Kentucky River Lock and Dam # 11 Hydroelectric Dam Project

Biological Opinion on the Round Hickorynut (*Obovaria subrotunda*) Sheepnose (*Plethobasus cyphyus*), and Snuffbox (*Epioblasma triquetra*)

FWS #: 2024-0023535

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May 27, 2025
Date

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CONSULTATION HISTORY

This section lists key events and correspondence during the course of this consultation. A complete administrative record of this consultation is on file in the U.S. Fish and Wildlife Service's (Service) Kentucky Field Office (KFO).

July 29, 2024: The United States Department of Agriculture **(**USDA) Rural Utilities Service (RUS) submitted an informal consultation request to the Kentucky Field Office for review and concurrence regarding the construction of a hydropower facility in an existing lock and dam structure on the Kentucky River.

September 9, 2024: The KFO reviewed and submitted a follow-up request for additional mussel habitat information.

October 31, 2024: A mussel survey report was provided to the KFO detailing the finding that 17 live federally threatened round hickorynut individuals and one recently dead/weathered dead federally endangered sheepnose individual was found immediately downstream of the existing dam.

November 8, 2024: USDA hosted a meeting with the KFO, ICF International, Inc. (ICF) and Appalachian Hydro Associates to discuss the results of the mussel survey report. Appalachian Hydro Associates suggested they perform a hydraulic analysis of the area to determine the scope of impacts.

February 18, 2025: USDA hosted a meeting with the KFO, ICF, Appalachian Hydro Associates, and Kleinschmidt Associates (Kleinschmidt) to discuss the results of a hydraulic analysis conducted by Kleinschmidt. Based on these results, USDA determined the project could adversely affect listed mussel species.

April 4, 2025: On behalf of the USDA, ICF provided a final draft BA to the KFO for review and comment. The KFO had no additional comments.

April 7, 2025: The USDA submitted the final BA to the KFO that determined the proposed action "may affect and is likely to adversely affect" the round hickorynut (*Obovaria subrotunda*), sheepnose (*Plethobasus cyphyus*), and snuffbox mussel (*Epioblasma triquetra*). The USDA requested initiation of formal consultation on the round hickorynut, sheepnose, and snuffbox.

The USDA also determined that the proposed action would have "no effect" on the gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Virginia big-eared bat (*Corynorhinus townsendii virginianus*), and short's bladderpod (*Physaria globosa*) and a "may affect, but is not likely to adversely affect" the salamander mussel (*Simpsonaias ambigua*). Potential adverse effects to these species would be addressed under a separate consultation process.

April 28, 2025: The KFO concurred that the proposed action "may affect, and is likely to adversely affect" the round hickorynut, sheepnose, and snuffbox mussel.

May 05, 2025: The KFO provided a draft biological opinion (BO) to the USDA for review and comment.

May 20, 2025: The USDA provided comments on the draft BO and the KFO incorporated those comments.

May 27, 2025: The final BO was provided to the USDA.

BIOLOGICAL OPINION AND CONFERENCE OPINION

INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act of 1973, as amended (ESA), as to whether a federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened, or
b) result in the destruction or adverse modification of designated critical habitat.

The United States Department of Agriculture (USDA) Rural Development's Rural Utilities Service proposes financial assistance for the installation of turbines in the Kentucky River at Lock and Dam #11 (KRLD11) to generate hydropower (the Action). A BO that concludes a proposed Federal action is not likely to jeopardize the continued existence of listed species and is not likely to result in the destruction or adverse modification of critical habitat fulfills the Federal agency's responsibilities under §7(a)(2) of the ESA. "Jeopardize the continued existence means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR §402.02). There is no designated critical habitat within the Action Area, therefore, this BO does not address critical habitat.

1.0 PROPOSED ACTION

The proposed project would be located at KRLD11 at river mile (RM) 201.0 on the Kentucky River (Figure 1). KRLD11 is owned by the Commonwealth of Kentucky and operated by the Kentucky River Authority (KRA) for water supply. The existing 208-foot-long fixed crest concrete dam has a 148-foot-long by 52-foot-wide lock chamber. The 482-acre reservoir provides approximately 4,820 acre-feet of storage and only operates at run-of-river levels (i.e., does not draw water from below its crest). The existing lock chamber of the structure is abandoned, and a concrete bulkhead has been placed in the lock chamber, below the upper miter gates, to prevent failure and loss of pool.

Lock 11 Hydro Partners would remove the concrete bulkhead and construct a 28.4-foot by 52-foot by 49.5-foot steel reinforced concrete powerhouse. A 58-foot by 52-foot horizontal trash rack would be installed from the lock chamber upper sill to the back wall of the powerhouse at three feet below the normal pool level. An inflatable rubber dam would be installed on top of the powerhouse wall to maintain the pool during normal operating conditions.

Lock 11 Hydro Partners would install four 642-kW Voith 14.9 and two 222-kW Voith 8.95 StreamDiver turbine-generators into the existing lock chamber of KRLD11. These submersible units directly couple permanent magnet generators with turbines, eliminating the need for a gearbox and associated oil lubrication. A prefabricated-steel and reinforced 42-foot by 20-foot by 28-foot concrete control building would be installed atop a concrete foundation at the edge of

the existing concrete esplanade and would be connected to the powerhouse via an underground cable trench. The control building would house the switchgear, controls, transformers, and the main circuit breaker for the plant. The control building would be interconnected to the existing 15-kV overhead distribution line which runs to the site from Madison County, which will be re-conductored to three-phase.

1.1 Components of the Action

The Action includes a planning component, construction component, and operation component.

Planning Component

Planning is the first component of the proposed Action and includes all necessary activities prior to construction activities. These activities include, but are not limited to, securing project funding; developing project timeframes and schedules; designing project plans; performing site visits; preparing preliminary assessments and reports; completing required consultations and permitting; and coordinating with the project team. The planning component is considered an administrative action only and will not result in potential impacts to any federally listed species. As a result, this component will have no effect on listed species and is not discussed further.

Construction Component

Construction is the second component of the proposed Action and includes three separate activities: 1.) site preparation, 2.) control building, and 3.) powerhouse concrete and draft tubes.

1. Site preparation is the first construction component. Activities associated with site preparation include:
    - installation of erosion prevention and sediment control (EPSC) measures
    - installation of a temporary access road
    - installation of all rock anchors and cofferdam
    - dewatering of the lock
    - grouting of north and south walls needed to prevent water seepage
    - establishment of staging areas
    - improvement and construction of access roads

EPSC measures will be installed prior to construction activities to minimize erosion and sedimentation into the Kentucky River. Next a temporary cofferdam will be installed and sealed on the downstream miter gate sill to block off water from entering the lock chamber. Next, the lock chamber will be dewatered and cleaned down to bedrock.

2. The control building work scope includes:
    - control building excavation
    - construction of the control building concrete structure
    - backfilling and grading around control building
    - fabrication and installation of structural steel
    - installation of the pre-fabricated metal building

3. Powerhouse work scope includes:

- installation of rock dowels along the powerhouse base
- installation of forms and rebar for mass concrete placement
- placement of mass concrete in lifts up to 565.0' to accommodate installation of embedded steel draft tubes, stoplog slots and conduits

Once clean bedrock is exposed, concrete construction can begin in the lock chamber of the powerhouse. The powerhouse is a mass concrete pour with embedded horizontal draft tubes. The trash rack system and rubber dams are then installed. The final installation is the turbine generators with shut-off valves, which are bolted to the receiving plates on the front of the draft tubes. Once all the equipment is installed, the upper concrete bulkhead and lower temporary cofferdam is removed, allowing water into the new plant.

Additionally, to provide recreational opportunities at the project, Lock 11 Hydro Partners proposes to: implement a Recreation Resources Management Plan to direct construction, operation, and maintenance of recreational resources at the project that includes the following:

- construction of a new portage trail around the lock and dam
- providing designated bank-fishing access to the tailrace
- construction of a new parking area for four to six vehicles, adjacent to an existing access road on KRA-owned land

Operation Component

The proposed project would operate in run-of-river using flows between 196 cubic feet per second (cfs) and 2,636 cfs for power generation. The turbines would be operated sequentially, based on inflow, and would maintain run-of-river operation levels. Lock 11 Hydro Partners proposes to install monitoring equipment in the lock chamber and headwater pool that is designed to shut down the generating units when water levels in the impoundment fall below 617.38 feet.

The proposed project would generate 13,556 MWh annually. Power would be transmitted from the powerhouse to the Clark Energy/East Kentucky Power Cooperative Hunt Substation. All power generated would be sold to the East Kentucky Power Cooperative at approved tariff rates based on spot-market pricing.

Trash-rack maintenance would be periodically performed by deflating the rubber dam atop the powerhouse and allowing water to wash accumulated debris downstream. Once the trash rack is cleared of debris, the rubber dam would be re-inflated to restore operating pool levels.

In addition to run-of-river operation, Lock 11 Hydro Partners proposes measures to ensure that the project does not affect municipal water withdrawals from the Kentucky River. The proposed project would not operate when flow limits on the Kentucky River are below thresholds required by the KDEP Division of Water, which may occur during severe droughts. Similarly, the project would not operate if KRA were to implement bypass valve releases in order to increase water levels downstream.

1.2 Action Area

For purposes of consultation under ESA §7, the Action Area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved

in the action" (50 CFR §402.02). The 10.7-acre Action Area includes KRLD11and the Kentucky river downstream of the dam for approximately 1,190 feet where changes in normal flow between existing and proposed conditions are predicted to occur. All construction activities will be limited to a work area within the lock chamber below the upper miter gates, concrete esplanade, and adjacent KRA property (Figure 2).

1.3 Conservation Measures

Conservation measures (CM) are those proposed actions taken to minimize incidental take and benefit or promote the recovery of the species under review. Conservation measures are included as an integral portion of the Action. The USDA, Lock 11 Hydro Partners, and the Service have committed to implement the following conservation measures, specific to the affected freshwater mussels, as part of the Action:

CM 1: Implementation of EPSC measures in the work area, including but not limited to: Stabilization of disturbed areas as soon as practicable but no more than seven (7) days after construction activities have temporarily or permanently ceased in any portion of the work area. At a minimum, interim and permanent practices implemented to stabilize disturbed areas will include temporary and/or permanent seeding, erosion control matting, mulching, and/or sodding, and silt fencing.

CM 2: Development of a spill response plan in case of an emergency spill.

CM 3: Implementation of BMPs when operating machinery on the lock chamber or within the riparian area to avoid and minimize the potential for accidental spills.

CM 4: Prior to project operation, mussels will be salvaged from the zone of predicted highest impact and relocated immediately downstream of the Action Area (Figure 3).

CM 5: Prior to relocation efforts a year 0 mussel survey will be conducted. Survey methods and survey extent will follow BioSurvey Group's October 2024 mussel survey (Appendix A).

CM 6: Mussel monitoring will be conducted in years 1, 3, and 5 post project operation. Monitoring methods and survey extent will follow BioSurvey Group's October 2024 mussel survey for direct comparison of any changes (Figure 4).

2.0 STATUS OF THE SPECIES

This section summarizes the best available data about the biology and current condition of the round hickorynut, sheepnose, and snuffbox mussels throughout their range that are relevant to formulating an opinion about the Action.

2.1 Round Hickorynut

The round hickorynut (*Obovaria subrotunda*) is a small- to medium-sized mussel up to 3 inches (75 millimeters) in size, which lives up to 15 years. Round hickorynut adults are greenish olive to dark or chestnut brown, sometimes blackish in older individuals, and may have a yellowish band. The shell is thick, solid, and up to three inches long, but usually is less than 2.4 inches. A

distinctive characteristic is that the shell is round, nearly circular. The foot can be pale tan to pale pinkish orange.

The round hickorynut is found in small streams to large rivers, and prefers a mixture of sand, gravel, and cobble substrates. The species is wide-ranging and was historically known from 12 states; however, it now only occurs in 9 states, as well as the Canadian province of Ontario. It is currently found in five major basins: the Great Lakes, Ohio (where it is most prevalent), Cumberland, Tennessee, and Lower Mississippi. The number of known populations in the U.S. has declined by 77 percent, from 301 historically documented populations to 69 today (USFWS 2019).

In Kentucky, the round hickorynut was historically found in most medium to large streams but the species does not adapt well to impoundments leaving only a few small populations in Kentucky. The species can be found sporadically in the Green, Barren, Kentucky, Licking, and Rockcastle Rivers as well as Buck Creek. The only notable exceptions are the Red River and the South Fork of the Kentucky River where the species is generally distributed throughout those systems (Haag and Cicerello 2016).

2.2 Sheepnose

The sheepnose is a medium-sized species, elongate quadrate to ovate in shape, that is thick-shelled and reaches nearly 5.5 inches in length. There is a row of large, broad tubercular swellings on the center of the shell extending from the beak to the ventral margin and the periostracum (external shell surface) is generally light yellow to dull yellowish brown in color. The species is generally considered a large-river species; however, it also inhabits medium-sized rivers. The species is typically found in deep water (greater than two meters) with slight to swift currents and mud, sand, or gravel bottoms. The sheepnose may also inhabit riffles with gravel/cobble substrates and appears capable of surviving in reservoirs (NatureServe 2020).

The sheepnose was listed as endangered under the ESA on April 12, 2012, throughout its entire range in Alabama, Illinois, Indiana, Iowa, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin (USFWS 2012). Historically, the sheepnose was known to occur throughout much of the Mississippi River system; however, this species has been extirpated from over 65 percent of its historical range (25 streams currently from 77 streams historically), including thousands of miles of the Mississippi, Wisconsin, Illinois, Ohio, Cumberland, and Tennessee Rivers and their tributaries. Of the 25 extant populations, nine are considered stable, eight are considered declining, and six others are considered extant, although the status of these six populations is unknown. The remaining two populations are located in the Allegheny River (Ohio) and Green River (Kentucky) and are the only two locations where the species is thought to be improving in population status.

In Kentucky, populations persist in the Ohio, Licking, Kentucky, and Green Rivers (USFWS 2012). Only a single record exists from the Kentucky River, a fresh dead individual found in Garrard County in the late 1990's. A recently deceased individual of the species, estimated to have died within the last 1-2 years, was identified by BioSurvey Group during the mussel survey conducted for this project. Therefore, there are only two known records of this species within the entire Kentucky River basin.

2.3 Snuffbox

The snuffbox is a small- to medium-sized mussel, with males reaching up to 2.8 in length The shape of the shell is somewhat triangular (females), oblong, or ovate (males), with the valves solid, thick, and very inflated. The umbo is located somewhat anterior of the middle, and is swollen, turned forward and inward, and extended above the hinge line. The anterior end of the shell is rounded, and the posterior end is truncated, highly so in females. The posterior ridge is prominent, being high and rounded, while the posterior slope is widely flattened. The posterior ridge and slope in females are covered with fine ridges and grooves, and the posterioventral shell edge is finely toothed. The shell is yellow or yellowish green and covered with dark green rays or chevrons. The nacre is white or with a slightly iridescent bluish white. The cardinal teeth are relatively large and serrated; lateral teeth are thick and short.

The snuffbox was listed as endangered by the USFWS on February 14, 2012. The snuffbox historically occurred in 210 streams and lakes in 18 States and 1 Canadian province: Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and Wisconsin; and Ontario, Canada. The major watersheds of historical streams and lakes of occurrence include: the upper Great Lakes sub-basin (Lake Michigan drainage), lower Great Lakes sub-basin (Lakes Huron, Erie, and Ontario drainages), upper Mississippi River sub-basin, lower Missouri River system, Ohio River system, Cumberland River system, Tennessee River system, lower Mississippi River sub-basin, and White River system. Extant populations of the snuffbox are known from 79 streams in 14 States and 1 Canadian province, representing a 62% decline in occupied streams.

In Kentucky, the snuffbox has declined dramatically in many basins. The species is presumed extirpated from the Cumberland and Green River basins, rare or potentially extirpated in Kinniconick and Tygarts creeks, and extant in the Licking, Rolling Fork, and multiple tributaries of the Kentucky River including the South Fork Kentucky, Middle Fork Kentucky, and Red River. This species was not found during the mussel survey, either alive or as a relic shell; however, the species co-occurs with the round hickorynut in the tributaries of the Kentucky River, so we presume that the species is likely to occur in this area. Additionally, the species can be buried most of the year and primarily comes to the surface for spawning in the early spring. Therefore, a mussel survey conducted in the fall, like the one completed for this project, is unlikely to result in finding individuals of the species that may be present in the area; thus, presence of the species was assumed.

3.0 ENVIRONMENTAL BASELINE

In accordance with 50 CFR 402.02, the environmental baseline refers to the condition of the listed species or its designated critical habitat in the Action Area, without the consequences to the listed species or designated critical habitat caused by the Action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing

agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

3.1 Species Status within the Action Area

A mussel survey was conducted by BioSurvey Group in October of 2024 (Appendix A) which observed 17 live round hickorynut and a weathered dead sheepnose shell. The survey area extended from approximately 160 m to 420 m downstream of the dam and 50 m riverward from each bank. Patches of relatively high density were present near the right descending bank at the downstream end of the survey area (Transects 5 – 6) and at the far riverward ends of Transects 3 – 4. Round hickorynut individuals were found on most of the right descending bank transects and at the shoreward end of Transect 7 on the left descending bank. Additionally, on August 30, 2023, a mussel survey contractor found a round hickorynut mussel on the right descending bank approximately 845 meters (~0.5 mile) downstream of KRLD11 on the Kentucky River suggesting habitats are favorable for these mussel species below multiple Kentucky River dams.

As previously mentioned in Section 2.2, only a single record of the sheepnose existed from the Kentucky River until the fresh dead/ slightly weathered shell was found during the mussel survey for this project. As a result, there are only two known records of this species within the entire Kentucky River basin. Additionally, snuffbox was not found during the mussel survey either live or as a relic shell; however, the species is known to co-occur with the round hickorynut in the tributaries of the Kentucky River. Additionally, the species can be buried most of the year and primarily comes to the surface for spawning in the early spring. Therefore, a fall mussel survey, like the one completed for this project, is unlikely to result in finding individuals of the species that may be present in the area; thus, presence of the species was assumed.

3.2 Action Area Numbers

Semi-quantitative data from the 2024 BioSurvey Group survey was used to calculate mussel densities downstream of KRLD11 (Appendix A). During the survey, 109 mussels were found along the six 50-meter transects, which included an area of 600 square meters. Based on these results, a density of 0.81 mussels per square meter is present in the semi-quantitative survey area. A total of 17 round hickorynut individuals were found during the semi-quantitative survey; therefore, the estimated density for this species is 0.0283 mussels per square meter (17 individuals ÷ 600 m^2 in survey area = 0.0283 mussels/m^2). One dead sheepnose individual was also encountered during the survey, resulting in an estimated density of 0.0016 mussels per square meter.

As mentioned previously, no snuffbox were found during the survey; therefore, we assume one individual of snuffbox is likely to be present in the semi-quantitative survey area. The estimated density for snuffbox would be 0.0016 mussels per square meter. The estimated density for each species in the semi-quantitative survey area downstream of KRLD11 is summarized below.

Species	Estimated Density in Survey Area (mussels/m^2)
Round hickorynut	0.0283
Sheepnose	0.0016
Snuffbox	0.0016

The estimated density for each species within the semi-quantitative survey area is assumed to be similar throughout the Action Area downstream of KRLD11; therefore, we used these values to estimate the number of individuals of each species within the Action Area. The portion of the Action Area downstream of KRLD11 totals approximately 43,301 square meters. To calculate the estimated number of individuals of each species in the Action Area, the Action Area size was multiplied by the estimated density for each species. The calculation for the estimated number of round hickorynut individuals is 0.0283 mussels/m^2 x 43,301 m^2 = 1,225.41 round hickorynut individuals. The calculation for the estimated number of sheepnose and snuffbox individuals is 0.0016 mussels/m^2 x 43,301 m^2 = 69.28. In summary, we estimate that 1,225 round hickorynut, 69 sheepnose, and 69 snuffbox individuals occur within the downstream portion of the Action Area.

Species	Estimated Individuals in Action Area
Round hickorynut	1,225
Sheepnose	69
Snuffbox	69

3.3 Action Area Conservation Needs and Threats

The primary factor affecting the three mussel species in the Action Area is the presence of Kentucky River Lock and Dam #10 and #11 which act as a barrier in the Kentucky River affecting flow, sediment deposition, water quality, and the movement of aquatic organisms. As a result of the lock and dams, a large portion of the Kentucky river became pooled and the natural flow regime was altered, causing riffles and shoals with clean sand and gravel bed materials to be replaced by slow-flowing, silt bottomed pools that do not provide suitable habitat for the listed mussel species. These conditions have been present in this portion of the Kentucky River since construction of the lock and dams in the early 1900's. The presence of the dams also acts as a barrier to fish movement, potentially limiting contact between mussels and fish hosts and restricting reproduction.

Other factors that could affect the three mussel species in the Action Area include increased sedimentation and the introduction of contaminants. Runoff associated with agricultural and logging activities contributes to the influx of sediment, suspended solids, pesticides, herbicides, fertilizers, petroleum-based products, and other contaminants into the Kentucky River. Additionally, point source releases from wastewater treatment and stormwater discharge further contribute to contamination, particularly when petroleum-based products, such as fuel, oil, and hydraulic fluid from vehicles, trains, and heavy equipment enter the system. Sediments can smother mussel beds, disrupt their feeding processes, and impede their ability to reproduce. Contaminants can significantly impact freshwater mussels by causing toxicity, bioaccumulation, impaired feeding, disrupted reproductive processes,

habitat degradation, increased susceptibility to disease, and changes in behavior, ultimately threatening their health and survival in aquatic ecosystems.

4.0 EFFECTS OF THE ACTION

In accordance with 50 CFR 402.02, effects of the Action are all consequences to listed species or critical habitat that are caused by the Action, including the consequences of other activities that are caused by the Action. A consequence is caused by the proposed action if it would not occur "but for" the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the Action (see § 402.17).

The following sections include an analysis of effects that may occur as a result of the proposed Action to the three mussel species. As previously mentioned, the Action Area includes KRLD11 and the Kentucky River downstream of the dam for approximately 1,190 feet. The upstream extent of the Action Area includes the top of the dam and the upper miter gates (Figure 2). Therefore, no effects on mussels or their habitat are anticipated upstream of the Action Area. Based on activities associated with the proposed Action and known threats to these species, the following stressors have been identified: 1) sediment disturbance; 2) changes to flow; and 3) displacement of individuals.

Kleinschmidt Associates performed a hydraulic analysis to evaluate and compare the existing and proposed (operation) flow conditions at KRLD11. The results of this hydraulic model provide a prediction for where downstream changes in flow and water velocity may occur (Appendix B). We then used these predicted changes in flow to evaluate potential impacts to the federally listed mussel species and their host fish in our analysis of the following stressors.

4.1 Sediment Disturbance

Site preparation, construction of the powerhouse, control building, site stabilization, and project operation (may) result in sediment disturbance along the adjacent bank during construction and within the river during operation. Sediment disturbance within the lock chamber, along the riverbanks and adjacent areas could expose soil and increase erosion by allowing sediment to enter the Kentucky River through runoff. Sediment disturbance from hydropower operations within the river could displace sediment in one location and deposit it in another location, potentially exposing or burying mussels. Potential impacts to the three mussel species from sediment disturbance in the work area and the Action Area downstream of the work area are discussed in the following sections.

4.1.1 Work Area

The construction of a temporary access road and parking lot during site preparation will disturb soil near the Kentucky River. Prior to site preparation, EPSC measures will be implemented and maintained throughout the work area to reduce erosion and minimize sediment inputs into the Kentucky River. Vehicles and equipment used during site preparation will be limited to the riverbanks and adjacent areas and will not enter the river. The project will not require tree removal and sediment displacement associated with site preparation will be minimal.

During construction, the lock chamber will be sealed at the upstream end using the existing concreted miter gate at the upstream end, and a cofferdam will be installed on the downstream side. The water will then be pumped out, and all sediments will be removed down to the bedrock to prepare for concrete and the powerhouse. Given all the sediments will be removed from the chamber, no release of sediments is anticipated post construction.

During periods when the river level is too high to work on the powerhouse in the lock chamber, work will commence to build the adjacent control building and conduit trench. Control building construction (excavation, backfill, grade) and conduit trench excavation will temporarily disturb soil adjacent to the river. EPSC measures will reduce the potential for sediment to enter the river and affect downstream mussels. Additionally, listed mussels are unlikely to be present in the adjacent lock chamber due to lack of suitable habitat, reducing the potential for sediment disturbance to impact individuals in this area. Site stabilization activities after construction will reduce the potential for sediment to enter the Kentucky River through seeding of disturbed areas and dressing of the access road and parking area. EPSC measures will also be maintained until the site is stabilized. As a result, sediment disturbance from this construction component is expected to be minimal and will not smother mussels or render habitat unsuitable.

4.1.2 Action Area Downstream of Work Area

As discussed above, site preparation, project construction, and stabilization activities are not expected to cause inputs of sediment beyond the work area due to the use of EPSC measures. Inputs that do occur are anticipated to be minimal and will be dispersed quickly over a large area due to the flow of the river.

Sediment disturbance is anticipated in the immediate downstream vicinity of the lock chamber during the initial weeks or months following the commencement of power generation. Fine sediments identified at Location 1 and 2 during the BioSurvey Group's mussel survey are likely to be disturbed and transported further downstream, potentially covering and/or smothering mussels or rendering their habitat unsuitable. This sediment movement is expected to be a one-time event; however, it may take several weeks to months for a new equilibrium to be established. Once the stream has reached an equilibrium, sedimentation is anticipated to be similar to existing conditions. While mussels may be able to adapt to minimal, temporary sediment deposition, the initial sediment movement from downstream of the lock chamber may lead to significant deposition that could hinder the ability of all individuals to adjust. Moreover, sediment deposition occurring during periods of low water temperatures and reduced mussel activity will further limit their capacity to respond effectively to these deposition events.

The sediment disturbance could also result in impacts to habitat for fish hosts for the three mussel species. Sediment displacement and deposition may damage or bury suitable habitat used by fish hosts for foraging, reproduction, and sheltering. The alteration or loss of habitat could cause the host fish to move from the area, limiting their exposure to the mussel species and potentially affecting mussel reproduction and recruitment.

During normal hydropower operations, the river's natural sediment transport will remain unaffected by the hydropower facility. Sediments within the water column will pass through the powerhouse and lock chamber, settling downstream of the facility. Since the mussels located downstream of KRLD11 are already exposed to this level of sedimentation due to natural

sediment transport during both high and low flow conditions, the three mussel species are not anticipated to be impacted beyond the existing conditions.

4.1.3 Applicable Science

Sedimentation is believed to adversely affect mussel populations that require clean, stable streams and has contributed to the decline of mussel populations nationwide (Vannote and Minshall 1982, Brim-Box and Mossa 1999). Specific biological effects to mussels from sedimentation include reduced feeding and respiratory efficiency from clogged gills, disrupted metabolic processes, reduced growth rates, limited burrowing activity, physical smothering, and disrupted host fish attraction mechanisms (Vannote and Minshall 1982, Waters 1995, Hartfield and Hartfield 1996). In addition, mussels may be indirectly affected if high turbidity levels significantly reduce the amount of light available for photosynthesis by potential food items or impede the ability of mussels to attract host fishes (Kanehl and Lyons 1992). Sedimentation can also eliminate or reduce the recruitment of juvenile mussels by clogging interstitial spaces, interfering with feeding activity, and acting as a vector in delivering contaminants to streams (Brim-Box and Mossa 1999).

Effects Pathway #1	
Activity: Site Preparation, Site Stabilization	
Stressor: Sediment Disturbance	
Exposure (time)	Duration of Construction
Exposure (space)	Work Area, Action Area Downstream of Work Area
Resource affected	Individuals (adults, juveniles), Habitat, Fish Hosts
Individual response	• Reduced respiration and feeding from clogged gills or smothering • Disruption of metabolic processes, leading to reduced fitness and growth rates • Reduced recruitment due to elimination of interstitial spaces used by juveniles • Movement due to alteration or loss of habitat • Displacement of fish hosts due to alteration or loss of habitat
Conservation Measures	• Implement EPSC measures in the work area. • Revegetate disturbed areas immediately following completion of ground disturbing activities.
Interpretation	Appropriate EPSC measures will be installed and maintained throughout the work area to reduce erosion and minimize sediment inputs into the Kentucky River. No construction components will occur upstream of the Action Area or downstream of the work area. Inputs of sediment into these areas are not expected due to the use of EPSC measures, and inputs that do occur are anticipated to be minimal. Effects from sediment disturbance caused by construction of the access road and parking lot are considered insignificant.
Effect	Insignificant

Effects Pathway #2
Activity: Construction of the Powerhouse, Conduit Bank, & Control Building

Effects Pathway #2	
Stressor: Sediment Disturbance	
Exposure (time)	Duration of Construction
Exposure (space)	Work Area
Resource affected	Individuals (adults, juveniles), Habitat, Fish Hosts
Individual response	• Reduced respiration and feeding from clogged gills or smothering • Disruption of metabolic processes, leading to reduced fitness and growth rates • Reduced recruitment due to elimination of interstitial spaces used by juveniles • Movement due to alteration or loss of habitat • Displacement of fish hosts due to alteration or loss of habitat
Conservation Measures	• Implement EPSC measures in the work area. • Revegetate disturbed areas immediately following completion of ground disturbing activities. • Perform powerhouse activities during periods of normal or low flows.
Interpretation	Appropriate EPSC measures will be installed and maintained throughout the work area to reduce erosion and minimize sediment inputs into the Kentucky River. Vehicles and equipment will not enter the river, and all river work will occur within the lock chamber. Effects from sediment disturbance caused by construction of the conduit bank and control building are considered insignificant. In addition, the areas immediately adjacent to the work area where the potential for impacts is highest do not provide suitable habitat for the three mussel species.
Effect	Insignificant

Effects Pathway #3	
Activity: Site Preparation, Site Stabilization	
Stressor: Sediment Disturbance	
Exposure (time)	Duration of Construction
Exposure (space)	Work Area, Action Area Downstream of Work Area
Resource affected	Individuals (adults, juveniles), Habitat, Fish Hosts
Individual response	• Reduced respiration and feeding from clogged gills or smothering • Disruption of metabolic processes, leading to reduced fitness and growth rates • Reduced recruitment due to elimination of interstitial spaces used by juveniles • Movement due to alteration or loss of habitat • Displacement of fish hosts due to alteration or loss of habitat
Conservation Measures	• Implement EPSC measures in the work area. • Revegetate disturbed areas immediately following completion of ground disturbing activities.

Effects Pathway #3	
Interpretation	Appropriate EPSC measures will be installed and maintained throughout the work area to reduce erosion and minimize sediment inputs into the Kentucky River. No construction components will occur upstream of the Action Area or downstream of the work area. Inputs of sediment into these areas are not expected due to the use of EPSC measures, and inputs that do occur are anticipated to be minimal. Effects from sediment disturbance caused by construction of the access road and parking lot are considered insignificant.
Effect	Insignificant

Effects Pathway #4	
Activity: Hydropower Operation	
Stressor: Sediment Disturbance	
Exposure (time)	Indefinite
Exposure (space)	Work Area
Resource affected	Individuals (adults, juveniles), Habitat, Fish Hosts
Individual response	• Reduced respiration and feeding from clogged gills or smothering • Disruption of metabolic processes, leading to reduced fitness and growth rates • Reduced recruitment due to elimination of interstitial spaces used by juveniles • Movement due to alteration or loss of habitat • Displacement of fish hosts due to alteration or loss of habitat
Conservation Measures	N/A
Interpretation	The proposed project would operate in run-of-river using flows for power generation and no effects due to sediment disturbance will occur upstream of the Action Area or in the work area. Additionally, the work area does not provide suitable habitat for the listed mussel species.
Effect	Insignificant

Effects Pathway #5	
Activity: Hydropower Operation	
Stressor: Sediment Disturbance	
Exposure (time)	Indefinite
Exposure (space)	Action Area Downstream of Work Area
Resource affected	Individuals (adults, juveniles), Habitat, Fish Hosts
Individual response	• Reduced respiration and feeding from clogged gills or smothering • Disruption of metabolic processes, leading to reduced fitness and growth rates • Reduced recruitment due to elimination of interstitial spaces used by juveniles

Effects Pathway #5	
	• Movement due to alteration or loss of habitat • Displacement of fish hosts due to alteration or loss of habitat
Conservation Measures	• Mussel relocation (salvage) to areas of downstream suitable habitat prior to project operation. • Post operation mussel monitoring in the Action Area for three years.
Interpretation	The movement and deposition of sediment during hydropower operation could smother mussels or make habitat unsuitable, causing individuals to move to other areas.
Effect	Adverse (harm, mortality)

4.2 Changes to Flow

Run-of-river hydroelectric plant operation is the only proposed Action component that could result in changes to flow in the Kentucky River. Site preparation and stabilization will not result in changes to flow due to the lack of in-stream activities associated with these components. Changes to flow from hydropower operations could impact mussels and their habitat by altering the morphology of the river channel, changing the hydrology of the stream, cause sediment disturbance, and displacement of individuals.

4.2.1 Work Area

The hydroelectric plant (powerhouse) will be installed entirely within the upper portion of the abandoned lock chamber. The powerhouse is the only construction component located within the Action Area. The hydroelectric plant will operate in run-of-river using flows between 196 cfs and 2,636 cfs for power generation. The turbines would be operated sequentially, based on inflow, and would maintain run-of-river operation levels. Units will turn on to operate as the upstream pool level increases and water flow in the river justifies additional generation. The units will cycle off to continually maintain some water running over the spillway. Lock 11 Hydro Partners proposes to install monitoring equipment in the lock chamber and headwater pool that is designed to shut down the generating units when water levels in the impoundment fall below 617.38 feet. The work area (powerhouse) is unsuitable for mussels. As a result, impacts to mussels in this area are not anticipated.

4.2.2 Action Area Downstream of Work Area

Changes to the hydraulic conditions below KRLD11 in the Kentucky River during existing and proposed (operation) flow conditions were analyzed by Kleinschmidt Associates (Appendix B). Changes in flow conditions over and near the existing mussel beds that could alter the likely presence of host fish species for the round hickorynut and sheepnose were evaluated. Suitable host fish species for the round hickorynut were identified through laboratory trials and include multiple darter species and the banded sculpin (*Cottus carolinae*). No natural infestation has been documented for this species, but the eastern sand darter (*Ammocrypta pellucida*) appears to be highly correlated with round hickorynut populations in Kentucky streams. More than 30 species of fish have been identified as suitable host for sheepnose through laboratory trials; however, only the sauger (*Sander canadensis*) has been identified through a natural infestation.

According to the results of the hydraulic model, the expected maximum change in peak depth-averaged velocity between existing and proposed conditions across the Action Area was found to be negligible in most flow scenarios. The most noticeable differences between existing and proposed conditions are during the Normal Flow (2,636 cfs) scenario. In the Normal Flow scenario, most locations are not expected to have a noticeable change in peak depth-averaged velocity. However, Locations 1 and 2 are expected to experience a 2.0 feet per second (fps) and a 1.2 fps change in water velocity under the proposed conditions, respectively. During existing normal flows, water is prevented from entering the lock structure, and all flow is routed over the existing spillway over a wide cross-sectional area. This allows more uniform dispersal of flows across the river channel. Conversely, under proposed conditions at normal flows, water will be routed through the proposed powerhouse and discharged at the outlet of the existing lock structure. This creates an area of increased water velocities at the edge of the concrete esplanade along the right descending bank at Location 1 as water exits the lock structure. Continuing downstream, flow patterns begin to distribute across the river channel through Locations 3 and 4 and begin to resume "normal" flow patterns across Locations 5 and 6 and exiting the survey reach (Figure 4).

Another potential change in flow pattern under the Normal Flow scenario includes the creation of an eddy along the left descending bank during normal flow conditions. This eddy may allow fine sediments to settle when normal flows resume after a post-high event. The area near the dam is predominately bedrock substrates and generally unsuitable for mussels however, mussels were found about halfway through the Action Area including one round hickorynut individual.

Under hydropower operations, increased water velocities in Locations 1 and 2 and the creation of an eddy is unlikely to directly affect the mussel species as they can typically tolerate higher flows; however, the change in the flow regime could alter the fish hosts' habitat causing the fish to move from the area, limiting their exposure to the mussel species and potentially affecting mussel reproduction and recruitment.

4.2.3 Applicable Science

Dams alter flow by impounding or pooling long reaches of free-flowing rivers, resulting in changes to hydrology and channel morphology, increased sediment deposition, altered water quality, decreased habitat heterogeneity, altered flood patterns, and decreased movement of mussels and fish (Neves et al. 1997, Watters 2000). Habitat heterogeneity is often reduced from six to seven habitat types to three or four, some of which are highly modified from the existing habitat or new to the river system (Watters 2000). Although the original channel remains upstream of the dam, increased depth and slower flow can rapidly alter existing habitats. Decreased flow reduces sediment transport, causing fine sediment to settle and blanket the substrate with silt. Siltation of the river bottom can affect mussels through smothering, diminishing food supply by limiting light penetration, altering temperatures, and reducing recruitment (Watters 2000). Siltation can also change species composition in the impounded or pooled areas by reducing the presence of species intolerant of silt with silt-tolerant species (Holland-Bartels 1990, Parmalee and Hughes 1993).

Changes in flow downstream of dams leads to scouring and bank erosion, reduced dissolved oxygen, temperature fluctuations, and changes in mussel and fish composition (Neves et al. 1997, Watters 2000). The acceleration of water as it flows over a run-of-river dam results in

scour of the stream bed and banks, often producing a scour area or plunge pool at the base of the dam (Csiki and Rhoads 2014, Pearson and Pizzuto 2015). Scouring at the base of the dam mobilizes fine sediments and smaller coarse sediments, leaving only cobble, boulders, and bedrock (Skalak et al. 2009, Csiki and Rhoads 2014). A mid-channel bar often forms downstream of the dam that consists of scoured materials (Csiki and Rhoads 2014). Scouring immediately below dams can be extensive and can eliminate or prevent mussels from inhabiting these areas (Miller and Payne 1992).

Effects Pathway #6	
Activity: Hydropower Operation	
Stressor: Changes to Flow	
Exposure (time)	Indefinite
Exposure (space)	Work Area
Resource affected	Individuals (adults, juveniles), Habitat, Fish Hosts
Individual response	• Mortality due to alteration of loss of flow regime • Reduction or loss of fish hosts due to changes to flow regime
Conservation Measures	None
Interpretation	The project will operate as a run-of-river facility and will not attenuate flows upstream beyond existing conditions. Additionally, work area contains unsuitable habitat for the three mussel species.
Effect	Insignificant

Effects Pathway #7	
Activity: Hydropower Operation	
Stressor: Changes to Flow	
Exposure (time)	Indefinite
Exposure (space)	Action Area Downstream of the Work Area
Resource affected	Individuals (adults, juveniles), Habitat, Fish Hosts
Individual response	• Mortality due to alteration of loss of flow regime • Reduction or loss of fish hosts due to changes to flow regime
Conservation Measures	• Mussel relocation (salvage) to areas of downstream suitable habitat prior to project operation. • Post operation mussel monitoring in the Action Area for three years.
Interpretation	Increased water velocity and changes to flow patterns during normal flows directly downstream of the lock chamber have the potential to affect fish host distribution and consequently, mussel reproduction.
Effect	Adverse (harm, mortality)

4.3 Displacement of Individuals

Run-of-river hydroelectric plant operation is the only proposed Action component that could result in displacement of individuals. Site preparation and stabilization will not displace individuals due to the lack of in-stream activities associated with these components. Changes to the hydraulic conditions that could cause displacement of mussels below KRLD11 in the

Kentucky River during proposed (hydropower operations) flow conditions were additionally analyzed by Kleinschmidt (Appendix B).

4.3.1 Work Area

The hydroelectric plant will be installed entirely within the upper portion of the abandoned lock chamber. The work area (powerhouse) is unsuitable for mussels and is unlikely to displace individuals. As a result, the displacement of individuals in this area is not anticipated as a result of the project.

4.3.2 Action Area Downstream of Work Area

According to the results of the hydraulic model, during the Normal Flow scenario, flow conditions are expected to change at Locations 1 and 2. Changes to flow from hydropower operations could disturb the downstream river substrate and individuals. Displaced mussels could be moved to an area of unsuitable habitat, requiring the individual to move to a more suitable area and expend energy. Displacement may also lead to harm or mortality if the mussel is unable to find suitable habitat quickly.

Conversely, the area does have large, coarse bed materials such as the cobble and boulders found during the mussel survey. This coarse bed material is unlikely to be scoured and displaced and could be stable enough for some individuals to sustain themselves in this habitat. However, based on the best available data, the mussels are utilizing the finer sediments to bury and shelter, and that material is anticipated to be scoured and moved downstream which will likely displace the mussels as well.

4.3.3 Applicable Science

Published data on the displacement of mussels from hydroelectric dams is lacking; however, mussel displacement from turbulence created by boats has been noted. Studies have shown that turbulence generated by the surge of large vessels as they pass by or over mussels and from boat propellers (i.e., propeller wash) can displace mussels from the substrate (Sparks and Blodgett 1985, Aldridge et al. 1987, Millar and Mahaffy 1989, Watters 2000). The potential for displacement is highest in shallow areas, particularly near riverbanks. Based on these studies, concentrated flows of turbulent water, such as those that may occur during initial dam operations, have the potential to displace mussels from the substrate.

Effects Pathway #8	
Activity: Hydropower Operation	
Stressor: Displacement of Individuals	
Exposure (time)	Indefinite
Exposure (space)	Work Area
Resource affected	Individuals (adults, juveniles)
Individual response	• Harm or mortality if displaced to unsuitable habitat • Movement of displaced individuals to suitable habitat, which may lead to increased energy expenditure and decreased fitness
Conservation Measures	N/A

Effects Pathway #8	
Interpretation	The project will operate as a run-of-river facility and will not attenuate flows upstream beyond existing conditions. The work area contains unsuitable habitat for the three mussel species.
Effect	Insignificant

Effects Pathway #9	
Activity: Hydropower Operation	
Stressor: Displacement of Individuals	
Exposure (time)	Indefinite
Exposure (space)	Action Area Downstream of Work Area
Resource affected	Individuals (adults, juveniles)
Individual response	• Harm or mortality if displaced to unsuitable habitat • Movement of displaced individuals to suitable habitat, which may lead to increased energy expenditure and decreased fitness
Conservation Measures	• Mussel relocation (salvage) to areas of downstream suitable habitat prior to project operation. • Post operation mussel monitoring in the Action Area for three years.
Interpretation	The hydraulic model indicates that changes in flow conditions during the Normal Flow scenario at Locations 1 and 2 could disturb the downstream substrate and displace mussels, potentially forcing them into unsuitable habitats and risking harm or mortality if they are transported to unsuitable habitat. While the area contains stable, coarse bed materials such as large cobble and boulder, which may support some individuals, the finer sediments that most mussel bury into will be displaced consequently displacing the mussels as well.
Effect	Insignificant

4.4 Summary of Effects

The proposed Action could expose the three mussel species to the stressors evaluated in the previous section. Anticipated adverse effects to the three mussel species are anticipated to be: sediment disturbance, changes to flow, and displacement of individuals in the Action Area downstream (DS) of the work area (powerhouse) during hydropower operations under normal flow conditions. Potential effects to the three mussel species are summarized below.

Stressor	Action Component	Location	Effect	
			Adverse	Insignificant
Sediment Disturbance	Site Preparation & Stabilization	Work Area & Action Area DS of Work Area		**X**
	Project Construction	Work Area		**X**
		Action Area DS of Work Area		**X**
	Hydropower Operation	Work Area		**X**
		Action Area DS of Work Area	**X**	
Changes to Flow	Hydropower Operation	Work Area		**X**
		Action Area DS of Work Area	**X**	
Displacement of Individuals	Hydropower Operation	Work Area		**X**
		Action Area DS of Work Area	**X**	

5.0 Cumulative Effects

Cumulative effects are those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation. The purpose of the proposed Action is to generate clean carbon-free renewable electricity to help combat climate change and generate distributed power near the locations where power is used. Future activities, such as increased residential or commercial development, agricultural practices, increased traffic, or tourism in the area are not reasonably certain to occur as a result of the Action. Based on these factors, no cumulative effects to the three mussel species are anticipated as a result of the proposed Action.

6.0 INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) and regulations issued under §4(d) prohibit the take of endangered and threatened fish and wildlife species without special exemption. The term "take" in the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA §3). "Harm in the definition of "take" in the Act means an act which actually kills or injures wildlife. Such [an] act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 CFR 17.3). Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited, provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS).

For the exemption in ESA §7(o)(2) to apply to the proposed Action considered in this BO, the USDA must undertake the non-discretionary measures described in this ITS, and these measures must become binding conditions of any permit, contract, or grant issued for implementing the Action.

The USDA has a continuing duty to regulate the activity covered by this ITS. The protective coverage of §7(o)(2) may lapse if the USDA fails to:
assume and implement the terms and conditions; or

- require a permittee, contractor, or grantee to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, contract, or grant document.

To monitor the impact of incidental take, the USDA must report the progress of the Action and its impact on the species to the Service as specified in this ITS.

6.1 Amount or Extent of Take Anticipated

This section specifies the amount or extent of take of the round hickorynut, sheepnose, and snuffbox mussels that the Action is reasonably certain to cause, which we estimated using the best available data in the "Effects of the Action" section of this Biological Opinion.

We estimated the number of individuals reasonably certain to occur in the Action Area (Section 3.0, Environmental Baseline). We then evaluated the potential for these individuals to be exposed to the stressors resulting from the proposed Action which included sediment disturbance, changes in flow, and displacement of individuals. Finally, we evaluated how the individuals' responses from exposure to these stressors would apply to the statutory and regulatory definition of take (Section 4.0, Effects of the Action). From our evaluation, the proposed Action is reasonably certain to cause the incidental take of the round hickorynut, sheepnose, and snuffbox mussels within the Action Area and is consistent with the definition of harm (Table 2). We estimate the incidental take of all individuals of the round hickorynut, sheepnose, and snuffbox mussels occurring downstream of KRLD11 using the density calculations detailed in Section 3.2 Action Area Numbers. See Table 2 below for expected incidental take of each of the three mussel species.

Table 2. Expected Incidental Take

Species	# of Individuals	Take Type
round hickorynut	1225	Harm
sheepnose	69	Harm
snuffbox	69	Harm

We anticipate that monitoring the incidental take using the number of individuals is not practical for the following reasons:

- The size and depth of the aquatic environment within the Action Area is difficult to monitor in its entirety.
- The mussel species are relatively small, cryptic, and not easily detected.
- Finding dead or injured specimens during the majority of project implementation is unlikely due to the riverine environment.
- The majority of incidental take is expected to be in the form of non-lethal harm, such as reduced feeding or reproductive efficiency due to increased turbidity, which is difficult to observe.

When it is not practical to monitor take in terms of individuals, the regulations at 50 CFR §402.14(i)(1)(i) indicate that an ITS may express the amount or extent of take using a surrogate provided that the Service also describes the causal link between the surrogate and take of the listed species and sets a clear standard for determining when the level of anticipated take has been exceeded.

Therefore, we have determined that it is appropriate to monitor the square meters of suitable habitat that will be affected by the Action to ensure the amount of incidental take is not exceeded. Our opinion is that this is appropriate because the mussel species are expected to occur in all areas of suitable habitat within the Action Area, square meters of suitable habitat was used to quantify the number of individuals within the Action Area for each species, and most incidental take associated with the Action is a result of habitat alteration/degradation. Incidental take is considered exceeded if the Action impacts more than the proposed 43,301 m^2 of downstream suitable habitat. We describe the procedures for monitoring in Section 6.4.

Table 3. Surrogate Measures for Monitoring Incidental Take

Species	Life Stages	Surrogate	Quantity
round hickorynut, sheepnose, snuffbox	All	Suitable habitat (m^2) within the Action Area downstream of KRLD4	43,301 m^2

6.2 Reasonable and Prudent Measures

The Action includes conservation measures to avoid and minimize impacts to the subject mussel species. The analysis of effects of the Action in this BO considers that the USDA will authorize, fund, or carry out all activities under the Action in a manner that is consistent with the description of activities provided in BA, including all applicable conservation measures. Due to the aforementioned commitments, our review of the Action, and Conservation Measures, the Service concludes that no reasonable and prudent measures are necessary or appropriate to minimize incidental take of the round hickorynut, sheepnose, and snuffbox caused by the Action.

6.3 Terms and Conditions

No reasonable and prudent measures to minimize incidental take caused by the Action are provided in this BO; therefore, no terms and conditions for carrying out such measures are necessary.

6.4 Monitoring and Reporting Requirements

The USDA will (1) ensure that all of the identified Conservation Measures are implemented and (2) inform the Service as soon as possible if the amount of take is exceeded or if any of the mussel species are observed, injured, or crushed within the Action Area. In order to monitor the impacts of incidental take, the USDA must report the progress of the Action and its impact on the species to the Service as specified in the ITS (50 CFR §402.14(i)(3)). The USDA should notify the Service once construction activities have commenced and should also provide a quarterly (~ every 3 months) project status summary that includes a brief summary of all activities that have been completed to date.

7.0 CONSERVATION RECOMMENDATIONS

§7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species. The Service has not identified any conservation recommendations for this BO.

8.0 RE-INITIATION NOTICE

Formal consultation for the Action considered in this BO is concluded. Reinitiating consultation is required if the USDA retains discretionary involvement or control over the Action (or is authorized by law) when:

a) the amount or extent of incidental take is exceeded;
b) new information reveals that the Action may affect listed species or designated critical habitat in a manner or to an extent not considered in this BO;
c) the Action is modified in a manner that causes effects to listed species or designated critical habitat not considered in this BO; or
d) a new species is listed or critical habitat designated that the Action may affect.

This consultation was assigned FWS ID 2024-0023535. Please refer to this number in any correspondence concerning this consultation.

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FIGURES

Figure 1. Project Location

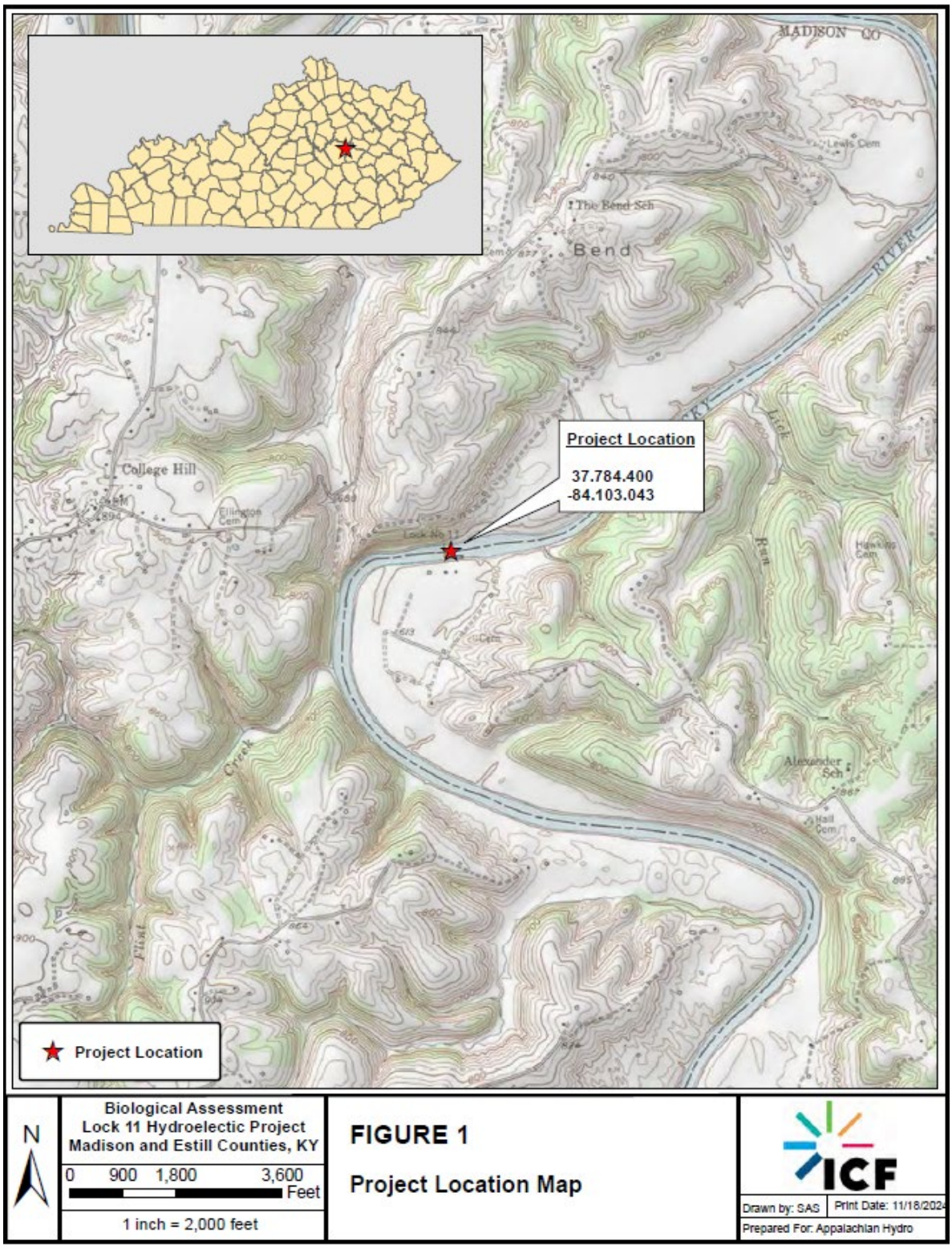


Figure 2. Work Area

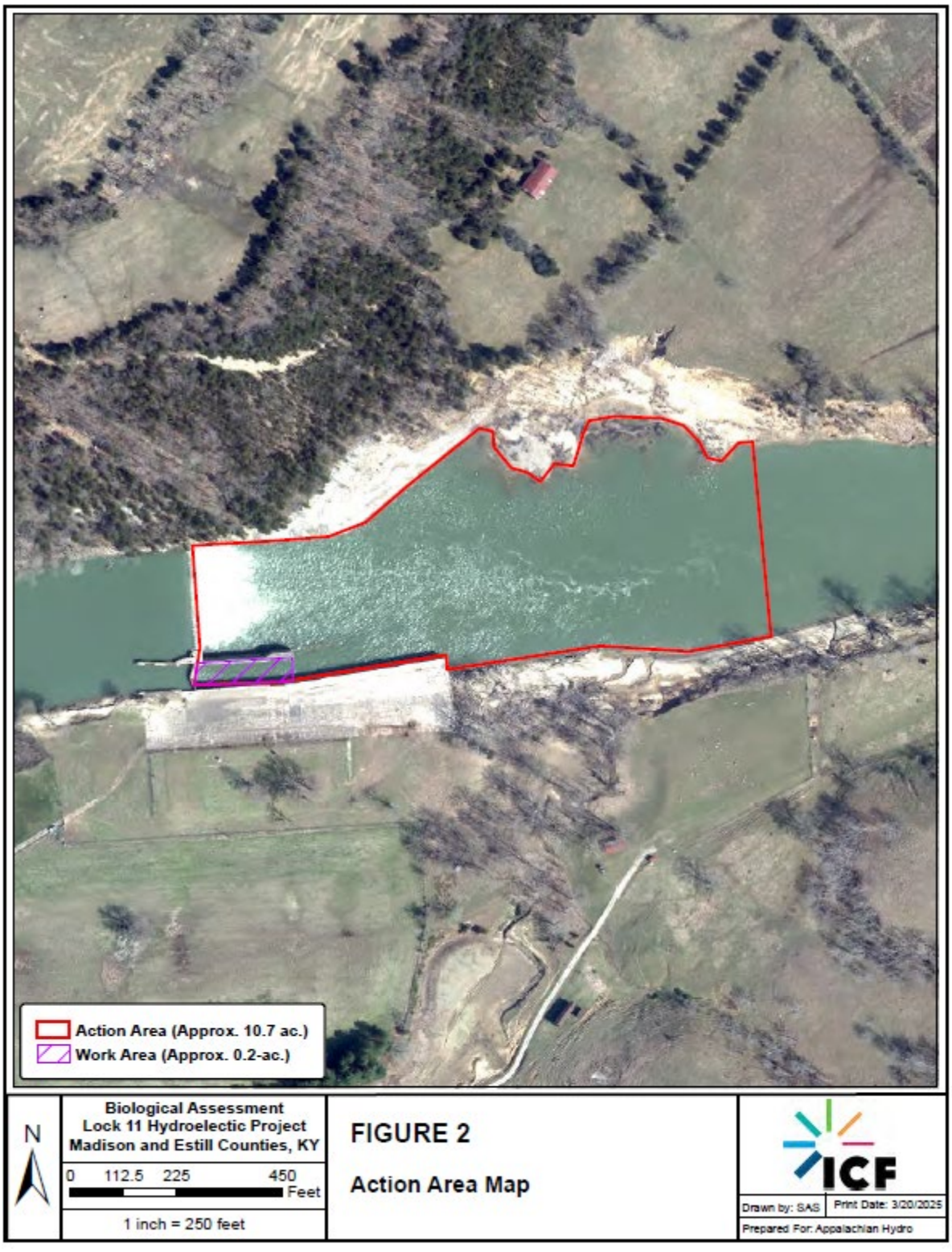


Figure 3. Mussel Salvage and Relocation Map

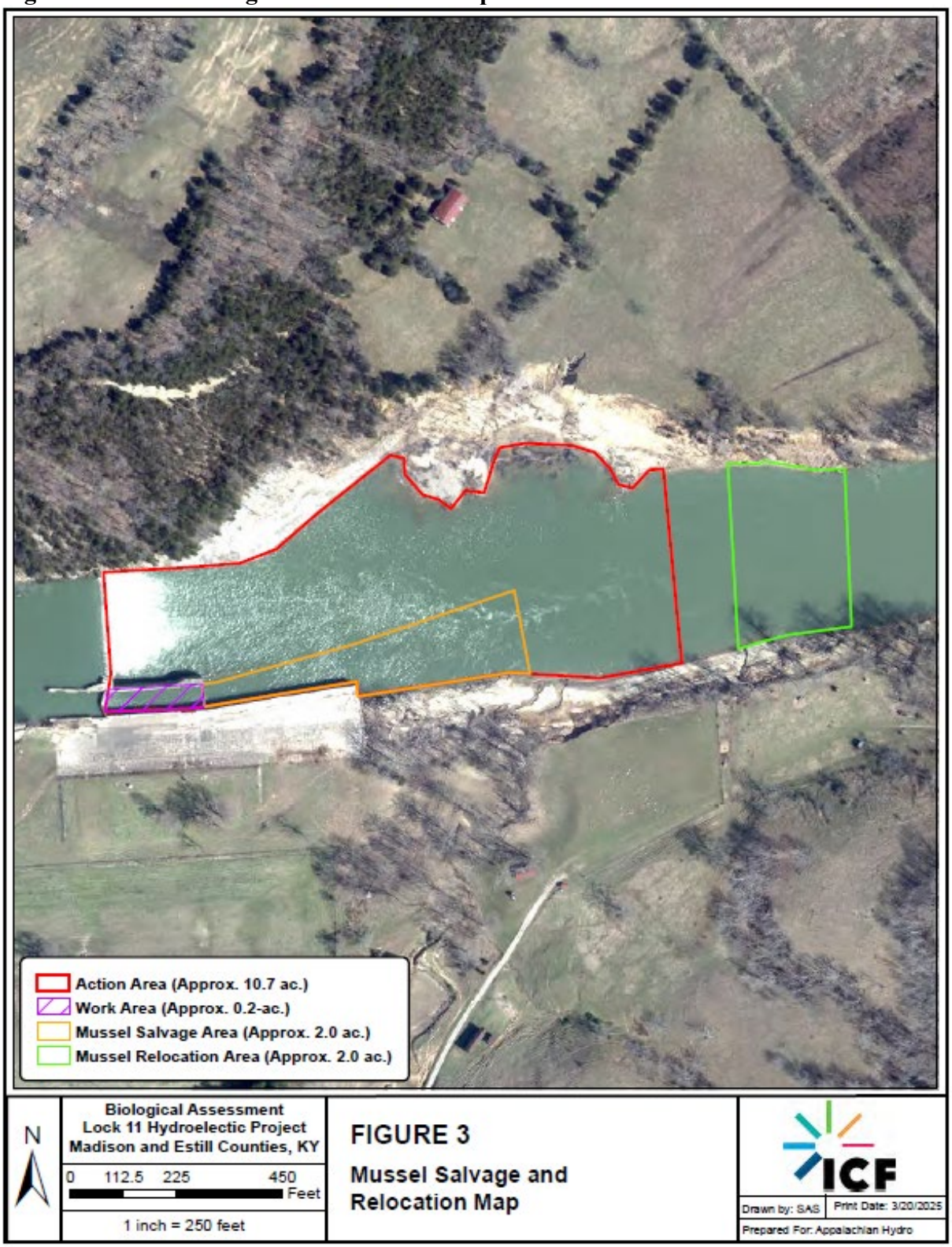
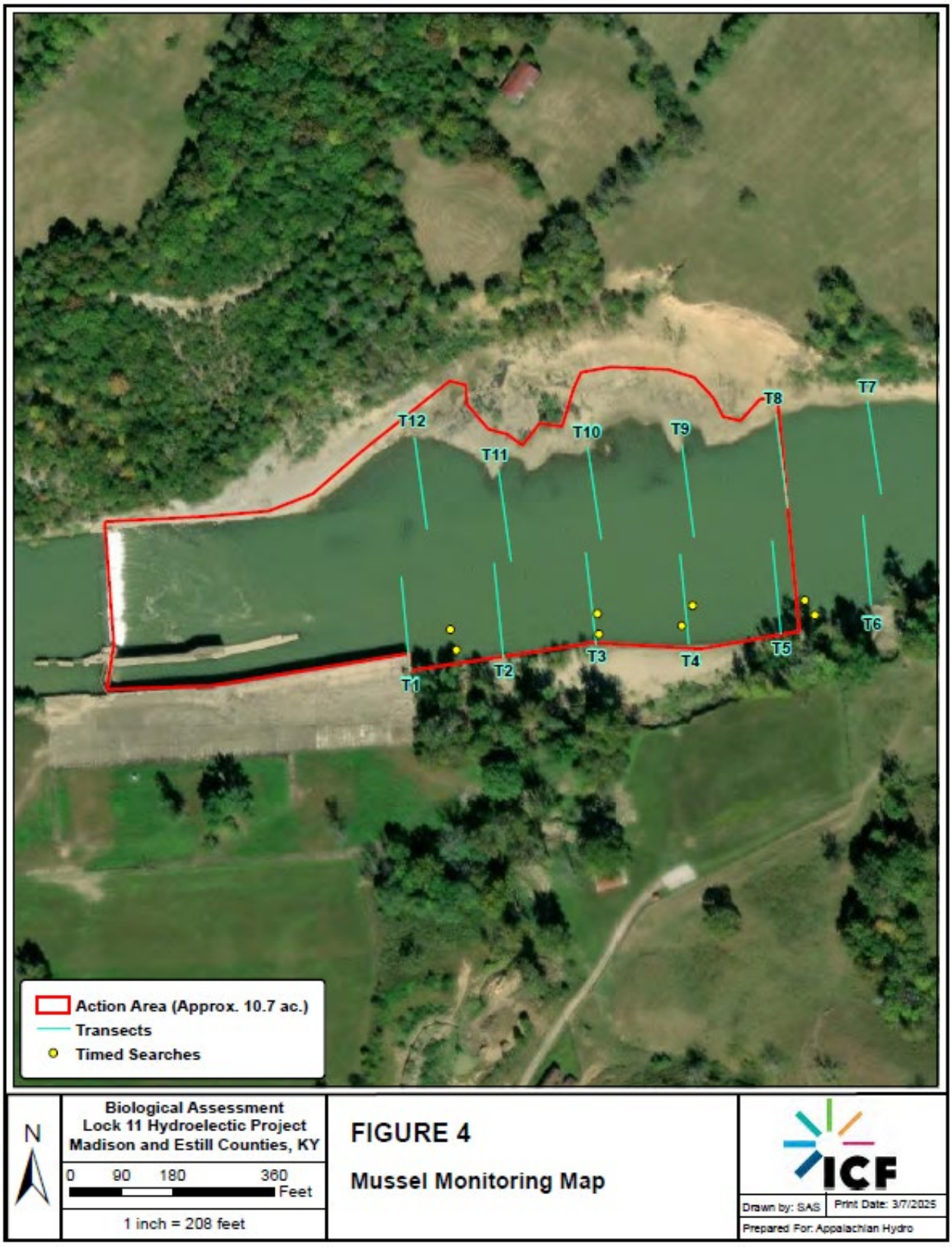


Figure 4. Mussel Survey Map



APPENDIX A

BioSurvey Group Mussel Survey Report

COLLEGE HILL HYDRO PROJECT ON THE KENTUCKY RIVER - MUSSEL SURVEY REPORT

MADISON AND ESTILL COUNTIES, KY

PREPARED FOR

Appalachian Hydro Associates

DATE: 10.24.24

PO Box 61
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Introduction

BioSurvey Group was contracted to provide environmental consulting services to Appalachian Hydro Associates for a mussel survey on the Kentucky River in Madison and Estill Counties, Kentucky as part of a proposed hydroelectric project at Lock and Dam 11 (Figure 1). The Project facilities will consist of a submersible powerhouse constructed in the existing abandoned lock chamber and a control building on the shore containing switchgear, controls, transformers and a main circuit breaker for the plant. The powerhouse will contain six submersible turbine generators that are unaffected by flooding. An underground cable trench will connect the powerhouse to the control building.

Project Need

The proposed construction and operation of the hydroelectric facility may impact freshwater mussels occurring within construction areas as well as downstream of the lock and dam. Several federally listed mussel species, including Clubshell (*Pleurobema clava*; endangered), Fanshell (*Cyprogenia stegaria*; endangered), Round Hickorynut (*Obovaria subrotunda*; threatened), and Salamander Mussel (*Simpsonaias ambigua*; proposed endangered) are known or believed to occur in this reach of the Kentucky River. Therefore, the U.S. Fish and Wildlife Service (USFWS) and Kentucky Department of Fish and Wildlife Resources (KDFWR) required a mussel survey be completed to obtain the regulatory permits required for this project.

Methods

Mussel Survey

The mussel survey extent was determined based on guidance from USFWS. The survey area extended from approximately 160 m to 420 m downstream of the dam and 50 m riverward from each bank. Six 50-m transects, spaced at 50-m intervals, were established perpendicular to flow on each bank, for a total transect length of 600 m (Figure 2).

Divers searched a 1-m wide swath along each survey transect which was divided into 10-m segments. Search rates included a minimum effort of 1.0 min/m^2 in areas of heterogeneous substrate and 0.5 min/m^2 in areas of homogenous substrate (bedrock, mud, silt, and sand). The visual search included moving cobble and woody debris; hand sweeping away silt, sand and/or small detritus; and disturbing/probing the upper 5 cm (2 in) of substrate to better view the mussels which may be there.

Data was compiled and recorded for each 10-m transect segment, including substrate (Wentworth Scale) and depth. In each segment, mussels observed (live and dead) were bagged and brought to the surface for further processing and positive identification. Live mussels were kept cool and moist on the surface and were not out of the water for more than five minutes. Dead mussel shells were scored as fresh dead, weathered dead, or subfossil. Mussel nomenclature followed that of the Freshwater Mollusk Conservation Society (2023). Photo vouchers of all representative species collected and any odd, questionably identified individuals were taken.

Timed Searches

Timed searches were completed for the development of a species richness curve to demonstrate that most species had been recorded from the survey area. Transect data was used to inform the best location to conduct the timed searches. The goal was to collect six consecutive samples in 10 min increments within the mussel concentration area until no new species were detected.

Results

The BioSurvey Group team performed the mussel survey on October 7 – 8, 2024, led by permitted malacologist Ms. Emily Grossman. Copies of Ms. Grossman's scientific collecting permits are presented in Appendix A. Weather conditions were favorable throughout the survey effort with sunny skies and an average air temperature of approximately 23ºC (73°F). Discharge on the Kentucky River at Lock and Dam 11 (USGS 03282290) ranged from 694 cubic feet per second (cfs) to 874 cfs and stage ranged from 11.27 ft to 11.45 ft. Water temperature was approximately 20ºC (68°F) at the surface. Site and mussel photos can be found in Appendix B.

Habitat

Variable habitat conditions were encountered throughout the survey area. Substrate on the right descending bank was primarily sand, though some coarse material (boulder / cobble / gravel) was present along the bank on Transects 1 – 3 and at the far riverward ends of some transects. In contrast, substrate along Transects 7 – 10 on the left descending bank was primarily coarse gravel, cobble, and boulder, and substrate along Transects 11 – 12 was almost exclusively bedrock (Figure 3). Depths ranged from approximately 1 ft (0.3 m) near the bank to a maximum of 15 ft (4.6 m) along Transect 1, with deeper depths generally occurring on the right descending half of the channel (Figure 3). Depth and substrate data by transect segment are presented in Table 1.

Transect Survey

A total of 109 mussels were detected during the transect survey, representing 11 species. Threeridge (*Amblema plicata*; 47.7%) was the most dominant species, followed by Pink Heelsplitter (*Potamilus alatus*; 26.6%) and the federally threatened Round Hickorynut (11.0%) (Table 2). Length and age estimates for all live federally listed mussels are presented in Table 3. Four additional species were represented by dead shell material only, including a weathered dead federally endangered Sheepnose (*Plethobasus cyphyus*) (Table 2). Catch per unit effort (CPUE) was 0.19 mussels per minute of search time.

Mussels were present on both the right and left descending banks, but abundance was highest along the right descending bank (Figure 3). Patches of relatively high density were present near the right descending bank at the downstream end of the survey area (Transects 5 – 6) and at the far riverward ends of Transects 3 – 4. Round Hickorynut individuals were found on most of the right descending bank transects and at the shoreward end of Transect 7 on the left descending bank (Figure 3).

Timed Searches

A total of eight timed searches, each 10 minutes in length, were completed to supplement the transect data for the development of a species richness curve. All timed searches were conducted

along the right descending bank, focusing on areas where mussels were abundant or federally listed species were present in transect samples. An additional 71 mussels were collected in timed searches, including one species not collected in transect samples (Pink Papershell; *Potamilus ohiensis*). Pink Heelsplitter (57.7%) and Threeridge (26.8%) were the dominant species. Five additional Round Hickorynut were collected during the timed search effort, and CPUE was 0.89 mussels / min (Table 2). The species richness curve, developed using both transect and timed search data, suggests that approximately 97 more individuals would need to be collected to find one additional species (Figure 5).

Discussion

Survey efforts yielded a total of 180 live mussels representing 12 species, including 17 federally threatened Round Hickorynut and a weathered dead federally endangered Sheepnose shell. Most mussels, including federally listed species, were collected on the right descending half of the channel in sandy substrate. Given the presence of federally listed species, additional consultation with USFWS may be needed prior to construction. Data collected in this survey can be used to develop population estimates for federally listed species in the project area if needed and can serve as a pre-construction baseline to assess whether the mussel community is being affected by operation of the hydropower facility.

Tables

Table 1. Mussel Habitat by Transect Segment

Transect	Segment	Max Depth (ft)	% Clay	% Silt	% Mud	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	% Wood
1											
	0-10	10					10	30	60		
	10-20	12				40		60			
RDB	20-30	13				100					
	30-40	14				75	25				
	40-50	15				50	20	30			
2											
	0-10	6					30		70		
	10-20	10				80	20				
RDB	20-30	12				90	10				
	30-40	13					20	40	40		
	40-50	14						30	70		
3											
	0-10	6				10			90		
	10-20	10				50		50			
RDB	20-30	12				40	30	30			
	30-40	12					40	40	20		
	40-50	13					40	40	20		
4											
	0-10	7				100					
	10-20	8		10		90					
RDB	20-30	10		20		80					
	30-40	12				50	20	30			
	40-50	13				10	40	50			
5											
	0-10	5				100					
	10-20	7				90			5		5
RDB	20-30	8				100					
	30-40	9				40		40			20
	40-50	9				40		40			20
6											
	0-10	5				95					5
	10-20	7				90					10
RDB	20-30	8				80			5		15
	30-40	9				100					
	40-50	9				75					25
7											
	0-10	6		80				10			10
	10-20	7		70				5	5		20
LDB	20-30	7			10	10		80			
	30-40	8			10	10		80			
	40-50	8			10	10		80			

BioSurvey Group

Table 1. Mussel Habitat by Transect Segment

Transect	Segment	Max Depth (ft)	% Clay	% Silt	% Mud	% Sand	% Gravel	% Cobble	% Boulder	% Bedrock	% Wood
8											
	0-10	6	30			30		30			10
	10-20	7	30			40					30
LDB	20-30	7	30			30					40
	30-40	8				30		30	20		20
	40-50	8				20		60	20		
9											
	0-10	3		10			40	50			
	10-20	6		10			40	50			
LDB	20-30	7					30	40	30		
	30-40	8		10			10	30	50		
	40-50	9				10	20		40		30
10											
	0-10	3					20	70	10		
	10-20	4		10				40	50		
LDB	20-30	4		10				30	60		
	30-40	5		10				60	30		
	40-50	7		10		10	20	60			
11											
	0-10	4					10	30	60		
	10-20	7					10		90		
LDB	20-30	8								100	
	30-40	8								100	
	40-50	8								100	
12											
	0-10	1								100	
	10-20	2								100	
LDB	20-30	4								100	
	30-40	4								100	
	40-50	4								100	

Table 2. Mussels Collected Downstream of Kentucky River Lock and Dam 11

Tribe / Species	Common Name	Transects		Timed Searches		Total	
		No. Live	%	No. Live	%		%
Amblemini							
Amblema plicata	Threeridge	52	47.7	19	26.8	71	39.4
Pleurobemini							
Fusconaia flava	Wabash Pigtoe	2	1.8	3	4.2	5	2.8
Plethobasus cyphyus	Sheepnose	WD	-	-	-	WD	-
Quadrulini							
Cyclonaias pustulosa	Pimpleback	1	0.9	-	-	1	0.6
Megalonaias nervosa	Washboard	WD	-	-	-	WD	-
Quadrula quadrula	Mapleleaf	1	0.9	-	-	1	0.6
Lampsilini							
Actinonaias ligamentina	Mucket	1	0.9	-	-	1	0.6
Ellipsaria lineolata	Butterfly	1	0.9	-	-	1	0.6
Lampsilis cardium	Plain Pocketbook	SF	-	-	-	SF	-
Lampsilis siliquoidea	Fatmucket	4	3.7	1	1.4	5	2.8
Lampsilis teres	Yellow Sandshell	1	0.9	-	-	1	0.6
Obliquaria reflexa	Threehorn Wartyback	5	4.6	-	-	5	2.8
Obovaria subrotunda	Round Hickorynut	12	11.0	5	7.0	17	9.4
Potamilus alatus	Pink Heelsplitter	29	26.6	41	57.7	70	38.9
Potamilus ohiensis	Pink Papershell	-	-	2	2.8	2	1.1
Truncilla donaciformis	Fawnsfoot	WD	-	-	-	WD	-
Total		**109**	**100.0**	**71**	**100.0**	**180**	**100.0**
Live Species		**11**		**6**		**12**	
Total Species		**15**		**6**		**16**	
CPUE (no. live / min)		**0.19**		**0.89**			

Table 3. Length and Age Estimates for Federally Listed Species

Species	Common Name	Transect / Timed Search	Transect Segment	Est. Age (External Annuli)	Length (mm)
Obovaria subrotunda	Round Hickorynut	Transect 1	20 - 30	6	29
Obovaria subrotunda	Round Hickorynut	Transect 2	10 - 20	17	60
Obovaria subrotunda	Round Hickorynut	Transect 2	10 - 20	13	47
Obovaria subrotunda	Round Hickorynut	Transect 2	10 - 20	7	31
Obovaria subrotunda	Round Hickorynut	Transect 4	0 - 10	8	42
Obovaria subrotunda	Round Hickorynut	Transect 5	0 - 10	(weathered dead)	
Obovaria subrotunda	Round Hickorynut	Transect 5	30 - 40	5	33
Obovaria subrotunda	Round Hickorynut	Transect 6	0 - 10	14	44
Obovaria subrotunda	Round Hickorynut	Transect 6	10 - 20	23	67
Obovaria subrotunda	Round Hickorynut	Transect 6	10 - 20	13	41
Obovaria subrotunda	Round Hickorynut	Transect 6	20 - 30	8	41
Obovaria subrotunda	Round Hickorynut	Transect 7	0 - 10	3	24
Obovaria subrotunda	Round Hickorynut	Transect 7	0 - 10	3	23
Plethobasus cyphyus	Sheepnose	Transect 7	30 - 40	(weathered dead)	
Obovaria subrotunda	Round Hickorynut	Timed Search 7	-	22	61
Obovaria subrotunda	Round Hickorynut	Timed Search 7	-	8	35
Obovaria subrotunda	Round Hickorynut	Timed Search 7	-	6	30
Obovaria subrotunda	Round Hickorynut	Timed Search 7	-	13	37
Obovaria subrotunda	Round Hickorynut	Timed Search 7	-	10	39
Total No. Live					**17**

Figures

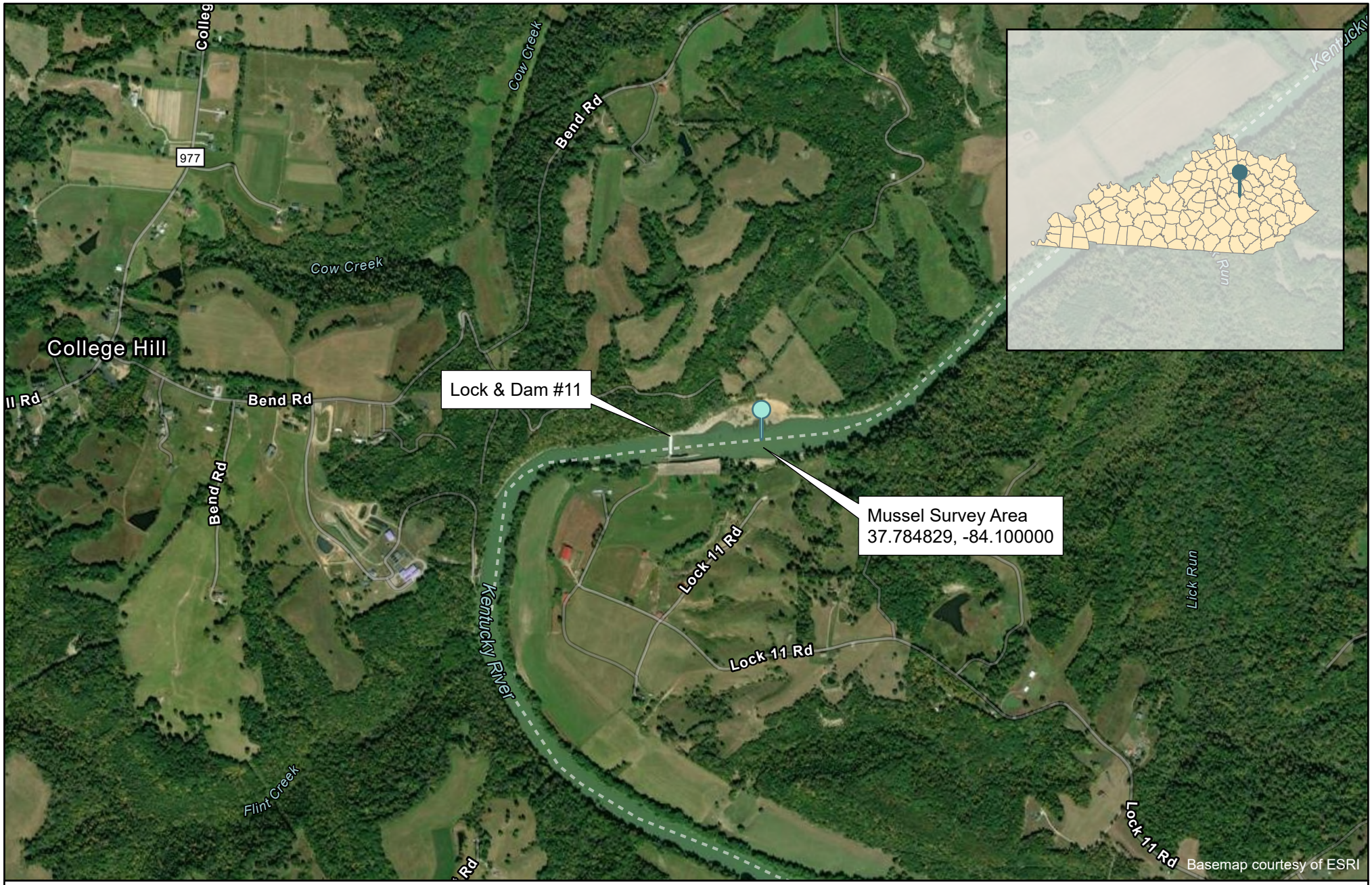


Figure 1. Project Location Map for the College Hill Hydroelectric Project, Madison and Estill Counties, Kentucky.

Project Location

N

0 150 300 600 Meters

BioSurvey Group

Figure 2. Mussel Survey Design Map for the College Hill Hydroelectric Project, Madison and Estill Counties, Kentucky.

Transects
Timed Searches

N

0 15 30 60 Meters

BioSurvey Group

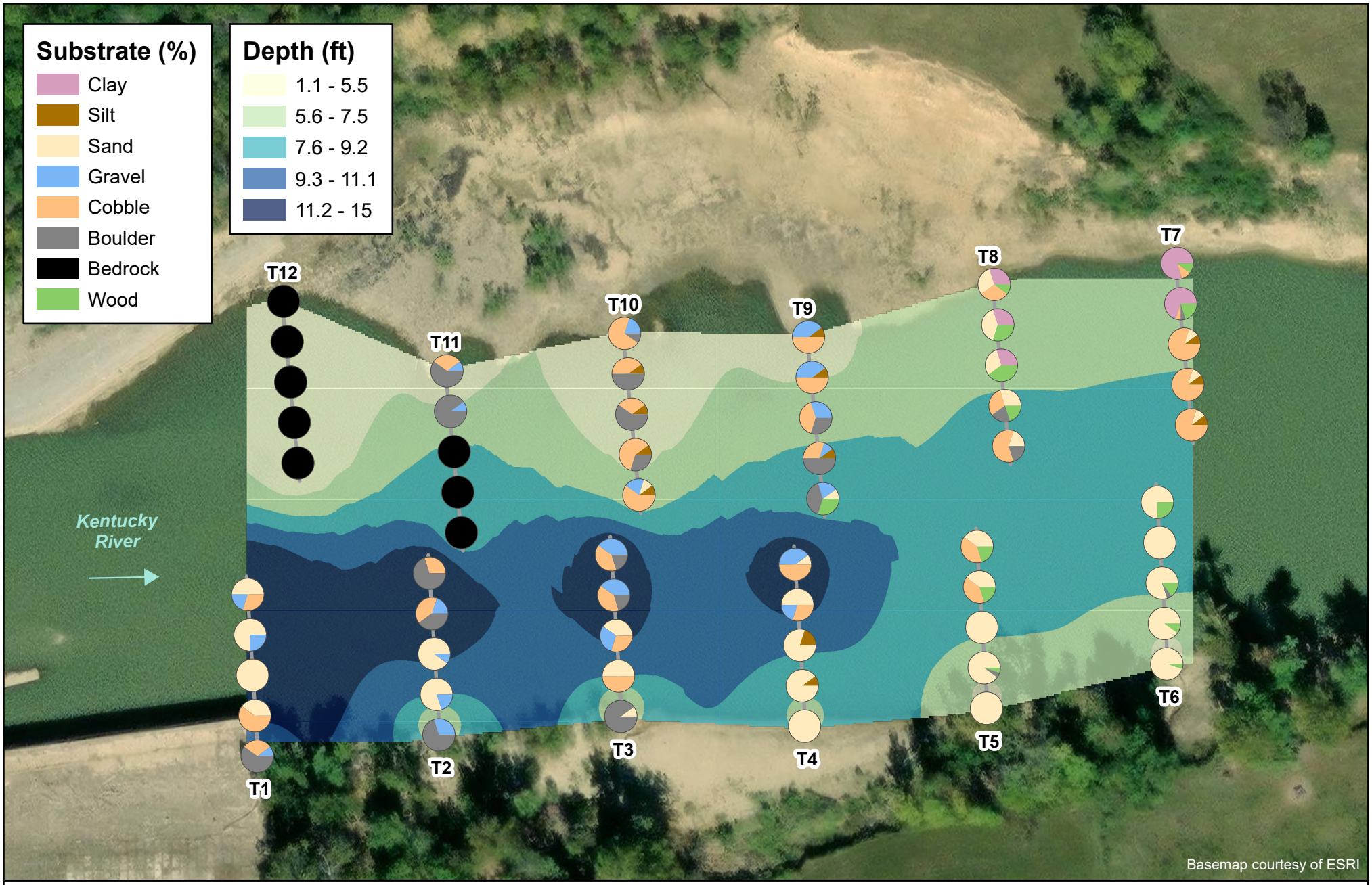


Figure 3. Substrate and Depth Map for the College Hill Hydroelectric Project, Madison and Estill Counties, Kentucky.

Transects

N

0 10 20 40 Meters

BioSurvey Group

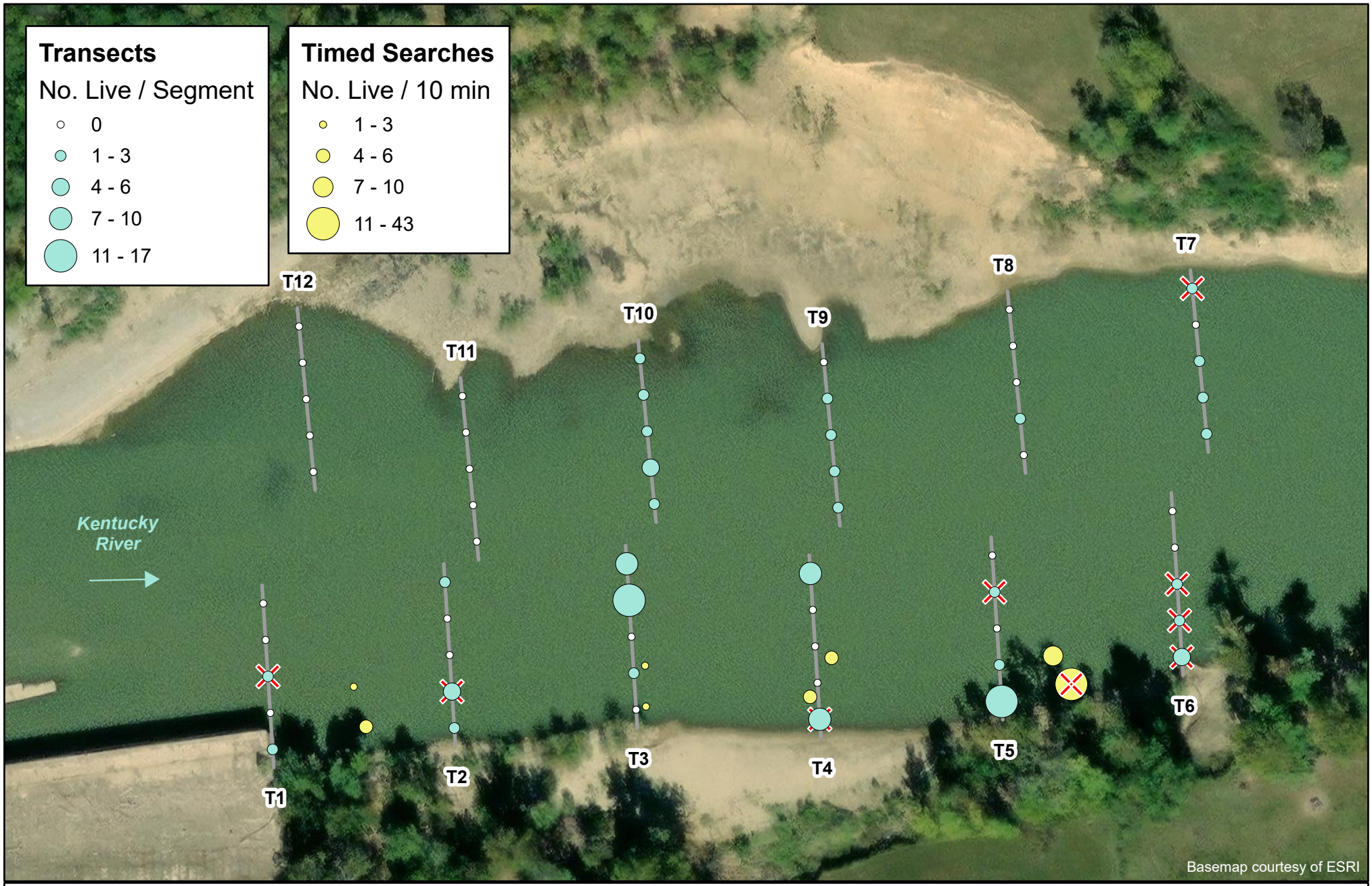


Figure 4. Mussel Abundance Map for the College Hill Hydroelectric Project, Madison and Estill Counties, Kentucky.

Transects

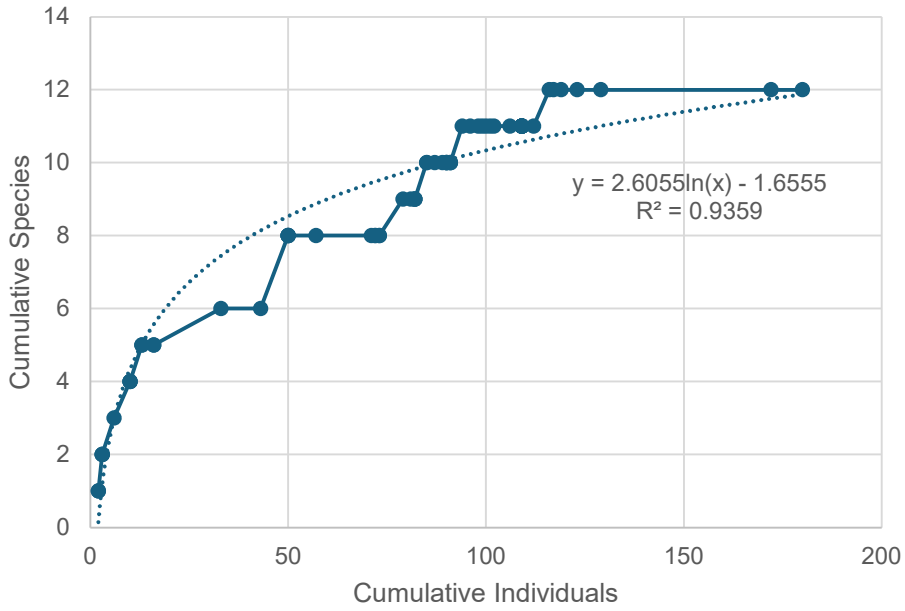
Federally Listed Species

N

0 10 20 40 Meters

BioSurvey Group

Figure 7. Species Richness Curve for the College Hill Hydroelectric Project, Madison and Estill Counties, Kentucky



Appendix A
Scientific Collection Permits

Scientific Wildlife Collecting - Fed Protected

SC2411259

BioSurvey Group
Emily Grossman
21 Fort Zumwalt Drive

O'Fallon, MO 63366

Effective: **1/1/24**
Expires: **12/31/24**
Fed Permit # ESPER0009122

This permit allows the taking and subsequent possession or release of federally-protected wildlife for the purposes of conducting scientific investigations or evaluations for which remuneration is received.

Regulated by
301 KAR 4:070

Your Scientific Wildlife Collecting - Fed Protected is attached below. Keep top portion for your records

Authorization Number: 9460
Issued on date: 03-Oct-2024

Kentucky Dept. of Fish and Wildlife Resources

Scientific Wildlife Collecting - Fed Protected
SC2411259 **Valid:** 1/1/24 **to** 12/31/24

BioSurvey Group
Emily Grossman
21 Fort Zumwalt Drive

O'Fallon, MO 63366

Authorized by KDFWR

ESPER0009122

The Kentucky Department of Fish and Wildlife Resources is funded through the sale of hunting and fishing licenses. KDFWR receives no general tax dollars.

REPORT-A-POACHER 1-800-25ALERT

Have a question? Call 1-800-858-1549

Visit us on the web at fw.ky.gov

Important Document

Enclosed

BioSurvey Group
Emily Grossman
21 Fort Zumwalt Drive

O'Fallon, MO 63366

NATIVE ENDANGERED & THREATENED SP. RECOVERY

Permit Number: ESPER0009122

Version Number: 2

Effective: 2024-04-26 **Expires:** 2027-12-31

Issuing Office:

Department of the Interior

U.S. FISH AND WILDLIFE SERVICE

ES Bloomington Permit Office
5600 American Boulevard, West, Suite 990
Bloomington, Minnesota 55437-1458
permitsR3ES@fws.gov

Karen Herrington

Midwest Region Ecological Services Program Leader

Digitally signed by
Karen Herrington
2024-04-25 15:27:07

Permittee:

Emily Grossman

21 Fort Zumwalt Dr.

O Fallon, Missouri 63368

U.S.A.

Authority: Statutes and Regulations: 16 U.S.C. 1539 (a), 16 U.S.C. 1533 (d) 50 CFR 17.22, 50 CFR 17.32, 50 CFR 13

Location where authorized activity may be conducted:

ON LANDS SPECIFIED WITHIN THE ATTACHED SPECIAL TERMS AND CONDITIONS

Reporting requirements:

DUE ANNUALLY ON 1/31

See permit conditions for reporting requirements

Appendix B
Mussel Survey Photo Log

Digital Image 1. View looking upstream toward Lock and Dam 11 from the middle of the survey area.

Digital Image 2. View looking downstream from the right descending bank.

Digital Image 3. View looking toward the left descending bank from the shoreward end of Transect 1.

Digital Image 4. View looking upstream along the left descending bank.

Digital Image 5. View looking toward the right descending bank of survey efforts on the left descending bank.

Digital Image 6. Representative photo of Mucket (*Actinonaias ligamentina*) collected in the survey.

Digital Image 7. Representative photo of Threeridge (*Amblema plicata*) collected in the survey.

Digital Image 8. Representative photo of Pimpleback (*Cyclonaias pustulosa*) collected in the survey.

Digital Image 9. Representative photo of Butterfly (*Ellipsaria lineolata*) collected in the survey.

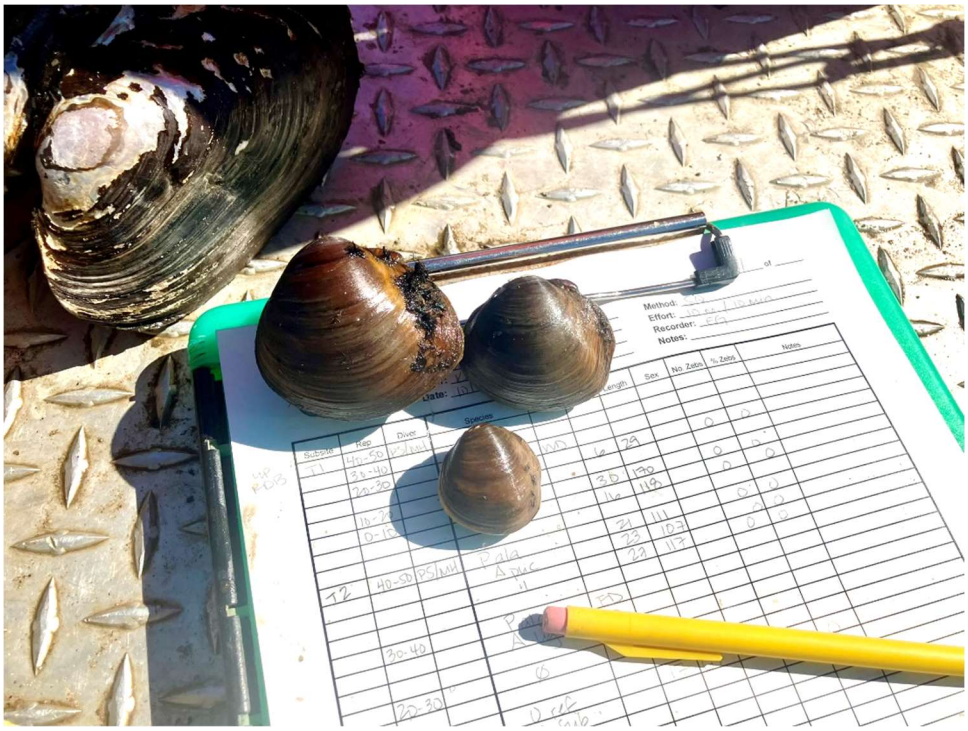
Digital Image 10. Representative photo of Wabash Pigtoe (*Fusconaia flava*) collected in the survey.

Digital Image 11. Representative photo of Fatmucket (*Lampsilis siliquoidea*) collected in the survey.

Digital Image 12. Representative photo of Yellow Sandshell (*Lampsilis teres*) collected in the survey.

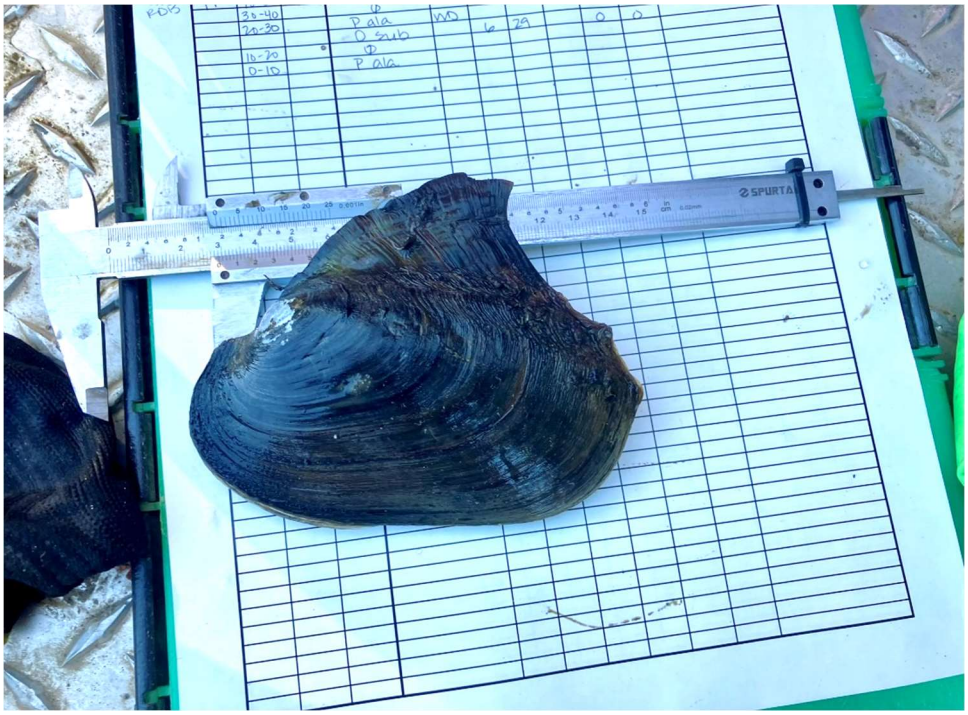
Digital Image 13. Representative photo of Threehorn Wartyback (*Obliquaria reflexa*) collected in the survey.

Digital Image 14. Representative photo of Round Hickorynut (*Obovaria subrotunda*) collected in the survey.



Digital Image 15. Representative photo of Round Hickorynut (*Obovaria subrotunda*) collected in the survey.

Digital Image 16. Representative photo of Round Hickorynut (*Obovaria subrotunda*) collected in the survey.



Digital Image 17. Representative photo of Pink Heelsplitter (*Potamilus alatus*) collected in the survey.

Digital Image 18. Representative photo of Pink Papershell (*Potamilus ohiensis*) collected in the survey.

Digital Image 19. Representative photo of Mapleleaf (*Quadrula quadrula*) collected in the survey.

Digital Image 20. Representative photo of subfossil Plain Pocketbook (*Lampsilis cardium*) shell collected in the survey.

Digital Image 21. Representative photo of weathered dead Washboard (*Megalonaias nervosa*) shell collected in the survey.

Digital Image 22. Representative photo of weathered dead Sheepnose (*Plethobasus cyphyus*) shell collected in the survey.

Digital Image 23. Representative photo of weathered dead Fawnsfoot (*Truncilla donaciformis*) collected in the survey.

APPENDIX B

Kleinschmidt Associates Hydraulic Study Memorandum

TECHNICAL MEMORANDUM

To: Mr. David Brown Kinloch (Appalachian Hydro Associates)

From: Jill L. Davis, P.E. (Kleinschmidt Associates)

Cc: Paul D. Drew, P.E., CFM, Will Pruitt, CE (Kleinschmidt Associates)

Date: January 28, 2025 **Project No.** 1349009.03

Re: Lock and Dam No. 11 – Mussel Hydraulic Review

INTRODUCTION

Appalachian Hydro Associates contracted Kleinschmidt Associates (Kleinschmidt) to perform a hydraulic analysis to evaluate and compare the existing and proposed (post-construction) flow conditions at Lock and Dam No. 11 (Lock No. 11). The U.S. Fish and Wildlife Service (USFWS), upon review of the recent Mussel Survey Report (BioSurvey Group 2024), has three primary concerns regarding the impact from planned operations for the College Hill Hydroelectric Project (Project; FERC Project No. 14276):

1. Changes in flow conditions that would cause dislodgement of existing mussel beds.
2. Sediment transport through the lock or scouring of sediment from the immediate vicinity of the Project that may deposit and bury the existing mussel beds.
3. Changes in flow conditions over/near mussel beds that alter the likely presence of host fish species.

This Technical Memorandum documents the development of a hydraulic model and the evaluation of the potential impacts of flow condition changes on federally listed mussel species and their host fish of concern downstream of the proposed Project (see Table 1).

Table 1 Federally Listed Species of Concern Downstream of the Proposed Project

Mussel Species	Host Fish Species
Round Hickorynut (*Obovaria subrotunda*) (17 live found)	Eastern Sand Darter (*Ammocrypta pellucida*)
Sheepnose (*Plethobasus cyphyus*) (1 dead, weathered shell found)	Sauger (*Sander canadensis*)

Elevations listed in this report reference the North American Vertical Datum of 1988 (NAVD 88). The spatial project is in reference to North American Datum of 1983 State Plan Kentucky South FIPS 1602 (feet US).

PROJECT DESCRIPTION

The proposed Project is located at River Mile 201 on the Kentucky River in east-central Kentucky, Madison County, near the Town of College Hill (Latitude 37° 47' 03", Longitude -84° 6' 11"), approximately 28 miles southeast of Frankfort, at Lock No. 11. The Kentucky River flows in a north-northwest direction to discharge into the Ohio River. The existing lock and dam were completed in 1906 by the United States Army Corps of Engineers (USACE) for purposes of navigation. The dam is no longer used for navigation, and use of the lock has been discontinued. In 1996, the USACE placed a concrete bulkhead on the sill of the upstream lock gate to close off the lock, and the downstream miter gates were left in the open position. The dam is currently owned and operated by the Kentucky River Authority, which took ownership from the USACE in March 2006.

The existing water retaining structures at the site span 289 feet between the guide and training walls that form the dam's north and south abutments. The structures develop a gross head of 17 feet between the upper (Elevation [El.] 582.5 feet) and lower pools (low pool condition, El. 565.5 feet). Tailwater from the downstream Lock and Dam No. 10 backs up against the dam. The passive spillway is 208 feet long, with a crest at El. 582.5 feet and a maximum height of approximately 35 feet above the foundation rock. The spillway is a concrete gravity structure, with an apron constructed of derrick stone that extends nearly 42 feet downstream of the spillway.

HYDRAULIC MODEL DEVELOPMENT

MODEL COMPUTATIONAL SETTING AND FLOW SCENARIOS

Kleinschmidt developed a two-dimensional (2D) hydraulic model using the USACE Hydraulic Engineering Center's River Analysis Software (HEC-RAS) version 6.4.1 to evaluate existing and proposed flow conditions for the Project. The model domain extends approximately 1,000 feet upstream of the Lock No. 11 spillway and 1,500 feet downstream.

The 2D model uses an unstructured computational mesh that allows computation cells with up to eight sides and a mixture of cell shapes and sizes. Each computation cell and cell face are based on the details of the underlying terrain to develop the geometric and hydraulic property tables for the flow simulations. Using RAS Mapper, one computation mesh was generated that covered the domain of the study area. The model existing conditions domain was developed using a 15-foot by 15-foot initial mesh square. The mesh was refined with several break lines to define the centerline, channel banks, hydraulic structures, and other pertinent features within the model domain. The resulting domain consists of 7,709 cells with maximum, minimum, and average cell areas equal to 4,257, 63, and 337 square feet, respectively. The proposed conditions domain used a

duplicate of the existing conditions domain, with modifications as necessary. The 2D model geometry is illustrated in Attachment 1.

The upstream boundary condition for the model was defined as a constant flow hydrograph for six flow scenarios summarized in Table 2. The downstream boundary condition was set as a rating curve using tailwater elevations developed using the one-dimensional (1D) HEC-RAS model (Kleinschmidt 2024a). The 1D HEC-RAS model uses a rating curve at the downstream Lock No. 10 spillway calibrated to flow and gage heights at U.S. Geological Survey (USGS) Gage No. 03284000 located in the Lock No. 10 headpond. Model calibration results are provided in Attachment 2. The hydraulic model was performed using the Full Momentum Shallow Water Equations with a 0.5-second timestep.

Table 2 HEC-RAS Model Scenarios

Model Scenario	Description	Flow (cfs*)
Existing Conditions		
1	Normal Flow – proposed maximum turbine capacity	2,636
2	Maximum Spillway Capacity – 20,000 cfs over the spillway only	20,000
3	Mean Annual Peak Flow (~2.3 Annual Exceedance Probability)	45,233
Proposed Conditions		
4	Maximum Turbine Capacity – maximum Project capacity before water spills over spillway	2,636
5	Maximum Spillway Capacity – 2,636 through Project; 17,364 over spillway	20,000
6	Mean Annual Peak Flow – bladder for Project lowered	45,233

* cfs = cubic feet per second

MODEL TERRAIN

The model terrain was developed using GIS and RAS Mapper (within HEC-RAS) from a combination of digital elevation models, depth sounding, and other hydraulic models. All elevation data were referenced with respect to NAVD88. The following is a comprehensive summary of data sources:

- Kentucky Light Detection and Ranging: KYFromAbove, 5-foot resolution.
- The mussel survey conducted by BioSurvey Group on October 7, 2024, included depth measurements from 12 transects (BioSurvey Group 2024). Depths were converted to elevations based on water surface elevation recorded by USGS Gage

No. 03284000 near the Lock No. 10 headpond. *Note that at low flows, the Lock No. 11 tailwater is approximately equivalent to the normal headwater elevation at Lock No. 10.*

- Upstream of the mussel survey area, channel elevations were estimated using data from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) reports for Madison and Estill counties (FEMA 2011, 2017).
- Downstream of the mussel survey area, the bathymetric surface was created using cross-sections from the effective FEMA 1D HEC-RAS model.
- Kleinschmidt drawings for the *Revised Phase 1 Submittal for the College Hill Hydroelectric Develop at Lock No. 11* (Kleinschmidt 2024b).

MANNING'S ROUGHNESS COEFFICIENTS (N)

The Manning's roughness coefficients (*n*) used in the model were selected based on guidance from the USACE *HEC-RAS 2D User's Manual* (USACE 2024), values reported in the FEMA FIS, and engineering judgement. Land cover regions were determined through a review of aerial imagery and manually assigned (Google 2024). The selected Manning's roughness coefficients (*n*) are summarized in Table 3.

Table 3 Manning's Roughness Coefficients (*n*)

Land Cover Type	Manning's Roughness Coefficient (*n*)
Channel	0.045
Lock	0.045
Forest	0.120
Overbanks	0.070
Pasture	0.040
Barren	0.040
Concrete	0.016

STRUCTURES

The spillway dimensions for both scenarios referenced Kleinschmidt drawings for the *Revised Phase 1 Submittal for the College Hill Hydroelectric Develop at Lock No. 11* (Kleinschmidt 2024b). The spillway was represented in the model as a single storage-area/2D (SA/2D) connection with a weir coefficient of 3.0. The predicted model headwater elevations were compared to the USGS gage data for each flow scenario to calibrate the weir coefficient. In the existing conditions, the upstream lock gates were assumed to remain closed during all flow scenarios. A comparison between predicted model headwater elevation and USGS gage data are provided in Attachment 2.

Proposed conditions incorporate a maintenance rubber bladder at the upstream end of the lock and an operational bladder located above the turbines. For all scenarios, the emergency bladder was fully deflated (572.5 feet). The operational bladder elevation was varied for different flow scenarios.

- In the lowest flow proposed scenario, the operational bladder is fully inflated (592.5 feet) with the turbines operating at maximum capacity (2,636 cfs), with all inflows passing through the turbines.
- In higher flow scenarios, turbines are non-operational, passing no flow, and the operational bladder is fully deflated (577.5 feet).

HYDRAULIC MODEL RESULTS

Reporting locations were selected based on mussel sampling transects in the BioSurvey report (BioSurvey Group 2024), combining collinear transects. The flood routing results at select transects are summarized in Table 4.

The model results indicate varying changes in peak velocity across different flow conditions and transects:

- The largest increase in velocity occurs at Transect 1 (immediately downstream of the lock structure) in all flow conditions (2.0 during normal flow and 0.5 feet per second [fps] during mean annual peak flow).
- **Normal Flow:** Maximum velocity increases at all transects. Under these conditions, the flow, which was previously distributed across the spillway, is now constrained to pass through the lock with a smaller cross-sectional area, leading to a relatively small (0.1 to 2.0 fps) increase in peak velocity.
- **Maximum Spillway Capacity:** In this scenario, the greatest change is an increase of 0.1 cfs at Transect 1; however, at all other transects, velocity decreases. This is due to flow passing through both the spillway and lock in the proposed condition, which allows flow to be more evenly distributed across the channel instead of only across the spillway.
- **Mean Annual Peak Flow:** At Transect 1, velocity increases by 0.5 fps, but at the remaining transects, there is little to no change. This proposed condition is most like the existing condition, where flow is distributed across both the spillway and the lock, with water overtopping both structures.

In addition to changes in velocity at each transect, flow patterns change between the existing and proposed conditions. Figure 1 through Figure 6 present plan views of velocity results at the transect locations, incorporating particle tracing to illustrate flow direction.

Under normal flow conditions, distinct differences are observed between existing and proposed conditions. In the existing conditions, flow within the main channel moves directly downstream. However, under the proposed conditions, the concentration of flow from the powerhouse outlet, combined with the absence of flow from the spillway, results in a zone of relatively low velocities directly downstream of the spillway. Additionally, a large eddy forms on the left side of the river between Transects 1 and 4.

Under maximum spillway capacity and mean annual flow conditions, flow patterns exhibit minimal changes. In both existing and proposed conditions, flow within the main channel continues to move directly downstream, with no significant alterations to flow direction or velocity distribution.

Table 4 Flood Routing Results

Reporting Location	Flow (cfs)*	Maximum Existing (fps)	Maximum Proposed (fps)	Velocity Change (fps)
Location 1	2,636	0.9	2.9	2.0
	20,000	3.1	3.2	0.1
	45,233	4.2	4.7	0.5
Location 2	2,636	0.8	2.0	1.2
	20,000	2.9	2.8	-0.1
	45,233	3.9	3.9	0.1
Location 3	2,636	0.8	1.6	0.8
	20,000	2.7	2.4	-0.3
	45,233	3.7	3.6	-0.1
Location 4	2,636	0.7	1.2	0.5
	20,000	2.5	2.1	-0.4
	45,233	3.5	3.5	0.0
Location 5	2,636	0.8	1.1	0.3
	20,000	2.5	2.2	-0.3
	45,233	3.4	3.5	0.1
Location 6	2,636	0.9	1.0	0.1
	20,000	2.6	2.5	-0.1
	45,233	3.5	3.6	0.1

* Flows of 2,636, 20,000, and 45,233 cfs correspond to the "Normal Flow," "Maximum Spillway Capacity," and "Mean Annual Peak Flow" flow scenarios, respectively.

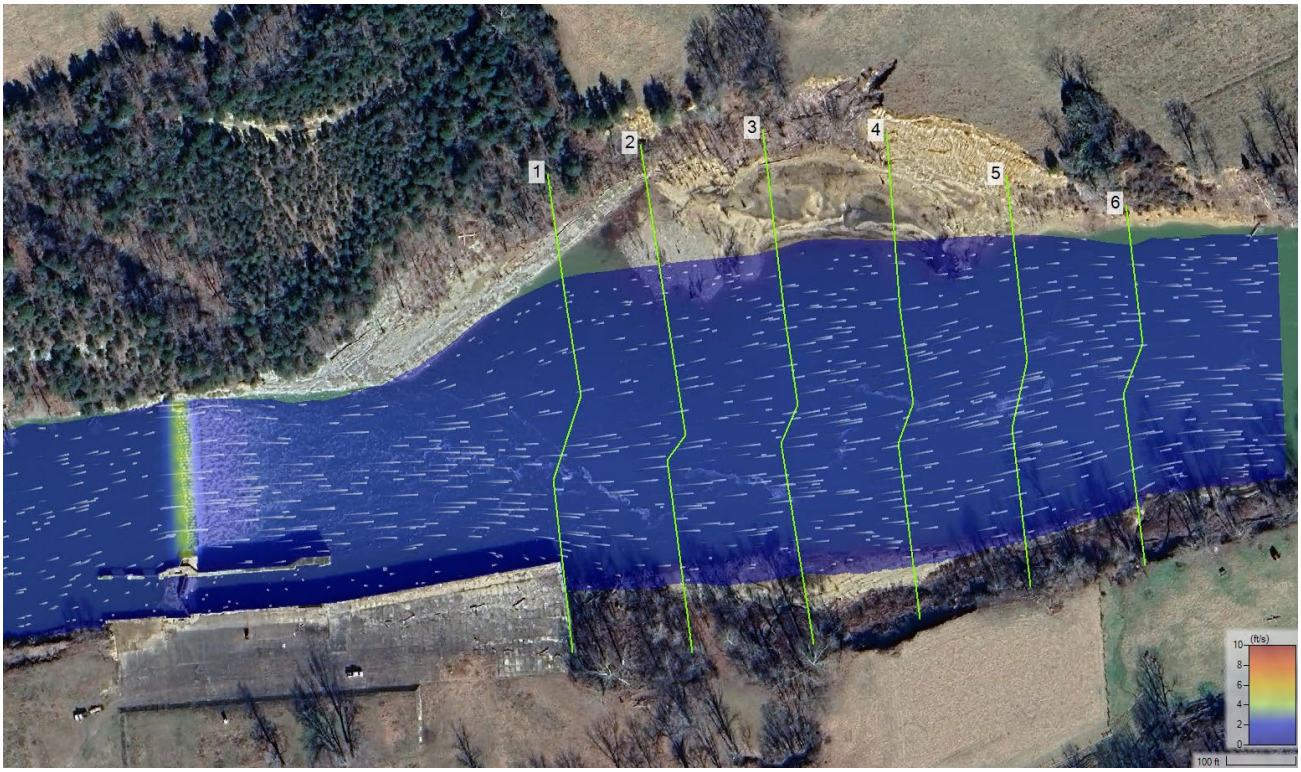


Figure 1 Existing Conditions Normal Flow

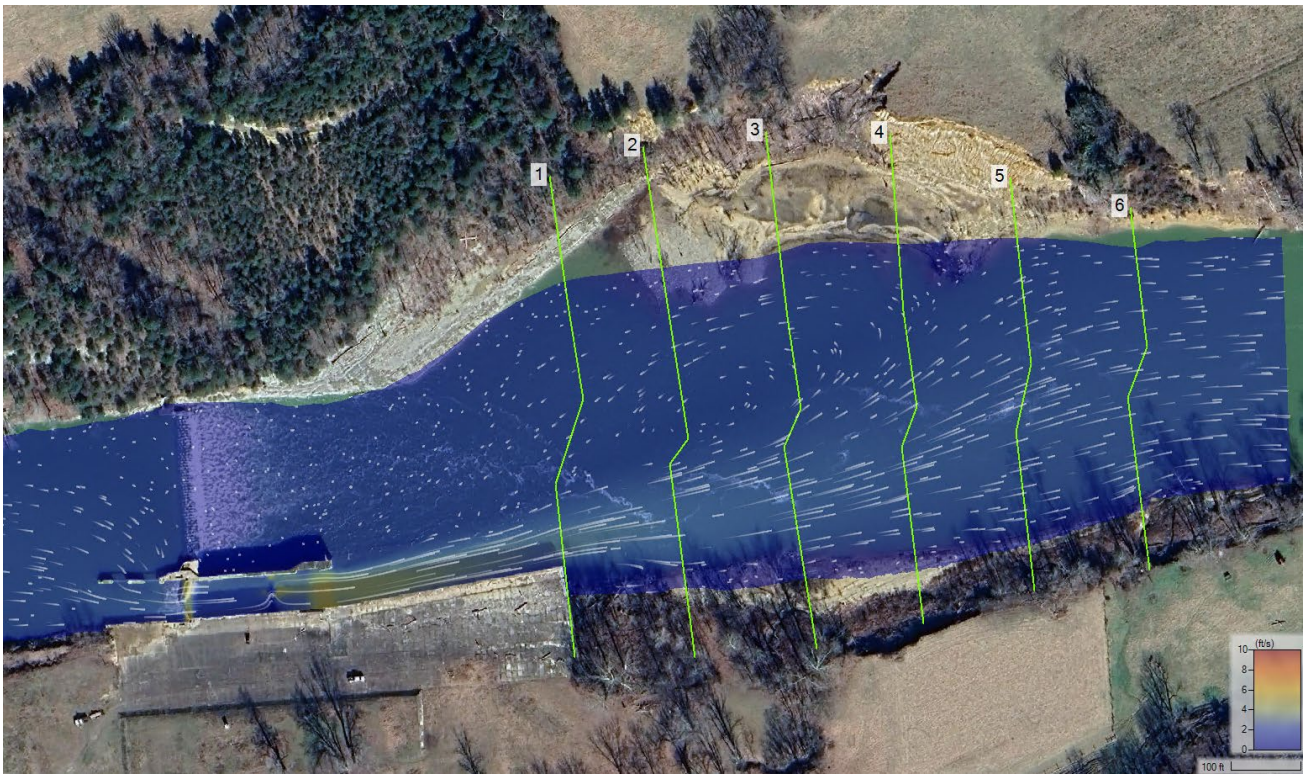


Figure 2 Proposed Conditions Normal Flow

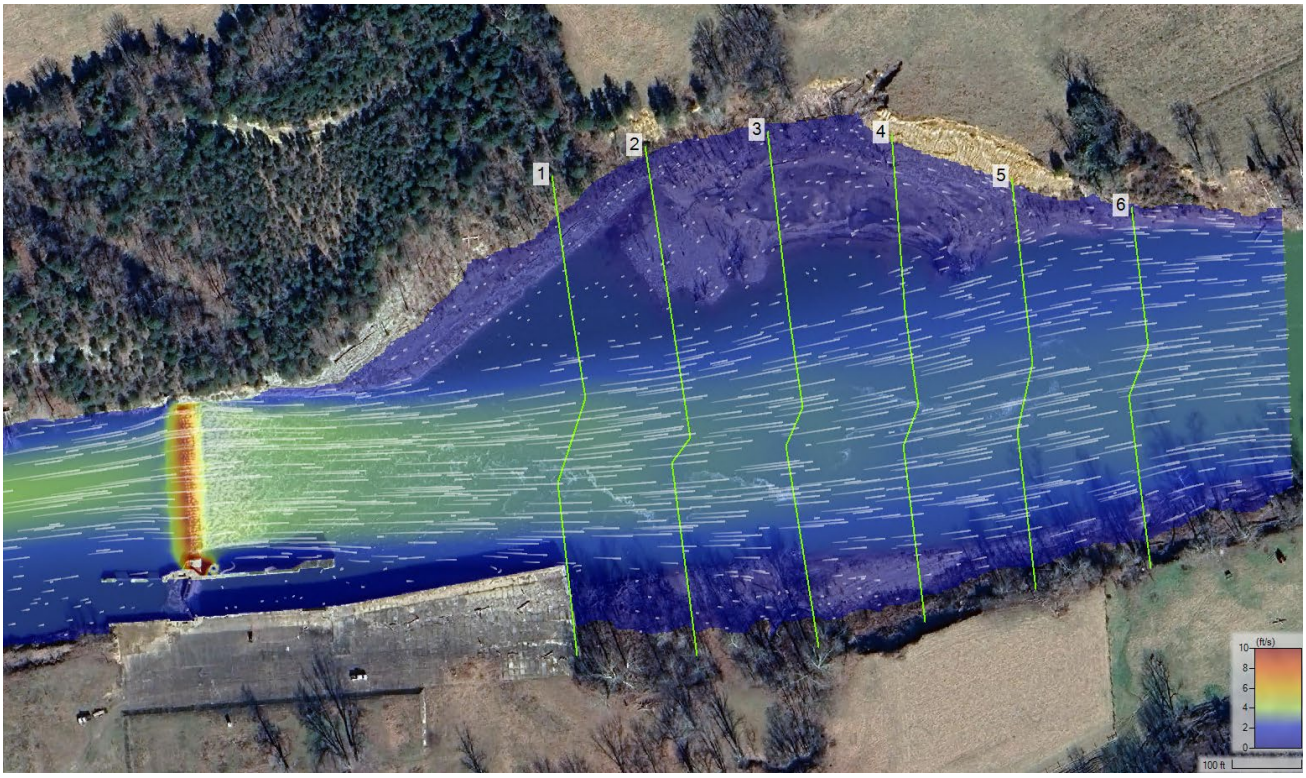


Figure 3 Existing Conditions Maximum Spillway Capacity Flow

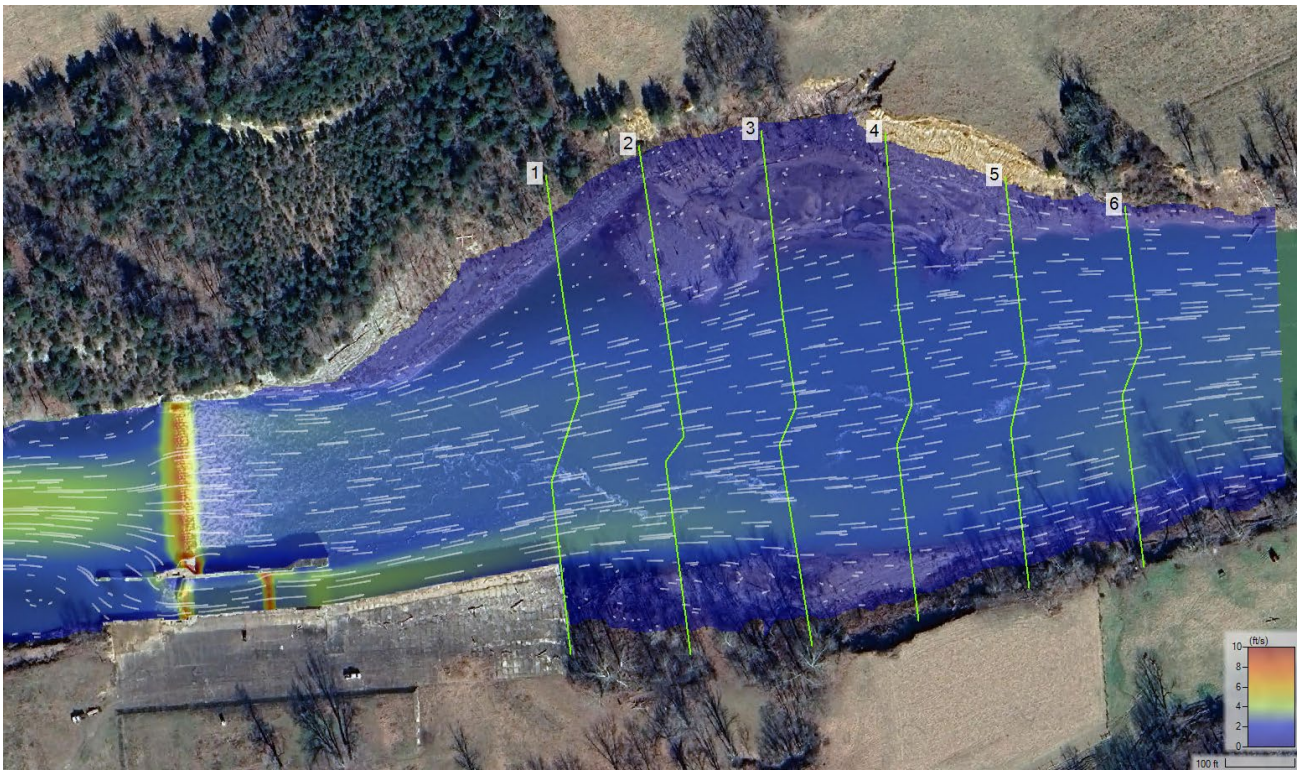


Figure 4 Proposed Conditions Maximum Spillway Capacity Flow

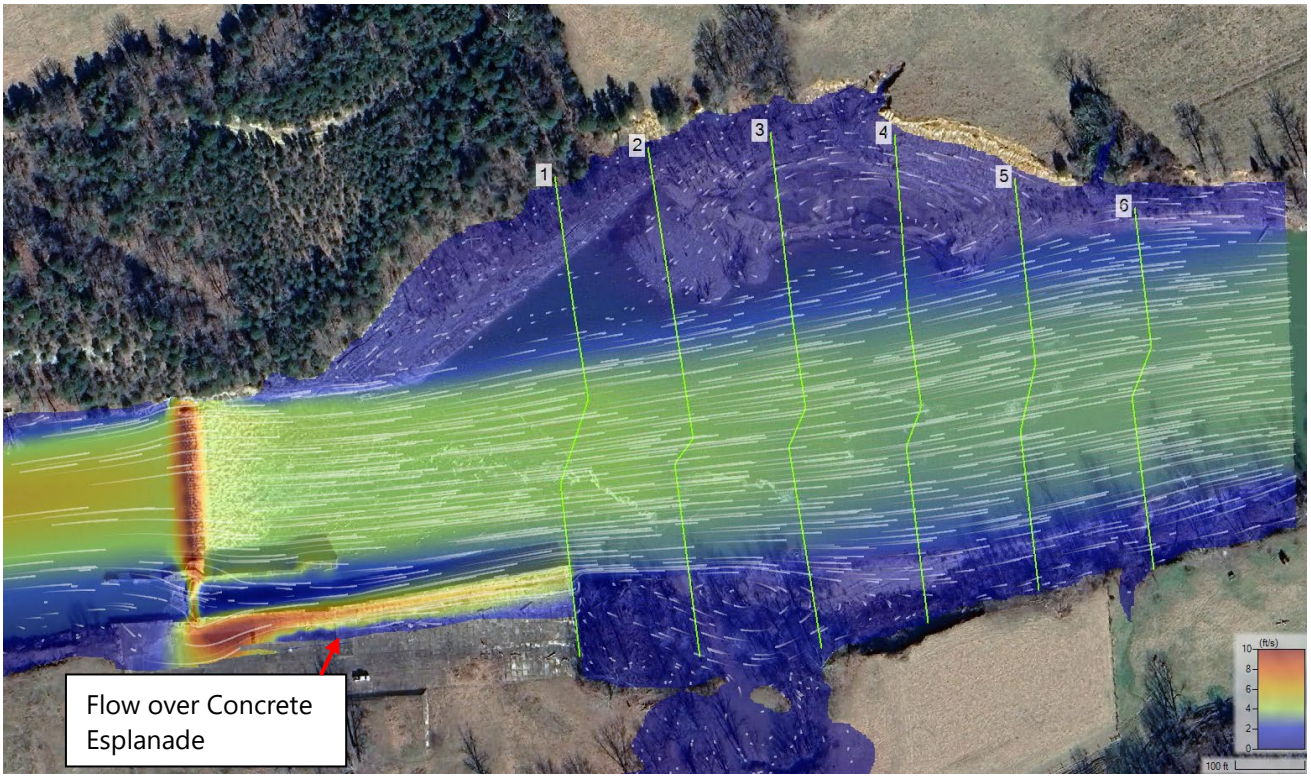


Figure 5 Existing Conditions Mean Annual Peak Flow

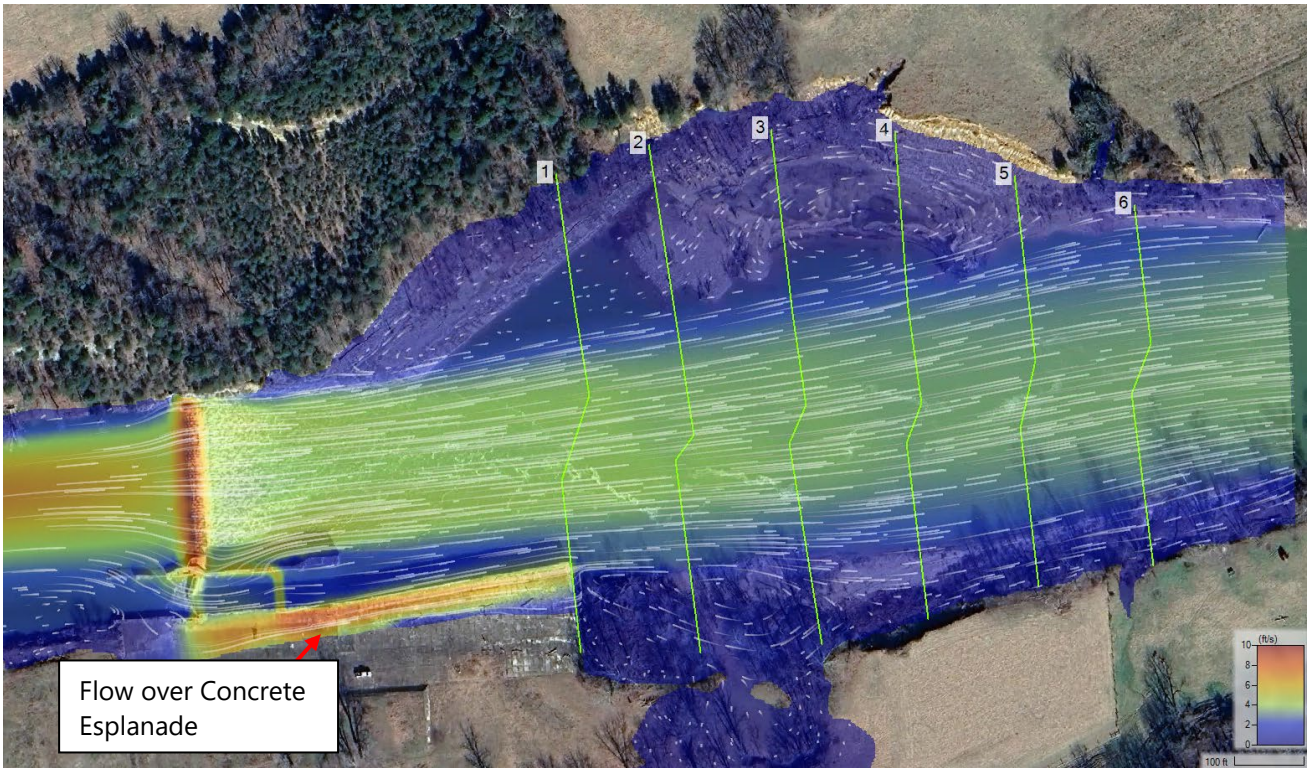


Figure 6 Proposed Conditions Mean Annual Peak Flow

MUSSEL IMPACT REVIEW

Freshwater mussel populations' susceptibility to environmental changes such as habitat fragmentation and alterations in flow regimes from dam construction and hydropower operations have been well-documented. Large-scale alteration in flow regimes, such as the series of locks and dams along the Kentucky River, had population-level effects on mussels, resulting in the listing of several species of concern. Although these past actions along the Kentucky River have altered the aquatic community throughout the basin over the last century, the focus of this discussion is at a much finer geographic scale (i.e., the potential change in hydraulic conditions at Lock No. 11 and potential effects on the mussel community). Specifically, the mussel species of concern include Round Hickorynut and Sheepnose.

As mentioned in the hydraulic model results above, the expected maximum change in peak depth-averaged velocity between existing and proposed conditions across each location/mussel transect is negligible in most flow scenarios. The most noticeable differences between existing and proposed conditions can be seen during the Normal Flow (2,636 cfs) scenario (Table 4, Figure 1, and Figure 2). In the Normal Flow scenario, most locations are not expected to have a noticeable change in peak depth-averaged velocity. However, Location 1 and Location 2 are expected to experience a 2.0 fps and a 1.2 fps change in water velocity under the proposed conditions, respectively (Table 4). In existing conditions, water is prevented from entering the lock structure, and all flow is routed over the existing spillway over a wide cross-sectional area. This allows more uniform dispersal of flows across the river channel. Conversely, under proposed conditions at normal flows, all water will be routed through the proposed powerhouse and discharged at the outlet of the existing lock structure. This creates an area of increased water velocities at the edge of the concrete esplanade at the right descending bank at Location 1 as water exits the existing lock structure (Figure 2). Continuing downstream, flow patterns begin to distribute across the river channel through Locations 3 and 4 and begin to resume "normal" flow patterns across Locations 5 and 6 and exiting the survey reach. Another potential change in flow pattern under the Normal Flow scenario includes the creation of an eddy along the left bank during base flow conditions. This eddy may allow fine sediments to settle when normal flows resume post-high event. The area is predominately bedrock substrates and generally unsuitable for mussels.

For proposed conditions, increased water velocity in Locations 1 and 2 (i.e., a maximum depth-averaged velocity of 2 fps) and change to flow patterns under Normal Flow scenario have the potential to affect the mussels in the immediate vicinity. The area at the outlet of the existing lock structure is expected to be most affected. Coincidentally, this is also the deepest part of the river that contains boulder, cobble, and gravel substrates. The water column depth and coarse substrate types are likely the result of this area continually

receiving the majority of discharge during high-water events. As such, these coarse substrates are not expected to scour under the proposed normal flow conditions. Some sand is present in Location 1, which may potentially be mobilized once the proposed project is in full operation, ultimately leaving more coarse substrates (i.e., boulder, cobble, and gravel) behind, as seen in Locations 2 and 3. However, this potential change is expected to be a one-time occurrence until a new equilibrium is reached.

In the Maximum Spillway Capacity (20,000 cfs) scenario (Figure 3 and Figure 4), there are some slight variations in flow patterns between existing and proposed conditions. This is the result of the modeled flows passing both through the powerhouse/lock structure and over the existing spillway. Although there may be a slight increase in water velocity exiting the lock in proposed conditions, the flow distribution across the river channel is relatively uniform and is not expected to affect substrates and in-river habitat conditions. Further, the flow of approximately 20,000 cfs occurs annually if not more frequently during the winter and springs months. As a result, there are no anticipated risks of mussel dislodgement or scouring of habitats, smothering of existing mussel beds, or alterations of habitats for fish hosts (i.e., Eastern Sand Darter and Sauger).

In the Mean Annual Peak Flow (45,233 cfs) scenario (Figure 5 and Figure 6), there is virtually no change in expected flow dynamics between existing and proposed conditions. The design and operation of the proposed gates would allow flows over the top of the turbine and through the lock structure during the Mean Annual Peak Flow. Because changes in flow pattern are essentially imperceivable, there are no anticipated impacts to mussels, their habitats, or host fishes in the Mean Annual Peak Flow proposed conditions.

It is important to understand the limitations of the modeling exercise and its 2D approach. As it stands, the existing model can produce a peak depth-averaged water velocity. Because this model is not three-dimensional, the expected velocities at various depths cannot be estimated. As such, the model cannot predict changes in velocities at the surface versus velocities at the substrate.

REVIEW SUMMARY

Based on the results of the hydraulic model and the evaluation of the potential impacts of these flow condition changes on the federally listed mussel species and their host fish of concern, the responses to the USFWS three primary concerns are as follows:

1. *Changes in flow conditions that would cause dislodgement of existing mussel beds.*

   During the Normal Flow scenario, flow conditions are expected to change at Locations 1 and 2. However, due to the existing depth and coarse substrate types, the expected increase in water velocity is unlikely to dislodge existing mussel beds

when compared to the yearly flow velocity changes that already exist. An important consideration when examining potential project effects are the flow conditions and river fluctuations that are currently experienced. This reach of the river frequently experiences flashy flows, particularly in the winter and spring months. As observed within the Mean Peak Flow scenario under existing conditions, water velocities increase 4.2 fps in Location 1 compared to the Normal Flow scenario. These flows pose a greater risk to mussel dislodgment than the expected increase of 2.0 fps at Normal Flow once the hydropower facility is in operation. In summary, the risk of mussel dislodgement and the movement of sediment occurs during high-flow events, which frequently happen under existing conditions. Under the proposed conditions, there is no observable difference in flow condition during the Mean Peak Annual Flow and is not likely to increase the risk of dislodgment that the existing mussel community currently faces. However, the substrates between Lock No. 11 and Location 1, presumed to be finer sediments, may potentially shift to coarser types after project implementation. This is due to the increased water velocity keeping the substrates in this deeper channel free of finer sediments, which is expected to stabilize post-project operation.

2. *Sediment transport through the lock or scouring of sediment from the immediate vicinity of the Project that may deposit and bury the existing mussel beds.*

   The sandy areas between Lock No. 11 and Location 1 (approximately 200-foot-long reach along the right bank) will likely be mobilized once power generation is online. This movement of substrates is expected to be a one-time occurrence until a new equilibrium is reached post-project implementation. Any mobilized soft sediments are expected to settle within or immediately downstream of the assessment area. Therefore, while initial scour and sediment deposition may occur, the volume is not expected to smother the mussel beds. The volume of sediment is not expected to exceed what is naturally scoured, transported, and deposited annually as the river continually fluctuates between base flow and peak flow conditions. As stated in Item 1 above, the risk of sediment scour or deposition is greatest during high-flow conditions and is not tied to the hydropower operations.

3. *Changes in flow conditions over/near mussel beds that alter the likely presence of host fish species.*

   Although some flow patterns are expected at the Project location during normal flow conditions at Locations 1 and 2, the changes in water velocity and flow patterns are not expected to alter habitats in a way that would affect the presence of known or potential fish host species.

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