Appendix D – Summary of the Historical Aquatic Animal Species Found Within the Project Area and Mussel and Snail Survey Methods and Results

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Table D-1. Federally and State-Listed Historical Aquatic Species known from Marion County and/or within the Potentially Affected Watersheds of the Project Area

Common Name	Scientific Name	State Status (Rank)		Federal Status
		AL	TN	
Fish				
Southern Cavefish*	*Typhlichthys subterraneus*	-	NMGT (S3)	-
Mussels				
Kidneyshell	*Ptychobranchus fasciolaris*	TRKD (S1)	-	-
Orange-foot Pimpleback	*Plethobasus cooperianus*	PROT (S1)	-	END
Pale Lilliput*	*Toxolasma cylindrellus*	-	END (S1)	END
Rabbitsfoot	*Quadrula c cylindrica*	PROT (S1)	-	-
Slabside Pearlymussel	*Lexingtonia dolabelloides*	PROT (S1)	-	CAND
Snuffbox	*Epioblasma triquetra*	TRKD (S1)	-	-
Tennessee Heelsplitter	*Lasmigona holstonia*	TRKD (S1S2)	-	-

Status codes: CAND = Candidate; END = Endangered; NMGT = In need of management; THR = Threatened; TRKD = Tracked as Sensitive, but has no legal status; PROT = State Protected
State ranks: S1 = Critically imperiled; S2 = Imperiled; S3 = Vulnerable
*Species does not occur within the affected watershed

Survey Plan – CB&I Barge Terminal at TRM 424

CB&I has plans for a barge terminal and ramp on the left bank of the Tennessee River downstream of Nickajack dam in Guntersville Reservoir near rivermile 424 (Marion County, TN). The plans show a property waterfront length of about 225 meters (m) or 730 feet (ft). Instream, direct impacts (project footprint) are expected to extend approximately 27m (90ft) off of the left bank. This reach of the Tennessee River is near known populations of the federal endangered Anthony's river snail (*Athearnia anthonyi*) and near recent collections of the federal endangered pink mucket (*Lampsilis abrupta*). This reach of the river is also part of a mussel sanctuary designated by the Tennessee Wildlife Resource Agency (TWRA).

The following survey plan recommendations are shaped by conversations with the natural resource agencies and the selected consultant, but the final plan must be approved by USFWS, TWRA, and TVA. If on-site modifications of the survey plan are necessary to ensure the safety of field personnel or adapt to ambient field conditions, the consultant will notify TVA of the changes as soon as possible. The approved consultant(s) must possess a valid scientific collector's permit from the USFWS and TWRA prior to conducting this survey. It should also be noted that the site occurs in an area normally subject to high velocity conditions from the release of water from Nickajack Dam. TVA engineers have arranged special operational conditions at the dam to facilitate flow conditions that will allow for safe, effective sampling of mussels and snails. At this time, TVA will try to coordinate period from 0700 to approximately 1300 hr on selected dates where no discharge will occur for hydroelectric generation; requests for changes in dam release schedules should be coordinated through TVA. Marine radio contact should be maintained by the consultants with navigational traffic, dam (TVA), and lock (USACE) operations as necessary.

The survey area will include the project footprint (which at this point may occur at any location along the property waterfront) and a buffer zone that should encompass any potential indirect impacts to mussels and snails from construction and use of the facility, such as altered flow patters, sedimentation, erosion and scouring, disturbance from tow propeller wash, disturbance of host fish activity of listed mussels, etc. The survey area is bounded upstream by an existing barge terminal and bounded riverward by the existing navigational channel. Therefore, the survey area boundaries will extend approximately 50m upstream of the property waterfront to 200m downstream of the property waterfront and extend 50m from the left bank. The total survey area will be approximately 475m long and 50m wide.

Mussels - The study area will be delineated for sampling using a series of eight 50m-long sampling transects (*i.e.*, lines weighted to the riverbed) extending perpendicular from the bank placed at generally the following locations: 50m upstream of the property waterfront (upstream boundary), at the upstream boundary of the property (= 0m mark), and 50m, 100m, 150m, 200m, 300m, and 400m downstream from the upstream boundary of the property. Sampling will generally occur in an upstream direction to minimize the reduction in visibility caused by sampling. GPS coordinates of transect endpoints and other reference features will be recorded so that an accurate map of mussel distribution and habitat can be generated for the report.

Each transect will be divided into 10m increments that will be considered separate samples (semi-quantitative). The diver will collect all unionid mussels (live and dead) within 1m of one side of the transect for each 10m increment (=10m^2 sample). Time spent within each

10m^2 sample should be timed; a target time of 5min/sample should be used, with appropriately less time in unsuitable habitat (*e.g.*, silt or hardpan clay) and more time in high-quality habitat (*e.g*., heterogeneous substrate with an abundance of mussels). The diver will use visual and tactual (groping the substrate by hand) search methods, placing all live and dead mussels into a mesh collection bag that will be retrieved and processed in the boat. A qualified malacologist will identify and count all live mussels; preferably, up to 20 individuals of each common species will be measured (length in mm) and aged (external annuli count). Length, height, age, and digital image (with size reference) will be recorded for any federally listed species. Zebra mussel infestation rates (*e.g*., % of shell covered) will be noted for live unionid mussels. Dead unionids (shells only) will be scored as either freshly dead (with or without soft tissues, nacre lustrous, valves typically intact, periostracum present; animal likely dead less than one year), weathered dead (no soft tissues, nacre very dull or chalky, valves may or may not be intact, periostracum worn; animal probably dead more than one year), or fragment (portion of a shell and/or extremely worn and chalky, valves not intact, little or no periostracum; animal dead from many years to many decades). Only freshly dead shells will be quantified to provide an estimate of annual mortality at the time of the study.

All live mussels will be held in mesh-collection bags suspended in the river in flowing water at all times outside of processing. During processing, mussels will be kept wet and cool, and out-of-water time will be minimized to not more than 1-5min. Live, non-listed unionids will be returned to the river from the water surface (boat) along each transect to the area they were collected. Any federally protected species will be returned as near to their point of origin as possible and placed into the substrate by hand (posterior end with siphons pointing upward and out of the substrate). Voucher specimens of previously dead shells for each non-listed species should be retained and donated to an appropriate public museum (*e.g.,* McClung Museum at University of Tennessee) and/or as directed on the scientific collecting permit of the on-site malacologist. Absolutely no live mussels or snails (listed or common species included) shall be translocated or held beyond the scope of this study unless specifically approved by the USFWS and TWRA.

Since the site is subject to strong flow conditions downstream of Nickajack dam, substrate may be compacted and mussels may be completely buried. Therefore, whole-substrate samples excavated (10-15cm deep) from a 0.25m^2 quadrat (0.5m x 0.5m) will be collected at the terminus of each 10m increment (= quantitative sampling). The diver will excavate ALL material (*e.g*., substrate, mussels, snails) from the quadrat by hand (or with assistance of a trowel) into a fine-mesh (≤3mm mesh size) bag or 19L (=5gal) bucket and transfered to the surface (boat) for processing. If high-flow conditions persist, a Hess sampler, Surber sampler, or similar device may be necessary to ensure small mussels and snails are retained in the sample. Mussels will be handled and processed as described above for semi-quantitative samples.

Snails - Snails collected in quantitative (quadrat) samples collected along transects will be visually assessed and processed by the malacologist to detect the presence of *A. anthonyi*. Divers (biologists) should also remain aware of *A. anthonyi* during semi-quantitative sampling of mussels and collect suspected individuals of this species as they are encountered. If no individuals of *A. anthonyi* are found during the collection of quantitative and semi-quantitative sampling, then the on-site malacologist will use professional judgment to determine if and how additional search efforts for *A. anthonyi* will be conducted.

Based on recommendations by Jeff Garner (ADGFF), the majority of any additional efforts should be spent at depths of 8 – 12 ft (= 2.5 – 3.5m), perhaps even a little deeper if necessary. Some shallow-water searches may be appropriate if rocky (*e.g.*, bedrock, boulder, and cobble size particles) substrate is present. If flow conditions create a high chance that snails will be swept downstream during sampling, appropriate sampling measures such as use of a Hess or Surber sampler should be used. If mesh collection bags are used, a fine mesh size (*i.e.*, ≤3mm mesh size) should be used to prevent the loss of small/young snails.

The location of additional samples will be mapped using GPS. Substrate, depth, and other important habitat features will also be recorded for each snail sample. A representative sample (if high numbers) or all individuals of *A. anthonyi* will be measured and returned to the substrate near their place of origin. No live specimens of *A. anthonyi* will be "taken" unless authorized and directed specifically by the USFWS. Mr. Garner also indicated that the corpulent hornsnail (*Pleurocera corpulenta*), a species of conservation interest (not federally listed) occurs near the study reach. He suggested the surveyors keep this species in mind, and to preserve a series of sizes of *P. corpulenta* in 95% ethanol for genetic analysis if possible; any take of this species should be coordinated with Mr. Garner and TWRA.

Habitat - Relative substrate composition (% total composition of each particle size using the Wentworth Scale, not just generalized descriptions) will be either visually estimated by the diver or sample processor for each quantitative sample. Depth will be measured using a pneumatic pressure gage attached to the diver or other suitable method at the site of each quantitative sample. Zebra mussel concentrations (% area coverage of quadrat) will be recorded at each quantitative sample (quadrat) location. If federally listed species are found during the study, water velocity and water chemistry (temperature, dissolved oxygen, pH, and clarity [turbidity or Secchi disk]) will be measured at appropriate locations in the study area to better assess habitat conditions; however, these habitat parameters may be measured at a later time should additional quantitative assessments of federal-listed species by required by the USFWS. Digital images of the site will be recorded.

Report - A full report will be prepared that includes: a description and map of the study area; a detailed description of the methods used; maps showing the GPS location of sampling transects and important features; results of the study describing unionid species composition and relative abundance by sample type; maps showing mussel and snail distribution by CPUE and/or density; location of federal-listed species; substrate and depth profiles along transects (preferably on maps); raw data and digital images in appendices, and the presentation of any other pertinent or summarized data helpful to clearly understand potential impacts of the proposed barge facility on mussels, snails, and their habitat. A copy of all electronic files (*e.g.*, database, GIS, report) will be provided on compact disc(s) upon completion of the report to: Chuck Howard, TVA Natural Heritage Program.

Revised Snail Survey Plan – CB&I Barge Terminal at TRM 424

Background and General Information - CB&I has plans for a barge terminal and ramp on the left bank of the Tennessee River downstream of Nickajack dam in Guntersville Reservoir near rivermile 424 (Marion County, TN). The plans show a property waterfront length of about 225 meters (m) or 730 feet (ft). Instream, direct impacts (project footprint) are expected to extend approximately 27m (90ft) off of the left bank. This reach of the

Tennessee River is near known populations of the federal endangered Anthony's riversnail (*Athearnia anthonyi*) and pink mucket pearlymussel (*Lampsilis abrupta*). A mussel survey of the area has already been conducted. The following survey plan recommendations are shaped by conversations with the natural resource agencies, but the final plan must be approved by USFWS, TWRA, and TVA after input by the selected consultant. If on-site modifications of the survey plan are necessary to ensure the safety of field personnel or adapt to particular site conditions, the consultant will notify all agencies of the changes as soon as possible to determine appropriate modifications. The approved consultant(s) must possess a valid scientific collector's permit from the USFWS and TWRA to handle Anthony's riversnail and provide a copy of the permit to TVA prior to conducting any field surveying.

Since the site occurs in an area normally subject to high water velocity conditions from the release of water through Nickajack Dam, special dam release operations must be coordinated with TVA to facilitate flow conditions that will allow for safe, effective sampling of snails. It is likely that TVA may only be able to restrict dam discharge for part of each working field day, and the applicant/consultants should plan accordingly The survey crew should maintain marine radio contact with navigational traffic, dam (TVA), and lock (USACE) operations as necessary.

Study Area - The survey area will include the project footprint (which may occur at any location along the property waterfront depending on survey results) and a buffer zone, which will encompass any potential indirect impacts to snails from construction and use of the facility such as altered flow patterns, sedimentation, erosion and scouring, and disturbance from tow propeller wash. The survey area is bordered upstream by an existing barge terminal (Nickajack Port) and bounded riverward by the existing navigational channel. Therefore, the survey area boundaries will extend approximately 50m upstream of the property waterfront to 200m downstream of the property waterfront and extend 50m from the left bank (= 475m long x 50m wide or 23,750m2). The study area will be delineated for sampling using a series of 15 50m-long sampling transects (*i.e.*, lines weighted to the riverbed) extending perpendicular from the bank. Transects will be placed at generally the following locations: 50m and 25m upstream of the waterfront property boundary (upstream boundary), at the upstream boundary of the property (= 0m mark), and 25m, 50m, 75m, 100m, 125m, 150m, 175m, 200m, 250m, 300m, 350m, and 400m downstream from the upstream boundary of the property. GPS coordinates of transect endpoints and other reference features will be recorded so that an accurate map of snail distribution and habitat can be generated for the report and management decisions.

Methods

Snails - Along each sampling transect, quantitative samples measuring 0.5m x 0.5m in area (quadrat) will be collected at 5m, 10m, 20m, 30m, 40m, and 50m from the bank. Within each quadrat, a diver with biological sampling experience or training will collect all live and dead snail specimens and place them in a fine mesh (*i.e.*, ≤3mm mesh size) collection bag that can be sealed and returned to the surface (boat) for processing by the on-site malacologist. If high-flow or low-visibility conditions persist or as directed by the onsite malacologist, a Hess sampler or Surber sampler may be necessary to ensure snails are retained in the sample. Depending on particle sizes of the riverbed substrate, it may be advantageous to collect substrate within the top few centimeters into the collection bag to facilitate thorough sampling of all snails, including those inhabiting crevices and interstitial spaces of the substrate surface. Additional quadrat samples may be collected if the onsite

malacologist deems the effort necessary to accurately characterize the presence, abundance, and distribution of federal-listed species.

All snails collected in quantitative (quadrat) samples will be visually assessed by the onsite malacologist to detect individuals of Anthony's riversnail and other federal-listed snail species. All individuals of federal-listed snail species will be identified, counted, and scored as live or dead. A representative sample of sizes for live federal-listed species will be measured (maximum width in millimeters; up to 10 individuals per species per sample). Non-listed snail species will be recorded as present, and total snail abundance for each sample will be recorded. During processing, snails will be kept wet and cool (avoiding extreme temperature changes), and out-of-water time will be minimized to not more than 1-5min. While in captivity, all snails will be held in mesh collection bags suspended in ambient, flowing river water. The onsite malacologist will ensure that all federal-listed snails are returned to the specific quadrat location from which they were collected by hand; non-listed snail species may be returned to the river from the water surface (boat) along each transect in the general area they were collected. Digital images of federal-listed snail species will be recorded, and voucher specimens of non-listed species should be retained and donated to an appropriate public museum and/or as directed by the scientific collecting permit of the on-site malacologist. Absolutely no live individuals of federal-listed snails will be harmed or taken from the site unless specifically authorized by the scientific collector's permit.

Habitat - Relative substrate composition (% total composition of each particle size using the Wentworth Scale - not just generalized descriptions) will be visually estimated by the either the diver or sample processor for each quantitative sample. Depth will be measured using a pneumatic pressure gage attached to the diver or other suitable method at the site of each quantitative sample. Zebra mussel concentrations (% area coverage of quadrat) will be recorded at each quantitative sample (quadrat) location. If federal listed species are found during the study, water velocity and water chemistry (temperature, dissolved oxygen, pH, and clarity [turbidity or Secchi disk]) will be measured at appropriate locations in the study area (*e.g.*, four corners of the study area) to better assess habitat conditions. Digital images of the site will be recorded.

Report - A full report will be prepared that includes: a description and map of the study area; a detailed description of the methods used; maps showing the GPS location of sampling transects and important features; results of the study describing snail species composition and trends in snail density; maps showing distribution of snail densities for Anthony's riversnail and all snail species combined; substrate and depth profiles along transects (preferably on maps); raw data and digital images in appendices, and the presentation of any other pertinent or summarized data helpful to clearly understand potential impacts of the proposed barge facility on snails and their habitat. A copy of all electronic files (*e.g.*, databases, GIS files, maps, and report) will be provided on compact disc(s) upon completion of the report to: Chuck Howard, TVA Natural Heritage Program.

Mussel Survey at Tennessee River Mile 423.6 – 423.9 Along the Left Descending Bank in Marion County, Tennessee

Prepared for:

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Mussel Survey at Tennessee River Mile 423.6 – 423.9 Along the Left Descending Bank in Marion County, Tennessee

ABSTRACT

Thompson Engineering, Inc. requested that a mussel survey be performed along the property located in Marion County, Tennessee between Tennessee River Mile (TRM) 423.6 – 423.9 along the left descending bank. The property is located downstream of Nickajack Dam and is the proposed site of the CB&I Nuclear Fabrication Facility barge loading dock. The mussel survey was conducted in order to assess the current mussel fauna in the area and to determine if the potential exists for federally or state listed endangered or threatened mussel species to be present in the area. Nine transects were surveyed within the property boundary, two transects were surveyed upstream of the area for the upstream buffer covering 50 meters, and four transects were surveyed downstream of the area for the downstream buffer covering 200 meters. During the survey, a total of 920 live mussels from 16 unionid species were encountered. The mussel species located at the site included, *Cyclonaias tuberculata, Ellipsaria lineolata, Elliptio crassidens, Lampsilis abrupta, Lampsilis ovata, Leptodea fragilis, Ligumia recta, Megalonaias nervosa, Obliquaria reflexa, Potamilus alatus, Quadrula metanevra, Quadrula pustulosa, Toxolasma parvus, Tritogonia verrucosa, Truncilla donaciformis,* and *Utterbackia imbecillis*. Weathered dead shells were also located for *Amblema plicata* and *Pleurobema cordatum*. Based on the transect survey data density estimates per 10 meter section ranged up to 3.80 mussels per square meter and averaged 1.64 mussels per square meter. CPUE (Catch per Unit Effort) ranged from 26.0 – 80.0 mussels per man hour during the transect survey and averaged 52.6 mussels per man hour. A total of 105 quarter square meter quadrats were excavated for the quantitative sampling. The mean densities per transect from the quantitative samples ranged from 1.1 – 10.9 mussels per square meter and the overall mean density for the entire survey area was 4.8 mussels per square meter. The area along the left descending bank of the Tennessee River between TRM 423.6 – 423.9 contains a healthy mussel community with at least 16 mussel species and densities ranging up to 20.0 per square meter. The fact that 16 species were found within the area represents that the area has a moderate species richness. A wide age range of mussels was found during the survey including multiple juveniles of several species (< 5 years). Of the subsample of individuals that were measured and aged during the survey, 117 individuals from nine species were less than five years old. The mussel concentration high density, evidence of recent recruitment, and limited numbers of zebra mussels, which are all factors indicating a healthy mussel concentration. Along with this, the federally endangered mussel species *Lampsilis abrupt*a was found.

INTRODUCTION

Thompson Engineering, Inc. requested that a mussel survey be performed along the property located in Marion County, Tennessee between Tennessee River Mile (TRM) 423.6 – 423.9 along the left descending bank (Figure 1). The property is located downstream of Nickajack Dam and is the proposed site of the CB&I Nuclear Fabrication Facility barge loading dock. The mussel survey was conducted in order to assess the current mussel fauna in the area and to determine if the potential exists for federally or state listed endangered or threatened mussel species to be present in the area.

METHODS

The mussel survey at TRM 423.6 – 423.9 extended through the entire property boundary, as well as upstream, downstream, and adjacent buffers (Figure 2). Nine transects were surveyed within the property boundary, two transects were surveyed upstream of the area for the upstream buffer covering 50 meters, and four transects were surveyed downstream of the area for the downstream buffer covering 200 meters (Figure 2). The 15 transects were spaced every 25 meters through the property and the upstream buffer area, and were spaced every 50 meters in the downstream buffer. The transects extended out 70 meters from the normal pool shoreline, which covered the adjacent buffer. The zero-meter mark of each transect line was set at the elevation of the normal pool shoreline.

Transects were set perpendicular to shore. Table 1 indicates the coordinates of the near shore end of each transect line along the left descending bank. Transect positions were located in the field using ArcPad GIS software with a Trimble GEOXT DGPS giving sub-meter position accuracy. Each transect was divided into 10 meter segments and the mussels from each section were recorded separately. Mussels were collected by commercial divers with considerable experience in mussel survey techniques and were certified to meet ADCI and OSHA requirements. The diver searched an area one meter wide along one side of each transect and all mussels located within the 10 meter segments were sent to the surface for identification.

At each 10-meter increment along the transect lines, a ¼ square meter quadrat was excavated by the diver. During quadrat sampling, the diver excavated all material within the

¼ square meter quadrat into a 20 L bucket. The material was excavated to a depth of 15 cm. The material was transported to the surface and processed on the work vessel. The material was sieved through a sieve series of ½ inch and ¼ inch mesh sizes. Mussels were collected from the screens during processing and were recorded separately for each sample. Substrate information and depth were recorded at each 10 meter increment. Depth readings were obtained from the diver's pneumofathometer (accuracy ± 6"). Substrate information was based on a visual description of the excavated material during processing.

Each mussel was identified to species and recorded on data sheets by LEC's malacologist. A subsample of mussels from each species were aged (ring count, yr) and measured (length, mm) to give an indication age structure in the mussel community (Appendix A). Mussels were returned to near the area from which they were collected. Federally endangered mussels were hand placed back to near their original location by the diver.

RESULTS AND DISCUSSION

The Tennessee River was surveyed for freshwater mussels between river miles 423.6 – 423.9 on September 9 - 12, 2008. The water temperature was 80° F at the time of the survey and the flow was minimal. Water elevation during the survey ranged from approximately 594 – 595 feet above mean sea level, which is near the normal pool level. Visibility was greater than a one meter during the mussel survey.

During the survey, a total of 920 live mussels from 16 unionid species were encountered (Table 2). The mussel species located at the site included, *Cyclonaias tuberculata, Ellipsaria lineolata, Elliptio crassidens, Lampsilis abrupta, Lampsilis ovata, Leptodea fragilis, Ligumia recta, Megalonaias nervosa, Obliquaria reflexa, Potamilus alatus, Quadrula metanevra, Quadrula pustulosa, Toxolasma parvus, Tritogonia verrucosa, Truncilla donaciformis,* and *Utterbackia imbecillis*. Weathered dead shells were also located for *Amblema plicata* and *Pleurobema cordatum*. No fresh dead shells were located for any mussel species during the survey. Table 2 lists the scientific and common names of the species found, the number of each species, and their percent composition. A total of four zebra mussels were located during the mussel survey. All of the zebra mussels were adults.

Potamilus alatus was the dominant species, representing 40.00% of the mussels in the area (Table 2). *Quadrula pustulosa* also comprised a significant portion of the mussel community, representing 21.96% (Table 2). Several other species occurred in significant numbers including *Megalonaias nervosa* (14.35%), *Obliquaria reflexa* (10.43%), *Elliptio crassidens* (7.72%), and *Ellipsaria lineolata* (2.07%) (Table 2). The other 10 species each comprised approximately 1% or less of the sampled individuals and five species were only found as single individuals (Table 2). Another species of notable significance was *Lampsilis abrupta*, which is listed as federally endangered by the USFWS (Photo 1).

During the survey of the transect lines a total of 795 live mussels from 13 unionid species were encountered (Table 3). Mussels were able to be consistently located throughout the entire survey area with the exception of three ten meter sections between 0 - 10 meters (Table 4). The mussel concentration generally began approximately five meters from the shoreline and extended out to at least 70 meters from the shoreline where the survey lines ended (Table 4). The 0 – 10 meter sections contained the least amount of mussels along the transects accounting for only 7.8% of the mussels collected (Table 4). A total of six species were located between 0 -10 meters including the individual of *Lampsilis abrupta* along transect TE-03b (Table 5). The individual of the federally endangered *Lampsilis abrupta*, was located approximately five meters from the normal pool shoreline in approximately five feet of water at normal pool elevation. The substrate consisted of 100% fine sand. Physical data for the *Lampsilis abrupta* is as follows: Sex: Male, Length = 113 mm, Height = 91 mm, Width = 53 mm, Weight = 422 g, Age = 13 years (Photo 1). The highest numbers of mussels were located between 10 - 20 meters, which accounted for 25.4% of the mussels collected (Table 4). The number of mussels collected per ten meter section remained fairly consistent from 20 – 70 meters (Table 4). The number of species collected varied from 8 – 10 per ten meter section collectively along the transects (Table 5).

The number of species collected per transect line ranged from 3 – 9 (Table 6). The number of individuals collected per transect line ranged from 26 – 88 (Table 6). During the transect survey the density estimates were based on surface searches for adult mussels with some excavation of substrate by the divers. The overall density estimates ranged from 0.37 – 1.26 mussels per square meter and averaged 0.76 mussels per square meter (Table 6). The maximum density estimates per 10 meter section ranged from 0.37 – 3.80 mussels per

square meter and averaged 1.64 mussels per square meter (Table 6). CPUE (Catch per Unit Effort) ranged from 26.0 – 80.0 mussels per man hour during the transect survey and averaged 52.6 mussels per man hour (Table 6).

The substrate was variable between the transect lines (Table 7). In the area from normal pool shoreline out to 10 meters, the substrate was primarily 100% fine sand with water depth ranging from 0 to 7 feet (Table 7). In the area out past 10 meters from normal pool shoreline, the water became deeper along most of the transect lines and the substrate remained primarily sand with a small percentage of gravel in some areas (Table 7). Typically by the time the diver reached the 20 meter mark on the transects the substrate changed to a mix of sand, gravel, and cobble (Table 7). The substrate varied as to the percentages of sand, gravel, and cobble throughout the survey area (Table 7). The divers noted that the mussels were typically buried several inches below the substrate in most areas. There were also several areas where the diver reported that the bottom was bedrock. A subsample of the rock was extracted and it appeared to be conglomerate rock (Table 7). The conglomerate rock was exposed in six areas that were reported by the diver (Table 7).

A total of 105 quarter square meter quadrats were excavated for the quantitative sampling, which included one sample at each ten meter section. A total of 125 live mussels from 11 unionid species were located during quantitative sampling (Table 8). The number of mussels per ¼ m^2 quadrat sample ranged from 0 – 5 individuals (Table 9). A total of 1.75 m^2 were quantitatively sampled along each transect line (7 samples per line) and the total mussels per set of samples ranged from 2 – 19 individuals (Table 9). The mean densities from the quantitative samples ranged from 1.1 – 10.9 mussels per square meter between the transect lines (Table 9). The overall mean density for the entire survey area was 4.8 mussels per square meter (Table 9). The maximum density per transect line ranged from 4.0 – 20.0 mussels per square meter based on the quantitative samples (Table 9).

CONCLUSIONS

The area along the left descending bank of the Tennessee River between TRM 423.6 – 423.9 contains a healthy mussel community with at least 16 mussel species and densities ranging up to 20.0 per square meter. The fact that 16 species were found within the area

represents that the area has a moderate species richness. A wide age range of mussels was found during the survey including multiple juveniles of several species (< 5 years). Of the subsample of individuals that were measured and aged during the survey, 117 individuals from nine species were less than five years old (Appendix A). The mussel concentration high density, evidence of recent recruitment, and limited numbers of zebra mussels, which are all factors indicating a healthy mussel concentration. Along with this, the federally endangered mussel species *Lampsilis abrupta* was found.

ACKNOWLEDGMENTS

I would like to thank the divers from DAS Dive Boat, Inc. for conducting a professional survey.

Disclaimer:

Depth measurements are approximate and sediment types are subjective and are neither intended nor provided for engineering purposes. They are intended only to provide a description of mussel habitat.

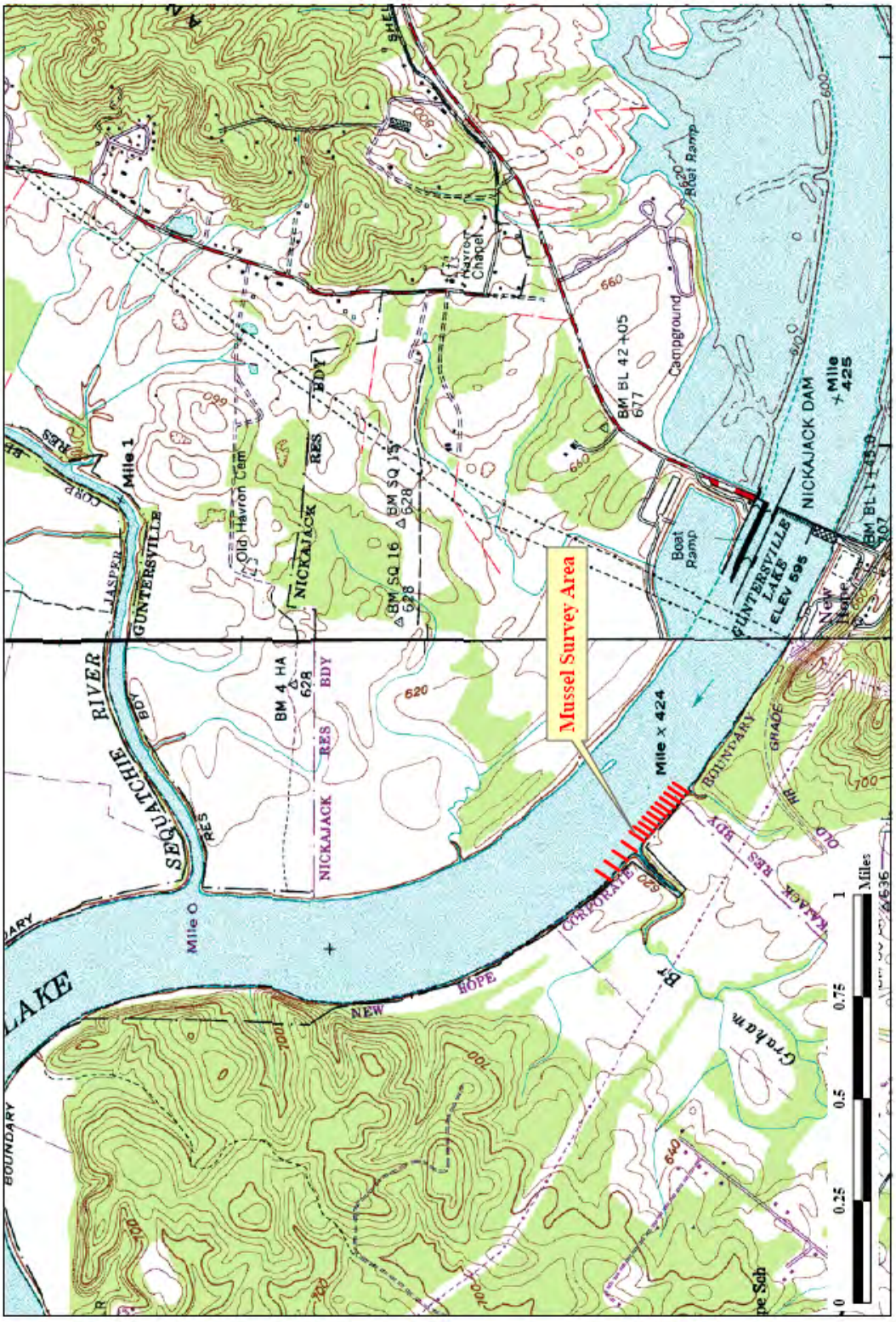

Figure 1. Mussel survey area at Tennessee River Mile 423.6 - 423.9 along the left descending bank in Marion County, Tennessee.

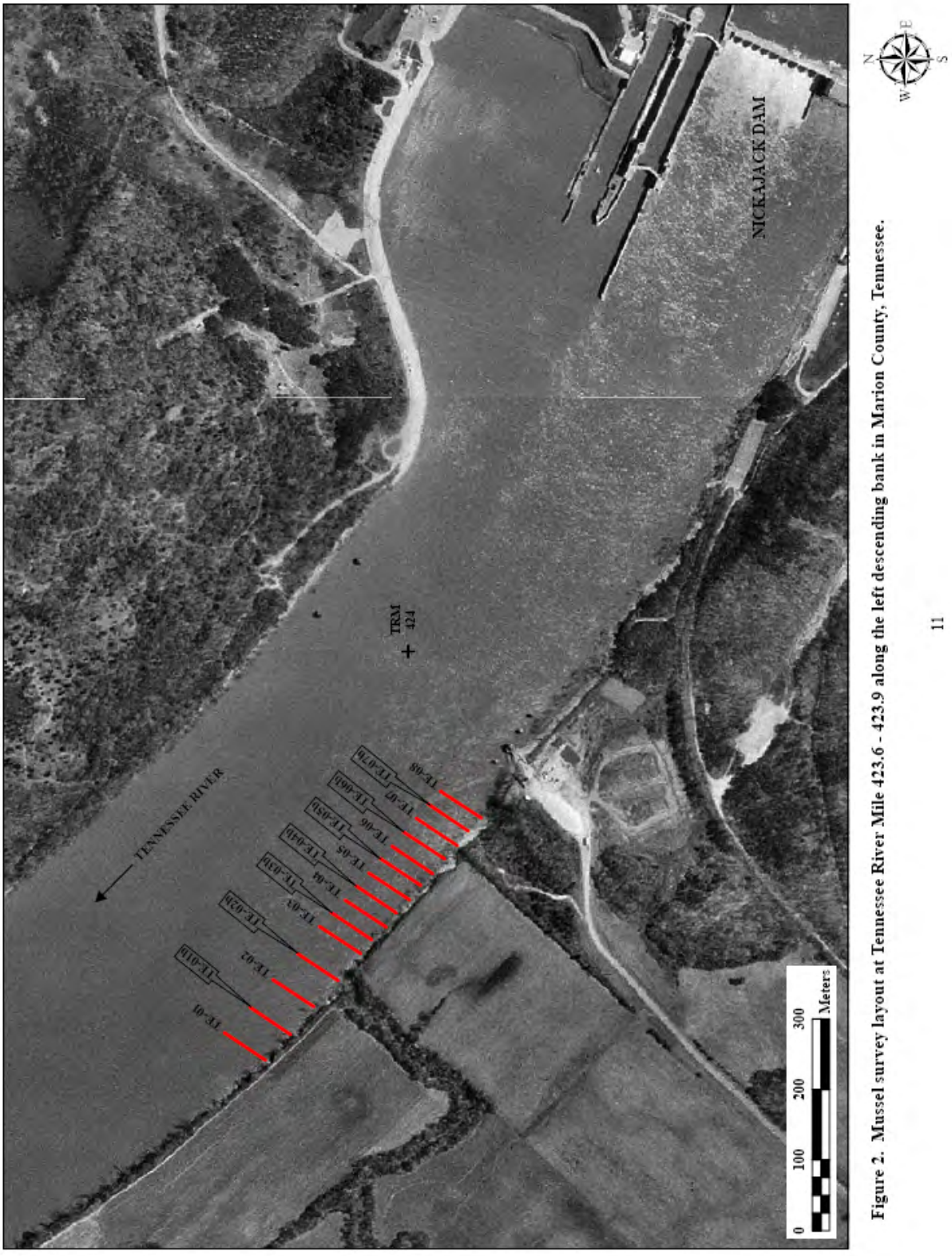

Figure 2. Mussel survey layout at Tennessee River Mile 423.6 - 423.9 along the left descending bank in Marion County, Tennessee.

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Table 1. Site coordinates for the shoreline end of the transect lines along the left descending bank at Tennessee River Mile 423.6 - 423.9. Coordinates are provided in Tennessee State Plane (Feet) NAD83 and Geographic (Degrees-Decimal Minutes) NAD83 or WGS84.

	TN State Plane (Feet)		Geographic	
Transect	Easting	Northing	Latitude	Longitude
TE-01	2077719	246616	35 00.6157304	85 38.1181576
TE-01b	2077839	246498	35 00.5962061	85 38.0942042
TE-02	2077968	246390	35 00.5783244	85 38.0684404
TE-02b	2078094	246273	35 00.5589611	85 38.0432846
TE-03	2078217	246173	35 00.5424017	85 38.0187173
TE-03b	2078283	246119	35 00.5334598	85 38.0055351
TE-04	2078342	246053	35 00.5225442	85 37.9937644
TE-04b	2078404	246005	35 00.5145938	85 37.9813793
TE-05	2078464	245944	35 00.5045018	85 37.9694046
TE-05b	2078532	245892	35 00.4958883	85 37.9558204
TE-06	2078587	245836	35 00.4866234	85 37.9448438
TE-06b	2078656	245780	35 00.4773499	85 37.9310624
TE-07	2078718	245722	35 00.4677510	85 37.9186850
TE-07b	2078785	245670	35 00.4591380	85 37.9053014
TE-08	2078845	245610	35 00.4492107	85 37.8933263

Table 2. Number of mussels collected and species percent abundance at Tennessee River Mile 423.6 - 423.9 along the left descending bank.

Scientific Name	Common Name	Total	% Abundance
Potamilus alatus (Say, 1817)	Pink Heelsplitter	368	40.00%
Quadrula pustulosa (Lea, 1831)	Pimpleback	202	21.96%
Megalonaias nervosa (Rafinesque, 1820)	Washboard	132	14.35%
Obliquaria reflexa Rafinesque, 1820	Threehorn Wartyback	96	10.43%
Elliptio crassidens (Lamarck, 1819)	Elephant-ear	71	7.72%
Ellipsaria lineolata (Rafinesque, 1829)	Butterfly	19	2.07%
Utterbackia imbecillis (Say, 1829)	Paper Pondshell	9	0.98%
Cyclonaias tuberculata (Rafinesque, 1820)	Purple Wartyback	6	0.65%
Lampsilis ovata (Say, 1817)	Pocketbook	6	0.65%
Tritogonia verrucosa (Rafinesque, 1820)	Pistolgrip	4	0.43%
Ligumia recta (Lamarck, 1819)	Black Sandshell	2	0.22%
Truncilla donaciformis (Lea, 1828)	Fawnsfoot	1	0.11%
Lampsilis abrupta* (Say, 1831)	**Pink Mucket**	1	0.11%
Leptodea fragilis (Rafinesque, 1820)	Fragile Papershell	1	0.11%
Toxolasma parvus (Barnes, 1823)	Lilliput	1	0.11%
Quadrula metanevra (Rafinesque, 1820)	Monkeyface	1	0.11%
	TOTAL	**920**	**100.00%**

*** Federally Endangered Species**

Table 3. Number of mussels collected and species percent abundance from the transects at Tennessee River Mile 423.6 - 423.9 along the left descending bank.

Scientific Name	Common Name	Total	% Abundance
Potamilus alatus (Say, 1817)	Pink Heelsplitter	357	44.91%
Quadrula pustulosa (Lea, 1831)	Pimpleback	147	18.49%
Megalonaias nervosa (Rafinesque, 1820)	Washboard	127	15.97%
Elliptio crassidens (Lamarck, 1819)	Elephant-ear	70	8.81%
Obliquaria reflexa Rafinesque, 1820	Threehorn Wartyback	64	8.05%
Ellipsaria lineolata (Rafinesque, 1829)	Butterfly	11	1.38%
Lampsilis ovata (Say, 1817)	Pocketbook	6	0.75%
Cyclonaias tuberculata (Rafinesque, 1820)	Purple Wartyback	5	0.63%
Tritogonia verrucosa (Rafinesque, 1820)	Pistolgrip	3	0.38%
Ligumia recta (Lamarck, 1819)	Black Sandshell	2	0.25%
Lampsilis abrupta* (Say, 1831)	**Pink Mucket**	1	0.13%
Leptodea fragilis (Rafinesque, 1820)	Fragile Papershell	1	0.13%
Quadrula metanevra (Rafinesque, 1820)	Monkeyface	1	0.13%
	TOTAL	**795**	**100.00%**

*** Federally Endangered Species**

Table 4. Distribution of mussels along each 10 meter segment of the transect lines at Tennessee River Mile 423.6 - 423.9 L.

	TE-01	TE-01b	TE-02	TE-02b	TE-03	TE-03b	TE-04	TE-04b
0m - 10m	6	1	7	4	3	16		5
10m - 20m	18	38	11	6	15	14	17	10
20m - 30m	10	14	6	9	3	6	5	12
30m - 40m	4	11	10	4	7	3	8	8
40m - 50m	8	4	1	3	6	5	12	3
50m - 60m	1	6	2	5	1	10	3	17
60m - 70m	4	6	8	3	8	8	6	7
Total	51	80	45	34	43	62	51	62

	TE-05	TE-05b	TE-06	TE-06b	TE-07	TE-07b	TE-08	Total	% of Mussels Collected
0m - 10m		7	2	2	6	3		62	7.8%
10m - 20m	15	10	11	7	15	12	3	202	25.4%
20m - 30m	10	6	10	4	15	7	8	125	15.7%
30m - 40m	8	9	7	5	8	2	1	95	11.9%
40m - 50m	4	19	16	5	12	2	1	101	12.7%
50m - 60m	10	2	13	3	5	5	8	91	11.4%
60m - 70m	9	4	29	6	8	8	5	119	15.0%
Total	56	57	88	32	69	39	26	795	100.0%

Table 5. Distribution of mussel species along each 10 meter segment of the transect lines at Tennessee River Mile 423.6 - 423.9 L.

	0m - 10m	10m - 20m	20m - 30m	30m - 40m	40m - 50m	50m - 60m	60m - 70m
Cyclonaias tuberculata				1		3	1
Ellipsaria lineolata		4	2		2	1	2
Elliptio crassidens		9	11	13	14	8	15
Lampsilis abrupta	1						
Lampsilis ovata			2		2	1	1
Leptodea fragilis					1		
Ligumia recta				1			1
Megalonaias nervosa	1	44	27	8	19	11	17
Obliquaria reflexa	3	13	2	5	6	13	22
Potamilus alatus	41	83	68	49	41	35	40
Quadrula metanevra		1					
Quadrula pustulosa	15	33	11	15	11	18	18
Quadrula pustulosa	1	15	2	2	4		2
Tritogonia verrucosa				1	1	1	
Total	62	202	125	95	101	91	119
# Species Collected	6	8	8	9	10	9	10

Table 6. Number of mussels of each species collected alive along the transects at Tennessee River Mile 423.6 - 423.9 L.

Scientific Name	TE-01	TE-01b	TE-02	TE-02b	TE-03	TE-03b	TE-04	TE-04b	TE-05	TE-05b	TE-06	TE-06b	TE-07	TE-07b	TE-08
Cyclonaias tuberculata		2						1		2					
Ellipsaria lineolata		1				2		2			1		4	1	
Elliptio crassidens	2	5		2	3	4	6	5	6	8	10	2	10	4	3
Lampsilis abrupta						1									
Lampsilis ovata	2			1							1		2		
Leptodea fragilis											1				
Ligumia recta													2		
Megalonaias nervosa	20	26	12	2	13	4	3	11	5	4	14	5	3	2	3
Obliquaria reflexa	2	3		1	4	5	7	7	7	5	10	2	2	6	3
Potamilus alatus	17	24	27	28	19	29	25	24	30	17	25	17	36	23	16
Quadrula metanevra							1								
Quadrula pustulosa	8	19	6		4	17	9	12	8	20	26	5	9	3	1
Tritogonia verrucosa										1		1	1		
Number of mussels collected	**51**	**80**	**45**	**34**	**43**	**62**	**51**	**62**	**56**	**57**	**88**	**32**	**69**	**39**	**26**
Number of species collected	**6**	**7**	**3**	**5**	**5**	**7**	**7**	**7**	**5**	**7**	**8**	**6**	**9**	**6**	**5**
Estimated Area Sampled	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**	**70 m²**
Est. Density Per Transect Line (#/m²)*	**0.73**	**1.14**	**0.64**	**0.49**	**0.61**	**0.89**	**0.73**	**0.89**	**0.80**	**0.81**	**1.26**	**0.46**	**0.99**	**0.56**	**0.37**
Max. Est. Density per 10 meter (#/m²)*	**1.80**	**3.80**	**1.10**	**0.90**	**1.50**	**1.60**	**1.70**	**1.70**	**1.50**	**1.90**	**2.90**	**0.70**	**1.50**	**1.20**	**0.80**
Collecting Time (Minutes)	**65**	**60**	**51**	**40**	**40**	**73**	**83**	**60**	**70**	**56**	**86**	**48**	**70**	**48**	**60**
CPUE (#/man hour)	**47.1**	**80.0**	**52.9**	**51.0**	**64.5**	**51.0**	**36.9**	**62.0**	**48.0**	**61.1**	**61.4**	**40.0**	**59.1**	**48.8**	**26.0**

***Density estimates are based on general surface searches conducted during the transect survey.**

Table 7. Tennessee River Mile 423.6 - 423.9 Transects - Approximate bottom elevation, water depth at normal pool elevation (595'), and type of sediment recorded at each 10-meter interval along the transects. (Elevations and Depths are only approximate and should not be used for engineering or navigational purposes. Depth and substrate are only intended to describe mussel habitat.)

	TE-01		
Transect Mark	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	591	4	100% fine sand
20 m	587	8	80% sand, 10% gravel, 10% cobble
30 m	586	9	80% sand, 10% gravel, 10% cobble
40 m	586	9	100% conglomerate rock
50 m	583	12	30% sand, 30% gravel, 40% cobble
60 m	579	16	30% sand, 30% gravel, 40% cobble
70 m	578	17	20% sand, 40% gravel, 40% cobble

	TE-01b		
Transect Mark	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	80% sand, 10% gravel, 10% cobble
30 m	586	9	80% sand, 10% gravel, 10% cobble
40 m	585	10	100% conglomerate rock
50 m	585	10	30% sand, 30% gravel, 40% cobble
60 m	585	10	30% sand, 30% gravel, 40% cobble
70 m	580	15	20% sand, 40% gravel, 40% cobble

	TE-02		
Transect Mark	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	588	7	100% fine sand
20 m	587	8	100% fine sand
30 m	586	9	80% sand, 10% gravel, 10% cobble
40 m	586	9	80% sand, 10% gravel, 10% cobble
50 m	587	8	40% sand, 30% gravel, 30% cobble
60 m	585	10	20% sand, 40% gravel, 40% cobble
70 m	580	15	10% sand, 80% gravel, 10% cobble

	TE-02b		
Transect Mark	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	590	5	100% fine sand
30 m	588	7	100% fine sand
40 m	585	10	100% fine sand
50 m	583	12	40% sand, 50% gravel, 10% cobble
60 m	585	10	30% sand, 50% gravel, 20% cobble
70 m	585	10	100% conglomerate rock

	TE-03		
Transect Mark	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	589	6	100% fine sand
20 m	586	9	80% sand, 20% gravel
30 m	585	10	80% sand, 10% gravel, 10% cobble
40 m	584	11	40% sand, 20% gravel, 40% cobble
50 m	583	12	100% large cobble
60 m	579	16	10% sand, 50% gravel, 40% cobble
70 m	578	17	100% conglomerate rock

Table 7. Cont'd.

Transect Mark	TE-03b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	589	6	70% sand, 20% gravel, 10% cobble
20 m	588	7	50% sand, 30% gravel, 20% cobble
30 m	585	10	50% sand, 30% gravel, 20% cobble
40 m	582	13	30% sand, 50% gravel, 20% cobble
50 m	578	17	10% sand, 70% gravel, 20% cobble
60 m	577	18	20% sand, 60% gravel, 20% cobble
70 m	577	18	10% sand, 70% gravel, 20% cobble

Transect Mark	TE-04		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	95% sand, 5% gravel
30 m	587	8	10% sand, 50% gravel, 40% cobble
40 m	586	9	30% sand, 40% gravel, 30% cobble
50 m	582	13	50% sand, 25% gravel, 25% cobble
60 m	579	16	50% sand, 40% gravel, 10% cobble
70 m	577	18	10% sand, 80% gravel, 10% cobble

Transect Mark	TE-04b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	587	8	90% sand, 5% gravel, 5% cobble
30 m	585	10	20% sand, 60% gravel, 20% cobble
40 m	583	12	10% sand, 50% gravel, 40% cobble
50 m	579	16	10% sand, 50% gravel, 40% cobble
60 m	577	18	10% sand, 60% gravel, 30% cobble
70 m	575	20	10% sand, 60% gravel, 30% cobble

Transect Mark	TE-05		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	590	5	90% sand, 5% gravel, 5% cobble
30 m	588	7	10% sand, 40% gravel, 50% cobble
40 m	584	11	20% sand, 30% gravel, 50% cobble
50 m	580	15	50% sand, 40% gravel, 10% cobble
60 m	579	16	20% sand, 40% gravel, 40% cobble
70 m	575	20	20% sand, 40% gravel, 40% cobble

Transect Mark	TE-05b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	50% sand, 25% gravel, 25% cobble
30 m	586	9	10% sand, 30% gravel, 60% cobble
40 m	580	15	50% sand, 25% gravel, 25% cobble
50 m	578	17	50% sand, 25% gravel, 25% cobble
60 m	578	17	100% conglomerate rock
70 m	575	20	10% sand, 40% gravel, 50% cobble

Table 7. Cont'd.

Transect Mark	TE-06		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	591	4	100% fine sand
20 m	588	7	100% fine sand
30 m	588	7	50% sand, 50% gravel
40 m	582	13	50% sand, 50% gravel
50 m	580	15	20% sand, 50% gravel, 30% cobble
60 m	579	16	10% sand, 80% gravel, 10% cobble
70 m	575	20	10% sand, 90% gravel

Transect Mark	TE-06b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	95% sand, 5% gravel
20 m	588	7	100% fine sand
30 m	585	10	40% sand, 50% gravel, 10% cobble
40 m	579	16	40% sand, 50% gravel, 10% cobble
50 m	576	19	10% sand, 70% gravel, 20% cobble
60 m	575	20	10% sand, 70% gravel, 20% cobble
70 m	574	21	10% sand, 50% gravel, 40% cobble

Transect Mark	TE-07		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	591	4	100% fine sand
20 m	587	8	60% sand, 30% gravel, 10% cobble
30 m	585	10	80% sand, 10% gravel, 10% cobble
40 m	581	14	50% sand, 40% gravel, 10% cobble
50 m	576	19	60% sand, 30% gravel, 10% cobble
60 m	574	21	10% sand, 80% gravel, 10% cobble
70 m	572	23	10% sand, 80% gravel, 10% cobble

Transect Mark	TE-07b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	80% sand, 10% gravel, 10% cobble
30 m	587	8	50% sand, 25% gravel, 25% cobble
40 m	585	10	20% sand, 50% gravel, 30% cobble
50 m	584	11	100% conglomerate rock
60 m	577	18	10% sand, 50% gravel, 40% cobble
70 m	574	21	10% sand, 80% gravel, 10% cobble

Transect Mark	TE-08		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	90% sand, 10% gravel
20 m	587	8	50% sand, 25% gravel, 25% cobble
30 m	585	10	20% sand, 30% gravel, 50% cobble
40 m	582	13	20% sand, 30% gravel, 50% cobble
50 m	578	17	10% sand, 50% gravel, 40% cobble
60 m	575	20	10% sand, 70% gravel, 20% cobble
70 m	573	22	10% sand, 70% gravel, 20% cobble

Table 8. Number of mussels collected and species percent abundance in the 1/4 m^2 quadrats at Tennessee River Mile 423.6 - 423.9 along the left descending bank.

Scientific Name	Common Name	Total	% Abundance
Quadrula pustulosa (Lea, 1831)	Pimpleback	55	44.00%
Obliquaria reflexa Rafinesque, 1820	Threehorn Wartyback	32	25.60%
Potamilus alatus (Say, 1817)	Pink Heelsplitter	11	8.80%
Utterbackia imbecillis (Say, 1829)	Paper Pondshell	9	7.20%
Ellipsaria lineolata (Rafinesque, 1829)	Butterfly	8	6.40%
Megalonaias nervosa (Rafinesque, 1820)	Washboard	5	4.00%
Elliptio crassidens (Lamarck, 1819)	Elephant-ear	1	0.80%
Cyclonaias tuberculata (Rafinesque, 1820)	Purple Wartyback	1	0.80%
Tritogonia verrucosa (Rafinesque, 1820)	Pistolgrip	1	0.80%
Truncilla donaciformis (Lea, 1828)	Fawnsfoot	1	0.80%
Toxolasma parvus (Barnes, 1823)	Lilliput	1	0.80%
	TOTAL	**125**	**100.00%**

Table 9. Number of mussels of each species collected alive within 0.25 m^2 quadrats at Tennessee River Mile 423.6 - 423.9 L.

Distance from Shore	TE-01	TE-01b	TE-02	TE-02b	TE-03	TE-03b	TE-04	TE-04b
10m			2	2		1		2
20m	3	2			1	1	1	
30m	2	4	3				3	1
40m		1	1			1	2	
50m	2							1
60m	1			1			1	2
70m		1		3	1	3	2	1
Number of mussels collected	8	8	6	6	2	6	9	7
Area Sampled	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2
Mean Density (#/m^2)*	4.6	4.6	3.4	3.4	1.1	3.4	5.1	4.0
Maximum Density (#/m^2)*	12.0	16.0	12.0	12.0	4.0	12.0	12.0	8.0

*Density estimates are based on excavated 0.25 m^2 quadrats.

Distance from Shore	TE-05	TE-05b	TE-06	TE-06b	TE-07	TE-07b	TE-08	Total	Mean Density vs. Distance from shore
10m		1	1	2		1		12	3.2
20m	2	1	1	4	1	4		21	5.6
30m			1	2	5	2	1	24	6.4
40m	1	1	1	3		1		12	3.2
50m	4	2	3	3	3		2	20	5.3
60m	5		2	1		1	3	17	4.5
70m	1		2	4			1	19	5.1
Number of mussels collected	13	5	11	19	9	9	7	Total Mussels = 125	
Area Sampled	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	1.75 m^2	Total Area Sampled = 26.25 m^2	
Mean Density (#/m^2)*	7.4	2.9	6.3	10.9	5.1	5.1	4.0	Overall Mean Density = 4.8 / m^2	
Maximum Density (#/m^2)*	20.0	8.0	12.0	16.0	20.0	16.0	12.0	Overall Max Density = 20.0 / m^2	

*Density estimates are based on excavated 0.25 m^2 quadrats.

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Photo 1. Federally endangered *Lampsilis abrupta* from transect TE-03b at Tennessee River Mile 423.6 – 423.9 along the left descending bank.

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Appendix A. Sub-sample of length and age data collected at TRM 423.6 - 423.9 L.

Transect	Sample ID	Species	Length (mm)	Age (yr)
TE-01	0-10	*Potamilus alatus*	140	10
TE-01	0-10	*Potamilus alatus*	135	10
TE-01	0-10	*Potamilus alatus*	150	12
TE-01	0-10	*Potamilus alatus*	132	10
TE-01	0-10	*Potamilus alatus*	135	10
TE-01	0-10	*Quadrula pustulosa*	70	11
TE-01	10-20	*Elliptio crassidens*	90	8
TE-01	10-20	*Elliptio crassidens*	110	11
TE-01	10-20	*Megalonaias nervosa*	155	18
TE-01	10-20	*Megalonaias nervosa*	160	20
TE-01	10-20	*Megalonaias nervosa*	140	23
TE-01	10-20	*Megalonaias nervosa*	150	20
TE-01	10-20	*Megalonaias nervosa*	150	20
TE-01	10-20	*Megalonaias nervosa*	135	16
TE-01	10-20	*Obliquaria reflexa*	47	7
TE-01	10-20	*Obliquaria reflexa*	50	8
TE-01	10-20	*Potamilus alatus*	120	9
TE-01	10-20	*Potamilus alatus*	132	10
TE-01	10-20	*Potamilus alatus*	152	13
TE-01	10-20	*Potamilus alatus*	145	12
TE-01	10-20	*Potamilus alatus*	145	12
TE-01	10-20	*Quadrula pustulosa*	60	14
TE-01	10-20	*Quadrula pustulosa*	58	13
TE-01	10-20	*Quadrula pustulosa*	45	5
TE-01	20-30	*Lampsilis ovata*	140	16
TE-01	20-30	*Megalonaias nervosa*	155	17
TE-01	20-30	*Megalonaias nervosa*	165	18
TE-01	20-30	*Megalonaias nervosa*	185	22
TE-01	20-30	*Megalonaias nervosa*	165	20
TE-01	20-30	*Megalonaias nervosa*	175	20
TE-01	20-30	*Megalonaias nervosa*	135	17
TE-01	20-30	*Megalonaias nervosa*	150	18
TE-01	20-30	*Potamilus alatus*	120	9
TE-01	20-30	*Quadrula pustulosa*	57	13
TE-01	30-40	*Megalonaias nervosa*	155	19
TE-01	30-40	*Potamilus alatus*	135	14
TE-01	30-40	*Potamilus alatus*	110	10
TE-01	40-50	*Megalonaias nervosa*	150	20
TE-01	40-50	*Megalonaias nervosa*	165	24
TE-01	40-50	*Megalonaias nervosa*	172	24
TE-01	40-50	*Potamilus alatus*	140	15
TE-01	40-50	*Potamilus alatus*	155	16
TE-01	40-50	*Quadrula pustulosa*	42	6
TE-01	40-50	*Quadrula pustulosa*	73	12
TE-01	40-50	*Quadrula pustulosa*	78	14
TE-01	50-60	*Potamilus alatus*	120	10
TE-01	60-70	*Lampsilis ovata*	110	9
TE-01	60-70	*Megalonaias nervosa*	155	20
TE-01	60-70	*Megalonaias nervosa*	170	21
TE-01	60-70	*Potamilus alatus*	145	16
TE-01	60m	*Quadrula pustulosa*	45	6

Appendix A. Sub-sample of length and age data collected at TRM 423.6 - 423.9 L.

Transect	Sample ID	Species	Length (mm)	Age (yr)
TE-01	20m	*Quadrula pustulosa*	45	5
TE-01	20m	*Quadrula pustulosa*	42	5
TE-01	20m	*Quadrula pustulosa*	38	4
TE-01	30m	*Quadrula pustulosa*	46	6
TE-01	30m	*Quadrula pustulosa*	28	3
TE-01	50m	*Obliquaria reflexa*	40	4
TE-01	50m	*Quadrula pustulosa*	63	11
TE-01b	50-60	*Cyclonaias tuberculata*	62	7
TE-02	0-10	*Potamilus alatus*	138	14
TE-02	0-10	*Potamilus alatus*	130	14
TE-02	0-10	*Potamilus alatus*	140	15
TE-02	0-10	*Potamilus alatus*	152	16
TE-02	0-10	*Potamilus alatus*	140	14
TE-02	0-10	*Potamilus alatus*	140	15
TE-02	0-10	*Potamilus alatus*	132	14
TE-02	10-20	*Quadrula pustulosa*	55	9
TE-02	10-20	*Quadrula pustulosa*	60	10
TE-02	10-20	*Quadrula pustulosa*	55	9
TE-02	20-30	*Quadrula pustulosa*	45	6
TE-02	10m	*Potamilus alatus*	150	15
TE-02	10m	*Quadrula pustulosa*	40	5
TE-02	30m	*Obliquaria reflexa*	42	6
TE-02	30m	*Quadrula pustulosa*	65	15
TE-02	30m	*Utterbackia imbecillis*	21	2
TE-02	40m	*Potamilus alatus*	88	5
TE-02b	40-50	*Lampsilis ovata*	130	14
TE-02b	60m	*Toxolasma parvus*	20	3
TE-03	30-40	*Elliptio crassidens*	83	11
TE-03	30-40	*Obliquaria reflexa*	48	7
TE-03	30-40	*Obliquaria reflexa*	40	5
TE-03	40-50	*Obliquaria reflexa*	45	6
TE-03	60-70	*Elliptio crassidens*	135	15
TE-03	60-70	*Elliptio crassidens*	100	7
TE-03	60-70	*Obliquaria reflexa*	45	6
TE-03	30m	*Quadrula pustulosa*	45	5
TE-03	60m	*Quadrula pustulosa*	40	6
TE-03b	0-10	*Lampsilis abrupta*	113	13
TE-03b	10-20	*Ellipsaria lineolata*	71	8
TE-03b	10-20	*Ellipsaria lineolata*	85	12
TE-03b	10m	*Quadrula pustulosa*	45	7
TE-03b	20m	*Potamilus alatus*	145	14
TE-03b	40m	*Obliquaria reflexa*	45	6
TE-04	10-20	*Elliptio crassidens*	110	13
TE-04	10-20	*Obliquaria reflexa*	48	7
TE-04	10-20	*Quadrula metanevra*	95	14
TE-04	20-30	*Elliptio crassidens*	88	7
TE-04	20-30	*Elliptio crassidens*	115	14
TE-04	30-40	*Elliptio crassidens*	112	14
TE-04	40-50	*Elliptio crassidens*	95	12
TE-04	40-50	*Elliptio crassidens*	120	14
TE-04	40-50	*Obliquaria reflexa*	50	9

Appendix A. Sub-sample of length and age data collected at TRM 423.6 - 423.9 L.

Transect	Sample ID	Species	Length (mm)	Age (yr)
TE-04	60-70	*Obliquaria reflexa*	45	5
TE-04	60-70	*Obliquaria reflexa*	48	6
TE-04	60-70	*Obliquaria reflexa*	48	5
TE-04	60-70	*Obliquaria reflexa*	38	4
TE-04	60-70	*Obliquaria reflexa*	40	4
TE-04	20m	*Quadrula pustulosa*	35	5
TE-04	30m	*Potamilus alatus*	130	12
TE-04	30m	*Potamilus alatus*	115	10
TE-04	30m	*Utterbackia imbecillis*	28	3
TE-04	40m	*Ellipsaria lineolata*	75	7
TE-04	40m	*Quadrula pustulosa*	28	3
TE-04	60m	*Elliptio crassidens*	90	8
TE-04	70m	*Quadrula pustulosa*	55	8
TE-04	70m	*Tritogonia verrucosa*	72	6
TE-04b	40-50	*Ellipsaria lineolata*	90	12
TE-04b	40-50	*Ellipsaria lineolata*	65	6
TE-04b	50-60	*Cyclonaias tuberculata*	76	11
TE-05	10-20	*Megalonaias nervosa*	90	8
TE-05	10-20	*Obliquaria reflexa*	42	6
TE-05	20-30	*Elliptio crassidens*	120	14
TE-05	20-30	*Elliptio crassidens*	130	16
TE-05	20m	*Quadrula pustulosa*	50	10
TE-05	20m	*Quadrula pustulosa*	40	6
TE-05	40m	*Quadrula pustulosa*	50	9
TE-05	50m	*Obliquaria reflexa*	43	8
TE-05	50m	*Obliquaria reflexa*	38	5
TE-05	50m	*Quadrula pustulosa*	60	14
TE-05	50m	*Utterbackia imbecillis*	28	3
TE-05	60m	*Obliquaria reflexa*	38	4
TE-05	60m	*Obliquaria reflexa*	48	9
TE-05	60m	*Quadrula pustulosa*	55	12
TE-05	60m	*Quadrula pustulosa*	55	12
TE-05	60m	*Quadrula pustulosa*	58	13
TE-05	70m	*Obliquaria reflexa*	48	7
TE-05b	40-50	*Tritogonia verrucosa*	57	4
TE-05b	20m	*Utterbackia imbecillis*	20	2
TE-05b	50m	*Utterbackia imbecillis*	21	2
TE-06	40-50	*Leptodea fragilis*	80	6
TE-06	50-60	*Lampsilis ovata*	155	13
TE-06	60-70	*Ellipsaria lineolata*	80	3
TE-06	10m	*Quadrula pustulosa*	48	9
TE-06	20m	*Quadrula pustulosa*	55	8
TE-06	30m	*Quadrula pustulosa*	40	5
TE-06	40m	*Utterbackia imbecillis*	28	3
TE-06	50m	*Megalonaias nervosa*	160	25
TE-06	50m	*Obliquaria reflexa*	31	3
TE-06	50m	*Quadrula pustulosa*	59	10
TE-06	60m	*Obliquaria reflexa*	50	10
TE-06	60m	*Obliquaria reflexa*	25	3
TE-06	70m	*Obliquaria reflexa*	48	6
TE-06	70m	*Potamilus alatus*	120	14

Appendix A. Sub-sample of length and age data collected at TRM 423.6 - 423.9 L.

Transect	Sample ID	Species	Length (mm)	Age (yr)
TE-06b	20m	*Cyclonaias tuberculata*	38	4
TE-06b	70m	*Utterbackia imbecillis*	31	4
TE-07	10-20	*Ellipsaria lineolata*	88	12
TE-07	20-30	*Ellipsaria lineolata*	83	10
TE-07	20-30	*Ellipsaria lineolata*	88	11
TE-07	20-30	*Lampsilis ovata*	140	18
TE-07	30-40	*Ligumia recta*	185	15
TE-07	30-40	*Tritogonia verrucosa*	98	8
TE-07	40-50	*Lampsilis ovata*	160	19
TE-07	60-70	*Ellipsaria lineolata*	55	7
TE-07	60-70	*Ligumia recta*	190	17
TE-07	20m	*Potamilus alatus*	127	10
TE-07	30m	*Ellipsaria lineolata*	70	7
TE-07	30m	*Quadrula pustulosa*	16	2
TE-07	30m	*Quadrula pustulosa*	61	13
TE-07	30m	*Quadrula pustulosa*	56	10
TE-07	30m	*Quadrula pustulosa*	59	10
TE-07	50m	*Megalonaias nervosa*	150	22
TE-07	50m	*Obliquaria reflexa*	55	7
TE-07	50m	*Quadrula pustulosa*	60	10
TE-07b	10m	*Utterbackia imbecillis*	15	1
TE-07b	20m	*Truncilla donaciformis*	26	4
TE-08	30-40	*Elliptio crassidens*	90	9
TE-08	30m	*Potamilus alatus*	91	4
TE-08	50m	*Ellipsaria lineolata*	55	6
TE-08	50m	*Obliquaria reflexa*	30	2
TE-08	60m	*Ellipsaria lineolata*	68	9
TE-08	60m	*Obliquaria reflexa*	38	4
TE-08	60m	*Utterbackia imbecillis*	30	3
TE-08	70m	*Quadrula pustulosa*	60	9

Aquatic Snail Survey – Tennessee River Miles 423.6-423.9: October 2008

INTRODUCTION - According to a Snail Survey Plan provided by Mr. Chuck Howard with the Tennessee Valley Authority, "CB&I has plans for a barge terminal and ramp on the left bank of the Tennessee River downstream of Nickajack dam in Guntersville Reservoir near river mile 424 (Marion County, TN). The plans show a property waterfront length of about 225 meters (m) or 730 feet (ft). Instream, direct impacts (project footprint) are expected to extend approximately 27m (90ft) off of the left bank. This reach of the Tennessee River is near known populations of the federal endangered Anthony's riversnail (*Athearnia anthonyi*) and pink mucket pearlymussel (*Lampsilis abrupta*). "Because Pennington and Associates, Inc. (PAI) currently holds a federal permit to collect and handle Anthony's River Snail a contract was issued to assist in the collection and identification of aquatic snails at the study site.

MATERIALS AND METHODS - The survey area boundaries extended approximately 50m upstream of the property waterfront to 200m downstream of the property waterfront and extend 50m from the left bank (= 475m long x 50m wide or 23,750m2). The study area was delineated for sampling using a series of 15 50m-long sampling transects (*i.e.*, lines weighted to the riverbed) extending perpendicular from the bank. Transects were placed at generally the following locations: 50m and 25m upstream of the waterfront property boundary (upstream boundary), at the upstream boundary of the property (= 0m mark), and 25m, 50m, 75m, 100m, 125m, 150m, 175m, 200m, 250m, 300m, 350m, and 400m downstream from the upstream boundary of the property. GPS coordinates (Table 1) of transect endpoints and other reference features were recorded so that an accurate map of snail distribution and habitat can be generated for the report and management decisions.

At each sampling transect, quantitative samples measuring 0.5m x 0.5m in area (quadrat) were collected at 5m, 10m, 20m, 30m, 40m, and 50m distances from the bank. Within each quadrat, a commercial diver collected all live and dead snail specimens and placed them in a fine mesh (*i.e.*, ≤3mm mesh size) closeable collection bag and returned them to the surface (boat) for processing by Mr. Wendell Pennington and Mr. Don Johnson with Pennington and Associates, Inc. The substrate within the top few centimeters was transferred into the collection bag to facilitate thorough sampling of all snails, including those inhabiting crevices and interstitial spaces of the substrate surface. Additional quadrat samples were to be collected if PAI deems the effort necessary to accurately characterize the presence, abundance, and distribution of federal-listed species.

All snails collected in quantitative (quadrat) samples were visually assessed by PAI to detect individuals of Anthony's river snail and any other federal-listed snail species. All individuals of federal-listed snail species were to be identified, counted, and scored as live or dead. A representative sample of sizes for live federal-listed species were to be measured (maximum width in millimeters; up to 10 individuals per species per sample). Non-listed snail species were recorded as present, and total snail abundance for each sample recorded. During processing, snails were kept wet and cool (avoiding extreme temperature changes), and out-of-water time was minimized to not more than 1- 5 minutes. While in captivity, all snails were held in mesh collection bags suspended in ambient, flowing river water. All federal-listed snails were to be returned to the specific quadrat location from which they were collected by hand; non-listed snail species were returned to the river from the water surface (boat) along each transect in the general area they were collected. Digital images of federal-listed and all other snail species photographed, and voucher specimens of non-listed species were retained and donated to an appropriate

public museum and/or as directed by the scientific collecting permit of the on-site malacologist. No live individuals of federal-listed snails were harmed or taken from the site.

SUBSTRATE - Relative substrate composition (% total composition of each particle size using the Wentworth Scale - not just generalized descriptions) was visually estimated by the either the diver or sample processor for each quantitative sample (Table 2). Depth was measured using a pneumatic pressure gage attached to the diver or other suitable method at the site of each quantitative sample. Zebra mussel concentrations (% area coverage of quadrat) were to be recorded at each quantitative sample (quadrat) location. If federal listed species are found during the study, water velocity and water chemistry (temperature, dissolved oxygen, pH, and clarity [turbidity or Secchi disk]) were to be measured at appropriate locations in the study area (*e.g.*, four corners of the study area) to better assess habitat conditions.

RESULTS AND DISCUSSION - A list of transect locations is presented in Table 1. A summary of depths and substrate types along each transect as determined during the mussel survey is presented in Table 2. Table 3 contains water quality data taken on October 7, 2008. Tables 4 thru 18 contain all data taken from the 90 quadrates along the 15 transects.

According to water quality data (table 3) the water was clear (2.55 ntu's), slightly alkaline (7.36 pH), had a temperature of 23.90C and a conductance of 233 µs/cm. The dissolved oxygen level was low (5.33 mg/l).

There were no live or relic Anthony's River Snails found in the 90 quadrants (Tables 4 thru 18)). A total of 225 live aquatic snail individuals representative of seven species, were taken from the 90 quadrants. There were five Pleuroceridae species and two Viviparidae species. The most abundant species was *Pleurocera canaliculatum* (131 individuals, Photo 1), followed by *Viviparus sp*. (58 individuals), and *Campeloma decisum* (27 individuals) (Photo 2). *Lithasia verrucosa* (1 individual, Photo 3), *Pleurocera corpulentum* (2 individuals, Photo 1), *Pleurocera nobile* (2 individuals) and *Elimia laqueata* (3 individuals) were represented by low numbers. *Elimia laqueata* is not normally found in the mainstem of the Tennessee River and probably originated from the adjacent creek near the site.

Table 1. Site coordinates for the shoreline end of the transect lines along the left descending bank at Tennessee River Mile 423.6 - 423.9. Coordinates are provided in Tennessee State Plane (Feet) NAD83 and Geographic (Degrees-Decimal Minutes) NAD83 or WGS84. (Data provided by Lewis Environmental Consulting, LLC).

	TN State Plane (Feet)		Geographic	
Transect	Easting	Northing	Latitude	Longitude
TE-01	2077719	246616	35 00.6157304	85 38.1181576
TE-01b	2077839	246498	35 00.5962061	85 38.0942042
TE-02	2077968	246390	35 00.5783244	85 38.0684404
TE-02b	2078094	246273	35 00.5589611	85 38.0432846
TE-03	2078217	246173	35 00.5424017	85 38.0187173
TE-03b	2078283	246119	35 00.5334598	85 38.0055351
TE-04	2078342	246053	35 00.5225442	85 37.9937644
TE-04b	2078404	246005	35 00.5145938	85 37.9813793
TE-05	2078464	245944	35 00.5045018	85 37.9694046
TE-05b	2078532	245892	35 00.4958883	85 37.9558204
TE-06	2078587	245836	35 00.4866234	85 37.9448438
TE-06b	2078656	245780	35 00.4773499	85 37.9310624
TE-07	2078718	245722	35 00.4677510	85 37.9186850
TE-07b	2078785	245670	35 00.4591380	85 37.9053014
TE-08	2078845	245610	35 00.4492107	85 37.8933263

Table 2. Tennessee River Mile 423.6 - 423.9 Transects - Approximate bottom elevation, water depth at normal pool elevation (595'), and type of sediment recorded at each 10-meter interval along the transects. Elevations and Depths are only approximate and should not be used for engineering or navigational purposes. Depth and substrate are only intended to describe mussel habitat. Data provided by Lewis Environmental Consulting, LLC.

Transect Mark	TE-01		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	591	4	100% fine sand
20 m	587	8	80% sand, 10% gravel, 10% cobble
30 m	586	9	80% sand, 10% gravel, 10% cobble
40 m	586	9	100% conglomerate rock
50 m	583	12	30% sand, 30% gravel, 40% cobble
60 m	579	16	30% sand, 30% gravel, 40% cobble
70 m	578	17	20% sand, 40% gravel, 40% cobble

Transect Mark	TE-01b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	80% sand, 10% gravel, 10% cobble
30 m	586	9	80% sand, 10% gravel, 10% cobble
40 m	585	10	100% conglomerate rock
50 m	585	10	30% sand, 30% gravel, 40% cobble
60 m	585	10	30% sand, 30% gravel, 40% cobble
70 m	580	15	20% sand, 40% gravel, 40% cobble

Transect Mark	TE-02		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	588	7	100% fine sand
20 m	587	8	100% fine sand
30 m	586	9	80% sand, 10% gravel, 10% cobble
40 m	586	9	80% sand, 10% gravel, 10% cobble
50 m	587	8	40% sand, 30% gravel, 30% cobble
60 m	585	10	20% sand, 40% gravel, 40% cobble
70 m	580	15	10% sand, 80% gravel, 10% cobble

Table 2. Tennessee River Mile 423.6 - 423.9 Transects - Approximate bottom elevation, water depth at normal pool elevation (595'), and type of sediment recorded at each 10-meter interval along the transects. Elevations and Depths are only approximate and should not be used for engineering or navigational purposes. Depth and substrate are only intended to describe mussel habitat. Data provided by Lewis Environmental Consulting, LLC.

Transect Mark	TE-02b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	590	5	100% fine sand
30 m	588	7	100% fine sand
40 m	585	10	100% fine sand
50 m	583	12	40% sand, 50% gravel, 10% cobble
60 m	585	10	30% sand, 50% gravel, 20% cobble
70 m	585	10	100% conglomerate rock

Transect Mark	TE-03		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	589	6	100% fine sand
20 m	586	9	80% sand, 20% gravel
30 m	585	10	80% sand, 10% gravel, 10% cobble
40 m	584	11	40% sand, 20% gravel, 40% cobble
50 m	583	12	100% large cobble
60 m	579	16	10% sand, 50% gravel, 40% cobble
70 m	578	17	100% conglomerate rock

Transect Mark	TE-03b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	589	6	70% sand, 20% gravel, 10% cobble
20 m	588	7	50% sand, 30% gravel, 20% cobble
30 m	585	10	50% sand, 30% gravel, 20% cobble
40 m	582	13	30% sand, 50% gravel, 20% cobble
50 m	578	17	10% sand, 70% gravel, 20% cobble
60 m	577	18	20% sand, 60% gravel, 20% cobble
70 m	577	18	10% sand, 70% gravel, 20% cobble

Table 2. Tennessee River Mile 423.6 - 423.9 Transects - Approximate bottom elevation, water depth at normal pool elevation (595'), and type of sediment recorded at each 10-meter interval along the transects. Elevations and Depths are only approximate and should not be used for engineering or navigational purposes. Depth and substrate are only intended to describe mussel habitat. Data provided by Lewis Environmental Consulting, LLC.

Transect Mark	TE-04		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	95% sand, 5% gravel
30 m	587	8	10% sand, 50% gravel, 40% cobble
40 m	586	9	30% sand, 40% gravel, 30% cobble
50 m	582	13	50% sand, 25% gravel, 25% cobble
60 m	579	16	50% sand, 40% gravel, 10% cobble
70 m	577	18	10% sand, 80% gravel, 10% cobble

Transect Mark	TE-04b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	587	8	90% sand, 5% gravel, 5% cobble
30 m	585	10	20% sand, 60% gravel, 20% cobble
40 m	583	12	10% sand, 50% gravel, 40% cobble
50 m	579	16	10% sand, 50% gravel, 40% cobble
60 m	577	18	10% sand, 60% gravel, 30% cobble
70 m	575	20	10% sand, 60% gravel, 30% cobble

Transect Mark	TE-05		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	590	5	90% sand, 5% gravel, 5% cobble
30 m	588	7	10% sand, 40% gravel, 50% cobble
40 m	584	11	20% sand, 30% gravel, 50% cobble
50 m	580	15	50% sand, 40% gravel, 10% cobble
60 m	579	16	20% sand, 40% gravel, 40% cobble
70 m	575	20	20% sand, 40% gravel, 40% cobble

Table 2. Tennessee River Mile 423.6 - 423.9 Transects - Approximate bottom elevation, water depth at normal pool elevation (595'), and type of sediment recorded at each 10-meter interval along the transects. Elevations and Depths are only approximate and should not be used for engineering or navigational purposes. Depth and substrate are only intended to describe mussel habitat. Data provided by Lewis Environmental Consulting, LLC.

Transect Mark	TE-05b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	50% sand, 25% gravel, 25% cobble
30 m	586	9	10% sand, 30% gravel, 60% cobble
40 m	580	15	50% sand, 25% gravel, 25% cobble
50 m	578	17	50% sand, 25% gravel, 25% cobble
60 m	578	17	100% conglomerate rock
70 m	575	20	10% sand, 40% gravel, 50% cobble

Transect Mark	TE-06		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	591	4	100% fine sand
20 m	588	7	100% fine sand
30 m	588	7	50% sand, 50% gravel
40 m	582	13	50% sand, 50% gravel
50 m	580	15	20% sand, 50% gravel, 30% cobble
60 m	579	16	10% sand, 80% gravel, 10% cobble
70 m	575	20	10% sand, 90% gravel

Transect Mark	TE-06b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	95% sand, 5% gravel
20 m	588	7	100% fine sand
30 m	585	10	40% sand, 50% gravel, 10% cobble
40 m	579	16	40% sand, 50% gravel, 10% cobble
50 m	576	19	10% sand, 70% gravel, 20% cobble
60 m	575	20	10% sand, 70% gravel, 20% cobble
70 m	574	21	10% sand, 50% gravel, 40% cobble

Table 2. Tennessee River Mile 423.6 - 423.9 Transects - Approximate bottom elevation, water depth at normal pool elevation (595'), and type of sediment recorded at each 10-meter interval along the transects. Elevations and Depths are only approximate and should not be used for engineering or navigational purposes. Depth and substrate are only intended to describe mussel habitat. Data provided by Lewis Environmental Consulting, LLC.

Transect Mark	TE-07		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	591	4	100% fine sand
20 m	587	8	60% sand, 30% gravel, 10% cobble
30 m	585	10	80% sand, 10% gravel, 10% cobble
40 m	581	14	50% sand, 40% gravel, 10% cobble
50 m	576	19	60% sand, 30% gravel, 10% cobble
60 m	574	21	10% sand, 80% gravel, 10% cobble
70 m	572	23	10% sand, 80% gravel, 10% cobble

Transect Mark	TE-07b		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	100% fine sand
20 m	588	7	80% sand, 10% gravel, 10% cobble
30 m	587	8	50% sand, 25% gravel, 25% cobble
40 m	585	10	20% sand, 50% gravel, 30% cobble
50 m	584	11	100% conglomerate rock
60 m	577	18	10% sand, 50% gravel, 40% cobble
70 m	574	21	10% sand, 80% gravel, 10% cobble

Transect Mark	TE-08		
	Bottom Elev. (Ft)	Depth (Ft)	Sediment
0 m	595	0	100% fine sand
10 m	590	5	90% sand, 10% gravel
20 m	587	8	50% sand, 25% gravel, 25% cobble
30 m	585	10	20% sand, 30% gravel, 50% cobble
40 m	582	13	20% sand, 30% gravel, 50% cobble
50 m	578	17	10% sand, 50% gravel, 40% cobble
60 m	575	20	10% sand, 70% gravel, 20% cobble
70 m	573	22	10% sand, 70% gravel, 20% cobble

Table 3. Water Quality, Tennessee River Mile 423.6, October 7, 2008.	
PARAMETER	VALUE
Conductivity (*u*s/cm)	233
Dissolved Oxygen (mg/l)	5.33
PH (Std. Units)	7.36
Turbidity (ntu's)	2.55
Temperature (^{0}C)	23.9

Table 4. Aquatic Snails, Transect TE-01, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	INDIVIDUALS Relic	SUBSTRATE
TE-01	5m	P.c.	2	2	Find Sand
		P. co.	1		
		V.		1	
		L.v.		1	
TE-01	10m	P.c.	5		Find Sand
		P. co.		1	
		C.d.		3	
		E.i.		1	
		V.	1	1	
TE-01	20m	P.c.	5	10	Sand and Corbicula shell
		C.d.	1		
		V.	1	1	
TE-01	30m	P.c.	3	5	Sand and Corbicula shell
		C.d.	1		
		E.i.		3	
		V.	3	3	
TE-01	40m	P.c.	2	1	Gravel, Sand and Corbicula Shell
		V.	2		
TE-01	50m	P.c.	2	2	Gravel, Sand and Corbicula Shell
		E.i.		1	
		V.	2		

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 5. Aquatic Snails, Transect TE-01B, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-01B	5m	P.c.	2		Fine Sand and Corbicula shell
		P. co.	1		
		C.d.		1	
TE-01B	10m	P.c.	2		Fine Sand and Corbicula shell
		V.	2		
TE-01B	20m	P.c.	2	1	Fine Sand and Corbicula shell
		L.v.		1	
		V.	4	1	
TE-01B	30m	P.c.	1	9	Fine Sand and Corbicula shell
		V.	2	2	
TE-01B	40m	P.c.	3	2	Fine Sand and Corbicula shell
TE-01B	50m	V.	1		Fine Sand and Corbicula shell

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 6. Aquatic Snails, Transect TE-02, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-02	5m	P.c.	3		Sand
		C.d.	2	1	
		V.	1		
TE-02	10m	P.c.	3	1	Sand and Corbicula shell
		C.d.		1	
		L.v.	1		
		V.	2		
TE-02	20m	P.c.	2	6	Sand and Corbicula shell
		L.v.	1	1	
		V.	1	1	
TE-02	30m	P.c.	4	2	Sand and Corbicula shell
		E.l.	1	1	
		L.v.		1	
TE-02	40m	P.c.	2	3	Sand and Corbicula shell
		V.		1	
TE-02	50m	P.c.		2	Sand and Corbicula shell
		L.v.		1	

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 7. Aquatic Snails, Transect TE-02B, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	INDIVIDUALS Relic	SUBSTRATE
TE-02B	5m	P.c.	2		Sand and Silt
		E.i.	1	3	
		V.	1		
TE-02B	10m	P.c.	1	12	Sand and Corbicula Shell
		E.i.		5	
		C.d.		2	
TE-02B	20m	P.c.	8	16	Sand and Corbicula Shell
		E.i.		1	
		C.d.		2	
		V.	3		
TE-02B	30m	P.c.	7	5	Sand, Gravel and Corbicula Shell
		C.d.	1	2	
		V.	1	1	
TE-02B	40m	P.c.		2	Sand, Gravel and Corbicula Shell
		V.	1		
TE-02B	50m	P.c.		3	Sand, Gravel and Corbicula Shell
		C.d.	1		
		V.	2		

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 8. Aquatic Snails, Transect TE-03, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	INDIVIDUALS Relic	SUBSTRATE
TE-03	5m	None			Sand and Corbicula Shell
TE-03	10m	V.		1	Sand and Corbicula Shell
TE-03	20m	P.c.	1	3	Sand and Corbicula Shell
		C.d.		2	
		V.	1		
TE-03	30m	P.c.		2	Sand and Corbicula Shell
TE-03	40m	P.c.		6	Sand and Corbicula Shell
		L.v.		1	
		V.	1		
TE-03	50m	P.c.	1	3	Sand and Corbicula Shell
		V.	1		

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 9. Aquatic Snails, Transect TE-03B, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-03B	5m	C.d.	1		Sand
TE-03B	10m	P.c.		1	Sand
		V.		1	
TE-03B	20m	P.c.	6	7	Sand and Corbicula Shell
		C.d.	1		
		V.	1		
TE-03B	30m	P.c.	4	7	Sand, Gravel and Corbicula Shell
		C.d.	1		
		V.		1	
TE-03B	40m	P.c.	1	4	Sand, Gravel and Corbicula Shell
		V.	1	1	
TE-03B	50m	P.c.	3	3	Sand, Gravel and Corbicula Shell
		L.v.		1	

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 10. Aquatic Snails, Transect TE-04, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-04	5m	C.d.	2		Sand and Silt
		V.	1		
TE-04	10m	C.d.	1		Sand and Corbicula Shell
		E.i.		1	
		V.	1	1	
TE-04	20m	P.c.		2	Sand and Corbicula Shell
		V.		3	
TE-04	30m	P.c.	1	3	Sand, Gravel and Cobble
		E.i.		1	
		L.v.		1	
		V.	1		
TE-04	40m	P.c.	2	3	Gravel and Corbicula Shell
TE-04	50m	P.c.		2	Gravel and Cobble

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 11. Aquatic Snails, Transect TE-04B, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS		SUBSTRATE
			Live	Relic	
TE-04B	5m	C.d.	3		Sand and Silt
		E.i.	1		
TE-04B	10m	P.c.		2	Sand and Silt
		C.d.		1	
		E.i.		1	
		V.	1	1	
TE-04B	20m	P.c.	1	5	Sand and Silt
		C.d.		3	
		V.	1	2	
TE-04B	30m	P.c.	6	5	Sand, and Corbicula Shell
		C.d.	2		
		V.	1	1	
TE-04B	40m	P.c.	2	3	Sand, Gravel and Corbicula Shell
		C.d.	3		
TE-04B	50m	P.c.	1		Sand, Gravel and Corbicula Shell

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 12. Aquatic Snails, Transect TE-05, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS		SUBSTRATE
			Live	Relic	
TE-05	5m	None			Sand and Silt
TE-05	10m	P.c.	1		Sand and Silt
		C.d.	1		
		E.i.		1	
		V.	1		
TE-05	20m	P.c.	1	13	Sand and Corbicula Shell
		V.	2	1	
TE-05	30m	P.c.	2	16	Sand, gravel and Corbicula Shell
		E.i.		1	
		C.d.		2	
TE-05	40m	P.c.	2		Sand, gravel and Corbicula Shell
TE-05	50m	P.c.	3	2	Sand, gravel and Corbicula Shell
		V.	1		

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 13. Aquatic Snails, Transect TE-05B, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS		SUBSTRATE
			Live	Relic	
TE-05B	5m	None			Sand and Silt
TE-05B	10m	P.c.		2	Sand and Silt
		C.d.		1	
TE-05B	20m	P.c.	7	12	Gravel and Cobble
		C.d.		3	
TE-05B	30m	P.c.	11	8	Gravel and Corbicula Shell
		E.i.		1	
		V.		1	
TE-05B	40m	P.c.		7	Gravel and Corbicula Shell
TE-05B	50m	P.c.	1	4	Gravel and Corbicula Shell

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 14. Aquatic Snails, Transect TE-06, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS		SUBSTRATE
			Live	Relic	
TE-06	5m	C.d.		1	Sand and Silt
TE-06	10m	P.c.		3	Sand and Silt
		C.d.		1	
TE-06	20m	P.c.	1	3	Sand and Silt
		E.i.		1	
		V.		1	
TE-06	30m	P.c.	1	7	Gravel, Cobble and Corbicula Shell
		V.		1	
TE-06	40m	None			Gravel, Cobble and Corbicula Shell
TE-06	50m	P.c.		3	Gravel, Cobble and Corbicula Shell
		C.d.	1		

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 15. Aquatic Snails, Transect TE-06B, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-06B	5m	P.c.		1	Sand and Silt
		E.i.		1	
TE-06B	10m	P.c.		3	Sand and Silt
TE-06B	20m	P.c.		4	Gravel, Cobble and Corbicula Shell
		V.	1		
TE-06B	30m	P.c.	1	5	Gravel, Cobble and Corbicula Shell
TE-06B	40m	P.c.		1	Gravel, Cobble and Corbicula Shell
		C.d.	1		
TE-06B	50m	P.c.		7	Gravel, Cobble and Corbicula Shell
		V.	3		

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 16. Aquatic Snails, Transect TE-07, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-07	5m	None			Sand and Silt
TE-07	10m	P.c.		1	Sand and Silt
		C.d.		1	
TE-07	20m	P.c.		3	Gravel, and Corbicula Shell
		E.i.		3	
TE-07	30m	P.c.		4	Gravel, and Corbicula Shell
		P.n.	1		
		V.	1		
TE-07	40m	None			Bedrock
TE-07	50m	P.c.		2	Gravel, and Corbicula Shell
		L.v.		1	
		V.		2	

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 17. Aquatic Snails, Transect TE-07B, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-07B	5m	P.c.		2	Sand and Silt
		C.d.	3		
		P.n.	1		
TE-07B	10m	E.i.		2	Gravel
TE-07B	20m	P.c.		1	Gravel, and Corbicula Shell
		P.n.		2	
		C.d.	1		
TE-07B	30m	P.c.	1	2	Gravel, and Corbicula Shell
		E.i.		1	
		V.		1	
TE-07B	40m	P.c.	4	3	Gravel, and Corbicula Shell
		V.	4		
TE-07B	50m	P.c.	5	5	Gravel, and Corbicula Shell
		V.	3		

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.

Table 18. Aquatic Snails, Transect TE-08, Tennessee River Mile ~423.6, October, 2008.

TRANSECT	QUADRANT	SPECIES	INDIVIDUALS Live	Relic	SUBSTRATE
TE-08	5m	P.c.		2	Gravel
TE-08	10m	P.c.		1	Gravel
		P.n.		1	
		C.d.		3	
TE-08	20m	P.c.		10	Gravel
		C.d.		2	
		E.i.		2	
TE-08	30m	P.c.		4	Gravel
		V.	1		
TE-08	40m	V.		3	Gravel
TE-08	50m	P.c.		1	Gravel

Footnote:

C.d. = Campeloma decisum
E.i. = Elimia laqueata
L.v. = Lithasia verrucosa
L.p. = Leptoxis praerosa
P.c. = Pleurocera canaliculatum
P. co. = Pleurocera corpulentum
P.n. = Pleurocera nobile
V. = Viviparus sp.