | 6.49 | 42.13 | 33.00 | 1.01 |
| 3 | 52850 | May | 186.60 | 59.37 | 61.02 | 61.02 | 61.57 | 0.037071 | 6.59 | 31.69 | 29.66 | 1.01 |
| 3 | 52850 | June | 140.20 | 59.37 | 60.83 | 60.82 | 61.28 | 0.037947 | 5.43 | 25.82 | 28.14 | 1.00 |
| 3 | 52850 | August | 64.90 | 59.37 | 60.57 | | 60.75 | 0.019361 | 3.41 | 19.05 | 25.31 | 0.69 |
| 3 | 52850 | Mean Annual Floe | 750.00 | 59.37 | 62.62 | 62.62 | 63.71 | 0.025767 | 9.44 | 62.99 | 48.64 | 0.66 |
| 3 | 52850 | 100-Year | 1350.00 | 59.37 | 63.74 | 63.74 | 65.20 | 0.021338 | 9.93 | 152.11 | 58.57 | 0.63 |
| 3 | 52822 | April | 273.30 | 58.99 | 60.56 | 60.79 | 61.38 | 0.123164 | 7.25 | 37.70 | 64.64 | 1.68 |
| 3 | 52822 | May | 186.60 | 58.99 | 60.48 | 60.62 | 61.00 | 0.092961 | 5.75 | 32.44 | 63.91 | 1.42 |
| 3 | 52822 | June | 140.20 | 58.99 | 60.50 | 60.50 | 60.77 | 0.046275 | 4.16 | 33.74 | 64.14 | 1.01 |
| 3 | 52822 | August | 64.90 | 58.99 | 60.27 | 60.27 | 60.45 | 0.052348 | 3.34 | 19.43 | 56.26 | 1.00 |
| 3 | 52822 | Mean Annual Floe | 750.00 | 58.99 | 61.00 | 61.68 | 62.93 | 0.149664 | 11.15 | 67.25 | 60.82 | 2.00 |
| 3 | 52822 | 100-Year | 1350.00 | 58.99 | 61.44 | 62.30 | 64.32 | 0.143672 | 13.61 | 99.19 | 74.84 | 2.07 |
| 3 | 52811 | April | 273.30 | 58.32 | 58.65 | 59.12 | 59.77 | 0.181002 | 7.69 | 35.53 | 74.76 | 1.97 |
| 3 | 52811 | May | 186.60 | 58.32 | 58.73 | 58.99 | 59.59 | 0.221409 | 7.06 | 26.47 | 73.97 | 2.08 |
| 3 | 52811 | June | 140.20 | 58.32 | 58.61 | 58.85 | 59.59 | 0.477594 | 7.96 | 17.62 | 72.98 | 2.86 |
| 3 | 52811 | August | 64.90 | 58.32 | 58.51 | 58.66 | 59.11 | 0.567711 | 6.18 | 10.49 | 72.27 | 2.86 |
| 3 | 52811 | Mean Annual Floe | 750.00 | 58.32 | 59.27 | 60.83 | 61.20 | 0.171464 | 11.15 | 67.26 | 77.81 | 2.11 |
| 3 | 52811 | 100-Year | 1350.00 | 58.32 | 61.79 | 60.51 | 62.18 | 0.096627 | 4.97 | 286.43 | 96.27 | 0.48 |
| 3 | 52773 | April | 273.30 | 54.83 | 57.58 | 55.98 | 57.60 | 0.000560 | 1.12 | 243.27 | 120.05 | 0.14 |
| 3 | 52773 | May | 186.60 | 54.83 | 56.90 | 55.84 | 56.97 | 0.000616 | 1.10 | 189.57 | 114.61 | 0.16 |
| 3 | 52773 | June | 140.20 | 54.83 | 56.58 | 55.76 | 56.60 | 0.001143 | 1.10 | 127.62 | 111.40 | 0.18 |
| 3 | 52773 | August | 64.90 | 54.83 | 56.10 | 55.63 | 56.11 | 0.001395 | 0.87 | 74.44 | 106.81 | 0.18 |
| 3 | 52773 | Mean Annual Floe | 750.00 | 54.83 | 56.97 | 56.56 | 59.99 | 0.006307 | 1.37 | 561.32 | 148.18 | 0.12 |
| 3 | 52773 | 100-Year | 1350.00 | 54.83 | 62.04 | | 62.08 | 0.006255 | 1.62 | 686.76 | 167.64 | 0.11 |
| 3 | 52686 | April | 273.30 | 44.87 | 57.80 | | 57.80 | 0.000004 | 0.25 | 1108.18 | 139.09 | 0.02 |
| 3 | 52686 | May | 186.60 | 44.87 | 56.97 | | 56.97 | 0.000002 | 0.18 | 1022.08 | 135.08 | 0.01 |
| 3 | 52686 | June | 140.20 | 44.87 | 56.80 | | 56.80 | 0.000001 | 0.14 | 972.41 | 132.74 | 0.01 |

HEC-RAS Plan: Koryon ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch E1 (ft) | W. S. Elev (ft) | Crit W. S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Chnl (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Crit |
|-------|-----------|------------------|------------------|-------------------|--------------------|--------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|---------------|
| 3 | 52686 | August | 64.90 | 44.87 | 56.11 | | 56.11 | 0.000000 | 0.07 | 907.73 | 129.82 | 0.00 |
| 3 | 52686 | Mean Annual Floo | 750.00 | 44.87 | 59.99 | | 59.99 | 0.000012 | 0.52 | 1458.06 | 156.06 | 0.33 |
| 3 | 52686 | 100-Year | 1350.00 | 44.87 | 62.07 | | 62.08 | 0.000020 | 0.77 | 1797.27 | 171.82 | 0.94 |
| 3 | 52646.5 | April | 273.30 | 51.50 | 57.80 | | 57.80 | 0.000031 | 0.49 | 553.21 | 127.49 | 0.04 |
| 3 | 52646.5 | May | 186.60 | 51.50 | 56.97 | | 56.97 | 0.000023 | 0.39 | 474.06 | 124.53 | 0.04 |
| 3 | 52646.5 | June | 140.20 | 51.50 | 56.80 | | 56.80 | 0.000018 | 0.33 | 428.37 | 122.30 | 0.03 |
| 3 | 52646.5 | August | 64.90 | 51.50 | 56.11 | | 56.11 | 0.000006 | 0.18 | 388.93 | 119.35 | 0.02 |
| 3 | 52646.5 | Mean Annual Floo | 750.00 | 51.50 | 59.98 | | 59.99 | 0.000057 | 0.87 | 882.17 | 132.52 | 0.06 |
| 3 | 52646.5 | 100-Year | 1350.00 | 51.50 | 62.05 | | 62.07 | 0.000074 | 1.18 | 1153.24 | 159.63 | 0.07 |
| 3 | 52537.75 | April | 273.30 | 53.30 | 57.56 | 54.33 | 57.56 | 0.000258 | 1.40 | 106.25 | 45.87 | 0.12 |
| 3 | 52537.75 | May | 186.60 | 53.30 | 56.95 | 54.10 | 56.97 | 0.000196 | 1.12 | 107.11 | 45.89 | 0.10 |
| 3 | 52537.75 | June | 140.20 | 53.30 | 56.58 | 53.97 | 56.80 | 0.000154 | 0.93 | 150.47 | 45.85 | 0.09 |
| 3 | 52537.75 | August | 64.90 | 53.30 | 56.10 | 53.60 | 56.11 | 0.000055 | 0.51 | 126.47 | 45.85 | 0.05 |
| 3 | 52537.75 | Mean Annual Floo | 750.00 | 53.30 | 59.88 | 56.33 | 59.96 | 0.000512 | 2.40 | 300.86 | 45.91 | 0.17 |
| 3 | 52537.75 | 100-Year | 1350.00 | 53.30 | 61.83 | 58.30 | 62.01 | 0.000754 | 3.45 | 381.24 | 45.94 | 0.21 |
| 3 | 52517 | Bridge | | | | | | | | | | |
| 3 | 52496.25 | April | 273.30 | 56.30 | 57.38 | 59.33 | 57.51 | 0.002526 | 2.87 | 65.23 | 45.84 | 0.35 |
| 3 | 52496.25 | May | 186.60 | 56.30 | 56.74 | 58.10 | 56.86 | 0.003859 | 2.83 | 65.01 | 45.83 | 0.42 |
| 3 | 52496.25 | June | 140.20 | 56.30 | 56.32 | 55.96 | 56.46 | 0.006782 | 3.01 | 48.60 | 45.82 | 0.53 |
| 3 | 52496.25 | August | 64.90 | 56.30 | 55.70 | 55.89 | 0.032118 | 3.56 | 18.23 | 45.81 | 0.99 | |
| 3 | 52496.25 | Mean Annual Floo | 750.00 | 56.30 | 59.64 | 57.33 | 59.86 | 0.001826 | 3.77 | 109.13 | 45.96 | 0.32 |
| 3 | 52496.25 | 100-Year | 1350.00 | 56.30 | 61.55 | 58.30 | 61.89 | 0.001923 | 4.71 | 288.64 | 45.93 | 0.33 |
| 3 | 52426 | April | 273.30 | 51.50 | 57.40 | | 57.47 | 0.000029 | 0.52 | 530.05 | 124.29 | 0.04 |
| 3 | 52426 | May | 186.60 | 51.50 | 56.82 | | 56.83 | 0.000022 | 0.41 | 451.68 | 121.10 | 0.04 |
| 3 | 52426 | June | 140.20 | 51.50 | 56.41 | | 56.41 | 0.000018 | 0.35 | 402.20 | 116.97 | 0.03 |
| 3 | 52426 | August | 64.90 | 51.50 | 55.45 | 52.50 | 55.49 | 0.000011 | 0.22 | 290.80 | 114.01 | 0.02 |
| 3 | 52426 | Mean Annual Floo | 750.00 | 51.50 | 59.78 | | 59.80 | 0.000053 | 0.91 | 827.09 | 131.62 | 0.06 |
| 3 | 52426 | 100-Year | 1350.00 | 51.50 | 61.77 | | 61.79 | 0.000070 | 1.24 | 1101.84 | 147.88 | 0.08 |
| 3 | 50805 | April | 273.30 | 53.10 | 57.31 | | 57.35 | 0.000314 | 1.45 | 188.97 | 55.85 | 0.14 |
| 3 | 50805 | May | 186.60 | 53.10 | 56.71 | | 56.73 | 0.000264 | 1.20 | 155.81 | 53.89 | 0.12 |
| 3 | 50805 | June | 140.20 | 53.10 | 56.32 | | 56.34 | 0.000232 | 1.04 | 134.95 | 52.76 | 0.11 |
| 3 | 50805 | August | 64.90 | 53.10 | 55.40 | | 55.41 | 0.000187 | 0.74 | 87.80 | 49.09 | 0.10 |
| 3 | 50805 | Mean Annual Floo | 750.00 | 53.10 | 59.50 | | 59.58 | 0.000497 | 2.36 | 318.14 | 62.63 | 0.18 |
| 3 | 50805 | 100-Year | 1350.00 | 53.10 | 61.37 | | 61.50 | 0.000754 | 2.90 | 481.55 | 140.42 | 0.23 |
| 3 | 50755 | April | 273.30 | 53.00 | 57.32 | 54.21 | 57.33 | 0.000088 | 0.73 | 372.04 | 103.94 | 0.07 |
| 3 | 50755 | May | 186.60 | 53.00 | 56.71 | 54.06 | 56.72 | 0.000057 | 0.60 | 311.36 | 100.79 | 0.06 |
| 3 | 50755 | June | 140.20 | 53.00 | 56.32 | 54.00 | 56.33 | 0.000051 | 0.52 | 272.18 | 100.69 | 0.06 |
| 3 | 50755 | August | 64.90 | 53.00 | 55.40 | 53.83 | 55.40 | 0.000043 | 0.36 | 170.86 | 100.45 | 0.05 |
| 3 | 50755 | Mean Annual Floo | 750.00 | 53.00 | 59.52 | 54.80 | 59.54 | 0.000106 | 1.27 | 501.57 | 101.49 | 0.09 |
| 3 | 50755 | 100-Year | 1350.00 | 53.00 | 61.40 | 55.36 | 61.44 | 0.000141 | 1.73 | 779.61 | 101.97 | 0.11 |
| 3 | 50742.5 | Bridge | | | | | | | | | | |
| 3 | 50730 | April | 273.30 | 53.70 | 57.31 | 54.32 | 57.32 | 0.000075 | 0.76 | 381.41 | 100.02 | 0.07 |
| 3 | 50730 | May | 186.60 | 53.70 | 56.71 | 54.17 | 56.71 | 0.000064 | 0.62 | 309.89 | 100.76 | 0.06 |
| 3 | 50730 | June | 140.20 | 53.70 | 56.32 | 54.09 | 56.32 | 0.000056 | 0.54 | 261.74 | 100.68 | 0.06 |
| 3 | 50730 | August | 64.90 | 53.70 | 55.40 | 53.94 | 55.40 | 0.000053 | 0.36 | 169.50 | 100.43 | 0.05 |
| 3 | 50730 | Mean Annual Floo | 750.00 | 53.70 | 59.50 | 54.61 | 59.53 | 0.000116 | 1.20 | 580.34 | 101.47 | 0.09 |
| 3 | 50730 | 100-Year | 1350.00 | 53.70 | 61.38 | 55.48 | 61.43 | 0.000148 | 1.76 | 767.77 | 101.94 | 0.11 |
| 3 | 50680 | April | 273.30 | 53.10 | 57.28 | | 57.31 | 0.000328 | 1.46 | 186.78 | 56.73 | 0.14 |
| 3 | 50680 | May | 186.60 | 53.10 | 56.69 | | 56.70 | 0.000273 | 1.21 | 154.21 | 53.96 | 0.13 |
| 3 | 50680 | June | 140.20 | 53.10 | 56.30 | | 56.31 | 0.000239 | 1.05 | 133.87 | 52.66 | 0.12 |
| 3 | 50680 | August | 64.90 | 53.10 | 55.39 | | 55.39 | 0.000192 | 0.75 | 87.05 | 49.00 | 0.10 |
| 3 | 50680 | Mean Annual Floo | 750.00 | 53.10 | 59.41 | | 59.50 | 0.000522 | 2.40 | 312.84 | 62.36 | 0.19 |
| 3 | 50680 | 100-Year | 1350.00 | 53.10 | 61.25 | | 61.38 | 0.000801 | 2.99 | 465.12 | 131.26 | 0.24 |
| 3 | 48880 | April | 273.30 | 53.00 | 58.79 | | 58.82 | 0.000231 | 1.28 | 230.06 | 86.10 | 0.12 |
| 3 | 48880 | May | 186.60 | 53.00 | 58.28 | | 58.30 | 0.000187 | 1.04 | 188.59 | 77.98 | 0.11 |
| 3 | 48880 | June | 140.20 | 53.00 | 55.95 | | 55.96 | 0.000159 | 0.89 | 163.44 | 73.32 | 0.10 |
| 3 | 48880 | August | 64.90 | 53.00 | 55.11 | | 55.11 | 0.000128 | 0.61 | 106.57 | 61.51 | 0.08 |
| 3 | 48880 | Mean Annual Floo | 750.00 | 53.00 | 58.63 | | 58.70 | 0.000378 | 2.18 | 406.94 | 110.81 | 0.17 |
| 3 | 48880 | 100-Year | 1350.00 | 53.00 | 60.13 | | 60.25 | 0.000502 | 2.97 | 604.42 | 232.42 | 0.20 |
| 3 | 44580 | April | 273.30 | 52.80 | 55.64 | | 55.65 | 0.000325 | 1.02 | 270.36 | 183.67 | 0.13 |
| 3 | 44580 | May | 186.60 | 52.80 | 55.24 | | 55.25 | 0.000330 | 0.88 | 211.47 | 145.32 | 0.13 |
| 3 | 44580 | June | 140.20 | 52.80 | 55.00 | | 55.01 | 0.000336 | 0.70 | 176.39 | 130.69 | 0.12 |
| 3 | 44580 | August | 64.90 | 52.80 | 54.36 | | 54.37 | 0.000252 | 0.53 | 102.82 | 92.71 | 0.11 |
| 3 | 44580 | Mean Annual Floo | 750.00 | 52.80 | 57.10 | | 57.13 | 0.000348 | 1.55 | 518.93 | 189.13 | 0.15 |
| 3 | 44580 | 100-Year | 1350.00 | 52.80 | 58.25 | | 58.31 | 0.000402 | 2.09 | 747.83 | 211.44 | 0.17 |
| 3 | 44230 | April | 273.30 | 52.80 | 54.05 | 54.65 | 55.23 | 0.023178 | 6.10 | 44.80 | 39.74 | 1.01 |
| 3 | 44230 | May | 186.60 | 52.80 | 54.35 | 54.35 | 54.84 | 0.024646 | 5.57 | 33.50 | 35.68 | 1.01 |
| 3 | 44230 | June | 140.20 | 52.80 | 54.16 | 54.16 | 54.56 | 0.025809 | 5.22 | 26.85 | 32.64 | 1.01 |

HEC-RAS Plan: Kenyon ramp (Continued)

| Reach | River Sta | Profile | Q Total (cfs) | Min Ch El (ft) | W.S. Elev (ft) | Crit W.S. (ft) | E.G. Elev (ft) | E.G. Slope (ft/ft) | Vel Crit (ft/s) | Flow Area (sq ft) | Top Width (ft) | Froude # Crit |
|-------|-----------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------------|--------------------|----------------------|-------------------|---------------|
| 3 | 44230 | August | 64.00 | 52.60 | 53.74 | 53.74 | 54.04 | 0.028823 | 4.41 | 14.73 | 25.09 | 1.01 |
| 3 | 44230 | Mean Annual Floo | 750.00 | 52.60 | 55.51 | 55.91 | 56.70 | 0.013300 | 7.29 | 121.29 | 109.56 | 0.88 |
| 3 | 44230 | 100-Year | 1350.00 | 52.60 | 57.39 | | 57.82 | 0.005429 | 6.53 | 301.81 | 156.91 | 0.69 |
| 3 | 44180 | April | 273.30 | 52.10 | 54.12 | 53.05 | 54.22 | 0.001937 | 2.61 | 104.89 | 52.75 | 0.32 |
| 3 | 44180 | May | 186.60 | 52.10 | 53.79 | 52.84 | 53.76 | 0.001947 | 2.24 | 83.14 | 52.58 | 0.31 |
| 3 | 44180 | June | 140.20 | 52.10 | 53.45 | 52.71 | 53.51 | 0.001954 | 2.00 | 66.96 | 52.47 | 0.30 |
| 3 | 44180 | August | 64.00 | 52.10 | 52.94 | 52.47 | 52.87 | 0.002029 | 1.49 | 43.58 | 52.26 | 0.29 |
| 3 | 44180 | Mean Annual Floo | 750.00 | 52.10 | 55.78 | 53.97 | 55.02 | 0.001060 | 3.93 | 190.92 | 53.40 | 0.36 |
| 3 | 44180 | 100-Year | 1350.00 | 52.10 | 57.30 | 54.88 | 57.89 | 0.002013 | 5.00 | 266.87 | 54.10 | 0.38 |
| 3 | 44156.7 | Bridge | | | | | | | | | | |
| 3 | 44133.4 | April | 273.30 | 51.30 | 54.01 | 52.25 | 54.07 | 0.009724 | 1.94 | 146.86 | 52.97 | 0.21 |
| 3 | 44133.4 | May | 186.60 | 51.30 | 53.62 | 52.04 | 53.65 | 0.009570 | 1.55 | 120.16 | 52.81 | 0.18 |
| 3 | 44133.4 | June | 140.20 | 51.30 | 53.38 | 51.91 | 53.40 | 0.009484 | 1.30 | 107.70 | 52.72 | 0.16 |
| 3 | 44133.4 | August | 64.90 | 51.30 | 52.86 | 51.88 | 52.90 | 0.009240 | 0.76 | 82.85 | 52.53 | 0.11 |
| 3 | 44133.4 | Mean Annual Floo | 750.00 | 51.30 | 55.58 | 53.17 | 55.76 | 0.001189 | 3.38 | 222.11 | 53.59 | 0.29 |
| 3 | 44133.4 | 100-Year | 1350.00 | 51.30 | 57.06 | 54.06 | 57.32 | 0.001484 | 4.57 | 295.72 | 54.15 | 0.34 |
| 3 | 44083.4 | April | 273.30 | 51.40 | 53.28 | 53.20 | 53.81 | 0.025040 | 5.96 | 45.82 | 42.75 | 1.02 |
| 3 | 44083.4 | May | 186.60 | 51.40 | 53.02 | 53.02 | 53.45 | 0.026756 | 5.27 | 35.43 | 42.14 | 1.01 |
| 3 | 44083.4 | June | 140.20 | 51.40 | 52.86 | 52.86 | 53.23 | 0.026994 | 4.81 | 28.98 | 41.76 | 1.02 |
| 3 | 44083.4 | August | 64.90 | 51.40 | 52.57 | 52.57 | 52.80 | 0.032385 | 3.83 | 18.62 | 37.67 | 1.01 |
| 3 | 44083.4 | Mean Annual Floo | 750.00 | 51.40 | 54.31 | 54.31 | 55.34 | 0.020960 | 8.18 | 91.73 | 45.07 | 1.01 |
| 3 | 44083.4 | 100-Year | 1350.00 | 51.40 | 56.32 | 55.32 | 56.80 | 0.018646 | 9.74 | 138.54 | 47.45 | 1.01 |

APPENDIX G

**RIVER AND WETLAND ASSESSMENT, PAWCATUCK RIVER
WORDEN POND TO LOWER SHANNOCK FALLS DAM, NOAA**

**RIVER AND WETLAND ASSESSMENT
PAWCATUCK RIVER
WORDEN POND TO LOWER SHANNOCK FALLS**

August 2006

Introduction

The Wood-Pawcatuck Watershed Association (WPWA) in partnership with the Town of Richmond was recently awarded grant funding through the National Oceanic and Atmospheric Administration (NOAA)-American Rivers (AR) partnership and the Rhode Island Coastal Resources Management Council to conduct a Feasibility Study (FS) to assess anadromous fish passage restoration at two dams on the Pawcatuck River in Richmond and Charlestown, Rhode Island. The FS, to be completed by an engineering consultant, will include a thorough analysis of fish passage alternatives at the Lower and Upper Falls Dams in Shannock, a village located in both Richmond and Charlestown. A third dam, located upstream of the two Shannock dams and owned by Kenyon Industry, will also be assessed, pending availability of supplemental funding. Various fish passage alternatives will be considered for each of the three dams including structural fishways (*e.g.*, Denil fishway), bypass channels, rock/roughened ramps, and full or partial dam removal. The full or partial dam removal alternatives, while offering the greatest potential for anadromous fish passage restoration, pose potential environmental constraints that may affect upstream riverine and wetland ecological communities and habitats.

The purpose of this assessment, completed by NOAA with assistance from the project partners, is to assess existing riverine and wetland conditions upstream of each of the three dams. The study area extends from Worden Pond, the largest natural freshwater lake in Rhode Island, downstream to the Lower Falls Dam. Results of this assessment will be evaluated by the engineering consultant during the preparation of the FS, and relevant information will be incorporated into the final FS and may be useful in recommending and selecting design alternative for each of the three subject dam sites.

Methods

Existing information was initially compiled and reviewed to identify physical riverine conditions, watershed hydrology, soil and bedrock characteristics, wetland vegetation communities, and other landscape land use features. The Rhode Island Geographical Information System (RIGIS) was accessed to collect topographic and wetland cover type data layers. The Soil Survey of Rhode Island (Rector, 1981) was reviewed to identify major soil mapping units in the project area. Bedrock information was obtained from Hermes *et al.* (1994). River flow conditions and dam and water surface elevation information was obtained from the Flood Insurance Study for the Town of Charlestown, Rhode Island (FEMA, 1986). Refined topographic elevation and survey benchmark data were obtained from the Rhode Island Department of Environmental Management (RIDEM), Rhode Island Department of Transportation (RIDOT), and Kenyon Industry.

Following the existing data review and evaluation, NOAA completed field assessments on August 8, 9 and 16, 2006, with assistance from the U.S. Fish and Wildlife Service (USFWS), Narragansett Bay Estuary Program (NBEP), and WPWA. The river and wetlands were accessed using canoe and john boat; elevation data were collected using Sokia survey level, tripod, and rod; river sediment reconnaissance was completed with a metal probing rod and survey rod; and sediments were sampled with a MacCauley peat corer. Sampling stations were located using hand-held GPS, photographs documented specific site conditions, and pertinent data were recorded in field notebooks.

River dimensions included both field measurements and aerial photograph measurements. Sinuosity was calculated using aerial photographs. River reaches were classified according to Rosgen (1994) and wetlands were classified according to Cowardin *et al.* (1979).

Results

This assessment investigated approximately 4.6 river miles of the Pawcatuck River. The upper Pawcatuck River traverses a broad glacial outwash plain consisting of thick, sorted gravel, sand, silt and clay deposits. Within the village of Shannock, sloping upland and to a lesser extent wetland till soils are more prevalent. Bedrock outcrop becomes more frequent in this sloping topography. Late Proterozoic augen, locally foliated and lineated, coarse-grained granitic gneiss is the prevalent bedrock type in this area, and was noted frequently along the riverbanks, forming the river bottom, and serving as a base for the Upper and Lower Falls Dams.

Hydric soil units including Carlisle muck (Co) and Adrian muck (Aa) are the predominant soils of the wetlands in the subject watershed area (Refer to Rector, 1981, maps 134 and 135). Adrian mucks are very poorly drained organic soils up to 50 inches in thickness in outwash plains and topographic depressions, where the water table is at or near the surface (+1.0-1.0) for most of the year. Carlisle mucks are similar to the Adrian series with very poorly drained organic soils often exceeding 50 inches in thickness and associated with depressions in glacial till and outwash plains and characterized by water at or near the surface for much of the year (+0.5-1.0). Raypol (Rc) silt loams, Scarboro (Sb) mucky sandy loams, and Ridgebury extremely stony fine sandy loams (Rf) are less frequently occurring hydric soils mapped for this watershed area.

Palustrine forested deciduous swamp (PFO1) dominated by red maple (*Acer rubrum*) and green ash (*Fraxinus pennsylvanica*) is the most common wetland type in the study area. Black gum (*Nyssa sylvatica*) was also noted as an infrequent canopy species. Maximum tree size noted during the field reconnaissance was estimated at 20 inches diameter at breast height. We note that the RIGIS mapping for the study area is largely accurate based on our field reconnaissance.

Results of the assessment identified five distinct river reaches and associated wetlands, described as follows.

Reach 1 – Worden Pond to Confluence with Usquepaug River (1.85 miles)

The Pawcatuck River through this section is a narrow, highly meandering, low gradient river discharging from Worden Pond. Worden Pond is a natural glacial outwash lake and has no man-

made water control structures. The bottom substrate is dominated by fine sands and organic mucks, with unconsolidated sediments of 2+ feet.

Bankfull width ranges from 18 to 25 feet and bankfull depth ranges from 3 to 6 feet. The W/D ratio is 3-8.3:1. Sinuosity is 1.61 (9768 ft/6072 ft). Stream gradient is $\leq 0.02\%$ (~2 ft/9768 ft). This river segment is classified as a Type E5 river.

The wetland floodplain is extensive in this reach, as wide as 2500 feet in some locations. Forested swamp (PFO1C/E) is the dominant cover type in this broad outwash floodplain. Scrub-shrub (PSS1C/E) (*Alnus*, *Ilex*, *Rhododendron viscosum*, *Clethra alnifolia*) cover was infrequently noted, emergent (particularly water willow - *Decodon verticillatus*)-dominant cover even less frequent (very small patches and in one location at a utility power line crossing). This river reach is largely undisturbed, and no invasive plant species were noted. Carlisle mucks are the dominant underlying soil of these outwash plain wetlands.

We noted locally abundant freshwater mussels (*Elliptio* spp.) in this reach.

Reach 2 – Usquepaug River Confluence to New Biscuit City Road (0.70 miles)

This river reach widens to approximately 40 feet and appears to be at least partially impounded along its length by the Kenyon Industry Dam. Bankfull width is 40-65 feet and bankfull depth is ~5-7 feet. The W/D ratio is 5.7-13. Sinuosity is 1.32 (3696 ft/2178 ft). Stream gradient is $\leq 0.005\%$ (0.1 ft/2112 ft). This river segment is classified as a Type C5c/C1c river.

The bottom substrate is composed of sands, organic mucks and bedrock and boulder. In the upper portions of this reach, greater accumulation of fine-grained sediments was noted, particularly along the emergent and scrub-shrub border. The main channel and thalweg have limited fine-grained sediment, and bedrock and/or boulder substrates are the predominant bottom type, suggesting the watershed has limited sediment sources and/or the main channel is frequently scoured by flows.

A complex of forested (PFO1C/E), scrub-shrub (PSS1E) and non-persistent emergent (PEM5) wetlands form the cover types along this reach, extending up to 2100 feet in width. Red maple dominates the forest and shrub canopy, and a fringe of arrow arum (*Peltandra virginica*) and pickerel weed (*Pontederia cordata*) dominates the emergent layer with a permanently to semi-permanently flooded hydrologic regime. Carlisle mucks are the dominant underlying soil of these outwash plain wetlands.

Reach 3 – New Biscuit City Road to Kenyon Industry Dam (0.78 miles)

This river reach is impounded by the Kenyon Industry Dam. The FEMA study identifies the Kenyon Dam at approximate elevation 86.3 feet, NGVD. This closely corresponds to the elevations (Dam crest elevations vary 85.72 – 86.18 ft NGVD) obtained through the NOAA survey using the benchmark provided by Kenyon Industry.

The NOAA field data were used to estimate bankfull width and depth. Bankfull width is 70-120 feet and bankfull depth is 7-9 feet. The W/D ratio is 7.8-17.1:1. Sinuosity is 1.32. Stream gradient is $\leq 0.06\%$ (0.24 ft/3828 ft). This river segment is classified as a Type C5c/C1c river.

Bedrock and boulder is the dominant bottom substrate type. Sands and organic mucks were found in limited depositional locations (inside channel meanders and small backwaters) to a maximum depth of 2+ feet.

The wetland cover along this river reach is relatively narrow but broadens to 600 feet in one section. This river reach is dominated by forested (PFO1C/E) and scrub-shrub (PFO1E) (red maple dominant) wetlands. The fringe emergent (PEM5) cover increases further downstream and is dominated by water willow, pickerel weed, and arrow arum, particularly in the vicinity of the Route 2 crossing. Adrian mucks are the predominant hydric soil underlying the wetlands in this river reach.

Reach 4 – Kenyon Industry Dam to Upper Falls Dam (0.83 miles)

Much of this segment is impounded by the Upper Falls Dam (~elevation 82.00 ft NGVD – FEMA study) although the river is free flowing immediately below the Kenyon Dam. This river section has been affected by urban development, particularly the Kenyon Industry buildings, dam, wastewater settling lagoons, as well as residential development. Along the river section bordering the Kenyon Industry, the floodplain has been eliminated by construction of rock retaining walls. Below the walled reach, the river has been affected by lagoon construction, but is well vegetated by a wetland complex.

NOAA field data and the FEMA study were used to estimate channel gradient. Bankfull width ranges from 45 to 130 feet and bankfull depth ranges from ~8-11 feet. The W/D ratio is 4.1-16.25. Sinuosity is 1.43 (4356 ft/3036 ft). Stream gradient is $\leq 0.009\%$ (0.38 ft/4356 ft). This river segment is classified as a Type C5c river.

Bedrock/boulder and sands and mucks are the dominant bottom substrate types. Sands and organic mucks were noted in depositional locations – inside channel meanders and backwaters such as the vicinity of the lagoons.

The wetland border extends out up to 250 feet along this river reach. Forested and scrub-shrub swamp (PFO1C/E, PSS1E) dominates this section of the river. Red maple and buttonbush (*Cephalanthus occidentalis*) dominate this section. We noted that invasive, non-native plants including common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*) were first noted along this reach of the entire river study area. Water quality appears degraded, and it should be noted that Kenyon Industry has a RIPDES permit for their industrial discharge. Duckweed (*Lemna* spp.), a floating aquatic species, was also noted in this area and is an indicator of excess nutrients.

Adrian mucks are the predominant hydric soil underlying the wetlands in this river reach. Urban fill soils (Ur - Udorthents) and upland soils including Canton-Urban very rocky, land complex (Cc), Canton and Charlton fine sandy loams (CeC), Sutton extremely stony fine sandy loams

(SvB), Sudbury sandy loams (Ss), and Hinkley gravelly sandy loams (HkC) are also found in this area, forming gentle sloping to steep lands along the river.

Reach 5 – Upper Falls Dam to Lower Falls Dam (0.45 miles)

Most of this segment is impounded. During the August site visit, NOAA noted that the upper limited of impoundment was approximately 60 feet downstream of the Shannock Road bridge. Bankfull width ranges from 90 to 160 feet and bankfull depth ranges from 7 to 16. The W/D ratio is 10-13. Sinuosity is 1.38. Stream gradient is $\leq 0.04\%$ (1.0 ft/2376 ft). This river segment is classified as a Type C1c river.

Bedrock and boulder is the dominant bottom substrate type. Very fine sands and organic mucks were found in only limited depositional locations (inside channel meanders and small backwaters) to a maximum depth of 3 feet. This impoundment lacks sediment as the two upper dams likely minimize downstream transport of sediments. A bedrock/boulder substrate characterizes the area immediately upstream of the Lower Falls Dam.

Wetlands along this reach are relatively narrow but broaden to nearly 800 feet in one section. Forested (red maple and green ash) wetlands (PFO1C, PSS1C/E) dominate this reach. Water willow and buttonbush-dominated scrub-shrub wetlands are prevalent in the central portion of this reach in the vicinity of several Shannock village residences on the north side of the river.

Adrian mucks are the predominant hydric soil underlying the wetlands in this river reach. Urban fill soils (Ur - Udorthents) and upland soils including Canton-Urban very rocky, land complex (Cc), and Hinkley gravelly sandy loams (HkC) are also found in this area, forming gentle sloping to steep lands along the river.

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August 2006 NOAA Field Survey Data – Pawcatuck River

Worden Pond

Surface water elevation was measured from public boat ramp (Worden Pond Road) (8/8/06).
Elevation = 89.18 ft, NGVD 29.

Pond Outlet -- Pawcatuck River cross section:

| | | | | |
|--|-------|-------|-------|-------|
| Station Number (feet from left bank) | 0 | 10 | 20 | 30 |
| Water Depth (ft) | 2.77 | 3.20 | 3.24 | 2.54 |
| Bottom Elev. (NGVD 29) | 86.42 | 85.98 | 85.94 | 86.64 |

New Biscuit City Road Bridge

Downstream cross section:

| | | | | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Station Number (ft from east edge of bridge) | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 |
| Water Depth (ft) | 0 | 1.95 | 2.99 | 2.95 | 3.05 | 3.70 | 3.37 | 3.21 | 3.56 | 3.79 |
| Bottom Elev (ft NGVD) | 86.75 | 84.80 | 83.76 | 83.80 | 83.70 | 83.05 | 83.38 | 83.54 | 83.19 | 82.96 |

Upstream cross section:

| | | | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Station Number (ft from east edge of bridge) | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
| Water Depth (ft) | 0.44 | 2.06 | 3.37 | 4.57 | 5.65 | 5.92 | 6.28 | 6.23 | 5.42 |
| Bottom Elev (ft NGVD) | 86.31 | 84.69 | 83.38 | 82.18 | 81.10 | 80.83 | 80.47 | 80.52 | 81.33 |

The bottom elevations and benchmark readings were taken by NOAA at New Biscuit City Road Bridge on 8/8/06. Water depth calculated using water surface elevation at downstream transect point 0, or approximate rivers edge.

Route 2 Bridge Survey

Survey measurements at Pawcatuck River at Route 2 bridge (8/8/06). Water surface elevation = 86.65 ft NGVD 29.

Upstream cross section:

| | | | | | | | | | | | |
|--------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Station Number (feet from left bank) | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| Water Depth (ft) | 1.8 | 2.96 | 3.90 | 5.35 | 6.55 | 7.23 | 7.77 | 7.50 | 5.15 | 2.0 | 0.65 |
| Bottom Elev (NGVD) | 84.85 | 83.69 | 82.75 | 81.30 | 80.10 | 79.42 | 78.88 | 79.15 | 81.50 | 84.65 | 86.00 |

Downstream cross section:

| | | | | | | | | | | | |
|---------------------------------|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Station Number (from left bank) | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| Water Depth (ft) | Exposed | 0.30 | 1.98 | 2.84 | 3.36 | 3.59 | 3.24 | 3.20 | 3.30 | 3.12 | 3.64 |
| Bottom Elev (NGVD) | | 86.35 | 84.67 | 83.81 | 83.29 | 83.06 | 83.41 | 83.45 | 83.35 | 83.53 | 83.01 |

Kenyon Industry Dam and Impoundment Survey

Headpond, tailwater, plunge pool and dam crest elevations (8/8/06).

Headpond elevation = 86.51 ft NGVD

Tailwater elevation = 82.38 ft NGVD

Plunge pool elevations vary 80.32 – 80.86 ft NGVD

Dam crest elevations vary 85.72 – 86.18 ft NGVD

Kenyon Industry Impoundment

Survey impoundment (8/16/06)

Water surface elevation = 86.15 NGVD 29

Transect 1 (~60 ft upstream of dam):

| | | | | | | | | | | |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Station Number (from left bank) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 85 |
| Water Depth (ft) | 0 | 1.16 | 3.25 | 5.70 | 6.05 | 4.90 | 4.70 | 5.52 | 4.16 | 0.85 |
| Bottom Elev (NGVD) | 86.15 | 84.99 | 82.90 | 80.45 | 80.10 | 81.25 | 81.45 | 80.63 | 81.99 | 85.30 |

Kenyon Industry Road – Bridge Crossing

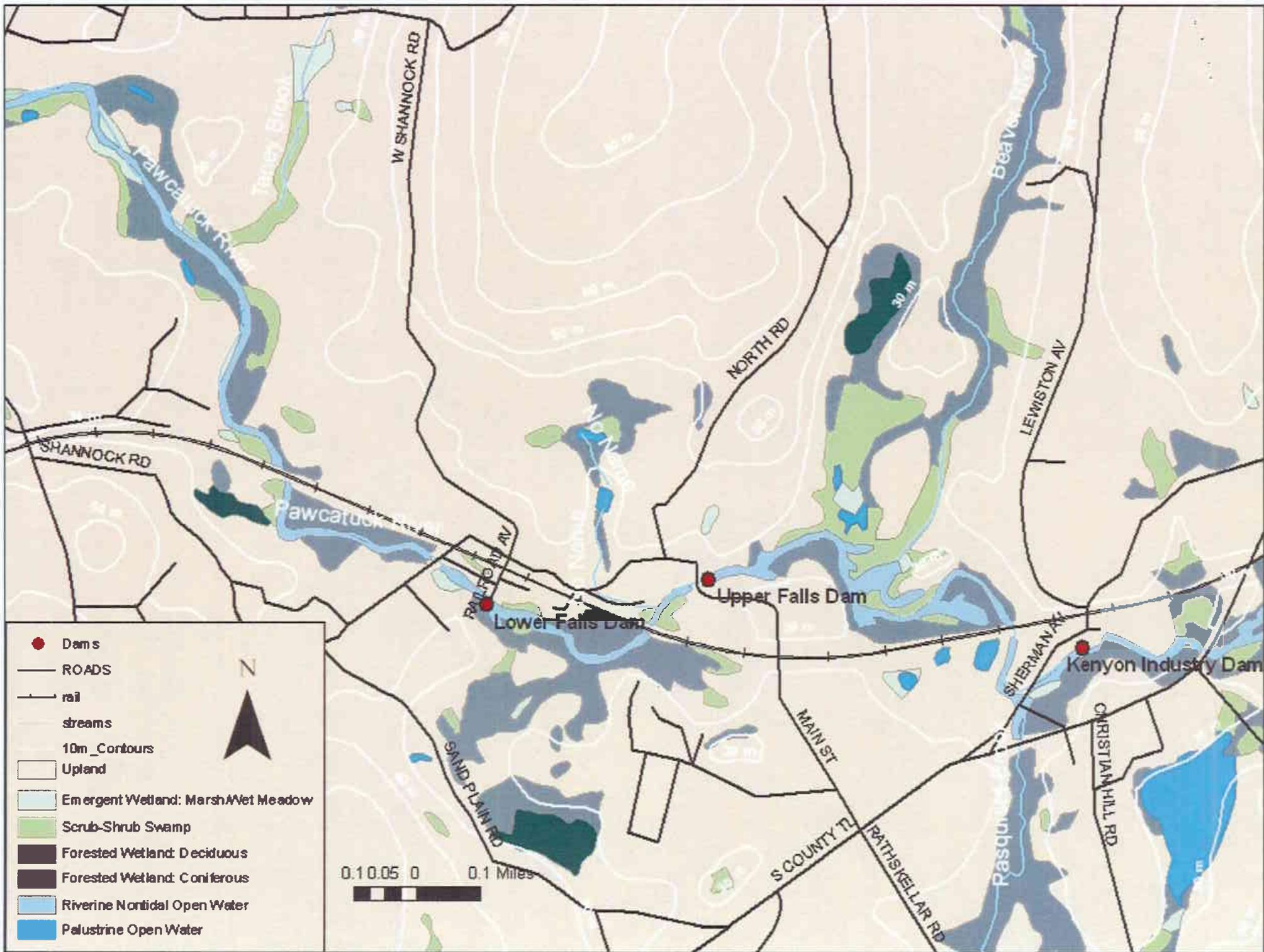
Water surface = 82.34 ft NGVD (8/8/06)

Upstream cross section:

| | | | | | | | | | |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Station Number (from left bank) | 0 | 5 | 11 | 15 | 20 | 25 | 30 | 35 | 40 |
| Water Depth (ft) | 0.95 | 3.31 | 6.17 | 6.25 | 6.19 | 6.77 | 6.85 | 6.91 | 5.16 |
| Bottom Elev (NGVD) | 81.44 | 79.03 | 76.17 | 76.03 | 76.15 | 75.57 | 75.49 | 75.43 | 77.18 |

Downstream cross section:

| | | | | | | | | | |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Station Number (from left bank) | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 |
| Water Depth (ft) | 1.64 | 2.44 | 2.62 | 3.95 | 4.57 | 4.56 | 4.17 | 3.38 | 3.20 |
| Bottom Elev (NGVD) | 80.71 | 79.91 | 79.73 | 78.40 | 77.78 | 77.79 | 78.18 | 78.97 | 79.15 |



APPENDIX H
BULK DENSITY DATA, URI

Shannock Bulk Density Determination

Prepared by: T. Boving, URI-GEO

| Sample ID | Date Collected | Date Analyzed | Vol. Soil - wet (cm ³) | Net weight wet soil (g) | Net weight dry soil (g) | Soil Bulk Density (g/cm ³) | Porosity | Dry Soil Density (g/cm ³) |
|--------------|----------------|---------------|------------------------------------|-------------------------|-------------------------|--|----------|---------------------------------------|
| KI-1 (48 cm) | 8/17/2006 | 9/20/2006 | 65.12 | 105.96 | 64.09 | 1.63 | 17.7% | 0.98 very |
| KI-2 (48 cm) | 8/17/2006 | 9/20/2006 | 65.61 | 77.31 | 21.18 | 1.18 | 39.6% | 0.32 signi |
| KI-3 (46 cm) | 8/17/2006 | 9/20/2006 | 60.65 | 78.04 | 29.64 | 1.29 | 36.5% | 0.49 |
| KI-4 (48 cm) | 8/17/2006 | 9/20/2006 | 66.16 | 72.65 | 11.11 | 1.10 | 47.4% | 0.17 signi |
| KI-5 (47 cm) | 8/17/2006 | 9/20/2006 | 56.71 | 70.36 | 23.43 | 1.24 | 33.8% | 0.41 sign |
| LF-1 (46 cm) | 8/17/2006 | 9/20/2006 | 58.26 | 78.04 | 31.99 | 1.34 | 30.1% | 0.55 |
| LF-2 (48 cm) | 8/15/2006 | 9/20/2006 | 60.73 | 94.83 | 55.42 | 1.56 | 19.9% | 0.91 lots |
| LF-3 (48 cm) | 8/17/2006 | 9/20/2006 | 63.65 | 76.33 | 19.19 | 1.20 | 43.4% | 0.30 |
| LF-4 (48 cm) | 8/17/2006 | 9/20/2006 | 60.86 | 74.88 | 24.54 | 1.23 | 36.2% | 0.40 |
| LF-5 (48 cm) | 8/17/2006 | 9/20/2006 | 59.05 | 73.35 | 22.69 | 1.24 | 37.8% | 0.38 |