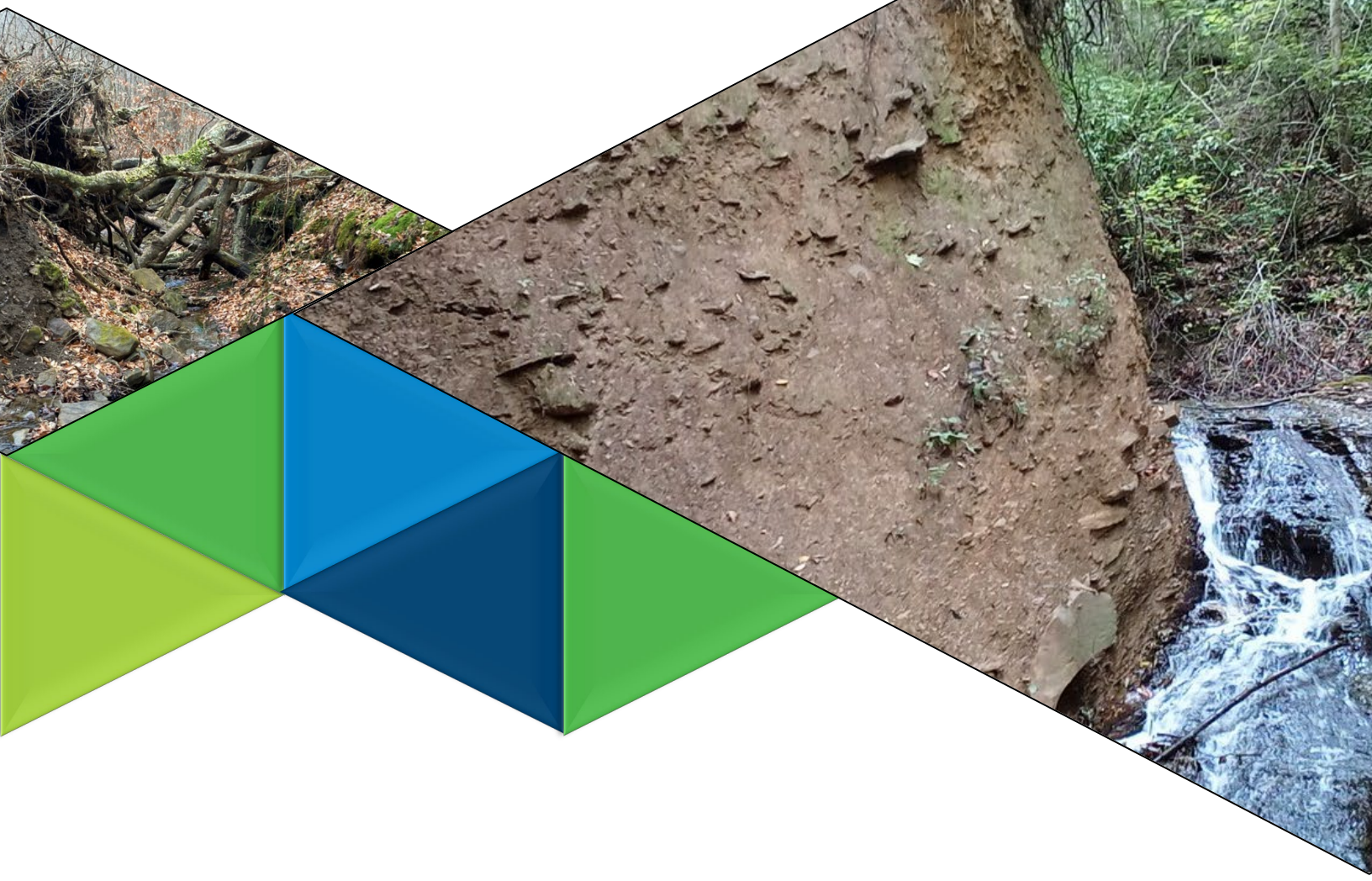
Nally & Hamilton Enterprises, Inc.

NALLY & HAMILTON ENTERPRISES, INC.
USACE #LRN-2025-01090 | KDNR #807-0501
CRANES CREEK PROJECT
NATIONWIDE PERMIT 49
PRE-CONSTRUCTION NOTIFICATION (PCN)
BELL COUNTY, KENTUCKY
WAYPOINT #2025-63
SEPTEMBER 2026



WAYPOINT LLC

Nally & Hamilton Enterprises, Inc.
Nationwide Permit 49
Cranes Creek Project
Bell County, Kentucky
LRN-2025-01090
KDNR# 807-0501
Waypoint# 2025-63

Submitted to:

U.S. Army Corps of Engineers
Nashville Regulatory District
3701 Bell Road
Nashville, Tennessee 37214

Prepared for:

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September 2026

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LRN-2025-01090 KDNR# 807-0501
Nationwide Permit 49 Pre-Construction Notification

EXECUTIVE SUMMARY

The following Clean Water Act (CWA) Section 404 Nationwide Permit (NWP) 49 (Remining) pre-construction notification is being submitted to the United States Army Corps of Engineers (USACE) (file number LRN-2025-01090) for Nally & Hamilton Enterprises, Inc. This verification is applicable to the Kentucky Department for Natural Resources (KDNR) Surface Mining Control and Reclamation Act (SMCRA) permit application number 807-0501 (Appendix G). The General Section 401 Water Quality Certification (WQC) is pending, and the CWA Section 402 Kentucky Pollutant Discharge Elimination System (KPDES) general permit has been approved (Appendix G).

This proposed project consists of contour re-mining of the Mason coal seam in Bell County, Kentucky. The operation will also reclaim over 5 miles of abandoned highwalls and saturated mine benches. Natural drainage patterns and outslope spoil piles will also be restored and reclaimed during the reclamation process. During the reclamation process the natural surface and groundwater flow and drainage patterns of these watersheds would be restored closer to their natural locations. Reclamation of the abandoned mine lands will contribute to the restoration of hydrologic balance to these areas, restore more natural vegetation and topography, reduce erosion and total suspended solids, and will reduce sediment loads downslope of the site.

An overall lift in aquatic resources is anticipated on-site through the restoration of 5,841 linear feet of stream channel. Reclamation of the abandoned mine lands also positively influences the entire watershed. Previous mining and logging activities have introduced impacts to the proposed mitigation sites.

Project Description

The proposed permit area is approximately 372.7 surface acres in extent and lies in Bell County, Kentucky. 239.4 acres of the Mason seam is proposed to be contour mined (Figure 1, Appendix A). Specifically, the site is located 0.4 miles east of Colmar, KY, on the Varilla and Middlesboro North, Kentucky 7.5' United States Geological Survey (USGS) topographic quadrangles, near NAD83 latitude N36.66492°, NAD83 longitude W83.64782 (Figure 2, Appendix A). The tract is positioned on the upper side slopes within the Clear Fork-Yellow Creek watershed (HUC12: 051301010202).

Alteration Summary

In order to meet the purpose and need of the project, 6,040 linear feet of stream channel, considered by the USACE to be "Waters of the U.S." (WOUS), would be temporarily altered (Table 1). These activities are necessary to operate the mining machinery and extract the target coal seams while sterilizing the reserves and maximizing the extraction of the target coal seams as required by SMCRA. These features have been impacted or created by the previous mining activities that occurred at this site.

Net Increase in Aquatic Resource Functions
In order to achieve the overall lift in aquatic resources, the applicant is proposing to restore 5,841 linear feet of stream channel, while simultaneously reclaiming abandoned mined lands. Once the restoration is completed and given time to mature, a lift of 913 Stream Functional Capacity Units (FCUs) is expected within 5 years.

Cumulative Impact Analysis
Due to the anticipated net increase in aquatic resource functions within the HUC12 watershed, the cumulative impacts on the local and regional watersheds are considered to be positive.

Avoidance and Minimization
The following avoidance and minimization measures have been taken by the applicant:

1. Water quality monitoring through the KPDES program provides avoidance and minimization of adverse effects and would provide remedial actions should any exceedance occur.
2. The Best Management Practices (BMPs) for the SMCRA permit minimize the overall project impacts.
3. Re-mining and altering sites that have been previously disturbed or are man-made features.

The area affected by previous mining is 196.5 acres. The unmined area being added to facilitate reclamation of re-mining is 176.2 acres for a total area of 372.7 acres. The entire project area is needed to reclaim the previous mining. The new mining area that could be added to the current total area of 372.7 acres is calculated as follows; 40% x (remine area + unmined area needed for reclamation) = 0.4 x (196.5 + 176.2) = 149.08 acres. No new mining is being added in this action.

NWP49 Verification Calculation

Area previously disturbed by mining activities	196.5 ac
Un-mined area required to reclaim previously mined area	176.2 ac
Previously mined area and un-mined area required to reclaim previously mined area **(required area)**	372.7 ac
Additional area that could be added to the required area (40% of required area)	149.08 ac
New area being added	0 ac
Total mine area added in NW	372.7 ac

Agency Correspondence
All available correspondence from the State Historic Preservation Office (SHPO), Kentucky Department of Natural Resources (KDNR), United States Fish and Wildlife Service (FWS), U.S. Army Corps of Engineers (USACE), and the Kentucky Division of Water (KDOW) is presented as Appendix G. The SMCRA permit is issued and all available correspondence from these agencies has been included or will be forwarded upon receipt. The General 401 Water Quality Certification is pending and will be provided upon receipt.

1) NAME AND ADDRESS OF THE APPLICANT:

Nally & Hamilton Enterprises, Inc.
195 Commercial Drive, Suite 105
London, KY 40744

2) SITE LOCATION

The proposed project is located 0.4 miles east of Colmar, KY, near the intersection of KY 188 and KY 988, on the Varilla and Middlesboro North, Kentucky 7.5' United States Geological Survey (USGS) topographic quadrangle, near NAD83 latitude N36.66492°, NAD83 longitude W83.64782.

3) PROJECT PURPOSE, ALTERATION SUMMARY, AVOIDANCE, AND MINIMIZATION

The overall purpose of the project is to meet the market demand for coal and fulfill the contracts and agreements that are in place to meet the demand. In addition, the project will provide jobs for local communities, reclaim abandoned mine lands, and restore the physical, biological, and chemical functions of "Waters of the United States".

Restoration, Alteration, and Enhancement Summary
Table 1 summarizes the proposed temporary alterations of jurisdictional waters that would occur due to the project. After the coal is extracted, the areas will be backfilled to form valleys and reconnect the hydrology above and below the mine site. For the NWP49, seven intermittent streams and two perennial streams would be temporarily altered as indicated in Figures 1-4 (Appendix A).

Table 1. Jurisdictional Waters of the U.S. Proposed Alteration Summary						
Impact Type / Site	**WOUS Name / Type**	**Length (Feet)**	**Drainage Area Above Site (Acres)**	**Cubic Yards into WOUS**	**Materials Discharged**	**Area of Impact (Acres)**
Remine Area / UT Cranes Creek	S3 / Int	844*	105.2	58.14	Shale, Rock, Gravel, Silt, Clay	0.060
Pond EP4 / Cranes Creek	S4 / Per	142	202.5	4.63	Shale, Rock, Gravel, Silt, Clay	0.029
Pond EP4 / Cranes Creek	S4 / Int	310	63.9	10.10	Shale, Rock, Gravel, Silt, Clay	0.063
Corridor 6 / Cranes Creek	S4 / Int	330	63.9	10.76	Shale, Rock, Gravel, Silt, Clay	0.067
Remine Area / Cranes Creek	S4 / Int	145	63.9	4.73	Shale, Rock, Gravel, Silt, Clay	0.029
Remine Area / UT Cranes Creek	S4A / Int	1060	35.6	30.62	Shale, Rock, Gravel, Silt, Clay	0.095
Pond EP4 / UT Cranes Creek	S5 / Int	46	51.2	5.37	Shale, Rock, Gravel, Silt, Clay	0.007
Corridor 5 / UT Cranes Creek	S5 / Int	345	51.2	40.25	Shale, Rock, Gravel, Silt, Clay	0.050
Remine Area / UT Cranes Creek	S5 / Int	810	51.2	94.50	Shale, Rock, Gravel, Silt, Clay	0.117
Pond EP3, Corridor 4-1 / UT Cranes Creek	S8 / Int	434	69.3	80.37	Shale, Rock, Gravel, Silt, Clay	0.100
Pond EP3 / UT Cranes Creek	S8 / Per	447	125.6	82.78	Shale, Rock, Gravel, Silt, Clay	0.103
Corridor 3 / UT Cranes Creek	S9 / Int	454	31.4	11.77	Shale, Rock, Gravel, Silt, Clay	0.036
Pond EP1 / UT Clear Fork	S12 / Int	673	46.3	40.88	Shale, Rock, Gravel, Silt, Clay	0.063
NWP49 Total		**6,040**		**474.89**		**0.818**

*Stream 3 impact length consists of the remine area. The downstream road flow that had existed at the time of the Jurisdictional Determination has since blown out the clogged culvert that was rerouting the flow and returned to its natural valley (See Photograph Point 1, in Appendix B). The impacted section will be restored, and a drainage corridor of this watershed will be returned to its natural location and enhanced through natural stream design techniques.

As illustrated, a total of 6,040 linear feet of stream channel, considered to be WOUS would be temporarily altered to successfully remine and reclaim the Mason coal seam and the abandoned mine lands surrounding the site. Existing road crossings of S2, S4, S15 and S16 will also be utilized. During this process, the disturbed drainage patterns of these watersheds would be restored to their natural locations. Backfilling of the abandoned mine lands will contribute to the restoration of hydrologic balance to these areas, restore more natural vegetation and topography, reduce erosion and total suspended solids, and reduce sediment loads downslope of the site.

The Hydrogeomorphic (HGM) assessment was used to evaluate important functions of hydrology, biogeochemical cycling, and habitat through assessments in parameters such as canopy coverage, average diameter at breast height (DBH) of trees in the riparian zones, and

bank erosion. Photographs of these sites are contained in Appendix B along with the HGM data sheets.

As illustrated by Table 2, the HGM functional capacity index (FCI) scores for the existing conditions range from 0.51-0.62.

Table 2. Existing HGM Summary

Site	Hydrology	Biogeochemical Cycling	Habitat	HGM Score	Length (ft)	Existing FCUs
S3 / Int	0.39	0.58	0.65	0.54	844	456
S4 / Int	0.34	0.55	0.63	0.51	785	398
S4 / Per	0.37	0.48	0.64	0.50	142	71
S4A / Int	0.34	0.55	0.63	0.51	1060	537
S5 / Int	0.39	0.56	0.62	0.52	1201	629
S8 / Int	0.47	0.61	0.67	0.58	513	299
S8 / Per	0.50	0.53	0.67	0.57	368	209
S9 / Int	0.52	0.63	0.68	0.61	454	277
S12 / Int	0.53	0.64	0.68	0.62	673	415
Totals					**6,040**	**3,289**

4) "WATERS OF THE U.S."

The jurisdictional determination for this project is being submitted along with this application as Appendix H.

5) MITIGATION

In order to compensate for unavoidable impacts and relocation of 6,040 linear feet of stream channels, on-site restoration using natural stream design techniques along 5,841 linear feet of stream channel is proposed. As illustrated by the existing conditions, the watersheds containing the proposed impacts and restoration sites have been impacted by previous mining activities. Natural stream substrates, in-stream habitats, and riparian zones have been adversely affected. The physical, biological, and chemical functions of the aquatic resources and other functional characteristics of the ecosystem and watershed would benefit from the proposed mitigation plan.

Baseline Information

Streams and channels across the site have been previously impacted. These impacts have caused decreased bank stability, subsequently increasing channel erosion and embeddedness. Channels have been altered and the vegetative composition has been compromised by the impacts, resulting in low functional assessment scores. Dominant trees in the riparian vegetation areas are mainly early successional species such as American beech (*Fagus grandifolia),* red maple *(Acer rubrum),* and tulip tree *(Liriodendron tulipifera)*. Invasive species observed in the assessment reaches included: tree of heaven (*Ailanthus altissima*), multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellate*), and princesstree (*Paulownia tomentosa*). Increasing riparian vegetation species richness and restoring bank stability across the mitigation areas are two of the primary goals of the mitigation plan. Baseline functional assessments of the existing stream

mitigation areas were performed through the Hydrogeomorphic (HGM[1]) assessment method. These functional assessment sheets are contained in Appendix B. As expressed by the HGM scores and site photographs, the existing conditions of the site are relatively poor, with a few segments of less disturbed stream. Previous mining and logging activities have severely impacted the areas proposed for restoration and relocation.

Mitigation Objectives and Work Plan

Due to the previous mining and deforestation activities in the watershed, the natural stream profile, pattern, dimensions, substrates, and riparian zones have been negatively affected. The photo document illustrates these adverse conditions (Appendix B).

Stream Mitigation

The stream mitigation plan includes both restoration reaches and enhancement reaches, with the level of intervention tailored to the existing condition and functional needs of each reach. Restoration will be re-established as near to the dimensions and geomorphic characteristics of the applicable reference conditions as practicable. These activities may include reconstruction of channel pattern, profile, and dimension; restoration of appropriate substrate; bank stabilization; installation of in-stream habitat and grade-control features; and establishment of a native riparian zone.

Enhancement reaches will not require wholesale reconstruction of the existing stream channel where stable channel morphology is already present. Within these reaches, existing stable channel dimensions, bed features, banks, mature riparian vegetation, and other desirable natural features will be retained to the maximum extent practicable. Enhancement activities will instead target specific functional deficiencies identified within each reach and may include localized bank stabilization, supplemental substrate, installation or enhancement of in-stream habitat and grade-control features, removal or modification of localized impediments, invasive species management, and supplemental riparian planting. Channel pattern, profile, or dimension will be modified only where necessary to correct an identified instability or functional deficiency.

Reference stream information was obtained from similar but less disturbed watersheds located within the Eastern Kentucky Coal Field Region. These sites represent slopes and watershed sizes similar to those of the proposed mitigation areas and were selected from watersheds determined to be relatively undisturbed (Appendix D). Reference reach information was used to establish appropriate hydrogeomorphic characteristics and target conditions for the mitigation reaches. Level II Rosgen assessments were conducted to provide information regarding channel pattern, profile, and dimension. Regional curve information presented in Geomorphic Characteristics of Headwater Streams in the Eastern Kentucky Coal Field Physiographic Region of Kentucky was also used during the mitigation design process. Regional curve data from watersheds with comparable drainage areas and slopes were used in conjunction with the reference reach data to develop and evaluate the proposed channel dimensions.

For restoration and relocation reaches, proposed bankfull channel dimensions and slopes based on the reference reach and regional curve information will be used to establish stable channel

[1] USACE, ERDC. Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low Gradient Perennial Streams in Appalachia. January 2017.

conditions in areas that have been previously degraded. The Rosgen stream types within these areas are generally expected to be Type A or A+, although local variations in channel morphology occur within individual reaches. Reference dimensions for enhancement reaches will serve as target ranges and design guidance rather than requirements for wholesale reconstruction of otherwise stable channel sections. Existing channel morphology that is stable and provides appropriate aquatic resource functions will generally be retained.

Following construction, disturbed riparian areas will be planted with native tree and shrub species to a minimum width of 50 feet on each side of the mitigated channel, or to the existing natural canopy where it occurs within that distance. Existing mature native riparian vegetation within enhancement reaches will be retained to the maximum extent practicable. These measures are intended to improve bank stability, shading and water temperature regulation, organic matter inputs, and aquatic and terrestrial habitat.

Mitigation of approximately 5,841 linear feet of stream channel, together with associated riparian improvements, will address watershed needs by improving stream stability, riparian condition, in-stream habitat, and overall aquatic resource function. Restoration and relocation reaches will be reconstructed where necessary to establish appropriate channel pattern, profile, dimension, and grade. Enhancement reaches will focus on improving existing functions while minimizing unnecessary disturbance to stable stream channels and established riparian communities.

The reclamation of more than five miles of abandoned highwalls across the mine site will provide additional watershed benefits through restoration of drainage patterns, elimination of outslope spoil piles and pits, restoration of natural slopes, and stabilization or amelioration of existing slide areas.

Within enhancement reaches, construction access and disturbance will be minimized to the greatest extent practicable. Enhancement measures will be installed by hand or using low-impact construction methods where feasible to avoid unnecessary disturbance to existing streambeds, banks, and riparian vegetation. The final location and extent of individual enhancement measures may be field-adjusted based on existing channel conditions, provided that the work remains consistent with the approved mitigation objectives, performance standards, and target functional improvements. Such field adjustments will be made under the direction of the restoration ecologist and construction manager.

Mitigation Site Selection

The primary consideration in selecting the mitigation sites was the rehabilitation of aquatic resource functions within a watershed previously affected by mining, logging, and deforestation. In-stream functions, including hydrology, biogeochemical cycling, and habitat, as well as associated riparian functions, have been negatively affected by these historical activities. The selected mitigation reaches provide opportunities to improve these functions through a combination of stream restoration, stream enhancement, riparian restoration, and watershed reclamation.

Additional watershed benefits will result from reclamation activities associated with the remining project, including the elimination of abandoned highwalls, erosional gullies, outslope

spoil piles, and other features that have altered natural drainage patterns and contributed to watershed degradation.

Stream Mitigation Plan
The applicant proposes to increase stream and riparian functions within the mitigation areas through a combination of restoration and enhancement activities using natural stream design principles. The type and intensity of treatment will be based on existing conditions and the functional needs of each reach.

Restoration reaches will receive more comprehensive channel treatments where necessary to establish stable pattern, profile, dimension, substrate, and in-stream habitat conditions consistent with the applicable reference conditions.

Enhancement reaches will generally retain existing stable channel morphology and will receive targeted treatments intended to correct specific functional deficiencies while minimizing unnecessary disturbance to existing streambeds, banks, and riparian vegetation. Full channel reconstruction is not proposed within enhancement reaches unless localized instability or other site-specific conditions require corrective work.

A) Stabilization of Stream Banks

Proposed mitigation activities will include stabilization of actively eroding or unstable banks within both restoration and enhancement reaches. As documented by the site photographs and functional assessment results, bank instability occurs within portions of the proposed mitigation areas.

Within restoration reaches, stabilization may include regrading steep, incised, or highly eroded banks and reconstructing channel banks where necessary to establish the proposed channel geometry. Boulders, logs, native vegetation, and other natural materials may be incorporated to provide lateral and vertical stability.

Within enhancement reaches, bank stabilization will be targeted to areas exhibiting active erosion or instability. Stable existing banks will generally remain undisturbed. Where feasible, localized enhancement work will be completed by hand or using low-impact construction methods to minimize disturbance to existing channel and riparian conditions.

B) In-Stream Habitat and Grade-Control Enhancements

A combination of natural stream structures will be used, as appropriate to individual reach conditions, to improve aquatic habitat, provide grade control, dissipate energy, and increase channel stability. Structures may include rock vanes, log vanes, cross vanes, step-pool sequences, cascades, constructed pools, and combinations of rock and large woody material.

Structure type, location, and spacing will be selected based on channel slope, bankfull dimensions, reference reach conditions, and the existing morphology of each mitigation reach.

Pool-to-pool spacing and grade-control spacing will be designed to be consistent with the target dimensions and geomorphic characteristics identified for the applicable reach.

Within enhancement reaches, structures will be incorporated selectively where needed to address an identified habitat, stability, or grade-control deficiency rather than uniformly reconstructing the existing channel.

C) Placement of Large Woody Debris and Snags

Locally available large woody debris (LWD) may be incorporated within the stream channel and riparian areas to increase habitat complexity, provide cover and organic matter inputs, and support macroinvertebrate and amphibian habitat. Where appropriate, woody material may also be incorporated into bank stabilization and in-stream structures.

Existing woody debris and snags that provide beneficial habitat and do not compromise channel stability will be retained where practicable. Additional snags or woody habitat features may be established within riparian areas where appropriate.

D) Velocity Dissipation and Grade Control

Velocity-dissipating and grade-control structures will be installed where necessary based on channel slope, existing stability, and proposed channel conditions. Depending on reach-specific conditions, these measures may include rock vanes, log vanes, cross vanes, step-pool sequences, cascades, and other natural stream design features.

Larger intermittent and perennial reaches will receive appropriately sized and spaced structures based on bankfull dimensions, channel slope, reference conditions, and anticipated hydraulic conditions. Existing stable grade controls and natural bed features within enhancement reaches will be retained where practicable and incorporated into the overall mitigation design.

E) Riparian Zone Plantings

Riparian areas will be planted with native trees and shrubs at a target density of 300 stems per acre, with an 80-percent survival goal. Plantings will generally extend a minimum of 50 feet from each side of restored or enhanced stream reaches, or to the existing natural canopy where it occurs within that distance.

Existing mature native trees and established riparian vegetation within enhancement reaches will be retained to the maximum extent practicable. Supplemental planting within these reaches will focus on increasing native woody vegetation, improving species richness, replacing invasive vegetation where appropriate, and achieving the proposed riparian functional improvements.

These mitigation activities are intended to improve hydrologic, biogeochemical, habitat, and riparian functions while restoring or enhancing natural stream characteristics within previously disturbed portions of the watershed. The proposed HGM functional conditions and anticipated functional lift for the mitigation reaches are presented in Appendix C.

Table 3. Successful Stream Mitigation Reporting Parameters		
PARAMETER	**SUCCESS**	**METHOD**
Geomorphology	Geomorphology Similar to Approved Plans	Photo Documentation/ Longitudinal Profile; Cross-sections
Hydrology, Biogeochemical Cycling, Habitat	Lift in Overall FCUs Across the Site	HGM
Riparian Zone	50' on Each Side of Mitigation Channels Planted*/ 300 Stems per Acre (80% Surviving); Including Volunteers	Stem Count; Measure Planted Riparian Zone Width

*Or until natural canopy is reached.

Geomorphology

1. Permanent cross-sections will be located using stakes or other permanent stationing landmarks.
2. Photo documentation will be included in the annual reports. Photos will be taken at permanent photo monitoring points which will be established along the mitigation reaches.
3. One longitudinal profile will be measured to document as-built conditions after final construction activities have been completed. One additional profile will be completed during year five of monitoring and compared to the target conditions.

Habitat

Existing habitat scores at the proposed mitigation site were assessed using the HGM method. These sheets are contained in Appendix B and are summarized in Table 4. HGM scores will be assessed along the restored mitigation areas during years 1, 3, and 5 of the monitoring program (Table 4). The functional capacity index (FCI) ranges from 0.0-1.0 and is a measure of the functional capacity of the assessment site relative to a reference standard reach.

Table 4. Projected HGM Summary for Stream Mitigation Sites							
Site Location ID	**Reach ID**	**Existing Linear Feet**	**Existing FCI**	**Existing FCU**	**Proposed Linear Feet**	**Proposed FCI**	**Proposed FCU**
UT Cranes Creek	S3 / Int	844	0.54	456	1292	0.72	930
Cranes Creek	S4 / Int	785	0.51	398	873	0.67	585
Cranes Creek	S4 / Per	142	0.50	71	142	0.58	82
UT Cranes Creek	S4A / Int	1060	0.51	537	699	0.67	468
UT Cranes Creek	S5 / Int	1201	0.52	629	863	0.65	561
UT Cranes Creek	S8 / Int	513	0.58	299	422	0.71	300
UT Cranes Creek	S8 / Per	368	0.57	209	368	0.8	294
UT Cranes Creek	S9 / Int	454	0.61	277	509	0.83	422
UT Clear Fork	S12 / Int	673	0.62	415	673	0.83	559
Total		**6,040**		**3,289**	**5,841**		**4,202**
FCUs Proposed in Mitigation Areas							**4,202**
Total FCUs Impacted by Project							**-3,289**
Net FCU Increase				**28%**			**913**

The FCI scores for the restoration sites 5 years after mitigation are proposed to achieve 0.58-0.83. This equates to an overall lift of 913 FCUs (28%).

Riparian Zone

The riparian zones of the restoration and relocation areas will be planted during the dormant season, following the final construction activities. Plantings will include, at minimum, a 50’ wide corridor using a variety of native trees and shrubs, as indicated by the tree planting list. One permanent and one random 0.25-acre tree plot for stem counts and riparian zone width determinations will be located along each mitigation area.

Timing

The proposed re-mining activity will commence as soon as possible after the Section 404 permit is issued (2026). The permittee shall implement the restoration work plan and complete the initial construction and plantings no later than 1 year from the date of initiating stream impacts on the corridor, mine-through and stream relocation areas. Restoration efforts at pond sites will commence after the ponds are no longer needed for sediment control according to the SMCRA permit (approximately 5 years). All mitigation sites will be monitored over a five-year period after the construction is complete, with all mitigation monitoring projected to be completed by the year 2036.

Monitoring and Management Program

The monitoring and management plan will evaluate the success of the mitigation as described in the previous sections. It will include annual inspection and grading of the mitigation areas, beginning the following year after stream restoration efforts are initially completed. Those items listed above will be examined and reported to the USACE in an annual monitoring report before January 31st of the following year. Monitoring will be conducted for a period extending through 5 years after the mitigation efforts are completed. The reports, guided by current USACE guidelines, will include photographs and assessment locations noted on site plan views, successes and/or failures of the mitigation efforts, and descriptions of any maintenance efforts

performed the previous year. Adaptive management will be utilized to address any challenges presented on-site, and results from monitoring will be evaluated by the applicant with management measures taken when necessary to achieve mitigation success. USACE will be provided access to the mitigation areas during the monitoring period to ensure the project is successful.

Table 5. Mitigation Monitoring Timeline					
PARAMETER	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Geomorphology					
Cross-sections	X		X		X
Longitudinal Profile	X				X
OHWM Indicators	X	X	X	X	X
Functional Assessment					
HGM	X		X		X
Riparian Zone					
Stem Count/Measure Width		X		X	X

Site Protection Measures
The applicant will maintain the mitigation areas for the full agreed upon life of the mitigation project.

Long-term Management
The mitigation areas will be monitored annually, which will provide guidance for management activities if needed. As illustrated by the plan views, proposed permanent photo points, and cross sections will be established within the stream restoration sites. Riparian areas along the restored streams will also be monitored annually to ensure that the projected riparian zone widths and stem counts are met by the end of the mitigation project.

Responsible Parties
The applicant is responsible for the implementation of the mitigation efforts:

(1) The Applicant:
Nally & Hamilton Enterprises, Inc.
195 Commercial Drive, Suite 105
London, KY 40744

(2) Preparer of PCN:
Waypoint, LLC
2343 Alexandria Dr. Suite 140
Lexington, KY 40504

Adaptive Management Plan
If the mitigation performance measures have not been met by the end of the 5-year mitigation monitoring schedule, an alternate mitigation plan would be provided to USACE for approval.

6) ENDANGERED SPECIES ACT (ESA)

Correspondence for Section 7 of the ESA is included in Appendix G.

7) NATIONAL HISTORIC PRESERVATION ACT

According to the KDNR correspondence dated October 11, 2023, no archaeological survey was requested for this project due to the amount of previous disturbances. See correspondence in Appendix G.

8) CLEAN WATER ACT SECTIONS 401 AND 402

The General Section 401 Water Quality Certification (WQC) is pending, and the CWA Section 402 Kentucky Pollutant Discharge Elimination System (KPDES) general permit has been approved (Appendix G).

Appendix A
Site Location Maps

Cranes Creek 807-0501 NW49 Impacts and Mitigation						
Feature ID	Regime	Impact Type	Mitigation Type	Length (ft.)	Mitigation (ft.)	Impact (ft.)
S3	Intermittent	UT Cranes Creek Remine Area	Restoration	823	1,292	844
S3	Intermittent	UT Cranes Creek Corridor Area	Enhancement	469		
S4	Perennial	Cranes Creek Pond Area	Restoration	142	1,015	927
S4	Intermittent	Cranes Creek Pond Area	Restoration	277		
S4	Intermittent	Cranes Creek Corridor Area	Enhancement	448		
S4	Intermittent	Cranes Creek Remine Area	Restoration	148		
S4A	Intermittent	UT Cranes Creek Remine Area	Restoration	699	699	1,060
S5	Intermittent	UT Cranes Creek Pond Area	Restoration	66	863	1,201
S5	Intermittent	UT Cranes Creek Corridor Area	Enhancement	344		
S5	Intermittent	UT Cranes Creek Remine Area	Restoration	453		
S8	Perennial	UT Cranes Creek Pond Area	Restoration	368	790	881
S8	Intermittent	UT Cranes Creek Pond Area	Restoration	96		
S8	Intermittent	UT Cranes Creek Corridor Area	Enhancement	325		
S9	Intermittent	UT Cranes Creek Corridor Area	Enhancement	509	509	454
S12	Intermittent	UT Clear Fork Pond Area	Restoration	655	673	673
S12	Intermittent	UT Clear Fork Corridor Area	Enhancement	19		
Total					**5,839**	**6,040**
Cranes Creek 807-0501 NW14 Existing Road Crossings						
S2	Intermittent	UT Cranes Creek Road Crossing	---	105	---	---
S3	Intermittent	UT Cranes Creek Road Crossing	---	137	---	---
S4	Perennial	Cranes Creek Road Crossing	---	189	---	---
S15	Intermittent	UT Cranes Creek Road Crossing	---	62	---	---
S15	Intermittent	UT Cranes Creek Road Crossing	---	134	---	---
S15	Intermittent	UT Cranes Creek Road Crossing	---	110	---	---
S16	Perennial	UT Cranes Creek Road Crossing	---	81	---	---
S16	Perennial	UT Cranes Creek Road Crossing	---	102	---	---
Total				**920**		

USACE Permitting Legend

- 807-0501 Permit Boundary
- Proposed Restoration
- Proposed Enhancement

Existing Aquatic Features

- Ephemeral (NRPW)
- Intermittent (RPW:S)
- Perennial (RPW:P)
- Isolated Open Water
- Isolated Wetland
- Open Water
- Wetland

OW11 0.81 ac
ISO OW11 0.29ac
WC 1.69ac
WD 0.18ac
WB 0.1ac
ISO OW8 0.08 ac
OW9 0.43 ac
OW7 0.08 ac
OW1 0.07 ac
OW6 0.74 ac
ISO OW3 0.89 ac
ISO OW4 0.59 ac
ISO OW2 0.29 ac
ISO OW10 0.65 ac
ISO OW5 0.03 ac

THIS ELECTRIC TRANSMISSION LINE NO LONGER EXISTS NOTHING FOUND DURING FIELD VISITS APPEARS TO BE REMOVED PRIOR TO 1995 WHEN VIEWING GOOGLE EARTH TIMELINE PHOTOS

0 1,000 2,000 Feet

FIGURE 1. KDNR# 807-0501 ALTERATION AND MITIGATION MAP ON THE MRP

PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 8/18/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	
WPT#: 2025-63	

Nally & Hamilton Enterprises, Inc. | WAYPOINT, LLC

MINING AND RECLAMATION PLAN MAP/ ENVIRONMENTAL RESOURCES INFORMATION MAP

COMPANY NAME: NALLY & HAMILTON ENTERPRISES, INC.
ADDRESS: P.O. BOX 157, 109 SOUTH 4TH STREET, BARDSTOWN, KENTUCKY 40004
PERMIT #: 807-0501 ACTION TYPE: MTS-01
QUADRANGLE: VARILLA, MIDDLESBORO NORTH COUNTY: BELL MAP SCALE: 1"-500'
LATITUDE: 36°39'53.4" LONGITUDE: 83°38'53.2" CONTOUR INTERVAL: 40'
LOCATION IN DETAIL: Located at the end of KY188 approximately 0.98 miles northeast of intersection of KY188 and KY516
NEAREST PUBLIC ROAD INT: 0.98 MILES SW TO KY188 JCT WITH KY516

ACREAGE LEGEND

ACTION (NW)

MINING TYPE	MINE AREAS	SEAM NAME - ELEV.	EX	ADDED DELETED	REDESIG-NATED	TOTAL
CONTOUR	APPROVED / PROPOSED	Mason - +/-1580'	239.4	-	-	239.4
		-	-	-	-	-
		TOTAL MINING ACREAGE	239.4	-	-	239.4
ROADS			AVG. WIDTH	LENGTH		
ACCES & HAUL ROADS	1		80'	5,605'	10.3	-	-	10.3
	2		150'	3,760'	13.0	-	-	13.0
	3		160'	180'	0.7	-	-	0.7
	4		100'	13,420'	30.8	-	-	30.8
	5		100'	3,665'	8.4	-	-	8.4
	6		100'	8,510'	19.5	-	-	19.5
	PR1		106'	1,025'	2.5	-	-	2.5
	PR2		97'	405'	0.9	-	-	0.9
	PR3		94'	930'	2.0	-	-	2.0
	PR4		53'	580'	0.7	-	-	0.7
	PR5		75'	3,150'	5.4	-	-	5.4
	PR6		90'	500'	1.1	-	-	1.1
	TOTAL ROAD ACREAGE				95.3	-	-	95.3
SILT STRUCTURES	TOTAL # 25							
	SEDIMENT CHANNEL				INCL.	INCL.	-	INCL.
	EMBANKMENT POND 1				4.1	-	-	4.1
	EMBANKMENT POND 2				2.8	-	-	2.8
	EMBANKMENT POND 3				1.9	-	-	1.9
	EMBANKMENT POND 4				1.7	-	-	1.7
	TOTAL POND ACREAGE				10.5	-	-	10.5
SPOIL STORAGE AREAS	FILL 1				3.8[1]	-	-	3.5
	FILL 2				7.9[1]	-	-	7.5
	FILL 3				2.6[1]	+0.4	-0.1	1.7
	FILL 4				3.9[1]	-	-	3.0
	FILL 5				1.5[2]	-1.2[2]	-0.3	0.0
	FILL 6				1.8[2]	-1.2[2] +0.4	-0.5	0.0
	TOTAL SPOIL ACREAGE				21.6[1]	+0.4	-0.9	15.7

1 - 3.2 acres of fills overlie mine area as follows:
(HF1-0.3 AC, HF2-0.4 AC, HF3-0.7 AC, HF4-0.8 AC, HF4-0.5 AC), HF5-0.5 AC, HF6-0.8 AC, HF6-0.5 AC, HF6-0.5 AC, HF6-0.1 AC
2 - 2.9 acres being deleted includes overlays of mine area from HF5=0.4 AC and HF6=0.5 AC.
3 - 3.0 acres being added to HF3 overlies mine area and is included in the mine area.
The 0.9 acres being redesignated as follows:
0.1 acres of HF3 being redesignated to DC5,
0.3 acres of HF5 being redesignated to DC5,
0.5 acres of HF6 being redesignated to DC5.

OTHER AREAS DRAINAGE CORRIDORS	DC1	0.4	-	- 0.4
	DC2	0.1	-	- 0.1
	DC3	0.4	-	+0.1 0.5
	DC4-1	0.6	-	- 0.6
	DC4-2	0.4	-	- 0.4
	DC5	0.1	-	+0.3 0.4
	DC6	0.1	-	+0.5 0.6
	TOTAL DRAINAGE CORRIDOR ACREAGE	2.1	-	+0.9 3.0
MINE MANAGEMENT AREAS	MMA1	1.9	-	- 1.9
	MMA2	2.6	-	- 2.6
	TOTAL MINE MANAGEMENT AREA ACREAGE	4.5	-	- 4.5
EXPLOSIVE STORAGE AREAS	ESA1	0.8	-	- 0.4
	ESA2	0.7	-	- 0.1
	ESA3	0.5	-	- 0.4
	ESA4	0.5	-	- 0.6
	TOTAL EXPLOSIVE STORAGE AREA ACREAGE	2.5	-	- 2.5
	TOTAL SURFACE DISTURBANCE	375.9[1,2]	-2.9[2] +5.3[1]	- 370.9
AUGER/HW MINE SHADOW AREA				
APPROVED / PROPOSED / DELETED	Mason	-	-	- -
	TOTAL PERMIT AREA	375.9[1,2]	-2.9[2] +5.3[1]	- 370.9

SYMBOL LEGEND

- APPROVED SURFACE PERMIT AREA
- PROPOSED SURFACE PERMIT AREA
- APPROVED AUGER/HW MINING SHADOW AREA
- PROPOSED AUGER/HW MINING SHADOW AREA
- DELETED PERMIT AREA
- ADJACENT PERMIT AREA
- MINERAL/LEASE LINE
- PROPERTY LINE
- GAS LINE w/50' buffer zone
- POWER LINE
- BERMS/WINDROWS
- EXISTING HIGHWALL
- STREAM
- COAL OUTCROP
- ALTERNATE SEGMENT POSITION
- SLOPE
- WATERSHED BOUNDARY
- WATER LINES, PINEVILLE UTILITY COMMISSION
- EPHEMERAL
- INTERMITTENT
- PERENNIAL
- NATURAL DRAINAGE
- CONTROLLED DRAINAGE
- CULVERT
- ROAD DITCH
- ROAD DIVERSION DITCH
- FILL DITCH
- UNDERGROUND MINE OPENING
- EXISTING UNDERGROUND WORKINGS
- PRE-LAW MINE AREA
- OIL WELL
- GAS WELL w/100' buffer zone
- CORE/DRILL HOLE
- WELL
- SURFACE/WATER USER
- GROUNDWATER FLOW
- MASON SEAM UNDERGROUND WORKS
- NALLY & HAMILTON PERMIT (807-0501)
- AREA DELETED BY THIS ACTION
- SURFACE WATER MONITORING STATION
- GROUNDWATER MONITORING STATION
- STOCK WATER MONITORING STATION
- BUILDING AND NUMBER
- GW FLOW DIRECTION
- WATERSHED DESIGNATION & ACREAGE
- GEOLOGIC SAMPLE SITE
- GROUNDWATER USER
- EXPLOSIVE STORAGE AREA
- ALTERNATE TOPSOIL SAMPLE SITE
- ALTERNATE TOPSOIL STORAGE SITE
- EXISTING SLOG AREAS

VEGETATIVE TYPES
FL = FORESTLAND
ML = MINED LANDS
R = RESIDENTIAL

BOUNDARY DISCLAIMER

THE PROPERTY LINES SHOWN ON THIS MAP ARE LOCATED APPROXIMATELY, ONLY FOR INFORMATIONAL PURPOSES, AND ARE FOR THE EXCLUSIVE USE OF THE PERMITTEE. THIS DOCUMENT IS NOT A PROPERTY SURVEY AND SHOULD NOT BE CONSTRUED AS SUCH. DO NOT USE THIS DOCUMENT IN THE PREPARATION OF DEEDS OR TRANSFER OF PROPERTY. PROPERTY LINES AND OWNERSHIP FURNISHED BY OTHERS. THIS DOCUMENT DOES NOT MEET THE MINIMUM STANDARDS FOR A BOUNDARY SURVEY AS PROMULGATED BY THE KENTUCKY STATE BOARD OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS. NO CERTIFICATION IS BEING MADE OR IMPLIED AS TO THE CORRECTNESS OR AUTHENTICITY OF ANY INFORMATION RELATIVE TO THE PROPERTY BOUNDARIES SHOWN.

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THIS DOCUMENT IS THE PROPERTY OF NALLY & HAMILTON ENTERPRISES, INC. AND SHALL NOT BE REPRODUCED IN WHOLE OR IN PART, OR USED IN THE CONSTRUCTION OF ANY PROJECT OTHER THAN THIS SPECIFIC PROJECT WITHOUT THE WRITTEN PERMISSION OF A REPRESENTATIVE OF NALLY & HAMILTON ENTERPRISES, INC.

Engineer's notes:

1. The engineer is hereby certifying changes to the map that are related to this permitting action only.
2. The source of the base map came from USGS 7-1/2 minute quadrangle.
3. The property lines shown on the map were supplied by others and are for the purpose of mine permitting under KRS 350 and are adequate for its intended purpose the lines are approximate and not to be used for boundary purposes. The engineer is not certifying the property line locations nor ownership of any kind. Only the property lines that cross or are adjacent to the proposed permitted area are shown.
4. Call 811 and field verify all utility locations before commencing any excavation. Contact the company responsible for each utility found, to locate and mark lines in the field. All utility lines and structure locations should be field checked prior to disturbance within a safe distance and at a minimum of 1000 feet of planned disturbance.
5. Locations of utility lines and structures on this map are approximate and are not to be relied up as to the exact location of each. Not all utility lines and structures may be shown. Owners of utility lines should be contacted before working in or around an area that contains utility lines. All utility line locations shown have been obtained by independent research. Contact 811 and/or the appropriate utility for certification of the location or extent of the utility lines shown. Utility includes gas lines & wells, electric lines & structures, water lines, sewer lines etc.). For Gas Line and well locations call Anderson Oil, Mike Sanders at 859-268-7747, or by email at mseagas@aol.com. For Water Lines contact Pine Knoll's, Utility Commission at 606-337-6615. For Power and Transmission Lines contact Kentucky Utilities, John Eichman at 859-357-9283.
6. The locations and extents of the underground mines shown are approximate and obtained from the Kentucky Mine Mapping Initiative. Adequate means of verifying the final extent of the underground mining should be used for safety purposes. This map should not be relied upon as the exact locations and extents. Please contact the appropriate personnel responsible for making the maps for certification of the location and extents. The known mine lacrose numbers for each map are shown for each mine. Not all underground works in the area may be mapped or shown.
7. The locations of the dwellings & structures on this map was taken from usgs mapping and aerial photography. All dwellings & structures should be field verified as needed prior to mining within a safe distance and at a minimum of 1000 feet of planned disturbance.
8. The user of this map is responsible reviewing, understanding and checking the information contained on this map. Any user of this map should also seek written authorization to use this map from the engineer prior to any disturbance. Written authorization will be given from the engineer once the map features are reviewed with the user. The engineer takes no responsibility for any situation that may occur with the unauthorized use of this map. It should be understood that since mapping features change with time that the features shown on this map may not be in the exact location on the ground. If any features may have been constructed after this map was formed.
9. The certification extends solely for the specific purpose noted herein for this regulatory permitting action and no representation or warranty, whether express, implied or statutory, applies to facility for any damages that may arise from the use of this map by anyone outside of this specific purpose, or for any damages that may occur due to anyone's improper use or understanding of this map, for anyone's non-compliance with any federal, state or local regulations, laws, and statutes, for anyone's failure to field check features or for anyone's failure to operate and maintain equipment per any manufacturer's recommendations while implementing any related action or plan.

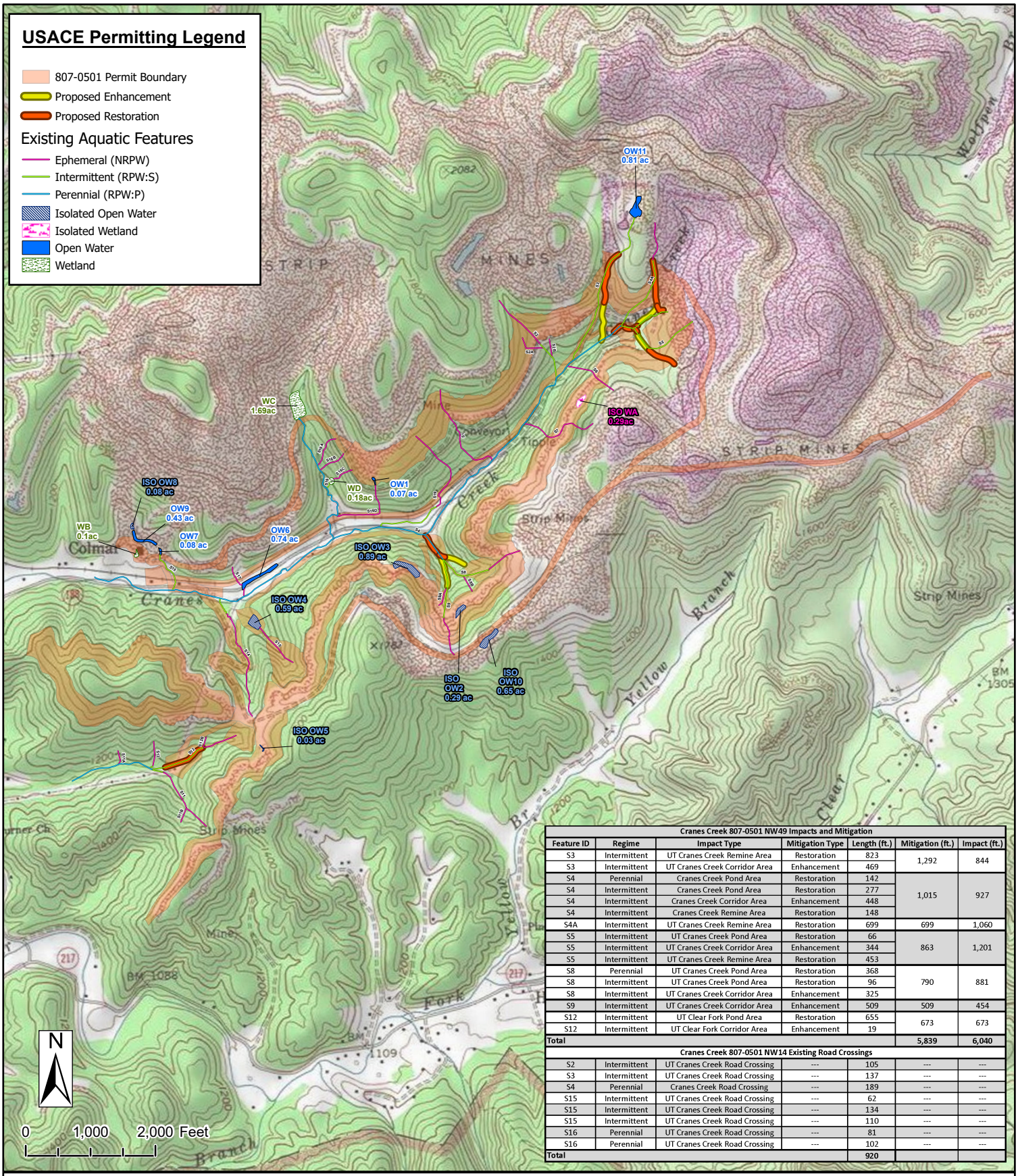
Nally & Hamilton Enterprises, Inc.
Engineering Office
195 Commercial Drive, Suite 105
London, Kentucky 40744
Ph: (606) 878-1500
email: nheinc@nallyandhamilton.com

Permit #807-0501 MTS-01

Colmar Mason Seam #2

MRP-ERI Map

MTS01_MrpEri_Map.dwg	06/17/2026	Scale 1"=500'



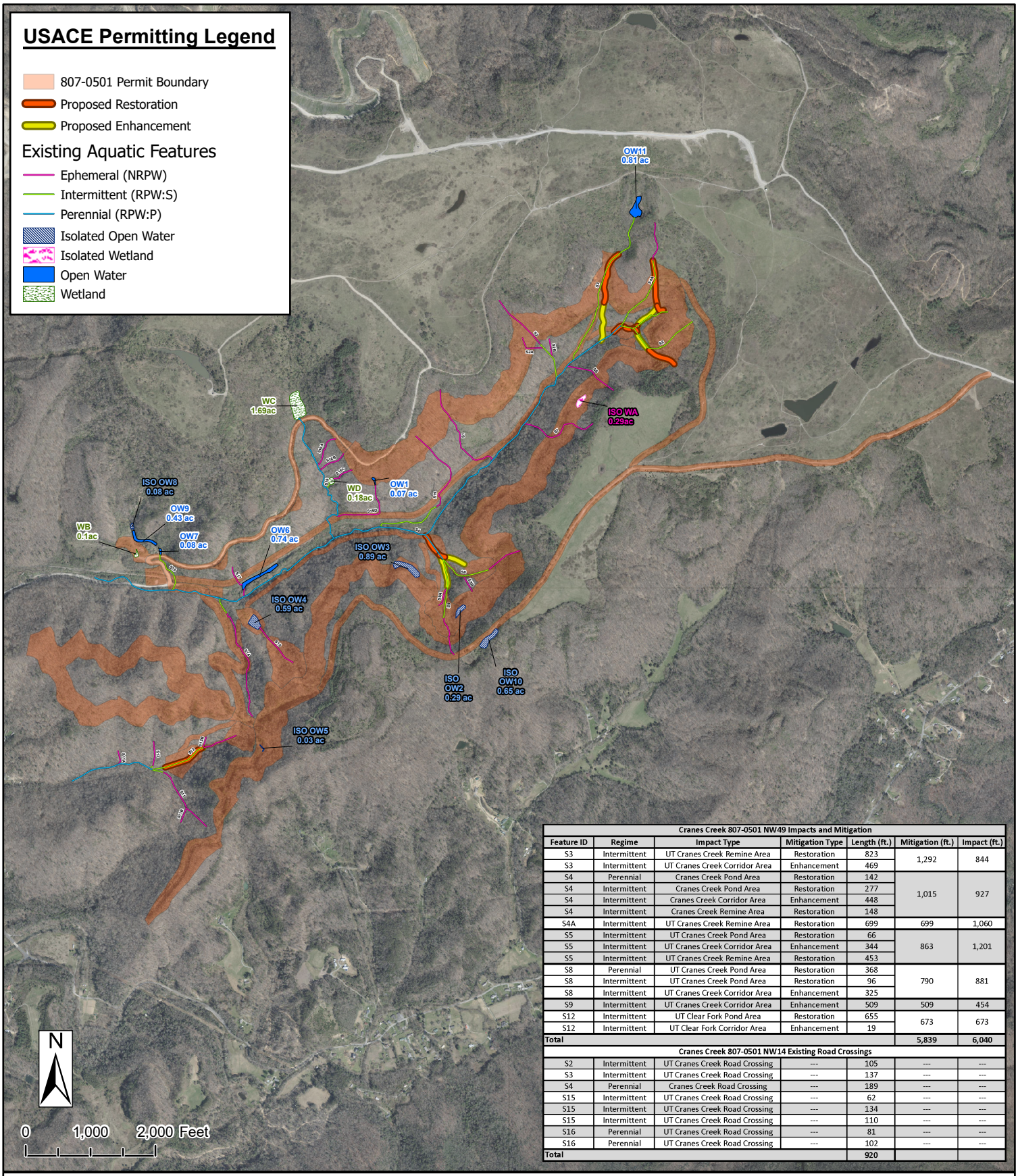
Cranes Creek 807-0501 NW49 Impacts and Mitigation						
Feature ID	Regime	Impact Type	Mitigation Type	Length (ft.)	Mitigation (ft.)	Impact (ft.)
S3	Intermittent	UT Cranes Creek Remine Area	Restoration	823	1,292	844
S3	Intermittent	UT Cranes Creek Corridor Area	Enhancement	469		
S4	Perennial	Cranes Creek Pond Area	Restoration	142	1,015	927
S4	Intermittent	Cranes Creek Pond Area	Restoration	277		
S4	Intermittent	Cranes Creek Corridor Area	Enhancement	448		
S4	Intermittent	Cranes Creek Remine Area	Restoration	148		
S4A	Intermittent	UT Cranes Creek Remine Area	Restoration	699	699	1,060
S5	Intermittent	UT Cranes Creek Pond Area	Restoration	66	863	1,201
S5	Intermittent	UT Cranes Creek Corridor Area	Enhancement	344		
S5	Intermittent	UT Cranes Creek Remine Area	Restoration	453		
S8	Perennial	UT Cranes Creek Pond Area	Restoration	368	790	881
S8	Intermittent	UT Cranes Creek Pond Area	Restoration	96		
S8	Intermittent	UT Cranes Creek Corridor Area	Enhancement	325		
S9	Intermittent	UT Cranes Creek Corridor Area	Enhancement	509	509	454
S12	Intermittent	UT Clear Fork Pond Area	Restoration	655	673	673
S12	Intermittent	UT Clear Fork Corridor Area	Enhancement	19		
Total					5,839	6,040
Cranes Creek 807-0501 NW14 Existing Road Crossings						
S2	Intermittent	UT Cranes Creek Road Crossing	---	105	---	---
S3	Intermittent	UT Cranes Creek Road Crossing	---	137	---	---
S4	Perennial	Cranes Creek Road Crossing	---	189	---	---
S15	Intermittent	UT Cranes Creek Road Crossing	---	62	---	---
S15	Intermittent	UT Cranes Creek Road Crossing	---	134	---	---
S15	Intermittent	UT Cranes Creek Road Crossing	---	110	---	---
S16	Perennial	UT Cranes Creek Road Crossing	---	81	---	---
S16	Perennial	UT Cranes Creek Road Crossing	---	102	---	---
Total				920		

FIGURE 2. KDNR# 807-0501 ALTERATION AND MITIGATION TOPOGRAPHIC MAP

Nally & Hamilton Enterprises, Inc.

PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 8/18/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC



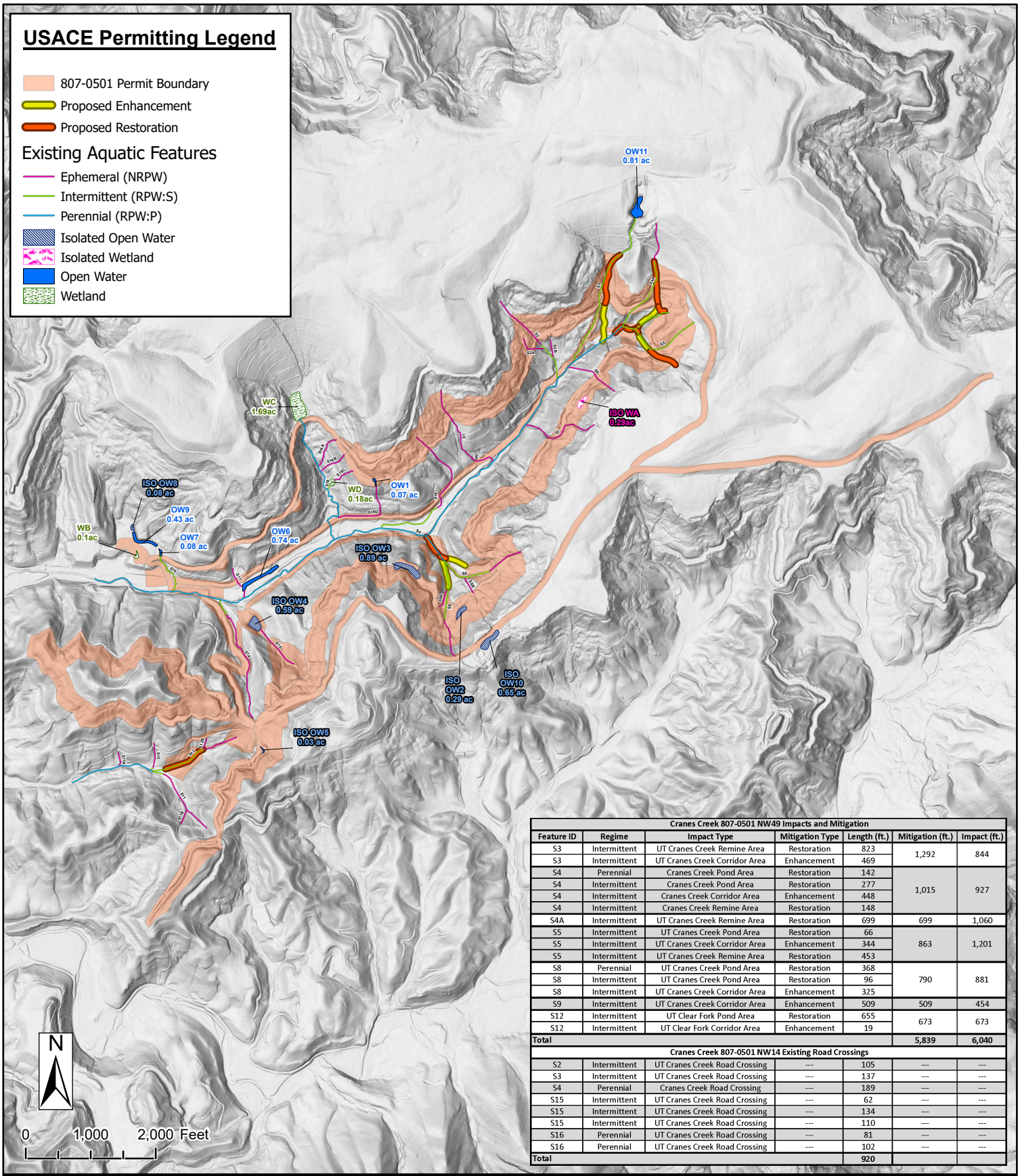
Cranes Creek 807-0501 NW49 Impacts and Mitigation						
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Total					5,839	6,040
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S16	Perennial	UT Cranes Creek Road Crossing	---	81	---	---
S16	Perennial	UT Cranes Creek Road Crossing	---	102	---	---
Total				920		

FIGURE 3. KDNR# 807-0501 ALTERATION AND MITIGATION MAP ON THE 2023 KYAPED 3IN ORTHOIMAGE

Nally & Hamilton Enterprises, Inc.

PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 8/18/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC



Cranes Creek 807-0501 NW49 Impacts and Mitigation						
Feature ID	Regime	Impact Type	Mitigation Type	Length (ft.)	Mitigation (ft.)	Impact (ft.)
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S16	Perennial	UT Cranes Creek Road Crossing	---	102	---	---
Total				920		

FIGURE 4. KDNR# 807-0501 ALTERATION AND MITIGATION MAP ON THE KYAPED 2FT DEM MULTIDIRECTIONAL HILLSHADE

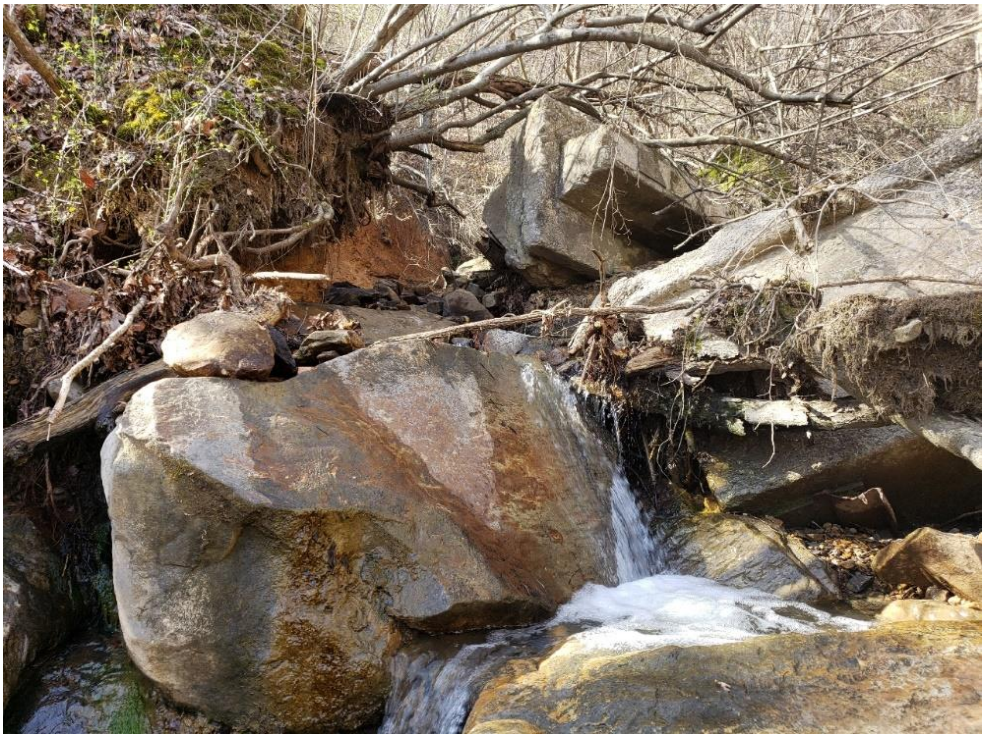
Nally & Hamilton Enterprises, Inc.

PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 8/18/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC

Appendix B
Existing Conditions

Part 1: Site Photographs



Former Stream 3 Road Flow Path, Looking North, Upslope
Photo Point 1 | **2023-02-23** | Lat. 36.67643°, Long. -83.62518°



Former Stream 3 Road Flow Path, Looking South, Downslope
Photo Point 1 | **2023-02-23** | Lat. 36.67643°, Long. -83.62518°



Abandoned Stream 3 Road Flow Path, Looking North, Upslope
Photo Point 1 | **2026-01-06** | Lat. 36.67635°, Long. -83.62504°



Abandoned Stream 3 Road Flow Path, Looking South, Downslope
Photo Point 1 | **2026-01-06** | Lat. 36.67635°, Long. -83.62504°



Stream 3, Existing Cross Section Location, Looking North, Upslope
Photo Point 2 | 2026-01-06 | Lat. 36.67668°, Long. -83.62503°



Stream 3, Flow has returned to Natural Valley, Looking South, Downslope
Photo Point 3 | 2026-01-06 | Lat. 36.67627°, Long. -83.62498°



Stream 4A, Existing Cross Section Location, Looking North, Upslope
Photo Point 4 | 2026-01-06 | Lat. 36.67652°, Long. -83.62315°



Stream 4A, Looking South, Downslope
Photo Point 4 | 2026-01-06 | Lat. 36.67652°, Long. -83.62315°



Stream 4 Intermittent, Existing Cross Section Location, Looking North, Upslope
Photo Point 5 | 2026-01-06 | Lat. 36.67611°, Long. -83.62192°



Stream 4 Intermittent, Looking South, Downslope
Photo Point 5 | 2026-01-06 | Lat. 36.67611°, Long. -83.62192°



Stream 4 Perennial, Looking East, Upslope
Photo Point 6 | 2026-01-06 | Lat. 36.67548°, Long. -83.62354°



Stream 4 Perennial, Looking West, Downslope
Photo Point 6 | 2026-01-06 | Lat. 36.67548°, Long. -83.62354°



Stream 5, Existing Cross Section Location, Looking South, Upslope
Photo Point 7 | 2026-01-06 | Lat. 36.67476°, Long. -83.62277°



Stream 5, Looking North, Downslope
Photo Point 7 | 2026-01-06 | Lat. 36.67476°, Long. -83.62277°



Stream 8 Intermittent, Existing Cross Section Location, Looking South, Upslope
Photo Point 8 | 2026-01-06 | Lat. 36.66558°, Long. -83.63339°



Stream 8 Intermittent, Looking North, Downslope
Photo Point 8 | 2026-01-06 | Lat. 36.66558°, Long. -83.63339°



Proposed Corridor for Stream 8 Intermittent Relocation, Looking South, Upslope
Photo Point 9 | 2026-01-06 | Lat. 36.66619°, Long. -83.63364°



Proposed Corridor for Stream 8 Intermittent Relocation, Looking North, Downslope
Photo Point 9 | 2026-01-06 | Lat. 36.66619°, Long. -83.63364°



Stream 8 Perennial, Looking South, Upslope

Photo Point 10 | 2026-01-06 | Lat. 36.66677°, Long. -83.63446°



Stream 8 Perennial, Looking North, Downslope

Photo Point 10 | 2026-01-06 | Lat. 36.66677°, Long. -83.63446°



Stream 9, Existing Cross Section Location, Looking South, Upslope

Photo Point 11 | 2026-01-06 | Lat. 36.66505°, Long. -83.63342°



Stream 9, Looking North, Downslope

Photo Point 11 | 2026-01-06 | Lat. 36.66505°, Long. -83.63342°



Stream 12, Existing Cross Section Location, Looking East, Upslope

Photo Point 12 | 2026-01-06 | Lat. 36.65757°, Long. -83.64753°



Stream 12, Looking West, Downslope

Photo Point 12 | 2026-01-06 | Lat. 36.65757°, Long. -83.64753°



Stream 15, Looking North, Upslope
Photo Point 13 | 2025-08-13 | Lat. 36.66519°, Long. -83.6478°



Stream 15, Looking South, Downslope
Photo Point 13 | 2025-08-13 | Lat. 36.66519°, Long. -83.6478°



Stream 16, Looking North, Upslope
Photo Point 14 | 2025-08-14 | Lat. 36.66815°, Long. -83.63915°



Stream 16, Looking South, Downslope
Photo Point 14 | 2025-08-14 | Lat. 36.66815°, Long. -83.63915°

Appendix B
Existing Conditions

Part 2: Existing Cross Sections

Cranes Creek (KDNR# 807-0501)
NWP49 Impact Cross Sections

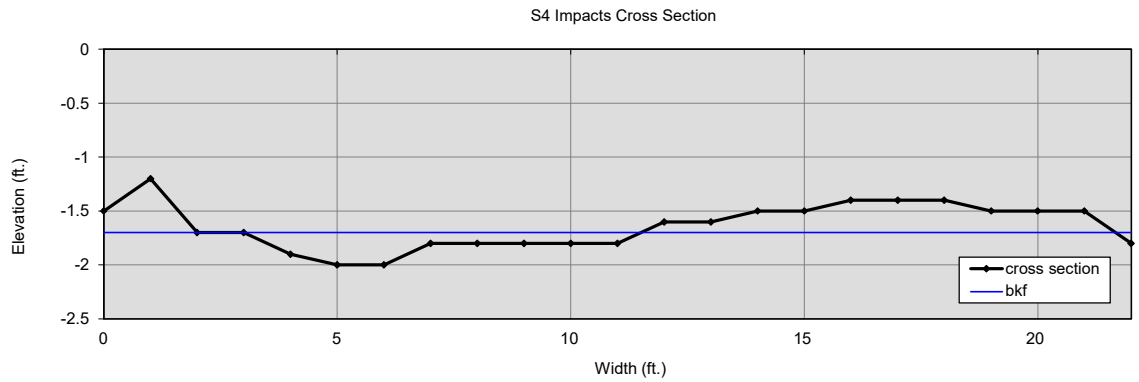
S3 Existing Cross Section



Bankfull Dimensions

3.1	x-section area (ft.sq.)
4.9	width (ft)
0.6	mean depth (ft)
1.1	max depth (ft)
5.4	wetted parimeter (ft)
0.6	hyd radi (ft)
7.7	width-depth ratio

S4 Existing Cross Section



Bankfull Dimensions

1.3	x-section area (ft.sq.)
8.8	width (ft)
0.1	mean depth (ft)
0.3	max depth (ft)
8.9	wetted parimeter (ft)
0.1	hyd radi (ft)
60.4	width-depth ratio

Prepared by:

Prepared for:

WAYPOINT LLC

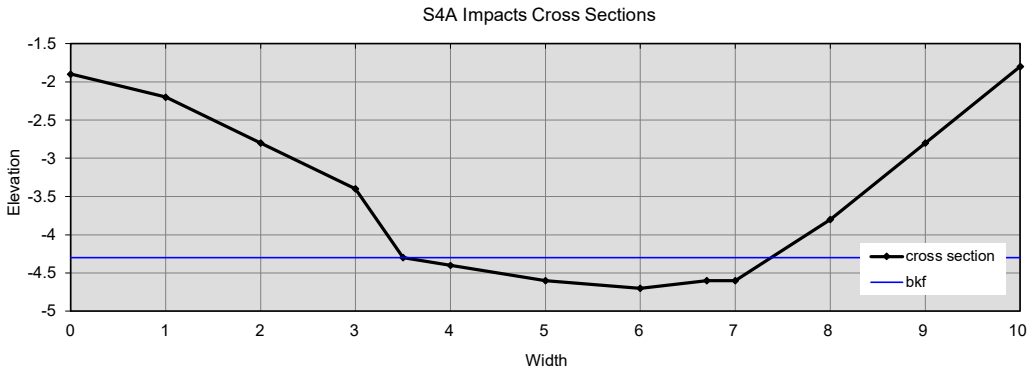
Nally & Hamilton Enterprises, Inc.

Cranes Creek Existing Cross Section of Impacted Streams. Data Obtained: 01/06/2026

PROJECT NAME: Cranes Creek NWP49	PROJECT LOCATION: Bell County, KY
PRINT DATE: 01/08/2026	USACE#: LRN# Pending
KDNR# 807-0501	WP#: 2025-63

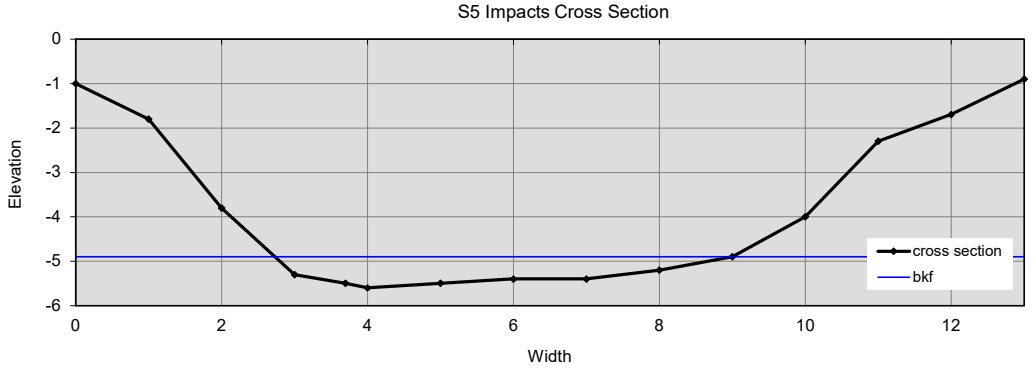
Cranes Creek (KDNR# 807-0501)
NWP49 Impact Cross Sections

S4A Existing Cross Section



Bankfull Dimensions	
1.0	x-section area (ft.sq.)
3.9	width (ft)
0.2	mean depth (ft)
0.4	max depth (ft)
4.0	wetted parimeter (ft)
0.2	hyd radi (ft)
15.5	width-depth ratio

S5 Existing Cross Section



Bankfull Dimensions	
2.8	x-section area (ft.sq.)
6.3	width (ft)
0.5	mean depth (ft)
0.7	max depth (ft)
6.6	wetted parimeter (ft)
0.4	hyd radi (ft)
13.8	width-depth ratio

Prepared by:

Prepared for:

WAYPOINT LLC

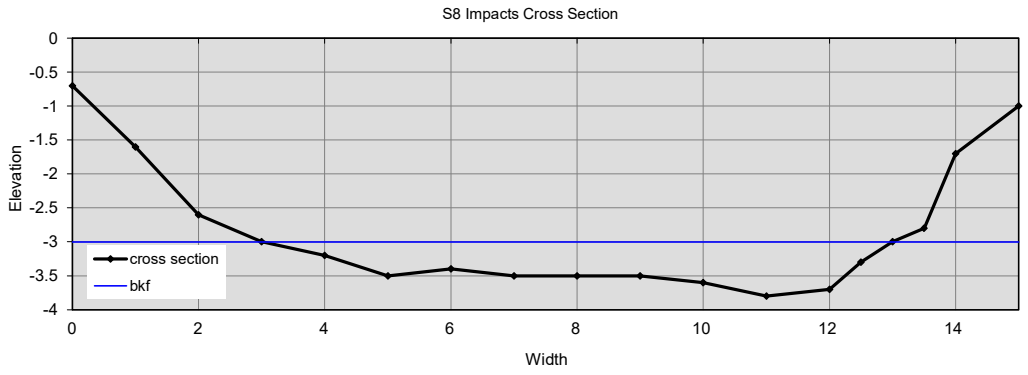
Nally & Hamilton Enterprises, Inc.

Cranes Creek Existing Cross Section of Impacted Streams.
Data Obtained: 01/06/2026

PROJECT NAME: Cranes Creek NWP49	PROJECT LOCATION: Bell County, KY
PRINT DATE: 01/08/2026	USACE#: LRN# Pending
KDNR# 807-0501	WP#: 2025-63

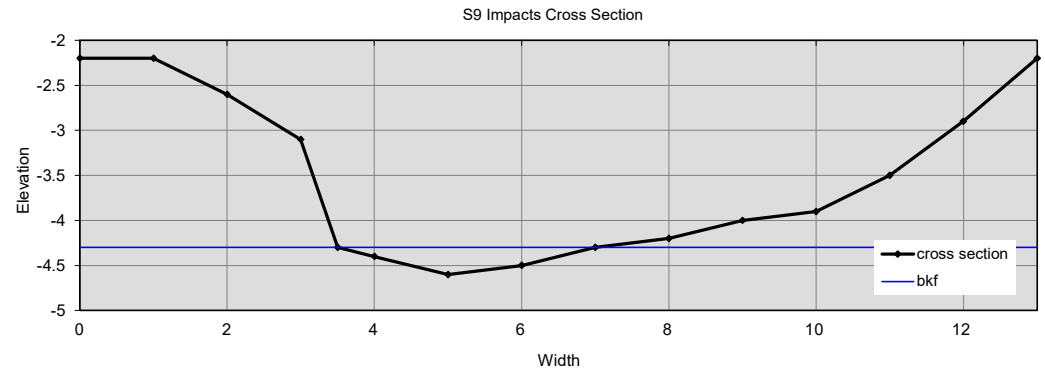
Cranes Creek (KDNR# 807-0501)
NWP49 Impact Cross Sections

S8 Existing Cross Section



Bankfull Dimensions	
4.7	x-section area (ft.sq.)
10.0	width (ft)
0.5	mean depth (ft)
0.8	max depth (ft)
10.3	wetted parimeter (ft)
0.5	hyd radi (ft)
21.4	width-depth ratio

S9 Existing Cross Section



Bankfull Dimensions	
0.6	x-section area (ft.sq.)
3.5	width (ft)
0.2	mean depth (ft)
0.3	max depth (ft)
3.6	wetted parimeter (ft)
0.2	hyd radi (ft)
21.3	width-depth ratio

Prepared by: WAYPOINT LLC

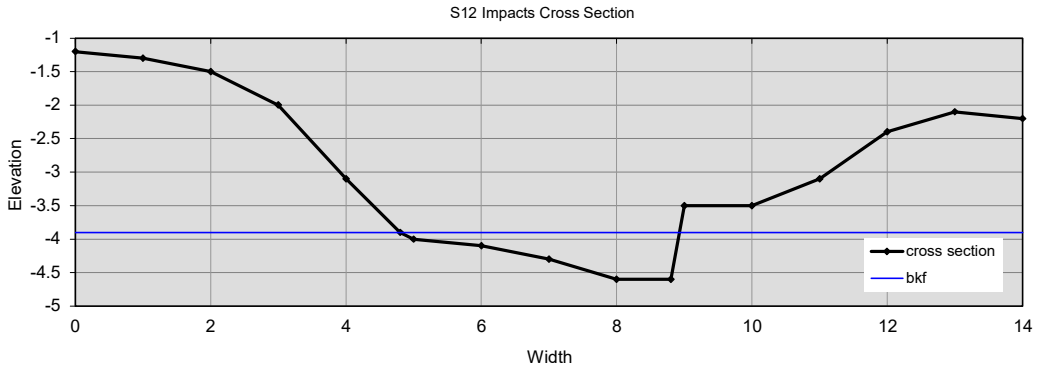
Prepared for: Nally & Hamilton Enterprises, Inc.

Cranes Creek Existing Cross Section of Impacted Streams.
Data Obtained: 01/06/2026

PROJECT NAME: Cranes Creek NWP49	PROJECT LOCATION: Bell County, KY
PRINT DATE: 01/08/2026	USACE#: LRN# Pending
KDNR# 807-0501	WP#: 2025-63

Cranes Creek (KDNR# 807-0501)
NWP49 Impact Cross Sections

S12 Existing Cross Section



Bankfull Dimensions	
1.6	x-section area (ft.sq.)
4.1	width (ft)
0.4	mean depth (ft)
0.7	max depth (ft)
4.8	wetted parimeter (ft)
0.3	hyd radi (ft)
10.6	width-depth ratio

Prepared by: WAYPOINT LLC

Prepared for: Nally & Hamilton Enterprises, Inc.

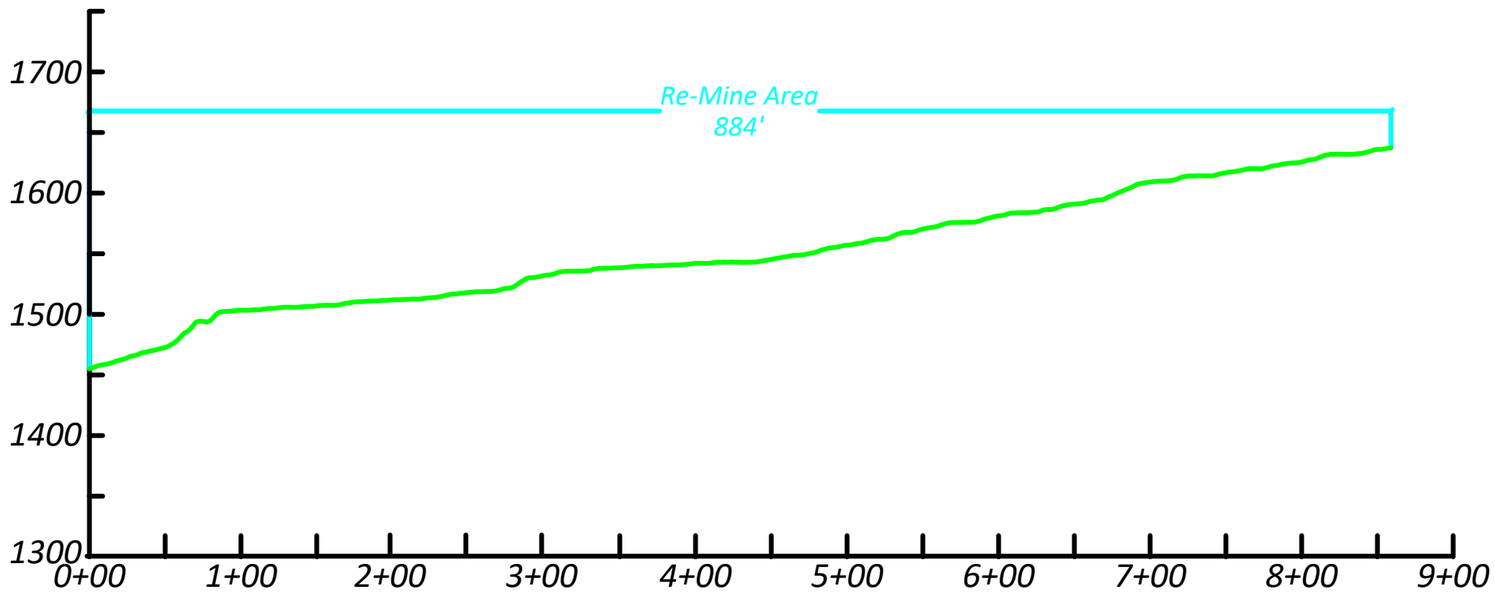
Cranes Creek Existing Cross Section of Impacted Streams.
Data Obtained: 01/06/2026

PROJECT NAME: Cranes Creek NWP49	PROJECT LOCATION: Bell County, KY
PRINT DATE: 01/08/2026	USACE#: LRN# Pending
KDNR# 807-0501	WP#: 2025-63

Appendix B
Existing Conditions

Part 3: Existing Profiles

Existing S3 Profile
(Through Proposed Mine Permit Boundary)



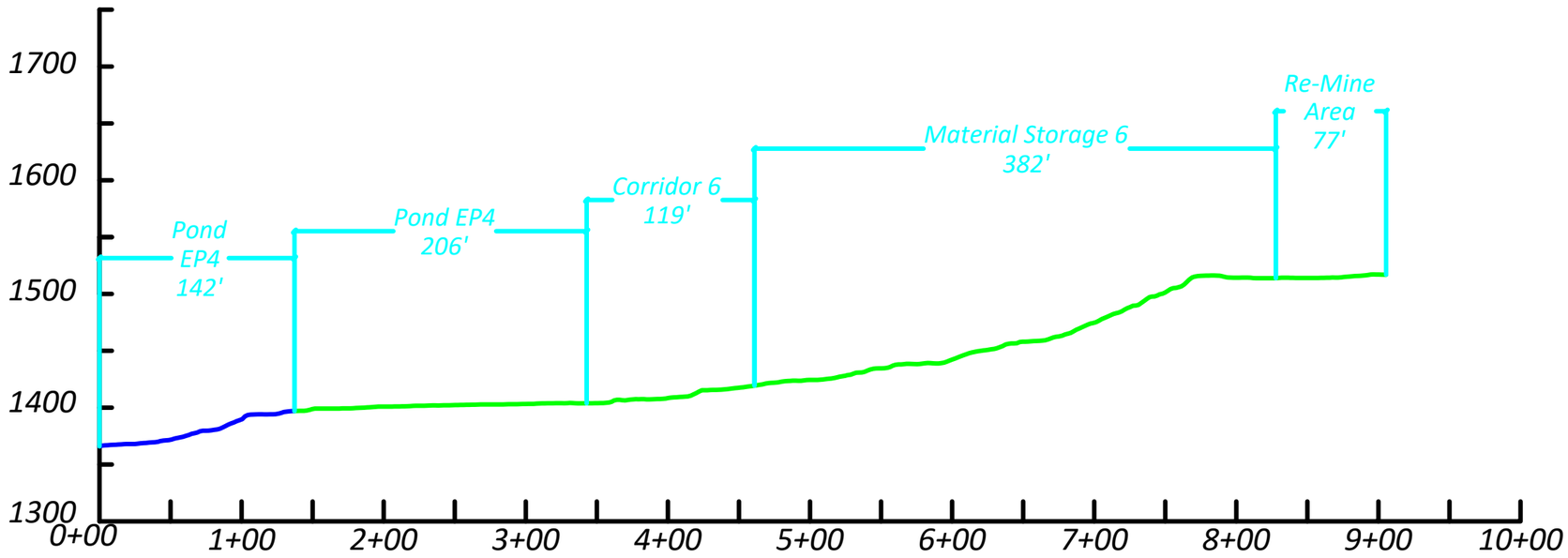


Nally & Hamilton Enterprises, Inc.

WAYPOINT LLC

Existing S3 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Existing S4 Profile
(Through Proposed Mine Permit Boundary)





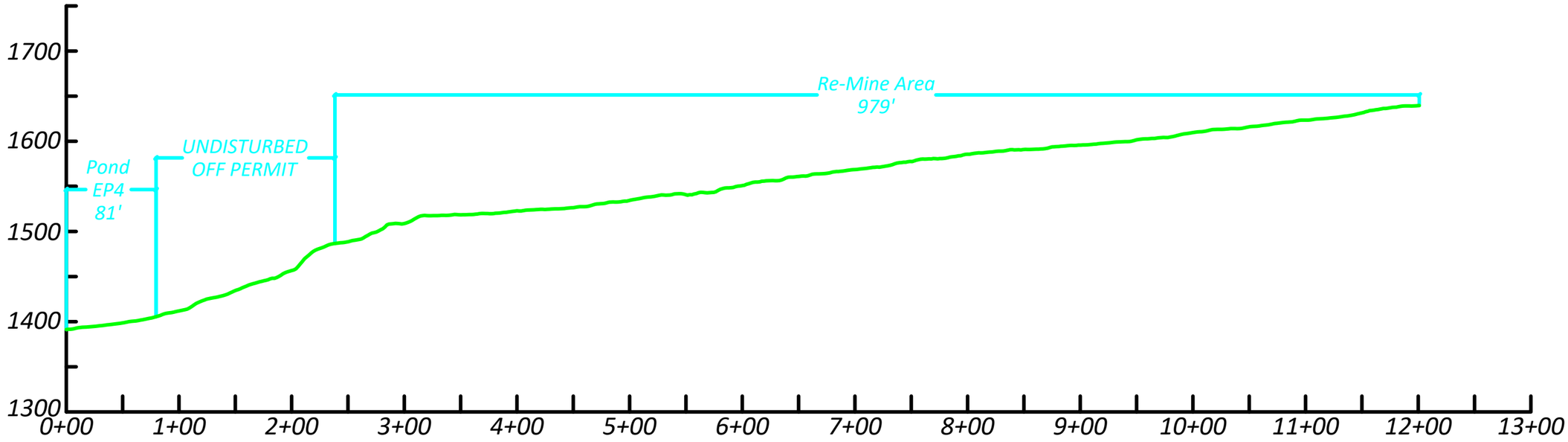
Nally & Hamilton Enterprises, Inc.

WAYPOINT LLC

Existing S4 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090

drawn by: BES		01/29/2026

Existing S4A Profile
(Through Proposed Mine Permit Boundary)



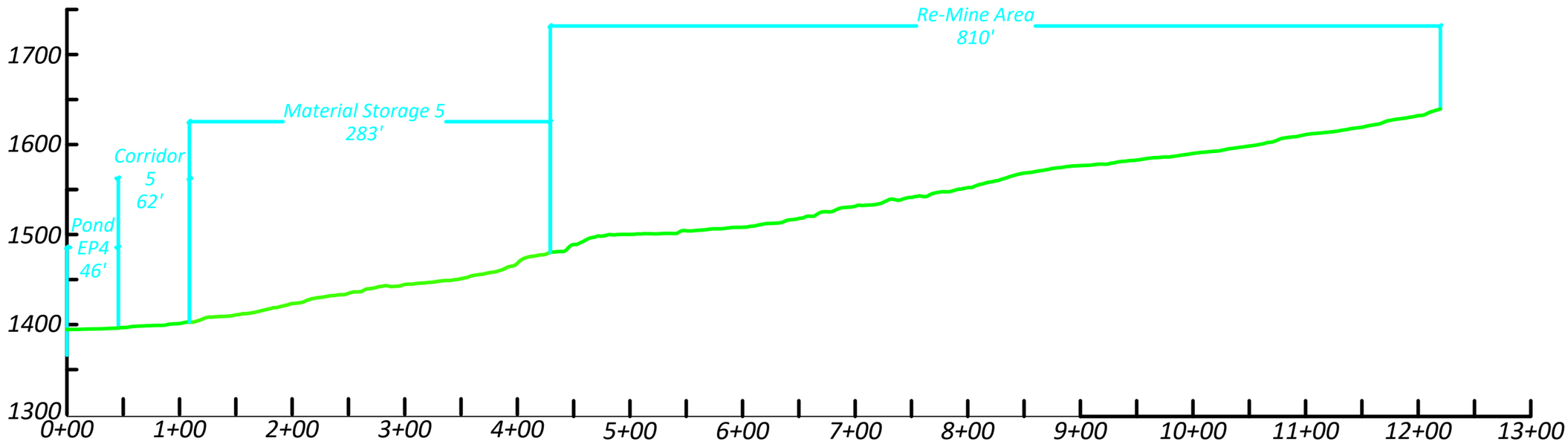


Nally & Hamilton Enterprises, Inc.

WAYPOINT LLC

Existing S4A Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Existing S5 Profile
(Through Proposed Mine Permit Boundary)





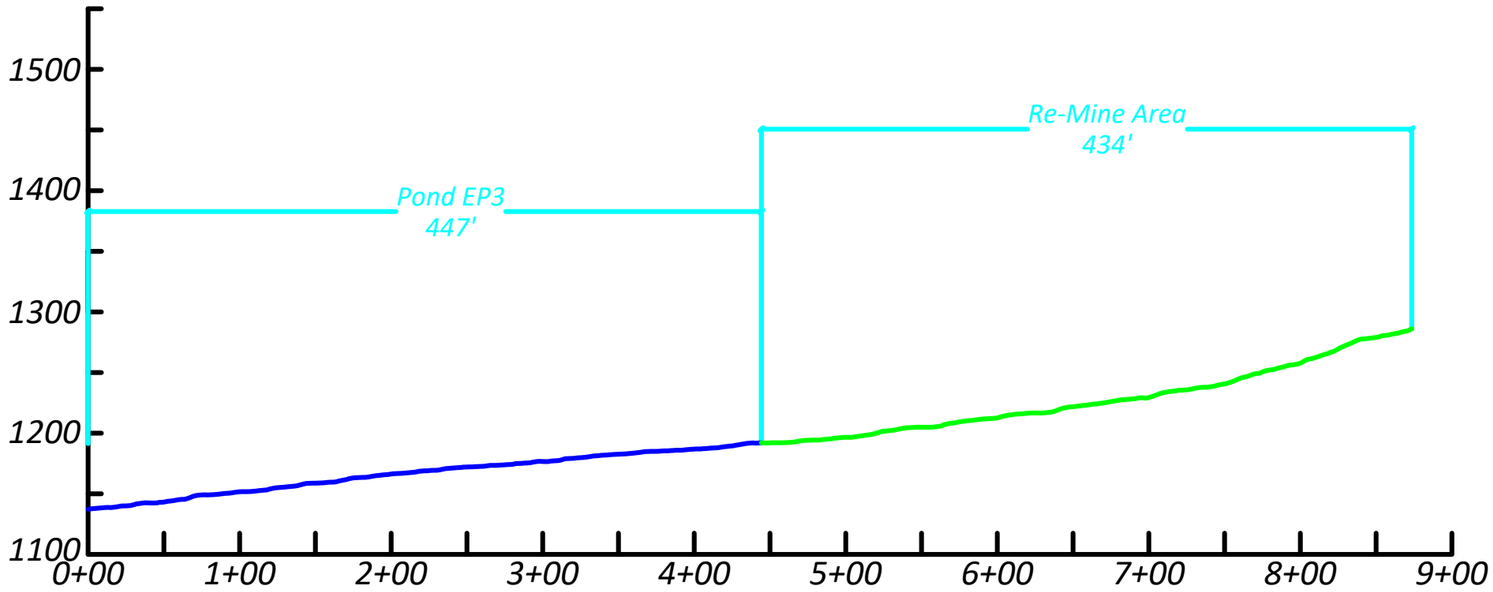
Nally & Hamilton Enterprises, Inc.

WAYPOINT

Existing S5 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090

drawn by: BES		01/29/2026

Existing S8 Profile
(Through Proposed Mine Permit Boundary)



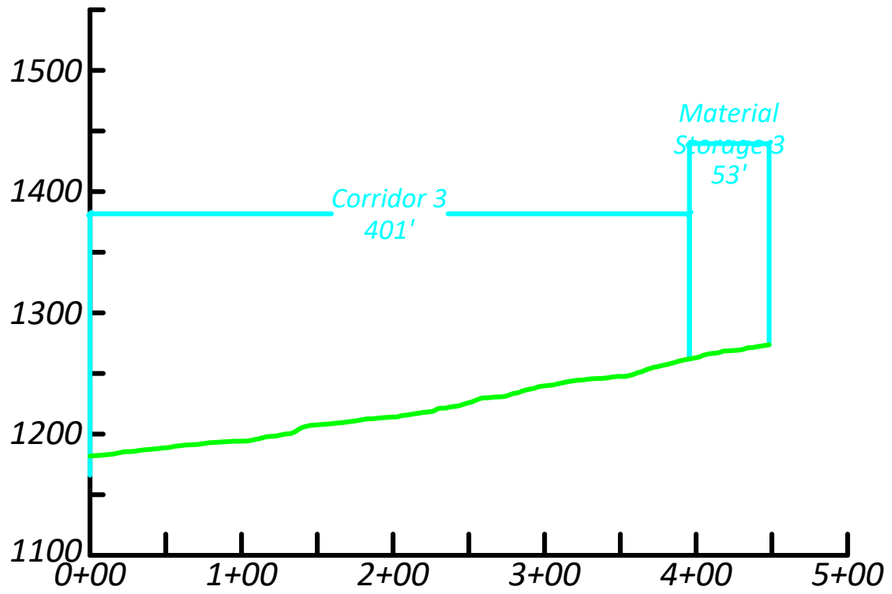
0’ 100’ 200’ 300’

Nally & Hamilton Enterprises, Inc.

WAYPOINT LC

Existing S8 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Existing S9 Profile
(Through Proposed Mine Permit Boundary)



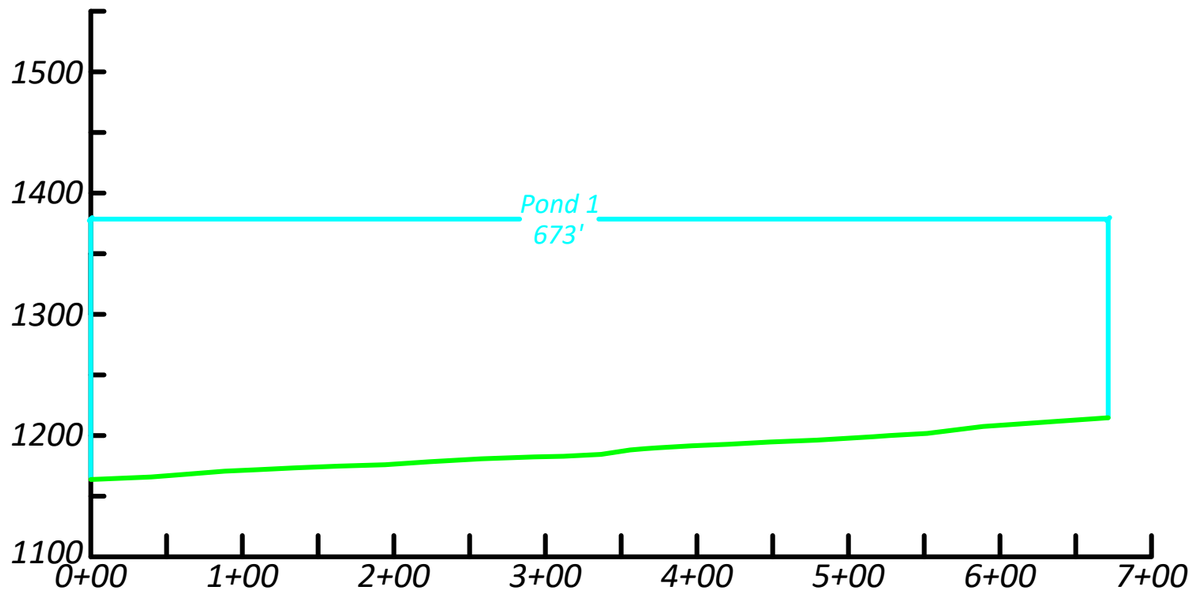
0’ 100’ 200’ 300’

Nally & Hamilton Enterprises, Inc.

WAYPOINT LLC

Existing S9 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Existing S12 Profile
(Through Proposed Mine Permit Boundary)





Nally & Hamilton Enterprises, Inc.

WAYPOINT LLC

Existing S12 Profiles		
Nationwide #49 Permit		
KDNR# 807-0501 | LRN-2025-01090		
drawn by: BES		01/29/2026

Appendix B
Existing Conditions

Part 4: Hydrogeomorphic (HGM) Assessment Sheets

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 3
Sampling Date: 2-23-23

Project Site Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.39
Biogeochemical Cycling	0.58
Habitat	0.65

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	82.50	0.93
V_{EMBED}	Average embeddedness of channel.	2.17	0.52
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	0.70	0.35
V_{BERO}	Total percent of eroded stream channel bank.	168.00	0.17
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	9.08	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	93.13	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.43	0.45

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 3
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67667
Longitude/UTM Easting: -83.62513
Sampling Date: 2-23-23

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

82.5 %

List the percent cover measurements at each point below:

80	85	80	85	75	90	95	80	80	75

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

2.2

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

4	3	2	1	1	1				
3	1	3	3	2	3				
1	1	2	1	1	1				
1	4	2	3	3	3				
3	3	2	3	1	3				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

0.70 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

16.10	0.40	1.20	0.08	3.70	0.80				
0.30	0.08	0.60	0.70	0.80	0.40				
0.08	0.60	1.20	0.08	0.90	0.70				
10.60	0.30	5.80	0.80	20.40	0.80				
8.30	0.20	3.50	0.50	0.08	0.60				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

168 %

Left Bank: 80 ft Right Bank: 88 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 4

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.1

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
5.3	5.3	18.3	11.2	8.3	6.2	7.2	8.7	7.4	6.3
10.5	12	8.6	15.2	11.4	13.2	7.7	14.6	13.3	12.7
7.1	11.8	9.4	4.2	4.5	5.2	8.4	5.1	7.8	13.1
8.1					4.8	6.6			

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

0.00

Group 1 = 1.0				Group 2 (-1.0)			
☐	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☑	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☐	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			4	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **93.13 %**

Left Side				Right Side			
90	100	100	85	75	95	100	100

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **Not Used**

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.43**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	38	38
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	56	94
Gravel	0	6	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	83 %	0.93
V_{EMBED}	2.2	0.52
$V_{SUBSTRATE}$	0.70 in	0.35
V_{BERO}	168 %	0.17
V_{LWD}	4.0	0.50
V_{TDBH}	9.1	1.00
V_{SNAG}	1.0	1.00
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	93.1 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.43	0.45

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Good canopy coverage. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in Stream 1.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 4
Sampling Date: 2-23-23

Project Site Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.34
Biogeochemical Cycling	0.55
Habitat	0.63

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	82.50	0.93
V_{EMBED}	Average embeddedness of channel.	2.17	0.52
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	0.70	0.35
V_{BERO}	Total percent of eroded stream channel bank.	168.00	0.17
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	9.08	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	93.13	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.33	0.35

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 4
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67616
Longitude/UTM Easting: -83.62176
Sampling Date: 2-23-23

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

82.5 %

List the percent cover measurements at each point below:

80	85	80	85	75	90	95	80	80	75

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 5. If the bed is composed of bedrock, use a rating score of 5.

2.2

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

4	3	2	1	1	1				
3	1	3	3	2	3				
1	1	2	1	1	1				
1	4	2	3	3	3				
3	3	2	3	1	3				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

0.70 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

16.10	0.40	1.20	0.08	3.70	0.80				
0.30	0.08	0.60	0.70	0.80	0.40				
0.08	0.60	1.20	0.08	0.90	0.70				
10.60	0.30	5.80	0.80	20.40	0.80				
8.30	0.20	3.50	0.50	0.08	0.60				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

168 %

Left Bank: 80 ft Right Bank: 88 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 4

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.1

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
5.3	5.3	18.3	11.2	8.3	6.2	7.2	8.7	7.4	6.3
10.5	12	8.6	15.2	11.4	13.2	7.7	14.6	13.3	12.7
7.1	11.8	9.4	4.2	4.5	5.2	8.4	5.1	7.8	13.1
8.1					4.8	6.6			

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

0.00

Group 1 = 1.0				Group 2 (-1.0)			
☐	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☑	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☐	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4 Species in Group 1				5 Species in Group 2			

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **93.13 %**

Left Side				Right Side			
90	100	100	85	75	95	100	100

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **Not Used**

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.33**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	13	13
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	78	91
Gravel	0	9	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	83 %	0.93
V_{EMBED}	2.2	0.52
$V_{SUBSTRATE}$	0.70 in	0.35
V_{BERO}	168 %	0.17
V_{LWD}	4.0	0.50
V_{TDBH}	9.1	1.00
V_{SNAG}	1.0	1.00
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	93.1 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.33	0.35

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Good canopy coverage. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in Stream 1.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 4 Perennial
Sampling Date: 8-14-25

Project Site | Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.37
Biogeochemical Cycling	0.48
Habitat	0.64

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	92.00	1.00
V_{EMBED}	Average embeddedness of channel.	1.83	0.40
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	1.50	0.75
V_{BERO}	Total percent of eroded stream channel bank.	81.00	0.64
V_{LWD}	Number of down woody stems per 100 feet of stream.	3.00	0.38
V_{TDBH}	Average dbh of trees.	9.17	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	0.50	0.85
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	89.38	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.33	0.35

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team:	Waypoint	Latitude/UTM Northing:	36.67548
Project Name:	Cranes Creek	Longitude/UTM Easting:	-83.62354
Location:	Stream 4 Perennial	Sampling Date:	8-14-25

SAR Number: 1 | Reach Length (ft): 200 | Stream Type: Intermittent Stream

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.) **92.0 %**

List the percent cover measurements at each point below:

95	80	95	95	90	95	95	95	85	95

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5. **1.8**

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

1	2	1	1	2	3				
1	3	1	2	1	1				
1	1	3	1	1	3				
1	1	2	1	3	2				
1	1	4	3	3	4				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}. **1.50 in**

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

6.20	3.90	0.08	0.08	12.10	2.00				
1.50	3.70	8.50	11.70	0.08	0.08				
0.08	16.10	0.80	1.20	0.08	1.50				
0.08	0.80	0.50	1.50	2.10	1.80				
3.00	0.20	19.20	1.00	7.80	10.10				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%. **81 %**

Left Bank: 79 ft Right Bank: 83 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated. **3.0**

Number of downed woody stems: 6

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches. **9.2**

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
4.5	4.5	4.5	15.6	15.5	12.8	21	4.2	4.5	28.3
18.1	5.7	12	11.8	4.5	5.6	12.6	4.5	11.1	6.2
4.4	5.6	9.6	9.5	9.8	7	10	7.9	5.4	4.2
11.8	6.8	4.8	5.4	4.6	4.1	5.9	4.8	13	6.7
11	12.5	9.9	8.6	8.5	11.9	12	4.8	7	9.2
7.4	11.6	6.9	10.8	5.4	7.4	8.4	9.2	5.2	6.1
17.1	20.7	18.2	17.4	14.8	11.5	11.4	19.9	19	10.3
4.5	5.1	4.9	4.3	8.1	4.5	4.9	4.8	4.6	4.5
8	6.9	7.8	10.6	22.5	4.7	8	5.7		

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated. **0.5**

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated. **Not Used**

Left Side: Right Side:

9	V_{SRICH}	Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.	0.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☑	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☑	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☐	*Liriodendron tulipifera*	☐	*Ulmus americana*				
☐	*Magnolia acuminata*						
	3 Species in Group 1				7 Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10	$V_{DETRITUS}$	Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot.	89.38 %

Left Side				Right Side			
90	95	85	90	95	95	75	90

11	V_{HERB}	Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot.	Not Used

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12	V_{WLUSE}	Weighted Average of Runoff Score for watershed:	0.33

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	13	13
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	78	91
Gravel	0	9	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	92 %	1.00
V_{EMBED}	1.8	0.40
$V_{SUBSTRATE}$	1.50 in	0.75
V_{BERO}	81 %	0.64
V_{LWD}	3.0	0.38
V_{TDBH}	9.2	1.00
V_{SNAG}	0.5	0.85
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	89.4 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.33	0.35

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Highly embedded cobble substrate. High canopy coverage and tree DBH. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in perennial Stream 16.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

High-Gradient Headwater Stream Field Data Sheet and Calculator used for perennial stream assessment due to >4% gradient in assessed valley.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 4A
Sampling Date: 2-23-23

Project Site Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.34
Biogeochemical Cycling	0.55
Habitat	0.63

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	82.50	0.93
V_{EMBED}	Average embeddedness of channel.	2.17	0.52
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	0.70	0.35
V_{BERO}	Total percent of eroded stream channel bank.	168.00	0.17
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	9.08	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	93.13	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.33	0.35

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 4A
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67669
Longitude/UTM Easting: -83.62256
Sampling Date: 2-23-23

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

82.5 %

List the percent cover measurements at each point below:

80	85	80	85	75	90	95	80	80	75

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 5. If the bed is composed of bedrock, use a rating score of 5.

2.2

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

4	3	2	1	1	1				
3	1	3	3	2	3				
1	1	2	1	1	1				
1	4	2	3	3	3				
3	3	2	3	1	3				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

0.70 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

16.10	0.40	1.20	0.08	3.70	0.80				
0.30	0.08	0.60	0.70	0.80	0.40				
0.08	0.60	1.20	0.08	0.90	0.70				
10.60	0.30	5.80	0.80	20.40	0.80				
8.30	0.20	3.50	0.50	0.08	0.60				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

168 %

Left Bank: 80 ft Right Bank: 88 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 4

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.1

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
5.3	5.3	18.3	11.2	8.3	6.2	7.2	8.7	7.4	6.3
10.5	12	8.6	15.2	11.4	13.2	7.7	14.6	13.3	12.7
7.1	11.8	9.4	4.2	4.5	5.2	8.4	5.1	7.8	13.1
8.1					4.8	6.6			

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

0.00

Group 1 = 1.0				Group 2 (-1.0)			
☐	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☑	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☐	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4 Species in Group 1				5 Species in Group 2			

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **93.13 %**

Left Side				Right Side			
90	100	100	85	75	95	100	100

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **Not Used**

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.33**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	13	13
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	78	91
Gravel	0	9	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	83 %	0.93
V_{EMBED}	2.2	0.52
$V_{SUBSTRATE}$	0.70 in	0.35
V_{BERO}	168 %	0.17
V_{LWD}	4.0	0.50
V_{TDBH}	9.1	1.00
V_{SNAG}	1.0	1.00
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	93.1 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.33	0.35

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Good canopy coverage. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in Stream 1.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 5
Sampling Date: 2-23-23

Project Site Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.39
Biogeochemical Cycling	0.56
Habitat	0.62

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	82.50	0.93
V_{EMBED}	Average embeddedness of channel.	2.17	0.52
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	0.70	0.35
V_{BERO}	Total percent of eroded stream channel bank.	112.00	0.47
V_{LWD}	Number of down woody stems per 100 feet of stream.	2.67	0.33
V_{TDBH}	Average dbh of trees.	9.08	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	0.67	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	93.13	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.41	0.43

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 5
SAR Number: 1
Reach Length (ft): 150
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67522
Longitude/UTM Easting: -83.62313
Sampling Date: 2-23-23

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

82.5 %

List the percent cover measurements at each point below:

80	85	80	85	75	90	95	80	80	75

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 5. If the bed is composed of bedrock, use a rating score of 5.

2.2

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

4	3	2	1	1	1				
3	1	3	3	2	3				
1	1	2	1	1	1				
1	4	2	3	3	3				
3	3	2	3	1	3				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

0.70 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

16.10	0.40	1.20	0.08	3.70	0.80				
0.30	0.08	0.60	0.70	0.80	0.40				
0.08	0.60	1.20	0.08	0.90	0.70				
10.60	0.30	5.80	0.80	20.40	0.80				
8.30	0.20	3.50	0.50	0.08	0.60				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

112 %

Left Bank: 80 ft Right Bank: 88 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

2.7

Number of downed woody stems: 4

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.1

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
5.3	5.3	18.3	11.2	8.3	6.2	7.2	8.7	7.4	6.3
10.5	12	8.6	15.2	11.4	13.2	7.7	14.6	13.3	12.7
7.1	11.8	9.4	4.2	4.5	5.2	8.4	5.1	7.8	13.1
8.1					4.8	6.6			

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

0.7

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

0.00

Group 1 = 1.0				Group 2 (-1.0)			
☐	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☑	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☐	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4 Species in Group 1				5 Species in Group 2			

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **93.13 %**

Left Side				Right Side			
90	100	100	85	75	95	100	100

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **Not Used**

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.41**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	30	30
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	65	95
Gravel	0	5	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	83 %	0.93
V_{EMBED}	2.2	0.52
$V_{SUBSTRATE}$	0.70 in	0.35
V_{BERO}	112 %	0.47
V_{LWD}	2.7	0.33
V_{TDBH}	9.1	1.00
V_{SNAG}	0.7	1.00
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	93.1 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.41	0.43

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Good canopy coverage. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in Stream 1.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 8
Sampling Date: 2-23-23

Project Site Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.47
Biogeochemical Cycling	0.61
Habitat	0.67

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	82.50	0.93
V_{EMBED}	Average embeddedness of channel.	2.17	0.52
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	0.70	0.35
V_{BERO}	Total percent of eroded stream channel bank.	168.00	0.17
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	9.08	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	93.13	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.58	0.61

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 8
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.66558
Longitude/UTM Easting: -83.63338
Sampling Date: 2-23-23

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

82.5 %

List the percent cover measurements at each point below:

80	85	80	85	75	90	95	80	80	75

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 5. If the bed is composed of bedrock, use a rating score of 5.

2.2

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

4	3	2	1	1	1				
3	1	3	3	2	3				
1	1	2	1	1	1				
1	4	2	3	3	3				
3	3	2	3	1	3				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

0.70 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

16.10	0.40	1.20	0.08	3.70	0.80				
0.30	0.08	0.60	0.70	0.80	0.40				
0.08	0.60	1.20	0.08	0.90	0.70				
10.60	0.30	5.80	0.80	20.40	0.80				
8.30	0.20	3.50	0.50	0.08	0.60				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

168 %

Left Bank: 80 ft Right Bank: 88 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 4

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.1

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
5.3	5.3	18.3	11.2	8.3	6.2	7.2	8.7	7.4	6.3
10.5	12	8.6	15.2	11.4	13.2	7.7	14.6	13.3	12.7
7.1	11.8	9.4	4.2	4.5	5.2	8.4	5.1	7.8	13.1
8.1					4.8	6.6			

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

0.00

Group 1 = 1.0				Group 2 (-1.0)			
☐	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☑	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☐	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4 Species in Group 1				5 Species in Group 2			

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **93.13 %**

Left Side				Right Side			
90	100	100	85	75	95	100	100

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **Not Used**

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.58**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	77	77
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	14	91
Gravel	0	9	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	83 %	0.93
V_{EMBED}	2.2	0.52
$V_{SUBSTRATE}$	0.70 in	0.35
V_{BERO}	168 %	0.17
V_{LWD}	4.0	0.50
V_{TDBH}	9.1	1.00
V_{SNAG}	1.0	1.00
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	93.1 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.58	0.61

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Good canopy coverage. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in Stream 1.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 8 Perennial
Sampling Date: 8-14-25

Project Site | Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.50
Biogeochemical Cycling	0.53
Habitat	0.67

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	92.00	1.00
V_{EMBED}	Average embeddedness of channel.	1.83	0.40
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	1.50	0.75
V_{BERO}	Total percent of eroded stream channel bank.	81.00	0.64
V_{LWD}	Number of down woody stems per 100 feet of stream.	3.00	0.38
V_{TDBH}	Average dbh of trees.	9.17	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	0.50	0.85
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	89.38	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.58	0.61

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team:	Waypoint	Latitude/UTM Northing:	36.66629
Project Name:	Cranes Creek	Longitude/UTM Easting:	-83.63401
Location:	Stream 8 Perennial	Sampling Date:	8-14-25

SAR Number: 1 Reach Length (ft): 200 Stream Type: Intermittent Stream

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

92.0 %

List the percent cover measurements at each point below:

95	80	95	95	90	95	95	95	85	95

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

1.8

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

1	2	1	1	2	3				
1	3	1	2	1	1				
1	1	3	1	1	3				
1	1	2	1	3	2				
1	1	4	3	3	4				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

1.50 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

6.20	3.90	0.08	0.08	12.10	2.00				
1.50	3.70	8.50	11.70	0.08	0.08				
0.08	16.10	0.80	1.20	0.08	1.50				
0.08	0.80	0.50	1.50	2.10	1.80				
3.00	0.20	19.20	1.00	7.80	10.10				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

81 %

Left Bank: 79 ft Right Bank: 83 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

3.0

Number of downed woody stems: 6

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.2

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
4.5	4.5	4.5	15.6	15.5	12.8	21	4.2	4.5	28.3
18.1	5.7	12	11.8	4.5	5.6	12.6	4.5	11.1	6.2
4.4	5.6	9.6	9.5	9.8	7	10	7.9	5.4	4.2
11.8	6.8	4.8	5.4	4.6	4.1	5.9	4.8	13	6.7
11	12.5	9.9	8.6	8.5	11.9	12	4.8	7	9.2
7.4	11.6	6.9	10.8	5.4	7.4	8.4	9.2	5.2	6.1
17.1	20.7	18.2	17.4	14.8	11.5	11.4	19.9	19	10.3
4.5	5.1	4.9	4.3	8.1	4.5	4.9	4.8	4.6	4.5
8	6.9	7.8	10.6	22.5	4.7	8	5.7		

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

0.5

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9	V_{SRICH}	Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.	0.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☑	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☑	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☐	*Liriodendron tulipifera*	☐	*Ulmus americana*				
☐	*Magnolia acuminata*						
	3 Species in Group 1				7 Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10	$V_{DETRITUS}$	Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot.	89.38 %

Left Side				Right Side			
90	95	85	90	95	95	75	90

11	V_{HERB}	Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot.	Not Used

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12	V_{WLUSE}	Weighted Average of Runoff Score for watershed:	0.58

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	77	77
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	14	91
Gravel	0	9	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	92 %	1.00
V_{EMBED}	1.8	0.40
$V_{SUBSTRATE}$	1.50 in	0.75
V_{BERO}	81 %	0.64
V_{LWD}	3.0	0.38
V_{TDBH}	9.2	1.00
V_{SNAG}	0.5	0.85
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	89.4 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.58	0.61

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Highly embedded cobble substrate. High canopy coverage and tree DBH. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in perennial Stream 16.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

High-Gradient Headwater Stream Field Data Sheet and Calculator used for perennial stream assessment due to >4% gradient in assessed valley.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 9
Sampling Date: 2-23-23

Project Site Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.52
Biogeochemical Cycling	0.63
Habitat	0.68

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	82.50	0.93
V_{EMBED}	Average embeddedness of channel.	2.17	0.52
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	0.70	0.35
V_{BERO}	Total percent of eroded stream channel bank.	168.00	0.17
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	9.08	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	93.13	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.67	0.71

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 9
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.66505
Longitude/UTM Easting: -83.63342
Sampling Date: 2-23-23

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

82.5 %

List the percent cover measurements at each point below:

80	85	80	85	75	90	95	80	80	75

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 5. If the bed is composed of bedrock, use a rating score of 5.

2.2

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

4	3	2	1	1	1				
3	1	3	3	2	3				
1	1	2	1	1	1				
1	4	2	3	3	3				
3	3	2	3	1	3				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

0.70 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

16.10	0.40	1.20	0.08	3.70	0.80				
0.30	0.08	0.60	0.70	0.80	0.40				
0.08	0.60	1.20	0.08	0.90	0.70				
10.60	0.30	5.80	0.80	20.40	0.80				
8.30	0.20	3.50	0.50	0.08	0.60				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

168 %

Left Bank: 80 ft Right Bank: 88 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 4

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.1

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
5.3	5.3	18.3	11.2	8.3	6.2	7.2	8.7	7.4	6.3
10.5	12	8.6	15.2	11.4	13.2	7.7	14.6	13.3	12.7
7.1	11.8	9.4	4.2	4.5	5.2	8.4	5.1	7.8	13.1
8.1					4.8	6.6			

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

0.00

Group 1 = 1.0				Group 2 (-1.0)			
☐	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☑	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☐	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4 Species in Group 1				5 Species in Group 2			

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **93.13 %**

Left Side				Right Side			
90	100	100	85	75	95	100	100

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **Not Used**

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.67**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	96	96
Gravel	0	4	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	83 %	0.93
V_{EMBED}	2.2	0.52
$V_{SUBSTRATE}$	0.70 in	0.35
V_{BERO}	168 %	0.17
V_{LWD}	4.0	0.50
V_{TDBH}	9.1	1.00
V_{SNAG}	1.0	1.00
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	93.1 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.67	0.71

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Good canopy coverage. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in Stream 1.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 12
Sampling Date: 4/16/24

Project Site Before Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Tree/Sapling Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section A of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.53
Biogeochemical Cycling	0.64
Habitat	0.68

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	82.50	0.93
V_{EMBED}	Average embeddedness of channel.	2.17	0.52
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	0.70	0.35
V_{BERO}	Total percent of eroded stream channel bank.	168.00	0.17
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	9.08	1.00
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	Not Used	Not Used
V_{SRICH}	Riparian vegetation species richness.	0.00	0.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	93.13	1.00
V_{HERB}	Average percent cover of herbaceous vegetation.	Not Used	Not Used
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.69	0.73

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 12
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.65727
Longitude/UTM Easting: -83.64855
Sampling Date: 4/16/24

Top Strata: Tree/Sapling Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | Before Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

82.5 %

List the percent cover measurements at each point below:

80	85	80	85	75	90	95	80	80	75

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 5. If the bed is composed of bedrock, use a rating score of 5.

2.2

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

4	3	2	1	1	1				
3	1	3	3	2	3				
1	1	2	1	1	1				
1	4	2	3	3	3				
3	3	2	3	1	3				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

0.70 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

16.10	0.40	1.20	0.08	3.70	0.80				
0.30	0.08	0.60	0.70	0.80	0.40				
0.08	0.60	1.20	0.08	0.90	0.70				
10.60	0.30	5.80	0.80	20.40	0.80				
8.30	0.20	3.50	0.50	0.08	0.60				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

168 %

Left Bank: 80 ft Right Bank: 88 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 4

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

9.1

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				
5.3	5.3	18.3	11.2	8.3	6.2	7.2	8.7	7.4	6.3
10.5	12	8.6	15.2	11.4	13.2	7.7	14.6	13.3	12.7
7.1	11.8	9.4	4.2	4.5	5.2	8.4	5.1	7.8	13.1
8.1					4.8	6.6			

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 1 Right Side: 0

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

Not Used

Left Side: Right Side:

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

0.00

Group 1 = 1.0				Group 2 (-1.0)			
☐	*Acer rubrum*	☐	*Magnolia tripetala*	☑	*Ailanthus altissima*	☐	*Lonicera japonica*
☑	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☑	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☑	*Elaeagnus umbellata*	☑	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☑	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☐	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☑	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4 Species in Group 1				5 Species in Group 2			

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **93.13 %**

Left Side				Right Side			
90	100	100	85	75	95	100	100

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **Not Used**

Left Side				Right Side			

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.69**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (50% to 75% ground cover)	0.7	98	98
Gravel	0	2	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	83 %	0.93
V_{EMBED}	2.2	0.52
$V_{SUBSTRATE}$	0.70 in	0.35
V_{BERO}	168 %	0.17
V_{LWD}	4.0	0.50
V_{TDBH}	9.1	1.00
V_{SNAG}	1.0	1.00
V_{SSD}	Not Used	Not Used
V_{SRICH}	0.00	0.00
$V_{DETRITUS}$	93.1 %	1.00
V_{HERB}	Not Used	Not Used
V_{WLUSE}	0.69	0.73

Notes:

The entire surrounding watershed of Cranes Creek and adjacent watersheds have been historically severely impacted due to previous resource extraction activities. Several access roads and a mine bench have disrupted natural stream morphology and hydrology and introduced a plethora of invasive plant species.

Highly unstable banks throughout the majority of the reach have led to high rates of erosion and sedimentation. Good canopy coverage. However, invasive plant species are abundant. Due to similar variables within the watershed; riparian, erosional, substrate and canopy assessment scores were based on the HGM assessment completed in Stream 1.

Land use was adjusted for historic mine bench and invasive plant coverage in the reach specific catchment area.

Appendix B
Existing Conditions

Part 5: High Gradient Data Sheets (HGDS)

Project Number: 2025-63

Station ID: S3

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 3	LOCATION: Cranes Creek
AI #: MILE: 0.25	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.67690 LONG.: -83.62482	COUNTY: Bell
DATE: 02/23/23 TIME: 03:07 ☐AM ■PM	INVESTIGATORS: MB / JRR / JK / TW
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 54

NOTES/COMMENTS:

Multiple road crossings, unstable banks, high sedimentation. SC: 1437
Invasives abundant

Project Number: 2025-63

Station ID: S4

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 4	LOCATION: Cranes Creek
AI #: MILE: 0.09	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.67588 LONG.: -83.62204	COUNTY: Bell
DATE: 03/07/23 TIME: 02:00 ☐AM ■PM	INVESTIGATORS: JK / TW / BS
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 57

NOTES/COMMENTS:

Multiple road crossings, unstable banks, high sedimentation. SC: 2470
Invasives abundant

Project Number: 2025-63

Station ID: S4A

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 4A	LOCATION: Cranes Creek
AI #: MILE: 0.23	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.676694 LONG.: -83.622562	COUNTY: Bell
DATE: 02/23/23 TIME: 02:52 ☐AM ■PM	INVESTIGATORS: MB / JRR / JK / TW
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 57

NOTES/COMMENTS:

Multiple road crossings, unstable banks, high sedimentation. SC:2700.
Invasives abundant

Project Number: 2025-63

Station ID: S5

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 5	LOCATION: Cranes Creek
AI #: MILE: 0.09	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.67473 LONG.: -83.62236	COUNTY: Bell
DATE: 03/07/23 TIME: 03:07 ☐AM ■PM	INVESTIGATORS: JK / TW / BS
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 54

NOTES/COMMENTS:

Multiple road crossings, unstable banks, high sedimentation. SC: 1854
Invasives abundant

Project Number: 2025-63

Station ID: S8

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 8	LOCATION: Cranes Creek
AI #: MILE: 0.22	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.66442 LONG.: -83.63212	COUNTY: Bell
DATE: 03/07/23 TIME: 03:50 ☐AM ■PM	INVESTIGATORS: JK / TW / BS
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 54

NOTES/COMMENTS:

Multiple road crossings, unstable banks, high sedimentation. SC:1021. Invasives abundant

Project Number: 2025-63

Station ID: S9

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 9	LOCATION: Cranes Creek
AI #: MILE: 0.29	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.66316 LONG.: -83.63370	COUNTY: Bell
DATE: 03/07/23 TIME: 04:00 ☐AM ■PM	INVESTIGATORS: JK / TW / BS
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 2	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 2	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 54

NOTES/COMMENTS:

Multiple road crossings, unstable banks, high sedimentation. SC:760. Invasives abundant

Project Number: 2025-63 Cranes Creek

Station ID: S12 Nally and Hamilton

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 12 (Int)	LOCATION: Cranes Creek
AI #: MILE: 0.00	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.657214 LONG.: -83.648975	COUNTY: Bell
DATE: 04/16/24 TIME: 13:57 ☐AM ■PM	INVESTIGATORS: JK / TW
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 4	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 4	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 4	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 6	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 6	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 4	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 93

NOTES/COMMENTS:

Disturbed hydrology due to historic logging and mining within watershed. Road runs parallel to right bank. Channel flow has abandoned natural stream bed in flat area as road flow. Some braiding/overflow channels in flat area. Multifloral rose on left bank in flat area.
SC: 50.6

Project Number: 2025-63

Station ID: S15

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 15	LOCATION: Cranes Creek
AI #: MILE: 0.03	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.66497 LONG.: -83.64785	COUNTY: Bell
DATE: 08/13/25 TIME: 12:30 ☐AM ■PM	INVESTIGATORS: MB / JK
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 5	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 5	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 1	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 74

NOTES/COMMENTS:

Multiple road crossings, Culverted road ditch
Invasives abundant

Project Number: 2025-63 Cranes Creek

Station ID: S16 Nally and Hamilton

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: Stream 16	LOCATION: Cranes Creek
AI #: MILE: 0.35	BASIN: Upper Cumberland
GPS Verified: LAT.: 36.671144 LONG.: -83.64088	COUNTY: Bell
DATE: 10/22/25 TIME: 02:00 ☐AM ■PM	INVESTIGATORS: MB / JK
TYPE SAMPLE: ☐Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 11	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 6	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 6	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 6	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 6	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 6	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 6	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 114

NOTES/COMMENTS:

Disturbed hydrology due to historic logging and mining within watershed. Multiple road crossings. Unstable, eroding banks.

Appendix B
Existing Conditions

Part 6: 2024 Pre-Mining Survey and Water Quality Data Submittal

NALLY & HAMILTON ENTERPRISES, INC.
KPDES PERMIT #: KYGE41104
SMCRA #: 807-0501 | AI #: 164460
CLEAR FORK & CRANES CREEK
HARLAN COUNTY, KENTUCKY
2024 PRE-MINING SURVEY AND WATER QUALITY DATA SUBMITTAL
WAYPOINT# 2024-66

AUGUST 12, 2024



WAYPOINT LLC

Pre-Mining Survey and Water Quality Data Submittal
Nally & Hamilton Enterprises, Inc.
KPDES Permit #: KYGE41104
SMCRA #: 807-0501
AI #: 164460
8/12/2024

Stream Name	Sampling Station ID	Date Sampled	MBI	Rank
Clear Fork	I01	5/14/2024	61.53	Fair
Cranes Creek	I02	5/14/2024	48.61	Fair
Cranes Creek	I03	5/14/2024	37.85	Poor

Contents:
Attachment 1- Macroinvertebrate Analysis Spreadsheets
Attachment 2- Macroinvertebrate Station Photodocumentation
Attachment 3- High Gradient Stream Assessment Data Sheets
Attachment 4- MBI Calculation Spreadsheets
Attachment 5- Water Quality Certificate of Analysis
Attachment 6- PMSM Accecptance Letter
Attachment 7- Station Location Map

Submitted By:
Waypoint, LLC
2343 Alexandria Dr. Suite 140
Lexington, KY 40504

Attachment 1
Macroinvertebrate Analysis Spreadsheets

Taxa	I01-KN	I01-MH	I02-KN	I02-MH	I03-KN	I03-MH				
Ephemeroptera										
Baetis flavistriga	1						CG		6.8	Baetidae
Baetis intercalaris	2						CG		5	Baetidae
Plauditus sp	1						CG		5.4	Baetidae
Procloeon sp	1						CG		1.9	Baetidae
Baetisca sp	1						SC		3.2	Baetiscidae
Caenis sp	14	2					CG		6.8	Caenidae
Ephemerella sp	2						CG	cn	2.1	Ephemerellidae
Eurylophella sp	2	2					CG	cn	4	Ephemerellidae
Stenacron sp	1						CG	cn	4	Heptageniidae
Stenonema sp	2						SC	cn	4.1	Heptageniidae
Isonychia sp	1						CF		3.6	Isonychiidae
Plecoptera										
Leuctra sp					2		SH	sp	0.7	Leuctridae
Amphinemura sp	1		0	1	0	1	SH	sp	3.3	Nemouridae
Perlesta sp	4	8	66	7	26	6	PR	cn	4.7	Perlidae
Eccoptura xanthenes			1		1		PR	cn	4.7	Perlidae
Isoperla sp	0	2					PR	cn	3.2	Perlodidae
Trichoptera										
Cheumatopsyche sp	11	1	3	1			CF	cn	6.2	Hydropsychidae
Diplectrona modesta					2		CF	cn	2.2	Hydropsychidae
Hydropsyche sp	5	2	2	2			CF	cn	4	Hydropsychidae
Chimarra sp	0	1					CF	cn	3.3	Philopotamidae
Dolophilodes sp			1				CF	cn	0.8	Philopotamidae
Polycentropus sp (s.l.)			2	1			PR	cn	3.5	Polycentropodidae
Odonata										
Boyeria grafiana	1	1					PR		6.1	Aeshnidae
Boyeria vinosa	4	1					PR		5.9	Aeshnidae
Cordulegaster sp	1						PR		5.7	Cordulegastridae
Progomphus sp	0	1					PR		8.7	Gomphidae
Stylogomphus sp	1						PR			Gomphidae
Megaloptera										
Nigronia fasciatus							PR	cn	5.6	Corydalidae
Nigronia serricornis	2	1			1		PR	cn	5	Corydalidae
Sialis sp					0	1	PR	bu	7.2	Sialidae
Coleoptera										
Helichus basalis	2						SC	cn	0.6	Dryopidae
Hydroporus sp					9	1	PR		7	Dytiscidae
Neoporus sp					0	1	PR		5	Dytiscidae
Macronychus glabratus	0	1					CG	cn	4.7	Elmidae
Optioservus sp	7	2			1		SC	cn	2.4	Elmidae
Stenelmis sp	1		7	1	8	2	SC	cn	5.1	Elmidae
Psephenus herricki			2				SC	cn	2.4	Psephenidae
Diptera										
Bezzia/Palpomyia gp			1		3		PR		6.9	Ceratopogonidae
Brillia sp	1						SH		5.7	Chironomidae
Chironomus sp	1						CG		9.6	Chironomidae
Conchapelopia sp	1		4	1	3		PR		8.7	Chironomidae
Corynoneura sp					1		CG		6	Chironomidae
Cryptochironomus sp	1						PR		6.4	Chironomidae
Demicryptochironomus sp			1				CG		2.1	Chironomidae
Krenopelopia sp					1		PR		6.2	Chironomidae
Limnophyes sp	1				2		CG			Chironomidae
Microtendipes pedellus gp			1				CF	bu	7.5	Chironomidae
Natarsia sp					4		PR		9.6	Chironomidae
Parametriocnemus sp	10		65	1	33	1	CG	cn	3.9	Chironomidae
Paratanytarsus sp	3						CG	cn	8	Chironomidae
Paratendipes albimanus	1						CG	cn	9.2	Chironomidae

cont.										
Pentaneura sp					3		PR		5	Chironomidae
Phaenopsectra obediens gp	4						SC	cn	6.6	Chironomidae
Polypedilum aviceps	9						SH	cn	3.6	Chironomidae
Polypedilum illinoense gp	12						SH	cn	8.7	Chironomidae
Rheotanytarsus exiguus gp	3						CF	cn	8	Chironomidae
Rheotanytarsus pellucidus	1						CG	cn	5.9	Chironomidae
Stenochironomus sp	1						CG	mn	6.3	Chironomidae
Thienemanniella sp			1				CG		6.4	Chironomidae
Tvetenia sp	2		1				CG		3.6	Chironomidae
Zavrelimyia sp			4		8		PR		8.6	Chironomidae
Dixa sp			1		21	4	CG		2.5	Dixidae
Dixella sp	1						PR		4.9	Dixidae
Clinocera sp										Empididae
Hemerodromia sp			1				PR		8.1	Empididae
Roederoides sp					1		PR	cl	4	Empididae
Unid. Empidid sp			3		10		PR		8.1	Empididae
Simulium sp	2		1				CF	cn	4.9	Simuliidae
Myxosargus sp			1				CG		10	Stratiomyidae
Unid. Tabanid sp					1		PR		8.6	Tabanidae
Dicranota sp			1				PR		0	Tipulidae
Hexatoma sp			1		1		PR		3.5	Tipulidae
Pseudolimnophila sp			4		4		PR		6.2	Tipulidae
Tipula sp	3		2		1		SH		7.5	Tipulidae
Isopoda										
Lirceus sp					25	2	CG		7.4	Asellidae
Gastropoda										
Elimia sp	0	1					SC		2.5	Pleuroceridae
Veneroida										
Corbicula fluminea	0	1					CF		6.1	Corbiculidae
Total number if individuals (TNI)		125		182		175				
TNI (combined riffle and habitat)		151		198		194				
Genus taxa richness		37		27		26				
Genus taxa richness combined riffle + MH		43		28		28				
Genus EPT richness		14		8		5				
Total EPT richness (riffle + MH)		16		9		5				
Modified %EPT abundance		30.4		41.7		19.4				
% Ephemeroptera abundance		22.4		0		0				
Modified Hilsenoff Biotic Index		5.49		4.88		5.47				
% Chironomide + Oligochaeta abundance		40.8		42.3		31.4				
% Clingers abundance		67.2		82.9		42.8				
%Dominant 5		44.8		80.2		54.8				
MBI (wadeable)		61.5								
MBI (headwater)				48.6		37.85				

Attachment 2
Macroinvertebrate Station Photodocumentation

N36.655854 / W83.659581

0501-I01, upstream:



0501-I01, downstream:



N36.664255 / W83.654244

0501-I02, upstream:



0501-I02, downstream:



N36.666994 / W83.635609

0501-I03, upstream:



0501-I03, downstream:



Attachment 3
High Gradient Stream Assessment Data Sheets

Project Number: 2024-66 KDNR: 807-0501

Station ID: 0501-I01

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: CLEAR FORK	LOCATION: Below hwy 188 bridge
AI #: 164460 MILE: 0.99	BASIN: UPPER CUMBERLAND
GPS Verified: LAT.: 36.655854 LONG.: -83.659581	COUNTY: BELL
DATE: 05/14/24 TIME: 04:36 ☐AM ■PM	INVESTIGATORS: TW/JK
TYPE SAMPLE: ☑Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 2	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 1	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 16	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 3	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 3	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 3	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 4	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 4	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 6	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 6	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 76 **NOTES/COMMENTS:**

Mostly deep runs with very few riffles

Project #: 2024-66

Station ID: 0501-I01

Wadeable (>5 mi^2) Macroinvertebrate Collection Check Sheet for E. KY Coal Permits

Date: 05/14/24 Time: 04:36

Collector(s) Initials: TW/JK

☑ Collected during the wadeable sampling period (May 1-Sept. 30).

Stream Conditions

☑ Clear with Normal flow
____Turbid or High flow. (If so, do not sample.)
____No flow in riffles. (If so, do not sample.)

Stream Reach

☑ 100 meters – 300 meters. How long? 100 meters
Number of riffles in stream reach: 3 (at least 3)
Number of runs in stream reach: 3 (at least 3)
Number of pools in stream reach: 3 (at least 3)

1 m^2 Kick-net Method

☑ 0.25 m^2 quadrat from the thalwag of Riffle #1
☑ 0.25 m^2 quadrat from the thalwag of a different area of Riffle #1 (If Riffle #1 is small, then sample Riffle #4 from the sample reach; Riffle #4 can be anywhere within the stream reach)
☑ 0.25 m^2 quadrat from the thalwag of Riffle #2 which is located at the most upstream portion of the stream reach
☑ 0.25 m^2 quadrat from the thalwag of Riffle #3 which is located at the most downstream portion of the stream reach

Multi-habitat Method

Boulder Picks

☑ Boulder Pick (5 rocks from pools, 5 rocks from 3 riffles and 5 rocks from 3 runs within reach totaling 15 rocks)

Sweeps (If any of these habitats are missing, then add one more sweep to each habitat that is present.)

☑ Undercut Banks/Roots Sweeps (3 sweeps in pools and 3 sweeps in at least 2 runs within reach; if tree roots are present in riffle at least 1 sweep required)
☑ Marginal Emergent Vegetation Sweeps (3 sweeps within reach)
☑ Bedrock/Slab-Rock Sweeps (3 from pools and one from a run within reach)
☐ *Justicia* Sweeps (3 sweeps within reach)

Conditioned Leaf Pack Picks

☑ Conditioned Leaf Pack Picks (3 conditioned leaf packs from pools, 3 conditioned leaf packs from runs and 3 conditioned leaf packs from riffles)

Fine Material (Silt/Sand/Fine Gravel) Scoops

☑ Fine Material Scoops (Using a US#10 sieve, scoop fine material and sieve. 6 depositional areas within reach)

***Aufwuchs* Picks – habitat associated with attached algae and mosses**

☑ *Aufwuchs* Picks (3 *Aufwuchs* picks from pools, 3 *Aufwuchs* picks from runs and 3 *Aufwuchs* picks from riffles within reach)

Submerged Wood Picks – Must pick at least 3 linear meters of submerged wood, but not more than 6 linear meters of submerged wood; wood pieces should be from 5 to 15 cm in diameter.

☑ Submerged Wood Picks: Linear Meters of Wood Sampled 3 (1 linear meter of wood from pools, 1 linear meter of wood from runs and 1 linear meter of wood from riffles within reach)

Comments:

Project Number: 2024-66 KDNR: 807-0501

Station ID: 0501-I02

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: CRANES CREEK	LOCATION: 1.1 miles east of hwy 516/188 intersection
AI #: 164460 MILE:	BASIN: UPPER CUMBERLAND
GPS Verified: LAT.: 36.664255 LONG.: -83.645244	COUNTY: BELL
DATE: 05/14/24 TIME: 03:55 ☐AM ■PM	INVESTIGATORS: TW / JK
TYPE SAMPLE: ☑Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 10	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 6	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 12	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 4	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 4	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 5	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 5	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 9	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 9	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 108 **NOTES/COMMENTS:**

2024-66

0501-I02

Headwater (<5 mi^2) Macroinvertebrate Collection Check Sheet for E. KY Coal Permits

Date: 05/14/24 Time: 03:55

Collector(s) Initials: TW / JK

☑ Collected during the headwater sampling period (Feb. 15 – May 30*).

*If hydrologic conditions are not favorable to collect all sites within the index period, contact DOW to extend sampling index period window.

☐ Collected outside the headwater sampling period. Date contacted DOW _____

Stream Conditions

☑ Clear /Normal flow
☐ Turbid/High flow. (If so, do not sample.)
☐ No flow in riffles. (If so, do not sample.)

Stream Reach

☑ 100 meters – 300 meters. How long? 100 meters
Number of riffles in stream reach: 3 (at least 3)
Number of runs in stream reach: 3 (at least 3)
Number of pools in stream reach: 3 (at least 3; for headwaters with no pools, then at least 4 runs and riffles)

1 m^2 Kick-net Method

☑ 0.25 m^2 quadrat from the thalwag of Riffle #1
☑ 0.25 m^2 quadrat from the thalwag of a different area of Riffle #1 (If Riffle #1 is small, then sample Riffle #4 from the sample reach; Riffle #4 can be anywhere within the stream reach)
☑ 0.25 m^2 quadrat from the thalwag of Riffle #2 which is located at the most upstream portion of the stream reach
☑ 0.25 m^2 quadrat from the thalwag of Riffle #3 which is located at the most downstream portion of the stream reach

Multi-Habitat Method

Boulder Picks

☑ Boulder Pick (5 rocks from pools/side channels/eddies within reach)

Sweeps (If any of these habitats are missing, then add one more sweep to each habitat that is present.)

☑ Undercut Banks/Roots Sweeps (3 sweeps in 2 pools/side channels/eddies and 3 sweeps in 2 runs/riffles within reach)
☑ Sticks/Wood Sweeps (3 sweeps in pools/side channels/eddies and 3 sweeps in runs within reach)

☐ Other Sweeps (Ex. Bedrock sweeps) Comments: _____

Conditioned Leaf Pack Picks

☑ Conditioned Leaf Pack Picks (3 conditioned leaf packs from pools/side channels/eddies, 3 conditioned leaf packs from runs and 3 conditioned leaf packs from riffles)

Fine Material (Silt/Sand/Fine Gravel) Scoops

☑ Fine Material Scoops (Using a US#10 sieve, scoop fine material and sieve. 6 depositional areas within reach)

Conditioned Submerged Wood Picks – Total between 2 and 4 linear meters of conditioned submerged wood.

☑ Submerged Wood Picks: Linear Meters of Wood Sampled 2 (Wood from riffles, runs and pools/side channels/eddies within reach shall be represented.)

Comments:

Project Number: 2024-66 KDNR: 807-0501

Station ID: 0501-I03

HIGH GRADIENT STREAM DATA SHEET

STREAM NAME: CRANES CREEK	LOCATION: 1.6 miles east of hwy 516/188 intersection
AI #: 164460 MILE: 1.5	BASIN: UPPER CUMBERLAND
GPS Verified: LAT.: 36.666994 LONG.: -83.635609	COUNTY: BELL
DATE: 05/14/24 TIME: 03:04 ☐AM ■PM	INVESTIGATORS: TW / JK
TYPE SAMPLE: ☑Macroinvertebrate ☐FISH	
Shocking Seconds:	Seining Minutes:

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE 9	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Sow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE 7	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25% of channel substrate is exposed.	Water fills 25-57% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 8	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 13	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE 12	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8.Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE (LB) 4	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 4	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE (LB) 4	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 4	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE (LB) 8	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE (RB) 8	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score 93

NOTES/COMMENTS:

Mostly shallow run

2024-66

0501-I03

Headwater (<5 mi^2) Macroinvertebrate Collection Check Sheet for E. KY Coal Permits

Date: 05/14/24 Time: 03:04

Collector(s) Initials: TW / JK

☑ Collected during the headwater sampling period (Feb. 15 – May 30*).

*If hydrologic conditions are not favorable to collect all sites within the index period, contact DOW to extend sampling index period window.

☐ Collected outside the headwater sampling period. Date contacted DOW _____

Stream Conditions

☑ Clear /Normal flow
☐ Turbid/High flow. (If so, do not sample.)
☐ No flow in riffles. (If so, do not sample.)

Stream Reach

☑ 100 meters – 300 meters. How long? 100 meters
Number of riffles in stream reach: 3 (at least 3)
Number of runs in stream reach: 3 (at least 3)
Number of pools in stream reach: 3 (at least 3; for headwaters with no pools, then at least 4 runs and riffles)

1 m^2 Kick-net Method

☑ 0.25 m^2 quadrat from the thalwag of Riffle #1
☑ 0.25 m^2 quadrat from the thalwag of a different area of Riffle #1 (If Riffle #1 is small, then sample Riffle #4 from the sample reach; Riffle #4 can be anywhere within the stream reach)
☑ 0.25 m^2 quadrat from the thalwag of Riffle #2 which is located at the most upstream portion of the stream reach
☑ 0.25 m^2 quadrat from the thalwag of Riffle #3 which is located at the most downstream portion of the stream reach

Multi-Habitat Method

Boulder Picks

☑ Boulder Pick (5 rocks from pools/side channels/eddies within reach)

Sweeps (If any of these habitats are missing, then add one more sweep to each habitat that is present.)

☐ Undercut Banks/Roots Sweeps (3 sweeps in 2 pools/side channels/eddies and 3 sweeps in 2 runs/riffles within reach)
☑ Sticks/Wood Sweeps (3 sweeps in pools/side channels/eddies and 3 sweeps in runs within reach)

☐ Other Sweeps (Ex. Bedrock sweeps) Comments: _____

Conditioned Leaf Pack Picks

☑ Conditioned Leaf Pack Picks (3 conditioned leaf packs from pools/side channels/eddies, 3 conditioned leaf packs from runs and 3 conditioned leaf packs from riffles)

Fine Material (Silt/Sand/Fine Gravel) Scoops

☑ Fine Material Scoops (Using a US#10 sieve, scoop fine material and sieve. 6 depositional areas within reach)

Conditioned Submerged Wood Picks – Total between 2 and 4 linear meters of conditioned submerged wood.

☑ Submerged Wood Picks: Linear Meters of Wood Sampled 2 (Wood from riffles, runs and pools/side channels/eddies within reach shall be represented.)

Comments:

Attachment 4
MBI Calculation Spreadsheets

Digital copies of this report include the MBI calculation spreadsheet(s) embedded as an attachment to the pdf.

Attachment 5
Water Quality Certificate of Analysis

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606)349-6145
Fax (606)349-6102

Certificate of Analysis

Nally & Hamilton Enterprises, Inc.
P.O. Box 157
Bardstown, KY 40004

Date/Time Collected: **5/13/2024 16:36:00**
Date/Time Received: **5/15/2024 15:30:00**
Lab Number: **024009845**
KPDES Number: **KYGE41104**
Permit Number: **807-0501**
Certification Id: **00072**

Attention: **Jamie Boles**
Test Type:
Site ID: **I01**

Parameter	EXC	Result	Units	MDL	MRL	Method	Preservative	Date/Time/Tech Analyzed
Lab Sample ID: 024009845			**Date/Time Received:**	**5/15/24**	**15:30**	Sample Type: Compliance		
Temperature Field		13.1	Degrees C			*		5/13/24 16:36 Thi
Flow		7.920	CFS			*		5/13/24 16:36 Thi
pH Field		7.72	S.U.			*SM 4500 H+-B		5/13/24 16:36 Thi
Conductivity Field		149	umhos/cm			*		5/13/24 16:36 Thi
Dissolved Oxygen		13.9	mg/L			*		5/13/24 16:36 Thi
Turbidity Field		4.85	NTU			*		5/13/24 16:36 Thi
Total Recoverable Iron		0.421	mg/L	0.002	0.025	EPA 200.7 Rev 4.4-1994	HNO3	5/22/24 16:03 BD
Total Recoverable Selenium		<0.5	ug/L	0.1	0.5	EPA 200.8 Rev 5.4-1994	HNO3	5/28/24 14:41 SLM
Alkalinity		17	mg/L	6	10	EPA 310.2 Rev 1974	Ice	5/21/24 12:03 MR
Total Sulfate (as SO4)		43	mg/L	2	10	ASTM D516-16	Ice	5/21/24 13:53 MR
Total Hardness (as CaCO3)		64.9	mg/L	0	1.0	SM 2340 B-11	HNO3	5/22/24 10:01 BD
Total Suspended Solids		15	mg/L	3	5	SM 2540 D-2015	Ice	5/20/24 13:52 JLH
Sample Received at	T	6.6	Degrees C					

*Taken on Site
NDP=No Data Provided
CLT=Client
ND=Not Detected
H - Holding Time
T - Temperature
J - Estimated Value

The analyses above are reported to the best of my knowledge and belief.

Submitted By: Sharlonda Matthews

Sharlonda Matthews *Environmental Manager*

Batch
24003388

Lab Id
024009845

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606)349-6145
Fax (606)349-6102

Certificate of Analysis

Nally & Hamilton Enterprises, Inc.
P.O. Box 157
Bardstown, KY 40004

Date/Time Collected: **5/13/2024 15:58:00**
Date/Time Received: **5/15/2024 15:30:00**
Lab Number: **024009846**
KPDES Number: **KYGE41104**
Permit Number: **807-0501**
Certification Id: **00072**

Attention: **Jamie Boles**
Test Type:
Site ID: **I02**

Parameter	EXC	Result	Units	MDL	MRL	Method	Preservative	Date/Time/Tech Analyzed	
Lab Sample ID: 024009846			**Date/Time Received:**	**5/15/24**	**15:30**	Sample Type: Compliance			
Temperature Field		13.7	Degrees C			*		5/13/24 15:58	Thi
Flow		1.660	CFS			*		5/13/24 15:58	Thi
pH Field		8.33	S.U.			*SM 4500 H+-B		5/13/24 15:58	Thi
Conductivity Field		1925	umhos/cm			*		5/13/24 15:58	Thi
Dissolved Oxygen		13.8	mg/L			*		5/13/24 15:58	Thi
Turbidity Field		2.68	NTU			*		5/13/24 15:58	Thi
Total Recoverable Iron		0.136	mg/L	0.002	0.025	EPA 200.7 Rev 4.4-1994	HNO3	5/22/24 16:03	BD
Total Recoverable Selenium		1.4	ug/L	0.1	0.5	EPA 200.8 Rev 5.4-1994	HNO3	5/28/24 14:41	SLM
Alkalinity		191	mg/L	6	10	EPA 310.2 Rev 1974	Ice	5/21/24 12:03	MR
Total Sulfate (as SO4)		989	mg/L	2	10	ASTM D516-16	Ice	5/21/24 13:53	MR
Total Hardness (as CaCO3)		1275.2	mg/L	0	1.0	SM 2340 B-11	HNO3	5/22/24 10:01	BD
Total Suspended Solids		<5	mg/L	3	5	SM 2540 D-2015	Ice	5/20/24 13:52	JLH
Sample Received at	T	6.6	Degrees C						

*Taken on Site
NDP=No Data Provided
CLT=Client
ND=Not Detected
H - Holding Time
T - Temperature
J - Estimated Value

The analyses above are reported to the best of my knowledge and belief.

Submitted By: Sharlonda Matthews

Sharlonda Matthews *Environmental Manager*

Batch
24003388

Lab Id
024009846

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606)349-6145
Fax (606)349-6102

Certificate of Analysis

Nally & Hamilton Enterprises, Inc.
P.O. Box 157
Bardstown, KY 40004

Attention: **Jamie Boles**
Test Type:
Site ID: **I03**

Date/Time Collected: **5/13/2024 15:08:00**
Date/Time Received: **5/15/2024 15:30:00**
Lab Number: **024009847**
KPDES Number: **KYGE41104**
Permit Number: **807-0501**
Certification Id: **00072**

Parameter	EXC	Result	Units	MDL	MRL	Method	Preservative	Date/Time/Tech Analyzed
Lab Sample ID: 024009847			**Date/Time Received:**	**5/15/24**	**15:30**	Sample Type: Compliance		
Temperature Field		13.6	Degrees C			*		5/13/24 15:08 Thi
Flow		.050	CFS			*		5/13/24 15:08 Thi
pH Field		8.10	S.U.			*SM 4500 H+-B		5/13/24 15:08 Thi
Conductivity Field		1473	umhos/cm			*		5/13/24 15:08 Thi
Dissolved Oxygen		10.4	mg/L			*		5/13/24 15:08 Thi
Turbidity Field		5.14	NTU			*		5/13/24 15:08 Thi
Total Recoverable Iron		0.227	mg/L	0.002	0.025	EPA 200.7 Rev 4.4-1994	HNO3	5/22/24 16:03 BD
Total Recoverable Selenium		3.2	ug/L	0.1	0.5	EPA 200.8 Rev 5.4-1994	HNO3	5/28/24 14:41 SLM
Alkalinity		146	mg/L	6	10	EPA 310.2 Rev 1974	Ice	5/21/24 12:03 MR
Total Sulfate (as SO4)		767	mg/L	2	10	ASTM D516-16	Ice	5/20/24 15:48 MR
Total Hardness (as CaCO3)		993.6	mg/L	0	1.0	SM 2340 B-11	HNO3	5/22/24 10:01 BD
Total Suspended Solids		<5	mg/L	3	5	SM 2540 D-2015	Ice	5/20/24 13:52 JLH
Sample Received at	T	6.6	Degrees C					

*Taken on Site
NDP=No Data Provided
CLT=Client
ND=Not Detected
H - Holding Time
T - Temperature
J - Estimated Value

The analyses above are reported to the best of my knowledge and belief.

Submitted By: Sharlonda Matthews

Sharlonda Matthews *Environmental Manager*

Batch
24003388

Lab Id
024009847

Attachment 6
PMSM Acceptance

Andy Beshear
GOVERNOR

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
300 Sower Boulevard
Frankfort, Kentucky 40601
Phone: (502) 564-2150
Fax: 502-564-4245

Rebecca Goodman
SECRETARY

Anthony R. Hatton
COMMISSIONER

January 31, 2024

Jay Miller
Nally & Hamilton
195 Commercial Drive
Suite 105
London, Kentucky 40744

Re: Pre-Mining Survey Acceptable
AI No.: 164460
KPDES No.: KYGE41104
DNR No.: 897-0501
Bell County, Kentucky

Dear Permittee

Effective on the date of this letter, the Kentucky Division of Water (DOW) has determined that the in-stream monitoring points listed in Table 1 and shown on the Pre-Mining Survey Map (PMSM) submitted to DOW are acceptable. You may proceed with collection of the necessary sampling for the Pre-Mining Survey.

TABLE 1 – IN-STREAM MONITORING POINTS

ID Number	Receiving Stream Name	Latitude	Longitude	Outfalls Covered
I01	Clear Fork	36.655854	-83.659581	101, 016-020
I02	Cranes Creek	36.664255	-83.645244	001-014, 102-104
I03	Cranes Creek	36.666994	-83.635609	002-001, 103, 104

At a minimum, one in-stream monitoring point directly below the outfall along with one downstream monitoring point of the receiving stream located after the confluence but above any tributaries is required.

Physical/chemical samples are to be collected in accordance with the following Standard Operating Procedures (SOPs): (1) Sampling surface waters, (2) In situ Water Quality Measurements and Meter Calibration for Lotic Waters, (3) Sample Control and Management, and (4) Measuring Stream Discharge. Biological sampling shall be performed annually during the appropriate index period; i.e. Headwater – Feb 15th thru May 31st; Wadeable – May 1 thru Sept 30th. Biological samples shall be collected in accordance with: (1) Methods for Conducting Resource Extraction Individual Permit Intensive Surveys in Non-OSRW Streams of the Eastern Kentucky Coalfields; (2) Methods for Conducting Resource Extraction Individual Permit Intensive Surveys in Non-OSRW Streams of the Western Kentucky Coalfields. All biological activities shall be performed by a qualified biologist. These SOPs may be found at: https://eec.ky.gov/Environmental-Protection/Water/PermitCert/KPDES/Pages/Mining.aspx .

The PMSM is a component of the permit application and is subject to the "sufficiently sensitive analytical methods" requirements of 40 CFR 122.21(e) and (i). All laboratory analysis must be performed by laboratories that have been certified by the Energy and Environment Cabinet (EEC) in accordance with the requirements of 401 KAR 5:320.

The permittee shall submit the biological background report along with all results to **"DOW-Biological Reports"** through the DEP portal found at:
https://dep.gateway.ky.gov/ePortal/DesktopDefault.aspx**.**

Should you have any questions regarding this matter, please contact me at 502-782-6969 or by email at john.beard@ky.gov .

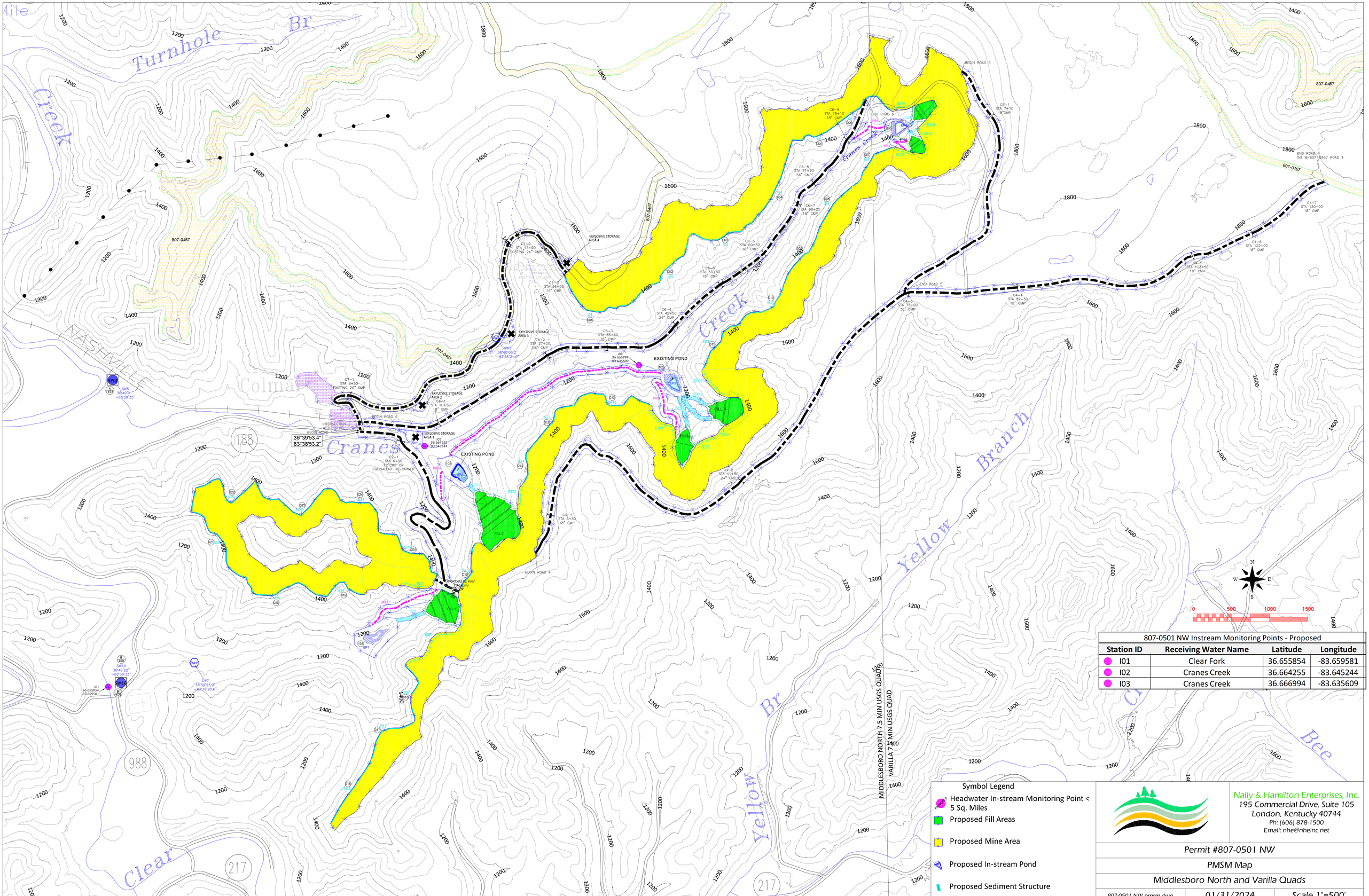
Sincerely,



John Beard
Stormwater Section
Surface Water Permits Branch
Division of Water

Cc:
Tom Barbour, DNR
ARM

Attachment 7
Pre-Mining Survey Map



807-0501 NW Instream Monitoring Points - Proposed			
Station ID	**Receiving Water Name**	**Latitude**	**Longitude**
I01	Clear Fork	36.655854	-83.659581
I02	Cranes Creek	36.664255	-83.645244
I03	Cranes Creek	36.666994	-83.635609

0 500 1000 1500

Symbol Legend

- Headwater In-stream Monitoring Point < 5 Sq. Miles
- Proposed Fill Areas
- Proposed Mine Area
- Proposed In-stream Pond
- Proposed Sediment Structure

Nally & Hamilton Enterprises, Inc.
195 Commercial Drive, Suite 105
London, Kentucky 40744
Ph: (606) 878-1500
Email: nhe@nheinc.net

Permit #807-0501 NW

PMSM Map

Middlesboro North and Varilla Quads

807-0501 NW pmsm.dwg | 01/31/2024 | Scale 1"=500'

Appendix B
Existing Conditions

Part 7: Annual Macroinvertebrate and Water Quality Data Submittal

Annual Macrinvertebrate and Water Quality Data Submittal
Nally & Hamilton Enterprises, Inc.
KPDES Permit #: KYGE41104
SMCRA #: 807-0501
AI #: 164460
11/24/2025

Stream Name	Sampling Station ID	Date Sampled	MBI	Rank
Clear Fork	I01	5/28/2025	70.3	Fair
Cranes Creek	I02	5/28/2025	57.9	Fair
Cranes Creek	I03	5/28/2025	53.7	Fair

Contents:
Attachment 1- Macroinvertebrate Analysis Spreadsheets
Attachment 2- Macroinvertebrate Station Photodocumentation
Attachment 3- High Gradient Stream Assessment Data Sheets
Attachment 4- MBI Calculation Spreadsheets
Attachment 5- Water Quality Certificate of Analysis
Attachment 6- Station Location Map
Attachment 7 - In-stream Requirements and Annual Comparison

Submitted By:
Waypoint, LLC
2343 Alexandria Dr. Suite 140
Lexington, KY 40504

Attachment 1
Macroinvertebrate Analysis Spreadsheets

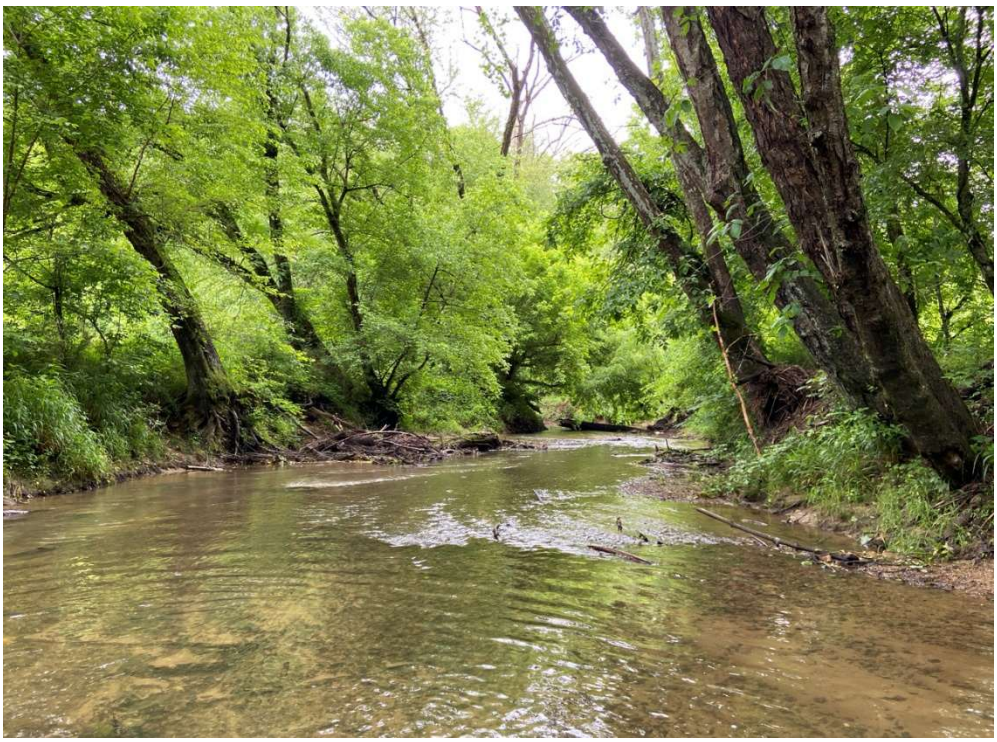
Taxa	I-01 KN	I-01 MH	I-02 KN	I-02 MH	I-03 KN	I-03 MH	FFG	TolVal	Family
Ephemeroptera									
Baetis flavistriga	2				2	1	CG	6.8	Baetidae
Baetis intercalaris	1						CG	5	Baetidae
Labiobaetis sp	0	3					CG	4.02	Baetidae
Procloeon sp	0	2					CG	1.9	Baetidae
Eurylophella sp	1	2					CG	4	Ephemerellidae
Stenonema femoratum	1						SC	7.18	Heptageniidae
Stenonema sp	9	1					SC	4.1	Heptageniidae
Isonychia sp	1						CF	3.6	Isonychiidae
Paraleptophlebia sp	4						CG	5	Leptophlebiidae
Plecoptera									
Leuctra sp	4		3		42	3	SH	0.67	Leuctridae
Amphinemura sp	0	1	8		2		SH	3.33	Nemouridae
Acroneuria abnormis	1						PR	2.1	Perlidae
Acroneuria carolinensis	1				1		PR	1.2	Perlidae
Eccoptura xanthenes			0	2	2	1	PR	4.7	Perlidae
Peltoperla sp			1				SH	1	Peltoperlidae
Perlesta sp	8	1	52	10	17	7	PR	4.7	Perlidae
Isoperla sp	0	1					PR	3.2	Perlodidae
Malirekus sp	1						PR	1.15	Perlodidae
Remenus bilobatus	2						PR	0.28	Perlodidae
Rhyacophila carolina	1		1		4		PR	2	Rhyacophilidae
Trichoptera									
Cheumatopsyche sp	43	2	43	2	10	2	CF	6.22	Hydropsychidae
Diplectrona modesta	5		0	1	7		CF	2.21	Hydropsychidae
Hydropsyche cheilonis	12	1	12	1			CF	1.4	Hydropsychidae
Hydropsyche slossonae			14	1	6		CF	0	Hydropsychidae
Hydropsyche betteni gp			1				CF	7.78	Hydropsychidae
Hydropsyche sp	5	1			3	1	CF	1.4	Hydropsychidae
Glossosoma sp			1				SC	1.4	Glossosomatidae
Pycnopsyche sp					0	1	SH	4	Limnephilidae
Lepidostoma sp	1						SH	0.9	Lepidostomatidae
Chimarra sp	1		1		1		CF	3.3	Philopotamidae
Wormaldia sp					1		CF	0.65	Philopotamidae
Polycentropus sp					1		PR	3.53	Polycentropodidae
Megaloptera									
Corydalus cornutus	0	1					PR	5.16	Corydalidae
Odonata									
Boyeria vinosa	7						PR	5.89	Aeshnidae
Calopteryx angustipennis			0	1	0	2	PR	7.8	Calopterygidae
Argia sp	0	1					PR	8.17	Coenagrionidae
Cordulegaster sp	5						PR	5.73	Cordulegastridae
Stylogomphus sp	4	1					PR		Gomphidae
Coleoptera									
Helichus basalis	0	2	0	1			SC	0.6	Dryopidae
Helichus lithophilus	2						SC	3	Dryopidae
Dubiraphia vittata	0	3					SC	5	Elmidae
Macronychus glabratus	1	3					CG	4.7	Elmidae
Optioservus ovalis	20	1					SC	2.1	Elmidae
Stenelmis sp			14		29	2	SC	5.1	Elmidae
Ectopria nervosa	2						SC	4.16	Psephenidae
Psephenus herricki	5	3	2		1		SC	2.35	Psephenidae
Anchytarsus bicolor	2						SH	2.4	Ptilodactylidae
Diptera									
Atherix sp	9		17		1		PR	0.9	Athericidae
Bezzia/Palpomyia gp					1		PR	6.9	Ceratopogonidae
Ablabesmyia janta	1						PR	6	Chironomidae
Conchapelopia sp	17		1		2		PR	8.7	Chironomidae
Diamesa sp					3		CG	6.6	Chironomidae
continued									

Parametriocnemus sp	1		10		9		CG	3.9	Chironomidae
Phaenopsectra obediens gp	2	1					SC	6.6	Chironomidae
Polypedilum aviceps			1				SH	3.6	Chironomidae
Polypedilum sp	29	1					SH	6.8	Chironomidae
Saetheria sp 1 (Epler)					0	1	CG	7	Chironomidae
Tanytarsus sp			1				CF	6.6	Chironomidae
Tvetenia sp	1						CG	3.6	Chironomidae
Xylotopus par	1						SH	6.1	Chironomidae
Zavrelimyia sp	0	1			1		PR	8.6	Chironomidae
Dixa sp	2		0	1			CG	2.5	Dixidae
Unid. Empidid sp					5		PR	8.1	Empididae
Unid. Muscid sp			1					8	Muscidae
Prosimulium sp					7		CF	4.5	Simuliidae
Simulium sp	7	1	2				CF	4.9	Simuliidae
Dicranota sp	1						PR	0	Tipulidae
Hexatoma sp			2		8	1	PR	3.5	Tipulidae
Pseudolimnophila sp	2						PR	6.2	Tipulidae
Tipula sp	5	1	12	3			SH	7.5	Tipulidae
Decapoda									
Cambarus sp	3	1			0	1	CG	4.9	Cambaridae
Isopoda									
Lirceus sp	1				21	5	CG	7.4	Asellidae
Pelecypoda									
Corbicula fluminea	0	1					CF	6.12	Corbiculidae
Total number if individuals (TNI)		234		202		173			
TNI (combined riffle and habitat)		271		228		202			
Genus taxa richness		39		24		19			
Genus taxa richness combined riffle + MH		49		27		23			
Genus EPT richness		16		11		12			
Total EPT richness (riffle + MH)		20		12		13			
Modified %EPT abundance		26.1		46.5		49.1			
% Ephemeroptera abundance		8.2		0		1.16			
Modified Hilsenoff Biotic Index		4.56		3.9		4.2			
% Chironomide + Oligochaeta abundance		22.2		6.4		8.7			
% Clingers abundance		70.9		17.2		50.9			
%Dominant 5		51.7		69.3		63			
MBI (headwater)				57.9		53.7			
MBI (wadeable)		70.3							

Attachment 2
Macroinvertebrate Station Photodocumentation



I01, Upstream | 2025-05-28
Lat. 36.65584°, Long. -83.65957° | 807-0501-I01



I01, Downstream | 2025-05-28
Lat. 36.65584°, Long. -83.65957° | 807-0501-I01



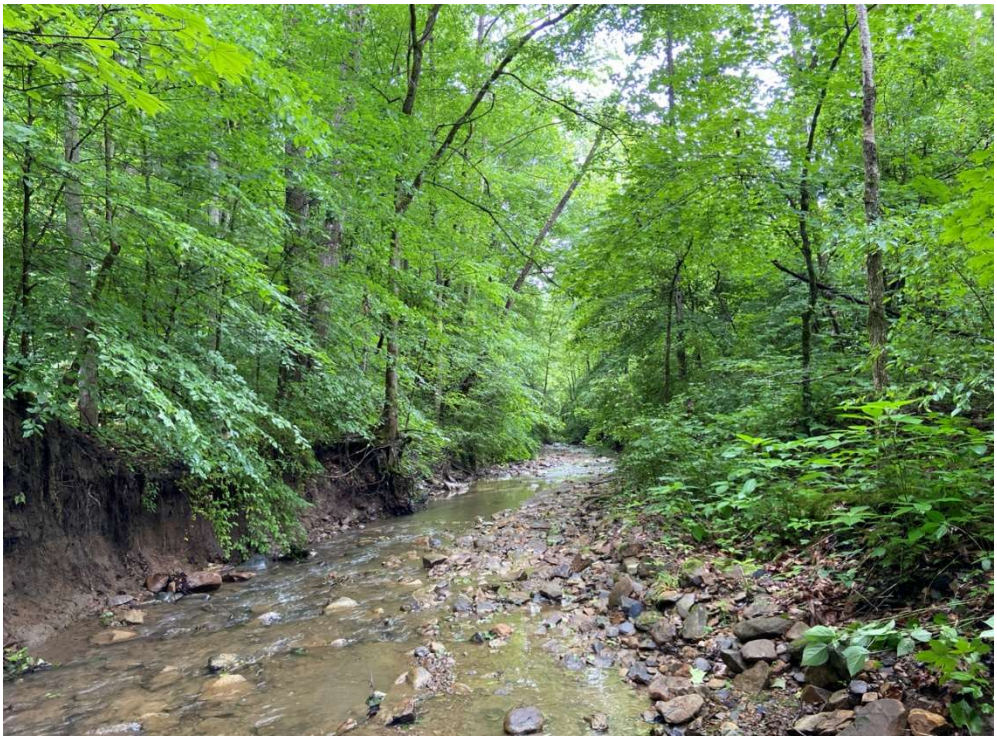
I02, Upstream | 2025-05-28
Lat. 36.66437°, Long. -83.6452° | 807-0501-I02



I02, Downstream | 2025-05-28
Lat. 36.66437°, Long. -83.6452° | 807-0501-I02



I03, Upstream | 2025-05-28
Lat. 36.66713°, Long. -83.63553° | 807-0501-I03



I03, Downstream | 2025-05-28
Lat. 36.66713°, Long. -83.63553° | 807-0501-I03

Attachment 3
High Gradient Stream Assessment Data Sheets

APPENDIX A. HIGH GRADIENT HABITAT ASSESSMENT DATASHEET

High Gradient Habitat Assessment Datasheet — Page 1

Station Visit Information

Locale Name:	CLEAR FORK	Project:	2025-18	Trip:		County:	BELL
Station ID:	0501-I01	Loc. Desc.:	DOWNSTREAM OF BRIDGE ON KY-188 AT KY-988			Visit Date:	05/28/25
Field Lead:	Tom Wilson	Primary Bioregion:	Mountains (MT)	Secondary Bioregion:		Visit Start Time:	11:03
Team:	Jake Riddle / Jack Babb	Stream Perm.	PERENNIAL	Stream Type (HW or WA):	WADEABLE	Visit Finish Time:	11:52

STATION POINT VERIFICATION

1) K-WADE Target Point	2) Field GPS Location	Nav. to Target Point Within GPS Error?	Target On Correct Stream?	Field GPS Error (M)	3) GPS Final (K-WADE / Field)	K-WADE Station Update	WEATHER
Lat:	N 36.655854					Staff:	Scouring Rain In Last 14 Days? YN: NO
Long:	W -83.659581	YES	YES	3		Date:	Now: Circle 1: CLOUDY OVERCAST
							Past 24hr: INT. SHOWERS

Stream Shading	STREAM FLOW Circle 1	INSTREAM FEATURES		RIFFLE/RUN/POOL SEQ.	
Leafed Out? YES	SEASONAL NORMAL	Avgerage Wetted Width (m):	8.0	# of riffles in reach	3
General Shading Circle 1: FULL		Maximum Depth (m):	1.3	# of runs in reach	3
		Reach Length (m):	100	# of pools in reach	5

LOCAL WATERSHED FEATURES (Major Land Use): (Check all that are present)

Surface Mining		Construction		Pasture/Grazing		Dredging:	Channelization:
Deep Mining		Commercial		Silviculture			
Oil Wells		Industrial		Urban Runoff			
Land Disposal		Row Crops		Storm Sewers			
Residential	✓	Forest	✓	Permitted Outfalls			

CHANNEL ALTERATIONS- Full, Partial or Not/None

RIPARIAN VEGETATION

Dom. Veg. Type: TREES — # of Strata: 3

Dom. Taxa: Birch

HYDRAULIC STRUCTURES (Check all that are present)

Dams:	Bridge Abutments:	Fords:	Islands:	Waterfalls:	Berms:

FIELD METER DATA

Temp (°C):	DO (mg/l):	DO %Sat:	pH (SU):	Sp. Cond (µS/cm):	Discharge CFS | Uncert.	
15.5	8.64	91.9	7.64	310.0		✓

FIELD ACTIVITIES

Activity Completed?	Collectors	Collection Information (Check all that apply and/or enter/circle necessary information)				
Algae:		QualMHC:	Visual Form:	R4MULTI:	Other:	
Fish:		Equip.:		EF Seconds:	Seine Minutes:	
Habitat: ✓	JR / JB / TW	Habitat data other than RBP?				
Invertebrate: ✓	TW	1m² riffle + MH: ✓		MACS 20-Jab:	Other:	
Multihabs Sampled Y/N or # Jabs	Undercuts/Roots: ✓ | Sticks/Wood: ✓ | Leaf Packs: ✓ | *Justicia*: | Aufwuchs: | Edge:					
	Bedrock/Slab: | Depositional: ✓ | Rock Pick: ✓ | Em. Veg.: | Wood Pick: ✓ | Other:					
Chemistry:		H_2SO_4 Lot #:		HNO_3 Lot #:		
Multi-Probe: ✓	JR / JB	Inst. ID:	010 / 053 / AB	Cal. Date:	05/27/2025	
Discharge:		Inst. ID:		Beam Check:		
Other:		Other Desc:				

SUBSTRATE CHARACTERIZATION

Substrate Category	% Riffle: 10	% Run: 80	% Pool: 10	Reach Total
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)	30	70	75	175
Gravel (2-64 mm)	40	25	10	75
Cobble (64 – 256 mm)	20	5	10	35
Boulders (>256 mm)	10		5	15
Bedrock/Hardpan Clay				

Site Not Sampled (Reason)- Please Add Comments:

Reach Location Description: RUNS ADJACENT TO KY-988

Weather Choices: HR = Heavy Rain \| SR = Steady Rain \| IS = Intermittent Showers \| CS = Clear Sunny \| CO = Cloudy Overcast \| SSH = Snow Sleet

Initial Data Review By:	Initial Data Review Date:	Date Entered:
TW	05/30/2025	05/30/2025

High Gradient Habitat Assessment Datasheet

Page 2

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1.Epifaunal Substrate/ Available Cover Score 2	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not now fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2.Embeddedness Score 2	Gravel, cobble, boulder, and bedrock are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, boulder and bedrock are 25-50% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are 50-75% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are more than 75% surrounded by fine sediment.
3.Velocity/ Depth Regime Score 15	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
4. Sediment Deposition Score 1	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5.Channel Flow Status Score 17	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
6.Channel Alteration Score 10	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
7.Frequency of Riffles (or bends) Score 3	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8.Bank Stability LB 3 RB 3	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
9. Vegetative Protection LB 4 RB 4	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
10. Riparian Vegetative Zone Width LB 6 RB 6	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.

Total Score	Notes/Comments:
76	Mostly deep runs with very few riffles

General Notes: Stream Mile: 0.99

Sediment Notes:

APPENDIX A. HIGH GRADIENT HABITAT ASSESSMENT DATASHEET

High Gradient Habitat Assessment Datasheet — Page 1

Station Visit Information

Locale Name:	CRANES CREEK	Project:	2025-18	Trip:		County:	BELL
Station ID:	0501-I02	Loc. Desc.:	NEAR THE REMNANTS OF MOUNTAIN DRIVE RD AND KY-188 INTERSECTION			Visit Date:	05/28/25
Field Lead:	Tom Wilson	Primary Bioregion:	Mountains (MT)	Secondary Bioregion:		Visit Start Time:	13:42
Team:	Jake Riddle / Jack Babb	Stream Perm.	PERENNIAL	Stream Type (HW or WA):	HEADWATER	Visit Finish Time:	14:46

STATION POINT VERIFICATION

1) K-WADE Target Point	2) Field GPS Location	Nav. to Target Point Within GPS Error?	Target On Correct Stream?	Field GPS Error (M)	3) GPS Final	K-WADE Station Update	WEATHER
Lat:	N 36.664255				K-WADE Field	Staff:	Scouring Rain In Last 14 Days? YN: NO
Long:	W -83.645244	YES	YES	3		Date:	Now: Circle 1: CLOUDY OVERCAST
							Past 24hr: INT. SHOWERS

Stream Shading		STREAM FLOW Circle 1	INSTREAM FEATURES		RIFFLE/RUN/POOL SEQ.	
Leafed Out?	YES	SEASONAL NORMAL	Avgerage Wetted Width (m):	2.5	# of riffles in reach	4
General Shading Circle 1	FULL		Maximum Depth (m):	1.0	# of runs in reach	4
			Reach Length (m):	100	# of pools in reach	8

LOCAL WATERSHED FEATURES (Major Land Use): (Check all that are present)

Surface Mining	✓	Construction		Pasture/Grazing		Dredging:	Channelization:
Deep Mining		Commercial		Silviculture			
Oil Wells		Industrial		Urban Runoff			
Land Disposal		Row Crops		Storm Sewers			
Residential		Forest	✓	Permitted Outfalls			

CHANNEL ALTERATIONS- Full, Partial or Not/None

RIPARIAN VEGETATION

Dom. Veg. Type:	SHRUBS	# of Strata:	3
Dom. Taxa:	Japanese Knotweed		

HYDRAULIC STRUCTURES (Check all that are present)

Dams:		Bridge Abutments:		Fords:		Islands:		Waterfalls:		Berms:	

FIELD METER DATA

Temp (°C):	DO (mg/l):	DO %Sat:	pH (SU):	Sp. Cond (µS/cm):	Discharge CFS | Uncert.	
16.0	8.67	97.1	8.42	1,844.0		✓

FIELD ACTIVITIES

Activity Completed?		Collectors	Collection Information (Check all that apply and/or enter/circle necessary information)				
Algae:			QualMHC:	Visual Form:	R4MULTI:	Other:	
Fish:			Equip.:		EF Seconds:	Seine Minutes:	
Habitat:	✓	JR / JB /TW	Habitat data other than RBP?				
Invertebrate:	✓	TW	1m² riffle + MH: ✓		MACS 20-Jab:	Other:	
Multihabs Sampled Y/N or # Jabs	Undercuts/Roots: ✓ | Sticks/Wood: ✓ | Leaf Packs: ✓ | *Justicia*: | Aufwuchs: | Edge:						
	Bedrock/Slab: | Depositional: ✓ | Rock Pick: ✓ | Em. Veg.: | Wood Pick: ✓ | Other:						
Chemistry:			H_2SO_4 Lot #:		HNO_3 Lot #:		
Multi-Probe:	✓	JR / JB	Inst. ID:	010 / 053 / AB	Cal. Date:	05/27/2025	
Discharge:			Inst. ID:		Beam Check:		
Other:			Other Desc:				

SUBSTRATE CHARACTERIZATION

Substrate Category	% Riffle: 15	% Run: 80	% Pool: 5	Reach Total
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)	20	10	20	50
Gravel (2-64 mm)	40	35	30	105
Cobble (64 – 256 mm)	40	55	40	135
Boulders (>256 mm)			5	5
Bedrock/Hardpan Clay				

Site Not Sampled (Reason)- Please Add Comments:

Reach Location Description:	REACH RUNS ALONG REMNANTS OF OLD ROAD (KY-188)	Weather Choices:	HR = Heavy Rain | SR = Steady Rain IS = Intermittent Showers | CS = Clear Sunny CO = Cloudy Overcast | SSH = Snow Sleet

Initial Data Review By:	TW	Initial Data Review Date:	05/30/2025	Date Entered:	05/30/2025

High Gradient Habitat Assessment Datasheet

Page 2

Habitat Parameter	Condition Category: Optimal		Suboptimal		Marginal		Poor	
SCORE	20 19 18 17 16		15 14 13 12 11		10 9 8 7 6		5 4 3 2 1 0	
1.Epifaunal Substrate/ Available Cover Score 10	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not now fall and not transient).		40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).		20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.		Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.	
2.Embeddedness Score 5	Gravel, cobble, boulder, and bedrock are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.		Gravel, cobble, boulder and bedrock are 25-50% surrounded by fine sediment.		Gravel, cobble, boulder, and bedrock are 50-75% surrounded by fine sediment.		Gravel, cobble, boulder, and bedrock are more than 75% surrounded by fine sediment.	
3.Velocity/ Depth Regime Score 13	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)		Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).		Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).		Dominated by 1 velocity/ depth regime (usually slow-deep).	
4. Sediment Deposition Score 4	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.		Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.		Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.		Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.	
5.Channel Flow Status Score 12	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.		Water fills >75% of the available channel; or <25% of channel substrate is exposed.		Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.		Very little water in channel and mostly present as standing pools.	
6.Channel Alteration Score 13	Channelization or dredging absent or minimal; stream with normal pattern.		Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.		Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.		Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.	
7.Frequency of Riffles (or bends) Score 13	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.		Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.		Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.		Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.	
Left/Right Bank	10	9	8	7 6	5	4 3	2	1 0
8.Bank Stability LB 4 RB 4	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.		Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.		Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.		Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.	
9. Vegetative Protection LB 5 RB 5	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.		70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.		50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.		Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.	
10. Riparian Vegetative Zone Width LB 9 RB 9	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.		Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.		Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.		Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.	

Total Score: 106

Notes/Comments: 0

General Notes: Stream Mile:

Sediment Notes:

APPENDIX A. HIGH GRADIENT HABITAT ASSESSMENT DATASHEET

High Gradient Habitat Assessment Datasheet — Page 1

Station Visit Information

Locale Name:	CRANES CREEK	Project:	2025-18	Trip:		County:	BELL
Station ID:	0501-I03	Loc. Desc.:	0.66 MILES EAST OF THE REMNANTS OF MOUNTAIN DRIVE RD			Visit Date:	05/28/25
Field Lead:	Tom Wilson	Primary Bioregion:	Mountains (MT)	Secondary Bioregion:		Visit Start Time:	12:20
Team:	Jake Riddle / Jack Babb	Stream Perm.	PERENNIAL	Stream Type (HW or WA):	HEADWATER	Visit Finish Time:	13:16

STATION POINT VERIFICATION

1) K-WADE Target Point	2) Field GPS Location	Nav. to Target Point Within GPS Error?	Target On Correct Stream?	Field GPS Error (M)	3) GPS Final	K-WADE Station Update	WEATHER
Lat:	N 36.666994				K-WADE Field	Staff:	Scouring Rain In Last 14 Days? YN: NO
Long:	W -83.635609	YES	YES	3		Date:	Now: Circle 1: CLOUDY OVERCAST
							Past 24hr: INT. SHOWERS

Stream Shading	STREAM FLOW Circle 1	INSTREAM FEATURES		RIFFLE/RUN/POOL SEQ.	
Leafed Out? YES	SEASONAL NORMAL	Avgerage Wetted Width (m):	2.5	# of riffles in reach	10
General Shading Circle 1: FULL		Maximum Depth (m):	0.6	# of runs in reach	10
		Reach Length (m):	100	# of pools in reach	6

LOCAL WATERSHED FEATURES (Major Land Use): (Check all that are present)

Surface Mining	✓	Construction		Pasture/Grazing		Dredging:	Channelization:
Deep Mining		Commercial		Silviculture			
Oil Wells		Industrial		Urban Runoff			
Land Disposal		Row Crops		Storm Sewers			
Residential		Forest	✓	Permitted Outfalls			

CHANNEL ALTERATIONS- Full, Partial or Not/None

RIPARIAN VEGETATION

Dom. Veg. Type: TREES — # of Strata: 3

Dom. Taxa: Sycamore

HYDRAULIC STRUCTURES (Check all that are present)

Dams: | Bridge Abutments: | Fords: | Islands: | Waterfalls: | Berms:

FIELD METER DATA

Temp (°C):	DO (mg/l):	DO %Sat:	pH (SU):	Sp. Cond (µS/cm):	Discharge CFS | Uncert.
15.4	9.54	100.6	8.46	1,875.0	

FIELD ACTIVITIES

Activity Completed?	Collectors	Collection Information (Check all that apply and/or enter/circle necessary information)				
Algae:		QualMHC:	Visual Form:	R4MULTI:	Other:	
Fish:		Equip.:		EF Seconds:	Seine Minutes:	
Habitat: ✓	JR / JB / TW	Habitat data other than RBP?				
Invertebrate: ✓	TW	1m² riffle + MH: ✓		MACS 20-Jab:	Other:	
Multihabs Sampled Y/N or # Jabs	Undercuts/Roots: ✓ | Sticks/Wood: ✓ | Leaf Packs: ✓ | *Justicia*: | Aufwuchs: | Edge:					
	Bedrock/Slab: | Depositional: ✓ | Rock Pick: ✓ | Em. Veg.: | Wood Pick: ✓ | Other:					
Chemistry:		H_2SO_4 Lot #:		HNO_3 Lot #:		
Multi-Probe: ✓	JR / JB	Inst. ID:	010 / 053 / AB	Cal. Date:	05/27/2025	
Discharge:		Inst. ID:		Beam Check:		
Other:		Other Desc:				

SUBSTRATE CHARACTERIZATION

Substrate Category	% Riffle: 70	% Run: 25	% Pool: 5	Reach Total
Silt/Clay (<0.06 mm)				
Sand (0.06 – 2 mm)	5	10	40	55
Gravel (2-64 mm)	25	30	25	80
Cobble (64 – 256 mm)	30	30	25	85
Boulders (>256 mm)	40	30	10	80
Bedrock/Hardpan Clay				

Site Not Sampled (Reason)- Please Add Comments:

Reach Location Description: REACH RUNS ALONG REMNANTS OF OLD ROAD (KY-188)

Weather Choices: HR = Heavy Rain | SR = Steady Rain | IS = Intermittent Showers | CS = Clear Sunny | CO = Cloudy Overcast | SSH = Snow Sleet

Initial Data Review By:	Initial Data Review Date:	Date Entered:
TW	05/30/2025	05/30/2025

High Gradient Habitat Assessment Datasheet

Page 2

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
1.Epifaunal Substrate/ Available Cover Score 9	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not now fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
2.Embeddedness Score 7	Gravel, cobble, boulder, and bedrock are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, boulder and bedrock are 25-50% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are 50-75% surrounded by fine sediment.	Gravel, cobble, boulder, and bedrock are more than 75% surrounded by fine sediment.
3.Velocity/ Depth Regime Score 10	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
4. Sediment Deposition Score 5	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
5.Channel Flow Status Score 8	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
6.Channel Alteration Score 13	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
7.Frequency of Riffles (or bends) Score 12	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
Left/Right Bank	10 9	8 7 6	5 4 3	2 1 0
8.Bank Stability LB 4 RB 4	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
9. Vegetative Protection LB 4 RB 4	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
10. Riparian Vegetative Zone Width LB 8 RB 8	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.

Total Score: 96

Notes/Comments: Mostly shallow run

General Notes: Stream Mile: 1.5

Sediment Notes:

Attachment 4
MBI Calculation Spreadsheets

Digital copies of this report include the MBI calculation spreadsheet(s) embedded as an attachment to the pdf.

Attachment 5
Water Quality Certificate of Analysis

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606)349-6145
Fax (606)349-6102

Certificate of Analysis

Nally & Hamilton Enterprises, Inc.
P.O. Box 157
Bardstown, KY 40004

Date/Time Collected: **5/28/2025 14:30:00**
Date/Time Received: **5/29/2025 8:00:00**
Lab Number: **025011024**
KPDES Number: **KYGE41104**
807-0501
Certification Id: **00072**

Attention: **Jamie Boles**
Test Type:
Site ID: **I01**
Clear Fork

Reporting Type:

Parameter	EXC	Result	Units	MDL	MRL	Method	Preservative	Date/Time/Tech Analyzed
Lab Sample ID: 025011024			**Date/Time Received:**	**5/29/25**	**8:00**	Sample Type: Compliance		
Temperature Field		66.0	Degrees F			*		5/28/25 14:30 CLT
Flow		.213	MGD			*		5/28/25 14:30 CLT
pH Field		7.43	S.U.			*SM 4500 H+-B		5/28/25 14:30 CLT
Dissolved Oxygen		12.6	mg/L			*		5/28/25 14:30 CLT
Total Recoverable Iron		0.165	mg/L	0.002	0.025	EPA 200.7 Rev 4.4-1994	HNO3	6/02/25 14:21 PH
Total Recoverable Selenium		<0.5	ug/L	0.1	0.5	EPA 200.8 Rev 5.4-1994	HNO3	6/04/25 18:35 SLM
Alkalinity		200	mg/L	6	10	EPA 310.2 Rev 1974	Ice	6/03/25 17:28 JWH
Specific Conductance		1496	uS/cm	1	1	SM 2510 B-2011	Ice	6/02/25 14:54 CL
Total Sulfate (as SO4)		998	mg/L	2	10	ASTM D516-16	Ice	6/06/25 14:47 JWH
Total Hardness (as CaCO3)		2086.3	mg/L	0	1.0	SM 2340 B-11	HNO3	6/05/25 13:17 PH
Total Suspended Solids		26	mg/L	3	5	SM 2540 D-2015	Ice	5/30/25 16:30 JDH
Turbidity	H	4.61	NTU	0.02	0.02	SM 2130 B-2011	Ice	6/12/25 15:17 SM
Sample Received at		2.8	Degrees C					

*Taken on Site
NDP=No Data Provided
CLT=Client
ND=Not Detected
H - Holding Time
T - Temperature
J - Estimated Value

The analyses above are reported to the best of my knowledge and belief.

Submitted By: Sharlonda Matthews

Sharlonda Matthews *Environmental Manager*

Batch
25003680

Lab Id
025011024

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606)349-6145
Fax (606)349-6102

Certificate of Analysis

Nally & Hamilton Enterprises, Inc.
P.O. Box 157
Bardstown, KY 40004

Date/Time Collected: **5/28/2025 15:00:00**
Date/Time Received: **5/29/2025 8:00:00**
Lab Number: **025011025**
KPDES Number: **KYGE41104**
807-0501
Certification Id: **00072**

Attention: **Jamie Boles**
Test Type:
Site ID: **I02**
Cranes Creek

Reporting Type:

Parameter	EXC	Result	Units	MDL	MRL	Method	Preservative	Date/Time/Tech Analyzed
Lab Sample ID: 025011025			**Date/Time Received:**	**5/29/25**	**8:00**	Sample Type: Compliance		
Temperature Field		65.8	Degrees F			*		5/28/25 15:00 CLT
Flow		1.939	MGD			*		5/28/25 15:00 CLT
pH Field		7.67	S.U.			*SM 4500 H+-B		5/28/25 15:00 CLT
Dissolved Oxygen		12.1	mg/L			*		5/28/25 15:00 CLT
Total Recoverable Iron		1.650	mg/L	0.002	0.025	EPA 200.7 Rev 4.4-1994	HNO3	6/02/25 14:21 PH
Total Recoverable Selenium		0.9	ug/L	0.1	0.5	EPA 200.8 Rev 5.4-1994	HNO3	6/04/25 18:35 SLM
Alkalinity		190	mg/L	6	10	EPA 310.2 Rev 1974	Ice	6/03/25 17:28 JWH
Specific Conductance		1276	uS/cm	1	1	SM 2510 B-2011	Ice	6/02/25 14:54 CL
Total Sulfate (as SO4)		758	mg/L	2	10	ASTM D516-16	Ice	6/06/25 14:47 JWH
Total Hardness (as CaCO3)		1893.0	mg/L	0	1.0	SM 2340 B-11	HNO3	6/05/25 13:17 PH
Total Suspended Solids		<5	mg/L	3	5	SM 2540 D-2015	Ice	5/30/25 16:30 JDH
Turbidity	H	3.34	NTU	0.02	0.02	SM 2130 B-2011	Ice	6/12/25 15:17 SM
Sample Received at		2.8	Degrees C					

*Taken on Site
NDP=No Data Provided
CLT=Client
ND=Not Detected
H - Holding Time
T - Temperature
J - Estimated Value

The analyses above are reported to the best of my knowledge and belief.

Submitted By: Sharlonda Matthews

Sharlonda Matthews *Environmental Manager*

Batch
25003680

Lab Id
025011025

MINERAL LABS INC.

Box 549
Salyersville, Kentucky 41465
Phone (606)349-6145
Fax (606)349-6102

Certificate of Analysis

Nally & Hamilton Enterprises, Inc.
P.O. Box 157
Bardstown, KY 40004

Date/Time Collected: **5/28/2025 15:30:00**
Date/Time Received: **5/29/2025 8:00:00**
Lab Number: **025011026**
KPDES Number: **KYGE41104**
807-0501
Certification Id: **00072**

Attention: **Jamie Boles**
Test Type:
Site ID: **I03**
Cranes Creek

Reporting Type:

Parameter	EXC	Result	Units	MDL	MRL	Method	Preservative	Date/Time/Tech Analyzed
Lab Sample ID: 025011026			**Date/Time Received:**	**5/29/25**	**8:00**	Sample Type: Compliance		
Temperature Field		65.6	Degrees F			*		5/28/25 15:30 CLT
Flow		.323	MGD			*		5/28/25 15:30 CLT
pH Field		7.76	S.U.			*SM 4500 H+-B		5/28/25 15:30 CLT
Dissolved Oxygen		12.9	mg/L			*		5/28/25 15:30 CLT
Total Recoverable Iron		0.233	mg/L	0.002	0.025	EPA 200.7 Rev 4.4-1994	HNO3	6/02/25 14:21 PH
Total Recoverable Selenium		<0.5	ug/L	0.1	0.5	EPA 200.8 Rev 5.4-1994	HNO3	6/04/25 18:35 SLM
Alkalinity		466	mg/L	6	10	EPA 310.2 Rev 1974	Ice	6/03/25 17:28 JWH
Specific Conductance		782	uS/cm	1	1	SM 2510 B-2011	Ice	6/02/25 14:54 CL
Total Sulfate (as SO4)		75	mg/L	2	10	ASTM D516-16	Ice	6/06/25 14:47 JWH
Total Hardness (as CaCO3)		861.0	mg/L	0	1.0	SM 2340 B-11	HNO3	6/05/25 13:17 PH
Total Suspended Solids		23	mg/L	3	5	SM 2540 D-2015	Ice	5/30/25 16:30 JDH
Turbidity	H	4.37	NTU	0.02	0.02	SM 2130 B-2011	Ice	6/12/25 15:17 SM
Sample Received at		2.8	Degrees C					

*Taken on Site
NDP=No Data Provided
CLT=Client
ND=Not Detected
H - Holding Time
T - Temperature
J - Estimated Value

The analyses above are reported to the best of my knowledge and belief.

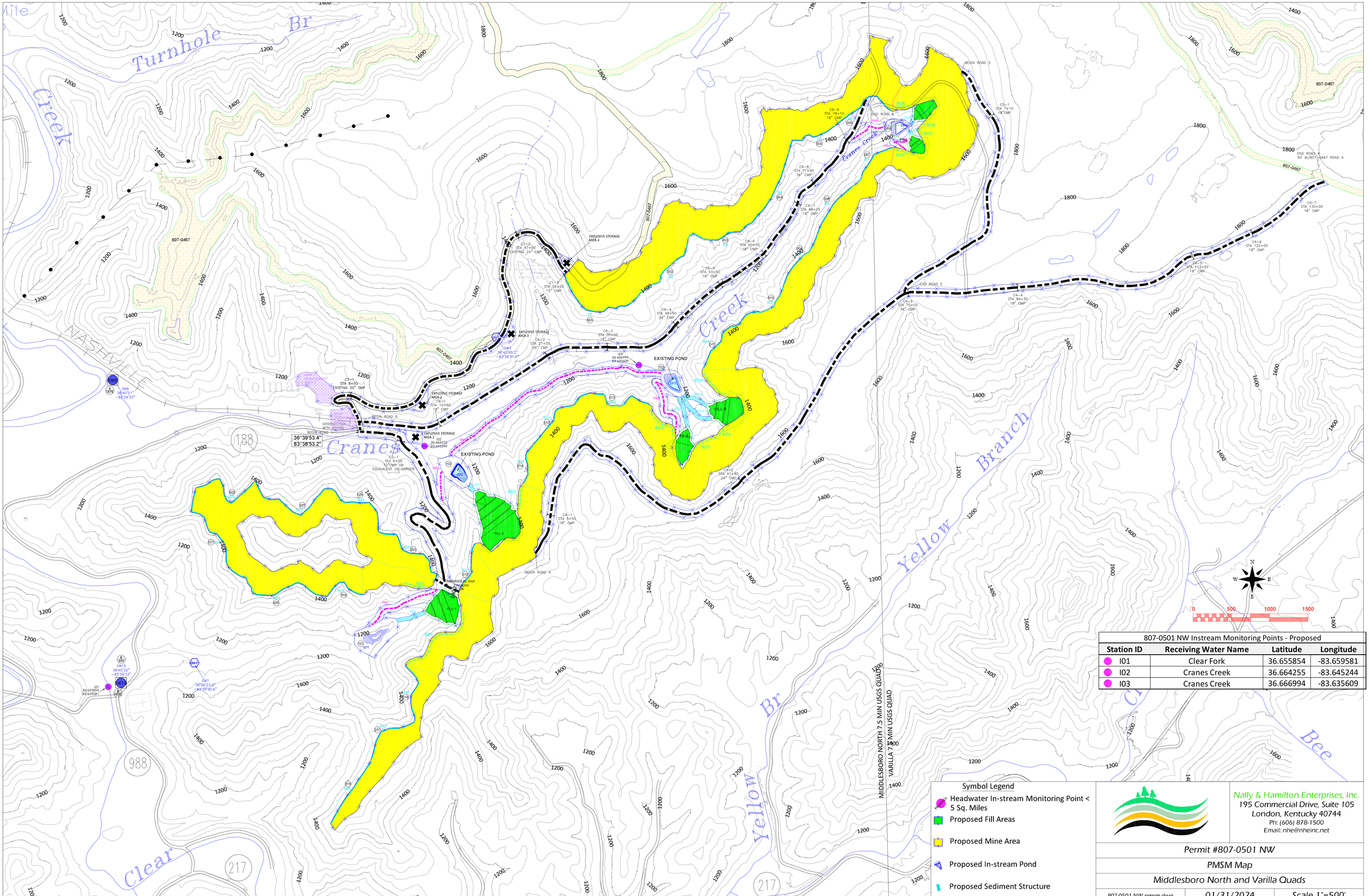
Submitted By: Sharlonda Matthews

Sharlonda Matthews *Environmental Manager*

Batch
25003680

Lab Id
025011026

Attachment 6
Station Location Map



807-0501 NW Instream Monitoring Points - Proposed			
Station ID	**Receiving Water Name**	**Latitude**	**Longitude**
I01	Clear Fork	36.655854	-83.659581
I02	Cranes Creek	36.664255	-83.645244
I03	Cranes Creek	36.666994	-83.635609

0 500 1000 1500

Symbol Legend

- Headwater In-stream Monitoring Point < 5 Sq. Miles
- Proposed Fill Areas
- Proposed Mine Area
- Proposed In-stream Pond
- Proposed Sediment Structure

Nally & Hamilton Enterprises, Inc.
195 Commercial Drive, Suite 105
London, Kentucky 40744
Ph: (606) 878-1500
Email: nhe@nheinc.net

Permit #807-0501 NW

PMSM Map

Middlesboro North and Varilla Quads

807-0501 NW pmsm.dwg | 01/31/2024 | Scale 1"=500'

Attachment 7
In-stream Requirements and Annual Comparison

IN-STREAM QUALITY REQUIREMENTS FOR I01							
In-stream Characteristic	**Units**	**Baseline Score[a]**	**Minimum**	**Maximum**	**Freuency**	**2025 Results**	**2024 Results**
Flow	MGD	N/A	N/A	N/A	1/Quarter	0.213	5.118
Total Suspended Solids	mg/l	5	N/A	N/A	1/Quarter	26	15
Specific Conductivity	µS/cm	149	N/A	N/A	1/Quarter	1496	149
Total Sulfate (as SO_4)	mg/l	43	N/A	N/A	1/Quarter	998	43
Biological Index[b]	None	62	48	N/A	1/Year	70	62
Total Recoverable Iron	mg/l	N/A	N/A	N/A	1/Year	0.165	0.421
pH	SU	N/A	Report	Report	1/Year	7.43	7.72
Total Recoverable Selenium	µg/l	N/A	N/A	N/A	1/Year	<0.5	<0.5
Turbidity	NTU	N/A	N/A	N/A	1/Year	4.61	4.85
Alkalinity (as $CaCO_3$)	mg/l	N/A	N/A	N/A	1/Year	200	17
Dissolved Oxygen	mg/l	N/A	Report	N/A	1/Year	12.6	13.9
Temperature	°F	N/A	N/A	N/A	1/Year	66.0	55.58
Total Hardness (as $CaCO_3$)	mg/l	N/A	N/A	N/A	1/Year	2086.3	64.9

[a]The baseline scores are the analytical results of an in-stream sample collected at KPDES In-stream Monitoring Point I01.

[b]Biological Index represents the Benthic Macroinvertebrate Index Score.

The Minimum Biotic Index represents the Minimum Benthic Macroinvertebrate Index Threshold.

IN-STREAM QUALITY REQUIREMENTS FOR I02							
In-stream Characteristic	**Units**	**Baseline Score[a]**	**Minimum**	**Maximum**	**Freuency**	**2025 Results**	**2024 Results**
Flow	MGD	N/A	N/A	N/A	1/Quarter	1.939	1.072
Total Suspended Solids	mg/l	5	N/A	N/A	1/Quarter	<5	<5
Specific Conductivity	µS/cm	1925	N/A	N/A	1/Quarter	1276	1925
Total Sulfate (as SO_4)	mg/l	989	N/A	N/A	1/Quarter	758	989
Biological Index[b]	None	49	35	N/A	1/Year	58	49
Total Recoverable Iron	mg/l	N/A	N/A	N/A	1/Year	1.650	0.136
pH	SU	N/A	Report	Report	1/Year	7.67	8.33
Total Recoverable Selenium	µg/l	N/A	N/A	N/A	1/Year	0.9	1.4
Turbidity	NTU	N/A	N/A	N/A	1/Year	3.34	2.68
Alkalinity (as $CaCO_3$)	mg/l	N/A	N/A	N/A	1/Year	190	191
Dissolved Oxygen	mg/l	N/A	Report	N/A	1/Year	12.1	13.8
Temperature	°F	N/A	N/A	N/A	1/Year	65.8	56.66
Total Hardness (as $CaCO_3$)	mg/l	N/A	N/A	N/A	1/Year	1893	1275.2

[a]The baseline scores are the analytical results of an in-stream sample collected at KPDES In-stream Monitoring Point I02.

[b]Biological Index represents the Benthic Macroinvertebrate Index Score.

The Minimum Biotic Index represents the Minimum Benthic Macroinvertebrate Index Threshold.

IN-STREAM QUALITY REQUIREMENTS FOR I03							
In-stream Characteristic	**Units**	**Baseline Score[a]**	**Minimum**	**Maximum**	**Freuency**	**2025 Results**	**2024 Results**
Flow	MGD	N/A	N/A	N/A	1/Quarter	0.323	0.032
Total Suspended Solids	mg/l	5	N/A	N/A	1/Quarter	23	<5
Specific Conductivity	µS/cm	1473	N/A	N/A	1/Quarter	782	1473
Total Sulfate (as SO_4)	mg/l	767	N/A	N/A	1/Quarter	75	767
Biological Index[b]	None	38	24	N/A	1/Year	54	38
Total Recoverable Iron	mg/l	N/A	N/A	N/A	1/Year	0.233	0.227
pH	SU	N/A	Report	Report	1/Year	7.76	8.1
Total Recoverable Selenium	µg/l	N/A	N/A	N/A	1/Year	<0.5	3.2
Turbidity	NTU	N/A	N/A	N/A	1/Year	4.37	5.14
Alkalinity (as $CaCO_3$)	mg/l	N/A	N/A	N/A	1/Year	466	146
Dissolved Oxygen	mg/l	N/A	Report	N/A	1/Year	12.9	10.4
Temperature	°F	N/A	N/A	N/A	1/Year	65.6	56.48
Total Hardness (as $CaCO_3$)	mg/l	N/A	N/A	N/A	1/Year	861.0	993.6

[a]The baseline scores are the analytical results of an in-stream sample collected at KPDES In-stream Monitoring Point I03.

[b]Biological Index represents the Benthic Macroinvertebrate Index Score.

The Minimum Biotic Index represents the Minimum Benthic Macroinvertebrate Index Threshold.

Appendix C
Proposed Conditions

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 3
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.79
Biogeochemical Cycling	0.61
Habitat	0.77

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	8.00	1.00
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	65.00	1.00
V_{SRICH}	Riparian vegetation species richness.	4.00	1.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.55	0.58

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 3
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67667
Longitude/UTM Easting: -83.62513
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

8.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

65.0

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

4.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.55**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	38	38
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	56	94
Gravel	0	6	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	8.0	1.00
V_{TDBH}	Not Used	Not Used
V_{SNAG}	1.0	1.00
V_{SSD}	65.0	1.00
V_{SRICH}	4.00	1.00
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.55	0.58

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 4 Perennial
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.56
Biogeochemical Cycling	0.51
Habitat	0.66

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	0.50	0.85
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	32.50	0.50
V_{SRICH}	Riparian vegetation species richness.	2.00	0.95
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.36	0.38

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 4 Perennial
SAR Number: 1
Reach Length (ft): 200
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67548
Longitude/UTM Easting: -83.62354
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

0.5

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

32.5

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

2.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.36**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	13	13
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	78	91
Gravel	0	9	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	4.0	0.50
V_{TDBH}	Not Used	Not Used
V_{SNAG}	0.5	0.85
V_{SSD}	32.5	0.50
V_{SRICH}	2.00	0.95
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.36	0.38

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

High-Gradient Headwater Stream Field Data Sheet and Calculator used for perennial stream assessment due to >4% gradient in assessed valley.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 4
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.69
Biogeochemical Cycling	0.57
Habitat	0.76

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	8.00	1.00
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	65.00	1.00
V_{SRICH}	Riparian vegetation species richness.	4.00	1.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.36	0.38

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 4
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67616
Longitude/UTM Easting: -83.62176
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

8.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

65.0

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

4.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.36**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	13	13
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	78	91
Gravel	0	9	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	8.0	1.00
V_{TDBH}	Not Used	Not Used
V_{SNAG}	1.0	1.00
V_{SSD}	65.0	1.00
V_{SRICH}	4.00	1.00
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.36	0.38

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 4A
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.69
Biogeochemical Cycling	0.57
Habitat	0.76

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	8.00	1.00
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	65.00	1.00
V_{SRICH}	Riparian vegetation species richness.	4.00	1.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.36	0.38

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 4A
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67669
Longitude/UTM Easting: -83.62256
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

8.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

65.0

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

4.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.36**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	13	13
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	78	91
Gravel	0	9	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	8.0	1.00
V_{TDBH}	Not Used	Not Used
V_{SNAG}	1.0	1.00
V_{SSD}	65.0	1.00
V_{SRICH}	4.00	1.00
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.36	0.38

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 5
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.68
Biogeochemical Cycling	0.57
Habitat	0.71

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	5.33	0.67
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	0.67	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	43.33	0.67
V_{SRICH}	Riparian vegetation species richness.	2.67	1.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.50	0.53

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 5
SAR Number: 1
Reach Length (ft): 150
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.67522
Longitude/UTM Easting: -83.62313
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

5.3

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

0.7

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

43.3

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

2.67

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.50**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	30	30
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	65	95
Gravel	0	5	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	5.3	0.67
V_{TDBH}	Not Used	Not Used
V_{SNAG}	0.7	1.00
V_{SSD}	43.3	0.67
V_{SRICH}	2.67	1.00
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.5	0.53

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 8 Perennial
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.80
Biogeochemical Cycling	0.62
Habitat	0.70

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	4.00	0.50
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	0.50	0.85
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	32.50	0.50
V_{SRICH}	Riparian vegetation species richness.	2.00	0.95
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.81	0.85

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 8 Perennial
Latitude/UTM Northing: 36.66629
Longitude/UTM Easting: -83.63401
Sampling Date: 2031
SAR Number: 1
Reach Length (ft): 200
Stream Type: Intermittent Stream
Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)
Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

4.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

0.5

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

32.5

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

2.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.81**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	77	77
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	14	91
Gravel	0	9	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	4.0	0.50
V_{TDBH}	Not Used	Not Used
V_{SNAG}	0.5	0.85
V_{SSD}	32.5	0.50
V_{SRICH}	2.00	0.95
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.81	0.85

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

High-Gradient Headwater Stream Field Data Sheet and Calculator used for perennial stream assessment due to >4% gradient in assessed valley.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 8
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	0.93
Biogeochemical Cycling	0.67
Habitat	0.79

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	8.00	1.00
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	65.00	1.00
V_{SRICH}	Riparian vegetation species richness.	4.00	1.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.81	0.85

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 8
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.66558
Longitude/UTM Easting: -83.63338
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

8.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

65.0

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

4.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.81**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	77	77
Open space (pasture, lawns, parks, etc.), grass cover >75%	0.3	14	91
Gravel	0	9	100

Summary: SAA Number 1

Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	8.0	1.00
V_{TDBH}	Not Used	Not Used
V_{SNAG}	1.0	1.00
V_{SSD}	65.0	1.00
V_{SRICH}	4.00	1.00
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.81	0.85

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 9
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	1.00
Biogeochemical Cycling	0.69
Habitat	0.81

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	8.00	1.00
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	65.00	1.00
V_{SRICH}	Riparian vegetation species richness.	4.00	1.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.96	1.00

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 9
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream
Latitude/UTM Northing: 36.66505
Longitude/UTM Easting: -83.63342
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 1. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

8.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

65.0

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

4.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.96**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	96	96
Gravel	0	4	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	8.0	1.00
V_{TDBH}	Not Used	Not Used
V_{SNAG}	1.0	1.00
V_{SSD}	65.0	1.00
V_{SRICH}	4.00	1.00
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.96	1.00

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

Ver. 10-20-17

FCI Calculator for the High-Gradient Headwater Streams in Appalachia

To ensure accurate calculations, the UPPERMOST STRATUM of the plant community is determined based on the calculated value for $V_{CCANOPY}$ (≥20% cover is required for tree/sapling strata). Go to the SAR Data Entry tab and enter site characteristics and data in the yellow cells. For information on determining how to split a project into SARs, see Chapter 5 of the Operational Draft Regional Guidebook for the Functional Assessment of High-Gradient Headwater Streams and Low-Gradient Perennial Streams in Appalachia (Environmental Laboratory U.S. Army Corps of Engineers 2017).

Project Name: Cranes Creek
Location: Stream 12
Sampling Date: 2031

Project Site After Project

Subclass for this SAR:
Intermittent Stream

Uppermost stratum present at this SAR:
Shrub/Herb Strata

SAR number: 1

Functional Results Summary:

Enter Results in Section B of the Mitigation Sufficiency Calculator

Function	Functional Capacity Index
Hydrology	1.00
Biogeochemical Cycling	0.69
Habitat	0.81

Variable Measure and Subindex Summary:

Variable	Name	Average Measure	Subindex
$V_{CCANOPY}$	Percent canpoy over channel.	Not Used, <20%	Not Used
V_{EMBED}	Average embeddedness of channel.	3.57	1.00
$V_{SUBSTRATE}$	Median stream channel substrate particle size.	3.00	1.00
V_{BERO}	Total percent of eroded stream channel bank.	0.00	1.00
V_{LWD}	Number of down woody stems per 100 feet of stream.	8.00	1.00
V_{TDBH}	Average dbh of trees.	Not Used	Not Used
V_{SNAG}	Number of snags per 100 feet of stream.	1.00	1.00
V_{SSD}	Number of saplings and shrubs per 100 feet of stream.	65.00	1.00
V_{SRICH}	Riparian vegetation species richness.	4.00	1.00
$V_{DETRITUS}$	Average percent cover of leaves, sticks, etc.	62.81	0.77
V_{HERB}	Average percent cover of herbaceous vegetation.	70.63	0.94
V_{WLUSE}	Weighted Average of Runoff Score for Catchment.	0.98	1.00

Version 10-20-17

High-Gradient Headwater Streams in Appalachia
Field Data Sheet and Calculator

Team: Waypoint
Project Name: Cranes Creek
Location: Stream 12
SAR Number: 1
Reach Length (ft): 100
Stream Type: Intermittent Stream

Latitude/UTM Northing: 36.65727
Longitude/UTM Easting: -83.64855
Sampling Date: 2031

Top Strata: Shrub/Herb Strata (determined from percent calculated in $V_{CCANOPY}$)

Site and Timing: Project Site | After Project

Sample Variables 1-4 in stream channel

1 $V_{CCANOPY}$ Average percent cover over channel by tree and sapling canopy. Measure at no fewer than 10 roughly equidistant points along the stream. Measure only if tree/sapling cover is at least 20%. (If less than 20%, enter at least one value between 0 and 19 to trigger Top Strata choice.)

Not Used, <20%

List the percent cover measurements at each point below:

20	0	10	10	10	10	0	20	10	10

2 V_{EMBED} Average embeddedness of the stream channel. Measure at no fewer than 30 roughly equidistant points along the stream. Select a particle from the bed. Before moving it, determine the percentage of the surface and area surrounding the particle that is covered by fine sediment, and enter the rating according to the following table. If the bed is an artificial surface, or composed of fine sediments, use a rating score of 5. If the bed is composed of bedrock, use a rating score of 5.

3.6

Embeddedness rating for gravel, cobble and boulder particles (rescaled from Platts, Megahan, and Minshall 1983)

Rating	Rating Description
5	<5 percent of surface covered, surrounded, or buried by fine sediment (or bedrock)
4	5 to 25 percent of surface covered, surrounded, or buried by fine sediment
3	26 to 50 percent of surface covered, surrounded, or buried by fine sediment
2	51 to 75 percent of surface covered, surrounded, or buried by fine sediment
1	>75 percent of surface covered, surrounded, or buried by fine sediment (or artificial surface)

List the ratings at each point below:

5	5	2	2	2	5				
4	5	4	3	3	4				
2	5	5	5	4	2				
3	5	2	4	4	5				
4	2	5	2	2	2				

3 $V_{SUBSTRATE}$ Median stream channel substrate particle size. Measure at no fewer than 30 roughly equidistant points along the stream; use the same points and particles as used in V_{EMBED}.

3.00 in

Enter particle size in inches to the nearest 0.1 inch at each point below (bedrock should be counted as 99 in, asphalt or concrete as 0.0 in, sand or finer particles as 0.08 in):

3.00	0.08	0.30	3.00	3.00	0.08				
1.00	3.00	0.08	7.00	3.00	3.00				
2.10	0.50	0.70	4.00	3.00	3.00				
0.70	3.00	5.60	1.00	3.00	4.50				
2.50	0.50	0.08	3.00	3.00	3.00				

4 V_{BERO} Total percent of eroded stream channel bank. Enter the total number of feet of eroded bank on each side and the total percentage will be calculated If both banks are eroded, total erosion for the stream may be up to 200%.

0 %

Left Bank: 0 ft Right Bank: 0 ft

Sample Variables 5-9 within the entire riparian/buffer zone adjacent to the stream channel (25 feet from each bank).

5 V_{LWD} Number of down woody stems (at least 4 inches in diameter and 36 inches in length) per 100 feet of stream reach. Enter the number from the entire 50'-wide buffer and within the channel, and the amount per 100 feet of stream will be calculated.

8.0

Number of downed woody stems: 8

6 V_{TDBH} Average dbh of trees (measure only if $V_{CCANOPY}$ tree/sapling cover is at least 20%). Trees are at least 4 inches (10 cm) in diameter. Enter tree DBHs in inches.

Not Used

List the dbh measurements of individual trees (at least 4 in) within the buffer on each side of the stream below:

Left Side					Right Side				

7 V_{SNAG} Number of snags (at least 4" dbh and 36" tall) per 100 feet of stream. Enter number of snags on each side of the stream, and the amount per 100 feet will be calculated.

1.0

Left Side: 0 Right Side: 1

8 V_{SSD} Number of saplings and shrubs (woody stems up to 4 inches dbh) per 100 feet of stream (measure only if tree cover is <20%). Enter number of saplings and shrubs on each side of the stream, and the amount per 100 ft of stream will be calculated.

65.0

Left Side: 33 Right Side: 32

9 V_{SRICH} Riparian vegetation species richness per 100 feet of stream reach. Check all species present from Group 1 in the tallest stratum. Check all exotic and invasive species present in all strata. Species richness per 100 feet and the subindex will be calculated from these data.

4.00

Group 1 = 1.0				Group 2 (-1.0)			
☑	*Acer rubrum*	☐	*Magnolia tripetala*	☐	*Ailanthus altissima*	☐	*Lonicera japonica*
☐	*Acer saccharum*	☐	*Nyssa sylvatica*	☐	*Albizia julibrissin*	☐	*Lonicera tatarica*
☐	*Aesculus flava*	☐	*Oxydendrum arboreum*	☐	*Alliaria petiolata*	☐	*Lotus corniculatus*
☐	*Asimina triloba*	☐	*Prunus serotina*	☐	*Alternanthera philoxeroides*	☐	*Lythrum salicaria*
☐	*Betula alleghaniensis*	☐	*Quercus alba*			☐	*Microstegium vimineum*
☐	*Betula lenta*	☐	*Quercus coccinea*	☐	*Aster tataricus*	☐	*Paulownia tomentosa*
☐	*Carya alba*	☐	*Quercus imbricaria*	☐	*Cerastium fontanum*	☐	*Polygonum cuspidatum*
☐	*Carya glabra*	☐	*Quercus prinus*	☐	*Coronilla varia*	☐	*Pueraria montana*
☐	*Carya ovalis*	☐	*Quercus rubra*	☐	*Elaeagnus umbellata*	☐	*Rosa multiflora*
☐	*Carya ovata*	☐	*Quercus velutina*	☐	*Lespedeza bicolor*	☐	*Sorghum halepense*
☐	*Cornus florida*	☐	*Sassafras albidum*	☐	*Lespedeza cuneata*	☐	*Verbena brasiliensis*
☑	*Fagus grandifolia*	☐	*Tilia americana*	☐	*Ligustrum obtusifolium*		
☐	*Fraxinus americana*	☐	*Tsuga canadensis*	☐	*Ligustrum sinense*		
☑	*Liriodendron tulipifera*	☑	*Ulmus americana*				
☐	*Magnolia acuminata*						
4	Species in Group 1			0	Species in Group 2		

Sample Variables 10-11 within at least 8 subplots (40" x 40", or 1m x 1m) in the riparian/buffer zone within 25 feet from each bank. The four subplots should be placed roughly equidistantly along each side of the stream.

10 $V_{DETRITUS}$ Average percent cover of leaves, sticks, or other organic material. Woody debris <4" diameter and <36" long are include. Enter the percent cover of the detrital layer at each subplot. **62.81 %**

Left Side				Right Side			
50	50	50	50	50	50	50	50
70	80	95	90	70	50	70	80

11 V_{HERB} Average percentage cover of herbaceous vegetation (measure only if tree cover is <20%). Do *not* include woody stems at least 4" dbh and 36" tall. Because there may be several layers of ground cover vegetation percentages up through 200% are accepted. Enter the percent cover of ground vegetation at each subplot. **71 %**

Left Side				Right Side			
80	70	60	50	80	60	70	50
70	70	90	75	75	70	80	80

Sample Variable 12 within the entire catchment of the stream.

12 V_{WLUSE} Weighted Average of Runoff Score for watershed: **0.98**

Land Use (Choose From Drop List)	Runoff Score	% in Catchment	Running Percent (not >100)
Forest and native range (>75% ground cover)	1	98	98
Gravel	0	2	100

Summary: SAA Number 1		
Variable	Value	VSI
$V_{CCANOPY}$	Not Used, <20%	Not Used
V_{EMBED}	3.6	1.00
$V_{SUBSTRATE}$	3.00 in	1.00
V_{BERO}	0 %	1.00
V_{LWD}	8.0	1.00
V_{TDBH}	Not Used	Not Used
V_{SNAG}	1.0	1.00
V_{SSD}	65.0	1.00
V_{SRICH}	4.00	1.00
$V_{DETRITUS}$	62.8 %	0.77
V_{HERB}	71 %	0.94
V_{WLUSE}	0.98	1.00

Notes:

Restored channel. Newly planted trees provide little canopy. Invasive species removed. Banks stabilized. Cobble substrate installed. Limited erosion.

Land Use Value increased from Forest and Native range 50-75% to >75% ground cover due to clearing land previously heavily inundated with invasive plant species. The proposed planting plan addresses that the riparian zones will be planted using a variety of native trees and shrubs from the selected species list and invasive species will be managed.

These activities are proposed to increase the habitat functions and restore natural stream characteristics in these previously impacted areas.

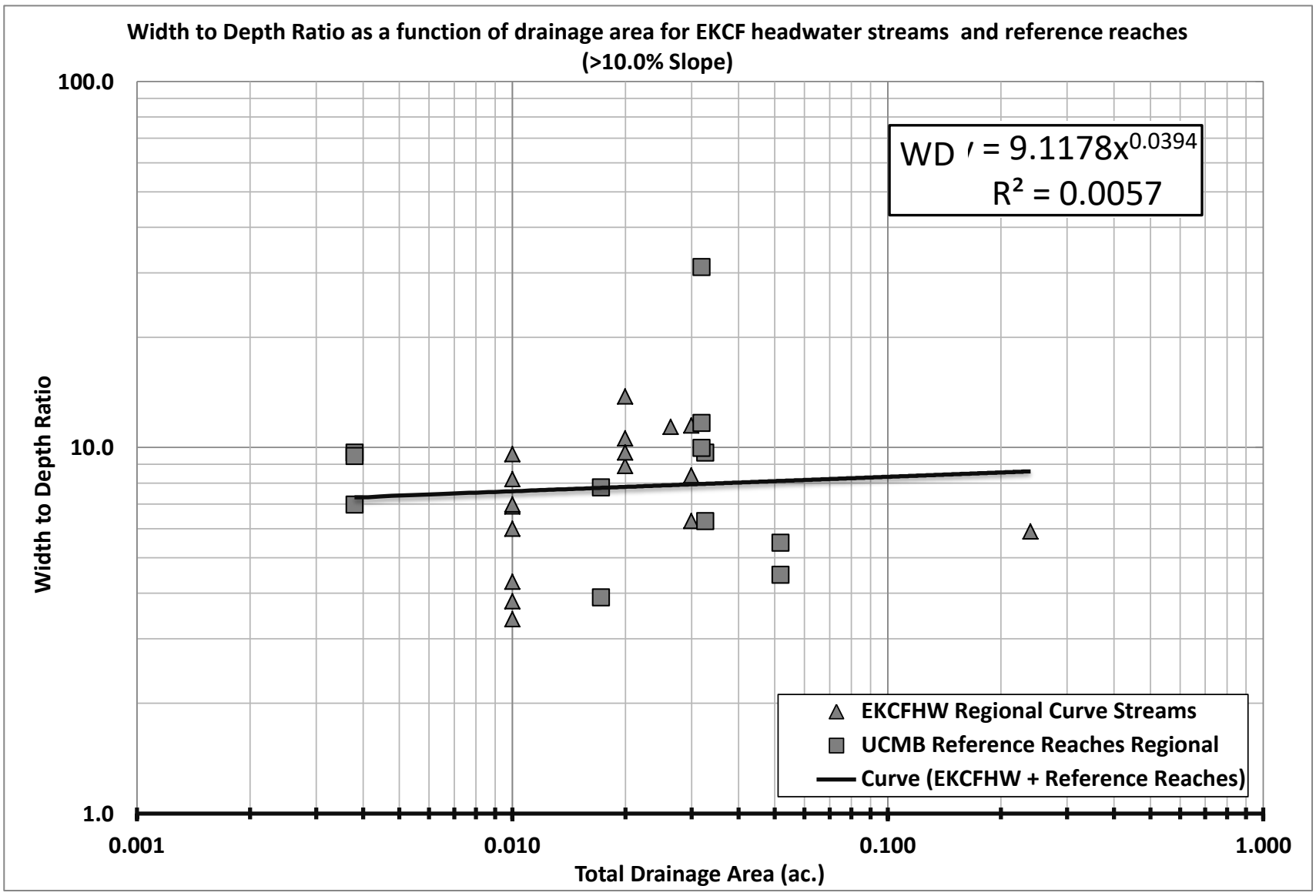
Appendix D
Regional Curve and Reference Data

Bankfull Geometry for Headwater Streams of the Eastern Kentucky Coal Field Region (>10.0% Slope)										
Bankfull Geometry for Headwater Streams of the Eastern Kentucky Coal Field Region (EKCFHW) with >10.0% Slope										
Reference ID	Stream Name	Total DA (acres)	Total DA (mi^2)	A_{bkf} (ft^2)	W_{bkf} (ft)	D_{bkf} (ft)	W/D Ratio	Slope (%)	ER	W_{bed} (ft)
	UT2 Evans Branch	16.9	0.026	2.0	5.0	0.4	11.4	11	--	4.00
2	UT3 Line Fork	19.6	0.03	2.5	5.3	0.5	11.5	11	--	2.90
3	UT3 Evans Branch	12.8	0.02	0.9	3.3	0.3	10.6	11	--	2.60
4	UT3 Evans Branch	11.4	0.02	0.4	2.0	0.2	8.9	11	--	1.45
5	UT2 Falling Rock Creek	16.0	0.03	1.4	3.2	0.5	6.3	12	--	2.20
6	UT Glade Branch	7.4	0.01	0.6	1.8	0.4	4.3	13	--	1.00
7	UT1 Claylick Creek	5.8	0.01	0.6	2.7	0.3	9.6	13	--	1.80
8	UT1 Evans Branch	2.3	0.01	0.5	2.2	0.3	6.9	17	--	0.80
9	UT Clemons Fork	20.2	0.03	1.6	3.8	0.5	8.4	20	--	3.10
10	UT3 Line Fork	10.1	0.02	3.3	7.6	0.6	14	21	--	4.50
11	Clemons Fork	7.3	0.01	0.8	2.8	0.3	8.2	22	--	2.10
12	Evans Branch	155.7	0.24	3.5	4.7	0.8	5.9	40	--	4.00
13	UT2 Falling Rock Creek	8.3	0.01	0.6	2.3	0.3	7.0	25	--	1.40
14	UT1 Line Fork	3.2	0.01	2.7	4.3	1.1	3.8	36	--	0.45
15	UT2 Line Fork	13.2	0.02	1.6	3.9	0.4	9.7	43	--	2.20
16	Clemons Fork	2.6	0.01	0.3	1.4	0.2	6.0	53	--	0.80
17	Falling Rock Creek	1.2	0.01	2.2	3.1	0.9	3.4	80	--	1.75
Bankfull Geometry for Reference Reaches										
18	UT Mill Branch R1-1	33.15	0.052	1.0	2.2	0.5	4.5	39	2.0	0.8
19	UT Mill Branch R1-1	33.15	0.052	0.8	2.1	0.4	5.5	39	2.1	0.9
20	UT Brownies Creek R2-1	20.86	0.033	2.3	3.8	0.6	6.3	19	1.7	2.5
21	UT Brownies Creek R2-1	20.86	0.033	0.4	1.9	0.2	9.7	19	3.1	1.5
22	UT Brownies Creek R2-4	20.42	0.032	2.1	4.9	0.4	12	14	1.4	1.0
23	UT Brownies Creek R2-4	20.42	0.032	0.8	2.8	0.3	10	14	1.2	1.8
24	UT Brownies Creek R2-4	20.42	0.032	1.7	7.2	0.2	31	14	1.1	2.1
25	UT Brownies Creek R2-5	11.01	0.017	0.2	0.8	0.2	3.9	22	5.4	0.8
26	UT Brownies Creek R2-5	11.01	0.017	0.5	2.0	0.3	7.8	22	1.5	1.2
27	UT Path Fork 10E	2.43	0.004	2.1	4.6	0.5	9.7	49	1.5	1.9
28	UT Path Fork 10E	2.43	0.004	0.9	2.9	0.3	9.5	49	4.0	0.5
29	UT Path Fork 10E	2.43	0.004	1.6	3.4	0.5	7.0	49	1.7	1.5

Bankfull Regression Equations for Headwater Streams of the Eastern Kentucky Coal Field Region (EKCFHW) with >10.0% Slope and Reference Reaches

Drainage Area = 1.2 - 158 acres			
Geomorphic Characteristic	Regression Equation	N Value	Coefficient of Determination R^2
Width to Depth Ratio (W/D)	$W/D = 9.1178x^{0.0394}$	29	0.0057
Entrenchment Ratio (ER)	$ER\ 1.3625x^{-0.092}$	12	0.0361

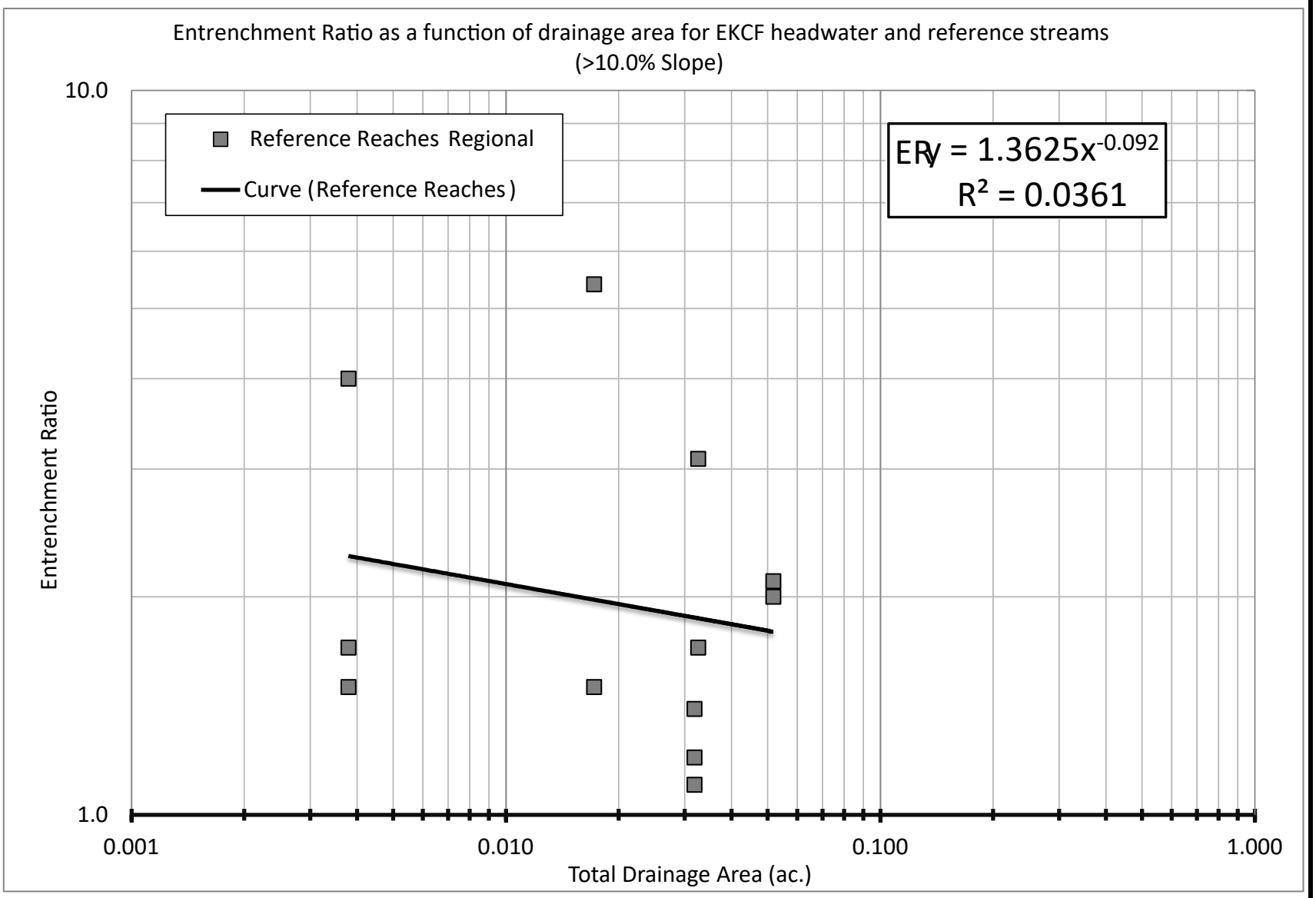
Bankfull Regression Equations for Headwater Streams of the Eastern Kentucky Coal Field Region (EKCFHW) with >10.0% Slope and Reference Reaches



Bankfull Regression Equation for Width to Depth Ratio as a function of drainage area for EKCF headwater streams (>10.0% Slope) and Reference Reaches

Drainage Area = 1.2 - 158 acres			
Geomorphic Characteristic	Regression Equation	N Value	Coefficient of Determination R^2
Width to Depth Ratio (W/D)	$W/D = 9.1178x^{0.0394}$	29	0.0057

Bankfull Regression Equations for Headwater Streams of the Eastern Kentucky Coal Field Region (EKCFHW) with >10.0% Slope and Reference Reaches



Bankfull Regression Equation for Entrenchment Ratio as a function of drainage area for EKCF headwater streams (>10.0% Slope) and Reference Reaches			
Drainage Area = 1.2 - 158 acres			
Geomorphic Characteristic	Regression Equation	N Value	Coefficient of Determination R^2
Entrenchment Ratio (ER)	ER $1.3625x^{-0.092}$	12	0.0361

Project Final Report

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Geomorphic Characteristics of Headwater Streams in the Eastern Kentucky Coal Field Physiographic Region of Kentucky

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Executive Summary

The geomorphic and hydrologic characteristics of headwater streams throughout the US have not been as well-documented as higher-order streams. Four types of geomorphic descriptions of Eastern Kentucky Coal Field (EKCF) headwater channels were developed to improve future identification, assessment, protection, and restoration of the region's headwater streams and downstream water resources:

1. Quantitative descriptions (regional curves) that represent expected values and variation of bankfull cross-sectional area, width, and depth as a function of upstream drainage area.
2. A classification of headwater valley and stream morphology focusing on bedform (step-pool, riffle-pool, plane bed, boulder swale, etc.), substrate characteristics, and potential response to disturbance.
3. A description of morphological features associated with channel heads and changes in hydrologic condition.
4. An estimation of the extent and density of the channel network and the location of the ephemeral/intermittent transitions, and a comparison of those extents to the corresponding networks shown as blue line streams on USGS topographic 7.5-minute quadrangle maps.

Development of the quantitative and qualitative descriptions also incorporated consideration of the effects of geology, historical land-use, and current land use on sediment loads and channel evolution.

The descriptions were developed from geomorphic data collected during an extensive examination of five sub-watersheds of five publicly owned EKCF recreational areas. Drainage areas for all sites where data was collected ranged from 1.2 to 1792 acres (approximately 0.0019 to 2.8 mi^2). Channel and overbank topographic data were surveyed to compute bankfull parameters. Geo-referenced photo-documentation was collected to facilitate identification of morphologic trends and sequences. Recorded features included stream and valley morphology, locations of measured cross sections, locations and types of each channel head, and locations of ephemeral-intermittent transitions.

Bankfull regional curves were derived from cross section data by using ordinary least-squares regression to relate bankfull channel dimensions to drainage area. Although morphology of EKCF headwater channels is highly variable, the regional curves show relationships between cross-sectional dimensions and drainage area that are highly statistically significant ($P < 0.001$ for both Kendall's τ and Spearman's ρ tests). Drainage area accounted for approximately 46% of the variation within the datasets for cross-sectional area and bankfull width. For bankfull depth, however, it accounted for only 15%. Depth may be a more locally variable parameter due to due to the high variation in relative roughness of the channel bed and banks and the high frequency

and irregularity of flow obstructions such as boulders and woody debris. Standard errors ranged from 39-68%.

Scatter in each of the regional curves indicated that factors other than drainage area must also be important in determining the cross-sectional dimensions of EKCF headwater channels. Data on several other key determinants of their morphology, such as bed material, channel slope, and valley confinement, were used to develop a general classification of valley and channel types according to measurable diagnostic features. Channel heads and ephemeral-intermittent transitions were also found to be associated with classifiable morphological features.

Channel head and ephemeral-intermittent transition data were used to estimate the extent of the channel and stream networks; these extents were compared to the corresponding networks shown as blue line streams on topographic maps. Results from the field assessment of hydrologic condition and simulation of the drainage networks showed that locations of channel heads, surface water, and continuous flow were typically located upstream of the start of the drainage network represented by blue line streams from the USGS 7.5-minute quadrangle maps. The blue line streams represent no more than 69% of the modeled stream length delimited by surface water—in some cases as little as 31%—and 48% to 262% of the modeled stream length delimited by continuous flow.

Geomorphic Characteristics of Headwater Streams in the Eastern Kentucky Coal Field Physiographic Region of Kentucky

By Michael A. Croasdaile, Arthur C. Parola, Jr.,
William S. Vesely, and Chandra Hansen

1. Introduction

Headwater streams comprise the vast majority of documented stream length in the United States (Benda et al. 2005) and are a source for much of the downstream network's water, sediment, and nutrients. Changes in their morphology can significantly affect both local and downstream water quality and habitat by changing functions and characteristics such as hydrologic retention capacity; contribution to base flows; flood attenuation; temperature maintenance; regulation of the base-level chemical composition of the watershed; nutrient retention, processing, and export; and sediment retention and supply (Schumm 1977; Vannote et al. 1980; NRC 2002). Conversely, changes in the downstream network can affect the lower-order channels, whose small size and susceptibility to intense rainfall (Jacobson et al. 1989) make them particularly sensitive to disturbance. Human manipulation of streams and their valleys may lead to the formation of headcuts, or zones of instability, which propagate up to and through headwater channels, thereby increasing the delivery of sediment to the downstream network (Schumm et al. 1984).

Because channel geometry is so closely related to the impairments that result from these processes, evaluation of geomorphic characteristics (e.g., bankfull parameters, local channel and valley morphology, and flow regime) is important not only for assessing stream conditions but also for identifying stream impairment sources and practical mitigation strategies. The geomorphic and hydrologic characteristics of headwater streams have not been well-documented (Leopold 1994), however. Most field studies have focused on higher-order, lowland streams, and information on headwater reach-scale morphology is dominated by results from the western US, especially the Pacific Northwest (e.g., Grant et al. 1990; Montgomery and Buffington 1997; Halwas and Church 2002; Benda et al. 2005). Headwater channels in the eastern US have received less scientific attention, and most studies have focused on the Appalachian mountains (the Valley and Ridge province and the Blue Ridge province) (e.g., Hack and Goodlett 1960; Eaton et al. 2003; Adams and Spotila 2005), where relief is considerably greater than in Kentucky, and rainfall events are much more intense (Jacobsen et al. 1989) due to the greater influence of remnant tropical storms.

1.1 BACKGROUND

One increasingly common quantitative method for evaluating geomorphic characteristics is the comparison of measured bankfull channel geometry and flow to estimates from regional

geomorphic curves. Estimates derived from regional curves can provide a reliable point of reference for assessing stream conditions, especially in those channels where bankfull indicators are unapparent or ambiguous: they facilitate Rosgen (1996) classification of stream reaches and estimations of degree of incision, relative bank stability, some channel pattern characteristics, and sediment transport capacity. They are also critical for evaluating the reasonableness of channel dimension and flow designs for stream restorations.

Qualitative descriptions of geomorphic characteristics are similarly useful for these types of assessments and evaluations. Geomorphic and hydrologic classification of reach types is particularly useful for predicting channel evolution and response to disturbance. The ability of stream reaches to absorb or transmit disturbances to the drainage network is important for evaluating the potential supply of sediment to the downstream network. This type of analysis can increase the effectiveness of best management practices such as development of sediment total maximum daily loads (TMDLs) or Watershed Based Plans (WBPs), which otherwise might rely primarily on quantitative measures such as total channel length and characteristic erosion rates (USEPA 1999; Rosgen 2001).

Regional Curves

Estimates of bankfull parameters may be obtained by several means, including direct measurement of reference reaches (Rosgen 1998), use of analytical procedures such as the application of an effective discharge (Andrews 1980), or use of regional curves, which describe bankfull channel geometry and flow as a function of upstream drainage area for streams in a given region. Quantitative geomorphology has been used for over half a century to support the assessment of channels and floodprone areas, beginning with Horton's (1945) drainage basin studies and Leopold and Maddock's (1953) hydraulic geometry relations, which described the relationship between channel dimensions and mean annual discharge within specific drainage basins. In the next decade, hydraulic geometry relations, or at-a-station curves, were developed for several geographic regions in the eastern US (Wolman 1955; Brush 1961; Kilpatrick and Barnes 1964; Leopold et al. 1964). After the introduction and deliberation of the concept of a bankfull discharge, whose stage is just contained within the stream banks (Wolman and Leopold 1957; Wolman and Miller 1960), bankfull channel geometry and discharge data were also collected in the early 1970s (Emmett 2004). In the late 1970s, Dunne and Leopold (1978:614) noted the correlation between bankfull channel parameters and drainage area, and they introduced curves describing average bankfull channel dimensions and bankfull discharge as a function of drainage area in "hydrologically homogenous" regions. In the last decade, regional curves have been developed for physiographic regions across much of the US (e.g., Wolman 1955; Brush 1961; Kilpatrick and Barnes 1964; Leopold et al. 1964; Harman et al. 1999; Smith and Turrini-Smith 1999; McCandless and Everett 2002; Mulvihill et al. 2005; NRCS 2007).

Regional curves are based on the premise that, over time, rivers develop and maintain a bankfull channel geometry and discharge that have a measurable relationship to the landscape characteristics influencing the fluvial processes that shape the channel (Leopold and Maddock 1953). Stream and valley hydrology and morphological processes are closely linked, and the interaction between landscape and channel processes affects the morphology, extent, and flow regime of the channel. The flow of water and the erosion, transport, and deposition of sediments are influenced by several landscape characteristics, including land cover, valley slope and topography, climate, geology, soil types, vegetative cover, and drainage area. Because many of these characteristics are similar throughout a given physiographic region, their influence on channel

geomorphology also tends to be similar. Therefore, when quantitative descriptions of channels are developed according to physiographic region, the influence of these similar landscape characteristics can be isolated, and bankfull geometry can be related directly to drainage area.

While regional curves cannot account for all sources of variability in channel characteristics, they do provide a reliable point of reference for assessment and design of alluvial channels with active floodplains and relatively low-gradient (generally less than 2%) valleys. In the higher-sloped valleys of small headwater channels, however, the relationship between bankfull geomorphic characteristics and drainage area may be less robust at a regional scale (Wohl et al. 2004; Adams and Spotila 2005). Variability of landscape characteristics from one basin to another within a region may introduce variability into regional curves (Ritter et al. 2002). Within each of those basins, landscape characteristics also tend to be more spatially variable than in lower-sloped valleys, and their increased variability contributes to increased variability in channel form. Moreover, hillslope processes (e.g., erosion and mass wasting) act more directly on the channel than in higher-order streams, and they not only introduce additional variability in the spatial distribution of channel forms but also may mask the influence of fluvial processes in shaping the channel, especially where bedrock exposure and colluvium deposits are frequent or extensive. At very small drainage areas, channels may be poorly defined and their morphology strongly controlled by colluvium.

In some regions, headwater channel morphology may be so variable that it precludes a quantifiable description altogether. In headwater streams draining less than 2 km^2 (about 1 mi^2) of the southern Appalachian Mountains of North Carolina and Virginia, the highly variable channel morphology could not be correlated with drainage area (Adams and Spotila 2005). Instead, valley topography, bedrock exposure, and past disturbance were identified as primary determinants of existing morphology.

The feasibility and applicability of regional curves for headwater streams in the Eastern Kentucky Coal Field (EKCF) physiographic region have not yet been tested. In spite of headwater channel morphology's local variability in small, high-gradient watersheds, it is still a product of measurable hillslope and fluvial channel-forming processes and therefore is likely to exhibit systematically distinct characteristics that are both qualitatively and quantitatively definable. The strength of the relationship described by regional curves for EKCF headwaters may depend on the presence or absence of a definable, well-developed floodplain. Because the floodplain acts as a buffer between hillslope and channel, regional curves estimated for sites with floodplains may exhibit less variability than curves estimated for sites without floodplains. Sites without floodplains tend to be located at the highest elevations in the drainage network. Therefore, regional curves may be more feasible at drainage areas large enough to allow for floodplains.

Classification of Reach-Scale Morphology

Bedforms and Substrate

Reach-scale (i.e., lengths of 10–20 channel widths) channel morphology can be associated with hillside and fluvial processes and characteristics that influence channel slope, discharge, sediment supply, shear stress, and sediment transport capacity. These characteristics may include land cover, valley slope and topography, bedrock lithology, coupling with hillslopes (Harvey 2001), degree of valley confinement, drainage area, bed-sediment gradation, and susceptibility to disturbance.

Some of these characteristics exhibit systematic changes with distance downstream and thus would support the development of a scheme for classifying reach types. In the Pacific Northwest,

for example, mountain channels have been shown to be classifiable on a reach scale according to consistently identifiable, measurable characteristics (Montgomery and Buffington 1997). These reach types were found to follow a generally consistent downstream sequence (Montgomery and Buffington 1997): colluvial reaches; bedrock reaches (found throughout the channel network where valley slopes are locally steep); and five types of alluvial reaches (cascade, step pool, plane bed, pool-riffle, and dune-ripple). While not all reach types are found in all watersheds, and disturbances may locally disrupt general trends (Wohl 2006), this process-based classification system was designed to be adapted to high-gradient channels in other regions and thus may be applicable to EKCF headwater channels.

Channel Heads

Channel heads, are the start of the definable channel boundary (Dietrich and Dunne 1993), and their locations, therefore, delimit the total length of a channel network. While channel head locations tend to be relatively constant over time periods of weeks or even years, with cumulative processes producing upslope or downslope movement over a decade or more, they also may change with a single hydrologic event, which can produce upslope migration through propagation of headcuts or mass slope movements. Upslope migration increases the length of the channel network, thereby increasing the number of sediment sources, decreasing the response time to runoff events, and more rapidly delivering pollutants to downstream waters.

The upslope or downslope movement of the channel head is often limited by the morphological features that "control" its location. Because different features will have different influences on the susceptibility of channel head locations to change, classifying the features may be useful in assessing whether the channel head is stable or actively migrating. In general, the morphology of the features associated with the channel head may be classified as one of two types: gradual or abrupt. In the case of gradual channel heads, no single feature controls the channel head location. Instead, a relatively short transition zone is typically found between a channel incised into the hillslope and an upstream swale. A gradual transition indicates that the position of the channel head is relatively stable. Channel heads classified as abrupt, on the other hand, are often associated with a specific feature (boulder, large root, macropore, headcut, etc.). An abrupt transition indicates that the channel head is actively migrating upslope, though the rate of migration may vary between different types of abrupt features.

The rate of channel head migration is controlled by the dominant runoff process, which may be surface or subsurface flow (Dietrich and Dunne 1993), and by the boundary materials at the channel head. The influence of boundary materials on channel head migration is determined by two characteristics. First, the boundary materials' resistance to erosion determines the time period over which the channel head is stable. Channel heads located in bedrock will migrate much more slowly than channel heads in unconsolidated soil. Second, the distribution of the boundary materials determines the potential for future expansion of the channel network if the present control fails or is outflanked by channel erosion. On forested hillsides, the abundance of tree roots provides a large number of potential channel head controls. In contrast, on bare slopes with no controls, the potential for future headward expansion of the channel network is much higher.

Transitions in Flow Regime: Locations and Morphological Indicators

At any given channel location, the hydrologic condition is a combination of groundwater/ base flow and/or storm- or quickflow. Groundwater/ base flow is the longer-term, sustained discharge derived from natural storage zones, while storm- or quickflow refers to the direct response to a rainfall event, which includes overland flow (runoff), lateral movement in the soil

profile (interflow), and direct rainfall onto the stream surface (direct precipitation). The distinction between these two types of flow can be used to identify locations of transition between ephemeral and intermittent flow regimes. Ephemeral channel reaches by definition respond to storm- or quickflow only, whereas intermittent channel reaches receive delayed or base flow, especially during wet periods. Thus, the upstream limit of base flow emergence during the wet season could also be considered the start of an intermittent reach and hence the location of the ephemeral-intermittent transition.

These locations can be identified most readily with a single field inspection during the wet season, which is approximately February through April in Kentucky. In many cases, however, the transition locations will be associated with morphological features that influence the infiltration or exfiltration of water between the surface and subsurface. Therefore, if field identification of the ephemeral-intermittent transition were to be based on the observed distribution of significant geological and geomorphic features that control the flow of groundwater and its presence or absence as surface water, then these locations could be identified during dry periods as well.

Drainage Density and Network Extents

The extent of the drainage network can be measured based on either the locations of channel heads, which define the start of the physical channel, or the upstream limit of a particular hydrologic characteristic, such as the presence of standing water or continuous flow. Herein, the extent based on channel head locations is termed the channel network, and the extent based on hydrologic condition is termed the stream network (after Dietrich and Dunne 1993).

A primary source for delineating channel or stream length and watershed topography in the United States has been the US Geological Survey (USGS) topographic 7.5-minute quadrangle maps produced at 1:24,000 scale. These maps also provide the topography for geology maps (e.g., Kentucky Geological Survey (KGS) 7.5-minute geologic quadrangles) and soil survey maps (e.g., US Department of Agriculture Natural Resources Conservation Service (USDA NRCS) soil surveys). A representation of the approximate extent of the channel network is shown on USGS 1:24,000 topographic maps by blue lines. These USGS blue line designations, however, significantly underestimate the length of headwater channels (Leopold et al. 1964). Generally, 1:24,000-scale topographic maps simplify the morphology of the valley, and many basins may contain more channels than are shown as blue lines (Mark 1983). Field surveys (e.g., Hansen 2001; OHEPA 2002; Rosenfeld et al. 2002) have established that USGS topographic maps under-represent headwater streams by 20%–100%. The omission of small channels from USGS topographic maps is not a flaw in the maps *per se*; instructions to cartographers include the guidance that, for the purpose of clarity, "[d]rainage should not be drawn nearer than 500 ft to the divide" (USGS 1964:80). The maps, therefore, offer the best reflection of the channel network for a large scale of inquiry and are not suited to delineating small channels.

Studies have shown that increased map resolution can allow greater detail in terms of identifying headwater channels (Werritty 1972), but obtaining such improved accuracy through traditional field surveys is labor intensive and prohibitively expensive over a wide area. Alternatively, some researchers have sought to extend the network of blue line streams by tracing depressions or notches in the contour lines, assuming that these "crenulations" represent the incision into the landscape that has been affected by the stream channel (Morisawa 1957). Opinion on the use of contour crenulations to infer the extent of stream channels is divided. Schneider (1961) criticized the effectiveness of such an approach, but Mark (1983), working on streams near Inez, Kentucky, found that it had merit. One distinct disadvantage of such a procedure is that it is

subjective and relies on the experience of the investigator. To circumvent this problem, Shreve (1974) suggested using the point at which the channel reaches a critical gradient to delineate the terminus of the stream channel. For eastern Kentucky, Shreve (1974) proposed a critical gradient of 0.2 ft/ft (20 percent), but he acknowledged that this value would vary from region to region depending on the local geology and climate. This method would also fail to indicate the locations of channel bifurcations.

Because the locations of channel heads and hydrologic condition transitions cannot be accurately estimated from existing geospatial datasets (Mark 1983), field measurements offer the best option for estimating the length of the channel network. If all channel heads in a watershed were to be mapped, the total extent of the channel network could be measured. Locating all channel heads is impractical, however, even in small watersheds. One alternative to direct measurement of these locations would be the use of existing geospatial datasets and sampled field data to estimate the drainage densities of assessed watersheds. From these drainage density estimates, which are ratios of stream length to drainage area, the extents of the drainage networks for each assessed watershed could be derived. The drainage density estimates could also be used to estimate drainage densities and channel and/or stream lengths of similar un-surveyed basins in the region. These estimates could prove to be more accurate than those that would be obtained by using the blue line streams drawn on USGS topographic 7.5-minute quadrangle maps.

1.2 PROJECT PURPOSE AND SCOPE

The main purpose of this project was to provide geomorphic descriptions that will strengthen resource managers' ability to (1) assess the morphological condition of small EKCF headwater streams, especially with regard to their stability, extent, and flow regimes; (2) make informed, effective decisions in the identification, assessment, and protection of headwater streams and downstream water resources; and (3) develop or evaluate best management practices and restoration approaches in EKCF headwaters. The descriptions also may be useful to stream restoration designers and other individuals assessing the stability and morphological characteristics of EKCF headwater streams.

The geomorphic data used to develop the descriptions were collected from five sub-watersheds of five publicly owned recreational areas in March 2006. The sub-watersheds were chosen because they were easily accessible and they had not been subjected to recent logging, mining, or other major disturbance activities. None of the study areas had a USGS gauging station; therefore, data were collected only on un-gauged streams. Drainage areas for all sites where data was collected ranged from 1.2 to 1792 acres (approximately 0.0019 to 2.8 mi^2).

Four types of descriptions were developed from data collected at the sites:

1. Quantitative descriptions (regional curves) that represent expected values and variation of bankfull cross-sectional area, width, and depth as a function of upstream drainage area.
2. A classification of headwater valley and stream morphology focusing on bedform (step-pool, riffle-pool, plane bed, boulder swale, etc.), substrate characteristics, and potential response to disturbance.
3. A description of morphological features associated with channel heads and changes in hydrologic condition.
4. An estimation of the extent and density of the channel network and the location of the ephemeral/intermittent transitions, and a comparison of those extents to the

corresponding networks shown as blue line streams on USGS topographic 7.5-minute quadrangle maps.

2. The Eastern Kentucky Coal Field Physiographic Region

The physiographic regions of Kentucky correspond to geologic regions of the state, as the effects of surface weathering and erosion of different geologies produce landscapes and streams of dissimilar characteristics. In the Eastern Kentucky Coal Field, gravel bed streams dissect the Cumberland Plateau. The major stream systems of the region include the Ohio, the Big Sandy, the Little Sandy, the Licking, the Kentucky, and the Cumberland rivers.

2.1 STRUCTURAL GEOLOGY

The EKCF physiographic region is part of a larger physiographic region known as the Cumberland Plateau, which extends from Pennsylvania south to Alabama. It is bounded on the west by the Pottsville or Cumberland Escarpment, formed from resistant sandstones and conglomerates in the lower part of the Pennsylvanian strata (Figures 2.1a and b). The Pennsylvanian stratigraphy of the Eastern Kentucky Coal Field includes the Breathitt and Lee formations (Table 2.1). During the Pennsylvanian period 250-300 million years ago, sediment eroding from the ancestral Appalachian Mountains was deposited in a large inland sea extending over a region known as the Appalachian Basin. Fluctuations in the level of this ancient sea, along with basin subsidence and changes in depositional environment, resulted in a cyclical layering of the region's coal-bearing lithology, comprised predominantly of interbedded sandstone, shale, coal, and to a lesser extent, limestone. Orthoquartzitic sandstone, possibly deposited as channel fills or sandbars, is the primary constituent of the older Lee formation (Rice et al. and Horne et al., as cited in Outerbridge 1987). The erosion-resistant quality of this rock type is responsible for its presence in prominent cliff outcroppings and river knickpoints. Additionally, this resistant rock generally provides terrain that is not prone to landslides (Outerbridge 1987). Overlying the Lee formation is the Breathitt formation, consisting of less resistant subgraywacke sandstone interbedded with siltstone, shale, and coal.

The EKCF region contains several major structural features: the Kentucky River fault system, the Irvine-Paint Creek fault system, the Pine Mountain thrust fault, and the Waverly arch of northeastern Kentucky. The Kentucky River fault system extends eastward into West Virginia, mostly as a concealed system within this region. The Irvine-Paint Creek fault system extends eastward from central Kentucky to a terminus near Paintsville. The Pine Mountain overthrust fault brings Devonian and younger rocks northwestward over Pennsylvanian rocks.

Due to relatively little deformation of the original layered lithology, the hills of the Eastern Kentucky Coal Field are a highly dissected upland plateau (Outerbridge 1987). With the exception of the Pine Mountain thrust fault, the structure of the region's geology remains in a relatively undisturbed state of limited dip, faults, or folding. The Appalachian Basin region was spared the rock-warping forces induced by continental collisions during the formation of Pangea. The flat-lying structure is only mildly deformed into a broad, shallow syncline spanning eastern Kentucky, southern West Virginia, Virginia, and Tennessee. Rocks dip gradually with existing localized anticlines.

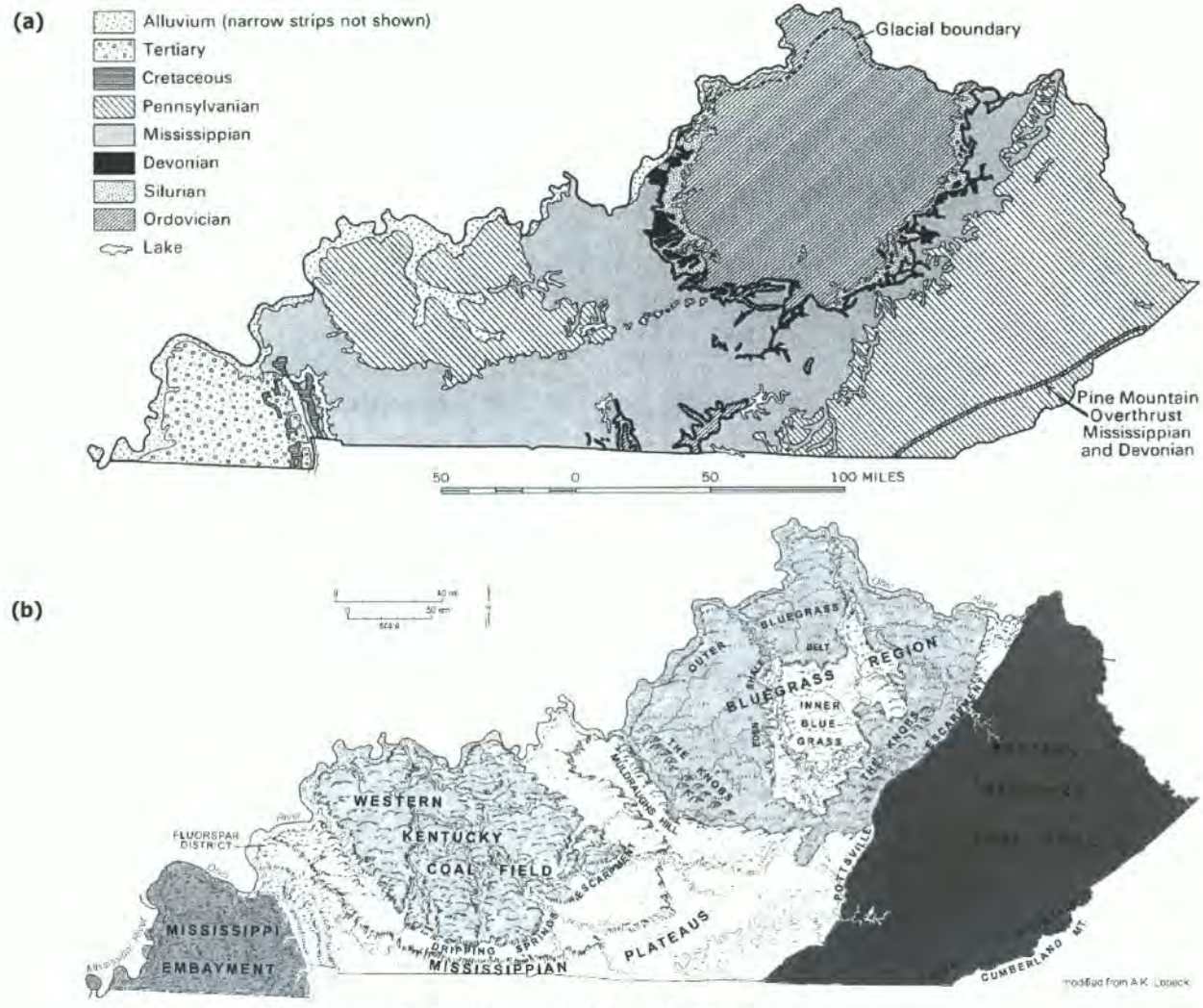


Figure 2.1 (a) Generalized geologic map of Kentucky (after McGrain 1983:12). (b) Physiographic map of Kentucky (KGS 2001).

In addition to these slight deformations, the geological structure of the Eastern Kentucky Coal Field includes abundant stress relief joints. As erosion dissects the uplifted Appalachian Basin, large amounts of sediment are removed from underlying rock. The newly exposed rock is relieved of the confining pressure of its overburden and subsequently expands. Due to the low tensile strength of rock, a network of stress relief joints forms. This network consists of vertical joints along valley walls and horizontal joints between bedding planes along valley floors. The interconnectedness of these joints provides a conduit for groundwater flow (Wyrick and Borchers, as cited in Outerbridge 1987).

2.2 PHYSIOGRAPHIC SETTING

The EKCF region encompasses all or part of 37 counties and covers roughly 11,650 mi^2 in the easternmost portion of Kentucky (Figure 2.1b). While no sub-regions have been defined for the EKCF, the region encompasses three topographically distinct areas: the eastern mountains;

Table 2.1 EKCF Generalized Stratigraphy*

System	Series	Formation	Facies	Description
PENNSYLVANIAN	Lower and Middle Pennsylvanian	Breathitt	Upper Delta Plain	Sandstone, siltstone, shale, and coal; sandstone, gray, weathers yellowish-brown, in locally large channel-fill deposits, interbedded with siltstone and shale; siltstone and shale, gray, weathers green to yellowish-brown; coal beds generally less than 1 m thick. Forms rounded to craggy hills with rockfalls and abundant debris flows and avalanches.
				Sandstone, siltstone, shale, and coal; sandstone, gray, weathers yellowish-brown, commonly in large channel-fill deposits which contain quartz-pebble conglomerate interbedded with siltstone and shale; siltstone and shale, medium-dark-gray weathers yellowish-brown; coal beds as much as 6 m thick. Forms very steep craggy hills with rockfalls and abundant debris flows and avalanches
			Lower Delta Plain	Sandstone, siltstone, shale, and coal; sandstone, gray, weathers yellowish-brown, commonly in channel-fill deposits, interbedded with siltstone and shale; siltstone and shale, medium-dark gray, weather yellowish-brown; coal beds generally less than 3 m thick. Forms steep craggy hills with rockfalls and abundant debris flows and debris avalanches. Thin limestone beds occur throughout the stratigraphic column above the top of the Lee Formation but aggregate less than 1% of the column; gray to black, weather gray; these rocks have no effect on topography or landslides. Orthoquartzites of the Lee Formation intertongue with adjacent formations.
			Lagoonal	Siltstone, shale, sandstone, and coal; siltstone and shale, dark-gray, weathers yellowish-brown, in units up to 20 m thick, commonly interbedded with sandstone laminae; sandstone, gray, weathers yellowish-brown, also in local channel fills; coal beds generally less than 2 m thick. Forms rounded hills with debris flows and debris avalanches.
		Lee	Barrier Bar	Sandstone, conglomerate, siltstone, shale, and coal; sandstone orthoquartzitic, light-gray to white, weather white to pink to brown, in thick channel-fill-like deposits commonly with basal quartz-pebble conglomerate as much as 3 m thick; interbedded with dark-gray siltstone and shale that weathers yellowish-brown; coal beds generally less than 2 m thick. Sandstone forms cliffs, as much as 90 m thick and mesas. Forms generally stable terrain, and stabilizes overlying beds except at cliffs where rockfalls litter slopes below with boulders up to about 10 m across.
MISSISSIPPIAN	Upper Mississippian	Pennington	Lower Delta Plain	Sandstone, siltstone, shale, and limestone; sandstone, reddish-gray to gray, weathers yellowish-brown to red, in channel fills, interbedded with siltstone and shale; siltstone and shale, reddish-gray, weathers yellowish-brown to red, with interbedded thin gray, yellow-weathering limestone beds. Forms very abundant earth flows and debris flows.

* The typical stratigraphy of the region provided by the US Geological Survey (USGS) as presented by Outerbridge (1987).

the western one-third of the region near the Pottsville or Cumberland Escarpment; and the area between these two limits. East of the Pine Mountain overthrust fault are the Pine and Cumberland mountains. These are true mountains with highly inclined strata. The other two areas, while commonly referred to as mountains, are ridges and valleys produced by the erosional processes of stream dissection.

The western third of the EKCF was termed the Ridge Top and Limestone Valley Settlements area by the Kentucky Geological Survey in the early twentieth century (Davis 1924). This area corresponds to an outcrop of the basal members of the coal measures strata, delineating the area along a meandering line roughly bisecting Whitley, Clay, Owsley, and Lee counties and terminating at the northwestern corner of Greenup County. Along much of the western portion of the Ridge Top and Limestone Valley Settlements area, the ridges are relatively narrow and the valleys wide. Streams of the Kentucky and Cumberland river networks have excavated valleys to the underlying limestone layers, in which sinkholes and subsurface channels have formed. Soils in these valleys are alluvial. In the rest of the Ridge Top and Limestone Valley Settlements area, the ridges are wide and level (Figure 2.2), and valley bottom areas are narrow. Streams are deeply entrenched and valley walls are steep or precipitous (Figure 2.3). Soils tend to be sandy, with gravels present in many places.

In the remaining portion of the EKCF region, termed the Creek Bottom Settlements area by Davis (1924), ridges are much narrower (Figure 2.4) and more uneven than in the Ridge Top area, and valleys are wider (Figure 2.5). The valley wall slopes in the Creek Bottom Settlements, while steep, are generally not precipitous and thus were better suited for agricultural production during the early settlement period. Soils are generally loams and silty loams but are thin on the hill slopes and subject to erosion when cultivated.

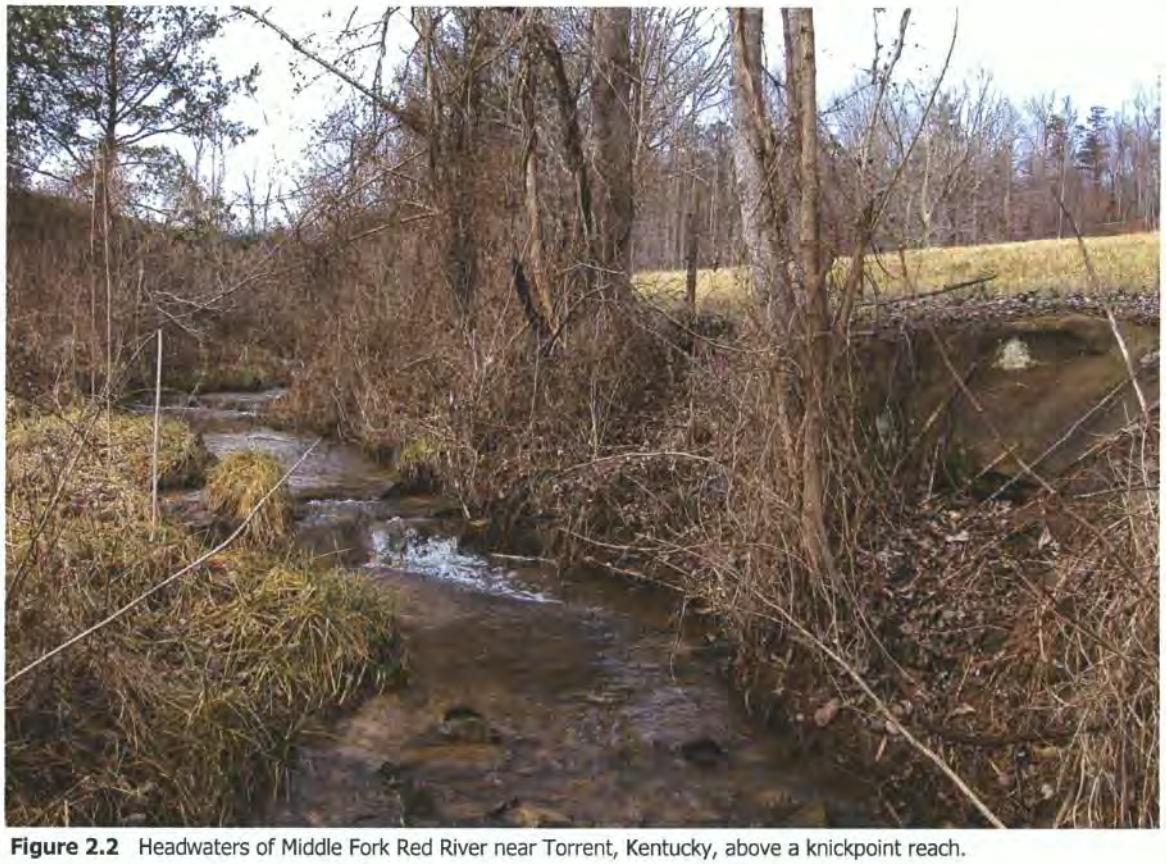


Figure 2.2 Headwaters of Middle Fork Red River near Torrent, Kentucky, above a knickpoint reach.



Figure 2.3 Salt Lick of South Fork Red River in the Ridge Top Settlements area near Slade, Kentucky.



Figure 2.4 Narrow ridge top in Lilley Cornett Woods in the Creek Bottom Settlements area.



Figure 2.5 Troublesome Creek at Noble, Kentucky, in the Creek Bottoms Settlements area.

3. Measurement and Analysis Methods

The main objective of data collection was to obtain both qualitative and quantitative descriptions of headwater channel morphology and drainage network extents in the Eastern Kentucky Coal Field region. Photographic documentation, detailed field notes, and geospatial datasets were used to record descriptions of bed material, valley confinement, and valley slope. These data were analyzed to identify morphologic trends and sequences. Bankfull channel characteristics, channel head locations, and locations of changes in hydrologic condition were measured. The surveyed channel geometric data were used to calculate channel dimensions and parameters needed for developing bankfull regional curves. Channel head and hydrologic condition data were used to calculate drainage areas that in turn were used to generate simulations of the channel and stream networks. Drainage densities were calculated for these simulated networks and for the corresponding networks shown as blue line streams on topographic maps.

3.1 SITE SELECTION

Initial Screening

To ensure ease of access to multiple headwater channels within a given area, only publicly-owned lands were considered for selection as study areas. An initial list of 22 publicly-owned EKCF lands, principally Wildlife Management Areas (WMAs) or State Resort Parks (SRPs), was compiled from readily-available map sources (DeLorme 2005). The boundaries of the WMAs and SRPs and their sub-watersheds were identified using a Kentucky atlas (DeLorme

2005); the boundaries were re-created in GIS and overlain on the most recent available USGS 7.5-minute topographic quadrangle maps (KEPPC 2002). Public lands east of the Pine Mountain overthrust fault (Figure 2.1a) were eliminated as potential study areas because their geology differed significantly from that of the rest of the EKCF region. Public lands in the Ridge Top and Limestone Valley Settlements area, in which sinkholes and subsurface channels have formed (KGS 2005), were also excluded.

Within the 12 remaining potential study areas, sub-watersheds (HUC14 or smaller) were screened for further consideration. One sub-watershed was selected from each study area based on five primary criteria:

1. The majority of the sub-watershed is located within publicly-owned land.
2. The sub-watershed has not been subjected to mining, which would alter surface or sub-surface hydrology.
3. Sub-watershed is accessible by road.
4. No roads have been constructed on the sub-watershed's ridgetops.
5. Streamflow in the sub-watershed is unregulated.

Five study areas were eliminated from further consideration because none of their sub-watersheds met the above screening criteria. Within each of the sub-watersheds that met the screening criteria, one or two first-order blue line streams were then selected at random for field inspection to determine their suitability for assessment.

Prior to field reconnaissance, contour maps, orthoimagery (aerial photographs), and additional geospatial datasets were reviewed to identify characteristics that could be relevant to field evaluation of the randomly selected first-order blue line streams' suitability for assessment. The following tasks were completed in the review:

1. Each of the randomly selected sub-watersheds and the HUC10 watersheds of their trunk streams were located on USGS 1:24,000 orthoimagery (USGS 2004).
   a. The images were reviewed to identify land use changes that had occurred since the creation of the topographic and geologic maps. These changes principally consisted of logging and mining. Possible impacts to the valley, the stream channel, and the floodplain were considered.
   b. Evidence of debris flows was identified.
2. A valley profile was constructed for each HUC10 watershed's trunk stream from the ridge top to a point where its drainage area was at least 100 mi^2: contour elevations along the valley centerline were plotted against distance along the valley centerline. The valley profile reveals differences in the overall valley slope, which is an important influence on channel morphology. Steep valleys generally contain steep streams.
3. The bedrock materials underlying each selected HUC10 watershed were identified from the KGS 7.5-minute geologic quadrangle maps (KGS 2000).
4. The HUC14 watersheds were examined on the USGS topographic maps:
   a. Blue line streams were examined for evidence of channel straightening, realignment, or other modifications such as excavation for old mill races. Streams that were aligned on one side of the valley flat and had a straight planform were assumed to have experienced some degree of channel straightening.
   b. Any structures spanning or encroaching on the blue line streams were identified.
   c. Valley constrictions or sharp bends that could create backwater during high flows were recorded.

d. The 1950s course of the blue line stream was identified on the topographic maps and compared with the present alignment documented by aerial photographs. Discrepancies were recorded to identify locations where channel movement or straightening may have occurred since the 1950s.

5. Active or recently active landslides and debris flows in the HUC14 watersheds were identified from KGS 1:24,000 landslide potential maps (KGS 1979). The maps also show areas susceptible to landslides and debris flows, and these were recorded.

Field Reconnaissance

Prior to data collection, final selection of each first-order blue line stream was conducted in the field on a site-by-site basis. Where field conditions indicated that the selected first-order blue line stream did not meet all of the initial screening criteria, a proximate first-order blue line stream within the same sub-watershed was substituted if it better met the criteria. For instance, at Greenbo Lake SRP, only three first-order blue line streams—Pruitt Fork, Claylick Creek, and Buffalo Branch—were located within the SRP boundary. The northern stream, Pruitt Fork, was found to have a road along the ridgetop and was rejected. Claylick Creek was considered preferable to Buffalo Branch because it had no ridgetop road, and its headwaters were located further from Greenbo Lake (and any associated impact due to the lake's dam) than Buffalo Branch. The substituted first-order blue line stream was usually the one most easily accessible by road.

Final Site Selection

A total of six first-order blue line streams within five sub-watersheds of five study areas (Table 3.1 and Figure 3.1) were chosen for assessment. (A sixth study area, Fishtrap Lake, was initially part of the sample, but equipment malfunctions during data collection required that the site

Table 3.1 Study Area and Study Site Locations

	Study Area	County	HUC10 Watershed & HUC14 Sub-Watershed	First-Order Blue Line Stream	Study Site Lat/Lon*	Stratig. Label	Stratigraphic Description
1	Greenbo Lake SRP (GL)	Greenup	HUC10: Lower Little Sandy River HUC14: Greenbo Lake	Unnamed trib. of Claylick Creek	N 38° 29.254' W 82° 53.994'	Pbl Pbm	Breathitt Formation, lower part. Breathitt Formation, middle part.
2	Lilley Cornett Woods (LCW)	Letcher	HUC10: Line Fork–N. Fork Kentucky River HUC14: Line Fork	Unnamed trib. of Line Fork	N 37° 4.661' W 82° 59.542'	Pbm	Breathitt Formation, middle part.
3	Paintsville Lake WMA (PL)	Johnson	HUC10: Paint Creek HUC14: Mudlick Creek	Glade Branch	N 37° 51.699' W 82° 53.430'	Pbl	Breathitt Formation, lower part.
4	Robinson Forest WMA (RF)	Breathitt	HUC10: Troublesome Creek HUC14: Clemons Fork	Clemons Fork	N 37° 29.937' W 83° 7.845'	Pbm Pbu	Breathitt Formation, middle part. Breathitt Formation, upper part.
			HUC14: Clemons Fork	Falling Rock Creek	N 37° 28.586' W 83° 8.401'	Pbm Pbu	Breathitt Formation, middle part. Breathitt Formation, upper part.
5	Yatesville Lake WMA (YL)	Lawrence	HUC10: Middle Blaine Creek HUC14: Brushy Creek	Evans Branch	N 38° 2.944' W 82° 47.400'	Pbu Pbm	Breathitt Formation, upper part. Breathitt Formation, middle part.

* Location of the downstream limit of the study site.

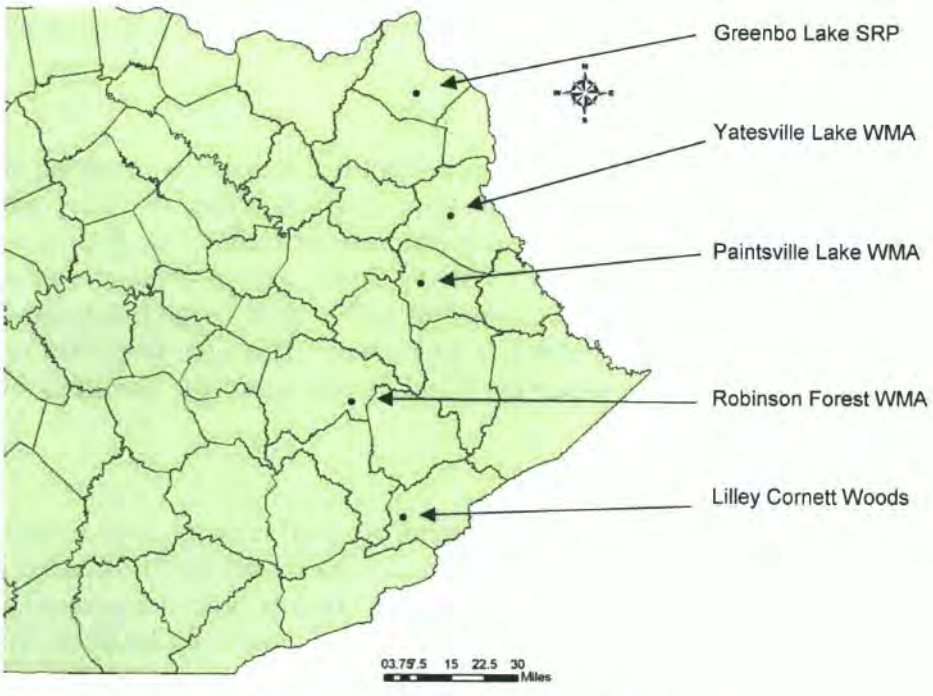


Figure 3.1 Location of study areas within the EKCF physiographic region.

be excluded.) A first-order blue line stream and at least three of its tributaries constituted a study site. For all study areas except Paintsville Lake WMA, the blue line streams were perennial streams denoted by solid blue lines. For Paintsville WMA, no perennial streams were denoted. Therefore, an intermittent stream denoted by a dash-dot blue line was selected.

3.2 DATA COLLECTION

Field data were collected in March 2006. Geo-referenced photo-documentation was collected along the selected first-order blue line streams and tributaries to facilitate identification of morphologic trends and sequences. Recorded features included stream and valley morphology, locations of measured cross sections, locations and types of each channel head, and locations of changes in the hydrologic condition (i.e., the degree of departure from completely dry condition (Fritz et al. 2006)). Channel and overbank topographic data were surveyed in multiple reaches to calculate parameters for bankfull regional curves.

Photo-Documentation

At each study site, the selected first-order blue line stream, its valley, and at least three of its tributaries were photo-documented using a high-resolution digital SLR camera and a handheld Geographical Positioning System (GPS) receiver pre-loaded with USGS 1:24,000 topographic maps. A road crossing, a confluence, or another relatively permanent feature was selected as a reference point that marked the downstream limit of the study site (Table 3.1). The geo-referenced photo-documentation was initiated at the reference point and continued up to the drainage divide. At regular intervals (not more than 10 channel widths), a GPS reading and photograph were taken. The identifier numbers of each photograph and its corresponding GPS data point were synchronized so each photograph could be tied to a specific geographic location. To

maximize the accuracy of GPS measurements, multiple readings (typically 30-60) were averaged to produce each GPS data point.

Stream and Valley Morphology

Starting at the downstream reference point, the field crew identified transitions in stream and valley morphology. Where bedrock exposure, channel bedforms, stream slope, or valley morphology changed, a GPS reading and photograph were taken, and a description of the feature was recorded in a field notebook. Evidence of landslides or debris flows, past or present, was described and photographed. Bed material was photographed at riffles or steps and at locations where it had been deposited upstream of these features; a scale (typically a ruler or pocket rod) was included in each photograph to enable post-survey visual estimation of the dominant bed material type.

Channel Head Morphology and Location

The morphologic characteristics and locations of the channel heads of each assessed tributary were photo-documented. Based on the premise that a channel is a watercourse that has created its own boundary through erosion by surface or sub-surface flow, the channel head was determined as the highest point that a topographic depression *with definable banks* could be identified. This definition is compatible with those of Dietrich and Dunne (1993) and Calver (1978:233), who defined a fluvial channel as "an incision into the ground surface such that, if water ceased to flow, morphological evidence of its former course would, at least initially, remain apparent."

If the channel head had the form of an abrupt step instead of a gradual transition, the height of the step was recorded as well as any evidence of controlling factors (e.g., large boulders or tree roots that might be stabilizing the step). Any signs of either recent flow or pathways of concentrated flow were documented in a field notebook and photographed. In many instances, multiple channel heads were recorded for a single stream because the transition from swale to channel was discontinuous, or because deposition had buried a segment of the stream channel.

Hydrologic Condition

The hydrologic condition was identified by visually assessing the surface and near-surface water and flow according to five categories (Hunter et al. 2005; Fritz et al. 2006):

- No surface water
- Surface water in pools only
- Surface water present but no visible flow (i.e., standing water over the riffles)
- Flow only interstitial
- Continuous surface flow

Subsurface water was examined by removing surficial sediment to a depth of at least 0.5 ft. Locations where the hydrologic condition changed were recorded using a handheld GPS device. Morphological features influencing the infiltration and exfiltration of groundwater (e.g., change in bed material from planar bedrock to alluvium) were documented in a field notebook and photographed. Other features relevant to the presence or absence of flow, such as where water emerged from a piping cavity, were recorded and photographed.

The field assessments were conducted during the wet season, which is the optimal time for determining the length of the stream network based on hydrologic condition. The amount of recent precipitation between sites varied, however. At Lilley Cornett Woods, Robinson Forest, and

Paintsville Lake, only minimal rain (<0.3 in) had fallen during the week preceding data collection (NOAA 2006). At Yatesville Lake WMA and Greenbo Lake SRP, over 1 in of rain had fallen during the two days prior to field measurements.

Bankfull Channel Geometry

Cross sections were surveyed in multiple reaches at locations that both coincided with a clear bankfull indicator (Rosgen 1996) and were representative of the reach morphology. Selected reaches were those with geomorphic characteristics suitable for surveying of bankfull indicators; suitability was determined based on evaluation of the channel and floodplain morphology. At a minimum, the reach had to have cross-sectional geometry with unambiguous depositional indicators of the bankfull level.

The bankfull level was determined according to the definition of bankfull flow proposed by Dunne and Leopold (1978), who described it as the flow that completely fills the channel so that its surface is level with the active floodplain. The active floodplain is the flat depositional surface adjacent to the channel that is constructed by the present river in the present climate and is frequently inundated by the river (Dunne and Leopold 1978).

The primary indicator used to identify the active or actively-forming floodplain was a fine-grained depositional feature (Schumm 1960; Kilpatrick and Barnes 1964; Bray 1972; Williams 1978). Only level depositional surfaces with a length exceeding one bankfull width were used as bankfull indicators. Close to the ridgetop, these features formed in the lee and wake of large boulders (Figure 3.2a), whereas further downstream the deposits were more continuous (Figure 3.2b). Where depositional benches suggested two or more possible bankfull levels within a reach, the lowest level was considered to be bankfull. The break in slope between this level surface and the stream bank was identified as the bankfull level.

Identification of the bankfull level was refined by evaluating secondary, non-morphological indicators. Secondary indicators of the bankfull level included the size fraction of the depositional material and changes in vegetation above and below the level identified as bankfull.

In each selected reach, cross section data were collected with the use of a line level, station tape, and elevation rod according to the following procedures:



Figure 3.2a Lilley Cornett Woods near the ridgetop. The channel reach is an alluvial section upstream of abundant boulders that were produced by weathering and erosion of the sandstone caprock.



Figure 3.2b Yatesville. At larger drainage areas, colluvial material from hillslopes is present, but the level surface found along the top of the banks is the result of alluvial sediment deposition.

1. A string line was pulled taut across the channel between the cross section control points and set to a level horizontal plane using a line level. The taut line established a horizontal datum to which all elevation data were referenced.
2. A graduated survey tape was strung parallel to the datum line with zero set at the left bank (facing downstream).
3. The cross section was measured by noting the cross-channel station and measuring the vertical distance from the datum using a graduated tape. Distance, elevation, and point description data were recorded by a second survey crew member.

This rapid survey method allowed for collection of a larger dataset than could be collected in rugged terrain using total station surveying equipment. The surveys extended to the width of the floodprone area or, when the floodprone width was clearly greater than four times the bankfull width, to a point at least one bankfull width from the top of each bank. Points were taken at intervals of approximately 1-2 ft and at all breaks in slope (Figure 3.3). The toes of each bank were identified based on sediment size, structure, and frequency of movement: bank sediments are typically finer and more layered than bed material and may have been deposited years, decades, or centuries prior to assessment, whereas bed material is coarser and more frequently mobile and is a product of more recent flows.

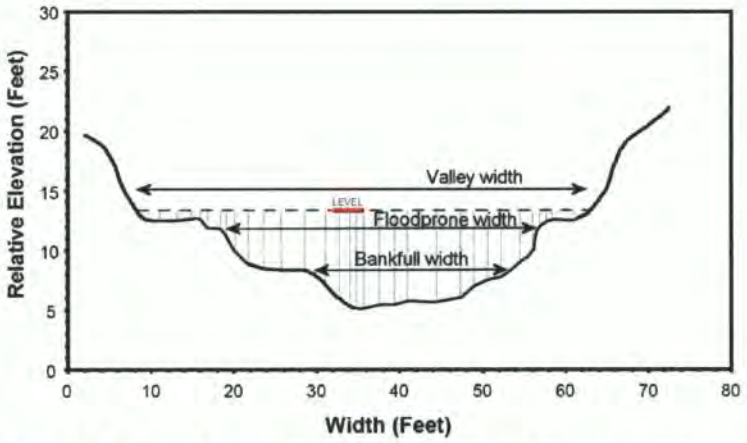


Figure 3.3 Typical cross-section of headwater stream showing multiple-level banks and proximity of hillslope to the channel.

3.3 DATA ANALYSIS

Cross Sections

Cross section data were imported into Microsoft Excel. Each surveyed cross section at each site was plotted at a 1:1 horizontal-to-vertical scale so that breaks in slope could be clearly identified. Based on each cross section plot, the following parameters were computed for developing regional curves: bed width (W_{BED}); bankfull cross-sectional area (A_{BKF}); bankfull width (W_{BKF}); and mean bankfull depth ($D_{BKF} = A_{BKF} / W_{BKF}$).

Stream and Valley Morphology

Field notes and photographic documentation were examined to identify bedforms, which were delineated according to a visual analysis of the bed profile (smooth and flat versus stepped),

the bed sediments (boulders vs. cobbles vs. gravels), and the presence or absence of large woody debris. Photos of bedforms of different study sites were visually compared to evaluate their similarities and differences, and the sequences of bedforms for each study site were plotted on the valley profiles that also revealed changes in valley slope.

Bed Material

The bed sediment was visually assessed in each bed sediment photograph, and the dominant bed material was assigned to one of four categories: sand (< 2 mm), gravel (2-63 mm), cobble (64-255 mm), or boulder (≥ 256 mm). Where a mixture of grain sizes was present, the dominant material type was assigned based on the size of material controlling the grade of the stream reach. For example, where cobbles and boulders were present in roughly equal proportions but the long profile was characterized by alternating pools and cobble riffles, the dominant bed material type was cobble. Conversely, where the majority of drops occurred over boulder steps, the dominant bed material type was boulder. The dominant bed material type was plotted on longitudinal valley profiles to illustrate the sequence and variability of different substrates within each study site.

Hydrologic Condition

Stream reaches were categorized according to three designations of hydrologic condition: "no surface water," "surface water in pools only" (SW), and "continuous surface flow" (CF). The other two of Fritz et al.'s (2006) five categories of hydrologic condition were not well represented at the time of the field visits for this project (during the wet season): reaches with "flow only interstitial" and "surface water present but no visible flow" were rarely observed.

Because the hydrologic condition is a combination of surface/direct runoff, which is the rapid response to recent rainfall, and groundwater or base flow, which is sustained discharge derived from storage zones, transition locations will vary with precipitation changes. Rainfall at Yatesville Lake WMA and Greenbo Lake SRP likely caused the measured locations of hydrologic condition transitions to be closer to the drainage divide than they would have been without a recent rainfall event. The potential significance of this rainfall cannot be determined, as several other factors (e.g., geology, vegetative cover, relief) also influence the locations of transitions. Because of the rapid response of headwater streams and the absence of precipitation during the day of assessment, however, any errors should be minimal.

Source Areas and Distance to Drainage Divide

The drainage area of the channel heads (e.g., Montgomery and Dietrich 1992) and the drainage area contributing to surface runoff (e.g., Sidle et al. 2000) are both referred to as the *source area*. Herein, the source areas are differentiated as the channel head (CH) source area, the SW source area, and the CF source area. Source areas were calculated for each channel head and each transition in hydrologic condition (SW and CF points), and drainage areas (DA) were calculated for the locations of each surveyed cross section, as follows:

1. USGS 7.5-minute topographic quadrangle maps and GPS coordinates of each location were imported to ArcGIS.
2. Drainage or source area boundaries for each location were delineated manually on the topographic maps by following ridgelines represented by contour lines. Where the scale of the topographic map rendered the location of the drainage divide unclear, orthoimagery and photographs showing the area around each channel head were used

to define the boundary. Therefore, the source areas calculated for those channel heads are less accurate than those calculated for points lower in the sub-watershed.

3. The contributing drainage or source areas for each location were calculated from the manually delineated boundaries.
4. Summary parameters (mean, maximum, and minimum) were calculated for the source areas of the channel heads, SW points, and CF points in each study site. The regional mean source area was also calculated for the channel heads of all of the study sites taken collectively.
5. Distances from the delineated ridge tops to three types of locations were calculated: (1) the locations of the channel heads; (2) the locations where the hydrologic condition changed; and (3) the start of the USGS perennial blue line streams on the topographic maps (or in the case of Paintsville WMA, the intermittent blue line stream). Relative to source areas, the distance from the drainage divide is less sensitive to map resolution and is a simple parameter to measure even at small drainage areas.

Drainage Density

Drainage density (mi/mi^2) is the total length of channel per unit area (Horton 1945), described as

$$D_d = \frac{\sum L}{A_d} \tag{3.1}$$

where $\sum L$ is the total channel length in a basin of area A_d. For a given valley network, the closer the channel heads are to the drainage divide, the greater the extent of the channel network and, therefore, the greater the drainage density (Knighton 1998).

Hydrologic modeling was used to generate the channel network for each HUC14 sub-watershed (see Table 3.1). At Lilley Cornett, the HUC14 was too small (<2.5 mi^2) for representative modeling; there, the HUC10 was used. At Greenbo Lake and Paintsville Lake, a HUC14 watershed immediately adjacent to the study site was used because the lakes cover a large percentage of the watersheds, which shortens the extent of the blue line stream network. The models were generated and analyzed as follows:

1. Thirty-foot resolution digital elevation models (DEMs) of the sub-watersheds were imported into GIS.
2. Standard ArcGIS Spatial Analyst routines were used to generate channel networks for each sub-watershed based on topography and user-input values defining the initial source areas at the upstream limits of the networks. The summary parameters (mean, maximum, and minimum) calculated for the source areas of the channel heads, SW points, and CF points were input to generate a total of nine networks (three networks for each type of feature) in each sub-watershed. A tenth channel network for each sub-watershed was generated using the regional mean source area calculated for the channel heads of all of the study sites taken collectively. Because each drainage network is based on the USGS DEM, the input source areas were rounded to the nearest 900 ft^2 (the pixel size of the USGS DEMs).
3. The generated channel lines were used to calculate the channel length from the downstream limit of the sub-watershed up to the channel heads, the SW points, and the CF points. Four values were calculated for each of these channel lengths based on the source areas of the sub-watersheds: L_{DAmean} for length using mean source area, L_{DAmax}

for length using maximum source area, L_{DAmin} for length using minimum source area, and $L_{DA\text{-}EKCF}$ for length using the regional mean source area. The lengths of the solid blue line streams (dashed for Paintsville) for each sub-watershed were also calculated.

4. Drainage densities of the sub-watersheds were calculated as the ratios of each of the 10 channel length values to the drainage area of the sub-watershed, as follows:

$$D_{d-DAmean} = \frac{L_{DAmean}}{A_d} \tag{3.2}$$

$$D_{d-DA\max} = \frac{L_{DA\min}}{A_d} \tag{3.3}$$

$$D_{d-DAmin} = \frac{L_{DA\max}}{A_d} \tag{3.4}$$

$$D_{d-EKCF} = \frac{L_{DA-EKCF}}{A_d} \tag{3.5}$$

The drainage densities of the blue line streams for each sub-watershed were also calculated in order to compare them with the densities of the generated channel networks.

The choice of the source area value produces bias in the estimation of total network length and drainage density. Use of the maximum field-measured source areas for the start of the channel network tends to underestimate the total drainage network length (Type II error). Use of the mean source area improves the estimation of network length but remains an underestimate of the true channel network. Use of the minimum field-measured source areas (<0.1 acre) for the initiation of channel heads works well in the upper reaches of the drainage network (Figure 3.4a), but it can overestimate the number of channels and total network length (Type I error) in wider floodplains, where vegetation and lower slopes reduce likelihood of incision (Figure 3.4b). In principle, the minimum source area could be used to generate a channel network, and some artificial channels could be removed based on a slope criterion because most of the false channels appear in lower-gradient floodplains. However, this process would be extremely time-consuming and was unnecessary for these watersheds, as the generation of this fishbone pattern was minimal for all the networks.

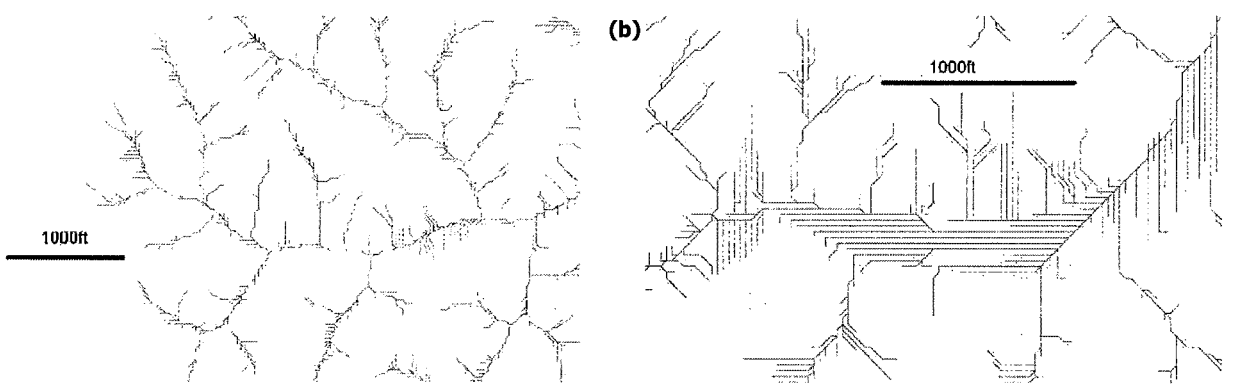


Figure 3.4 Drainage networks generated using small source areas in the (a) upstream and (b) downstream parts of the basin.

4. Morphological Characteristics of Eastern Kentucky Coal Field Headwater Channels

Bankfull channel parameters calculated for each cross section location (Table 4.1) were used to develop regional curves for Eastern Kentucky Coal Field headwater streams. The curves describe the relationship between drainage area, bankfull geometry, and bed width. A general classification of valley and channel types was developed based on qualitative and quantitative observations of the morphology of the headwater streams and their valleys. Those observations were also used to identify morphological features associated with channel heads and changes in hydrologic condition.

4.1 BANKFULL REGIONAL CURVES

Bankfull regional curves were derived from the bankfull geometry data (Figures 4.1-4.4 and Table 4.2) for headwater streams draining between 1.2 to 266.4 acres (approximately 0.0019 to 0.42 mi^2) and those draining at least 12.5 acres (0.02 mi^2), which corresponds to the point at which the valley is generally wide enough for the channel to have a well-developed floodplain. The relationship between cross-sectional parameters and drainage area was derived using ordinary least squares regression, from which power functions with the following form were developed:

$$Y = a\,DA^{b} \tag{4.1}$$

where a and b are empirically-derived constants, DA is drainage area (mi^2), and Y (ft) represents either the bed width, W_{bed} (ft), or one of the following bankfull parameters: cross-sectional area, A_{bkf} (ft^2); width, W_{bkf} (ft); or mean depth, D_{bkf} (ft).

The morphology of EKCF headwater channels is highly variable, with major changes in bankfull geometry, slope, and bed material composition occurring over relatively short distances (< 500 ft). Nevertheless, the regional curves show relationships between cross-sectional dimensions and drainage area that are highly statistically significant ($P < 0.001$ for both Kendall's τ and Spearman's ρ tests). The difference between estimates derived from the regional curves and the range of values within the 95% confidence limits, however, is large. The range between upper and lower confidence limits for cross-sectional area is approximately one order of magnitude (i.e., at 0.01 mi^2 the range is 0.29-3.13 ft^2, and at 0.1 mi^2 the range is 0.74-7.98 ft^2). The range for bankfull width, bed width, and depth is approximately a half order of magnitude.

Scatter in each of the regional curves indicates that factors other than drainage area must also be important in determining the cross-sectional dimensions of EKCF headwater channels (see Section 4.2). For cross-sectional area and bankfull width, the coefficient of determination (R^2) showed that drainage area accounted for approximately 46% of the variability within the entire dataset. For depth, however, it accounted for only 15%. Depth may be a more locally variable parameter due to the high variation in relative roughness of the channel bed and banks and the high frequency and irregularity of flow obstructions such as boulders and woody debris. Bed width, though not commonly included in regional curves, showed a stronger relationship with drainage area than bankfull width. At drainage areas greater than 12.5 acres, however, the advantage of using bed width was less distinct, indicating that bed width might be a more useful parameter for assessment at very small drainage areas, where floodplain development is limited.

Table 4.1 Bankfull Geometry for Headwater Streams of the Eastern Kentucky Coal Field Region

Study Area	Stream Site	Total DA (mi^2)	Total DA (acres)	A_{bkf} (ft^2)	W_{bkf} (ft)	D_{bkf} (ft)	W/D Ratio	Slope* (%)	W_{bed} (ft)
1 GL	UT1 Claylick Creek	0.01	5.8	0.63	2.70	0.28	9.6	12.7	1.80
	UT1 Claylick Creek	0.02	13.1	0.46	2.10	0.25	8.4	9.8	1.60
	UT1 Claylick Creek	0.02	14.3	1.65	4.10	0.47	8.7	9.8	2.90
	UT1 Claylick Creek	0.05	33.4	1.17	3.00	0.46	6.5	3.4	2.10
	UT1 Claylick Creek	0.21	137.5	2.18	5.70	0.38	14.9	2.6	4.10
	UT1 Claylick Creek	0.26	163.3	4.73	8.30	0.57	14.6	4.9	6.70
	UT2 Claylick Creek	0.03	17.6	0.71	2.60	0.33	7.9	8.7	1.70
	UT2 Claylick Creek	0.03	20.3	0.88	2.60	0.43	6.0	8.0	1.50
	UT3 Claylick Creek	0.02	10.4	0.61	2.50	0.29	8.6	3.4	1.70
	Claylick Creek	0.42	266.4	2.75	6.00	0.55	10.9	8.7	4.00
2 LCW	UT1 Line Fork	<0.01	3.2	2.66	4.30	1.12	3.8	35.7	0.45
	UT1 Line Fork	0.22	140.0	4.60	7.00	0.66	10.7	4.9	4.70
	UT1 Line Fork	0.22	140.8	4.13	6.80	0.70	9.7	4.9	5.00
	UT2 Line Fork	0.02	13.2	1.56	3.90	0.40	9.7	43.1	2.20
	UT2 Line Fork	0.31	197.7	3.83	7.00	0.62	11.3	4.9	5.40
	UT3 Line Fork	0.03	19.6	2.45	5.30	0.46	11.5	11.1	2.90
	UT3 Line Fork	0.02	10.1	3.33	7.60	0.55	13.8	20.6	4.50
3 PL	Glade Branch	0.01	8	0.48	1.5	0.34	4.4	9.8	0.85
	Glade Branch	0.02	10.6	0.37	1.5	0.2	7.5	4.1	1.1
	Glade Branch	0.04	22.4	0.74	1.9	0.46	4.1	4.1	1.3
	Glade Branch	0.06	39.7	1.95	3	0.75	4	2.3	2.2
	Glade Branch	0.06	39.7	1.65	2.6	0.7	3.7	2.3	2.1
	Glade Branch	0.06	39.7	1.75	2.9	0.7	4.1	2.3	2.1
	Glade Branch	0.36	232.9	3.99	5.5	0.73	7.6	3.4	4.5
	UT Glade Branch	0.01	7.4	0.59	1.8	0.42	4.3	12.5	1
	UT Glade Branch	0.04	24.3	1.35	3.9	0.37	10.5	3.8	2.3
4 RF	Clemons Fork	<0.01	2.6	0.26	1.4	0.23	6	52.8	0.8
	Clemons Fork	0.01	7.3	0.83	2.8	0.34	8.2	22.3	2.1
	Clemons Fork	0.04	23.7	3.01	5.1	0.7	7.3	9.6	3.5
	Clemons Fork	0.05	32.3	2.5	5.7	0.51	11.2	9.6	4.1
	Clemons Fork	0.1	66.1	3.36	5.3	0.73	7.3	3.9	3.9
	UT Clemons Fork	0.03	20.2	1.55	3.8	0.45	8.4	20.4	3.1
	Falling Rock Creek	<0.01	1.2	2.18	3.1	0.9	3.4	80	1.75
	Falling Rock Creek	0.02	10.4	2.95	3.8	1	3.8	8.6	2.1
	Falling Rock Creek	0.04	24.9	2.28	4.4	0.7	6.3	6.3	2.1
	Falling Rock Creek	0.07	41.6	3.15	5.4	0.67	8.1	6.3	4
	Falling Rock Creek	0.08	52.7	2.73	6	0.52	11.5	4.5	4.5
	Falling Rock Creek	0.1	65.2	3.72	5.7	0.68	8.4	4.5	4.3
	Falling Rock Creek	0.17	111.4	7.04	10.6	0.66	16	4.5	10.1
	Falling Rock Creek	0.19	120.4	6.37	11.8	0.54	21.9	1.5	11.1
	UT1 Falling Rock Creek	0.07	46.7	2.28	4.2	0.67	6.3	7.2	2.6
	UT2 Falling Rock Creek	0.01	8.3	0.58	2.25	0.32	7	25.2	1.4
	UT2 Falling Rock Creek	0.03	16	1.38	3.2	0.51	6.3	11.5	2.2
5 YL	Evans Branch	0.24	155.7	3.48	4.7	0.8	5.9	40	4
	UT1 Evans Branch	<0.01	2.3	0.48	2.2	0.32	6.9	16.5	0.8
	UT1 Evans Branch	0.05	33	2.22	4.5	0.57	7.9	5.6	3.3
	UT2 Evans Branch	0.03	16.9	1.98	5	0.44	11.4	11	4
	UT3 Evans Branch	0.02	11.4	0.37	1.95	0.22	8.9	11.4	1.45
	UT3 Evans Branch	0.02	12.8	0.91	3.3	0.31	10.6	11.2	2.6
	UT4 Evans Branch	0.03	20.8	0.69	2.7	0.3	9	6	1.9

* The valley slope derived from the valley profile is provided as a surrogate for the channel slope.

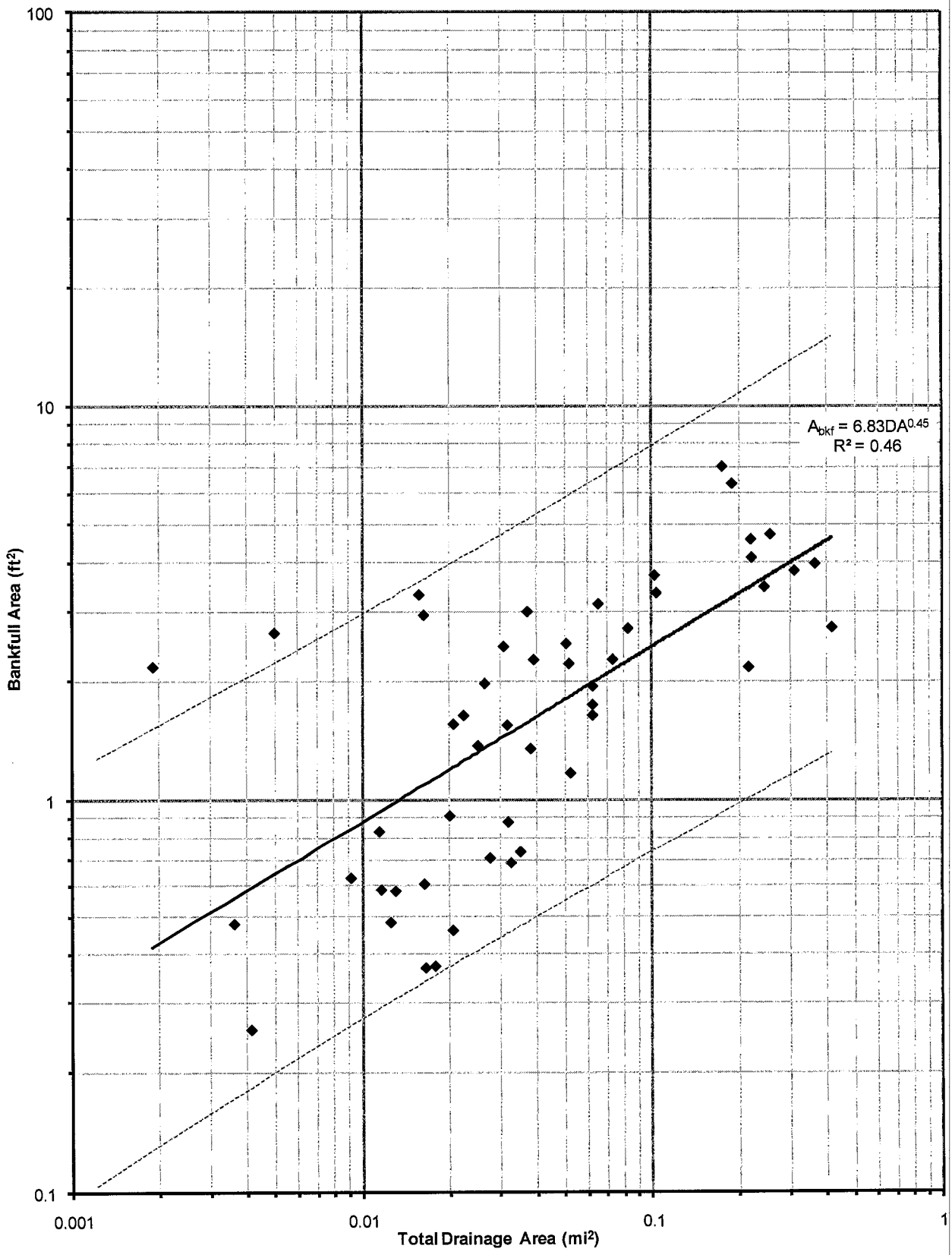


Figure 4.1 Bankfull cross-sectional area as a function of drainage area for EKCF headwater streams.

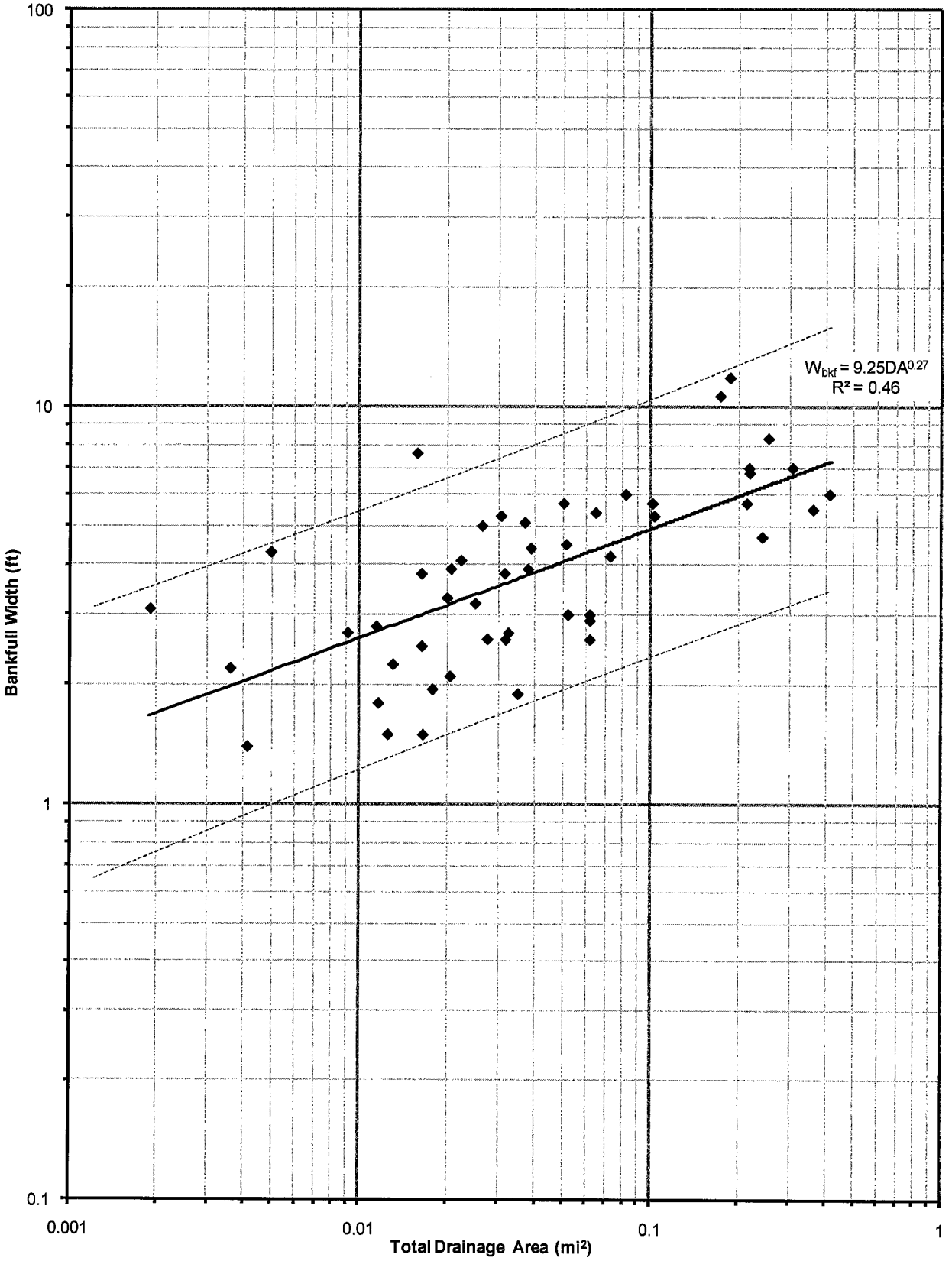


Figure 4.2 Bankfull width as a function of drainage area for EKCF headwater streams.

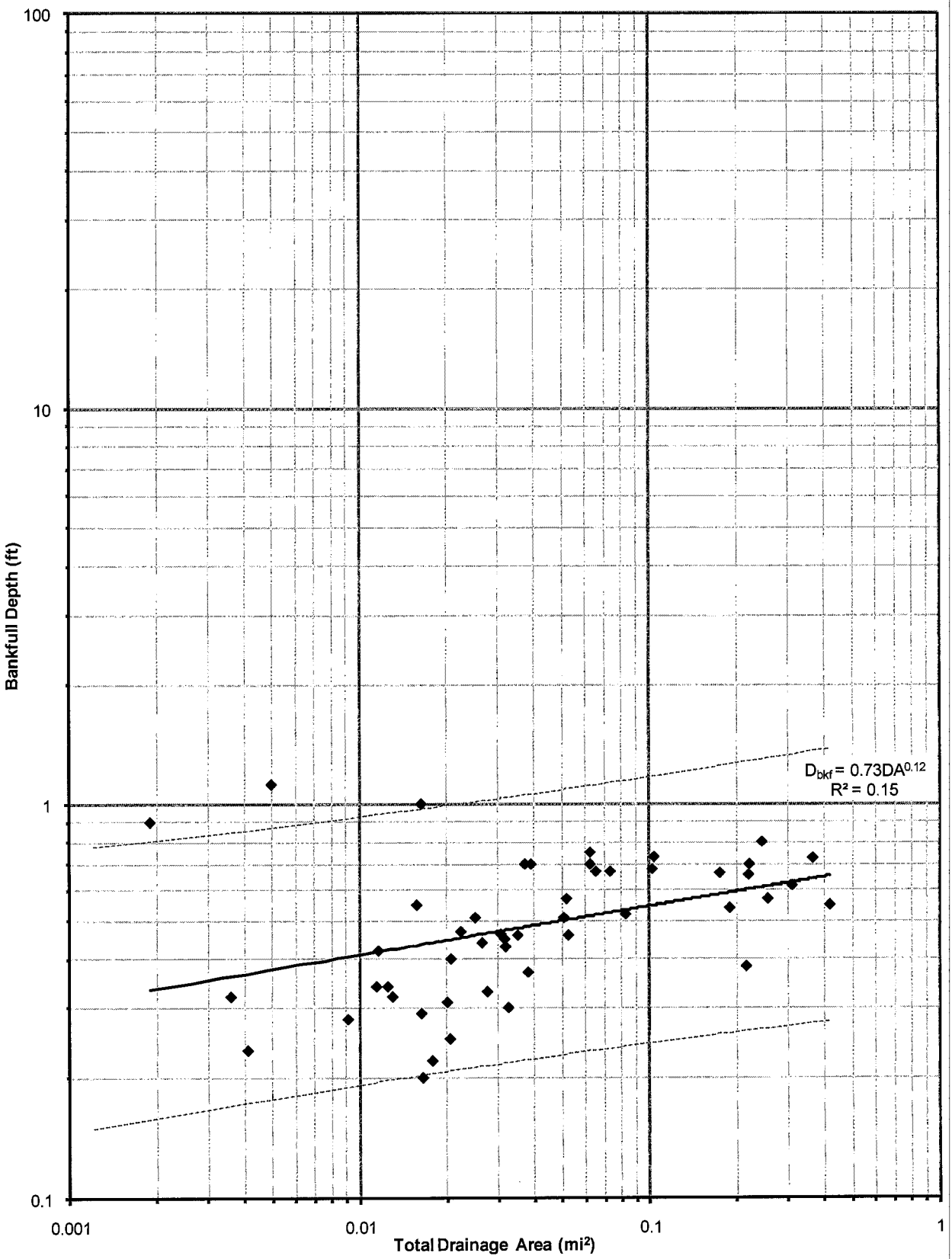


Figure 4.3 Bankfull mean depth as a function of drainage area for EKCF headwater streams.

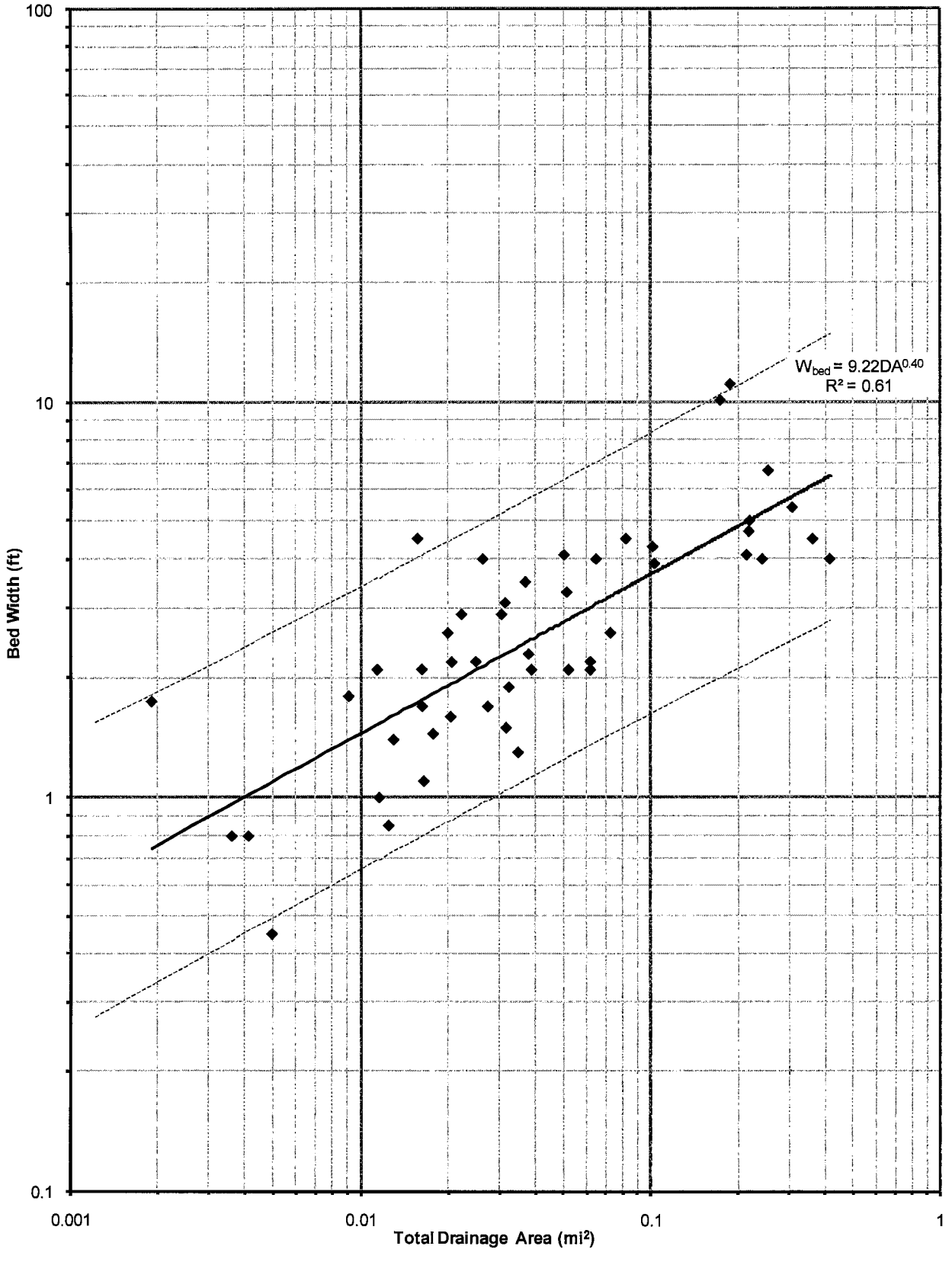


Figure 4.4 Bed width as a function of drainage area for EKCF headwater streams.

Table 4.2 Bankfull Regression Equations for Headwater Streams of the Eastern Kentucky Coal Field Region

All Data (DA = 1-270 acres)		Coefficient of	Standard	DA > 12.5 acres (0.02 mi^2)		Coefficient of	Standard
Regression Equation	N	Determination, R^2	Error, S_e (%)*	Regression Equation	N	Determination, R^2	Error, S_e (%)*
$A_{bkf} = 6.83\ DA^{0.45}$	50	0.46	67.8	$A_{bkf} = 8.30\ DA^{0.51}$	39	0.54	45.6
$W_{bkf} = 9.25\ DA^{0.27}$	50	0.46	38.9	$W_{bkf} = 10.81\ DA^{0.33}$	39	0.45	32.6
$D_{bkf} = 0.73\ DA^{0.12}$	50	0.15	39.1	$D_{bkf} = 0.77\ DA^{0.14}$	39	0.17	24.8
$W_{bed} = 9.22\ DA^{0.40}$	50	0.61	42.5	$W_{bed} = 8.74\ DA^{0.41}$	39	0.51	36.9

* Transformed from the log10 domain as a percentage of the mean according to Tasker (1978).

4.2 REACH-SCALE MORPHOLOGY

In spite of the considerable variability in the morphology of headwater channels, they tend to exhibit a sequence of morphological types (Table 4.3 and Figures 4.5 and 4.6) that can be classified according to diagnostic features (illustrated in Appendix C). Data on several other key determinants of their morphology, such as bed material, channel slope, and valley confinement, were used to develop a general classification of valley and channel types according to measurable diagnostic features. The classification scheme developed for EKCF headwater channels is based on a typology developed in the Pacific Northwest (Montgomery and Buffington 1997).

Diagnostic features also can be used to predict a channel reach's potential for response to disturbance, which often produces changes in discharge or sediment supply. The initial response to disturbance in headwaters streams is generally channel incision (bed degradation). While deposition (aggradation) may also result from some disturbances, in high-gradient streams it is more frequently a by-product of degradation, as sediment produced by headcuts may lead to aggradation downstream (Schumm 1973). The propagation of headcuts though the drainage network not only increases the sediment supply to downstream watercourses but also increases the length of stream channels and decreases the response time of streams to runoff events. Reaches that contain active headcuts or are incised may entrain soil and landslide debris to downstream waters and may undercut hillslopes, releasing further volumes of sediment from the side of the valley. Undercutting of the hillsides may promote landslides that increase sediment supply to the streams (Figure 4.7).

Some reach types were found to have a greater sensitivity to disturbance than others. The absorption or transmission of disturbance is influenced primarily by four factors (cf. Montgomery and Buffington 1997):

1. The relative position of the morphological reach type. The relative spatial distribution of the reach types influences how sediment is produced, stored, and moved, and hence, how disturbances are transmitted through the channel network.
2. The caliber and mobility of the sediment (or, occasionally, large woody debris) that is determining the local channel slope. The most resistant stream reaches are composed of materials that are immobile over all but the largest flood events. Typically, bedrock reaches will exhibit the least change of all the reach types. The strong mechanical resistance of bedrock reaches prohibits rapid erosion (Figure 4.8), and the steep slopes prevent widespread deposition. Colluvial channels and step-pool channels also have a high degree of resistance to disturbance due to the inherently immobile sediment that forms the channel boundary.

Table 4.3 Morphological Classification of Headwater Valleys and Channels of the Eastern Kentucky Coal Field Region

Landscape Segment Type	Valley Segment Type	Reach Type	Observed Local Valley Slope, % (Median)	Drainage Area, mi^2 (Median)	Diagnostic Features
Hillslope and Ridgetop			34.5-54.8 (43.7)	<0.001-0.002 (0.0015)	The ridgetops of four of the six study sites were well-rounded with gentle gradients and very little evidence of sediment erosion. At Lilley Cornett Woods and Yatesville WMA, an outcrop of resistant, massively jointed sandstones was located at the drainage divide. The breakdown of this caprock produced huge boulders that littered the hillslopes.
Valley	Unchanneled Colluvial	Hollows	12.8-54.8 (44.0)	0.001-0.006 (0.0015)	Hollows were of gentle-to-moderate slopes with little evidence of the material build-up or landsliding described in studies of other regions (Hack and Goodlett 1960; Dietrich and Dunne 1978; Reneau et al. 1984). Material accumulation followed by landsliding was only observed at Lilley Cornett Woods, where the relief is greater than in the other study areas.
		Boulder Swales	23.8-75.5 (46.5)	0.0016-0.004 (0.0027)	A boulder swale located below the hollow often marked the start of the channel network. The boulder swale is formed from convergence of topography that causes the build-up of coarse colluvial debris and concentrates the flow of surface water. It is differentiated from the hollow above by the steep hillsides and narrow valley bottom. The funneling of groundwater and surface water by bedrock and surface topography, respectively, is one reason why the channel head is often located in this reach.
	Channeled Colluvial	Colluvial Channel	12.0-66.7 (30.5)	0.016-0.12 (0.03)	Colluvium is material that is sourced from hillslopes and ridgetops and is transported by wash and mass movement processes (in contrast to fluvial agency). Colluvial channel reaches are by definition coupled with adjacent hillsides that provide most but not all of the sediment stored within the channel. This coupling means that the channel is largely undifferentiated from the valley bottom: fluvial banks are absent or poorly developed, and larger boulders and cobble may obscure banks. In some cases, a bank and bankfull indicators may be present on one side of the channel. Flows within the colluvial reaches are typically shallow and insufficient to mobilize the larger colluvial material. Hence, these reaches are a significant store of sediment that may be released only during rare large-flow events or debris flows.
	Bedrock	Bedrock Channel	2.4-50 (4.2)	0.036-0.34 (0.16)	Bedrock reaches do not have a continuous alluvial cover, although small amounts of alluvial material may be stored in the wake of obstructions. The scouring of the channel bed to reveal underlying bedrock is associated with a high transport capacity (Gilbert 1914). Bedrock reaches were found to occur throughout the watershed in locations associated with two different sets of geomorphic conditions contributing to high transport capacity: (1) a steep channel slope relative to reaches upstream and downstream and a greater degree of lateral confinement by hillslopes, or (2) a channel planform pattern that has been straightened and realigned adjacent to the valley wall, where depth to bedrock tends to be more shallow. Steep reaches may be the sites of debris flows that scoured to bedrock, especially where the channel has a chute- or canyon-like appearance. Where the stream had been straightened and relocated adjacent to the valley wall, a terrace occupied the center of the valley. The terrace may be the site for an existing road or it may have reverted to forest.

Landscape Segment Type	Valley Segment Type	Reach Type	Observed Local Valley Slope, % (Median)	Drainage Area, mi^2 (Median)	Diagnostic Features
	Colluvial-Alluvial transition	Step-Pool Channel	1.9-15.4 (4.2)	0.015-0.25 (0.18)	Step-pool reaches are characterized by channel-spanning accumulations of boulders or woody debris that form vertical steps and intervening pools that may store small amounts of finer material, primarily sand and fine gravel. In some reaches, roots may fulfill a similar role in holding grade and creating a plunge pool downstream. Like colluvial reaches, step-pool channel reaches have an abundant supply of coarse material because of the close coupling with the hillslopes, but during very large floods, these boulders are organized into a series of steps that are stationary during most flow events (Chin 2003).
		Plane-Bed Channel	2.1-10.4 (4.2)	0.012-0.39 (0.13)	Reaches with a plane-bed morphology lack discrete bars and significant variations in water surface slope but have significant cover of gravel- and cobble-sized material above the bedrock. Plane-bed reaches were observed in both confined and non-confined valleys, although a large supply of coarse colluvial material usually was absent or at least less abundant than more mobile alluvial sediment. Plane bed reaches invariably had a straight to mildly sinuous planform, as sharp bends tend to promote bar development.
	Alluvial	Riffle-Pool Channel	1.6-8.3 (2.7)	0.04-2.8 (0.22)	Riffle-pool reaches are characterized by an undulating bed profile with riffles and pools representing topographic high and low points (Leopold et al. 1964). Pools were generally shallow (<2 ft) unless flow impinged upon a root wad or large boulder to induce scour. Riffle sediments were generally coarser (gravel and cobble) than pool sediments (sand and gravel). Riffle-pool channel reaches are indicative of increasing storage within the channel boundary of gravel and small cobble that comprise the riffle framework (Montgomery and Buffington 1997). Riffle-pool reaches were generally unconfined, although they may receive some colluvial inputs. The planform of riffle-pool reaches with a high slope (1-2%) tended to be more sinuous than those with a lower slope (<1%), which had been straightened and aligned proximate to the valley side slope.

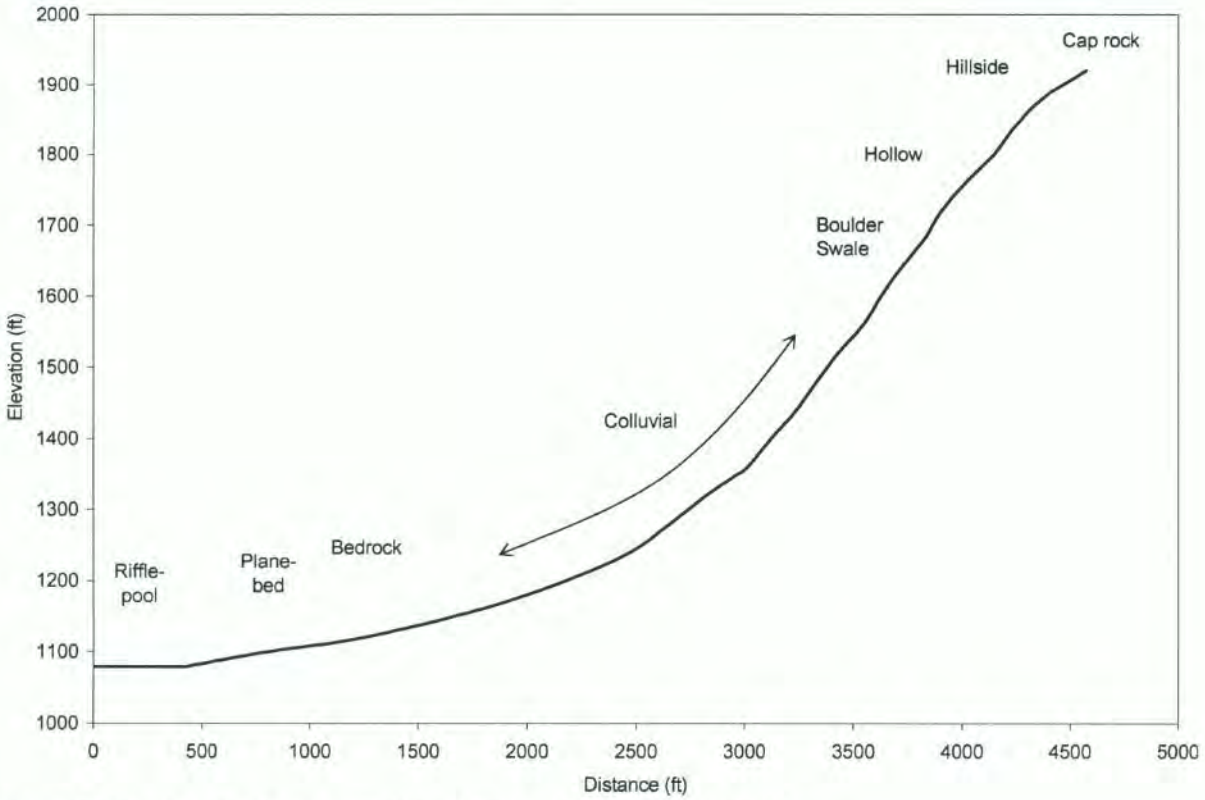


Figure 4.5 Long profile of un-named tributary of Line Fork in Lilley Cornett Woods.

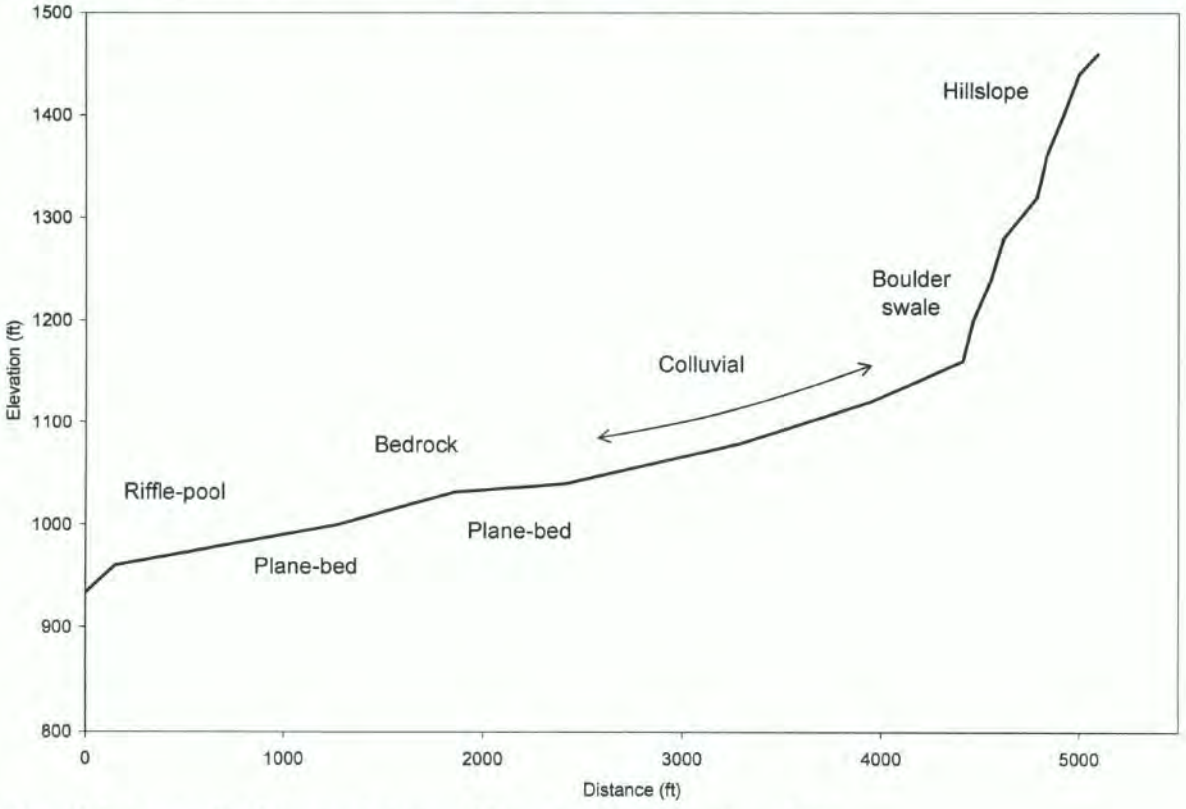


Figure 4.6 Long profile of un-named tributary of Falling Rock Creek in Robinson Forest.

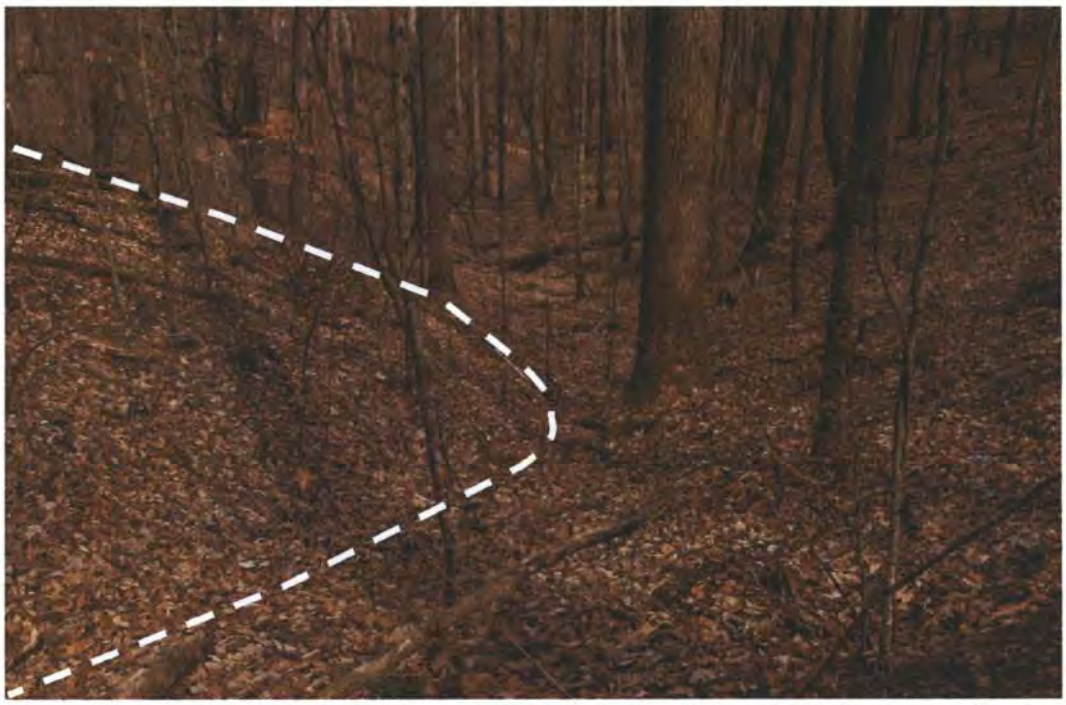


Figure 4.7 Landslide lobe which may have created locus for incision of channel. Note the absence of large trees on the lobe itself, indicating a recent (<15 years) landslide event.



Figure 4.8 "Geologic" knickpoint at Glade Branch forming a bedrock waterfall immediately upstream from confluence with Paint Creek (now Paintsville Lake). The waterfall prevents transmission of downstream disturbances to upstream reaches. Channel straightening and deposition of post-settlement alluvium, however, have resulted in channel incision upstream of the waterfall.

3. Volume of coarse sediment supply. Steep headwater reaches may be restructured only by large, infrequent floods (Grant et al. 1990; Chin 1998), and the abundance of boulders and large woody debris will influence how the morphology of the reach responds to these events. Structural elements of reach morphology, such as steps, riffles, or debris jams, can only re-form if eroded sediment is replaced.
4. The degree of interaction between the channel and the hillslopes. In general, the degree of interaction between hillsides and the stream channel decreases with increasing distance downstream, although structural controls and geomorphic history may disrupt this trend. Colluvial channels have a strong coupling with the adjacent hillslopes, so the sediment supply in these reaches is likely to be significantly impacted by the hillslope stability. Step-pool channels also show a high degree of interaction with

hillsides; large colluvial material typically comprises the key stones in channel-spanning steps. Wider floodplains downstream provide a buffer between stream channel and hillslope.

4.3 CHANNEL HEAD CONTROLS

Channel heads are typically located at an area where the valley morphology acts to concentrate groundwater or surface flow. The transition from upland swales or hollows to a definable channel was often discontinuous, with multiple channel heads for a single channel. Those channels become less well-defined downstream of the channel head before a headcut marks the re-initiation of a distinct channel boundary. The transition from swale/hollow to channel was found to occur abruptly at a small step in some cases (Figure 4.9) and over a more gradual transition zone in others (Figure 4.10). Most of the gradual channel heads appeared to be stable.

The majority of the studied channel heads were formed through subsurface flow, the pathways of which were commonly influenced by tunnels created by decaying tree roots. At a few sites, these piping processes were clearly responsible for channel head formation (Figure 4.11), and channel heads that were classified as having no control may include some that were held in their present location by root mats. The features controlling the head of the channel varied considerably, however, between different sites (Figure 4.12). Where an abrupt transition could be identified, the upstream extension of the channels appeared to be limited by one of three types of grade control:

1. Tree roots: collective mat of small roots or a single large root
2. Boulder: an isolated large boulder or possibly an outcrop of bedrock (Figure 4.13)
3. Boulder-lined swale: a narrow, v-shaped swale lined with cobble- and boulder-sized material



Figure 4.9 Small step marking the location of an abrupt transition.



Figure 4.10 Gradual channel head with no distinct break between unchanneled swale and channeled valley. Falling Rock Creek, Robinson Forest WMA.



Figure 4.11 Channel head with piping cavity and emerging subsurface flow in Evans Branch, Yatesville Lake WMA. Pen marks outlet of piping cavity.

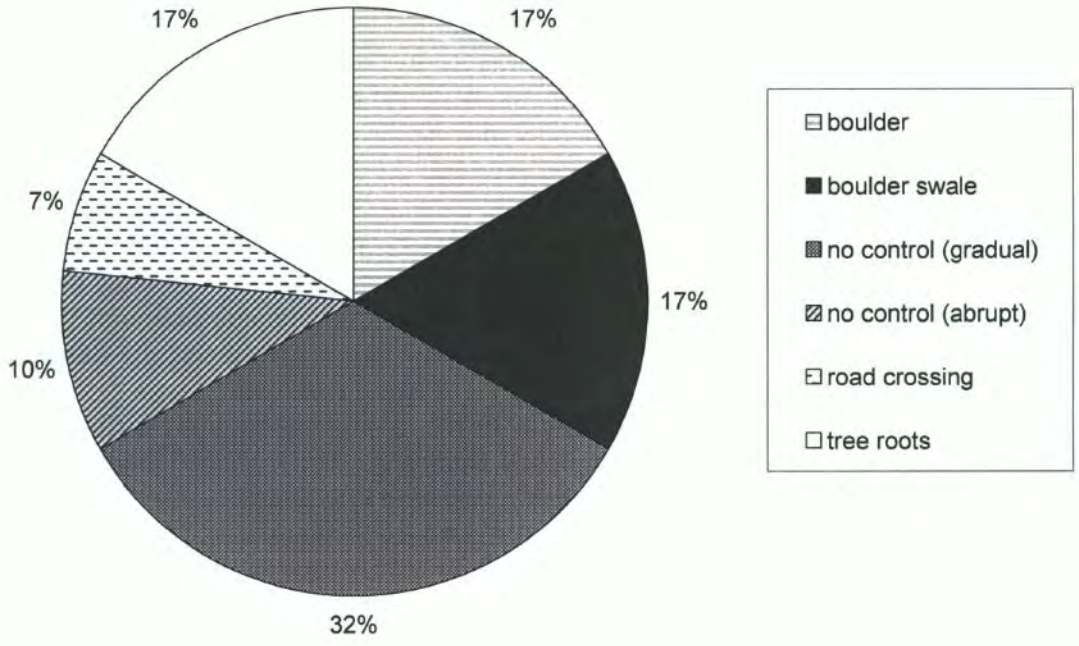


Figure 4.12 Types of channel heads found in the EKCF region.



Figure 4.13 Large boulder defines head of channel. Unnamed tributary of Line Fork, Lilley Cornett Woods.

4.4 CHANGES IN HYDROLOGIC CONDITION

The "clogging" of the valley floor with colluvium and coarser alluvial material significantly affects the stream channels, producing highly variable surface flow and altering the distribution and type of bedforms (step-pool, riffle-pool, plane-bed, and cascades). In areas where the valley slope decreases or the valley widens, the channel may be discontinuous, and/or the base flow water surface elevation may drop below the streambed. At these locations, the sediment from landslides and large runoff events accumulates, and the water flows subsurface through the deposited alluvium (see Figure 4.14). This alternation of surface and subsurface flow may be repeated from the channel head down to second- or even third-order streams (Strahler classification). Hence, the presence or absence of surface flow is dependent on a combination of the hydrology and morphology of the valley, and the surface flow may constitute (especially during low-flow conditions) only a small percentage of the total water flowing downvalley.

The pattern of subsurface and surface flow is further complicated by the differential permeability of the underlying rock strata that is typically fractured and weathered near the surface. Surface flow may disappear when underlain by bedrock that is highly permeable (typically fractured and weathered sandstone in eastern Kentucky). Where less permeable rocks are present (typically a shale layer), the surface flow re-emerges.

In general, the hydrologic condition changed with increasing distance downstream from no surface water to increasing amounts and flows of surface water. While the distance from the ridge top to the SW and CF points and to the channel head was highly variable, field observations indicated some consistencies in the location of these changes. Specifically, three geomorphic features were frequently associated with a change in hydrologic condition:

1. Headcuts: A common occurrence in the headwater streams was the emergence of surface flow at a headcut (Figure 4.15). Occasionally, the headcut was also the channel head. Flow generally emerged at a headcut in two situations:
   a. An impermeable rock layer was exposed at the base of the headcut. The relatively impermeable rock unit acted as an aquitard, concentrating subsurface flow into the rock or soil units immediately above it. In this situation, the incision of the channel bed had intersected the water table.
   b. A piping cavity outlet was discharging at the base of the headcut.
2. Colluvial valley fill: Some sections of the valley were particularly susceptible to the accumulation of coarse colluvial material supplied by mass wasting of the adjacent hillsides (Figure 4.16). These included sections where stream gradient decreased and/or valley side slopes were steep. Very large boulders often provided the main framework of the deposited material, and finer sediments and organic debris were trapped within open pockets created by the larger clasts. Close to the drainage divide (typically at locations with a drainage area less than about 15 acres (0.023 mi^2)), a transition from surface to subsurface flow was often observed at the upstream extent of the colluvial valley fill. In wider valley sections, though, the large framework boulders were not jammed together, and a small channel with surface flow was present between the individual larger rocks.
3. Alluvial fill: Sections of the valley where valley width increased and/or valley slope decreased were frequently sites of deposition of sand- and gravel-sized alluvial material (Figure 4.17). Alluvial deposition was also common immediately upstream of debris jams. In many situations, surface flow was observed upslope and downslope of alluvial fill, so subsurface flow through the alluvial material could be inferred.

Because these features are relatively stable, their associated changes in hydrologic condition would be expected to persist over time periods of months or years. This suggests that they could be used as a basis for a method to identify ephemeral-intermittent transitions.



Figure 4.14 Accumulation of colluvial and alluvial material in the valley bottom. During low flow, the majority of water flows subsurface through the deposited material. Extreme flow events may organize coarse material into bedforms (e.g. step-pools). Flow is towards the camera.



Figure 4.15 Ephemeral-intermittent transition is marked by headcut that has propagated upstream and is exposing groundwater. Valley also appears to widen appreciably where surface flow emerges.



Figure 4.16 Groundwater emerges at base of small step located at base of boulder swale. Falling Rock Creek, Robinson Forest WMA.



Figure 4.17 Alluvial fill of the valley bottom, creating discontinuous surface flow. Unnamed tributary of Claylick Creek, Greenbo Lake SRP.

5. Extents of Channel and Stream Networks

The locations of each surveyed channel head and each transition in hydrologic condition (SW and CF points) were used to estimate the extent of EKCF channel networks and stream networks, respectively. From these estimates of network lengths, drainage densities were calculated and compared between watersheds of different sizes. These estimates of drainage density were also compared to blue line channels to estimate the percentage of channel and stream networks represented by the USGS 1:24,000 topographic maps.

5.1 SOURCE AREAS

Channel head (CH) source areas ranged from 0.2 to 4.8 acres (0.0003 to 0.0165 mi^2) (Table 5.1 and Figure 5.1). The mean CH source area was 2.24 acres (0.0035 mi^2). Surface water (SW) source areas (Table 5.2) ranged from 0.23 to 23.1 acres (0.000355 to 0.0361 mi^2) or from very close to the channel head to very close to the start of continuous flow. CF source areas (Table 5.3) ranged from 7.2 to 289.9 acres (0.0112 to 0.453 mi^2), or from a confined colluvial channel to a meandering riffle-pool channel.

Table 5.1 Source Areas* for Field-Surveyed Channel Heads (CHs)

	No.	Source Area (acres)											
	CHs	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	Mean	Min	Max
GL†	5	1.48	2.59	1.22	0.88	1.49					1.54	0.88	2.59
LCW	1	3.17									3.17	3.17	3.17
PL†	9	0.38	0.96	0.96	0.83	0.19	0.83	0.77	1.60	10.6	1.9	0.19	10.6
RF	5	0.90	4.42	8.32	1.41	4.86					3.98	0.90	8.32
YL	7	0.83	0.82	0.77	1.73	1.79	1.86	0.64			1.21	0.64	1.86
All Sites	**27**										**2.24**	**0.19**	**10.56**

* Generally, the topographic information available from geospatial datasets was insufficient to accurately calculate the source area close to the drainage divide; therefore, source areas calculated to be less than or equal to 2 acres represent a maximum possible value.
† Adjacent HUC14 used because of presence of lake.

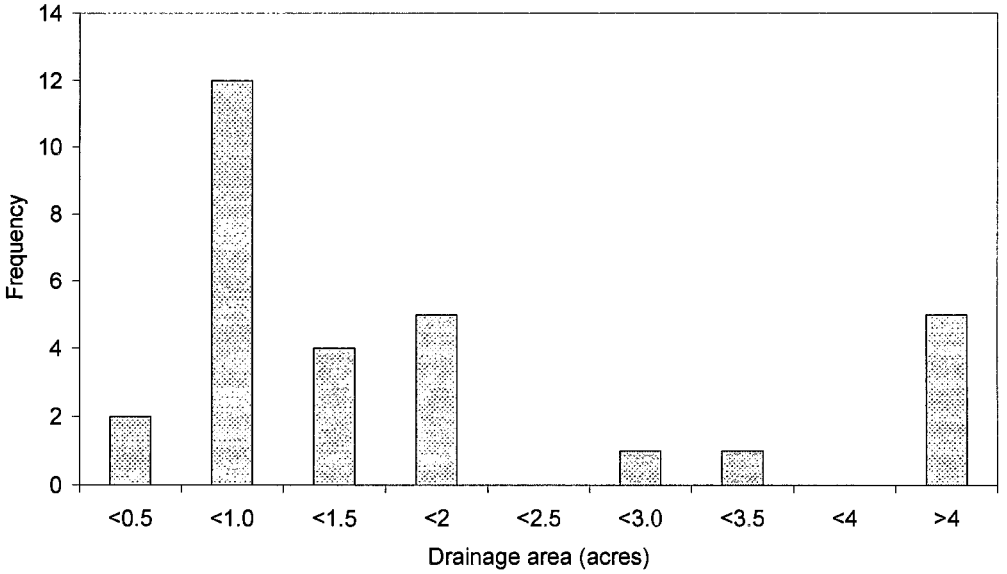


Figure 5.1 Source areas of surveyed channel heads in the EKCF region.

Table 5.2 Source Areas* for Field-Surveyed Upstream Extent of Surface Water (SW)

	Source Area (acres)								
	SW1	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**Mean**	**Min**	**Max**
GL†	2.85	8.29	8.70	10.4			7.55	2.85	10.4
LCW	11.0	15.5	19.3				15.3	11.0	19.3
PL†	2.50	10.6	6.71	1.14	0.23	6.26	4.57	0.23	10.6
RF	23.1	16.5	20.3	10.6			17.6	10.6	23.1
YL	3.29	6.74	4.30	3.95	4.57		4.57	3.29	6.74

Table 5.3 Source Areas* for Field-Surveyed Upstream Extent of Continuous Flow (CF)

	Source Area (acres)								
	CF1	**CF2**	**CF3**	**CF4**	**CF5**	**CF6**	**Mean**	**Min**	**Max**
GL†	15.2	290	10.8	262			144	10.8	290
LCW	22.1	32.9	99.5				51.5	22.1	99.5
PL†	30.7	21.6	21.6	34.9	8.26	7.19	20.7	7.19	34.9
RF	27.6	20.1	32.0	23.4			25.8	20.1	32.0
YL	10.2	48.2	67.4	93.4	93.5		62.5	10.2	93.5

* Generally, the topographic information available from geospatial datasets was insufficient to accurately calculate the source area close to the drainage divide; therefore, source areas calculated to be less than or equal to 2 acres represent a maximum possible value.
† Adjacent HUC14 used because of presence of lake.

5.2 DRAINAGE DENSITY

Channel Network Drainage Density

Based on Equations 3.2-3.5, the drainage density of modeled channel networks ranged from 4.86 to 15.03 mi/mi^2 (Table 5.4), while the drainage density of blue line streams ranged from 1.45 to 2.46 mi/mi^2. The blue line streams represent no more than half of the total modeled channel length—in some cases as little as 15%—depending on the estimate of the channel head source area (maximum, minimum, or mean) used in generating a channel network. Even with the use of the maximum source area, which produces the smallest estimate of total stream length, the blue lines account for just 21-50% of the modeled channel network.

The percentage of the EKCF channel lengths represented by topographic maps is consistent with results from other surveys (e.g., OHEPA 2002; Rosenfeld et al. 2002; Benda et al. 2005) that indicate that the majority of headwater channels have not been identified or documented and that USGS topographic maps under-represent headwater channels by 20%–100%. In particular, a study in the Blue Ridge Mountains in the southeastern US showed the blue line (1:24,000 scale) streams representing about 20% of the channel network (Hansen 2001), which is very similar to results from the EKCF region. Moreover, the EKCF data were recorded for WMAs and an SRP that have experienced limited logging, mining, or other disturbances within recent decades. Headwaters with greater levels of disturbance may have considerably higher drainage densities; thus, even less of their lengths will be represented by blue line streams on USGS maps.

Stream Network Drainage Density

Results from the field assessment of hydrologic condition and modeling of the drainage networks showed that both surface water and continuous flow are typically located upstream of the start of the drainage network represented by blue line streams from the USGS 7.5-minute quadrangle maps (Tables 5.4 and 5.5 and Figure 5.2). The blue line streams represent no more

than 69% of the modeled stream length delimited by surface water—in some cases as little as 31%—depending on the estimate of the SW source area (maximum, minimum, or mean) used in generating the stream network.

Table 5.4 Drainage Densities* (mi/mi^2) of Channel Networks Based on Field-Surveyed Channel Heads (and percentage represented as solid blue line streams)

Study Area	HUC14	Blue Line D_d	$D_{d\text{-}DAmean}$	$D_{d\text{-}DAmax}$	$D_{d\text{-}DAmin}$	$D_{d\text{-}EKCF}$
Greenbo Lake	North Fork†	2.49 (100)	9.44 (26)	11.7 (21)	8.06 (30)	8.43 (29)
Lilley Cornett	Line Fork	1.62 (100)	7.63 (21)	7.63 (21)	7.63 (21)	8.27 (20)
Paintsville Lake	Mudlick Creek†	2.48 (100)‡	8.96 (27)	N/A§	4.86 (50)	8.72 (28)
Robinson Forest	Clemons Fork	2.26 (100)	5.99 (37)	10.9 (21)	4.93 (45)	7.21 (31)
Yatesville Lake	Bushy Fork	2.25 (100)	11.0 (20)	15.0 (15)	9.12 (24)	8.47 (26)

* Generally, the topographic information available from geospatial datasets was insufficient to accurately calculate the drainage area close to the drainage divide; therefore, these drainage densities represent lower-limit estimates of the total lengths of the channel networks.
† Adjacent HUC14 used because of presence of lake.
‡For Paintsville WMA, the dash-dot blue line denoting an intermittent stream was used.
§ Source area was too small to be a valid input.

Table 5.5 Distance from Ridge Top to Blue Line Stream; Uppermost Channel Head; Uppermost Surface Water (SW); and Uppermost Continuous Flow (CF)

Distance From	Percentage of Sites		
Ridge Top (ft)	Blue Line	SW	CF
<1000	5	89	41
<2000	63	100	100

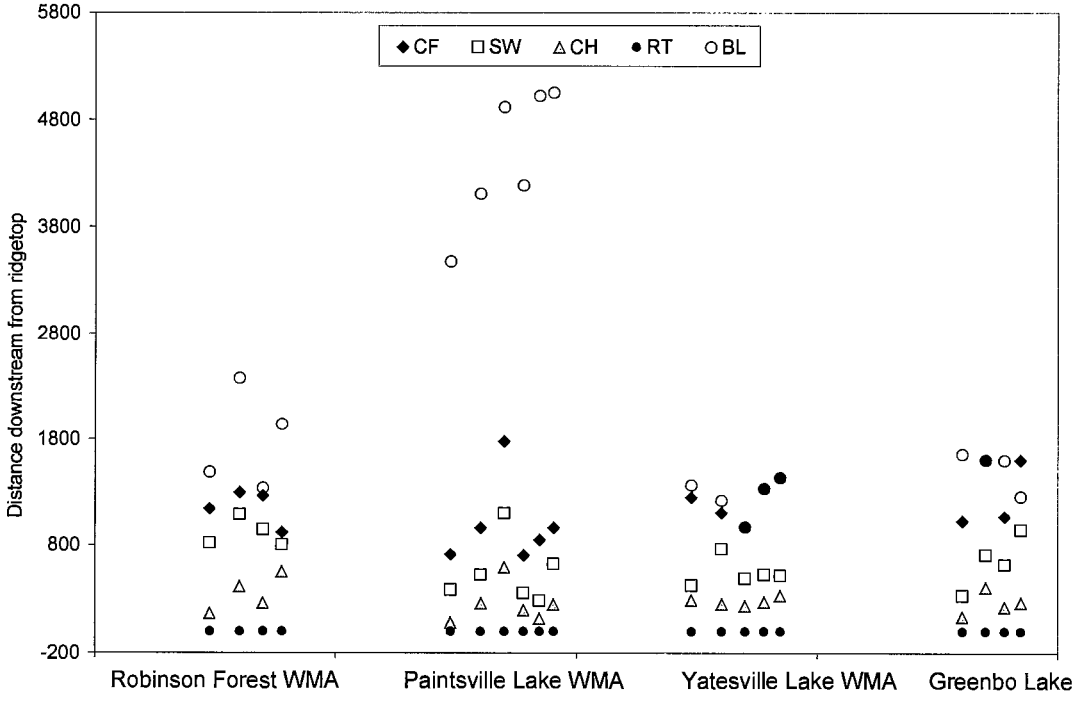


Figure 5.2 Distance from the ridge top (RT) to the channel head (CH), the uppermost point of surface water with no flow (SW), the uppermost observed continuous flow (CF), and the blue line stream (BL).

The drainage density of stream networks estimated up to the location of surface water ranged from 3.28 to 7.18 mi/mi^2 (Table 5.6), while the drainage density of blue line streams ranged from 1.45 to 2.46 mi/mi^2. Even with the use of the maximum source area, which produces the smallest estimate of total stream length, the blue lines account for just 41-69% of the modeled stream network. Use of the location of continuous flow as the starting point of the stream network produces a greater overlap between the predicted stream network and the blue line streams. Drainage density from CF points ranged from 0.95 to 5.51 mi/mi^2; blue lines represented 48% to 262% of the modeled CF stream length.

Table 5.6 Drainage Densities (mi/mi^2) of Stream Networks Based on Hydrologic Condition (and percentage represented as solid blue line streams)

		Blue Line	Surface Water			Continuous Flow		
Study Area	HUC14	D_d	$D_{d\text{-}mean}$	$D_{d\text{-}max}$	$D_{d\text{-}min}$	$D_{d\text{-}mean}$	$D_{d\text{-}max}$	$D_{d\text{-}min}$
Greenbo Lake	North Fork†	2.49	5.63 (44.3)	7.60 (32.8)	4.93 (50.5)	1.32 (188.9)	4.86 (51.2)	0.95 (262)
Lilley Cornett Woods	Line Fork	1.64	3.60 (45.5)	4.22 (38.8)	3.18 (51.4)	2.03 (80.7)	2.98 (54.9)	1.59 (103.1)
Paintsville Lake	Mudlick Creek†	2.48*	6.51 (38.1)	4.75 (52.3)	3.95 (62.8)	3.60 (68.9)	5.51 (45.0)	2.87 (86.5)
Robinson Forest	Clemons Fork	2.26	3.77 (60.1)	4.47 (50.6)	3.28 (69.1)	3.08 (73.6)	3.53 (64.2)	2.83 (80.1)
Yatesville Lake	Bushy Fork	2.25	6.37 (35.3)	7.18 (31.3)	5.54 (40.6)	2.13 (105.7)	4.72 (47.6)	1.68 (134)

* For Paintsville WMA, the dash-dot blue line denoting an intermittent stream was used.
† Adjacent HUC14 used because of presence of lake

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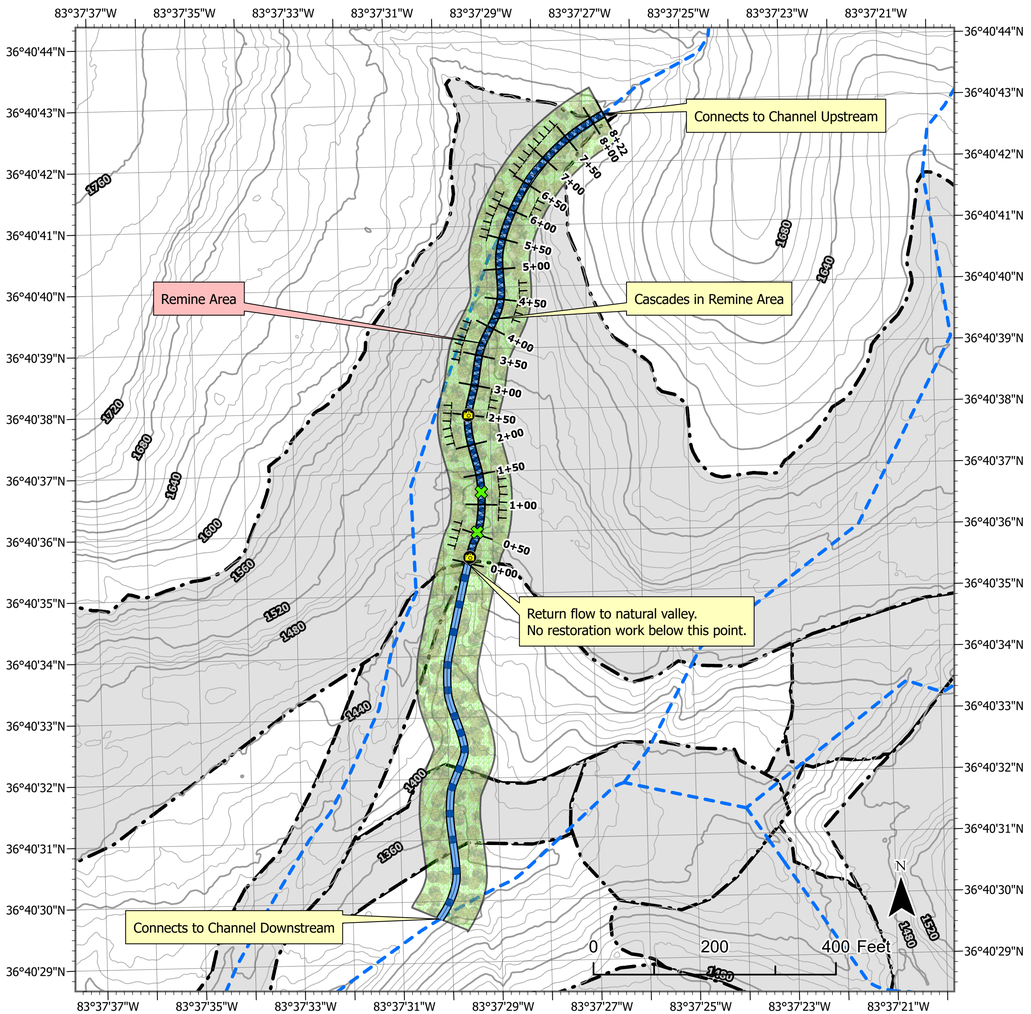
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Appendix E
Proposed Design Drawings

Part 1: Planviews, Cross Sections, Profiles

Stream 3 RESTORED STREAM CHANNEL
UT Cranes Creek (Intermittent) - Station 0+00-8+22 (105.2 AC.)
SCALED PLANVIEW AND CROSS-SECTION



Legend

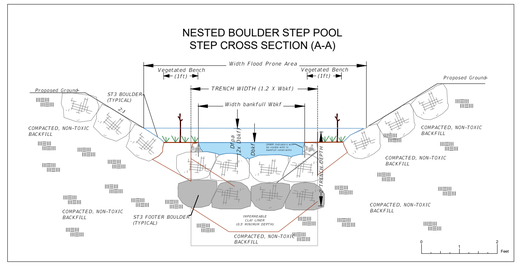
- Cascade
- Proposed Stream
- 50' Riparian Buffer
- 807-0501 Permit Boundary
- Jurisdictional Streams
- TTTT Rock Deflectors
- Existing Contours
- Pool
- Permanent Photo Point
- Permanent Cross Sections

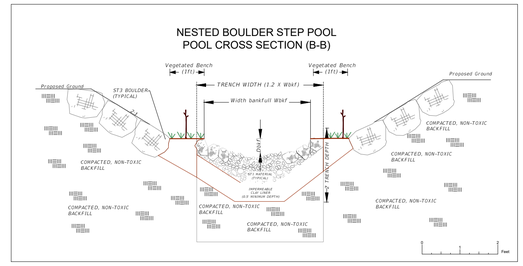
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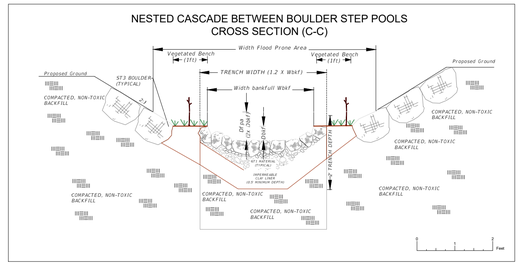
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PRINT DATE: 3/1/2026	
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WPT#: 2025-63	Checked by: MDB

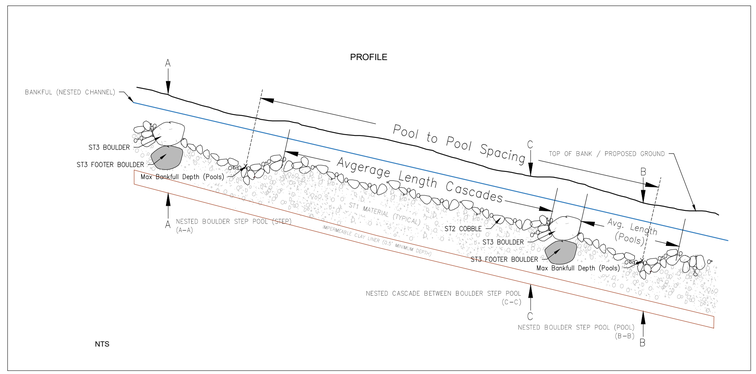
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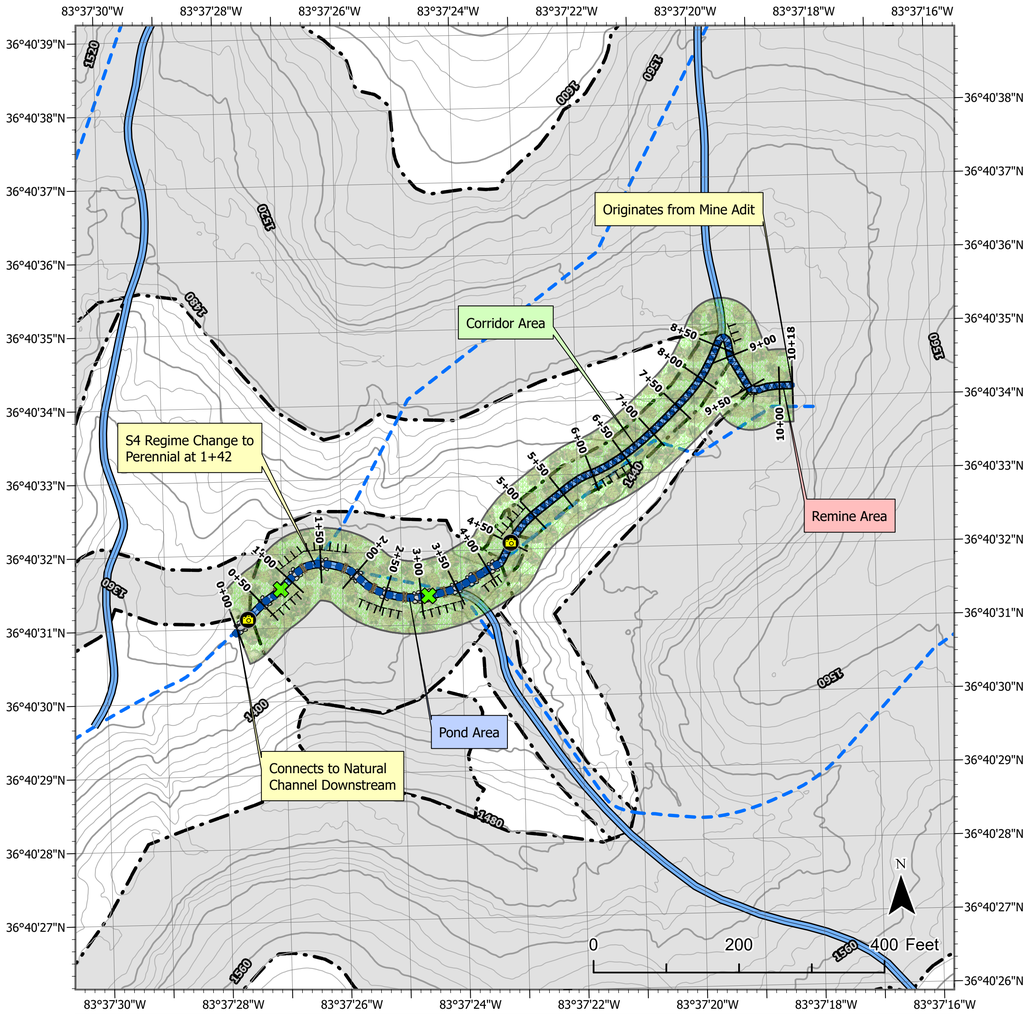




Stream 3 Restored Stream Channel Schedule and Summary Table
UT Cranes Creek - Intermittent (105.2 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	*32 - 48*	*40.0*
Average Length Riffles (Ft.)	*10 - 15*	*12.5*
Average Length Pools (Ft.)	*1.44 - 2.16*	*1.8*
Pool-Pool Spacing (Ft.)	*11.2 - 16.8*	*14.0*
Sinuosity	*1.0-1.32*	*1.1*
Average Riffle Bankfull Width (Ft.)	*4.54 - 6.82*	*5.68*
Average Bankfull Width (Ft.)	*5.34 - 8.02*	*6.68*
Riffle Cross-sectional Area (Ft.)	*2.42 - 3.64*	*3.03*
Pool Cross-sectional Area (Ft.)	*2.82 - 4.24*	*3.53*
Width/Depth Ratio	*7.73 - 11.6*	*9.7*
Riffle Mean Bankfull Depth (Ft.)	*0.47 - 0.71*	*0.59*
Pool Max Bankfull Depth (Ft.)	*0.87 - 1.31*	*1.09*
Entrenchment Ratio	*1.12 - 1.68*	*1.40*

Stream 4 RESTORED STREAM CHANNEL
Cranes Creek (Intermittent - Station 1+42-10+18 (63.9 AC.)
SCALED PLANVIEW AND CROSS-SECTION



Legend

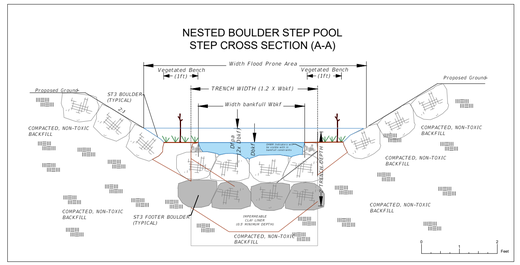
- 807-0501 Permit Boundary
- Cascade
- Proposed Stream
- 50' Riparian Buffer
- TTTT Rock Deflectors
- Jurisdictional Streams
- Existing Contours
- Pool
- Log Vane
- Rock Vane
- Permanent Photo Point
- Permanent Cross Sections

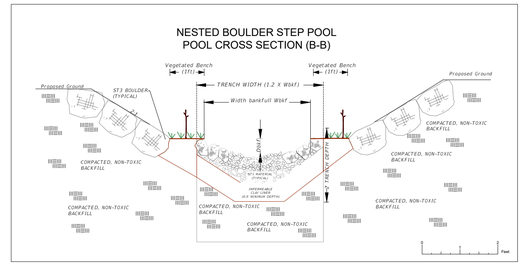
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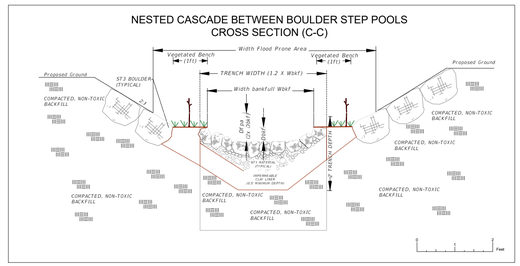
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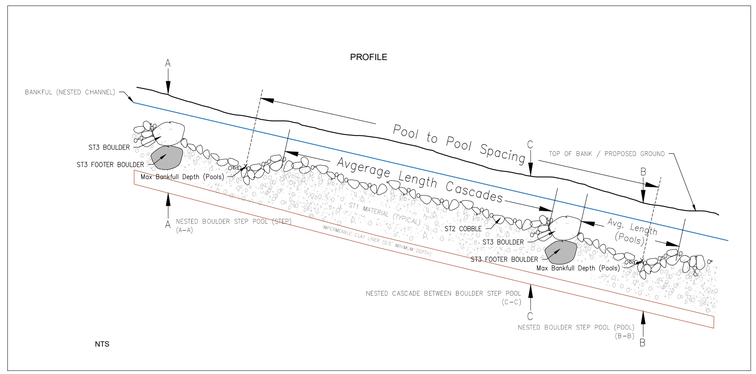
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PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 9/3/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC





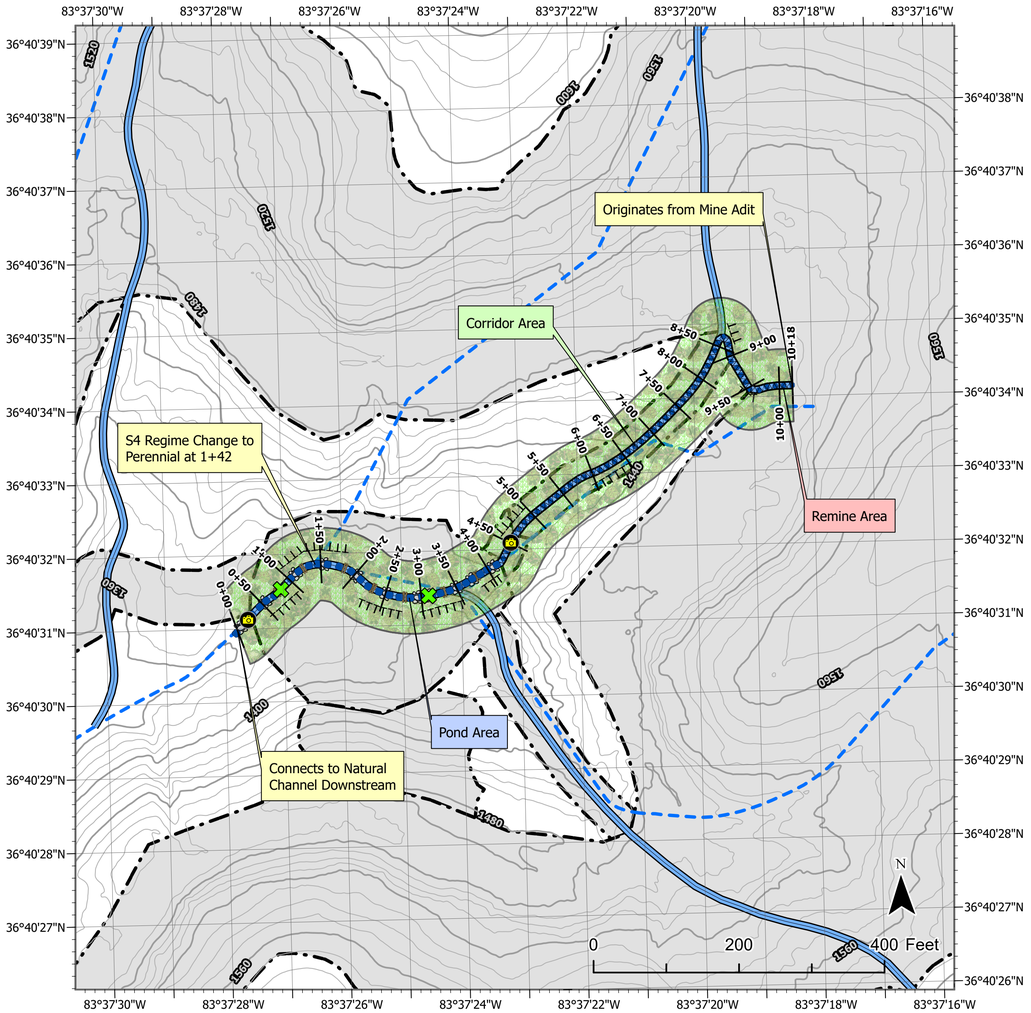




Stream 4 Restored Stream Channel Schedule and Summary Table
Cranes Creek - Intermittent (63.9 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	*32 - 48*	*40.00*
Average Length Riffles (Ft.)	*10 - 15*	*12.5*
Average Length Pools (Ft.)	*1.44 - 2.16*	*1.8*
Pool-Pool Spacing (Ft.)	*11.2 - 16.8*	*14.0*
Sinuosity	*0.88 - 1.32*	*1.1*
Average Riffle Bankfull Width (Ft.)	*3.97 - 5.96*	*4.97*
Average Bankfull Width (Ft.)	*4.77 - 7.16*	*5.97*
Riffle Cross-sectional Area (Ft.)	*1.94 - 2.91*	*2.42*
Pool Cross-sectional Area (Ft.)	*2.34 - 3.51*	*2.92*
Width/Depth Ratio	*7.17 - 10.76*	*9.0*
Riffle Mean Bankfull Depth (Ft.)	*0.44 - 0.66*	*0.55*
Pool Max Bankfull Depth (Ft.)	*0.84 - 1.26*	*1.05*
Entrenchment Ratio	*1.12 - 1.68*	*1.40*

Stream 4 RESTORED STREAM CHANNEL
Cranes Creek (Perennial - Station 0+00-1+ 42 (202.5 AC.)
SCALED PLANVIEW AND CROSS-SECTION



Legend

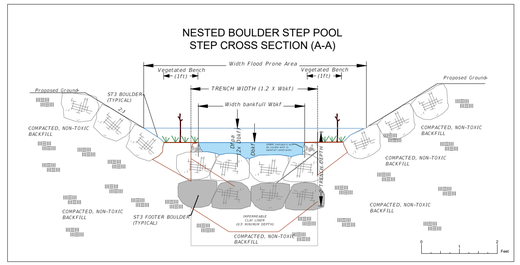
- 807-0501 Permit Boundary
- Cascade
- Proposed Stream
- 50' Riparian Buffer
- TTTT Rock Deflectors
- Jurisdictional Streams
- Existing Contours
- Pool
- Log Vane
- Rock Vane
- Permanent Photo Point
- Permanent Cross Sections

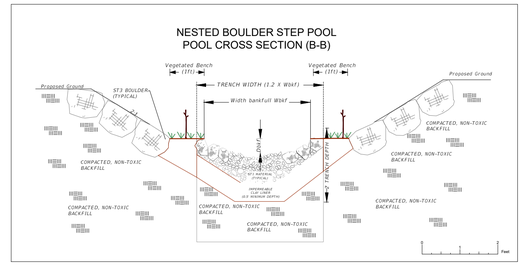
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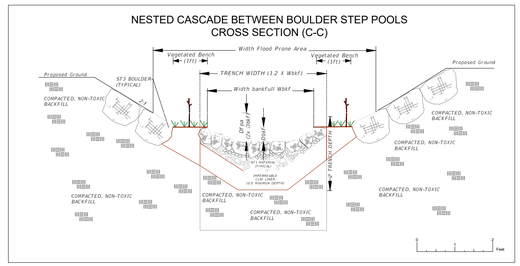
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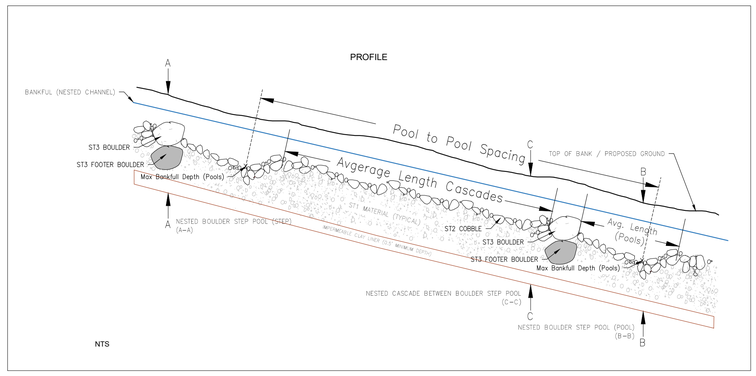
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WAYPOINT LLC









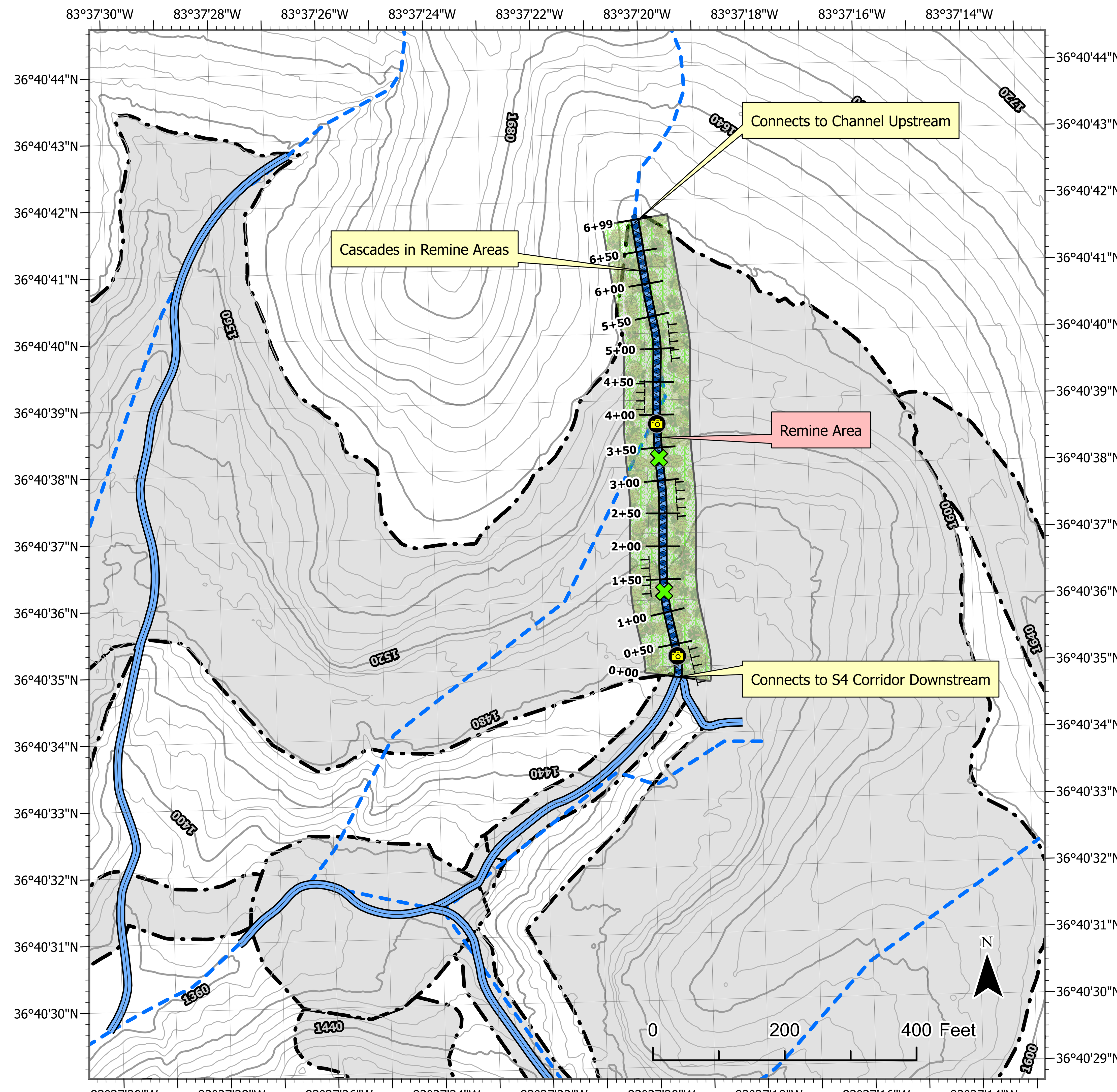
Stream 4 Restored Stream Channel Schedule and Summary Table
Cranes Creek - Perennial (202.5 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	32 - 48	40.00
Average Length Riffles (Ft.)	10 - 15	12.5
Average Length Pools (Ft.)	1.44 - 2.16	1.8
Pool-Pool Spacing (Ft.)	11.2 - 16.8	14.0
Sinuosity	1.0-1.32	1.1
Average Riffle Bankfull Width (Ft.)	5.42 - 8.14	6.78
Average Bankfull Width (Ft.)	6.22 - 9.34	7.78
Riffle Cross-sectional Area (Ft.)	3.26 - 4.88	4.07
Pool Cross-sectional Area (Ft.)	3.66 - 5.48	4.57
Width/Depth Ratio	8.53 - 12.79	10.66
Riffle Mean Bankfull Depth (Ft.)	0.51 - 0.76	0.64
Pool Max Bankfull Depth (Ft.)	0.91 - 1.36	1.14
Entrenchment Ratio	1.12 - 1.68	1.40

Stream 4A RESTORED STREAM CHANNEL

UT Cranes Creek (Intermittent - Station 0+00-6+99 (35.6 AC.)

SCALED PLANVIEW AND CROSS-SECTION



Legend

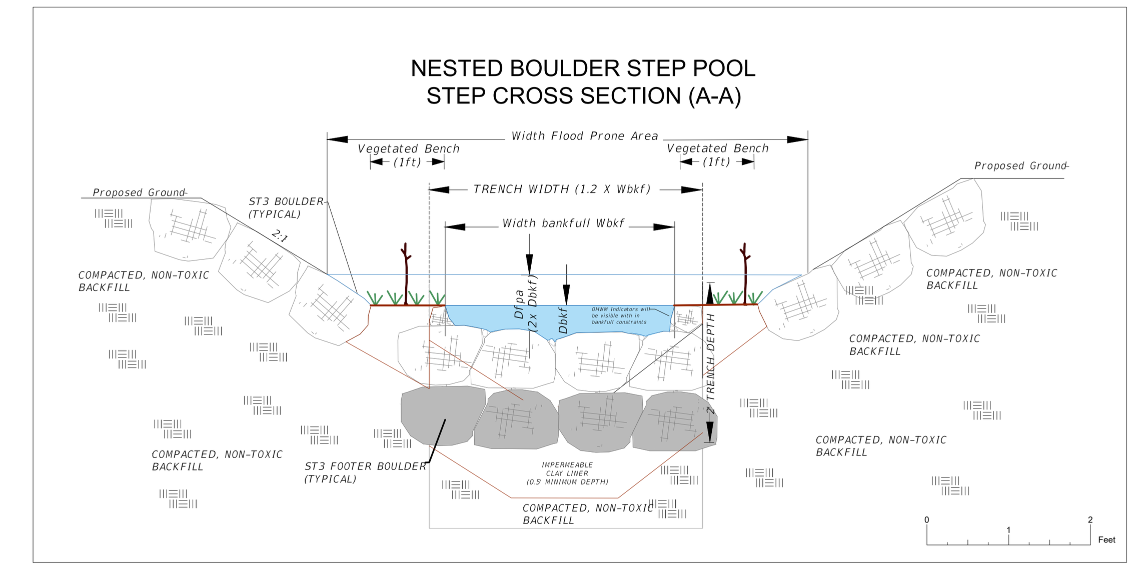
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Cascade	Jurisdictional Streams	Rock Vane
Proposed Stream	Existing Contours	Permanent Photo Point
50' Riparian Buffer	Pool	Permanent Cross Sections

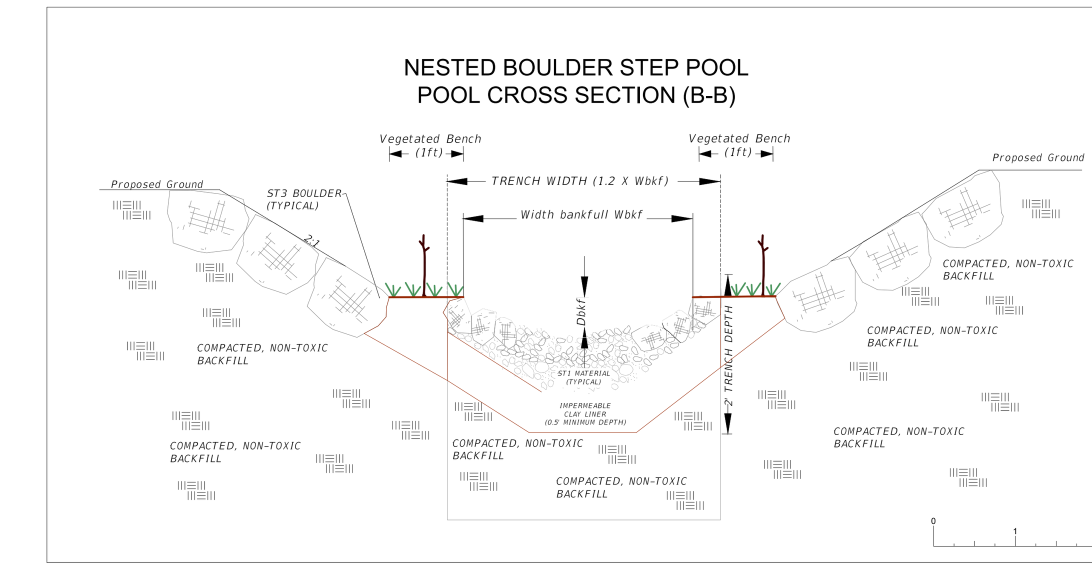
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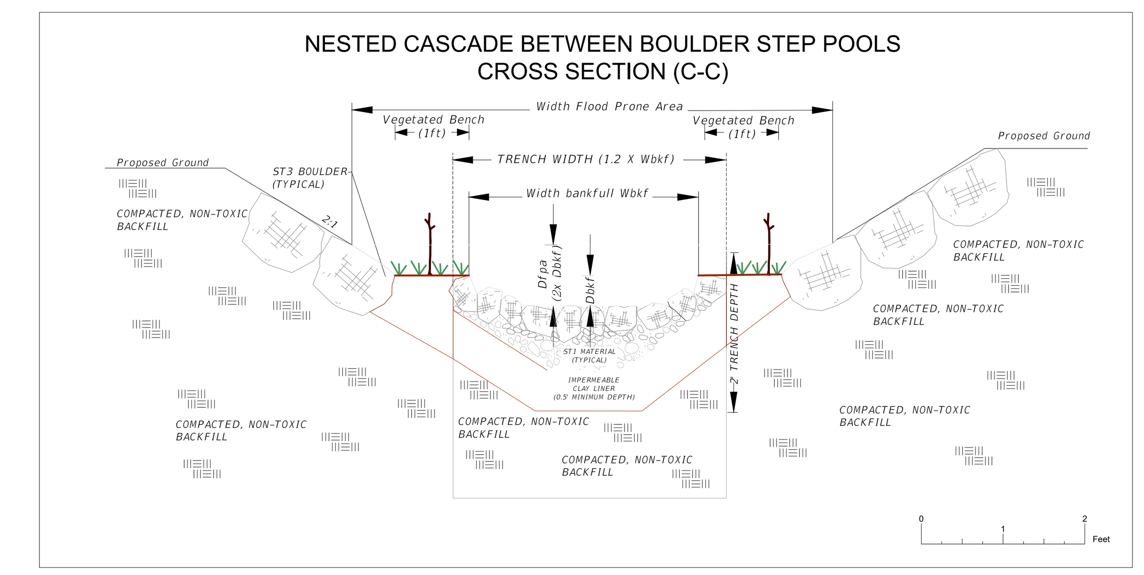
Nally & Hamilton Enterprises, Inc.

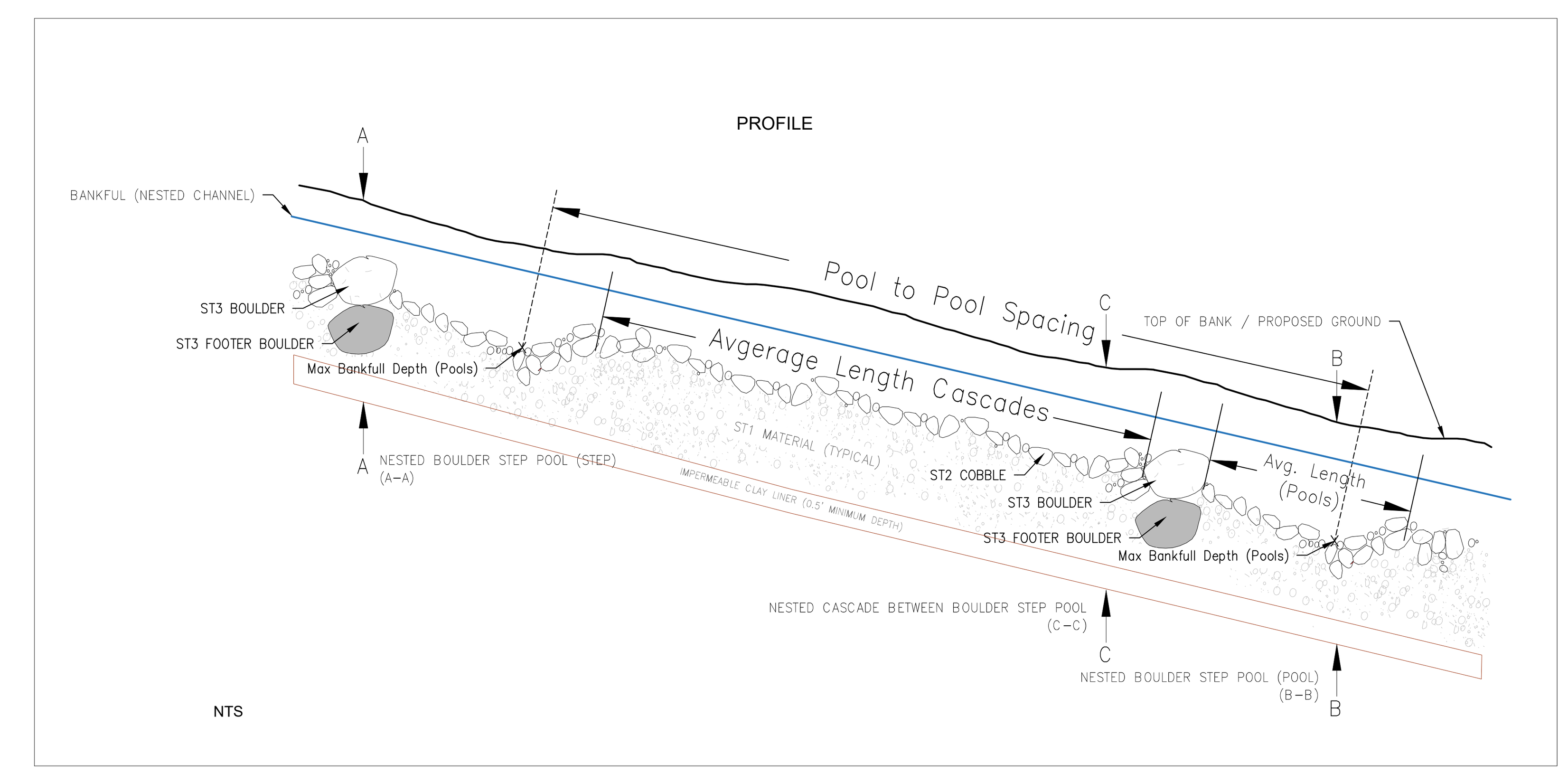
PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 8/23/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC





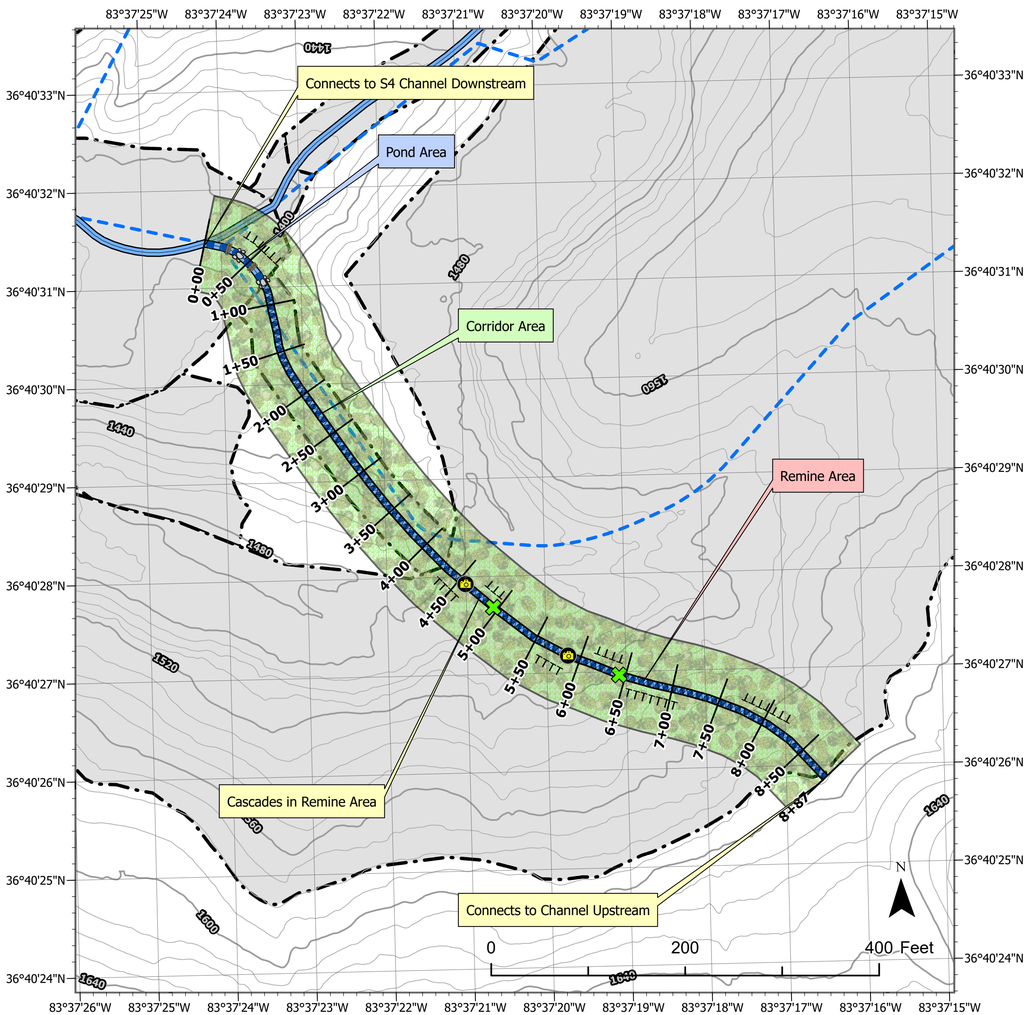




Stream 4A Restored Stream Channel Schedule and Summary Table
UT Cranes Creek - Intermittent (35.6 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	32 - 48	40.00
Average Length Riffles (Ft.)	10 - 15	12.5
Average Length Pools (Ft.)	1.44 - 2.16	1.8
Pool-Pool Spacing (Ft.)	11.2 - 16.8	14.0
Sinuosity	1.0-1.32	1.1
Average Riffle Bankfull Width (Ft.)	3.39 - 5.09	4.24
Average Bankfull Width (Ft.)	4.19 - 6.29	5.24
Riffle Cross-sectional Area (Ft.)	1.49 - 2.23	1.86
Pool Cross-sectional Area (Ft.)	1.89 - 2.83	2.36
Width/Depth Ratio	6.57 - 9.86	8.22
Riffle Mean Bankfull Depth (Ft.)	0.41 - 0.62	0.52
Pool Max Bankfull Depth (Ft.)	0.81 - 1.22	1.02
Entrenchment Ratio	1.12 - 1.68	1.40

Stream 5 RESTORED STREAM CHANNEL
UT Cranes Creek (Intermittent - Station 0+00-8+87 (51.2 AC.)
SCALED PLANVIEW AND CROSS-SECTION

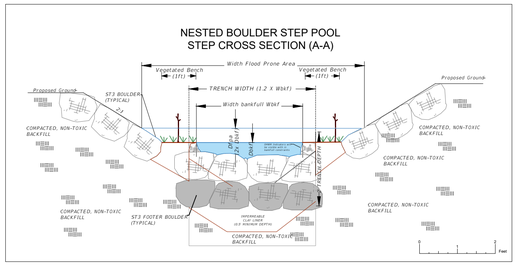


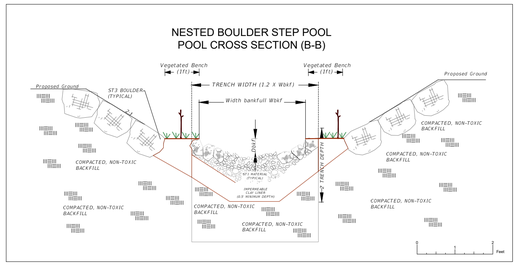
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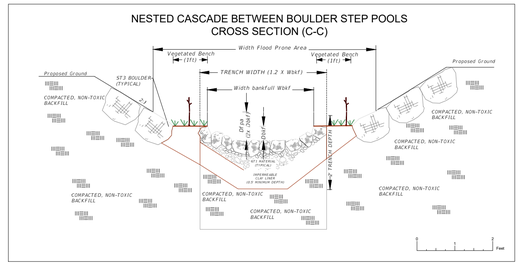
807-0501 Permit Boundary	TTTT Rock Deflectors	Log Vane
Cascade	Jurisdictional Streams	Rock Vane
Proposed Stream	Existing Contours	Permanent Photo Point
50' Riparian Buffer	Pool	Permanent Cross Sections

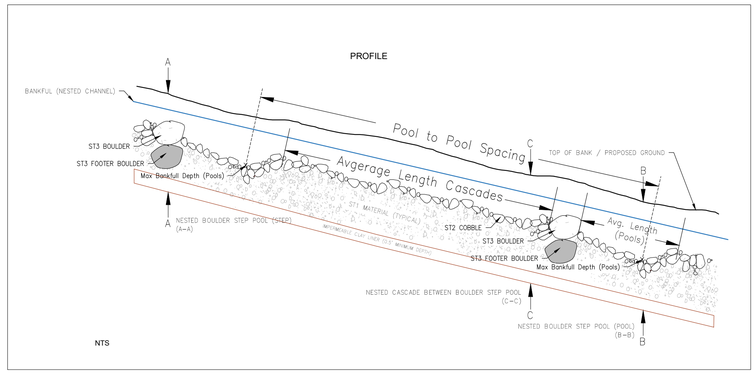
STREAM 5 (S5) INTERMITTENT RESTORATION OF UNNAMED TRIBUTARY TO CRANES CREEK

Nally & Hamilton Enterprises, Inc.	PROJECT NAME: Cranes Creek NWP49	
	PROJECT LOCATION: Bell County, Kentucky	
	PRINT DATE: 8/23/2026	
	KDNR#: 807-0501	
	USACE#: LRN-2025-01090	Drawn by: JK
	WPT#: 2025-63	Checked by: MDB
WAYPOINT LLC		





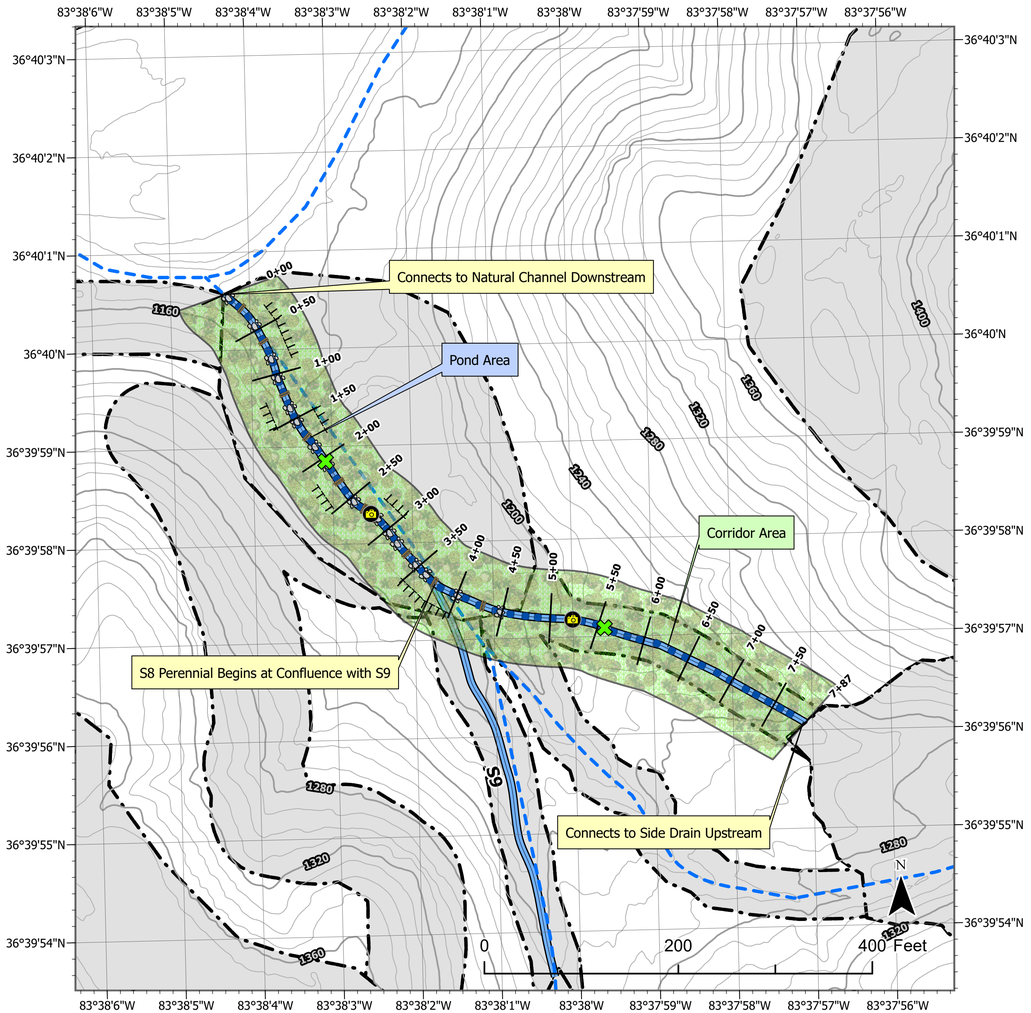




Stream 5 Restored Stream Channel Schedule and Summary Table
UT Cranes Creek - Intermittent (51.2 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	*32 - 48*	*40.00*
Average Length Riffles (Ft.)	*10 - 15*	*12.5*
Average Length Pools (Ft.)	*1.44 - 2.16*	*1.8*
Pool-Pool Spacing (Ft.)	*11.2 - 16.8*	*14.0*
Sinuosity	*1.0-1.32*	*1.1*
Average Riffle Bankfull Width (Ft.)	*3.74 - 5.61*	*4.68*
Average Bankfull Width (Ft.)	*4.54 - 6.81*	*5.68*
Riffle Cross-sectional Area (Ft.)	*1.75 - 2.63*	*2.19*
Pool Cross-sectional Area (Ft.)	*2.15 - 3.23*	*2.69*
Width/Depth Ratio	*6.94 - 10.41*	*8.67*
Riffle Mean Bankfull Depth (Ft.)	*0.43 - 0.65*	*0.54*
Pool Max Bankfull Depth (Ft.)	*0.83 - 1.25*	*1.04*
Entrenchment Ratio	*1.12 - 1.68*	*1.40*

Stream 8 RESTORED STREAM CHANNEL
UT Cranes Creek (Intermittent - Station 3+72-7+87 (69.3 AC.)
SCALED PLANVIEW AND CROSS-SECTION



Legend

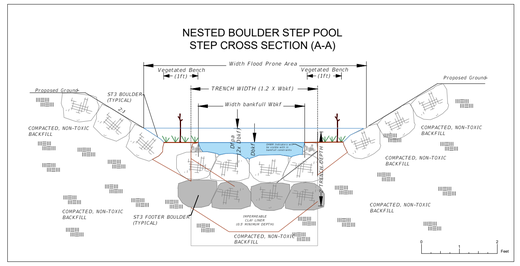
- Proposed Stream
- 50' Riparian Buffer
- 807-0501 Permit Boundary
- Existing Contours
- TTTT Rock Deflectors
- Jurisdictional Streams
- Pool
- Log Vane
- Rock Vane
- Permanent Photo Point
- Permanent Cross Sections

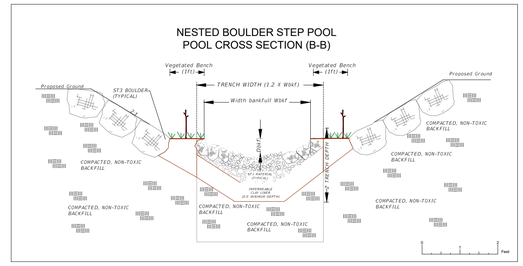
STREAM 8 (S8) INTERMITTENT AND PERENNIAL RESTORATION OF UNNAMED TRIBUTARY TO CRANES CREEK

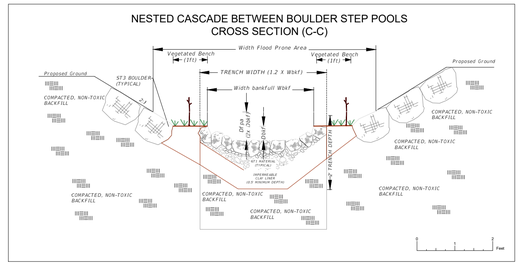
Nally & Hamilton Enterprises, Inc.

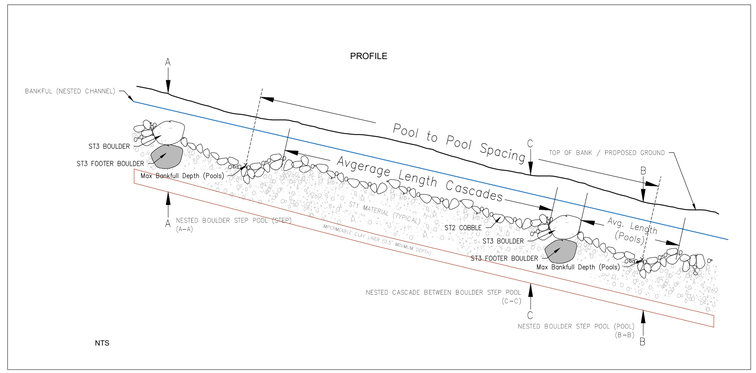
PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 3/1/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC





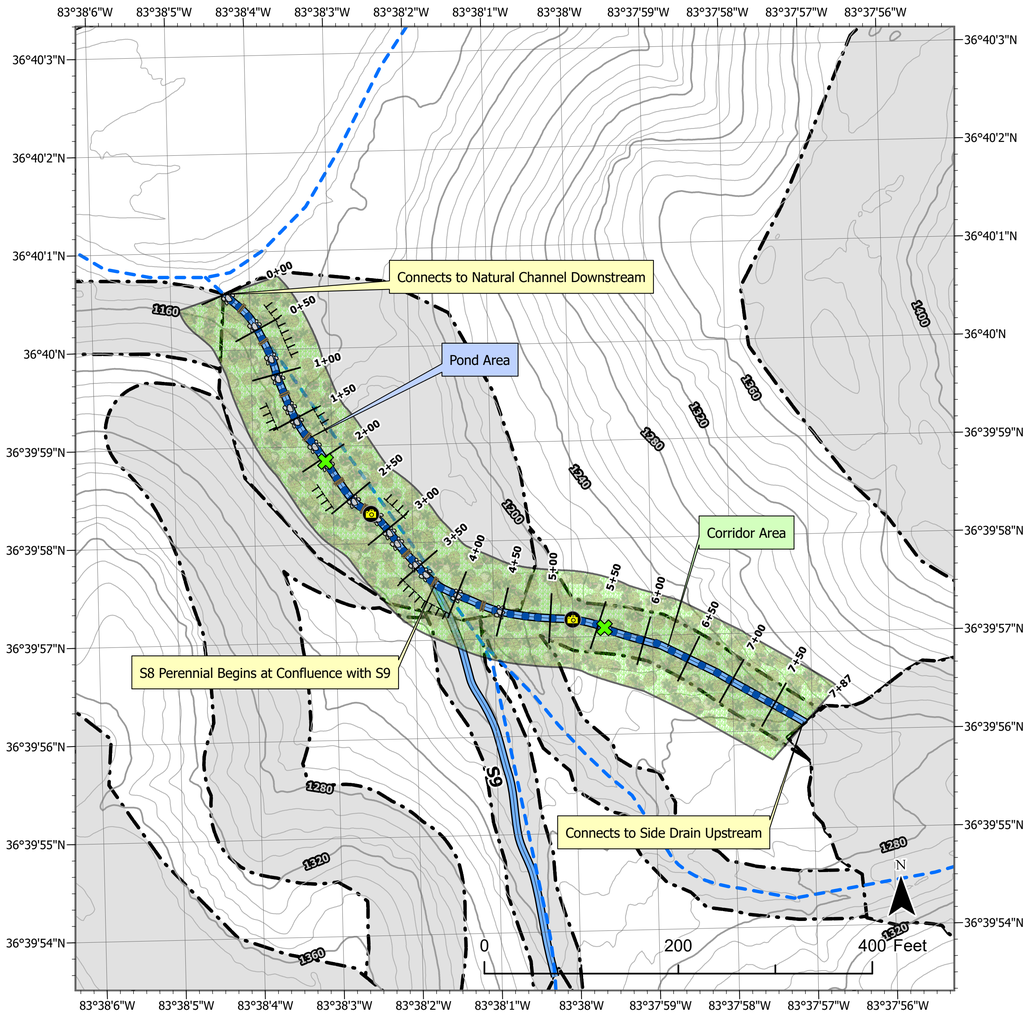




Stream 8 Restored Stream Channel Schedule and Summary Table
UT Cranes Creek - Intermittent (69.3 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	*32 - 48*	*40.00*
Average Length Riffles (Ft.)	*10 - 15*	*12.5*
Average Length Pools (Ft.)	*1.44 - 2.16*	*1.8*
Pool-Pool Spacing (Ft.)	*11.2 - 16.8*	*14.0*
Sinuosity	*1.0-1.32*	*1.1*
Average Riffle Bankfull Width (Ft.)	*4.06 - 6.09*	*5.08*
Average Bankfull Width (Ft.)	*4.86 - 7.29*	*6.08*
Riffle Cross-sectional Area (Ft.)	*2.01 - 3.01*	*2.51*
Pool Cross-sectional Area (Ft.)	*2.41 - 3.61*	*3.01*
Width/Depth Ratio	*7.26 - 10.89*	*9.08*
Riffle Mean Bankfull Depth (Ft.)	*0.45 - 0.67*	*0.56*
Pool Max Bankfull Depth (Ft.)	*0.85 - 1.27*	*1.06*
Entrenchment Ratio	*1.12 - 1.68*	*1.40*

Stream 8 RESTORED STREAM CHANNEL
UT Cranes Creek (Perennial - Station 0+00-3+72 (125.6 AC.)
SCALED PLANVIEW AND CROSS-SECTION



Legend

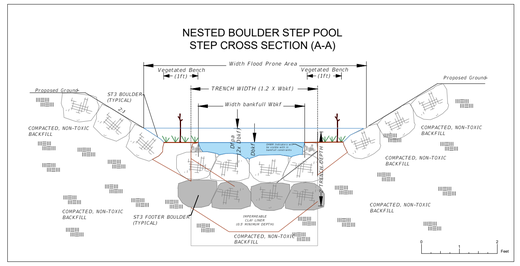
- Proposed Stream
- 50' Riparian Buffer
- 807-0501 Permit Boundary
- Existing Contours
- TTTT Rock Deflectors
- Jurisdictional Streams
- Pool
- Log Vane
- Rock Vane
- Permanent Photo Point
- Permanent Cross Sections

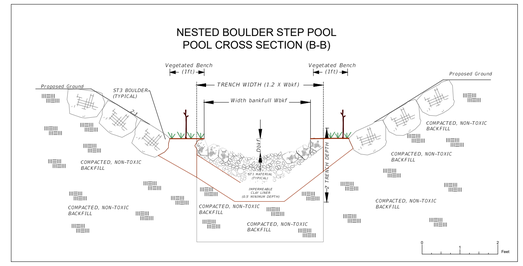
STREAM 8 (S8) INTERMITTENT AND PERENNIAL RESTORATION OF UNNAMED TRIBUTARY TO CRANES CREEK

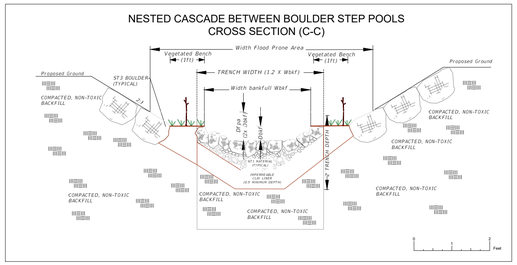
Nally & Hamilton Enterprises, Inc.

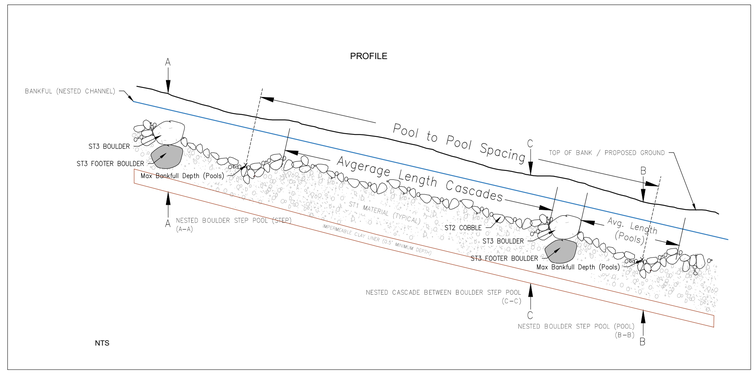
PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 3/1/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC





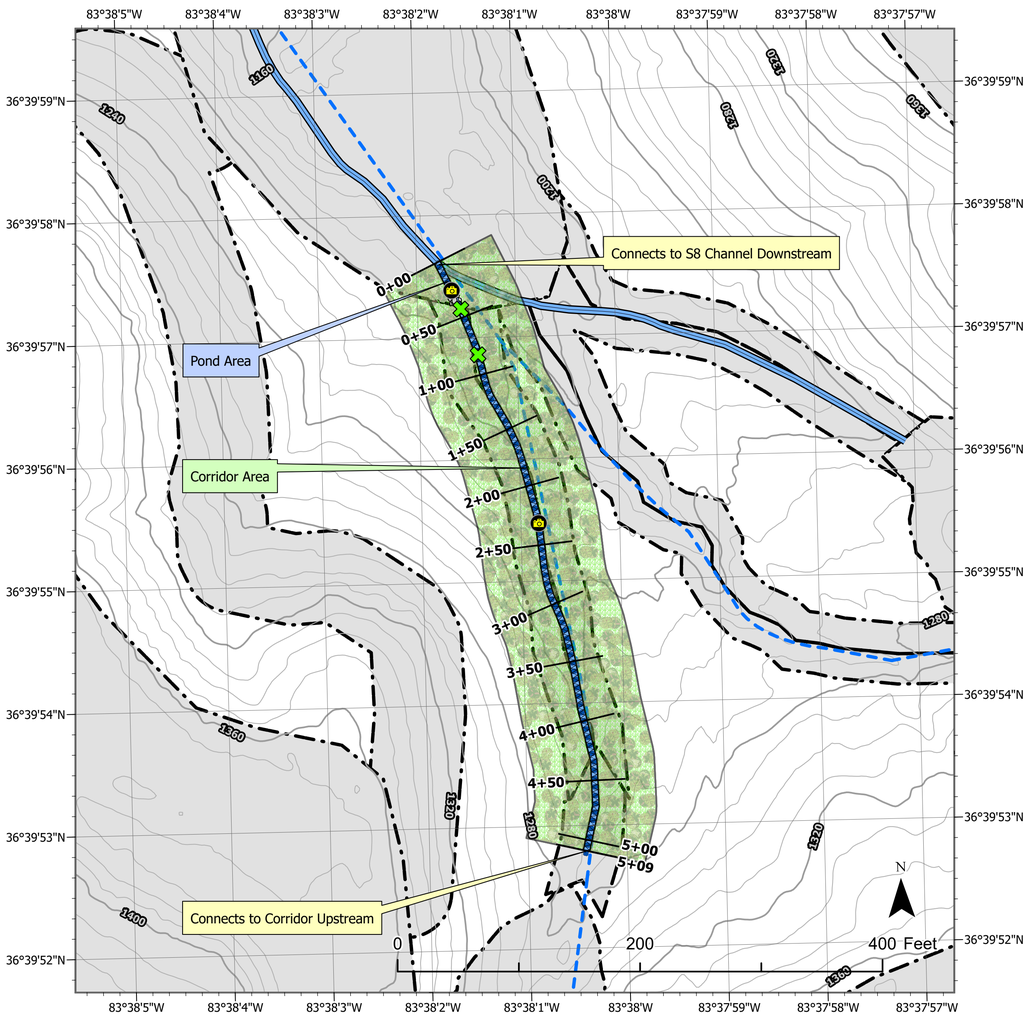




Stream 8 Restored Stream Channel Schedule and Summary Table
UT Cranes Creek - Perennial (125.6 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	*32 - 48*	*40.00*
Average Length Riffles (Ft.)	*10 - 15*	*12.5*
Average Length Pools (Ft.)	*1.44 - 2.16*	*1.8*
Pool-Pool Spacing (Ft.)	*11.2 - 16.8*	*14.0*
Sinuosity	*1.0-1.32*	*1.1*
Average Riffle Bankfull Width (Ft.)	*4.77 - 7.15*	*5.96*
Average Bankfull Width (Ft.)	*5.57 - 8.35*	*6.96*
Riffle Cross-sectional Area (Ft.)	*2.63 - 3.94*	*3.28*
Pool Cross-sectional Area (Ft.)	*3.03 - 4.54*	*3.78*
Width/Depth Ratio	*7.94 - 11.91*	*9.93*
Riffle Mean Bankfull Depth (Ft.)	*0.48 - 0.72*	*0.60*
Pool Max Bankfull Depth (Ft.)	*0.88 - 1.32*	*1.10*
Entrenchment Ratio	*1.12 - 1.68*	*1.40*

Stream 9 RESTORED STREAM CHANNEL
UT Cranes Creek (Intermittent - Station 0+00-5+09 (31.4 AC.)
SCALED PLANVIEW AND CROSS-SECTION



Legend

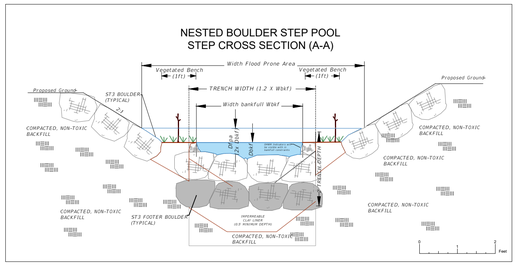
- 807-0501 Permit Boundary
- Cascade
- Proposed Stream
- 50' Riparian Buffer
- Rock Deflectors
- Jurisdictional Streams
- Existing Contours
- Pool
- Log Vane
- Rock Vane
- Permanent Photo Point
- Permanent Cross Sections

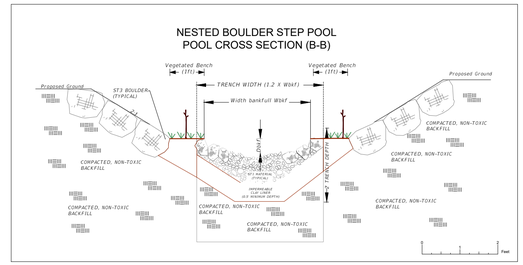
STREAM 9 (S9) INTERMITTENT RESTORATION OF UNNAMED TRIBUTARY TO CRANES CREEK

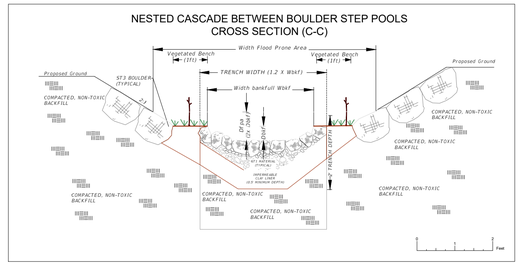
PROJECT NAME: Cranes Creek NWP49		
PROJECT LOCATION: Bell County, Kentucky		
PRINT DATE: 8/23/2026		
KDNR#: 807-0501		
USACE#: LRN-2025-01090	Drawn by: JK	
WPT#: 2025-63	Checked by: MDB	

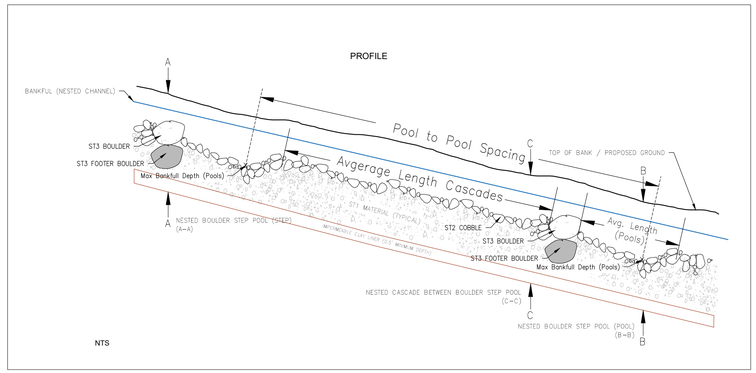
Nally & Hamilton Enterprises, Inc.

WAYPOINT LLC





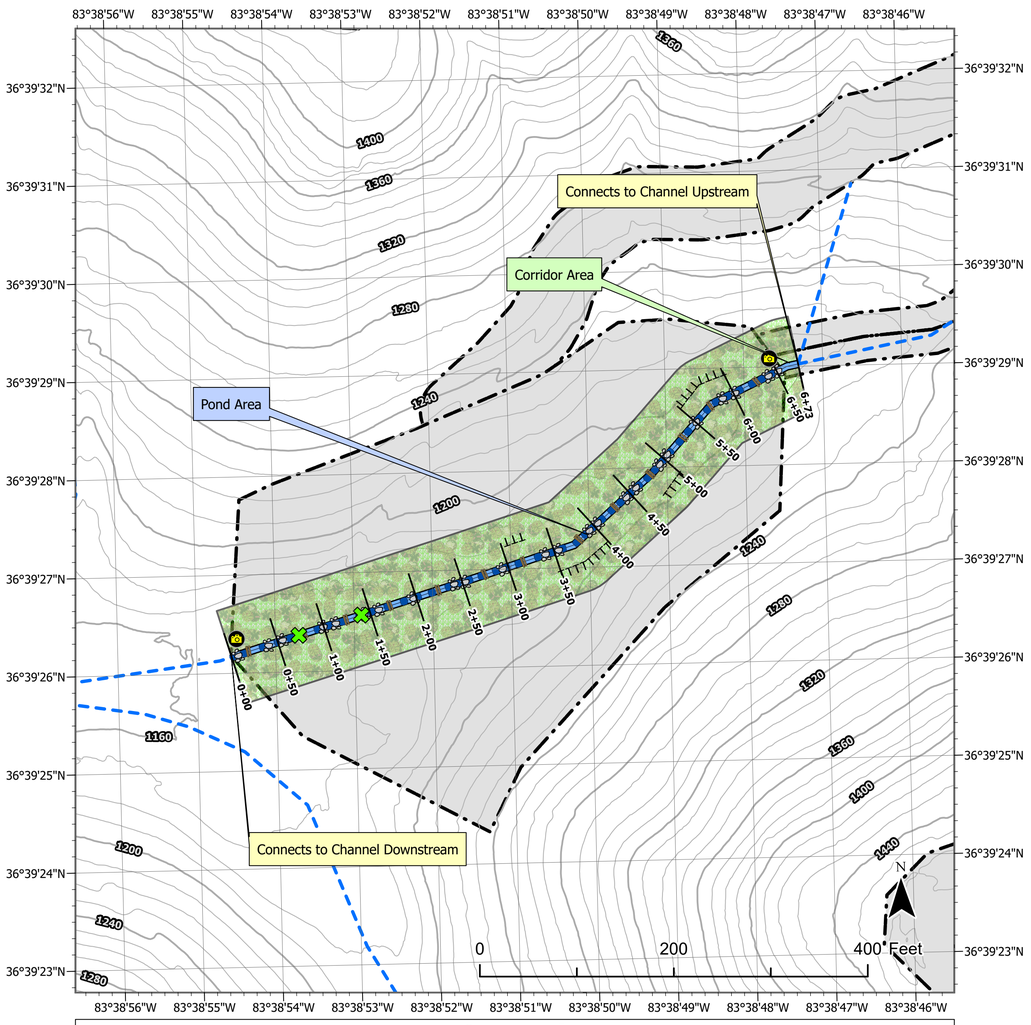




Stream 9 Restored Stream Channel Schedule and Summary Table
UT Cranes Creek - Intermittent (31.4 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	*32 - 48*	*40.00*
Average Length Riffles (Ft.)	*10 - 15*	*12.5*
Average Length Pools (Ft.)	*1.44 - 2.16*	*1.8*
Pool-Pool Spacing (Ft.)	*11.2 - 16.8*	*14.0*
Sinuosity	*1.0-1.32*	*1.1*
Average Riffle Bankfull Width (Ft.)	*3.28 - 4.92*	*4.10*
Average Bankfull Width (Ft.)	*4.08 - 6.12*	*5.10*
Riffle Cross-sectional Area (Ft.)	*1.41 - 2.11*	*1.76*
Pool Cross-sectional Area (Ft.)	*1.81 - 2.71*	*2.26*
Width/Depth Ratio	*6.45 - 9.67*	*8.06*
Riffle Mean Bankfull Depth (Ft.)	*0.41 - 0.61*	*0.51*
Pool Max Bankfull Depth (Ft.)	*0.81 - 1.21*	*1.01*
Entrenchment Ratio	*1.12 - 1.68*	*1.40*

Stream 12 RESTORED STREAM CHANNEL
UT Clear Fork (Intermittent - Station 0+00-6+63 (46.3 AC.)
SCALED PLANVIEW AND CROSS-SECTION



Legend

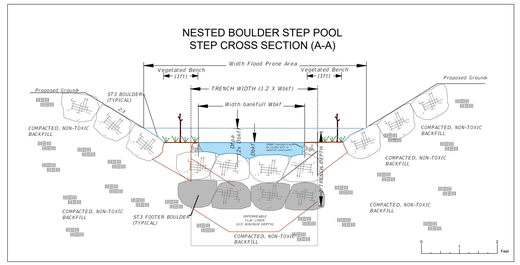
- 807-0501 Permit Boundary
- Proposed Stream
- 50' Riparian Buffer
- TTTT Rock Deflectors
- Jurisdictional Streams
- Existing Contours
- Pool
- Log Vane
- Rock Vane
- Permanent Photo Point
- Permanent Cross Sections

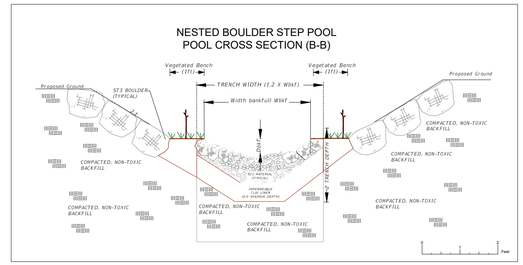
STREAM 12 (S12) INTERMITTENT RESTORATION OF UNNAMED TRIBUTARY TO CLEAR FORK

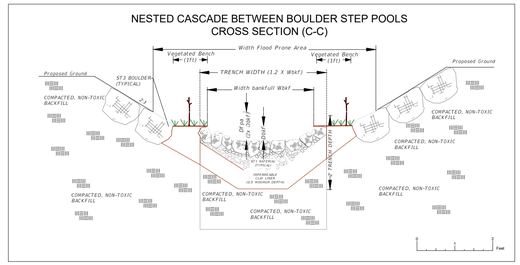
Nally & Hamilton Enterprises, Inc.

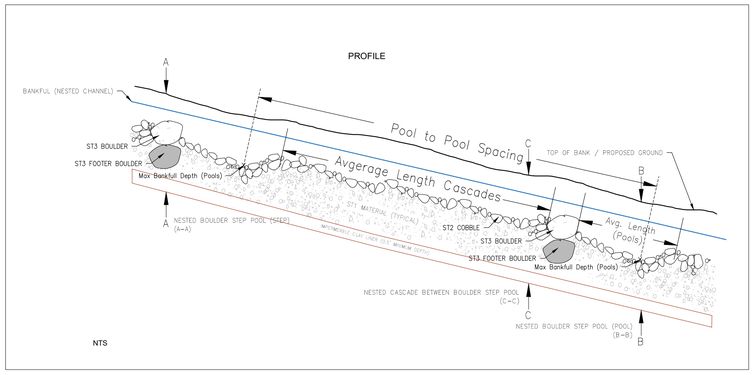
PROJECT NAME: Cranes Creek NWP49	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 9/3/2026	
KDNR#: 807-0501	
USACE#: LRN-2025-01090	Drawn by: JK
WPT#: 2025-63	Checked by: MDB

WAYPOINT LLC





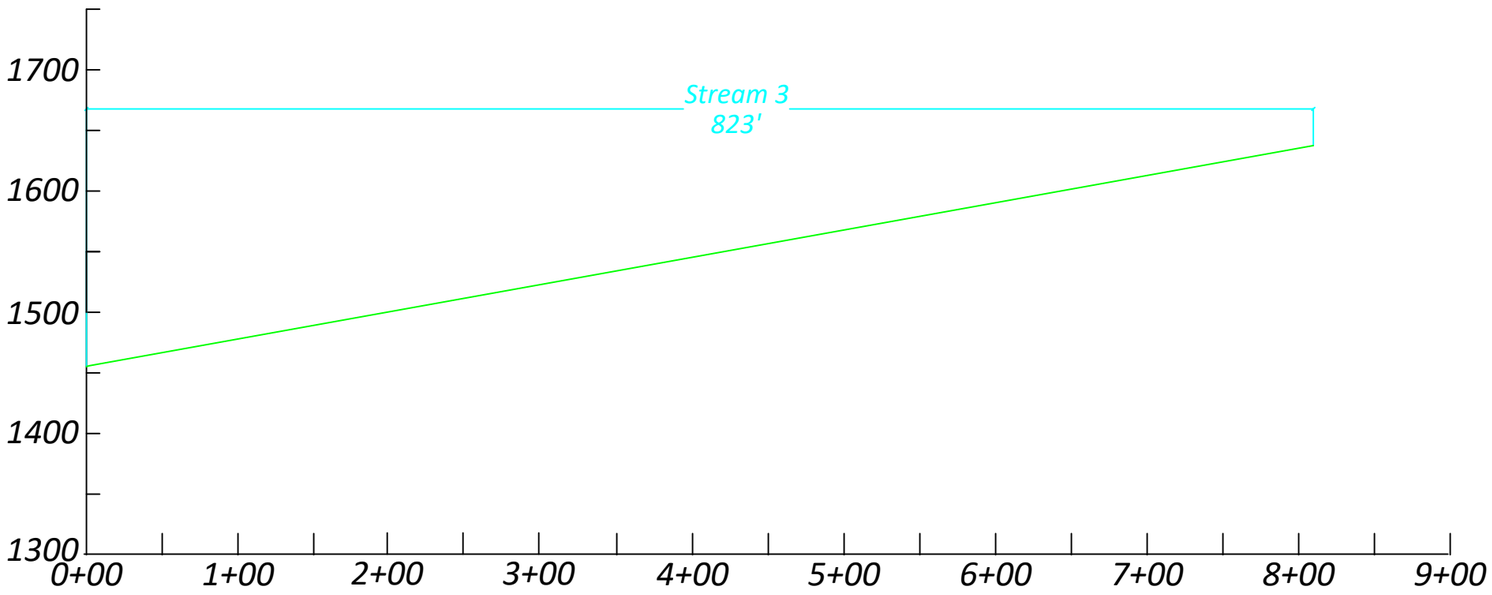




Stream 12 Restored Stream Channel Schedule and Summary Table
UT Clear Fork - Intermittent (46.3 Ac.)

CATEGORY	Proposed Range	Proposed Target
Longitudinal Profile		
Average Channel Slope (Pct.)	*32 - 48*	*40.0*
Average Length Riffles (Ft.)	*10 - 15*	*12.5*
Average Length Pools (Ft.)	*1.44 - 2.16*	*1.8*
Pool-Pool Spacing (Ft.)	*11.2 - 16.8*	*14.0*
Sinuosity	*1.0-1.32*	*1.1*
Average Riffle Bankfull Width (Ft.)	*3.64 - 5.46*	*4.55*
Average Bankfull Width (Ft.)	*4.44 - 6.66*	*5.55*
Riffle Cross-sectional Area (Ft.)	*1.68 - 2.51*	*2.09*
Pool Cross-sectional Area (Ft.)	*2.08 - 3.11*	*2.59*
Width/Depth Ratio	*6.84 - 10.25*	*8.5*
Riffle Mean Bankfull Depth (Ft.)	*0.43 - 0.64*	*0.53*
Pool Max Bankfull Depth (Ft.)	*0.83 - 1.24*	*1.03*
Entrenchment Ratio	*1.12 - 1.68*	*1.40*

Proposed Mitigated S3 Profile
(Through Proposed Mine Permit Boundary)





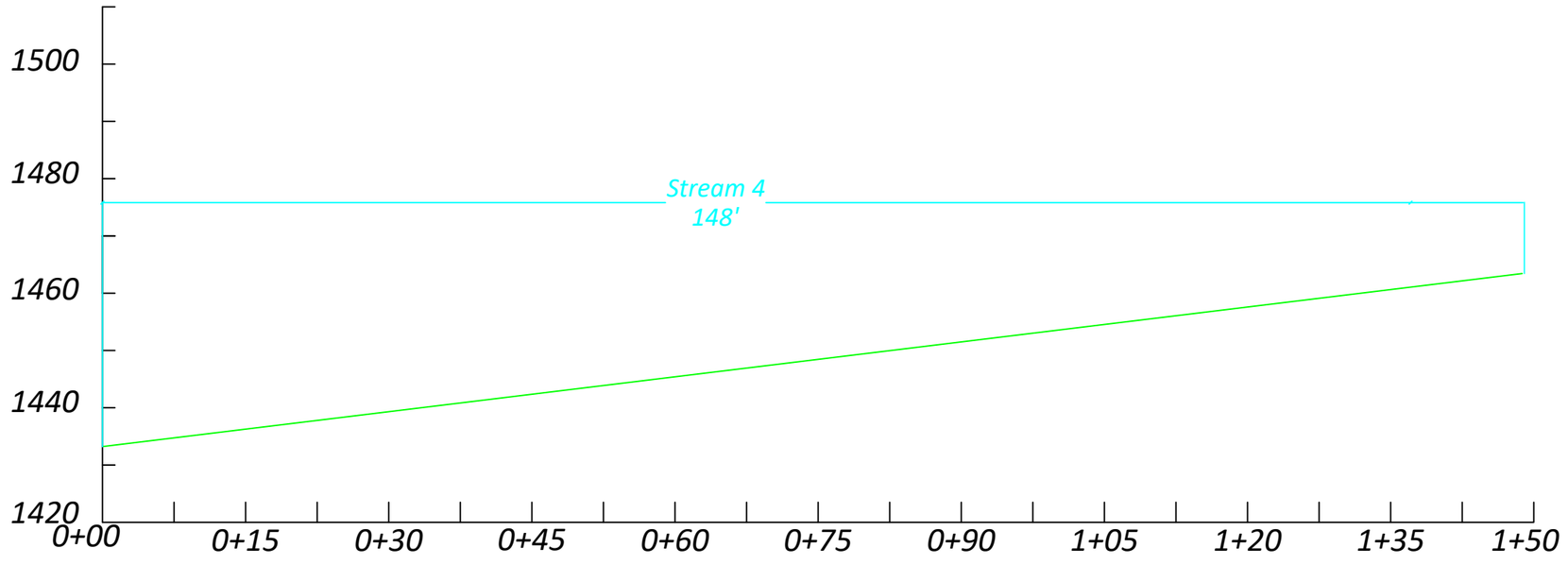
Nally & Hamilton Enterprises, Inc.

WAYPOINT

Proposed Mitigated S3 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090

drawn by: BES		01/29/2026

Proposed Mitigated S4 Profile
(Through Proposed Mine Permit Boundary)



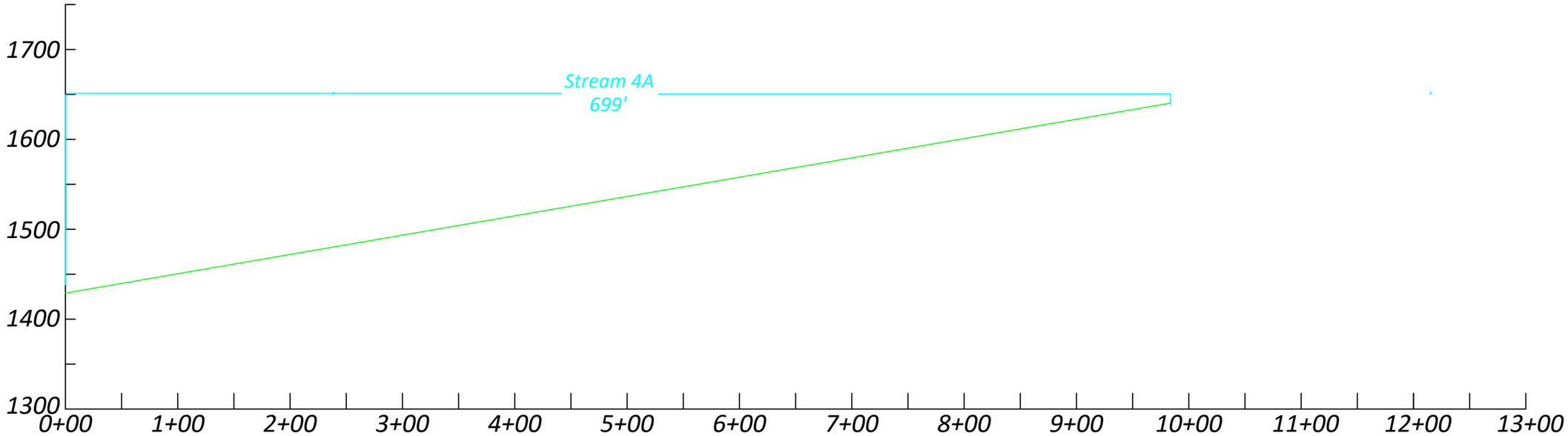


Nally & Hamilton Enterprises, Inc.

WAYPOINT LLC

Proposed Mitigated S4 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Proposed Mitigated S4A Profile
(Through Proposed Mine Permit Boundary)





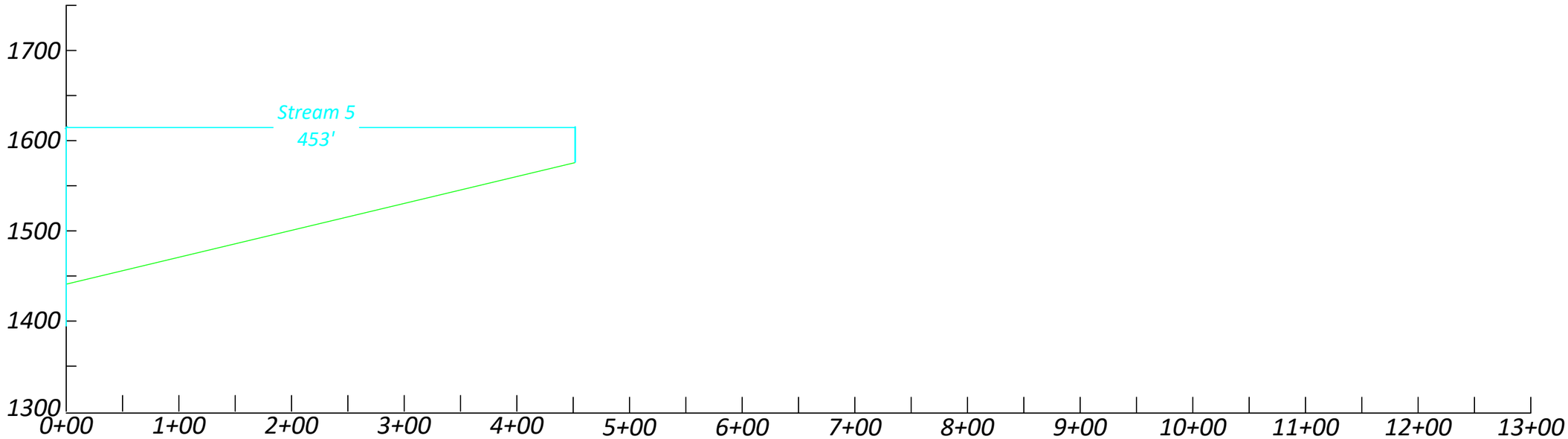
Nally & Hamilton Enterprises, Inc.

WAYPOINT inc

Proposed Mitigated S4A Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Proposed Mitigated S5 Profile

(Through Proposed Mine Permit Boundary)



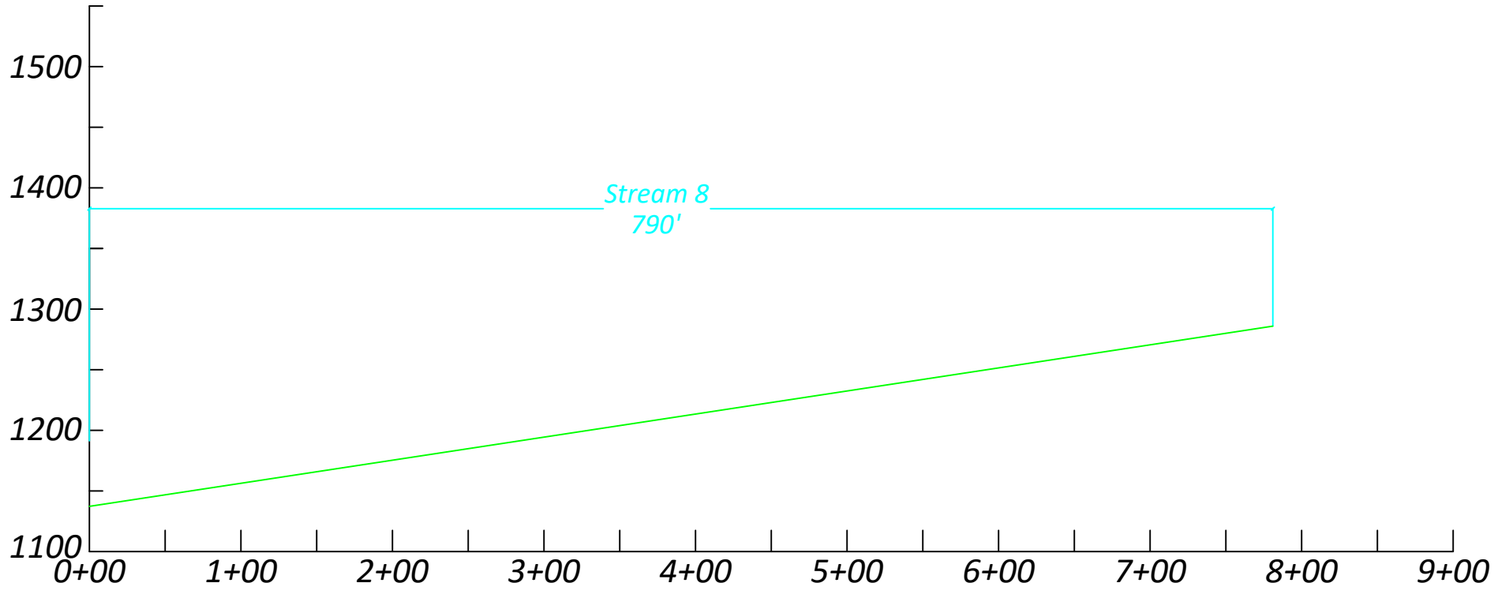


Nally & Hamilton Enterprises, Inc.

WAYPOINT LC

Proposed Mitigated S5 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

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(Through Proposed Mine Permit Boundary)



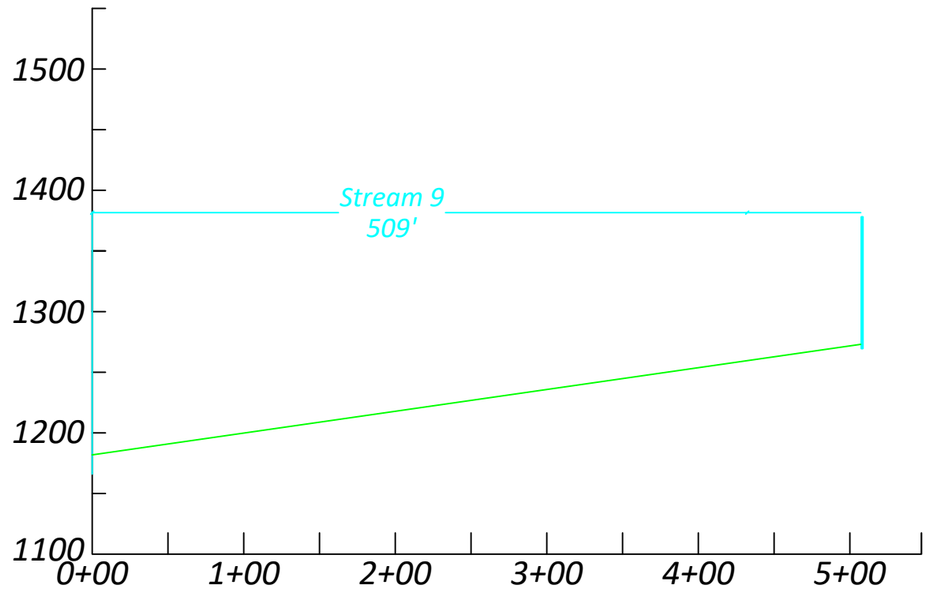


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Proposed Mitigated S8 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Proposed Mitigated S9 Profile
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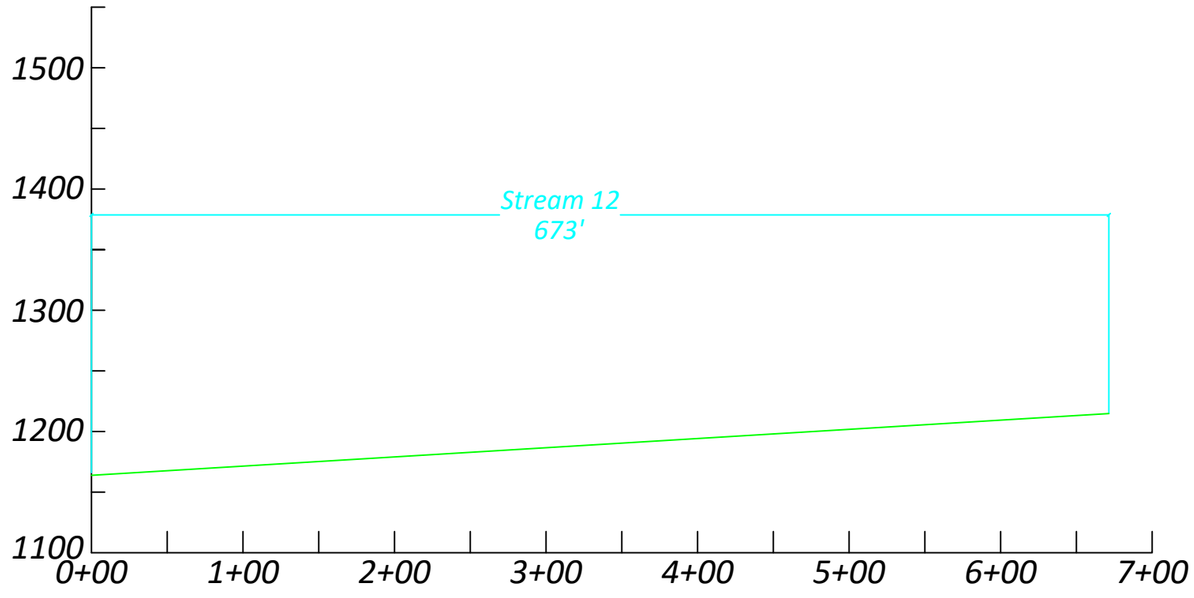


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Proposed Mitigated S9 Profiles
Nationwide #49 Permit
KDNR# 807-0501 | LRN-2025-01090
drawn by: BES | | 01/29/2026

Proposed Mitigated S12 Profile
(Through Proposed Mine Permit Boundary)





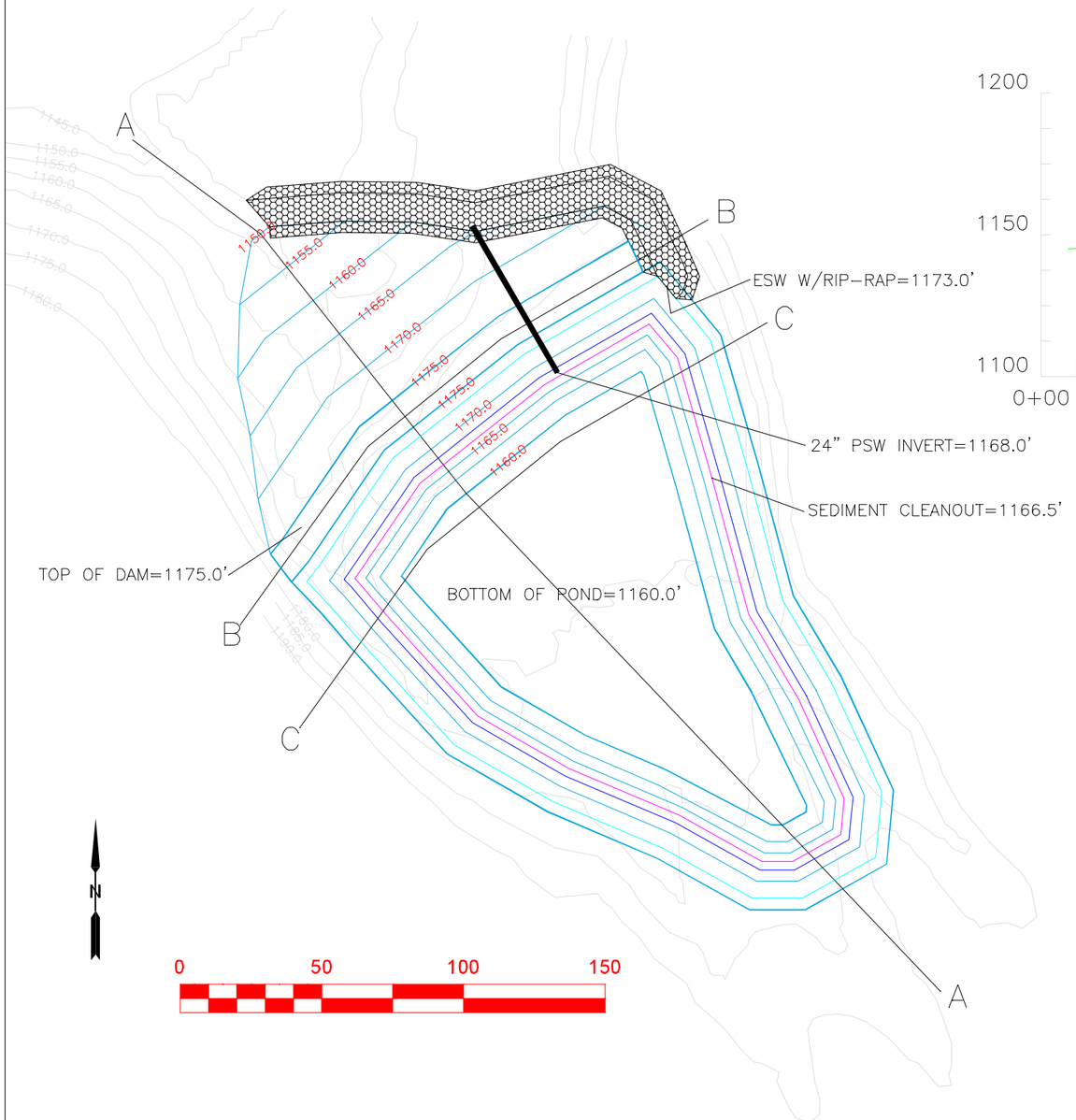
Nally & Hamilton Enterprises, Inc.

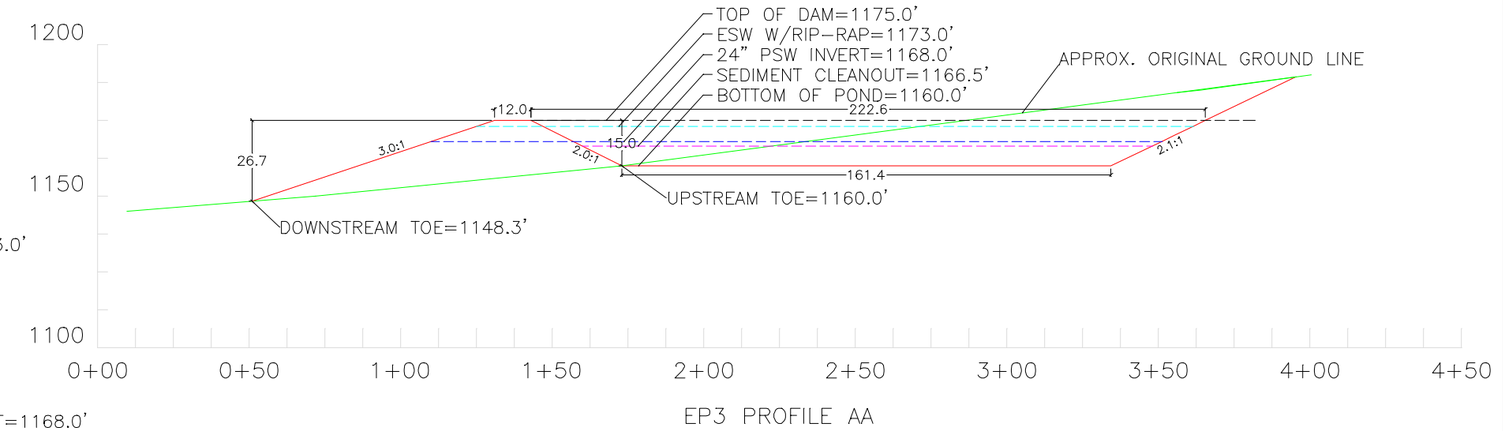
WAYPOINT

Proposed Mitigated S12 Profiles		
Nationwide #49 Permit		
KDNR# 807-0501 | LRN-2025-01090		
drawn by: BES		01/29/2026

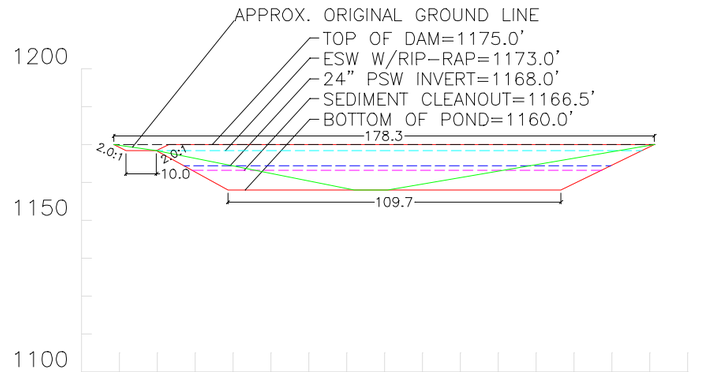
Appendix E
Proposed Design Drawings

Part 2: Details





EP3 PROFILE AA



EP3 PROFILE CC

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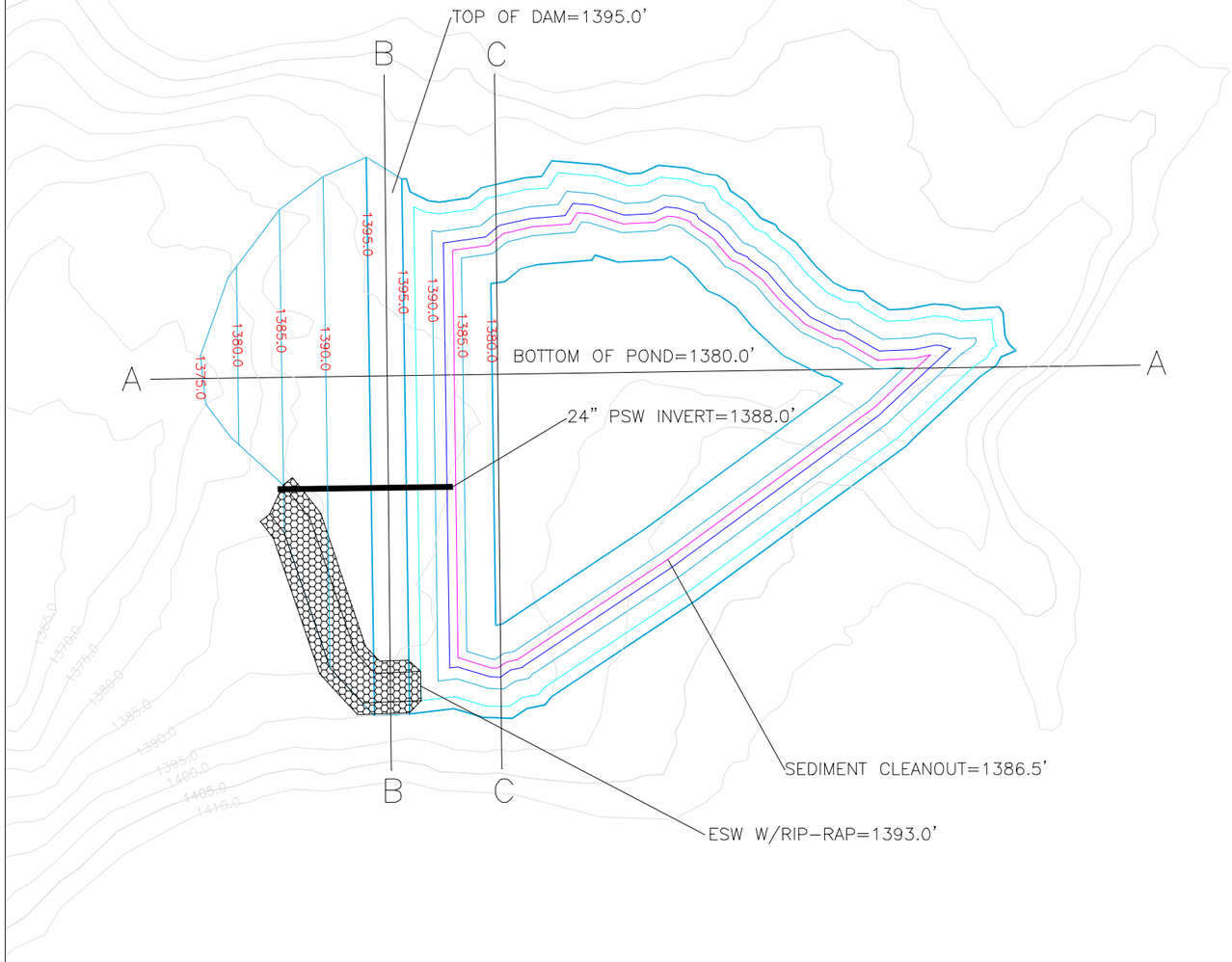
I, _____ (Name), 24,487 (Lic. #), 08/10/2023 (Date)

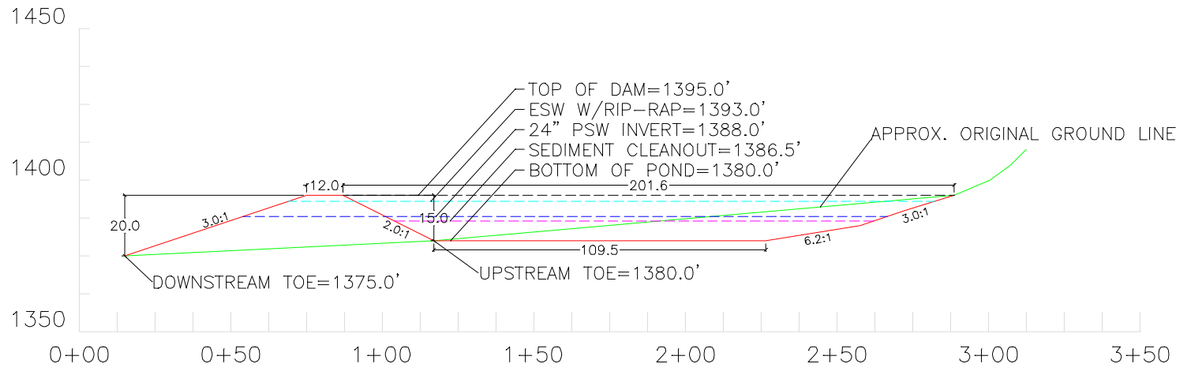
Hereby certify, in accordance with 405 KAR 7:040, Section 10 that this document is correct as determined by accepted engineering practices and includes all the information required of it by KRS Chapter 350 and KAR Title 405.

STATE OF KENTUCKY
J.D. MILLER
24,487
LICENSED PROFESSIONAL ENGINEER

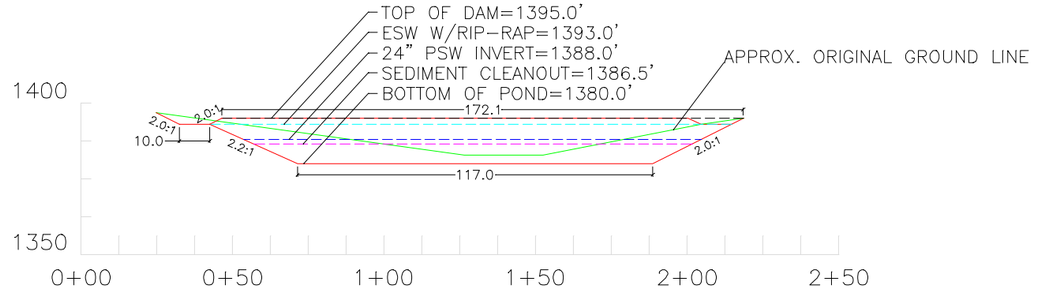
Nally & Hamilton Enterprises, Inc.
195 Commercial Drive, Suite 105
London, Kentucky 40744
Ph: (606) 878-1500
Email: nhe@nheinc.net

Permit #807-0501 NW		
Embankment Pond 3 Drawings		
Item 29		
embankment pond 3.dwg	08/14/2023	Scale 1"=50'





EP4 PROFILE AA



EP4 PROFILE BB AND CC

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N

0 50 100 150

I, _____, 24,487, 08/10/2023
Name Lic. # Date

Hereby certify, in accordance with 405 KAR 7:040, Section 10 that this document is correct as determined by accepted engineering practices and includes all the information required of it by KRS Chapter 350 and KAR Title 405.

STATE OF KENTUCKY
J.D. MILLER
24,487
LICENSED PROFESSIONAL ENGINEER

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Permit #807-0501 NW

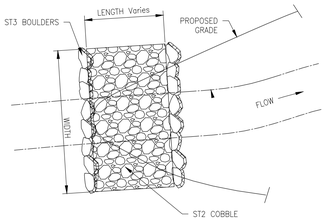
Embankment Pond 4 Drawings

Item 29

embankment pond 4.dwg	11/17/2023	Scale 1"=50'

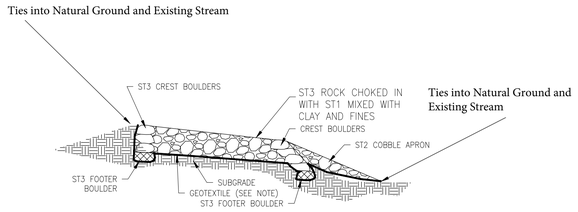
RESTORATION DETAIL
(Not to Scale)

DETAIL - GRADE CONTROL STRUCTURE



TYPICAL GRADE CONTROL STRUCTURE PLANVIEW

NOT TO SCALE



TYPICAL GRADE CONTROL STRUCTURE PROFILE

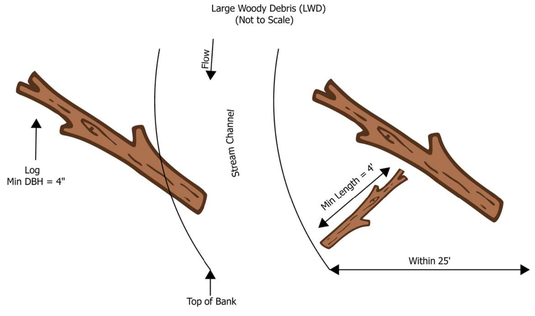
NOT TO SCALE

Construction Notes

Grade control structures can be used in transitional areas between the restored reach and natural ground.

1. Channel flow should be diverted away from the work area in accordance with the approved ECP, and the site should be dewatered.
2. Calculations for the dimensions and size of stone are based on the following guidelines.
3. Grade controls should be designed with a minimum dishcarge in mind.
4. It is recommended that boulder stone be properly sized to resist the tractive forces utilizing empirical relationships for shear stress and velocities.
5. Once the dimensions and stone size have been determined, excavate the footprint.
6. Working downstream to upstream, excavate a section of the existing stream channel and associated banks to obtain the necessary sub-grade. Allow room for placement of cobble, boulders, channel backfill, and any associated bank treatments. The downstream boulders shall be placed first prior to cobble installation. Limit the total length of work to that which can be completed and stabilized in a single work day or dry weather period.
7. After the excavation, geotextile shall be placed over the prepared surface. Cobble shall be placed by mechanical or other acceptable methods. The cobble shall be placed to form a neat and uniform surface area. No mortar is permitted.
8. Cobble shall be graded from the smallest to the largest pieces as specified by the materials requirements and will be controlled by visual inspection. The thickness of the cobble layer shall be a minimum 18 in. in depth).
9. Boulders shall be placed by mechanical or other acceptable methods with a minimum of voids. The boulders shall be placed to form a neat and uniform surface area. No mortar is permitted.
10. If necessary, boulders can be chiseled or broken to achieve improved contact between stones.
11. If geotextile is punctured during boulder placement, the boulders shall be fully removed for at least three feet outside the limits of the fabric puncture and a new geotextile patch with minimum overlap of 16 in. shall be securely fastened over the puncture with securing pins.
12. The finished grade control shall be backwashed until refusal with additional channel gravel, sand, and cobble to seal the voids in structure prior to placement of the final compost or soil layer. Fine grains and clay shall be incorporated to ensure no subsurface flow occurs.
13. A grade control will be deemed installed correctly when the return of surface stream flow through the reach is accomplished without damaging the riffle grade control,no subsurface flow occurs, and no movement of the cobble or boulders is observed.

Large Woody Debris (LWD)
(Not to Scale)

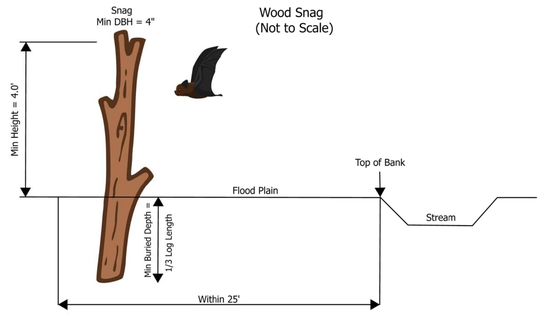


Notes:

1. LWD shall be placed within 25 feet of the top of bank of the proposed or existing stream location
2. Minimum length of LWD is 4 feet
3. Minimum diameter is 4 inches
4. Logs to be used should be hardwood, relatively straight and recently harvested
5. All materials are to be approved by the engineer or on-site construction manager
6. Install 8-20 LWD per 100 feet of reach

Snag
Min DBH = 4"

Wood Snag
(Not to Scale)



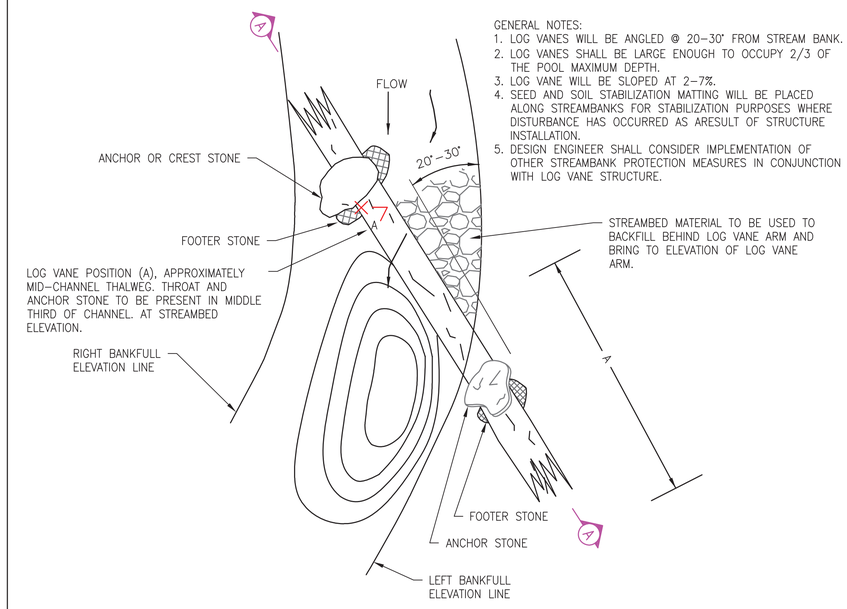
Notes:

1. Wood snags shall be placed within 25 feet of the top of bank of the proposed or existing stream location
2. At least 1/3 of the total length of the log shall be buried
3. Minimum above ground heights 4 feet
4. Minimum Diameter at Breast Height (DBH) is 4 inches
5. Logs to be used should be hardwood, relatively straight and recently harvested
6. All materials are to be approved by the engineer or on-site construction manager
7. Install 1-3 wood snags per 100 feet of reach

Construction Notes

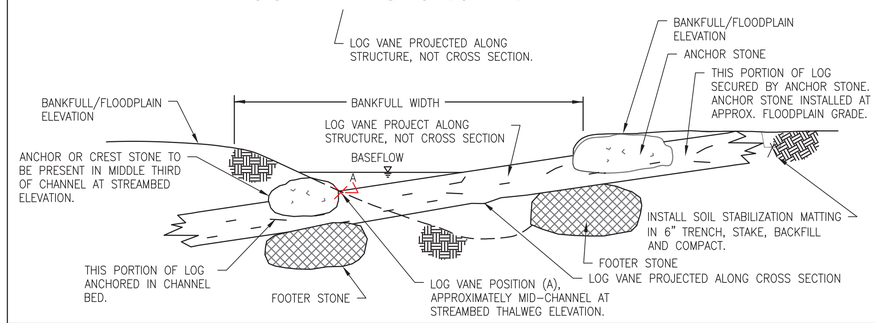
1. Compact and grade backfill material allowing for tie in with streams above and below work area.
2. Divide the stream length by pool-pool spacing (P-P) (see channel schedule) to get the total number of cascades.
3. Place grade stakes offset from each cascade location noting bankfull elevation at center of cascade, height of center of the surface boulders in the cascade (dbkf) (see channel schedule), and depth of trench (2').
4. Grade to bankfull elevation.
5. Excavate a trench of width 1.2Wbkf (See Channel Schedule) and Depth 2'
6. Dump substrate material type ST1 into trench and spread out to create a parabolic channel shape of width Wbkf and height dbkf (See Channel Schedule for Dimensions).
7. Working from upstream to downstream place substrate materials ST2 and ST3.
8. Cascades shall be constructed so that low flow is concentrated within the center 1/3 of the bankfull channel reaches >10% bkf slope.
9. Cascades shall slope 2-4% with the highest portion of the step on the downstream leading edge.
10. Perform final grading of the channel bed.
11. Perform final grading above bankfull elevation to achieve slopes of 2(H):1(V) or flatter.
12. Install groundcover including temporary and permanent seeding of topsoil, compost, fertilizer, and mulch.

LOG VANE - PLAN VIEW



GENERAL NOTES:
1. LOG VANES WILL BE ANGLED @ 20-30° FROM STREAM BANK.
2. LOG VANES SHALL BE LARGE ENOUGH TO OCCUPY 2/3 OF THE POOL MAXIMUM DEPTH.
3. LOG VANE WILL BE SLOPED AT 2-7%.
4. SEED AND SOIL STABILIZATION MATTING WILL BE PLACED ALONG STREAMBANKS FOR STABILIZATION PURPOSES WHERE DISTURBANCE HAS OCCURRED AS ARESULT OF STRUCTURE INSTALLATION.
5. DESIGN ENGINEER SHALL CONSIDER IMPLEMENTATION OF OTHER STREAMBANK PROTECTION MEASURES IN CONJUNCTION WITH LOG VANE STRUCTURE.

LOG VANE - SECTION VIEW A-A



Philadelphia Water Department

LOG VANE

DRAWN BY:	R. WASIK	DATE:	9/8/15		
CHECKED BY:	A. BIRMINGHAM, PE	SHEET NO.	3 OF 3	PAGE NO.	45 OF 80

WAYPOINT LLC

PROJECT INFORMATION

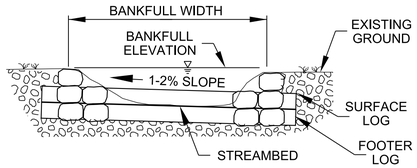
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PREPARED FOR: NASHVILLE DISTRICT CORPS OF ENGINEERS
PRINT DATE: 01/09/2026 USACE#: LRN-2025-01090
PROJECT# 2025-63 STATE A#: Pending
KDNR# 807-0501 CHECKED BY: MDB
DRAWN BY: JK

REVISION TABLE

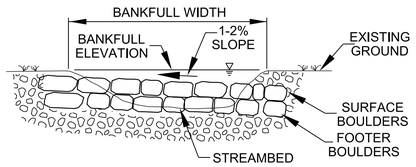
DATE	DESCRIPTION

DETAIL - Stream Structures

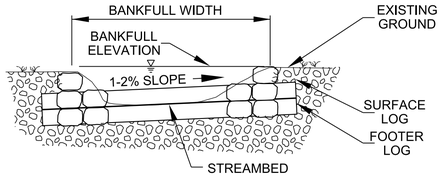
Nally & Hamilton Enterprises, Inc.



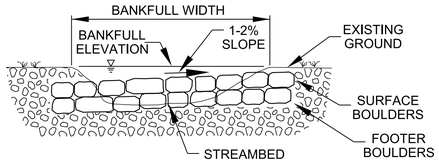
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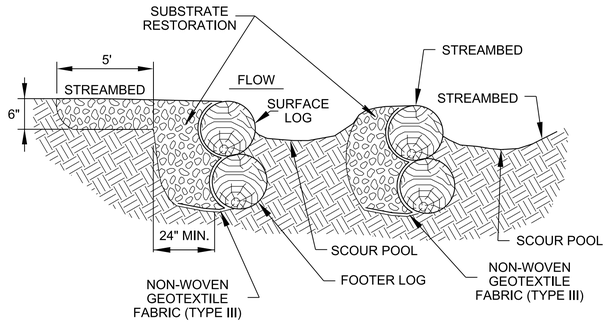
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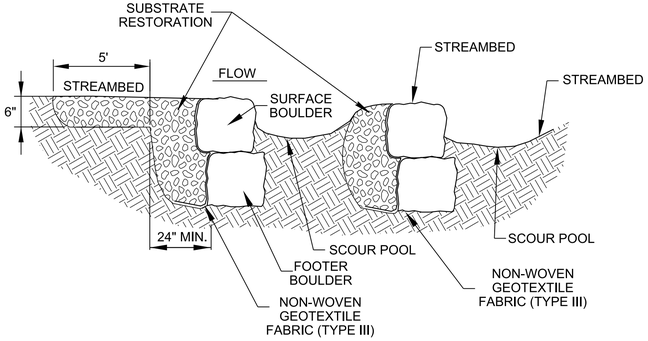
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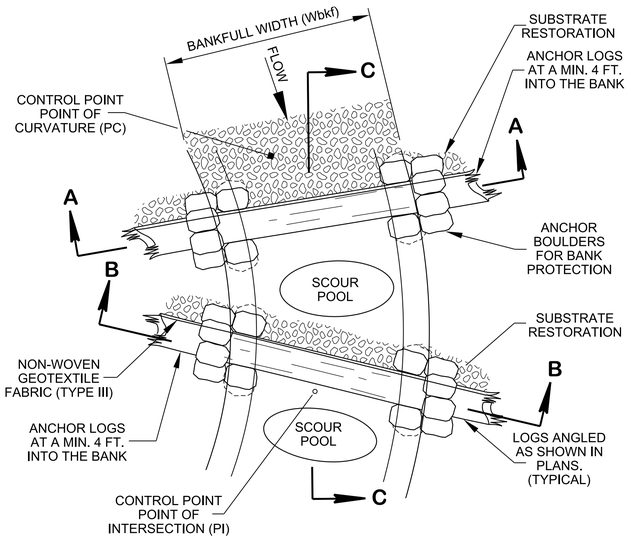
SECTION E-E



SECTION C-C

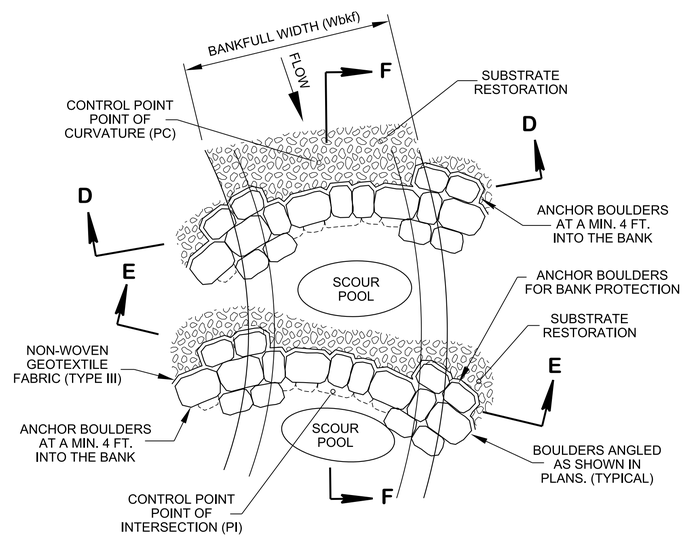


SECTION F-F



PLAN VIEW

LOG STEP POOL



PLAN VIEW

BOULDER STEP POOL

BOULDER SHOWN ARE A GRAPHICAL REPRESENTATION AND DOES NOT REPRESENT ACTUAL # OF BOULDERS TO BE USED.

NOT TO SCALE

LOG AND BOULDER STEP POOLS NOTES

(A) LOG AND BOULDER STEP POOLS ARE HYDRAULIC AND GRADE CONTROL MEASURES THAT ARE USED TO MAINTAIN GRADE, CONTROL FLOW VELOCITY, DISSIPATE ENERGY, AND DEVELOP RIFFLE-RUN-STEP POOL HABITAT IN STREAMS WITH SLOPES GREATER THAN 2%. THIS DETAIL CAN BE USED FOR CONSTRUCTING A SINGLE LOG OR BOULDER STEP POOL OR A SERIES OF MULTIPLE STEP POOLS.

(B) LOG AND BOULDER STEP POOL STRUCTURES AND ASSOCIATED POOL HABITAT ENHANCEMENTS AND BANK STABILIZATION MEASURES (ROOT WADS, BRUSH LAYERING, LIVE STAKING, ETC.) SHOULD BE PLACED AT THE STATIONS, OFFSETS, ELEVATIONS, AND GEOMORPHIC POSITIONS INDICATED ON THE STREAM MITIGATION DATA TABLE IN THE PROJECT PLANS, STREAM MITIGATION PLAN, OR AS DIRECTED BY THE ENGINEER. AT A MINIMUM, THE BANKFULL WIDTH, MINIMUM LOG AND BOULDER DIMENSIONS, INVERT ELEVATIONS, ESTIMATED SCOUR DEPTH AND SELECT MATERIAL CLASSIFICATION SHOULD BE PECIFIED IN THE STREAM MITIGATION DATA TABLE.

(C) REFER TO STANDARD DRAWING D-NSD-37 "SPECIAL NOTES FOR NATURAL STREAM DESIGN".

(D) LOGS SHALL BE RELATIVELY STRAIGHT, RECENTLY HARVESTED AND DECAY RESISTANT SPECIES SUCH AS CEDAR, WHITE OAK, ETC.

(E) BOULDERS PRESENT IN THE EXISTING STREAM MEETING THE SPECIFIED TYPE AND SIZE SHOULD BE USED IN THE RESTORED CHANNEL SEGMENT.

(F) LOCATE LOG OR BOULDER STEP STRUCTURES IN THE CHANNEL AT THE POINTS OF CURVATURE AND TANGENCY IN MEANDER BENDS, AND ALIGN THE STRUCTURE ALONG THE AXIS OF THE RADIUS.

(G) CONSTRUCT STEP STRUCTURES WITH A MAXIMUM DROP OF A HALF FOOT (SIX INCHES) AND A SLOPE BETWEEN ONE PERCENT (1%) AND FOUR PERCENT (4%).

(H) CONSTRUCT LOG OR BOULDER STEPS STRUCTURES BY:

(1) FIRST SHAPE THE CHANNEL AND FLOODPLAIN TO THE SPECIFIED GRADES AND DIMENSIONS.

(2) NEXT, EXCAVATE ENOUGH BED MATERIAL TO PLACE THE LOGS AND/OR BOULDERS, NON-WOVEN GEOTEXTILE FABRIC (TYPE III) AND ALLUVIUM OR SELECT MATERIAL BACKFILL.

(3) PLACE FOOTER LOG OR BOULDERS AND SURFACE BOULDERS AT THE CHANNEL INVERT, WITH THE SURFACE LOG OR BOULDERS SLIGHTLY UPSTREAM OF THE FOOTER LOG OR BOULDERS. SURFACE AND FOOTER LOGS SHOULD EXTEND A MINIMUM OF FOUR FEET INTO EACH BANK AND LOG STEPS SHOULD BE PINCHED OR ANCHORED INTO THE BANKS WITH BOULDERS.

(4) THE FOLLOWING GUIDELINES APPLY WHEN INSTALLING MULTIPLE STEP POOL STRUCTURES IN SEQUENCE:

(a) THE INVERT ELEVATION OF THE DOWNSTREAM STEP SHALL BE AT OR ABOVE THE TOP OF THE FOOTER FOR THE UPSTREAM STRUCTURE.

(b) ALTERNATE INVERTS OF THE STRUCTURES FROM SIDE TO SIDE IN THE CHANNEL TO CREATE A MEANDERING FLOW PATH ACROSS THE STRUCTURES.

(5) USE SURVEY EQUIPMENT TO CHECK THE ELEVATIONS OF THE INVERTS IN ACCORDANCE WITH THE STREAM MITIGATION PLANS.

(6) ONCE THE INVERTS HAVE BEEN ESTABLISHED, FILL THE VOIDS BETWEEN LOGS OR BOULDERS ON THE UPSTREAM SIDE OF THE STRUCTURE.

(7) PLACE NON-WOVEN GEOTEXTILE FABRIC (TYPE III) ALONG THE ENTIRE UPSTREAM FACE OF THE STRUCTURE, EXTENDING FROM THE BOTTOM OF THE FOOTER TO THE FINISHED GRADE ELEVATION. ONLY GEOTEXTILE FABRIC (TYPE III) LISTED ON THE QUALIFIED PRODUCTS LIST SHALL BE USED. FOR LOGS, NAIL GEOTEXTILE FABRIC (TYPE III) TO THE SURFACE LOG APPROXIMATELY ONE QUARTER OF THE CIRCUMFERENCE DOWN FROM THE TOP OF THE SURFACE LOG USING TWO-INCH GALVANIZED ROOFING NAILS ON ONE-FOOT SPACING ALONG THE ENTIRE LENGTH OF THE LOG.

(8) BACKFILL STRUCTURE AND NON-WOVEN GEOTEXTILE FABRIC (TYPE III) WITH EXCAVATED ON-SITE STREAM ALLUVIUM (IF AVAILABLE), OTHERWISE USE THE SPECIFIED SELECT MATERIAL. SOIL SHALL BE COMPACTED WELL AROUND BURIED PORTIONS OF THE STRUCTURE. TRIM ANY EXPOSED NON-WOVEN GEOTEXTILE FABRIC (TYPE III).

(9) ONCE THE STRUCTURE IS INSTALLED, EXCAVATE THE DOWNSTREAM SCOUR POOL AND PLACE SELECT MATERIAL AS REQUIRED.

(10) RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

(I) A MIXTURE OF SELECT MATERIALS, AS SPECIFIED ON THE STREAM MITIGATION PLAN SHEETS, SHOULD BE USED FOR SUBSTRATE RESTORATION IN RIFFLE AND RUN HABITATS AND TO FILL GAPS IN THE VANE BOULDERS. COARSE ALLUVIUM EXCAVATED FROM THE EXISTING STREAM BED, WHICH MEETS THE SPECIFIED SIZE CLASSIFICATION, IS THE PREFERRED MATERIAL TO USE FOR SUBSTRATE RESTORATION. REFER TO D-NSD-30 AND D-NSD-37 FOR ADDITIONAL SUBSTRATE RESTORATION INFORMATION.

(J) THE SURFACE OF LOG AND BOULDER STEP POOL SHALL BE FINISHED TO A NEAT AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES AND CROSS SECTIONS OR ELEVATIONS SHOWN ON THE PLANS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.10 FOOT OF THE GRADES AND ELEVATIONS INDICATED, OR AS DIRECTED BY THE ENGINEER. ALL GAPS OR VOIDS SHALL BE PLUGGED WITH SELECT MATERIAL TO FORM A TIGHT-FITTING SEAL.

(K) ALL MATERIALS ARE TO BE APPROVED BY ENGINEER OR ENGINEER'S ON-SITE CONSTRUCTION OBSERVER.

(L) PAYMENT FOR THE LOG AND BOULDER STEP POOLS SYSTEM SHALL INCLUDE ALL MATERIALS, EQUIPMENT, AND LABOR FOR CONSTRUCTION, ANS SHALL BE PAID FOR UNDER THE FOLLOWING ITEM NUMBER:

209-03.36, STREAM MITIGATION - STEP POOL, EACH

STREAM MITIGATION PLAN LEGEND:  **LOG STEP POOLS,**  **BOULDER STEP POOLS**

REV. 9-15-17: MODIFIED THE STREAM MITIGATION PLAN LEGEND SYMBOLS.

REV. 05-01-20: REDREW SHEET.

REV. 11-30-20: REVISED NON-WOVEN GEOTEXTILE FABRIC NOTE ON PLANS AND SECTIONS.

MATERIAL SHOWN ARE ONLY A GRAPHICAL REPRESENTATION AND DO NOT DEPICT THE ACTUAL DEPTH OR QUANTITY OF MATERIALS TO APPROPRIATELY CONSTRUCT OR STABILIZE THE CHANNEL.

STATE OF TENNESSEE
STANDARD DRAWING
DEPARTMENT OF TRANSPORTATION

LOG AND BOULDER STEP POOLS

11-01-2016 | D-NSD-27

P:\StandDraw\DESIGN STANDARDS\Standards Drawings Library\Standard Roadway Drawings - CURRENT\In Progress\10-103.00 Natural Stream Design IP\DNSD27-20200501.dgn
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Appendix E
Proposed Design Drawings

Part 3: Riparian Species List

Suggested Riparian Species List

The species on list are only suggestions. Native species that are appropriate for a given site may be proposed.

Tree Species

Pin Oak	*Quercus palustris*
Cherrybark Oak	*Quercus pagoda*
Bur Oak	*Quercus macrocarpa*
Swamp Chestnut Oak	*Quercus michauxii*
Shingle Oak	*Quercus imbricaria*
Northern Red Oak	*Quercus rubra*
Post Oak	*Quercus stellata*
Red Maple	*Acer rubrum*
Green Ash	*Fraxinus pennsylvanica*
Shellbark Hickory	*Carya laciniosa*
Blackgum	*Nyssa sylvatica*
American Elm	*Ulmus americana*
Eastern Cottonwood	*Populus deltoides*
Black Walnut	*Juglans nigra*
River Birch	*Betula nigra*
Yellow Poplar	*Liriodendron tulipifera*
Persimmon	*Diospyrus virginiana*
Black Walnut	*Juglans nigra*
Ohio Buckeye	*Aesculus glabra*
Sugar Maple	*Acer saccharum*
Sycamore	*Plantanus occidentalis*
Persimmon	*Diospyros virginiana*

Shrubs

Arrow-wood	*Viburnum dentatum*
American Plum	*Prunus americana*
Deciduous Holly	*Ilex decidua*
Gray Dogwood	*Cornus racemosa*
Silky Dogwood	*Cornus amomun*
Spicebush	*Lindera benzoin*
Sassafrass	*Sassafras albinum*
American Elder	*Sambucus canadensis*
Button Bush	*Cephalanthus occidentalis*
River Cane	*Arundinaria gigantea*
Coralberry	*Symphoricarpos orbiculatus*

Herbaceous Species

Rice cutgrass	*Leersia oryzoides*
Managrass	*Glyceria striata*
Spangle grass	*Chasmanthium latifolium*
Switchgrass	*Panicum virgatum*
Annual rye	*Secale cereale*
Wild rye	*Elymus virginicus*
Deertongue grass	*Panicum clandestinum*
Panic grass	*Panicum microcarpon*
Giant Cane Bambo	*Arundinaria gigantea*
Boneset	*Eupatorium perfoliatium*
Big Bluestem	*Andropogon gerardii*
Prairie cordgrass	*Spartina pextinata*

Water Plantain	*Alisima subcordatum*
Common Milkweed	*Asclepias syracia*
Beggar's Ticks	*Biden polyeps*
Canada Brome	*Bromus pubescens*
American Bellflower	*Campanula americana*
Frank's Sedge	*Carex frankii*
Sedge	*Carex granularis*
Shallow Sedge	*Carex lurida*
Hop Sedge	*Carex lupulina*
River Oats	*Chasmanthium latifolium*
Riverbank Wild rye	*Elymus riparius*
Downy Wild rye	*Elymus villosus*
Joe-pie Weed	*Eupatorium maculatum*
Fowl Manna Grass	*Glyceria striata*
Rush	*Juncus sp.*
Western Panic grass	*Panicum acuminatum*
Switchgrass	*Panicum virginica*
Foxglove Beardtongue	*Penstemon digitalis*
Leafcup	*Polymnia canadensis*
Brown-eyed Susan	*Rudbeckia triloba*
Dark Green Bulrush	*Scirpus cyprinus*
Yellow Wingstem	*Verbesina alternafolia*
White Wingstem	*Verbesina virginica*

Appendix F
Performance Standards

Stream Geomorphological, Hydrological, Habitat Performance Standards		
Performance Category and Criteria	**As-Built**	**Year 1-5 Monitoring**
Geomorphological		
Geometry	Within target range	<20% change from as-built
Vertical Stability	Report	BEHI Score of Low or Very Low
OHWM (RGL 05-05)	N/A	Present and continuous
Bed and Banks	Present	
Bankfull Events	2 within 5 years (intermittent streams)	
Hydrological		
Stream Flow Type	JD	Consistent with JD or increase
Habitat		
HGM	Report	Meet or exceed baseline by Year 5

Stream Vegetation Performance Standards and Success Criteria	
Planting Rate (Trees)	Minimum 300 native tree stems/acre – 80% survival
Planting Rate (Shrubs)	Minimum 100 native shrub stems/acre – 80% survival
Invasive/Exotic Species	≤ 5% invasive/exotic species present

Appendix G
Agency Correspondence

Part 1: Kentucky Division of Mine Permits (KDMP)

Andy Beshear
GOVERNOR

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR NATURAL RESOURCES
300 Sower Boulevard
Frankfort, Kentucky 40601
Phone: (502) 564- 6940

Rebecca Goodman
SECRETARY

Gordon R. Slone
COMMISSIONER

October 11, 2023

JAY MILLER
NALLY & HAMILTON ENTERPRISES, INC
195 COMMERCIAL DR STE 105
LONDON KY 40744

RE: Nally & Hamilton Enterprises, Inc
Application # 807-0501 NW

Dear Mr. Miller:

The Division of Mine Permits has conducted the critical resources review of the above referenced application. Attached are the Division's findings, listed by application item, describing the issues that must be addressed. The findings for each application item are summarized below.

11.1 Areas Designated Unsuitable for Mining: None identified
11.6 Intermittent or Perennial Stream Disturbance: Stream restoration plan not required
12.3 General Description of Mining and Reclamation Operations: BMPs recommended
13.1 Cultural or Historic Resources: Archaeological survey not required
14.1 Fish and Wildlife Information: T/E species identified - Indiana bat, northern long-eared bat
14.3 Fish and Wildlife Survey: Required - Bat PEP
21.11 Fish and Wildlife Enhancement Plan: Required

These attachments and supporting documentation may be incorporated into the appropriate sections of the comprehensive application.

Significant changes from the preliminary application or to the mine plan may require additional environmental review.

If you have any questions concerning this matter, please contact me at (502) 782-6549.

Sincerely,

Thomas Barbour
Environmental Scientist Consultant
Division of Mine Permits

Enclosure to Applicant
c: Thomas Barbour (e)
Permit File – w/enclosure Richard Daye (e)

Nally & Hamilton Enterprises, Inc
Application No. 807-0501 NW
October 11, 2023

Application Item 11.1: Lands Unsuitable for Mining

1. As of this date, there are no lands in the proposed permit area designated unsuitable for surface coal mining or under study for such designation, as provided in 405 KAR Chapter 24.

2. The proposed permit area does not fall within an area with special conditions as a result of a lands unsuitable study.

3. The proposed permit area is not located within a U.S. Army Corps of Engineers project area.

4. Based on information available to the Department, there are no federal lands within or adjacent to the proposed permit area.

5. Please be advised that mining operations seeking new or modified coverage under the Coal KPDES General Permit must submit a Notice of Intent (NOI-CM) to the Division of Water. Please file the NOI-CM with the Division of Water as soon as possible in order to avoid potential delays in the processing and issuance of your SMCRA/DNR permit.

6. The proposed permit area may include an in-stream discharge and may require a Section 401 WQC from the Commonwealth of Kentucky, and a 404 Permit from the U.S. Army Corp of Engineers. Applications should be submitted as soon as possible to DNR in order to expedite review.

Nally & Hamilton Enterprises, Inc
Application No. 807-0501 NW
October 11, 2023

Application Item 11.6: Intermittent and/or Perennial Stream Disturbance

The Critical Resource Review Section has determined that the proposed mining activity will not impact any intermittent or perennial streams. Therefore, no stream restoration plan is required for this application. Should additional activities be proposed during the review process, a new review of the application by CRRS is required, and this determination may change based on alterations to the proposed mining plan.

Nally & Hamilton Enterprises, Inc
Application No. 807-0501 NW
October 11, 2023

Application Item 12.3: General Description of Mining and Reclamation Operations

The proposed permit may result in impacts on aquatic resources. The Division recommends the use of Best Management Practices (BMPs) to aid in sediment control. BMPs may include, but are not limited to, any of the following, singly or in combination:

Basins
Diversion ditches
Filter strips
Land grading and reshaping
Maintenance of a 100' buffer zone along streams
Minimization of surface disturbance
Mulching
Placement of rip-rap
Rapid revegetation, especially along stream banks
Rock check dams
Silt fences
Straw bale barriers
Stream bank stabilization
Sumps
Work in periods of no or low flow or dry weather

The narrative description of mining operations (Attachment 12.2.A) provided in the comprehensive application should specify what BMPs will be implemented.

Nally & Hamilton Enterprises, Inc
Application No. 807-0501 NW
October 11, 2023

Application Item 13.1: Cultural or Historic Resources

After completing the environmental review for the above referenced permit application, the Critical Resources Review Section has determined that an archaeological survey will not be required for the reason stated below:

The proposed permit consists of areas that have been prior permitted and/or surveyed. Also, the permit is mostly pre-law disturbance, existing facilities, or other disturbances. Very little of the permit is undisturbed.

Nally & Hamilton Enterprises, Inc
Application No. 807-0501 NW
October 11, 2023

Application Item 14.1: Fish and Wildlife Information

The Division's review of the Kentucky State Nature Preserves Commission's Natural Heritage Database and information provided by the US Fish & Wildlife Service indicates that occurrences of state/federally designated threatened or endangered species **have been recorded** within or adjacent to the proposed permit area, OR that potential habitat suitable for a federally designated species is present within the proposed permit area. Please refer to Attachment 14.3 for information on any site-specific resource information that is required in the permit application to satisfy 405 KAR 8:030/040, Section 20. For additional assistance, please contact:

United States Fish & Wildlife Service
Kentucky Ecological Services Field Office
330 West Broadway, Room 266
Frankfort, KY 40601
(502) 695-0468

Federally listed species:

Indiana bat	*Myotis sodalis*
Northern long-eared bat	*Myotis septentrionalis*

Nally & Hamilton Enterprises, Inc
Application No. 807-0501 NW
October 11, 2023

Application Item 14.3: Fish and Wildlife Survey

Based upon the Division's environmental review, it has been determined that the proposed operation has the potential to impact the Indiana bat, *Myotis sodalis*, and the northern long-eared bat, *Myotis septentrionalis*, both federally listed species. The proposed permit area has suitable habitat for these species, and data provided by the Kentucky State Nature Preserves Commission and the US Fish and Wildlife Service show that the proposed permit area is within known Indiana bat or northern long-eared bat habitat. Therefore, in accordance with 405 KAR 8:030/040, Section 20(2)(a-c), a **protection and enhancement plan (PEP)** for these species is required**.** This plan should follow the strategies outlined in the September 2009 *Range-Wide Indiana Bat Protection and Enhancement Plan Guidelines.* Surveying of the proposed permit area for presence/absence is NOT and option.

The applicant must incorporate the protection & enhancement plan in the comprehensive application as an attachment to Item 14.4.

Nally & Hamilton Enterprises, Inc
Application No. 807-0501 NW
October 11, 2023

Application Item 21.11: Fish and Wildlife Enhancement Plan

Based on the Division's environmental review, it has been determined that the application **will** require a fish and wildlife enhancement plan, as specified in 405 KAR 8:030/040, Section 36(1). This plan must be submitted as an attachment to application Item 21.11.

Note: The Indiana Bat Protection & Enhancement Plan (PEP) referenced in Application Item 14.3 is a species specific Fish & Wildlife Enhancement Plan that satisfies this requirement.

Appendix G
Agency Correspondence

Part 2: United States Fish and Wildlife Service (USFWS)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Kentucky Ecological Services Field Office
J C Watts Federal Building, Room 265
330 West Broadway
Frankfort, KY 40601-8670
Phone: (502) 695-0467 Fax: (502) 695-1024
Email Address: kentuckyes@fws.gov

In Reply Refer To: 11/01/2024 13:19:11 UTC
Project Code: 2025-0014158
Project Name: 807-0501 NW

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the

human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see https://www.fws.gov/program/migratory-bird-permit/what-we-do..

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of

this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

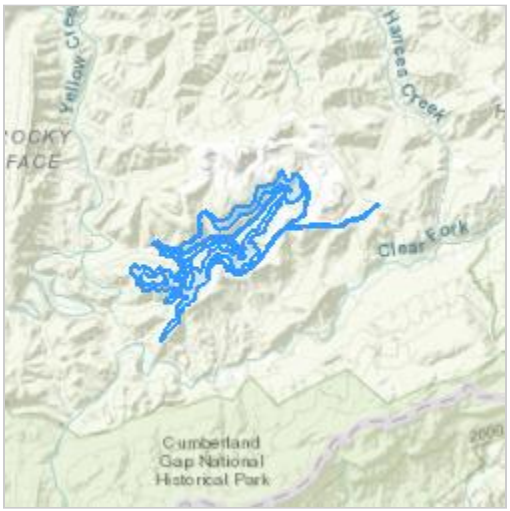
This species list is provided by:

Kentucky Ecological Services Field Office
J C Watts Federal Building, Room 265
330 West Broadway
Frankfort, KY 40601-8670
(502) 695-0467

PROJECT SUMMARY

Project Code: 2025-0014158
Project Name: 807-0501 NW
Project Type: Surface Extraction - Coal
Project Description: New mine project for NHE Inc.
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@36.6646583,-83.64634275109125,14z



Counties: Bell County, Kentucky

ENDANGERED SPECIES ACT SPECIES

There is a total of 7 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 2 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

MAMMALS

NAME	STATUS
Gray Bat *Myotis grisescens* No critical habitat has been designated for this species. This species only needs to be considered under the following conditions: ▪ The project area includes potential gray bat habitat. Species profile: https://ecos.fws.gov/ecp/species/6329 General project design guidelines: https://ipac.ecosphere.fws.gov/project/4JIEWDQQYVGYTCYJ5FQ77KLRVI/documents/generated/6422.pdf	Endangered
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. This species only needs to be considered under the following conditions: ▪ The project area includes known 'swarming 1' habitat. ▪ The project area includes known 'swarming 2' habitat. ▪ The project area includes known 'summer 1 (outer-tier)' habitat. Species profile: https://ecos.fws.gov/ecp/species/5949 General project design guidelines: https://ipac.ecosphere.fws.gov/project/4JIEWDQQYVGYTCYJ5FQ77KLRVI/documents/generated/6422.pdf	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045 General project design guidelines: https://ipac.ecosphere.fws.gov/project/4JIEWDQQYVGYTCYJ5FQ77KLRVI/documents/generated/6422.pdf	Endangered
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

BIRDS

NAME	STATUS
Whooping Crane *Grus americana* Population: U.S.A. (AL, AR, CO, FL, GA, ID, IL, IN, IA, KY, LA, MI, MN, MS, MO, NC, NM, OH, SC, TN, UT, VA, WI, WV, western half of WY) No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/758	Experimental Population, Non-Essential

FISHES

NAME	STATUS
Blackside Dace *Phoxinus cumberlandensis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4775 General project design guidelines:	Threatened

NAME	STATUS

https://ipac.ecosphere.fws.gov/project/4JIEWDQQYVGYTCYJ5FQ77KLRVI/documents/generated/5224.pdf

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus*	Candidate

No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/9743

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency:	Kentucky Division of Mining
Name:	Thomas Barbour
Address:	Division of Mine Permits
Address Line 2:	300 Sower Blvd
City:	Frankfort
State:	KY
Zip:	40601
Email	thomas.barbour@ky.gov
Phone:	5027826549

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Kentucky Ecological Services Field Office
330 West Broadway, Suite 265
Frankfort, Kentucky 40601
(502) 695-0468

December 19, 2024

Thomas Barbour
Department of Natural Resources
300 Sower Boulevard
Frankfort, KY 40601

Subject: FWS #2025-0028533; DNR #807-0501, Nally & Hamilton Enterprises, Inc, Bell County, Kentucky

Dear Mr. Barbour:

The U.S. Fish and Wildlife Service's (Service) Kentucky Field Office (KFO) has reviewed the request for concurrence for the above-referenced project received by our office on December 10, 2024. The KFO offers the following comments in accordance with the Endangered Species Act (ESA) of 1973 (87 Stat.884, as amended; 16 U.S.C. 1531 et seq.) and to ensure that the proposed action is consistent with the terms and conditions of the incidental take statement and Appendix A provided in the 2020 Biological Opinion on the Surface Mining Control and Reclamation Act (SMCRA) Regulatory Program (2020 BO).

Project Description
The Kentucky Department of Natural Resources' Division of Mine Permits (DMP) is reviewing an application from Nally & Hamilton Enterprises, Inc (#807-0501), for a proposed contour coal mine in the Cranes Creek and Clear Creek watersheds, Bell County, Kentucky. The proposed permit area encompasses 372.7 total acres, including 95.3 acres of existing roads and 277.4 acres of forest. There will be impacts to streams in the area; however, all water from the permitted area must go through sediment control structures that have been designed to meet discharge requirements set by the Kentucky Pollution Discharge Elimination System to minimize water quality impacts. Previous disturbances in both watersheds include residences, logging operations, gas wells and lines, surface and underground mining, and associated roads. The project site contains forested habitat that will be removed by this project.

Federally Listed and Proposed Species
The Kentucky Division of Mine Permits (DMP) obtained an official species list from the Information for Planning and Consultation (IPaC) website and determined that the project has the potential to affect the gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), northern

long-eared bat (*Myotis septentrionalis*), blackside dace (*Phoxinus cumberlandensis*), and the proposed tricolored bat (*Perimyotis subflavus*).

Indiana bat, Northern Long-eared Bat, Tricolored Bat

The DMP determined this project is likely to adversely affect the Indiana bat, northern long-eared bat, and the proposed tricolored bat; however, an approved Protection and Enhancement Plan (PEP) is in place for this project and addresses these species. The Service proposed listing the tricolored bat as endangered under the ESA on September 13, 2022. While not currently a listed species under the ESA, the tricolored bat was included in the PEP for this project as a proactive conservation measure and because individuals of this species could be adversely affected by the project. The KFO believes that the measures proposed in the PEP for the tricolored bat, which are closely aligned with the PEP guidelines for the Indiana bat, will minimize effects on the tricolored bat if the species is listed prior to completion of the mining action. Because the tricolored bat is a proposed species for listing, the DMP determined that the project would not result in jeopardy of the tricolored bat and provided a rationale for its no jeopardy determination. We concur with DMP's no jeopardy determination for the tricolored bat and agree that DMP's rationale for the no jeopardy determination supports the determination.

Gray Bat

DMP evaluated potential effects on the gray bat from the proposed project and made a "may affect" determination for this species utilizing the Kentucky Statewide Determination Key on the Service's Information for Planning and Consultation (IPaC) website. No open mine portals, rock shelters, karst features, suitable sinkholes, or caves that could serve as hibernacula or roosting habitat for this species were identified at the project site. Additionally, the KFO does not have any records of known gray bat hibernacula or roosting habitat within the project site. As a result, no effects to hibernating or roosting gray bats or their hibernacula or non-forested roosting habitat are anticipated from the proposed project.

The forested habitat was identified as suitable commuting habitat for this species, and the proposed project would require removal of 277.4 acres of this habitat. However, because the gray bat is a cave dwelling species that forages and commutes over long linear distances and sufficient foraging and commuting habitat is available outside the project site, the removal of this habitat would not result in significant adverse effects on the gray bat. There will be impacts to streams in the area; however, all water from the permitted area must go through best management practices (BMPs), such as diversion ditches and sediment control structures that have been designed to meet discharge requirements set by the Kentucky Pollution Discharge Elimination System to minimize water quality impacts. As a result, the DMP made a "may affect, not likely to adversely affect" effects determination for the gray bat. Based on the insignificant effects to the species from commuting habitat impacts and the implementation of BMPs to protect water quality important for foraging, we concur with your determination that the proposed project "may affect, not likely to adversely affect" the gray bat.

Blackside Dace

DMP evaluated potential effects on the blackside dace from the proposed project and made a "may affect" determination for this species utilizing the Kentucky Statewide Determination Key on the Service's IPaC website. There will be impacts to streams in the area; however, all water

from the permitted area must go through sediment control structures that have been designed to meet discharge requirements set by the Kentucky Pollution Discharge Elimination System to minimize water quality impacts. Additionally, the KFO does not have any records of the blackside dace within or near the project site. As a result, the DMP made a "may affect, not likely to adversely affect" effects determination for the blackside dace. Based on no occurrence of the species within the project site and the implementation of BMPs to protect on-site and downstream water quality, we concur with your determination that the proposed project "may affect, not likely to adversely affect" the blackside dace.

Summary

The KFO concurs that the proposed action "may affect, not likely to adversely affect" the gray bat and blackside dace. The KFO finds the PEP to be acceptable for the Indiana bat, northern long-eared bat, and tricolored bat with no needed revisions. DMP will need to quantify the incidental take of the Indiana bat and northern long-eared bat by the extent of habitat likely to be destroyed or disturbed. This incidental take should be tracked on a permit-by-permit basis and reported to the KFO in an annual report by January 31, 2025, per the Guidelines. Monitoring of take of the tricolored bat would not be necessary until it is listed. In view of these findings, we believe that the Section 7 requirements of the Endangered Species Act are fulfilled. The DMP should reconsider their Section 7 obligation if: (1) new information reveals that the proposed project may affect listed species in a manner or to an extent not previously considered; (2) the proposed project is subsequently modified to include activities which were not considered during this consultation; (3) new species are listed or critical habitat designated; or (4) changes to the post-mine land use, as described in the PEP, occur that alter the amount of impacted acres that are reforested.

We appreciate the opportunity to review the project. If you have any questions, please contact Kyle Sams of my staff at stephen_sams@fws.gov.

Sincerely,

JOSHUA LILLPOP

Digitally signed by JOSHUA LILLPOP
Date: 2024.12.19 14:38:47 -05'00'

for Virgil Lee Andrews, Jr.
Field Supervisor

Barbour, Thomas T (EEC)

From: Floyd, Mike <mike_floyd@fws.gov>
Sent: Friday, February 9, 2024 3:01 PM
To: Barbour, Thomas T (EEC)
Cc: Sewell, Brent J CIV USARMY CELRN (USA); Van Horne, Amy (EEC); Miller, Corey T.; Moran, Matthew T
Subject: DNR Permit #807-0501 Bat PEP
Attachments: 20240125_Ltr_807-0501_Bat PEP_KFO to DNR_concur.pdf

****CAUTION** PDF attachments may contain links to malicious sites. Please contact the COT Service Desk ServiceCorrespondence@ky.gov for any assistance.**

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Report Suspicious

FWS #2024-0031915
DNR #807-0501

Tom – attached is our Bat PEP concurrence letter for the permit referenced above. Please let me know if you have any questions.

Michael

Michael A. Floyd, PhD
Fish and Wildlife Biologist
KY Ecological Services Field Office
US Fish & Wildlife Service
Frankfort, KY 40601
(502) 229-5433 (m)
mike_floyd@fws.gov

Andy Beshear
GOVERNOR

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR NATURAL RESOURCES
300 Sower Boulevard
Frankfort, Kentucky 40601
Phone: (502) 564- 6940

Rebecca Goodman
SECRETARY

Gordon R. Slone
COMMISSIONER

January 2, 2024

Michael Floyd
United States Fish & Wildlife Service
Kentucky Ecological Services Field Office
330 West Broadway, Room 266
Frankfort, KY 40601

RE: Nally & Hamilton Enterprises Inc
Application # 807-0501 NW

Dear Mr. Floyd:

The Division of Mine Permits received a Bat Protection & Enhancement Plan (PEP) for this application. Please review this information, and **provide your written recommendation, comments, questions, or approvals concerning this matter to me via email within thirty (30) calendar days**.

Let me know if you need any additional information. If you have any questions, please contact me (502) 782-6549.

Sincerely,

Thomas Barbour
Environmental Scientist Consultant
Division of Mine Permits

c: Permit File (e)

Appendix G
Agency Correspondence

Part 3: Kentucky Division of Water (KDOW)

Andy Beshear
GOVERNOR

ENERGY AND ENVIRONMENT CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
300 Sower Boulevard
Frankfort, Kentucky 40601
Phone: (502) 564-2150
Fax: 502-564-4245

Rebecca W. Goodman
SECRETARY

Anthony R. Hatton
COMMISSIONER

October 3, 2025

Stephen Hamilton
Nally & Hamilton Enterprises, Inc.
P.O. Box 157
Bardstown, Kentucky 40004

Re: Coal General Permit Coverage
AI No.: 164460
KPDES No.: KYGE41104
DNR No.: 807-0428
807-0467
807-0501
Bell County, Kentucky

Dear Stephen Hamilton:

Effective on the first of the month following the date of this letter, the Kentucky Division of Water (DOW) has determined to grant coverage under the "General Permit for Coal Mining Activities in the Commonwealth of Kentucky" (KYGE40000) for the following DNR actions:

TABLE 1– KPDES APPROVALS		
DNR Permit No.	**Action No.**	**Approval Date**
807-0428	NW thru MI-01	October 3, 2025
807-0467	NW thru MI-04	
807-0501	NW	

Discharges from sediment control structures associated with these actions are subject to the requirements and conditions of KYGE40000 (KYGE4) until both final bond release and termination of coverage. A copy of KYGE4 and its accompanying Fact Sheet are available on the DOW web address:
https://eec.ky.gov/Environmental-Protection/Water/PermitCert/KPDES/Documents/KYG04PermitPage.pdf

The following additional conditions apply to the referenced permitted activity:

- Only those outfalls (ponds) listed in Table 2 of this letter are authorized to discharge. Please contact the DOW within thirty (30) days regarding any omissions or errors to Table 2.
- **Sampling for the in-stream monitoring requirements of Section V of the permit, shall be conducted at the locations listed in Table 3. Please contact the DOW within thirty (30) days regarding any omissions or errors regarding Table 3.**
- Discharges of runoff from a coal haul road shall be managed using Best Management Practices (BMPs).

The permittee shall select, install, operate and maintain those BMPs that are necessary to minimize the discharge of pollutants from haul roads.

- Discharges of runoff from the repair of slides associated with DNR enforcement actions shall be addressed in a specific section of the BMP plan for that mine.
- The permittee shall install, operate, and maintain wastewater treatment facilities consistent with those identified in the permittee's Socioeconomic Demonstration and Alternatives Analysis (SDAA) form as accepted by the DOW as a part of this KPDES general permit coverage.
- **With this application, an estimated or justified off-site sample was submitted in place of an on-site discharge for RPA purposes. Therefore within two (2) years of commencing discharge, the permittee shall submit to DOW actual discharge data for the pollutants required by the eNOI. To fulfill this requirement, this discharge sample must be from an outfall that is receiving Active drainage.**
- **This KYGE4 coverage was previously issued with the requirement to submit a full RPA sample within 2 years of commencing discharge. As some of this site is entering into reclamation status, you are reminded to submit a full RPA sample of Active drainage.**

Failure to comply with these conditions may result in the termination of this general permit coverage. A copy of this coverage letter and the associated BMP plan shall be kept on-site.

Electronic submission of DMRs using NetDMR is required beginning with the effective date of this permit. NetDMR Instructions are available at: https://eec.ky.gov/Environmental-Protection/Water/SubmitReport/Pages/NetDMR.aspx. This site has step by step instructions for NetDMR Production.

Any person aggrieved by the issuance of a permit final decision may demand a hearing pursuant to KRS 224.10-420(2) within thirty (30) days from the date of the issuance of this letter. Any demand for a hearing on the permit shall be filed in accordance with the procedures specified in KRS 224.10-420, 224.10-440, 224.10-470, and the regulations promulgated thereto. The request for hearing should be submitted in writing to the Energy and Environment Cabinet, Office of Administrative Hearings, 211 Sower Boulevard, Frankfort, Kentucky 40601 and the Commonwealth of Kentucky, Energy and Environment Cabinet, Division of Water, 300 Sower Boulevard, Frankfort, Kentucky 40601. For your record keeping purposes, it is recommended that these requests be sent by certified mail. The written request must conform to the appropriate statutes referenced above.

If in the future you wish to amend this KPDES permit coverage, you can recall this action by using the following Submittal ID to generate a template: **521595**. The eForm eNOI-KYG04 is available at: https://eec.ky.gov/Environmental-Protection/Water/PermitCert/KPDES/Documents/KYG04PermitPage.pdf.

Should you have any questions regarding this matter, please contact Paul Tangel at (502) 782-1677, or by e-mail at paul.tangel@ky.gov.

Sincerely,

Paul Tangel, Permit Writer
Surface Water Permits Branch
Division of Water

Cc: Jodi Joseph, Nally & Hamilton Enterprises, Inc.
Kristin Gale, Division of Mine Reclamation and Enforcement
Division of Mine Reclamation and Enforcement
Tempo

Effective on the first of the month following the date of this letter and lasting through expiration of the "General Permit for Coal Mining Activities in the Commonwealth of Kentucky" (KYGE40000), final bond release, or termination of coverage, the following outfalls are authorized to discharge.

TABLE 2 - OUTFALLS									
KPDES Outfall No.	DNR Permit No. - Pond No.	Latitude	Longitude	Receiving Water Name	Type of Outfall	Status of Outfall	Type of Drainage Received	Effluent Limitations Table	CRO
001	807-0467-1	36.6719	-83.5937	UT into Hances Creek	N	E	SSMR	Table 3	No
002	807-0467-2	36.675680	-83.593470	UT into Hances Creek	N	E	SSMR	Table 3	No
003	807-0467-3	36.6790	-83.594860	UT into Hances Creek	N	E	SSMR	Table 3	No
004	807-0467-4	36.681050	-83.598290	UT into Hances Creek	N	E	SSMR	Table 3	No
005	807-0467-5	36.683090	-83.598050	UT into Hances Creek	N	E	SSMR	Table 3	No
006	807-0467-6	36.684840	-83.5983	UT into Hances Creek	N	E	SSMR	Table 3	No
007	807-0467-7	36.683430	-83.600460	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
008	807-0467-8	36.680510	-83.601850	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
009	807-0467-9	36.677880	-83.602680	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
010	807-0467-10	36.677370	-83.605120	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
011	807-0467-11	36.678860	-83.608460	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
012	807-0467-12	36.681660	-83.610820	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
013	807-0467-13	36.683480	-83.610630	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
014	807-0467-14	36.687710	-83.612360	UT into Hances Creek	N	E	SSMR	Table 3	No
015	807-0467-15	36.6894	-83.613810	UT into Hances Creek	N	E	SSMR	Table 3	No
016	807-0467-16	36.693570	-83.614590	UT into Hances Creek	N	E	SSMR	Table 3	No
017	807-0467-17	36.696880	-83.615310	UT into Hances Creek	N	E	SSMR	Table 3	No
018	807-0467-18	36.694520	-83.617620	UT into Williams Branch	N	EXP	SSMR	Table 3	No
019	807-0467-19	36.691880	-83.618720	UT into Williams Branch	N	E	SSMR	Table 3	No
020	807-0467-20	36.689930	-83.619840	UT into Williams Branch	N	E	SSMR	Table 3	No
021	807-0467-21	36.690340	-83.6241	UT into Williams Branch	N	E	SSMR	Table 3	No
022	807-0467-22	36.694030	-83.630230	UT into Right Fork Williams Branch	N	E	SSMR	Table 3	No

023	807-0467-23	36.690730	-83.627590	UT into Right Fork Williams Branch	N	E	SSMR	Table 3	No
024	807-0467-24	36.687560	-83.6289	UT into Right Fork Williams Branch	N	E	SSMR	Table 3	No
025	807-0467-25	36.685980	-83.631950	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
026	807-0467-26	36.688190	-83.634620	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
027	807-0467-27	36.688580	-83.6379	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
028	807-0467-28	36.686750	-83.638630	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
029	807-0467-29	36.685570	-83.639140	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
030	807-0467-30	36.686430	-83.642290	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
031	807-0467-31	36.688360	-83.644970	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
032	807-0467-32	36.690880	-83.645560	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
033	807-0467-33	36.694020	-83.644460	UT into Right Fork Williams Branch	N	E	RA	Table 4	No
034	807-0467-34	36.694220	-83.646720	UT into Yellow Creek	N	E	RA	Table 4	No
035	807-0467-35	36.691330	-83.650960	UT into Yellow Creek	N	E	RA	Table 4	No
036	807-0467-36	36.694170	-83.650210	UT into Yellow Creek	N	E	RA	Table 4	No
037	807-0467-37	36.6953	-83.6523	UT into Yellow Creek	N	E	RA	Table 4	No
038	807-0467-38	36.693290	-83.655010	UT into Yellow Creek	N	E	RA	Table 4	No
039	807-0467-39	36.692030	-83.656440	UT into Stillhouse Branch	N	E	RA	Table 4	No
040	807-0467-40	36.696670	-83.6422	UT into Right Fork Williams Branch	N	E	SSMR	Table 3	No
041	807-0467-41	36.696390	-83.644440	UT into Yellow Creek	N	E	SSMR	Table 3	No
042	807-0467-42	36.695830	-83.646110	UT into Yellow Creek	N	E	SSMR	Table 3	No
043	807-0467-43	36.689170	-83.649720	Stillhouse Branch	N	E	RA	Table 4	No

044	807-0467-44	36.686940	-83.649720	UT into Stillhouse Branch	N	E	RA	Table 4	No
045	807-0467-45	36.686390	-83.653610	UT into Stillhouse Branch	N	E	RA	Table 4	No
046	807-0467-46	36.684440	-83.6550	UT into Stillhouse Branch	N	E	RA	Table 4	No
047	807-0467-47	36.686110	-83.656390	UT into Stillhouse Branch	N	E	RA	Table 4	No
048	807-0467-48	36.6850	-83.658610	UT into Yellow Creek	N	E	RA	Table 4	No
049	807-0467-49	36.682780	-83.656940	UT into Yellow Creek	N	E	RA	Table 4	No
050	807-0467-50	36.681670	-83.6575	UT into Turnhole Branch	N	E	RA	Table 4	No
051	807-0467-51	36.681670	-83.653890	UT into Turnhole Branch	N	E	RA	Table 4	No
052	807-0467-52	36.681110	-83.652220	UT into Turnhole Branch	N	E	RA	Table 4	No
053	807-0467-53	36.681110	-83.647220	UT into Turnhole Branch	N	E	RA	Table 4	No
054	807-0467-54	36.678890	-83.645830	UT into Turnhole Branch	N	E	RA	Table 4	No
055	807-0467-55	36.677780	-83.649720	UT into Turnhole Branch	N	E	RA	Table 4	No
056	807-0467-56	36.676670	-83.651940	UT into Turnhole Branch	N	E	SSMR	Table 3	No
057	807-0467-57	36.676390	-83.653330	UT into Turnhole Branch	N	E	RA	Table 4	No
058	807-0467-58	36.674440	-83.654720	UT into Turnhole Branch	N	E	RA	Table 4	No
059	807-0467-59	36.670280	-83.657220	UT into Yellow Creek	N	E	SSMR	Table 3	No
060	807-0467-60	36.669170	-83.656670	UT into Yellow Creek	N	E	SSMR	Table 3	No
061	807-0467-61	36.669170	-83.655560	UT into Cranes Creek	N	E	SSMR	Table 3	No
062	807-0467-62	36.692780	-83.626940	UT into Williams Branch	N	E	SSMR	Table 3	No
063	807-0467-63	36.694720	-83.6275	UT into Williams Branch	N	E	SSMR	Table 3	No
064	807-0467-64	36.695560	-83.628890	UT into Right Fork Williams Branch	N	E	SSMR	Table 3	No
065	807-0467-65	36.691390	-83.612220	UT into Wolfpen Branch	N	E	SSMR	Table 3	No
066	807-0467-66	36.693330	-83.610280	UT into Hances Creek	N	E	SSMR	Table 3	No
067	807-0467-67	36.693890	-83.612220	UT into Hances Creek	N	E	SSMR	Table 3	No
068	807-0467-68	36.69917	-83.6125	UT into Yellow Creek	N	P	SSMR	Table 3	No
069	807-0467-69	36.69778	-83.61861	UT into Williams Branch	N	P	SSMR	Table 3	No

101	807-0428-1	36.6750	-83.572778	Clear Fork	N	E	SSMR	Table 3	No
102	807-0428-2	36.674444	-83.574444	Clear Fork	N	E	SSMR	Table 3	No
103	807-0428-3	36.673611	-83.576944	Clear Fork	N	E	SSMR	Table 3	No
104	807-0428-4	36.672778	-83.579792	UT into Clear Fork	N	E	SSMR	Table 3	No
105	807-0428-5	36.671389	-83.581667	UT into Clear Fork	N	E	SSMR	Table 3	No
106	807-0428-6	36.67	-83.583611	UT into Clear Fork	N	E	SSMR	Table 3	No
107	807-0428-7	36.669167	-83.586661	UT into Clear Fork	N	E	SSMR	Table 3	No
108	807-0428-8	36.668889	-83.589722	Clear Fork	N	E	SSMR	Table 3	No
109	807-0428-9	36.670833	-83.591667	Hances Creek	N	E	SSMR	Table 3	No
110	807-0428-10	36.673333	-83.590028	Hances Creek	N	E	SSMR	Table 3	No
111	807-0428-11	36.675278	-83.589167	Hances Creek	N	E	SSMR	Table 3	No
112	807-0428-12	36.676111	-83.586944	UT into Hances Creek	N	E	SSMR	Table 3	No
113	807-0428-13	36.678056	-83.584722	UT into Hances Creek	N	E	SSMR	Table 3	No
114	807-0428-14	36.680556	-83.584722	UT into Meadow Branch	N	E	SSMR	Table 3	No
115	807-0428-15	36.680833	-83.581111	UT into Meadow Branch	N	E	SSMR	Table 3	No
116	807-0428-16	36.682222	-83.578333	UT into Meadow Branch	N	E	SSMR	Table 3	No
117	807-0428-17	36.684722	-83.578611	UT into Meadow Branch	N	E	SSMR	Table 3	No
118	807-0428-18	36.686389	-83.579722	UT into Meadow Branch	N	E	SSMR	Table 3	No
119	807-0428-19	36.688020	-83.581113	UT into Meadow Branch	N	E	SSMR	Table 3	No
120	807-0428-20	36.6875	-83.583611	UT into Meadow Branch	N	E	SSMR	Table 3	No
121	807-0428-21	36.686667	-83.586389	UT into Hances Creek	N	E	SSMR	Table 3	No
122	807-0428-22	36.687778	-83.589444	UT into Hances Creek	N	E	SSMR	Table 3	No
123	807-0428-23	36.689167	-83.588056	UT into Hances Creek	N	E	SSMR	Table 3	No
124	807-0428-24	36.691111	-83.587222	UT into Hances Creek	N	E	SSMR	Table 3	No
125	807-0428-25	36.693056	-83.59	UT into Hances Creek	N	E	SSMR	Table 3	No
126	807-0428-26	36.693333	-83.594444	UT into Hances Creek	N	E	SSMR	Table 3	No
301	807-0501-SS1	36.669170	-83.636390	UT into Cranes Creek	N	E	SSMR	Table 3	No

302	807-0501-SS2	36.670560	-83.634170	UT into Cranes Creek	N	E	SSMR	Table 3	No
303	807-0501-SS3	36.671390	-83.631670	UT into Cranes Creek	N	E	SSMR	Table 3	No
304	807-0501-SS4	36.672780	-83.629720	UT into Cranes Creek	N	E	SSMR	Table 3	No
305	807-0501-SS5	36.6750	-83.628610	Cranes Creek	N	E	SSMR	Table 3	No
306	807-0501-SS6	36.675830	-83.626110	UT into Cranes Creek	N	E	SSMR	Table 3	No
307	807-0501-SS7	36.674440	-83.624720	UT into Cranes Creek	N	E	SSMR	Table 3	No
308	807-0501-SS8	36.672220	-83.627220	UT into Cranes Creek	N	E	SSMR	Table 3	No
309	807-0501-SS9	36.670830	-83.628060	UT into Cranes Creek	N	E	SSMR	Table 3	No
310	807-0501-SS10	36.668890	-83.63	UT into Cranes Creek	N	E	SSMR	Table 3	No
311	807-0501-SS11	36.667220	-83.6325	UT into Cranes Creek	N	E	SSMR	Table 3	No
312	807-0501-SS12	36.665560	-83.636670	UT into Cranes Creek	N	E	SSMR	Table 3	No
313	807-0501-SS13	36.6650	-83.639720	UT into Cranes Creek	N	E	SSMR	Table 3	No
314	807-0501-SS14	36.663060	-83.640560	UT into Cranes Creek	N	E	SSMR	Table 3	No
315	807-0501-SS15	36.659720	-83.643330	UT into Cranes Creek	N	E	SSMR	Table 3	No
316	807-0501-SS16	36.655830	-83.645830	UT into Clear Run	N	E	SSMR	Table 3	No
317	807-0501-SS17	36.653890	-83.6475	UT into Clear Run	N	E	SSMR	Table 3	No
318	807-0501-SS18	36.652220	-83.648610	UT into Clear Run	N	E	SSMR	Table 3	No
319	807-0501-SS19	36.659440	-83.648890	UT into Clear Run	N	E	SSMR	Table 3	No
320	807-0501-SS20	36.659440	-83.651110	UT into Clear Run	N	E	SSMR	Table 3	No
321	807-0501-SS21	36.661110	-83.654440	UT into Clear Run	N	E	SSMR	Table 3	No
322	807-0501-SS22	36.6625	-83.653890	UT into Cranes Creek	N	E	SSMR	Table 3	No
323	807-0501-SS23	36.661940	-83.650830	UT into Cranes Creek	N	E	SSMR	Table 3	No
324	807-0501-SS24	36.661940	-83.6475	UT into Cranes Creek	N	E	SSMR	Table 3	No
325	807-0501-SS25	36.660560	-83.646110	UT into Cranes Creek	N	E	SSMR	Table 3	No
401	807-0501-EP1	36.657220	-83.648060	UT into Clear Fork	C	E	SSMR	Table 2	No
402	807-0501-EP2	36.663890	-83.644170	Cranes Creek	C	E	SSMR	Table 2	No
403	807-0501-EP3	36.666670	-83.634440	Cranes Creek	C	E	SSMR	Table 2	No

404	807-0501-EP4	36.675280	-83.624170	Cranes Creek	C	E	SSMR	Table 2	No

UT means Unnamed Tributary.
Type of Outfall: Continuous (C) or Non-Continuous (N)
Status of Outfall: Existing (E), Proposed (P), Deleted from Plan (D), Outfall Removed (R), or Expanded (EXP)
Type of Drainage Received:

UGNC - Discharges from underground workings of underground mines and/or seep not commingled.
UGC - Discharges from underground workings of underground mines commingled.
CSMD - Controlled surface mine drainage (except steep slope and mountaintop removal).
NSMD - Non-controlled surface mine drainage (except steep slope and mountaintop removal).
SSMR - Discharges from steep slope and mountaintop removal areas.
PPAA - Discharges from coal preparation plant and coal preparation plant associated areas (excluding coal refuse disposal piles).
RA - Reclamation Areas.
SAND – Sanitary wastewaters are comprised of wastewaters from bathhouses, mine offices, etc. SAND is a direct discharge to a water of the Commonwealth.
SANO - Sanitary wastewaters are comprised of wastewaters from bathhouses, mine offices, etc. SANO is a discharge to another treatment system prior to entering a water of the Commonwealth.

Effluent Limitations Table: The regulating Effluent Table as shown in the permit.
Compliance Representative Outfall (CRO):

Yes – This outfall is designated as a compliance representative outfall.
No – This outfall is not representative of or represented by another outfall.
- The number of the outfall that is representing this outfall for compliance purposes.

TABLE 3 – In-Stream Monitoring

In-stream Monitoring Identifier*	Stream Name	Latitude	Longitude	Background Benthic Macro Index Score	Background Sampling Date	Minimum Benthic Macro Index Threshold	TSS (mg/L)	SC (µS/cm)	SO_4 (mg/L)
I01	Clear Fork	36.655854	-83.659581	62	5/14/2024	48	5	149	43
I02	Cranes Creek	36.664255	-83.645244	49	5/14/2024	35	5	1925	989
I03	Cranes Creek	36.666994	-83.635609	38	5/14/2024	24	5	1473	767

TSS - Background Total Suspended Solids
SC - Background Specific Conductivity
SO_4 - Background Total Sulfate (SO_4)
*In-Stream monitoring requirements are found in Table 9 of this permit.

Appendix G
Agency Correspondence

Part 4: Kentucky Department for Natural Resources (KDNR)

Surface Coal Mining and Reclamation Operations Permit

TEAM KENTUCKY™
Department for Natural Resources

NALLY & HAMILTON ENTERPRISES INC
PO BOX 157
BARDSTOWN KY 40004

This permit is issued based on ownership and control information contained in the permit application. The permittee shall notify the Division of Mine Permits in writing of any change in officers, directors, persons performing functions similar to directors, stockholders owning ten percent (10%) or more of any class of voting stock, or addresses of the permittee or other persons listed above. Written notification shall be made within thirty (30) days of such changes. After notifying the Division of such changes in writing, the permittee shall make all necessary changes in the permit application on forms supplied by the Division. The Department for Natural Resources hereby grants the above-named operator a permit to engage in surface coal mining and reclamation operations. This permit has been issued under the provisions of KRS Chapter 350 and regulations promulgated pursuant thereto. Issuance of this permit does not relieve the permittee from the responsibility of obtaining any other permits, licenses or approvals required by this Cabinet and/or other state, federal and local agencies. Conformance with all such laws and regulations is the responsibility of the permittee. Further, this permit is subject to any conditions and operating limitations specified below:

A. PERMIT ACTION

(1) This Original permit is issued for 372.70 acres.

(2) Within ten (10) days of initial disturbance of the permit, in accordance with 405 KAR 10:070, Section 1(2)the permittee shall file Kentucky Reclamation Guaranty Fund Notification of Permit Activity, Form RGF-3 with the Office of the Reclamation Guaranty Fund, 300 Sower Blvd., Frankfort, KY 40601. The form may be downloaded at: http://dnr.ky.gov/krgf/Pages/Electronic-Forms.aspx.

B. POST MINING LAND USE

(1) Approval is granted for the following post mining land use(s):

Land Use	Acres
Fish and Wildlife	372.70

(OVER)

No deviation from the plans and specifications submitted with your application or the conditions specified above is permitted, unless previously authorized in writing by the Division of Mine Permits. At any time the terms and conditions contained in the permit are violated, it shall become null and void. All rights of inspection by representatives of the Department for Natural Resources are reserved. Receipt of the permit fee and bond amount specified below is hereby acknowledged.

Major Watershed:	Lower Cumberland River	Effective Date:	07/15/2024
Legal Structure:	Corporation	Expiration Date:	07/15/2029
Permit Fee:	$8,100	Type of Operation:	Surface Contour/Remining
Bond Type:	Surety	County:	Pike
Bond Amount:	$210,500	Acres:	372.70
Bond Number:	See Condition No. E(1)	Issued:	07/15/2024
Permit Number:	807-0501		

COMMONWEALTH OF KENTUCKY

Director, Division of Mine Permits

C. GENERAL

(1) Disposal of hazardous waste and solid waste other than "coal mining solid waste" is prohibited on the permit area unless a permit is obtained from the Division of Waste Management.

(2) As required by the Indiana Bat Protection and Enhancement Plan, trees can only be removed from November 15th to March 31st. If it is necessary to remove trees between April 1st to November 14th, DNR and USFWS must be notified, and approval obtained before tree removal can occur.

D. WAIVERS / VARIANCES

(1) Approval is granted for an alternate contemporaneous reclamation allowing a total maximum highwall length of 4,500 feet, including the 1,500 feet associated with the base bond. The permittee has paid supplemental assurance in the amount of $0 and is required to pay a total of $300,000 in payments of $150,000 as per the payment schedule in the application. Backfilling and grading shall be completed within 180 calendar days after initial excavation for the purpose of removal of topsoil or overburden in a coal removal area. Approval is granted for a total of 3 pits. The permittee is required to pay additional supplemental assurance in the amount of $150,000 prior to excavation of each additional pit. Based upon field conditions during the mining and reclamation operations, the Department may re-evaluate this variance at any time to ensure it is still justified and adequately demonstrated in the current issued permit.

(2) A variance is granted for roads 1, 2, 3, 4, 5, and 6 to exceed the maximum allowed grades as proposed in the Original permit application.

(3) A tentative waiver is granted approving the retention of roads 1, 2, 3, 4, 5, and 6, as permanent roads. Final approval will be contingent on the establishment of the dependent post mining land use.

(4) A variance is granted to install culverts beneath roads 1, 2, 3, 4, 5, and 6 on the interval spacing proposed in the Original permit application.

(5) A variance is granted for the use of alternate topsoil material on 270.40 acres as proposed in the Original permit application.

(6) Surface blasting is prohibited within 500 feet of an abandoned underground mine until the Anticipated Blast Design (SMP-61) has been submitted, and either 30 days have expired, or the SMP-61 is approved.

(7) A variance is granted allowing surface disturbance operations within 100 feet but no closer than 0 feet of Cranes Creek, Unnamed Tributary of Crane's Creek, and Unnamed Tributary of Clear Fork.

E. BOND AND ACREAGE DETAIL

(1) This permit is for a total of 372.70 acres divided into 2 increments. The increments currently bonded are listed below:

Increment Number	Permit Acreage	Bond Amount	Bond Number	Acreage Fee
1	102.30	$210,500	18011361	$7,725

The permittee shall not conduct any surface coal mining and reclamation operations on other increments of the permit area until the full bond amount and acreage fees have been filed for that increment.

(2) For all remining areas identified in the Original application, the success of revegetation will be determined by KRS 350.095(2).

F. VIOLATION DETAIL

(1) This permit is conditioned on the abatement of the following non-compliances within the time frames prescribed by the Cabinet. Failure to comply with this condition may cause the Department to suspend or revoke this permit without a hearing.

COMPANY	PERMIT	NON-COMPLIANCE
Nally & Hamilton Enterprises, Inc.	807-0339	236839
Nally & Hamilton Enterprises, Inc.	807-0355	238244
Nally & Hamilton Enterprises, Inc.	807-0372	236840
Nally & Hamilton Enterprises, Inc.	807-0467	236826
Nally & Hamilton Enterprises, Inc.	848-0242	232664
Nally & Hamilton Enterprises, Inc.	848-0242	236671
Nally & Hamilton Enterprises, Inc.	848-0242	236673
Nally & Hamilton Enterprises, Inc.	848-0242	238471
Nally & Hamilton Enterprises, Inc.	848-0256	236953
Nally & Hamilton Enterprises, Inc.	848-0256	236954
Nally & Hamilton Enterprises, Inc.	848-0310	238366
Nally & Hamilton Enterprises, Inc.	848-0377	232767
Nally & Hamilton Enterprises, Inc.	848-0377	232768
Nally $ Hamilton Enterprises, Inc.	867-0552	801473
Nally & Hamilton Enterprises, Inc.	867-0552	801596
Nally & Hamilton Enterprises, Inc.	867-0556	800700
Nally & Hamilton Enterprises, Inc.	867-0556	801424
Nally & Hamilton Enterprises, Inc.	867-0556	801569

(2) The validity of this permit is conditioned upon the strict compliance with the terms and conditions of the Final Order in the action styled Energy and Environment Cabinet vs. Nally & Hamilton Enterprises, Inc., File No. PAC-24-4-0112.

Appendix H
Jurisdictional Determination

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
REGULATORY DIVISION
3701 BELL ROAD
NASHVILLE, TENNESSEE 37214

December 18, 2025

SUBJECT: File No. LRN-2025-01090; Nally & Hamilton Enterprises, Inc.; Cranes Creek Surface Mine; Colmar, Bell County, Kentucky

Mr. Stephen Hamilton
Nally & Hamilton Enterprises, Inc.
195 Commercial Drive, Suite 105
London, KY 40744

Dear Mr. Hamilton:

This letter is in regard to the information you provided on September 8, 2025 and updated on November 14, 2025, which documented potential waters of the United States within the proposed 995 acre mine area known as the Cranes Creek Surface Mine located at 36.66492, -83.64782 in Bell County, Kentucky. This project has been assigned File No. LRN-2025-01090, please refer to this number in any future correspondence.

The U.S. Army Corps of Engineers (USACE) has regulatory responsibilities pursuant to Section 404 of the Clean Water Act (33 U.S.C. 1344) and Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). Under Section 10, the USACE regulates any work in, or affecting, navigable waters of the U.S. It appears the review area does not include navigable waters of the U.S. and would not be subject to the provisions of Section 10. Under Section 404, the USACE regulates the discharge of dredged and/or fill material into waters of the U.S., including wetlands.

a. Preliminary Jurisdictional Determination: Based on the October 22, 2025 site visits and information provided in the report titled “Cranes Creek Project”, twelve (12) reaches of stream totaling 21,788 linear feet of relatively permanent waters, one (1) wetland totaling 1.69 acre, and two (2) open water features totaling 0.89 acre were documented within the review area. This office has determined these features may be jurisdictional waters of the U.S. in accordance with 33 C.F.R. 331.2 and a PJD has been prepared. The PJD is non-binding, cannot be appealed and only provides a written indication that waters of the U.S., including wetlands, may be present on-site. For purposes of computation of impacts, compensatory mitigation requirements and other resource protection measures, a permit decision made on the basis of a PJD will treat all waters that would be affected in any way by the

permitted activity on the site as if they are jurisdictional waters of the U.S. This determination is only valid for the “PJD Review Area” shown on the attached map entitled “Figure 1: LRN-2025-01090”, attached to this letter.

Enclosed with this letter is a copy of the PJD. If you agree with the findings of this PJD and understand your options regarding the same, please sign and date the form and return it to this office within 30 days of receipt of this letter. You should submit the signed copy to the following address:

US Army Corps of Engineers
Nashville District
3701 Bell Road
Nashville, TN 37214
Attn: Brent Sewell

b. Approved Jurisdictional Determination: Also enclosed is an approved jurisdictional determination for aquatic resources identified within the review area. The rationale for this determination is provided in the attached Approved Jurisdictional Determination form. This approved jurisdictional determination expires five years from the date of this letter, unless new information warrants revision of the determination before the expiration date, or the District Engineer identifies specific geographic areas with rapidly changing environmental conditions that merit re-verification on a more frequent basis. This approved jurisdictional determination is only valid for the “AJD Review Area” as shown on the enclosed map labeled “Figure 2: LRN-2025-01090”.

The delineation included herein has been conducted to identify the location and extent of the aquatic resources for purposes of the Clean Water Act for the particular site identified in this request. This delineation may not be valid for the Wetland Conservation Provisions of the Food Security Act of 1985, as amended. If you or your tenant are USDA program participants, or anticipate participation in USDA programs, you should discuss the applicability of an NRCS Certified Wetland Determination with the local USDA service center, prior to starting work.

If you object to this decision, you may request an administrative appeal under USACE regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeals Process (NAP) fact sheet and Request for Appeal (RFA) form. If you request to appeal this decision you must submit a completed RFA form to the Great Lakes and Ohio River Division, Division Office at the following address:

Regulatory Appeal Review Officer
ATTN: Ms. Suzanne Chubb

Army Engineer Division
550 Main Street, Room 10-714
Cincinnati, OH 45202-3222
TEL (513) 218-1243
E-mail: suzanne.l.chubb@usace.army.mil

In order for an RFA to be accepted by the USACE, the USACE must determine that it is complete, that it meets the criteria for appeal under 33 CFR Part 331.5, and that it has been received by the Division Office within 60 days (February 16, 2026) of the date listed on the RFA form. **It is not necessary to submit an RFA form to the Division Office if you do not object to the decision in this letter**.

We appreciate your awareness of the USACE regulatory program. If you have any questions, you may contact me or Brent Sewell at (615) 417-0240 or by e-mail at Brent.J.Sewell@usace.army.mil.

Sincerely,



William E Worrall, P.E.
Chief, Technical Services Branch
Regulatory Division

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NASHVILLE DISTRICT
3701 BELL ROAD
NASHVILLE TENNESSEE 37214

CELRN-RDT December 19, 2025

MEMORANDUM FOR RECORD

SUBJECT: US Army Corps of Engineers (Corps) Approved Jurisdictional Determination in accordance with the "Revised Definition of 'Waters of the United States'"; (88 FR 3004 (January 18, 2023) as amended by the "Revised Definition of 'Waters of the United States'; Conforming" (8 September 2023) ,[1] LRN-2025-01090, MFR 1 of 1[2]

BACKGROUND. An Approved Jurisdictional Determination (AJD) is a Corps document stating the presence or absence of waters of the United States on a parcel or a written statement and map identifying the limits of waters of the United States on a parcel. AJDs are clearly designated appealable actions and will include a basis of JD with the document.[3] AJDs are case-specific and are typically made in response to a request. AJDs are valid for a period of five years unless new information warrants revision of the determination before the expiration date or a District Engineer has identified, after public notice and comment, that specific geographic areas with rapidly changing environmental conditions merit re-verification on a more frequent basis.[4]

On January 18, 2023, the Environmental Protection Agency (EPA) and the Department of the Army ("the agencies") published the "Revised Definition of 'Waters of the United States,'" 88 FR 3004 (January 18, 2023) ("2023 Rule"). On September 8, 2023, the agencies published the "Revised Definition of 'Waters of the United States'; Conforming", which amended the 2023 Rule to conform to the 2023 Supreme Court decision in *Sackett v. EPA*, 598 U.S., 143 S. Ct. 1322 (2023) ("*Sackett*").

This Memorandum for Record (MFR) constitutes the basis of jurisdiction for a Corps AJD as defined in 33 CFR §331.2. For the purposes of this AJD, we have relied on Section 10 of the Rivers and Harbors Act of 1899 (RHA),[5] the 2023 Rule as amended,

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[1] While the Revised Definition of "Waters of the United States"; Conforming had no effect on some categories of waters covered under the CWA, and no effect on any waters covered under RHA, all categories are included in this Memorandum for Record for efficiency.
[2] When documenting aquatic resources within the review area that are jurisdictional under the Clean Water Act (CWA), the Corps will use an additional MFR and group the aquatic resources on each MFR based on the TNW, the territorial seas, or interstate water that they are connected to. An identifier to indicate when there are multiple MFRs associated with a single AJD request will be used (i.e., 1, 2, 3).
[3] 33 CFR 331.2.
[4] Regulatory Guidance Letter 05-02.
[5] USACE has authority under both Section 9 and Section 10 of the Rivers and Harbors Act of 1899 but for convenience, in this MFR, jurisdiction under RHA will be referred to as Section 10.

as well as other applicable guidance, relevant case law, and longstanding practice in evaluating jurisdiction.

1. SUMMARY OF CONCLUSIONS.

   a. Provide a list of each individual feature within the review area and the jurisdictional status of each one (i.e., identify whether each feature is/is not a water of the United States and/or a navigable water of the United States).

i. **S9, reach 1 is a water of the United States**
ii. **S12, reach 1 is a water of the United States**
iii. WB **is not** a water of the United States
iv. ISO OW8 **is not** a water of the United States
v. OW9 **is not** a water of the United States
vi. S17 **is not** a water of the United States
vii. OW6 **is not** a water of the United States
viii. S16A **is not** a water of the United States
ix. S16B **is not** a water of the United States
x. S16C **is not** a water of the United States
xi. WD **is not** a water of the United States
xii. S16D **is not** a water of the United States
xiii. OW1 **is not** a water of the United States
xiv. S19 **is not** a water of the United States
xv. S1 **is not** a water of the United States
xvi. S2 **is not** a water of the United States
xvii. **S2, reach 1 is a water of the United States**
xviii. S2A **is not** a water of the United States
xix. S2B **is not** a water of the United States
xx. S6 **is not** a water of the United States
xxi. ISO WA **is not** a water of the United States
xxii. S7 **is not** a water of the United States
xxiii. S8 **is not** a water of the United States
xxiv. S8B **is not** a water of the United States
xxv. ISO OW2 **is not** a water of the United States
xxvi. ISO OW10 **is not** a water of the United States
xxvii. S9 **is not** a water of the United States
xxviii. S9A **is not** a water of the United States
xxix. ISO OW3 **is not** a water of the United States
xxx. S10 **is not** a water of the United States
xxxi. ISO OW4 **is not** a water of the United States
xxxii. ISO OW5 **is not** a water of the United States
xxxiii. S14 **is not** a water of the United States

xxxiv. S12B **is not** a water of the United States
xxxv. S12 **is not** a water of the United States
xxxvi. S13 **is not** a water of the United States
xxxvii. S11 **is not** a water of the United States
xxxviii. S11, reach 1 **is not** a water of the United States
xxxix. S11B **is not** a water of the United States
xl. S11A **is not** a water of the United States

2. REFERENCES.

a. "Revised Definition of 'Waters of the United States,'" 88 FR 3004 (January 18, 2023) ("2023 Rule")

b. Revised Definition of 'Waters of the United States'; Conforming" 88 FR 61964 (September 8, 2023)

c. Sackett v. EPA, 598 U.S. 651, 143 S. Ct. 1322 (2023)

d. Memorandum to the Field Between the U.S. Department of the Army, U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency Concerning the Proper Implementation of "Continuous Surface Connection" Under the Definition of "Waters of the United States" Under the Clean Water Act (March 12, 2025).

e. Headquarters Field Memos, "Memorandum on MVS-2023-00288"

REVIEW AREA. The AJD review area includes a portion of the proposed 995-acre permit boundary known as 807-0501, as shown on Figure 2 near Colmar, Bell County, Kentucky (36.66492, -83.64782). The site has been used historically for surface mining and logging.

3. NEAREST TRADITIONAL NAVIGABLE WATER (TNW), THE TERRITORIAL SEAS, OR INTERSTATE WATER TO WHICH THE AQUATIC RESOURCE IS CONNECTED. Cumberland River

Prior to the determination and listing of the Nashville District's navigable waters, detailed navigability studies were performed throughout the Nashville District to determine which waters meet the navigable waters definition found in 33 CFR Part 329. These studies are available for review in the Nashville District office. Upon completion of these navigability studies, the Nashville District issued Public Notice #86-23, dated May 8, 1986, listing all navigable waters within the district. The complete list of navigable waters can be found on the district's website at https://www.lrn.usace.army.mil/Missions/Regulatory/Navigable-Waters-List/.

4. FLOWPATH FROM THE SUBJECT AQUATIC RESOURCES TO A TNW, THE TERRITORIAL SEAS, OR INTERSTATE WATER.

<table>
<tr><td colspan="4">Resource Name</td><td colspan="4">Flows Into</td><td>Section 10</td></tr>
<tr><td colspan="4">OW9</td><td>OW7</td><td>S15</td><td>Cranes Creek</td><td rowspan="20">Yellow Creek</td><td rowspan="20">Cumberland River</td></tr>
<tr><td colspan="3">OW6</td><td>S17</td><td colspan="3" rowspan="4">Cranes Creek</td></tr>
<tr><td colspan="3">S16A</td><td rowspan="3">S16</td></tr>
<tr><td colspan="3">S16B</td></tr>
<tr><td>WD</td><td colspan="2">S16C</td></tr>
<tr><td>OW1</td><td>S16D</td><td colspan="2">S16</td><td colspan="2">Cranes Creek</td></tr>
<tr><td colspan="3">S19</td><td colspan="4" rowspan="8">Cranes Creek</td></tr>
<tr><td colspan="3">S1</td></tr>
<tr><td>S2A</td><td colspan="2">S2</td></tr>
<tr><td>S2B</td><td colspan="2"></td></tr>
<tr><td colspan="3">S6</td></tr>
<tr><td colspan="3">S7</td></tr>
<tr><td>S8B</td><td>S8</td><td>S9, reach 1</td></tr>
<tr><td>S9A</td><td>S9</td><td></td></tr>
<tr><td colspan="3">S14</td></tr>
<tr><td colspan="2">S12</td><td>S12, reach 1</td><td rowspan="5">S11, reach 2</td><td rowspan="5">Clear Fork</td></tr>
<tr><td colspan="2">S12B</td></tr>
<tr><td colspan="2">S11</td><td rowspan="2">S11, reach 1</td></tr>
<tr><td colspan="2">S11B</td></tr>
<tr><td colspan="3">S13</td></tr>
<tr><td colspan="3">S11A</td><td colspan="3">N/A</td></tr>
<tr><td colspan="3">WB</td><td colspan="5" rowspan="11">N/A</td></tr>
<tr><td colspan="3">ISO OW8</td></tr>
<tr><td colspan="3">OW9</td></tr>
<tr><td colspan="3">ISO WA</td></tr>
<tr><td colspan="3">ISO OW2</td></tr>
<tr><td colspan="3">ISO OW3</td></tr>
<tr><td colspan="3">ISO OW4</td></tr>
<tr><td colspan="3">S10</td></tr>
<tr><td colspan="3">ISO OW5</td></tr>
<tr><td colspan="3">ISO OW10</td></tr>
</table>

5. SECTION 10 JURISDICTIONAL WATERS[6]: Describe aquatic resources or other features within the review area determined to be jurisdictional in accordance with Section 10 of the Rivers and Harbors Act of 1899. Include the size of each aquatic resource or other feature within the review area and how it was determined to be jurisdictional in accordance with Section 10.[7] N/A

6. SECTION 404 JURISDICTIONAL WATERS: Describe the aquatic resources within the review area that were found to meet the definition of waters of the United States in accordance with the 2023 Rule as amended, consistent with the Supreme Court's decision in *Sackett*. List each aquatic resource separately, by name, consistent with the naming convention used in section 1, above. Include a rationale for each aquatic resource, supporting that the aquatic resource meets the relevant category of "waters of the United States" in the 2023 Rule as amended. The rationale should also include a written description of, or reference to a map in the administrative record that shows, the lateral limits of jurisdiction for each aquatic resource, including how that limit was determined, and incorporate relevant references used. Include the size of each aquatic resource in acres or linear feet and attach and reference related figures as needed.

    a. Traditional Navigable Waters (TNWs) (a)(1)(i): N/A

    b. The Territorial Seas (a)(1)(ii): N/A

    c. Interstate Waters (a)(1)(iii): N/A

    d. Impoundments (a)(2): N/A

    e. Tributaries (a)(3):

The features described in the below table are natural, man altered, or man-made water bodies that flow directly or indirectly into (a)(1)(i)-(iii) waters or (a)(2) impoundments. See Section 5 for flow path information. These tributaries have been determined to meet the relatively permanent standard. The tributaries have flowing or standing water year round or continuously during certain times of year. The OHWM (Ordinary High Water Mark) represents the lateral limits of jurisdiction of the tributaries per

[6] 33 CFR 329.9(a) A waterbody which was navigable in its natural or improved state, or which was susceptible of reasonable improvement (as discussed in § 329.8(b) of this part) retains its character as "navigable in law" even though it is not presently used for commerce, or is presently incapable of such use because of changed conditions or the presence of obstructions.
[7] This MFR is not a determination that the water is a navigable water of the United States. Procedures to make a determination that water is a navigable water of the United States subject to Section 10 of the RHA are outlined in 33 CFR part 329.14.

33CFR328.4. The OHWMs were determined using field indicators in RGL 05-05. The upstream and downstream limits of these tributaries are identified on the attached Figure 1. The flow regimes are based on multiple observations and data. USACE determined that the downstream limit of the tributaries best represent the overall flow regime for each of the reaches discussed below.

Resource Name	Size	Rationale
S2, reach 1	595 LF	This tributary is a 2nd order stream and had strong indicators of relatively permanent flow at the downstream limit of the tributary before reaching S4. The flow regime remained consistent throughout the entirety (100%) of the reach. S2, reach 1 begins at the confluence of S2 and S2A and was determined to be a relevant reach to the confluence with S4. USACE reviewed the entirety of the reach. This determination is supported by observations of surface flow, baseflow, pooling, and saturation during the October 22, 2025 site walk indicating relative permanence, and channel development documentation provided by Waypoint indicating the reach is a Relatively Permanent Water (RPW). The report indicated that the channel was ~3 feet wide with flowing water observed during Waypoint's February 23, 2023site visit. The following OHWM indicators were also observed: strong bed and bank, sorting, wracking, disturbance of leaf litter, destruction of terrestrial vegetation, scour, and changes in the character of the soil were observed within the channel. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the feature from the start of the reach to the downstream confluence with S8 has relatively permanent flow. Based on the information above we have determined that the resource meets the definition of "waters of the United States".
S9, Reach 1	454 LF	This tributary is a 2nd order stream and had strong indicators of relatively permanent flow at the downstream

		limit of the tributary before reaching S8, reach 1. The flow regime remained consistent throughout the entirety (100%) of the reach. S9, reach 1 begins at the confluence of S9 and S9A and was determined to be a relevant reach to the confluence with S8. USACE reviewed the entirety of the reach. This determination is supported by observations of surface flow, baseflow, pooling, and saturation during the October 22, 2025 site walk indicating relative permanence, and channel development documentation provided by Waypoint indicating the reach is RPW. The report indicated that the channel was ~3 feet wide with flowing water (0.1-0.5" deep) observed during Waypoint's March 7, 2023 site visit. The following OHWM indicators were also observed: strong bed and bank, sorting, wracking, disturbance of leaf litter, destruction of terrestrial vegetation, scour, and changes in the character of the soil were observed within the channel. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the feature from the start of the reach to the downstream confluence with S8, reach 1 has relatively permanent flow. Based on the information above we have determined that the resource meets the definition of "waters of the United States".
S12, reach 1	882 LF	This tributary is a 2nd order stream and had strong indicators of relatively permanent flow at the downstream limit of the tributary before reaching S11 perennial. The flow regime remained consistent throughout the entirety (100%) of the reach. S12, reach 1 begins at the confluence of S12 and S12B and was determined to be a relevant reach to the confluence with S11, perennial. USACE reviewed the entirety of the reach. This determination is supported by observations of surface flow, baseflow, pooling, and saturation during the

		October 22, 2025 site walk indicating relative permanence, and channel development documentation provided by Waypoint indicating the reach is RPW. The report indicated that the channel was ~3 feet wide with flowing water (0.1-0.5" deep) observed during Waypoint's April 24, 2024 site visit. The following OHWM indicators were also observed: strong bed and bank, sorting, wracking, disturbance of leaf litter, destruction of terrestrial vegetation, scour, and changes in the character of the soil were observed within the channel. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the feature from the start of the reach to the downstream confluence with S8 has relatively permanent flow. Based on the information above we have determined that the resource meets the definition of "waters of the United States".

f. Adjacent Wetlands (a)(4): N/A

g. Additional Waters (a)(5): N/A

7. NON-JURISDICTIONAL AQUATIC RESOURCES AND FEATURES

a. Describe aquatic resources and other features within the review area identified in the 2023 Rule as amended as not "waters of the United States" even where they otherwise meet the terms of paragraphs (a)(2) through (5). Include the type of excluded aquatic resource or feature, the size of the aquatic resource or feature within the review area and describe how it was determined to meet one of the exclusions listed in 33 CFR 328.3(b).[8] N/A

[8] 88 FR 3004 (January 18, 2023)

b. Describe aquatic resources and features within the review area that were determined to be non-jurisdictional because they do not meet one or more categories of waters of the United States under the 2023 Rule as amended (e.g., tributaries that are non-relatively permanent waters; non-tidal wetlands that do not have a continuous surface connection to a jurisdictional water).

The features listed in the below table are natural, man altered, or manmade water bodies that flow directly or indirectly into (a)(1)(i)-(iii) waters or (a)(2) impoundment. The tributaries have been determined to not meet the relatively permanent standard. These tributaries generally flow for a short duration in direct response to precipitation. The OHWM (Ordinary High Water Mark) represents the lateral limits of jurisdiction of the tributaries per 33CFR328.4. The OHWMs were determined using field indicators in RGL 05-05. The upstream and downstream limits of the tributaries are identified on the attached figure. The flow regimes were based on multiple observations by Waypoint and USACE where noted in the reach specific notes. USACE determined the representative flow regime based on a weight of evidence approach for each of the features as discussed below.

Resource Name	Size	Rationale
S17	452 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S4 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by documentation provided by Waypoint, LLC. USACE did not review the reach due to time constraints. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by

		Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
S16A	552 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S16 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by documentation provided by Waypoint, LLC. USACE did not review the reach due to time constraints. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
S16B	464 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S16 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by documentation provided by Waypoint, LLC. USACE did not review the reach due to time constraints.

		The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States"
S16C	408 LF	This tributary is a 1st order stream determined to be 82% NRPW (334 LF) and 18% RPW (74 LF) before reaching the confluence with S16. The upper reach of this stream had strong indicators of non-relatively permanent flow. The NRPW portion of this tributary transitions to RPW where flowing water, fish and iron oxidizing bacteria were observed. This determination is supported by documentation provided by Waypoint, LLC. USACE did not review the reach due to time constraints. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, scour, along with wracking, some sediment sorting, and disturbed leaf litter. The upper portion of this feature lacked evidence of seasonal flow as it had no indicators of subsurface flow

		nor groundwater connection, upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the NRPW portion of this feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the majority of this stream (~82%) does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events, and the lack of aquatic organisms which require seasonal or year-round flow. Therefore, the reach is determined to have non-relatively permanent flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
S16D	1,113 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S16 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by documentation provided by Waypoint, LLC. USACE did not review the reach due to time constraints. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream

		does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States
S19	2,445 LF	This tributary is a 1st order stream determined to be 59% NRPW (1433 LF) and 41% RPW (1,012 LF) before reaching the confluence with S4. The upper reach of this stream had strong indicators of non-relatively permanent flow. The NRPW portion of this tributary transitions to RPW where flowing water, fish and iron oxidizing bacteria were observed. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the lower portion of the reach including the entire RPW section. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, scour, along with wracking, some sediment sorting, and disturbed leaf litter. The upper portion of this feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the NRPW portion of this feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the majority of this stream (~59%) does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events, and the lack of aquatic organisms which require seasonal or year-round flow. Therefore, the reach is determined to have non-relatively permanent flow. Based on the information above, we have determined that the

		subject resource does not meet the definition of "waters of the United States".
S1	1,597 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S4 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the lower portion of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States
S2A	440 LF,	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S2 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach.

		The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States
S2B	280 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S2 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation.

		Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
S2	932 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching the confluence of S2 and S2A and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
S6	840 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the

		downstream limit of the tributary before reaching S4 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
S7	1,283 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S4 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter.

		The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
S8	969 LF	This tributary is a 1st order stream determined to be 59% NRPW (574LF) and 41% RPW (395 LF) before reaching the confluence with S8B. The upper reach of this stream had strong indicators of non-relatively permanent flow. The NRPW portion of this tributary transitions to RPW where flowing water and iron oxidizing bacteria were observed. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the lower portion of the reach including the entire RPW section. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, scour, along with wracking, some sediment sorting, and disturbed leaf litter. The upper portion of this feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the NRPW portion of this feature only flows in direct response to precipitation.

		Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the majority of this stream (~59%) does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events, and the lack of aquatic organisms which require seasonal or year-round flow. Therefore, the reach is determined to have non-relatively permanent flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
S8B	253 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S8 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have

		determined that the subject resource does not meet the definition of "waters of the United States.
S9	1,084 LF	This tributary is a 1st order stream determined to be 57% NRPW (620 LF) and 43% RPW (464 LF) before reaching the confluence with S9A. The upper reach of this stream had strong indicators of non-relatively permanent flow. The NRPW portion of this tributary transitions to RPW where flowing water and iron oxidizing bacteria were observed. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the lower portion of the reach including the entire RPW section. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, scour, along with wracking, some sediment sorting, and disturbed leaf litter. The upper portion of this feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the NRPW portion of this feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the majority of this stream (~57%) does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events, and the lack of aquatic organisms which require seasonal or year-round flow. Therefore, the reach is determined to have non-relatively permanent flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
S9A	312 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the

		downstream limit of the tributary before reaching S9 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of “waters of the United States.
S10	751 LF	This feature is a natural, man-altered, or man-made water body that does not flow directly or indirectly into a traditional navigable water (TNW). During the Corps’ site visit on October 22, 2025 S10 was observed to be isolated and did not have a continuous surface connection to a jurisdictional water. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to S10 is S4, located approximately 335 feet to the north.

		Based on the information above we have determined that the subject resource does not meet the definition of "waters of the United States."
S14	2,025 LF	This tributary is a 1st order stream determined to be 87% NRPW (1757 LF) and 13% RPW (268 LF) before reaching the confluence with S4. The upper reach of this stream had strong indicators of non-relatively permanent flow. The NRPW portion of this tributary transitions to RPW where flowing water and iron oxidizing bacteria were observed. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the lower portion of the reach including the entire RPW section. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, scour, along with wracking, some sediment sorting, and disturbed leaf litter. The upper portion of this feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the NRPW portion of this feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the majority of this stream (~87%) does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events, and the lack of aquatic organisms which require seasonal or year-round flow. Therefore, the reach is determined to have non-relatively permanent flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".

S12	546 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching the confluence with S12B and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of “waters of the United States.
S12B	169 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S12 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including

		presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
S11	418 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching the confluence with S11B and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation.

		Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
S11B	234 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S11 and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
S11, reach 1	854 LF	This tributary is a 2nd order stream determined to be 80% NRPW (680 LF) and 20% RPW (174 LF) from the confluence with S11B to the confluence with S12. The

		upper reach of this stream had strong indicators of non-relatively permanent flow. The NRPW portion of this tributary transitions to RPW where flowing water, fish and iron oxidizing bacteria were observed. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the lower portion of the reach including the entire RPW section. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, scour, along with wracking, some sediment sorting, and disturbed leaf litter. The upper portion of this feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the NRPW portion of this feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the majority of this stream (~80%) does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events, and the lack of aquatic organisms which require seasonal or year-round flow. Therefore, the reach is determined to have non-relatively permanent flow. Based on the information above, we have determined that the subject resource does not meet the definition of “waters of the United States”.
S13	415 LF	This tributary is a 1st order stream determined to be 91% NRPW (376 LF) and 9% RPW (39 LF) before reaching the confluence with S11, perennial. The upper reach of this stream had strong indicators of non-relatively permanent flow. The NRPW portion of this tributary transitions to

		RPW where flowing water and iron oxidizing bacteria were observed. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach including the entire RPW section. The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, scour, along with wracking, some sediment sorting, and disturbed leaf litter. The upper portion of this feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the NRPW portion of this feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined utilizing a weight of evidence approach that the majority of this stream (~91%) does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events, and the lack of aquatic organisms which require seasonal or year-round flow. Therefore, the reach is determined to have non-relatively permanent flow. Based on the information above, we have determined that the subject resource does not meet the definition of “waters of the United States”.
S11A	226 LF	This tributary is a 1st order stream and had strong indicators of non-relatively permanent flow at the downstream limit of the tributary before reaching S11, perennial and the flow regime remained consistent throughout the entirety (100%) of the reach. This determination is supported by USACE field observation on October 22, 2025 and documentation provided by Waypoint, LLC. USACE reviewed the entirety of the reach.

		The stream channel had a moderately defined bed and bank and ordinary high-water mark (OHWM), including presence of fibrous roots in the stream bed, along with wracking, some sediment sorting, and disturbed leaf litter. The feature lacked evidence of seasonal flow as it had no indicators of subsurface flow nor groundwater connection, which included upland soils within the stream bed, no macroinvertebrates and no other aquatic organisms. These factors indicate that the feature only flows in direct response to precipitation. Based on the direct observations noted above, climatic conditions discussed in this form and within the administrative record, and documentation provided by Waypoint, LLC, USACE has determined that this stream does not have relatively permanent flow based on the moderately defined channel, indicating infrequent flow events. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States.
WB	0.1 Ac	The wetland is not directly abutting a water of the United States based on field verification on October 22, 2025. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to WB is S15 located approximately 334 feet to the east. The National Wetland Inventory and USA Hydric Soils dataset indicate the wetland is surrounded and confined by uplands with no discrete feature to indicate path of flow Based on the information above we have determined that the subject resource does not meet the definition of "waters of the United States."
ISO WA	0.29 Ac	The wetland is not directly abutting a water of the United States based on field verification on October 22, 2025. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest

		WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to ISO WA is S4 located approximately 428 feet to the northwest. The National Wetland Inventory and USA Hydric Soils dataset indicate the wetland is surrounded and confined by uplands with no discrete feature to indicate path of flow Based on the information above we have determined that the subject resource does not meet the definition of "waters of the United States."
WD	0.18 Ac	The wetland is abutting a non-jurisdictional feature. The adjacent water body (S16C) has been determined to be non-jurisdictional. See Section B of this MFR for documentation of the jurisdictional status of the adjacent water body. Based on the information above we have determined that the subject resource does not meet the definition of "waters of the United States."
OW6	0.74 Ac	The open water feature is abutting a non-jurisdictional feature. The adjacent water body (S17) has been determined to be non-jurisdictional. See Section B of this MFR for documentation of the jurisdictional status of the adjacent water body. Based on the information above we have determined that the subject resource does not meet the definition of "waters of the United States."
OW1	0.07 Ac	The open water feature is abutting a non-jurisdictional feature. The adjacent water body (S16D) has been determined to be non-jurisdictional. See Section B of this MFR for documentation of the jurisdictional status of the adjacent water body. Based on the information above we have determined that the subject resource does not meet the definition of "waters of the United States."
OW9	0.43 Ac	The open water is not directly abutting a water of the United States based on field verification on October 22, 2025. LIDAR imagery did not reveal the presence of a

		continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to OW9 is OW7 located approximately 59 feet to the south. The National Wetland Inventory and USA Hydric Soils dataset indicate the wetland is surrounded and confined by uplands with no discrete feature to indicate path of flow Based on the information above we have determined that the subject resource does not meet the definition of "waters of the United States."
ISO OW8	0.08 Ac	The open water is not directly abutting a water of the United States based on field verification on October 22, 2025. During the Corps' site visit on October 22, 2025 ISO OW8 was observed to be isolated and did not have a continuous surface connection to a jurisdictional water. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to ISO OW8 is OW09, located approximately 20 feet to the south severed by a road with no visible outlets. The National Wetland Inventory and USA Hydric Soils dataset indicate the open water is surrounded and confined by uplands with no discrete feature to indicate path of flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
ISO OW10	0.65 Ac	The open water is not directly abutting a water of the United States based on field verification on October 22, 2025. During the Corps' site visit on October 22, 2025, ISO OW10 was observed to be isolated and did not have a continuous surface connection to a jurisdictional water. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including

		shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to ISO OW10 is S9, located approximately 419 feet to the west. The National Wetland Inventory and USA Hydric Soils dataset indicate the open water is surrounded and confined by uplands with no discrete feature to indicate path of flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
ISO OW2	0.29 Ac	The open water is not directly abutting a water of the United States based on field verification on October 22, 2025. During the Corps' site visit on October 22, 2025 ISO OW2 was observed to be isolated and did not have a continuous surface connection to a jurisdictional water. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to ISO OW2 is S9, located approximately 190 feet to the west. The National Wetland Inventory and USA Hydric Soils dataset indicate the open water is surrounded and confined by uplands with no discrete feature to indicate path of flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
ISO OW3	0.89 Ac	The open water is not directly abutting a water of the United States based on field verification on October 22, 2025. During the Corps' site visit on October 22, 2025 ISO OW3 was observed to be isolated and did not have a continuous surface connection to a jurisdictional water. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to ISO OW3 is S8 perennial, located approximately 423 feet to the east. The National Wetland Inventory and USA Hydric Soils dataset

		indicate the open water is surrounded and confined by uplands with no discrete feature to indicate path of flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
ISO OW4	0.59 Ac	The open water is not directly abutting a water of the United States based on field verification on October 22, 2025. During the Corps' site visit on October 22, 2025 ISO OW4 was observed to be isolated and did not have a continuous surface connection to a jurisdictional water. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to ISO OW4 is S4, located approximately 375 feet to the north. The National Wetland Inventory and USA Hydric Soils dataset indicate the open water is surrounded and confined by uplands with no discrete feature to indicate path of flow. Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".
ISO OW5	0.03 Ac	The open water is not directly abutting a water of the United States based on field verification on October 22, 2025. During the Corps' site visit on October 22, 2025 ISO OW5 was observed to be isolated and did not have a continuous surface connection to a jurisdictional water. LIDAR imagery did not reveal the presence of a continuous surface water connection to the nearest WOTUS. The National Hydrography Dataset and delineation materials submitted by the applicant, including shapefiles, and the DEM and Hillshade layers show the nearest downgradient waters of the U.S. to ISO OW5 is S12, located approximately 412 feet to the west. The National Wetland Inventory and USA Hydric Soils dataset indicate the open water is surrounded and confined by uplands with no discrete feature to indicate path of flow.

		Based on the information above, we have determined that the subject resource does not meet the definition of "waters of the United States".

8. DATA SOURCES. List sources of data/information used in making determination. Include titles and dates of sources used and ensure that information referenced is available in the administrative record.

   a. Consultant report dated September 8, 2025
      I. Field photos (consultant field visit conducted February 23, 2023, March 7, 2023, April 16, 2024, and August 13-14, 2025
      II. Feature Description Narratives
      III. Topographic Map
      IV. Watershed Map
      V. USACE disagreed with the jurisdictional assertions documented in the consultants' report of features S8, OW10, S8B, S8A, OW4, S14, and S12A as headwater or intermittent transition (I/E) points that were not correctly identified in the report. Additionally, two previously unmapped features were identified during the USACE field visit conducted on October 22, 2025 (S2A and S2B in S-2 valley).

   b. Data provided by the consultant at later dates:
      I. Updated map, received November 14, 2025, addressing the discrepancies outlined in Section a.V above. This map was utilized for the AJD.

   c. USACE field visit conducted October 22, 2025
      I. Field Verification Photos
      II. Site Visit Notes
      III. APT, dated October 22, 2025: USACE utilized a USACE generated APT report which indicated wetter than normal conditions in the dry season during the 90-day rolling average preceding the October 22, 2025 site visit. USACE determined that the site conditions on the day of the site visits were "normal" and that the ordinary high water mark indicators were representative of the streams' normal condition. The observations did not seem to be heavily altered by drought conditions or unduly influenced by large flood events.
      IV. All the above aquatic features were considered together with the site visit observations and a review of the climatic data to determine the appropriate flow and jurisdictional determinations for the features listed above. A weight of evidence approach has been utilized.

   d. National Regulatory Viewer Layers accessed December 2, 2025

I. National Wetland Inventory
II. National Hydrography Dataset
III. USA Soils Map Units
IV. 3DEP Digital Elevation Model (DEM)
V. 3DEP Hill Shade

9. OTHER SUPPORTING INFORMATION.

10. NOTE: The structure and format of this MFR were developed in coordination with the EPA and Department of the Army. The MFR's structure and format may be subject to future modification or may be rescinded as needed to implement additional guidance from the agencies; however, the approved jurisdictional determination described herein is a final agency action.

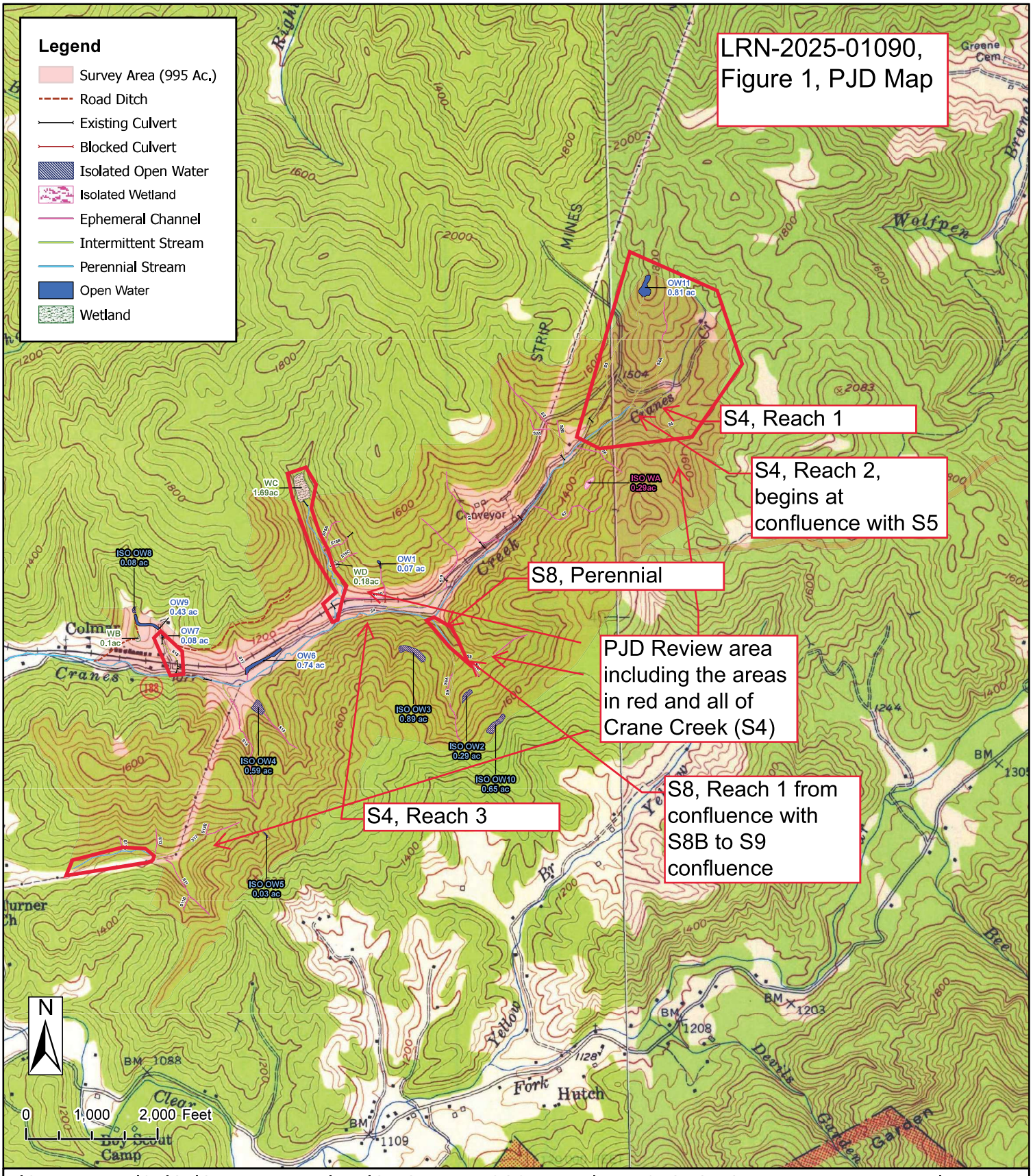


FIGURE 5. JURISDICTIONAL DETERMINATION ON THE USGS 1954 MIDDLESBORO NORTH, KY AND 1954 VARILLA, KY 7.5' TOPOGRAPHIC QUADRANGLES

Nally & Hamilton Enterprises, Inc.

PROJECT NAME: Cranes Creek	
PROJECT LOCATION: Bell County, Kentucky	
PRINT DATE: 11/10/2025	
KDNR#: 807-0501	
USACE#: LRN-Pending	Drawn by: JK
WPT#: 2023-10	Checked by: MDB

WAYPOINT LLC

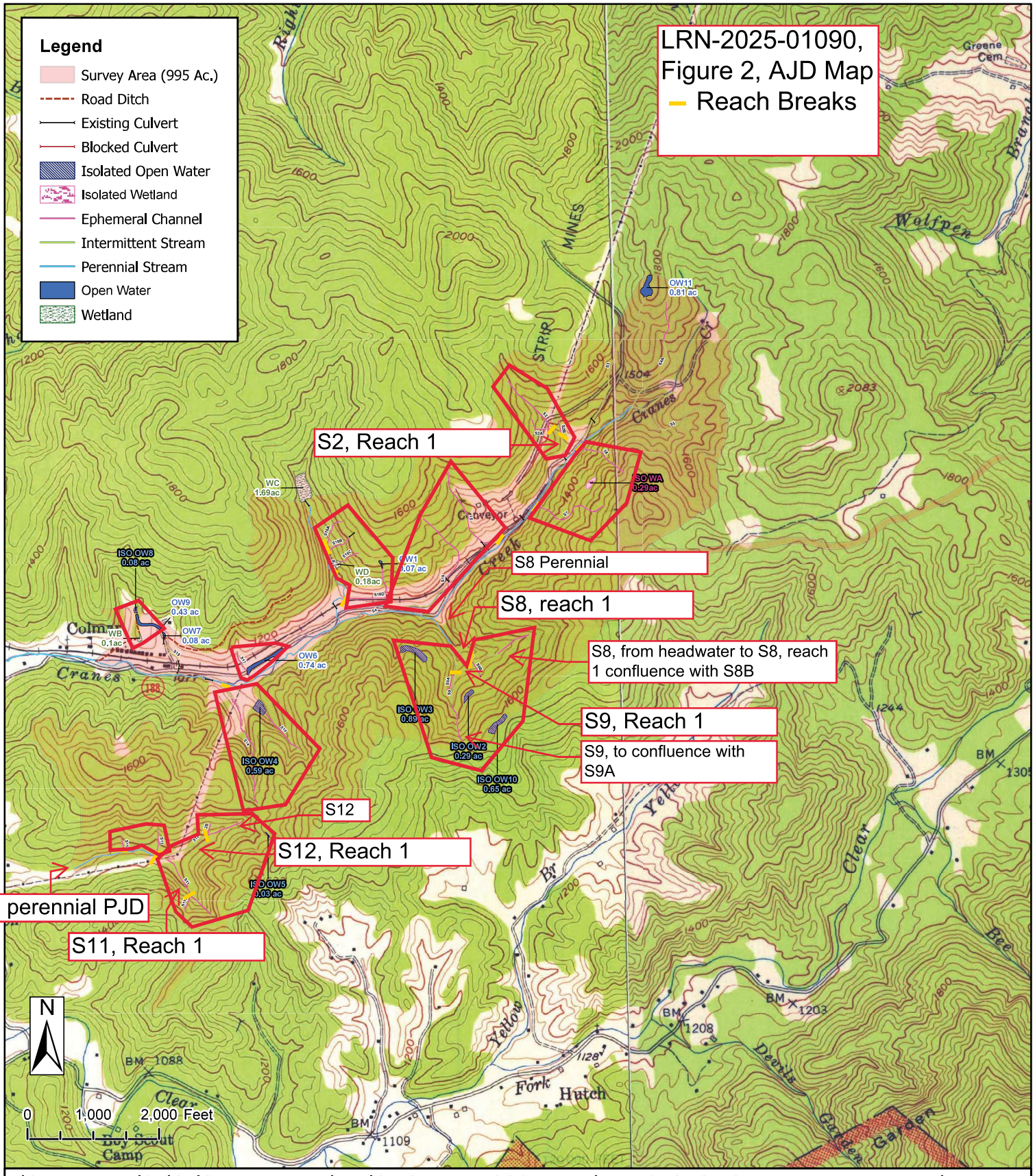


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WPT#: 2023-10	Checked by: MDB

WAYPOINT LLC

Table 1: PJD Water Table

Site Number	Latitude (decimal degrees)	Longitude (decimal degrees)	Estimated amount of aquatic resource in review area (acreage and linear feet, if applicable)	Type of aquatic resource (i.e., wetland vs. non-wetland waters)	Geographic authority to which the aquatic resource "may be" subject (i.e., Section 404 or Section 10/404)
OW11	36.680479	-83.623059	0.81 acres	Non-wetland waters	Section 404
OW7	36.666407	-83.648487	0.08 acres	Non-wetland waters	Section 404
S11 Per	36.65718	-83.64917	1318.5187 feet	Non-wetland waters	Section 404
S15	36.6661	-83.6485	661.5707 feet	Non-wetland waters	Section 404
S16	36.67172	-83.64084	2335.2913 feet	Non-wetland waters	Section 404
S3	36.68009	-83.62318	2509.1637 feet	Non-wetland waters	Section 404
S4	36.67553	-83.62402	10212.1322 feet	Non-wetland waters	Section 404
S4 Lower	36.6754	-83.62334	206.3615 feet	Non-wetland waters	Section 404
S4 Upper	36.67606	-83.62167	616 feet	Non-wetland waters	Section 404
S4A Eph	36.67985	-83.62211	608.6663 feet	Non-wetland waters	Section 404
S4A Int	36.67826	-83.62226	1208.3584 feet	Non-wetland waters	Section 404
S5	36.67565	-83.62024	1205.4078 feet	Non-wetland waters	Section 404
S8 Per	36.66582	-83.63365	473.5953 feet	Non-wetland waters	Section 404
S8, reach 1	36.66509	-83.63261	433.861 feet	Non-wetland waters	Section 404
WC	36.672453	-83.641119	1.69 acres	Wetland	Section 404