HDSS Survey of Parkerson Mill Creek
Project Report

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Executive Summary

Parkerson Mill Creek and its tributaries, located in and around Auburn University (AU) in east-central Alabama, are increasingly impacted by urbanization within the watershed, resulting in heightened stormwater runoff and associated environmental issues. AU has observed symptoms of degradation, including flashy hydrology, accelerated erosion, and diminished streambed quality, all contributing to stream instability and compromised water quality. In response, AU enlisted Trutta Environmental Solutions, LLC to perform a detailed High Definition Stream Survey (HDSS), aiming to collect data that would support an effective stormwater management and stream restoration strategy.

The HDSS project's core objectives were twofold: (1) to conduct a baseline HDSS inventory across the Parkerson Mill Creek watershed to assess current conditions and (2) to complete an HDSS-SCA (Stream Condition Assessment) for classifying, identifying, and prioritizing the stream sections most in need of remediation. The HDSS approach enabled a high-resolution survey of stream channels, banks, and riparian zones, producing a detailed and actionable dataset for AU to guide its watershed management efforts.

HDSS methodologies involved systematic, rapid collection of data across Parkerson Mill Creek's mainstem and tributaries, capturing baseline conditions through high-resolution, geo-referenced video (StreamView) and high-quality still imagery. The data classified various stream functions and modifications, detailing conditions such as streambed, bank, and riparian zone health, as well as noting natural and human-made point features affecting the stream. This comprehensive dataset facilitated the creation of a geospatial database and allowed for a thorough condition assessment of the stream corridor.

Overall findings indicate that the Parkerson Mill Creek watershed is in average condition, with 62.6% of the surveyed area classified as 'Average,' 27.5% as 'Sub-optimal,' and less than 10% as 'Poor' or 'Very Poor.' Notably, upstream segments displayed poorer conditions relative to downstream areas, with tributary streams performing worse than the mainstem for specific metrics, such as 'Poor' and 'Very Poor' scores. The HDSS survey also highlighted areas with clusters of discrete point features, such as seeps and springs, where discolored water appeared to percolate from the streambed. These features may require additional assessment to determine their potential as point-source contaminants.

Segment-specific evaluations revealed that the AU Forestry and Coliseum segments were in the poorest condition, likely due to ongoing restoration in the AU Forestry segment and significant urban development along the Coliseum section. Conversely, the AU Beef Unit, Lower Mainstem, and The Hub segments demonstrated the highest scores, with the AU Beef Unit achieving the best overall condition.

The HDSS approach allows AU to prioritize areas needing intervention, relying on the combined Overall Functional, Condition, and Point Severity scores derived from the HDSS-SCA analysis. These assessments provide a prioritized roadmap for addressing the impacts of urbanization on watershed health, focusing on specific restoration needs and critical areas. The HDSS system's

flexibility also allows for further refinement of priorities by incorporating additional criteria, such as access, resource availability, and proximity to infrastructure.

The application of HDSS provides AU with a comprehensive dataset that will support targeted, data-driven watershed management decisions, ultimately aiming to enhance the Parkerson Mill Creek watershed's ecological health and resilience against the adverse effects of stormwater runoff and urbanization.

Introduction

Parkerson Mill Creek and its tributaries, located in and around Auburn University (AU) in east-central Alabama, are showing signs of degradation due to development within the watershed. As the watershed landscape has changed, increased stormwater runoff has led to impacts such as flashy hydrology, accelerated erosion, and degradation of natural streambed materials, all of which contribute to stream instability and water quality issues.

To address stormwater management challenges, AU required a detailed inventory and assessment of Parkerson Mill Creek and its tributaries. In response, Trutta Environmental Solutions, LLC (Trutta) utilized its advanced High Definition Stream Survey (HDSS) approach to collect extensive data on stream channels, streambanks, and riparian zones within the watershed. This comprehensive evaluation aims to inform a targeted management strategy, helping to mitigate the impacts of stormwater runoff on the streams and support long-term ecological health.

The HDSS method offers several advantages over traditional stream assessments by capturing continuous, high-quality data along the entire stream corridor, enhancing the University's ability to identify and address problem areas in the watershed. HDSS StreamView Video, a key component of this project, provides a visual record of current conditions, enables clear identification of degraded areas, and serves as a valuable tool for monitoring future remediation efforts. Additionally, this video footage is designed to be an educational resource, assisting managers and the public in understanding the importance of stream health and the impacts of anthropogenic alterations within the watershed.

The HDSS project for Parkerson Mill Creek focused on conducting a detailed visual stream corridor survey to provide AU with an extensive dataset to guide effective stream restoration and stormwater mitigation efforts. The project comprised seven key tasks:

(1) Conduct HDSS Stream Corridor Inventory of Parkerson Mill Creek and related tributaries,
(2) Develop high-resolution, geo-referenced video (i.e., StreamView videos) for HDSS,
(3) Use StreamView video or high-resolution still imagery to classify:
    a. function and modification of streambed, streambanks, and riparian zones,
    b. the extent and location of natural and anthropogenic discrete point features affecting in- and near- stream channel conditions,
(4) Develop geospatial databases of inventory
(5) Conduct a Condition Assessment of the stream corridor by applying the classified data,
(6) Incorporate Condition Assessment into geospatial database,
(7) Deliver technical Report, StreamView videos, and geospatial databases.

This thorough approach provides AU with valuable tools for prioritizing and addressing stormwater-related challenges in the watershed.

Methods

The High Definition Stream Survey (HDSS) is a structured inventory and assessment approach that follows a repeatable methodology for consistent data collection and analysis across the watershed (Figure 1). The tasks were conducted systematically to ensure comprehensive coverage of the streams within the Parkerson Mill watershed. The HDSS approach allowed for the documentation of current stream conditions (inventory) and facilitated a comparative analysis (assessment) of both high-quality and degraded stream segments. This consistent and repeatable methodology provides a robust framework for evaluating stream health and prioritizing areas for reclamation and remediation efforts.

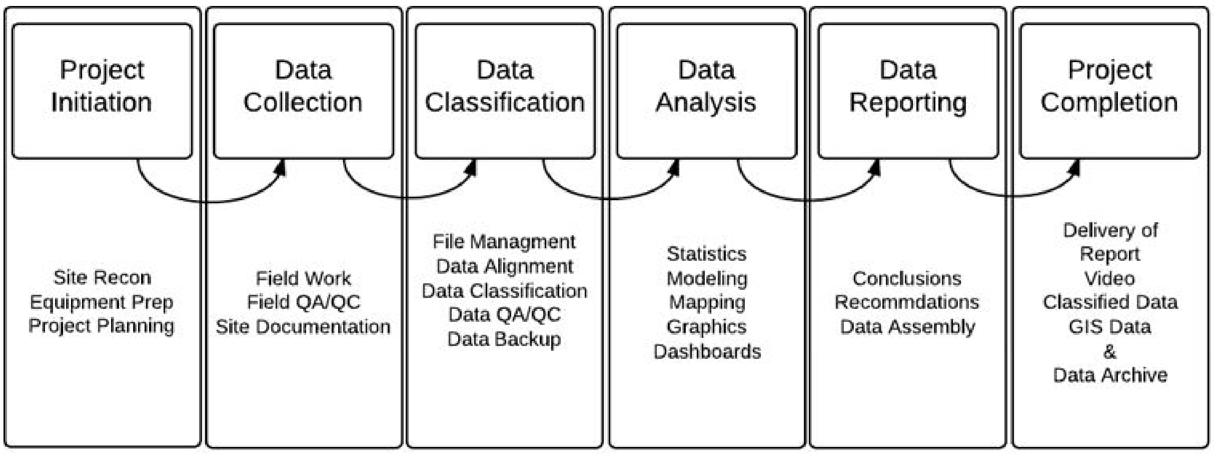


Figure 1: The standardized HDSS project flow chart.

HDSS Stream Corridor Survey

The High Definition Stream Survey (HDSS) method was used to collect, classify, and analyze the data required for this project. In general, the HDSS approach follows a standardized series of steps that promotes rapid, systematic collection and processing of large amounts of river condition information. The specifics of the data collected may vary with the project's requirements but following the general HDSS process ensures a successful project.

In addition to a structured data collection methodology, we prioritize safety as a key component of field operations. A comprehensive safety approach was implemented to ensure the well-being of survey teams while working in diverse and sometimes hazardous environments, including fast-flowing streams, difficult terrain, and areas with limited access. The safety plan included pre-survey preparations, personal protective equipment (PPE), communication protocols, and emergency response strategies tailored to the specific conditions observed in Parkerson Mill Creek.

- **Pre-survey safety planning** involved conducting risk assessments for each stream segment before the field team began data collection. This included reviewing stream conditions such as flow rate, depth, potential hazards (e.g., obstructions, unstable banks), and access points. Weather conditions were closely monitored, and surveys were rescheduled in the event of heavy rain or high-water levels to avoid unsafe situations. The field team was trained in water safety, including how to handle swift water.
- **Personal protective equipment (PPE)** was mandatory for all team members and included life vests (on boats), high-visibility vests, wading boots with good traction, gloves, and weather-appropriate clothing, when applicable. Additionally, specialized gear is required when conditions warrant such.
- **Communication protocols** were established to maintain constant contact between field teams and base personnel. Additionally, real-time communication devices were available and routine check-in times were established to ensure safety.
- **Emergency response procedures** were reviewed prior to field surveys and rehearsed regularly. Team members were required to carry a first aid kit and were trained in basic first aid and CPR.

By integrating these safety measures into every aspect of the HDSS, Trutta ensures that field operations are conducted with the highest regard for the health and safety of the team, minimizing risks while ensuring high-quality data collection.

Field Methods

HDSS Platforms

For this HDSS survey, the backpack mounted system (Figure 2) was utilized. This specific data collection platform was selected based on stream conditions such as depth, discharge, and accessibility of the individual stream segments. The HDSS backpack was outfitted with four video cameras that were also integrated with GPS technology (Table 1).

Coordinate positions were recorded for each second of the survey using an Emlid Reach M2 GNSS GPS receiver. Previous surveys revealed challenges in obtaining accurate positional data due to the lack of Real Time Kinematic (RTK) corrections caused by poor cellular network coverage, as well as the presence of tall bluffs and dense tree cover along many stream segments. To overcome these challenges, all positional data was post-processed using post-processing kinematic correction to improve coordinate accuracy. As a backup, a Garmin GPSMap 64 GPS receiver, featuring a high-sensitivity GPS and GLONASS system with a quad-helix antenna, was also used to provide approximately 1-meter horizontal accuracy.

Video imagery was captured using four GPS-enabled video cameras. The above-water video was recorded with GoPro Hero 8 cameras, each equipped with custom polarizing filters to reduce water surface glare. This comprehensive suite of tools ensured that the survey gathered robust, high-resolution data for both visual assessment and quantitative analysis of stream conditions within the Parkerson Mill Creek survey area.

Figure 2: HDSS backpack setup for the survey on wadable segments of Parkerson Mill Creek. Emlid Reach M2 was located at the top of the backpack directly behind the surveyor's head on the backpack. Two video cameras were located on the chest of surveyor (forward and down views) and two cameras were mounted on the left and right of the backpack frame providing a view of the left and right streambanks. A GPSMap 64 was also located in the front breast pocket of the surveyor.

Table 1: Hardware used on the data collection platforms.

Collector Type	Make	Model	Enabled Features	Rate	Company
Primary Locational Receiver	Reach GPS	M2	RTK and PPK data collection	1 Hz	Emlid Tech Kft. Budapest, Hungary
Secondary Locational Receiver	Garmin	GPS Map 64	WAAS GPS	1 Hz	Garmin International Inc. Olathe, KS
Above water Video Camera	GoPro	Hero 8	GPS, Image Stabilization	30 fps	GoPro, Inc. San Mateo, CA.

Data Processing and Analysis

Following field data collection, geo-referenced video was combined with the GPS such that each data point was associated with Coordinated Universal Time (UTC) and coordinate information. The individual files were assembled to form a single, georeferenced, continuous video tracklog (i.e., StreamView), referenced to a common location and time, covering the Parkerson Mill Creek survey area. This StreamView Video was classified using HDSS video coder software which allowed an appropriate score to be applied to each second of the video and associated GPS location. Data from each survey track were used to show conditions across the stream channel. The centerline of the Parkerson Mill Creek and tributaries were based on a modified National Hydrography Dataset (NHD) GIS layer for the Parkerson Mill Basin. The line of the stream, based on this modified NHD, allows the data to be used in other analyses using this commonly available line file. Each point in the survey was spatially associated with the nearest point stream centerline. From this relationship, we were able to plot points (approximately equal to 1 m) for each parameter by their defined category ranking.

Data Quality

Following the assembly of the high-definition video into a continuous StreamView tracklog, the quality of the video was assessed to determine the appropriateness of the video for classification and use prior to analysis. This classification is referred to as Data Quality. To ensure consistency among the surveys, data quality classification identified possible issues with the data such as the locations where the geo-referenced video is obscured. Additionally, the data quality classification noted where issues or questions with the data occurred for the visual classifier (e.g., revisits) which triggered additional review by the project lead. The continuous video file was classified into one of 12 categories (Table 2) for their entire duration.

Table 2: Data location and type with respective definitions used during Data Quality classification.

Data Location or Type	Definition
Good Data	Video allows for analysis
Restricted data	All video data obstructed, limiting analysis
Right bank obscured	View of right bank obstructed, limiting analysis
Left bank obscured	View of left bank obstructed, limiting analysis
Left bank and streambed obscured	View of left bank and streambed obstructed, limiting analysis
Right bank and streambed obscured	View of right bank and streambed obstructed, limiting analysis
Dragging	Kayak is dragging on in-channel obstacle requiring the navigator to exit the kayak to continue, often over shallow riffles or debris jams.
Transect	Video where cross-sectional transects were performed
Underground	Channel goes underground, inaccessible by foot or kayak
Off-channel	Video identifies a water management related structure (e.g., detention pond, terracing)
Revisit	Video needs additional review by field staff or others for clarification.
Tablet Survey	Video will be used for photographic description due to safety and difficulty of survey.

Data Review

To increase consistency and completeness, all comments and revisits were addressed following classification and prior to analysis. Comments and revisits that were noted by the observer during the classification process were discussed with the project manager. Once the project reviewer and manager agreed, the element was classified appropriately.

Data Classification

Data were identified and classified using a standard set of criteria. Visual classifications and software algorithms were used to classify the parameters of interest. Visual classifications for the streambed, streambanks, riparian, and discrete point features were conducted using HDSS video coder software while viewing the StreamView videos. Each parameter visually classified was independently observed and scored, requiring multiple viewings of the video. To avoid observer reliability error due to different observers, all scoring of riparian, streambed, streambank, and discrete point feature conditions were performed by a single experienced classifier. Software algorithms were used to classify water depth from digital sonar data. After classification, every GPS point had an associated collection time, latitude, and longitude for the parameter of interest.

The stream condition variables that were assessed in the Parkerson Mill Creek watershed included:

1. Right and left riparian condition,
2. Right and left streambank condition,
3. Streambed condition, and
4. Discrete points features

HDSS Stream Corridor Assessment

One goal of this project was the development of an HDSS Stream Corridor Assessment (HDSS-SCA). The HDSS-SCA framework consists of six fundamental elements: streambed, right and left streambank, right and left riparian area and discrete point features (Figure 3). This framework is similar to the Platts et al. (1983) definition of the riparian zone, with the exception of discrete features. Continuous data include the streambed, left and right streambanks, and left and right riparian areas while discrete point features are point locations of anthropogenic or environmental importance. When combined, these six elements provide an HDSS Stream Corridor Condition Assessment where these six elements define the location, extent, and condition of issues within the stream corridor to aid in planning and effective management. Additionally, each element can be used independently to identify and target specific management actions.

**Note - In the following methods, example images are from many different locations and are meant to be examples of the range and type of conditions observed, not observational results from the Parkerson Mill Creek watershed.*

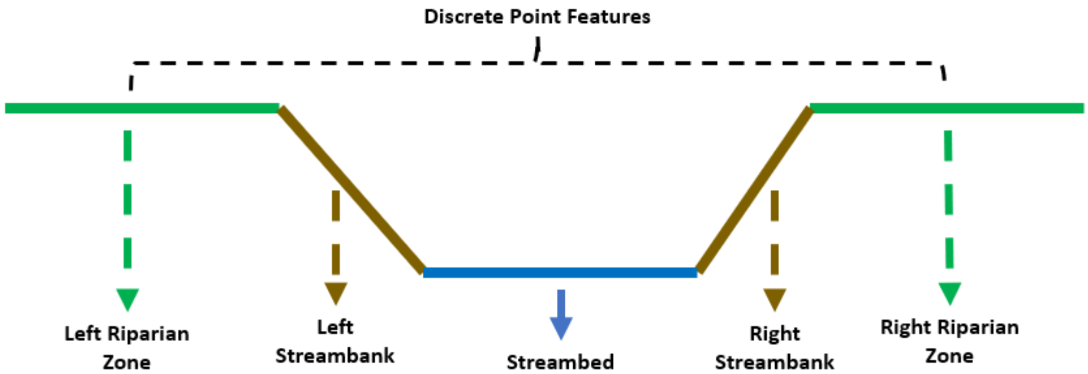


Figure 3: Elements of the HDSS Stream Corridor Assessment evaluated using the high-definition stream survey technique. Discrete features are located within the corridor and can affect the stream form and function, most often along the streambanks or streambed.

Streambed Function and Modification

The streambed is the confine for which water is actively touching within the stream channel during normal flow conditions; this could also be described as the area within the wetted width of the stream. Many physical parameters associated with habitat for aquatic species are found along the streambed as well as parameters affecting channel morphology. The two elements of function and modification were classified for the streambed. Streambed function was classified and used as a measure of disturbance to the streambed and potential impacts on stream function and stability during high and low flow events. Streambed modification was classified and used as a measure of anthropogenic influence on the streambed. Streambed function and modification were independently viewed and classified during the classification process.

Function of the streambed was primarily rated on a scale from 1 (fully functional) to 5 (non-functional; Figure 4) based on conditions during the survey. The primary characteristics used to classify streambed function included a visual integration of habitat heterogeneity (e.g., water depth and velocities, substrate types, and instream cover), channel shape (e.g., appropriate channel sinuosity and width) and sedimentation. Streambed modification was identified as unmodified (i.e., no human influence), modified (e.g., riprap, gabion baskets, or other highly porous, permeable material) or highly modified (e.g., concrete channel or other non-porous material; Figure 5).

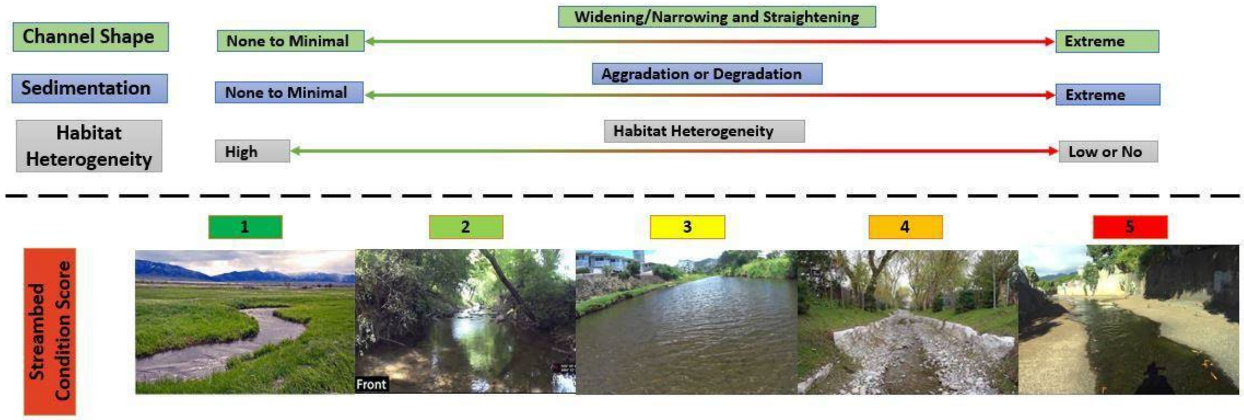


Figure 4: Streambed function scoring criteria that is visually integrated to provide an overall streambed function score (above) and examples of each of the five categories (below) ranging from 1-5, with 1 being the best and 5 being the worst.

Type Score	Type Class	Description
1	Unmodified	Little to no human modification. No obvious erosion control measures have been implemented.
2	Modified	Obvious signs of human modification such as placement of erosion control measures. Measures implemented allow for surface water and ground interaction (e.g., riprap, gabion baskets, etc.)
3	Highly Modified	Obvious signs of intensive human modification to control erosion and discharge. Measures implemented do not allow for surface water and ground interaction (e.g., poured concrete or other highly impermeable surface)

Figure 5: Examples of streambed and streambank modification identifying unmodified, modified, and highly modified streambeds (above) and streambed modification scores, classes, and descriptions (lower).

Streambank Function and Modification

Streambanks are defined as the sloping lands that contain the stream under normal flows. The method used to score streambank function consists of the two elements of function and modification. Streambank function scores reflect the potential for streambank erosion or streambank failure, while streambank modification is used as a measure of anthropogenic influence along the streambank. The functional score consists of five levels ranging from fully functional (1) to non-functional ((5); Figure 6; Figure 7). Streambank modification is identified as unmodified (i.e., no human influence), modified (e.g., riprap, gabion baskets, concrete blankets, or other highly porous, permeable material) or highly modified (e.g., concrete channel or other non-porous material; Figure 8). These two elements of function and modification were individually classified for both the left and right streambank. Both function and modification were continuously assessed individually for both the left and right banks along the entire sampling area by a single experienced classifier.

Left and right streambank function and modification were visually assessed from the high-definition video for both sides of the river. The method used to score function is similar to BESI developed by Connell et al. (2019) for landscape scale assessments of streambank erosion susceptibility. Streambank function is a visual integration of streambank angle, height, surface protection and vegetated diversity. Compared to the BEHI method developed by Rosgen (2001), our method utilizes a riparian condition parameter, similar to Sass and Keane (2012), as a surrogate for root depth and density, and data were viewed on high-definition video captured from the HDSS system. Video has been used with success to determine streambank erosion rates (Hensley and Ayers 2018) and areas susceptible to erosion (Connell et al. 2019). The major advantages of this method over traditional erosion assessments are the reduction of field time, cost and uncertainty when extrapolating data to represent the entire river.

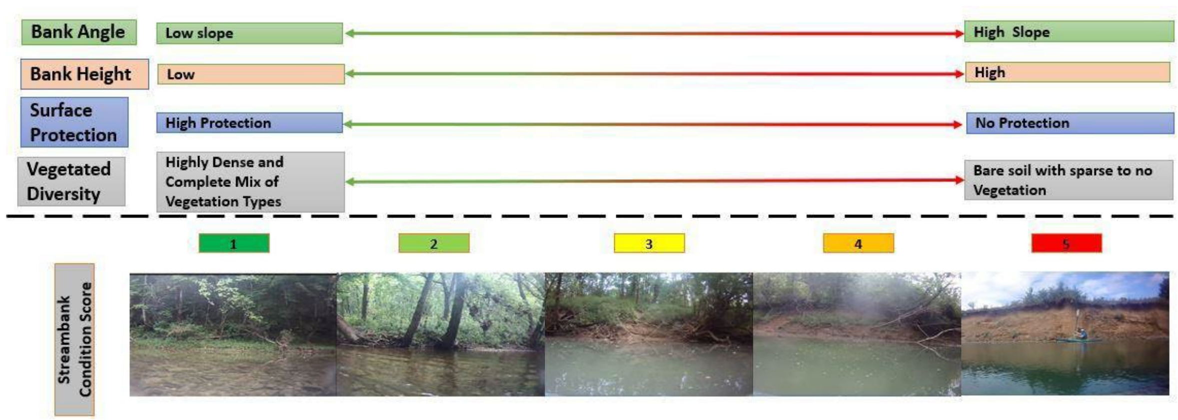


Figure 6: Streambank scoring criteria that is visually integrated to provide an overall streambank function score (above) and examples of each of the five categories (below) ranging from 1-5, with 1 being the best and 5 being the worst.

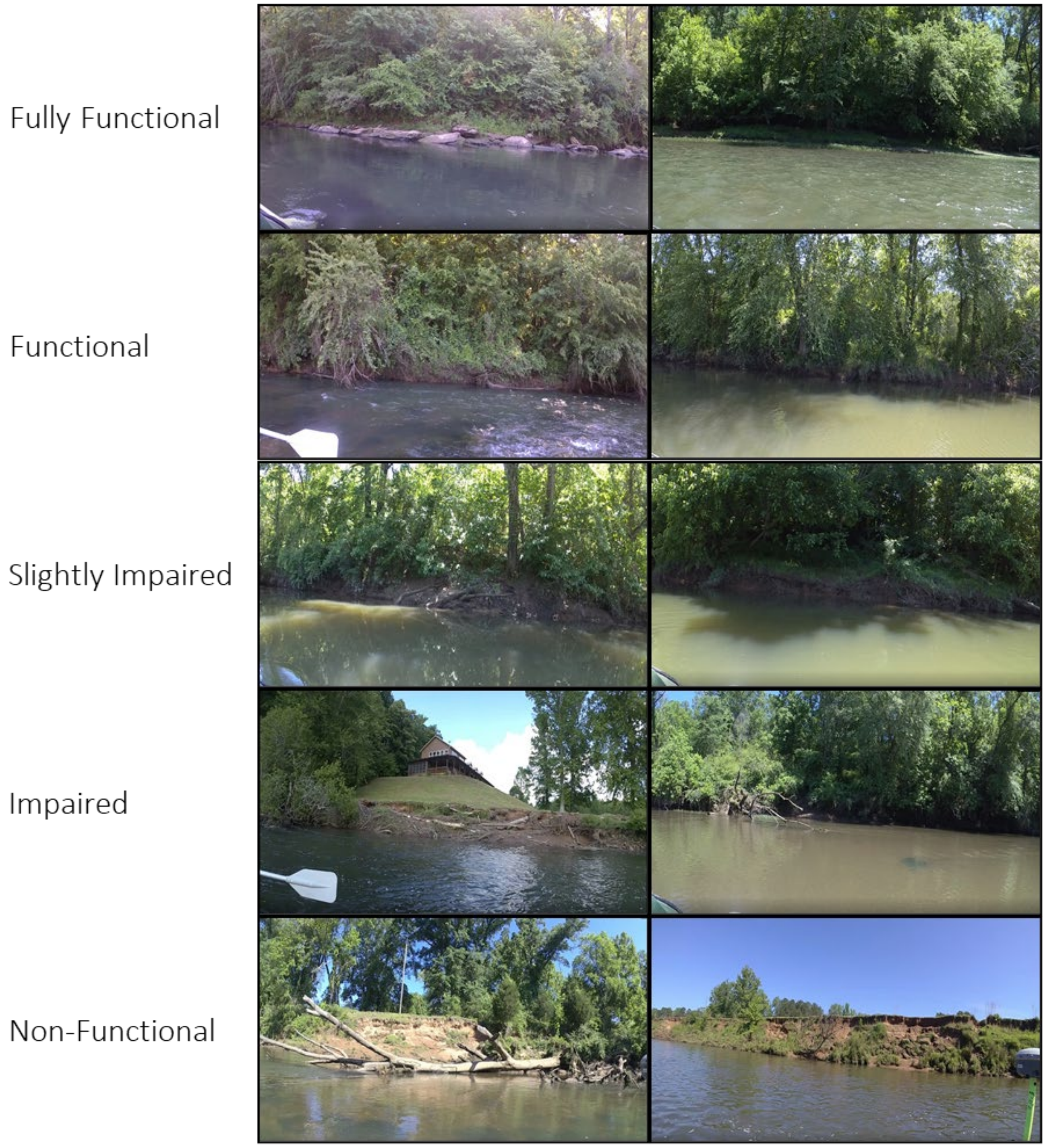


Figure 7: Examples of the five streambank impairment classification levels from various projects.

Type Score	Type Class	Description
1	Unmodified	Little to no human modification. No obvious erosion control measures have been implemented.
2	Modified	Obvious signs of human modification such as placement of erosion control measures. Measures implemented allow for surface water and ground interaction (e.g., riprap, concrete blanket, gabion baskets, etc.)
3	Highly Modified	Obvious signs of intensive human modification to control erosion and discharge. Measures implemented do not allow for surface water and ground interaction (e.g., poured concrete or other highly impermeable surface)

Figure 8: Examples of streambank modification identifying unmodified, modified, and highly modified streambanks (above) and streambank modification scores, classes, and descriptions (below).

Riparian Function

The riparian area encompasses that portion of the terrestrial landscape from the top of the bank outward 30 m (≈160 ft) on the mainstem of Parkerson Mill Creek and its tributaries. Riparian function score reflects the potential for the riparian area to provide food and shelter for aquatic organisms, increase filtration and infiltration of overland flows, increase infiltration to reduce overland flows and stabilize the streambank. Riparian function score also reflects the level of anthropogenic influence along the riparian zone. The functional score consisted of five levels ranging from fully functional (1) to non-functional ((5); Figure 9) and could also be viewed as a range from little (i.e., little to no human influence), to moderate (e.g., agricultural, ranching, timber harvest) to high (e.g., urbanized) levels of human modification. Riparian function was continuously assessed individually for both the left and right banks along the entire sampling area.

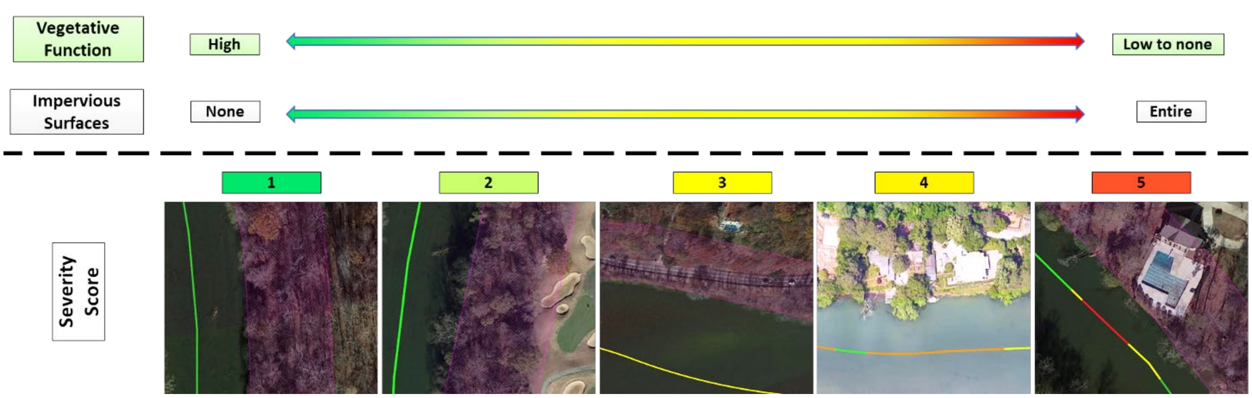


Figure 9: Riparian area scoring criteria that is visually integrated to provide an overall riparian function score (above) and examples of the five categories (below) ranging from 1-5, with 1 being the best and 5 being the worst. Note: functional scores are color coded with fully functional = dark green, functional = light green, slightly impaired = yellow, impaired = orange, and non-functional = red.

Left and right riparian function was assessed by importing aerial imagery and then integrating it with the HDSS data for continuous riparian classification. Function was scored based on the visual integration of vegetative function and impermeable surfaces, with decreases in tree quantity and size, along with an increase in impermeable surfaces, reducing riparian function (Figure 9).

The riparian data was based on the 2022 aerial imagery (Google Satellite images). Each riparian zone was identified by creating 30 m buffers along its length. Left and right riparian zones are identified while looking downstream. The classification of the projected aerial images was viewed at scale ranging from 1:1000-2000. The “average” of the classified riparian function (fully functional to nonfunctional) was collected across the buffer (Figure 10) to obtain a mean functional score. This resulted in a single score (1 to 5) that represented the function and modification of the riparian area. Examples of the five functional riparian classification scores are below (Figure 11).

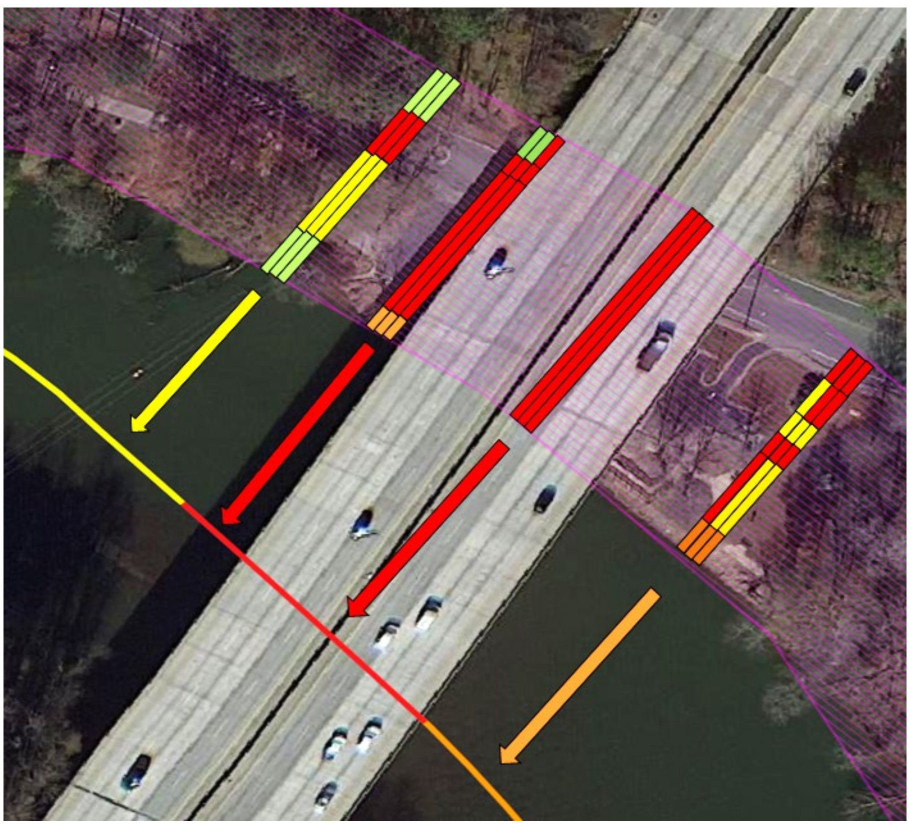


Figure 10: Generalization (not to scale) of the visual integration of the two parameters, vegetative function, and impermeable surfaces, across the riparian buffer to obtain a mean cross-sectional score.

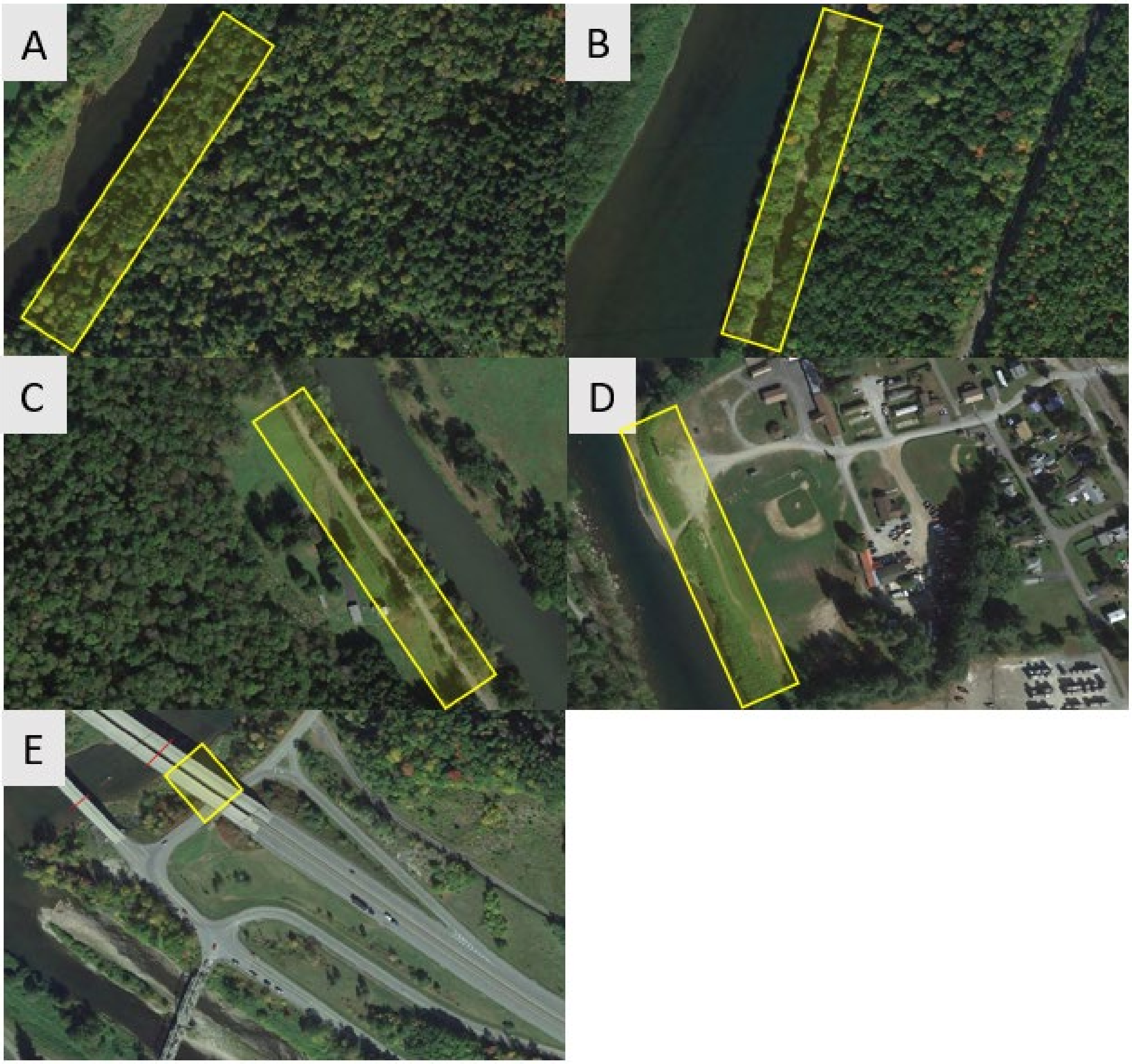


Figure 11: Example images from the Hurricane Creek watershed identify typical riparian classifications fully functional (A), functional (B), slightly impaired (C), impaired (D), and non-functional (E). Yellow boxes represent the 30 m wide riparian area and indicate the location of interest.

Discrete Point Features

Discrete point features are unique manmade or natural features that may affect the physical and biological function of the stream corridor. Discrete point features were identified and classified based on type, with each type containing the elements of position, size, and severity, (Table 3). The type and values for each element are visually determined using the StreamView video. This framework is an expansion of the concept developed by Yetman (2001).

Each discrete point feature type is hierarchically arranged within a class within a category. The five categories include Infrastructure, Natural Features, Intermittent, Recreational User, and Other (Table 4). The infrastructure category has four classes (pipe, road, recreational, and dam). The natural feature category has a single class (complexity), the intermittent category contains four classes (agriculture, construction, sedimentation, and trash), while the recreational user category has a single class (users). The final category, Other, is available for unique or requested classifications and has one class (other). Additionally, new or unique types can be created within the hierarchy under any of the category-class combinations when necessary.

A total of 11 classes containing 33 types were available for classification (Table 5). Each class contains a type or series of types that are identified and described with their respective elements. Discrete point feature types identified within the pipe class include exposed pipe, intake, manhole stack, outfall, and drainage ditch (Figure 12). Features identified within the road class include culvert, overhead bridge, and low water crossing (Figure 13). The two types of in-channel and near-channel were included in the construction class (Figure 14), while types identified within the dam class were dam (i.e., anthropogenic) and beaver dam (Figure 15). The Recreational class includes three types: boat ramp, dock, and pier (Figure 16). The single class of complexity, within the category of natural features, includes the eight discrete point feature types: in-coming channel, in-channel bar, vegetated island, log/debris jam, in-channel vegetation, large wood debris, side channel present, and seeps/springs (Figure 17). The discrete point feature types of excess fines - within the sedimentation class, feature type livestock - within the agriculture class, and type trash - within the trash class, are captured in the intermittent category (Figure 18). The user class, within the recreational user category, has the four types of anglers: angler-wading, angler-shore, angler-boat, and leisure-boat (Figure 19). Additionally, multiple other types within an “other” class are available for additional classifications when required or necessary.

After identifying the type of point feature and the position (Table 6) of the point within the channel, its relative size, and severity were described. These variables combine to determine the overall management issue with the point and can also be used to determine the potential cost for fixing the issue.

Table 3: Elements and description determined for each element of a discrete point feature.

Element	Description
Type	What the point feature represents.
Position	Where across the stream corridor the point occurs.
Size	The relative size to other points within that type.
Severity	The relative scale of impact the feature will have on the stream corridor.

Table 4: Hierarchy of category and class for commonly identified discrete point feature types with definitions.

Category	Class	Description
Infrastructure	Infrastructure related to the installation and maintenance of road, rail, water, electric, waste, etc. systems.	
	Pipe	Any pipe in, along, or over the streambed and streambanks is susceptible to damage during a high discharge event.
	Road	Impacts associated with the development of road and rail infrastructure.
	Dam	Stream flow is reduced or impounded.
	Recreational	Related to the ability to access of stream corridor for recreational use.
Natural Feature	Features that naturally occur within the stream corridor and their presence is not always considered to have a negative effect.	
	Complexity	Features that naturally occur within the stream corridor and their presence is not always considered to have a negative effect.
Intermittent	Common and uncommon observed features not captured in the other categories.	
	Agriculture	Related to agricultural activities.
	Construction	Related to current and recent past actives of construction.
	Sedimentation	Features primarily associated with the negative impact of erosion.
	Trash	Deposition and/or accumulation of refuse material along or within the stream corridor.
Recreational User	Observed human recreational activities	
	User	Human recreational use activities along, within, and on the stream corridor.
Other	Category available for unique or requested classifications.	
	Other	Available for classification of additional types for the Other category.

Table 5: List of potentially identifiable discrete feature types within classes and their brief descriptions.

Class	Type	Description
Pipe	Outfall	Any pipes that discharge into the stream
	Intake	Any pipes that remove discharge from the stream
	Manhole Stack	Prefabricated or constructed pit to access utilities below grade.
	Exposed Pipe	Pipes along the stream's banks or on bed that have become exposed, or pipes built over a stream that could be affected by occasional high flows and does not include pipes with an open end exposed.
	Drainage Ditch	Manmade ditch that discharges into or removes water from the stream.
Road	Overhead Bridge	A structure carrying a pathway, roadway, or railway over a waterway, typically spanning greater than 6.5m (or 20ft).

	Low Water Crossing	Stream crossing of improved, reinforced roadbed, often with concrete planks, slabs, or asphalt, at or slightly above the elevation of the streambed without pipes.
	Culvert	A structure that can allow water to flow under a road, railroad, trail, etc. from one side to the other side. Typically embedded by soil).
Construction	Near-Channel	Construction occurring near or along the banks and/or riparian
	In-Channel	Construction within the stream channel affecting the streambed.
Dam	Dam	A manmade structure used to retain and/or retard flow.
	Beaver Dam	A natural structure used to retain and/or retard flow.
Recreational	Boat Ramp	Location where boats, tubes, and other methods of floating the river or stream routinely enter and exit the water.
	Dock	Location where on-the-water watercraft can be parked on the water.
	Pier	Location where foot access is provided too and/or over the water.
Complexity	In-coming Channel	Is a confluence or where the channel being surveyed meets another stream channel.
	In-channel Bar	Exposed ridge-like accumulation of sand, gravel, or other alluvial material formed in a channel, along the banks, or at the mouth of a stream at an elevation lower than the floodplain.
	Vegetated Island	Discrete parcels of land surrounded by water within the stream channel that are relatively stable. Additionally, the elevation of an island has a point that is ≥ to the floodplain.
	Log/Debris Jam	Accumulation of debris, primarily of material other than LWD, in a channel that may cause ponding of water or alluvial deposition upstream from the accumulation and diversion or widening of the channel.
	In-channel Vegetation	Clump or cluster of emergent or submergent vegetation, more than a few plants, that has the potential to reduce flows and/or assist in bar development.
	Large Woody Debris	LWD is counted inside the wetted width of the channel and has a diameter greater than six inches.
	Side Channel	Location where the channel diverges or converges
	Seeps/Springs	Upwellings of water from the ground
Sedimentation	Excess Fines	Accumulations of fine sediment on the sides and/or bottom of the stream.
Agriculture	Livestock	Livestock are in the stream or near the stream and access is not limited.
Trash	Trash	Areas where trash is concentrated due to dumping or aggregation by currents.
Users	Angler- wading	Angler in stream, not in boat
	Angler- shore	Angler on shore
	Angler- boat	Angler in boat
	Leisure- wading	Individual in stream, not in boat and fishing
	Leisure- shore	Individual on shore fishing
	Leisure- boat	Individual not fishing but using a boat, kayak, raft, tube, etc.

Other	Other	Available for classification of additional unique discrete point features.

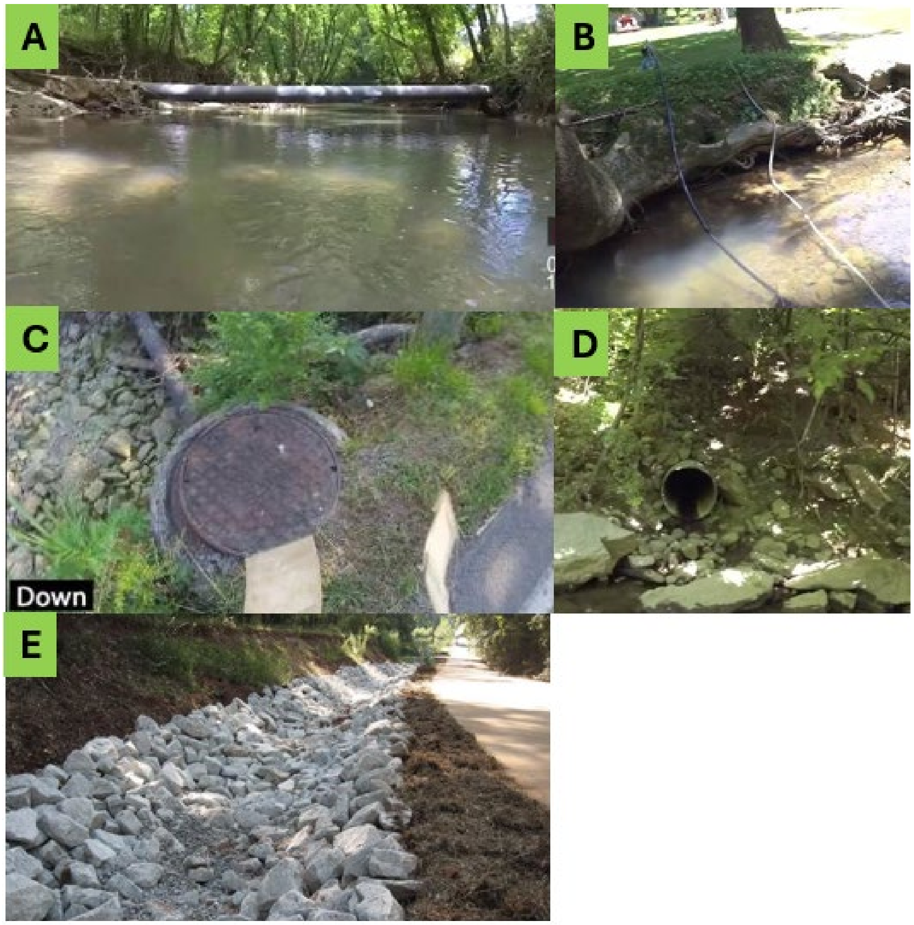


Figure 12: Example images of Pipe discrete point feature type including Exposed pipe (A), intake (B), manhole stack (C), outfall (D), and drainage ditch (E). Example images may not be from this project.

Figure 13: Example images of Road discrete point feature type including bridge (A), culvert (B), and low water crossing (C). Example images may not be from this project.

Figure 14: Example images of Construction discrete point feature type including near-channel (A) and in-channel (B). Example images may not be from this project.

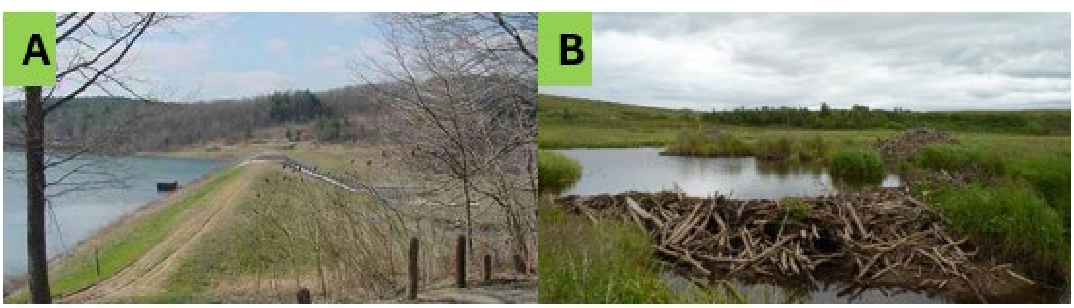


Figure 15: Example images of Dams discrete point feature type including Dam (A) and bever dam (B). Example images may not be from this project.

Figure 16: Example images of Recreation discrete point feature type including boat ramp (A) dock (B), and pier (C). Example images may not be from this project.

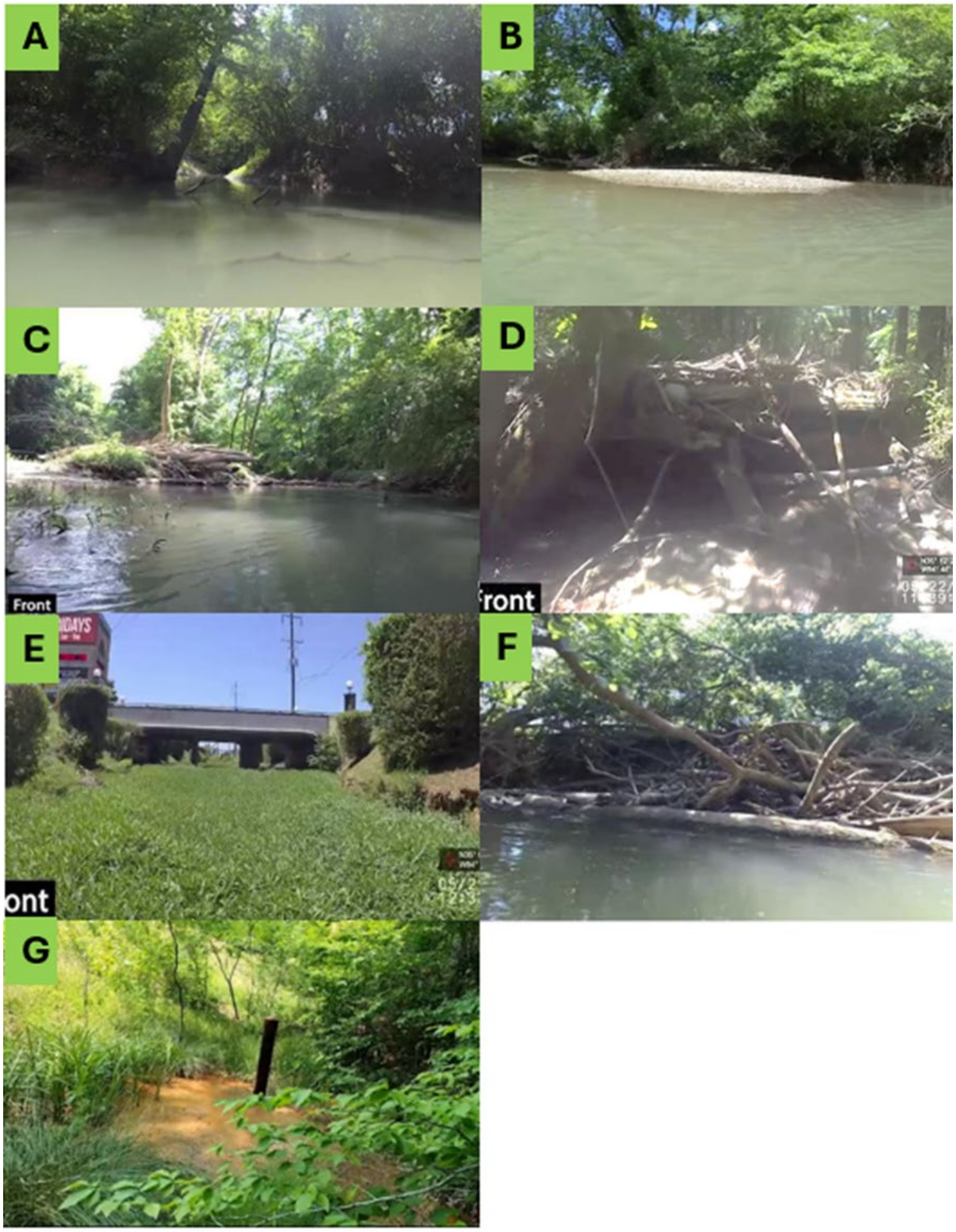


Figure 17: Example images of Complexity discrete point feature types including incoming channel (A), in-channel bar (B), vegetated island (C), debris jam (D), in-channel vegetation (E), large woody debris (F), seep/spring (G) and side channel (image is not present). Example images may not be from this project.

Figure 18: Example images of Intermittent discrete point features by class and type including Sediment (A; excess fines), Agriculture (B; livestock), and Trash (C; trash). Example images may not be from this project.

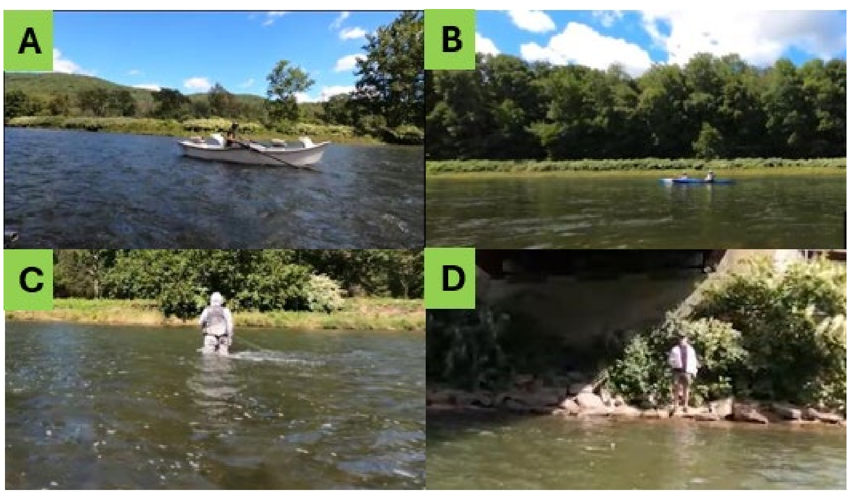


Figure 19: Example images of Recreational User discrete point features of the User class including the four types of angler boat (A), leisure boat (B), angler wading (C), and anger shore (D), while the two remaining types of leisure shore and leisure wading are not provided. Example images may not be from this project.

Table 6: Locations where discrete point features could be observed and their brief description.

Location	Description
Left Bank	Within ¼ of the streams total wetted width of the left bank
Right Bank	Within ¼ of the streams total wetted width of the right bank
In-channel	Between the areas for left and right bank listed above
Both Banks	Occurs only at both left and right banks
Overall	Occurs on left and right banks and in-channel

Data Organization

The data associated with the Parkerson Mill Creek HDSS were stored in geopackages. A geopackage is a spatial data container that allows multiple layers, layer styles and other information to be contained in a single file. For this project, we grouped similar information into five different geopackages (Figure 20). The HDSS StreamView videos that were used for classification were linked to the TrackPoint data and to the general information through their associated video track, date and time, and meter ID (mid). The general information is primarily based on the centerline for the river. The centerline has data from each backpack, associated with a single meter of the river. This allowed the field data to be associated with a common area for subsequent analyses. The general information also contained information and groupings for the overall project. The stream corridor assessment was created from the centerline data. The stream corridor assessment includes information associated with riparian, streambank, streambed conditions, point features and points of interest observed during the survey

It is important to note that most of these data layers were created from custom processing algorithms written in the R software package. The computer programs automate many of the steps needed to go from field data to results and write out the data into a geopackage, spreadsheet, plot or table as necessary. The common field among most of these layers is the meter ID (‘*mID*’ in the data) which is a unique identifier for each meter of the river surveyed. This unique identifier allows relationships to be developed among various layer attributes.

The spatial data contained in the geopackages was all projected in NAD83/UTM Zone 16N (EPSG:26916) and the elevation data used the geoid height based on the EGM(2008-5) geoid above the WGS84 ellipsoid. Most units of measure were in meters, except when noted in the variable title.

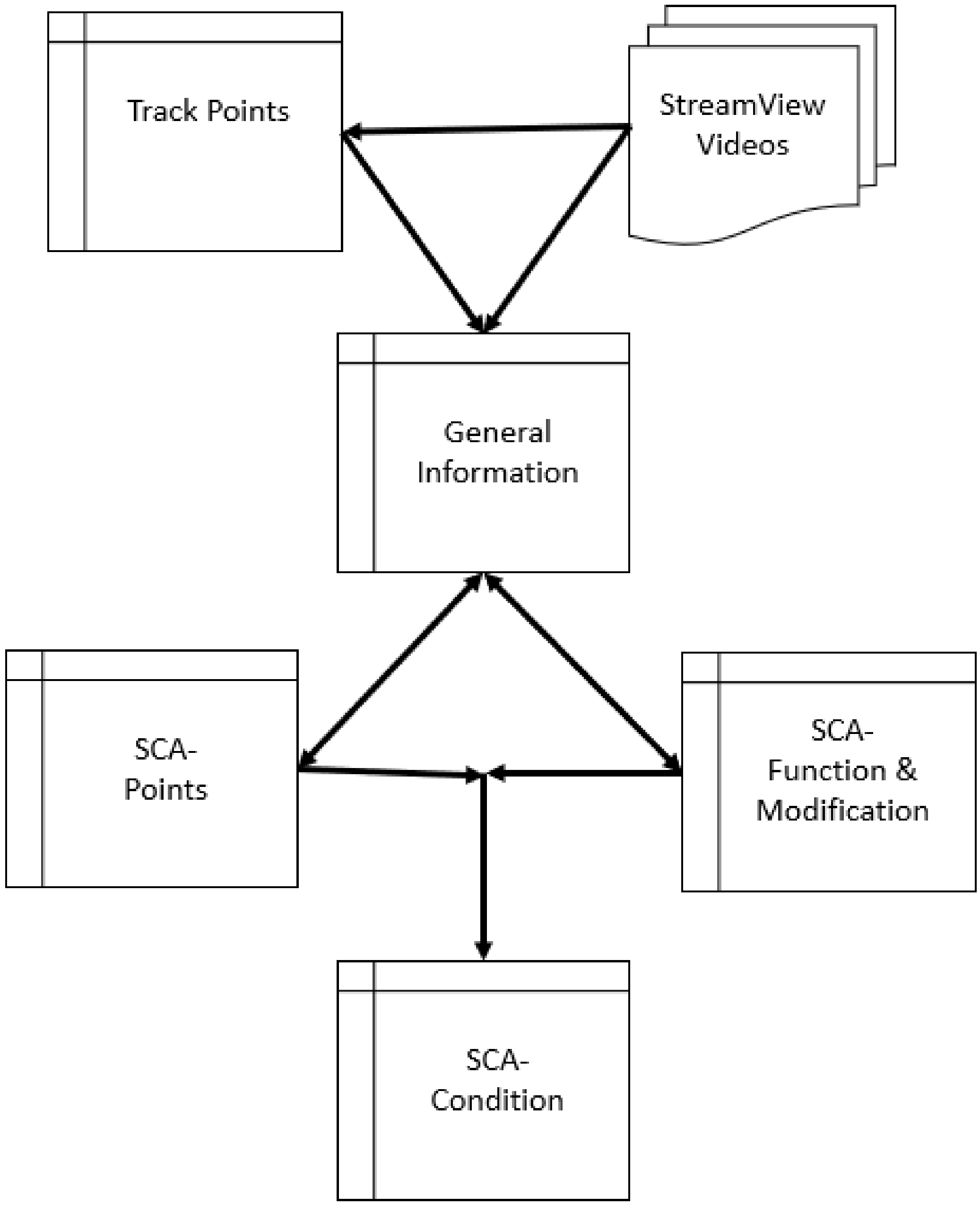


Figure 20: A flowchart depicting the major HDSS data sections and their relationships.

The results are supported with extensive maps found in the Appendices. The maps include an overview map and associated submap sequence covering five more detailed segments of the overall Parkerson Mill Creek sampling area (Figure 21). In most cases, the maps were not duplicated in the results section except where specific examples were appropriate. The submaps were designed to include the entire StreamView video track; however, multiple submaps may need to be reviewed to view the entire track.

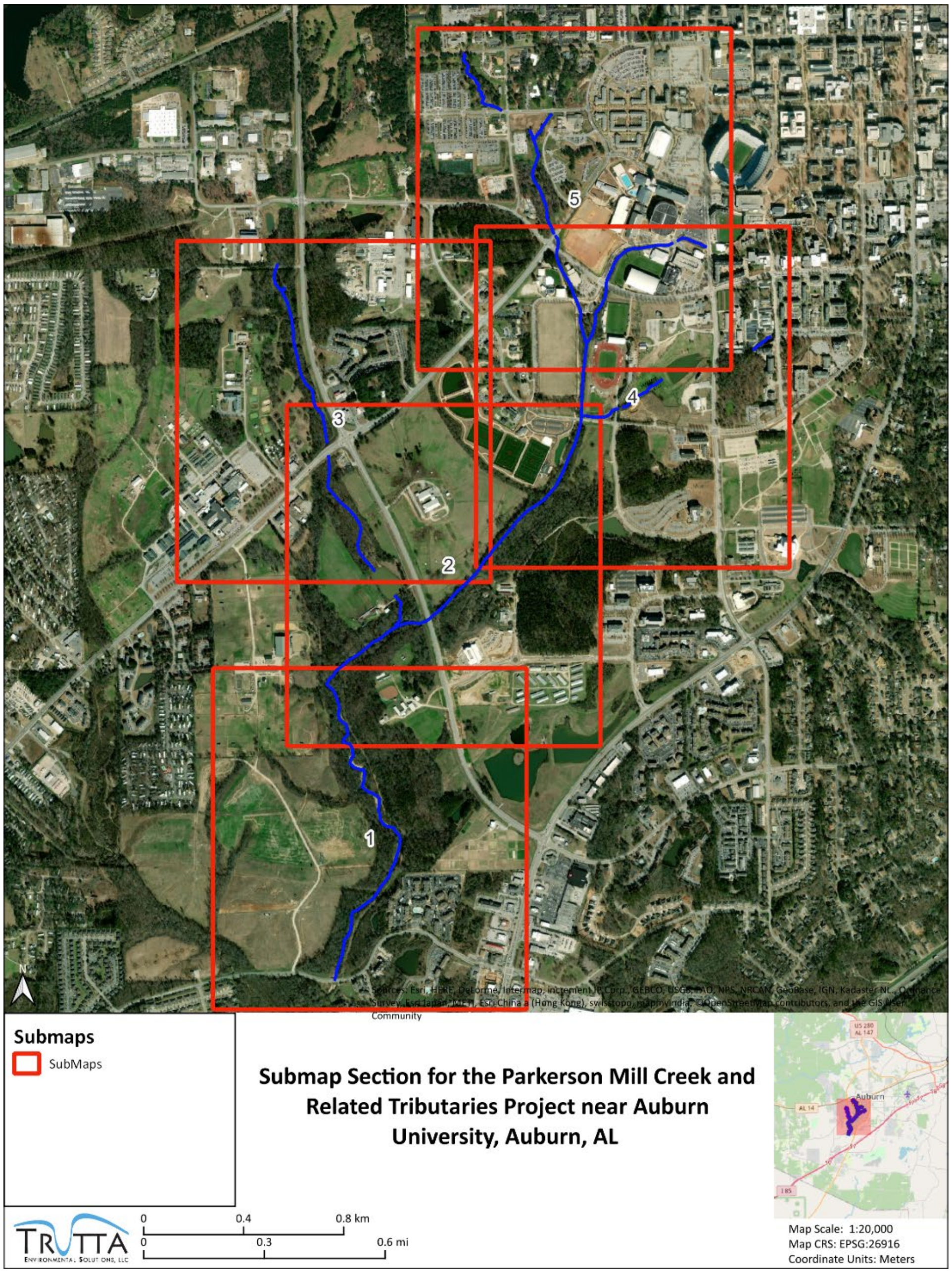


Figure 21: The detailed map sections for the Parkerson Mill Creek HDSS project.

Results

General Project Information

A total of 7.2 km (4.5 miles) of Parkerson Mill Creek and relevant tributaries were surveyed on December 14, 2023, near the Auburn University campus, Auburn, AL. (Table 7). The survey was conducted using the HDSS backpack survey platform (Figure 22). The data collected from the backpack platform were linked to the nearest meter along the centerline of each respective stream. The centerline was created from the National Hydrographic Dataset (NHD) to allow the results to be integrated with other or future management projects.

Table 7: Survey location, dates, platform, and distance for Parkerson Mill Creek, near the University of Auburn, Auburn, AL.

River Segment	**Survey Date**	**Platform**	**Distance (km)**
Parkerson Mill Creek and tributaries	Dec. 14, 2023	Backpack	7.2

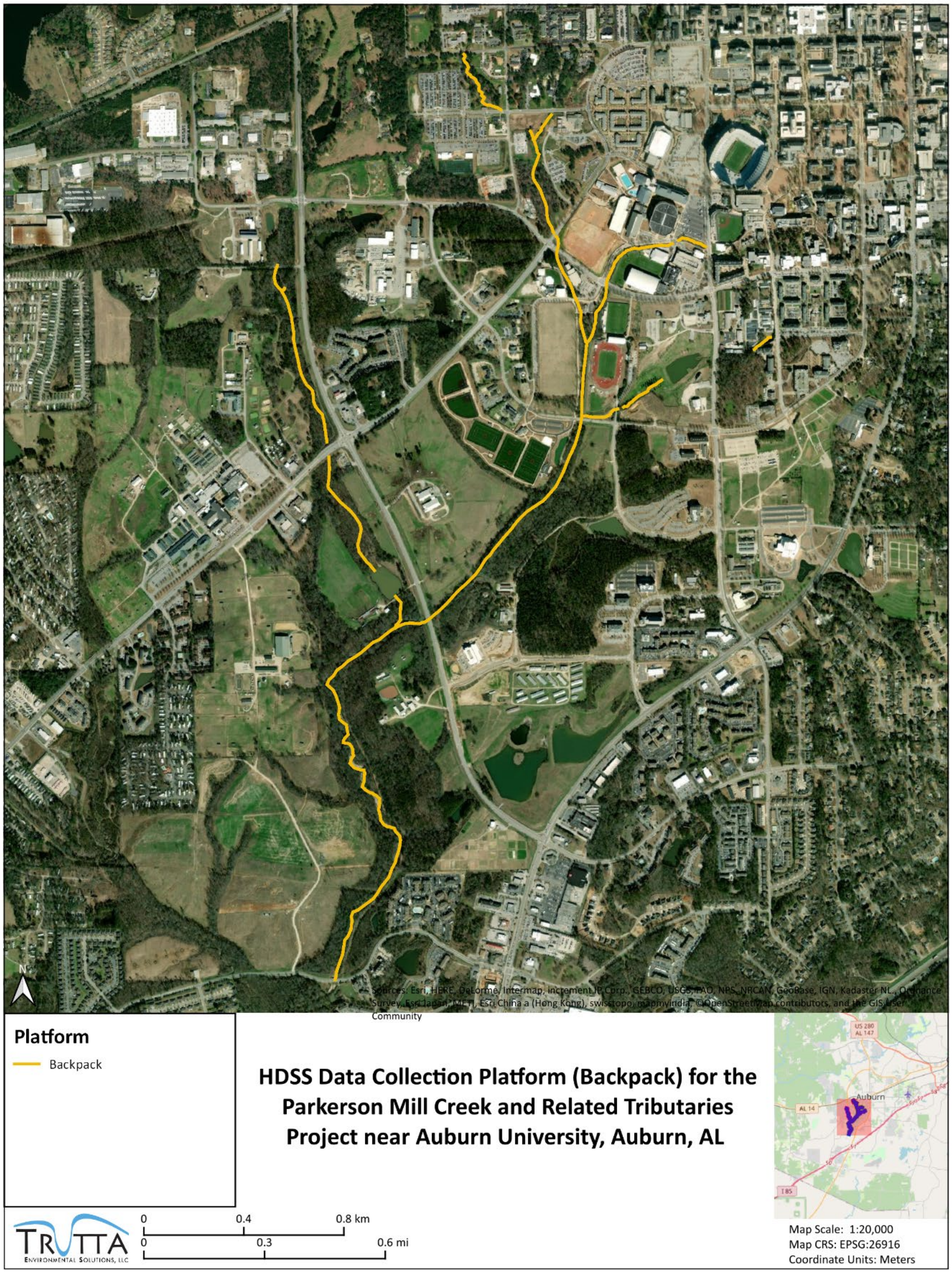


Figure 22: Backpack survey track conducted along Parkerson Mill Creek and major tributaries, near Auburn University, AL., on December 14, 2023.

Weather Conditions

Local weather conditions, during the HDSS survey of Parkerson Mill Creek and its tributaries on December 14, 2023, were generally sunny and cool. Overnight temperature was in the mid-40s, with a daytime high in the lower 60s. Total precipitation in December 2023 prior to the survey was 2.01 inches, reported at the Auburn Number 2 station (station: USC00010425; southeast Auburn) by the National Oceanic and Atmospheric Administrations - National Center for Environmental Information. A total of 1.83 inches was recorded on December 9th and 10th just prior to the sampling event. In the previous month of November, a total of 3.07 inches was recorded at the same station.

Local Flow Conditions

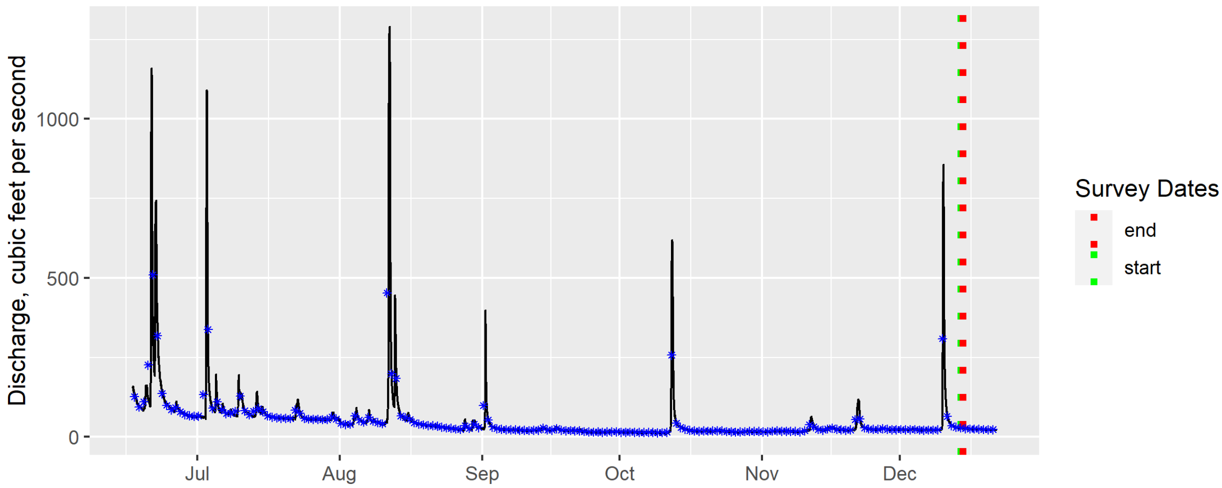
To understand local flow conditions during, pre-, and post- survey periods, we viewed the USGS stream gage data. Streamflow gage data is not available within or for the Parkerson Mill Creek drainage basin; however, data from two gage stations located in neighboring basins were used to describe general flow conditions. These include Sougahatchee Creek, which drains 184.7 km^2 (71.3 mi^2), and Chewacla Creek, which drains 118.6 km^2 (45.8 mi^2). Mean daily discharge was calculated by summing the instantaneous data observations, recorded and reported by the USGS every 15 minutes, from 00:00 to 23:45 each day and then dividing it by the total number of recorded observations during that period. The data for the following discharge plots were retrieved from the USGS website.

Table 8: Gage number and description for the nearest USGS stream gage station that near to was most near the Parkerson Mill Creek Watershed.

Gauge Number	Gauge Description	Gage Drainage area (km^2)
USGS 02418230	SOUGAHATCHEE CREEK AT CO RD 188 NR LOACHAPOKA, AL	184.7 (71.3 mi^2)
USGS 02418760	CHEWACLA CREEK AT CHEWACLA STATE PARK NR AUBURN, AL	118.6 (45.8 mi^2)

Discharge during the survey varied between the neighboring basins (Sougahatchee Creek 28.05 cfs and Chewacla Creek 7.59 cfs); however, trends were observed. In general, for the two neighboring basins, discharge was seasonally low during the survey period, which was observed in both of the long-term discharge plots (Figure 23; Figure 24). However, a recent rainfall around December 9th and 10th of 2023, significantly increased discharge within these creeks for approximately two days (Figure 25; Figure 26), as observed in both short-term discharge plots.

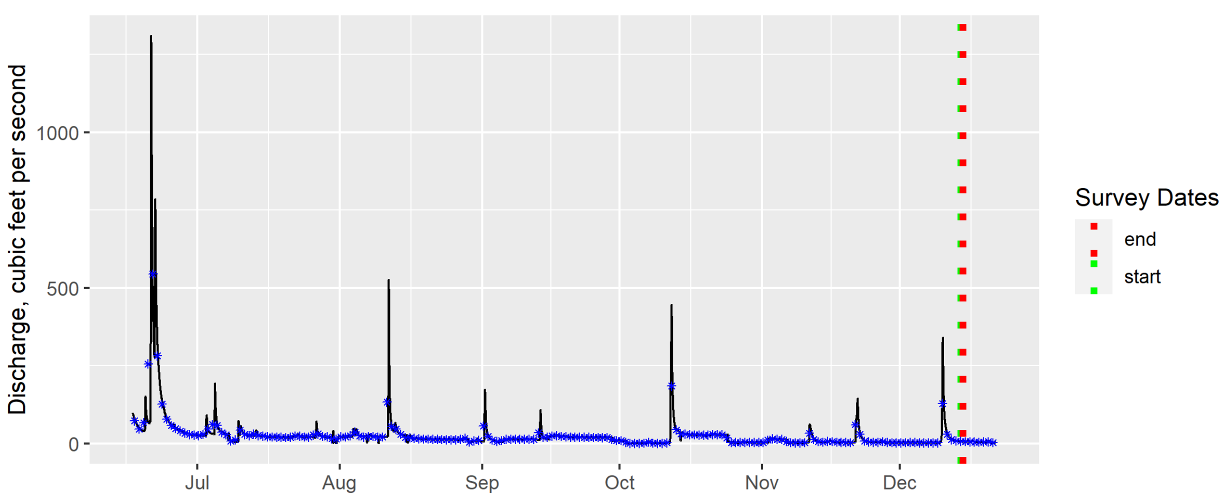
USGS Stream Discharge for SOUGAHATCHEE CREEK AT CO RD 188 NR LOACHAPOKA, AL.
Site number: 02418230



Data Source: https://nwis.waterservices.usgs.gov/nwis/iv/?site=02418230&format=waterml,1.1&ParameterCd=00060&startDT=2023-06-17&endDT=2023-12-21

Figure 23: 187-day stream discharge, 180 days prior and 7 days post sampling event, for Sougahatchee Creek near Loachapoka, AL (USGS Site Number: 02418230) during the backpack survey. Blue stars represent mean daily discharge, the green vertical dashed line is the backpack survey beginning and red vertical dashed line is the backpack survey end.

USGS Stream Discharge for CHEWACLA CREEK AT CHEWACLA STATE PARK NR AUBURN
Site number: 02418760



Data Source: https://nwis.waterservices.usgs.gov/nwis/iv/?site=02418760&format=waterml,1.1&ParameterCd=00060&startDT=2023-06-17&endDT=2023-12-21

Figure 24: 187-day stream discharge, 180 days prior and 7 days post sampling event, for Chewacla Creek near Auburn (USGS Site Number: 02418760) during the backpack survey. Blue stars represent mean daily discharge, the green vertical dashed line is the backpack survey beginning and red vertical dashed line is the backpack survey end.

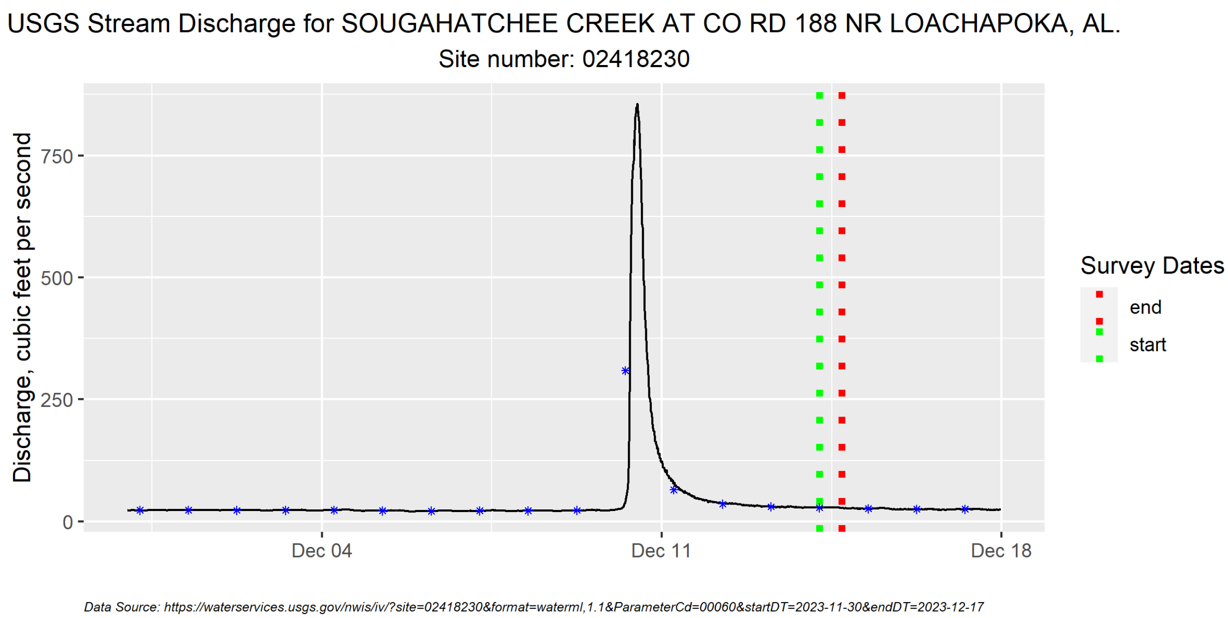


Figure 25: 17-day stream discharge, 14 days prior and 3 days post sampling event, for Sougahatchee Creek near Loachapoka, AL (USGS Site Number: 02418230) during the backpack survey. Blue stars represent mean daily discharge, the green vertical dashed line is the backpack survey beginning and red vertical dashed line is the backpack survey end.

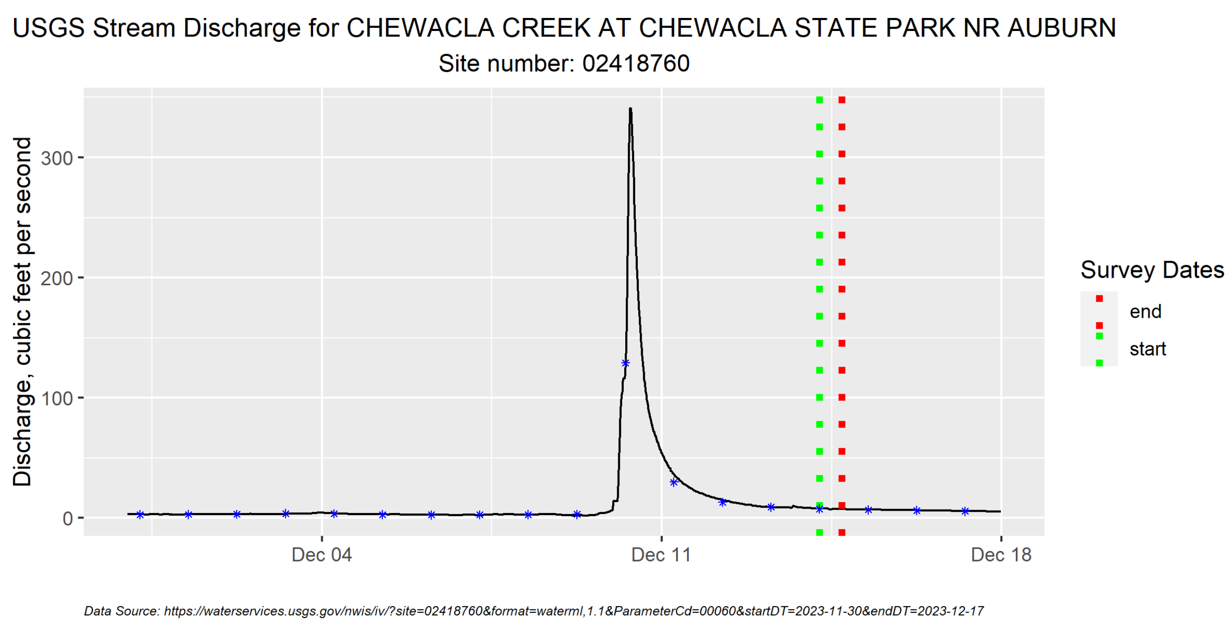


Figure 26: 17-day stream discharge, 14 days prior and 3 days post sampling event, for Chewacla Creek near Auburn (USGS Site Number: 02418760) during the backpack survey. Blue stars represent mean daily discharge, the green vertical dashed line is the backpack survey beginning and red vertical dashed line is the backpack survey end.

StreamView Videos

One of the fundamental products from the HDSS field work was the creation of the StreamView videos. The StreamView videos provide a georeferenced video with front- and downward-facing and left- and right-side video, as well as a reference map (Figure 27). Eight individual StreamView video tracks were recorded in high-definition (1080p) resolution.

Figure 28 shows the track segments and Table 9 provides the track name, stream segment represented, duration, and file size information. The date, time, and GPS location were embedded into the video so that the video and the geospatial data were related correctly for both time and location.

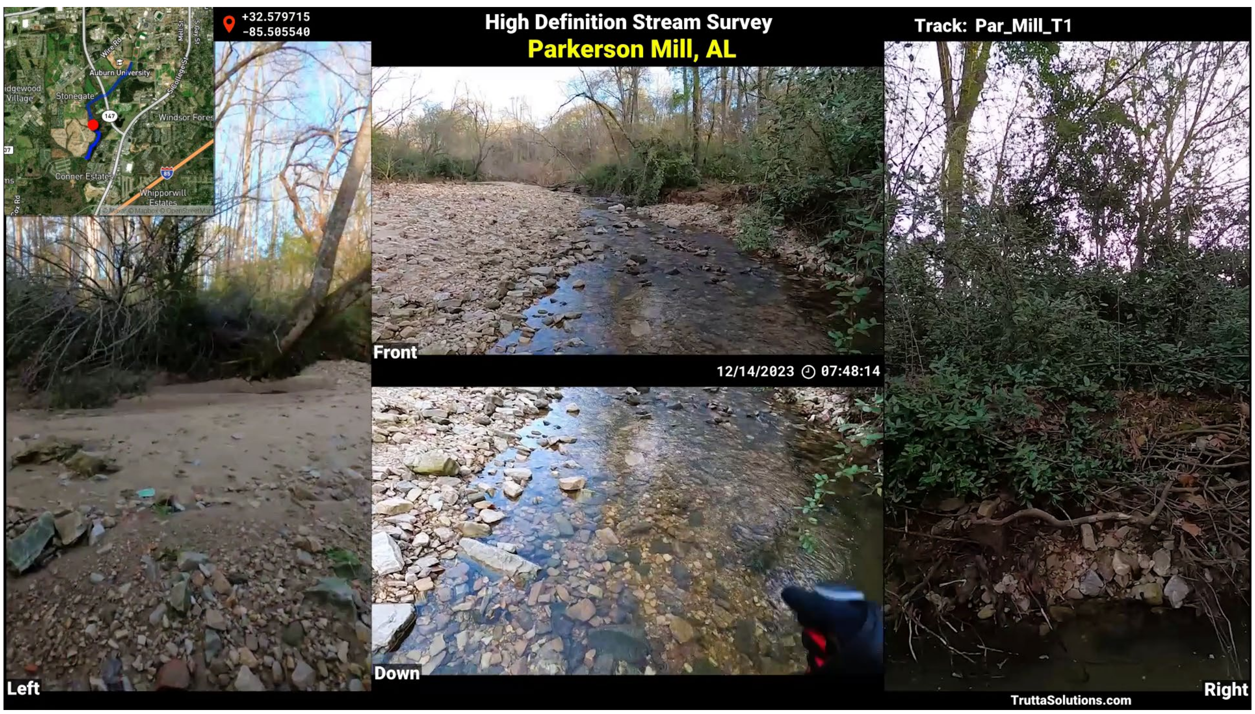


Figure 27: An example image from the HDSS StreamView video.

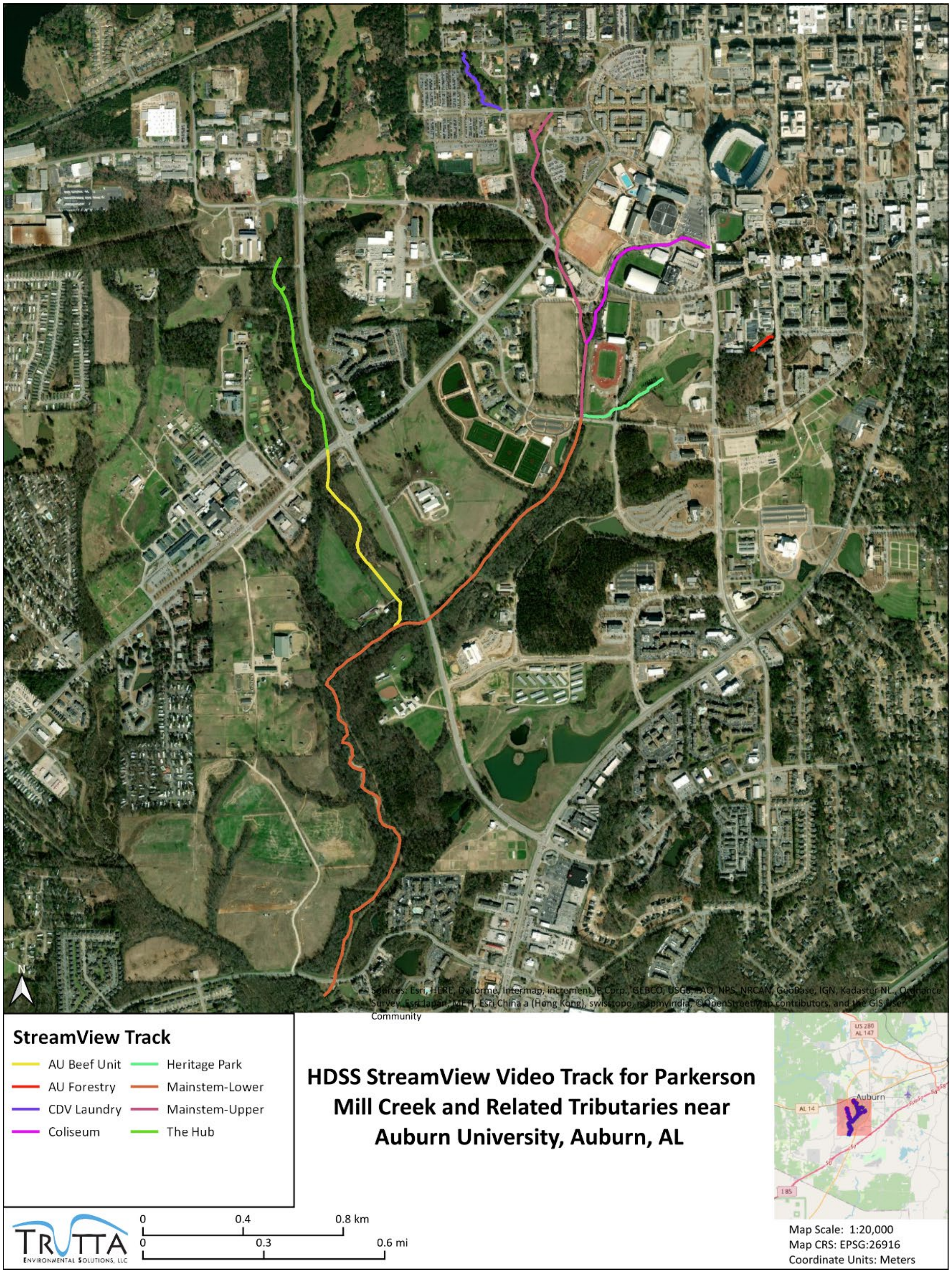


Figure 28: StreamView video tracks along Parkerson Mill Creek and major tributaries, near Auburn University, Auburn, AL.

Table 9: StreamView video track, location and time information for the surveys of Parkerson Mill Creek and related tributaries near Auburn University, Auburn, AL.

Track ID	Stream Segment	River/Stream	Survey Date	Duration (hh:mm:ss)
Par_Mil_T1	Mainstem-Lower	Parkerson Mill Creek	12/14/2023	1:13:21
Par_Mil_T11	Mainstem-Upper	Parkerson Mill Creek	12/14/2023	00:33:14
Par_Mil_T12	CDV-Laundry	Tributary	12/14/2023	00:06:37
Par_Mil_T2	AU Beef Unit	Tributary	12/14/2023	00:21:15
Par_Mil_T21	The Hub	Tributary	12/14/2023	00:23:09
Par_Mil_T3	Coliseum	Tributary	12/14/2023	00:16:59
Par_Mil_T32	Heritage Park	Tributary	12/14/2023	00:12:50
Par_Mil_T4	AU Forestry	Tributary	12/14/2023	00:03:47

SCA

Project Level Results and Discussion

Results at the overall project level for the mainstem of the Parkerson Mill Creek and tributary streams combined, show the corridor was generally in average condition (Figure 29). The Overall Condition scores were 62.6% Average, 27.5% Sub-optimal, and less than 10% scoring as Poor or Very Poor (Table 10). Spatially, the upstream portions of the watershed were generally in worse condition compared to downstream segments (Figure 30). The Overall Condition score reflects the impacts of Functional and Discrete Point Feature severity score combined. The Overall Functional score, which considers the continuous riparian, streambank, and streambed function, also showed the system to be in an average state. Of the surveyed area, 26.1% scored Functional or better while less than 68% scored Slightly Impaired and Impaired. Less than 1% of the sites scored Non-functional (Table 10). The other component of the Overall Condition score was the discrete point feature (Point) severity score. As expected, most locations had no discrete point features, with just over 244 m showing some impact from points on the stream corridor with 12 m having points in the two most severe categories. The combination of the more severe points in areas with degraded corridor function resulted in less than 1% of all areas being classified as Very Poor in the Overall Condition category.

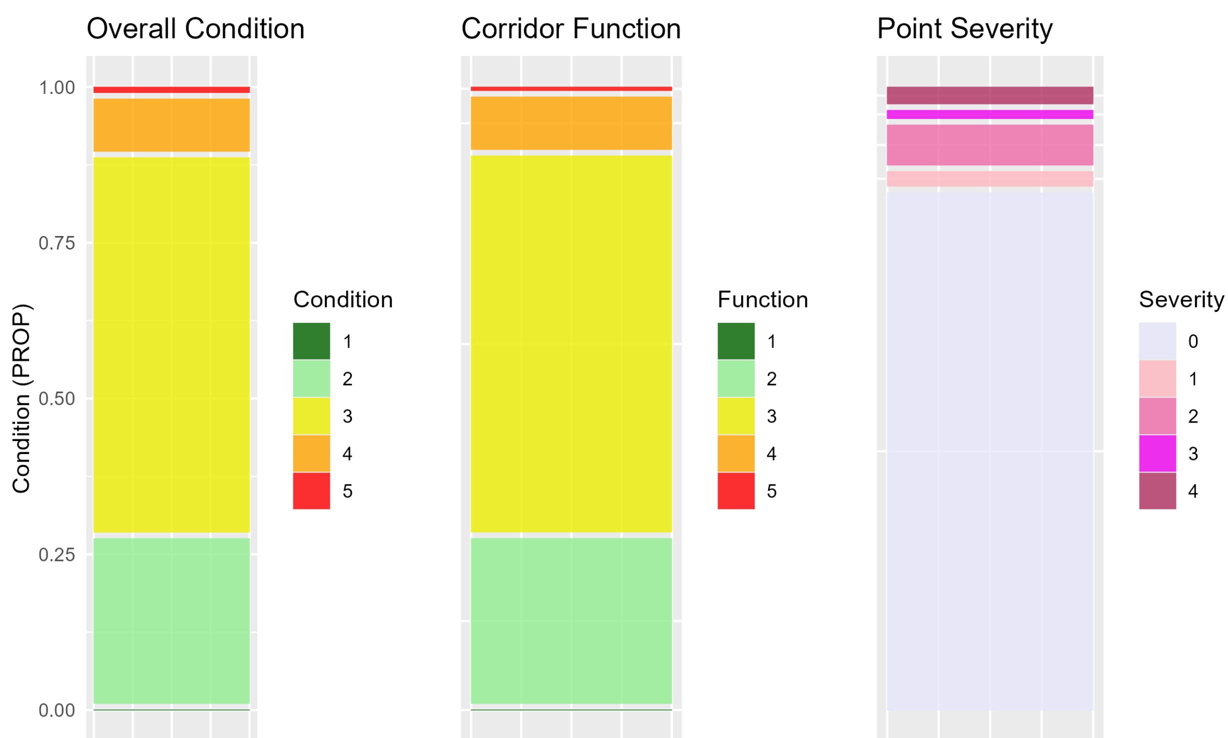


Figure 29: Overall Condition, Corridor Function and Point Severity along Parkerson Mill and related tributaries project.

Table 10: Overall Condition, Function and Discrete Point Feature Point (Point) severity ratings for the surveys along Parkerson Mill and related tributaries project.

Project	Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
Parkerson Mill	1	3	0.0	1	3	0.0	0	244	86.5
Parkerson Mill	2	1,992	27.6	2	1,994	26.1	1	7	2.5
Parkerson Mill	3	4,521	62.6	3	4,541	59.3	2	19	6.7
Parkerson Mill	4	634	8.8	4	636	8.3	3	4	1.4
Parkerson Mill	5	68	0.9	5	44	0.6	4	8	2.8

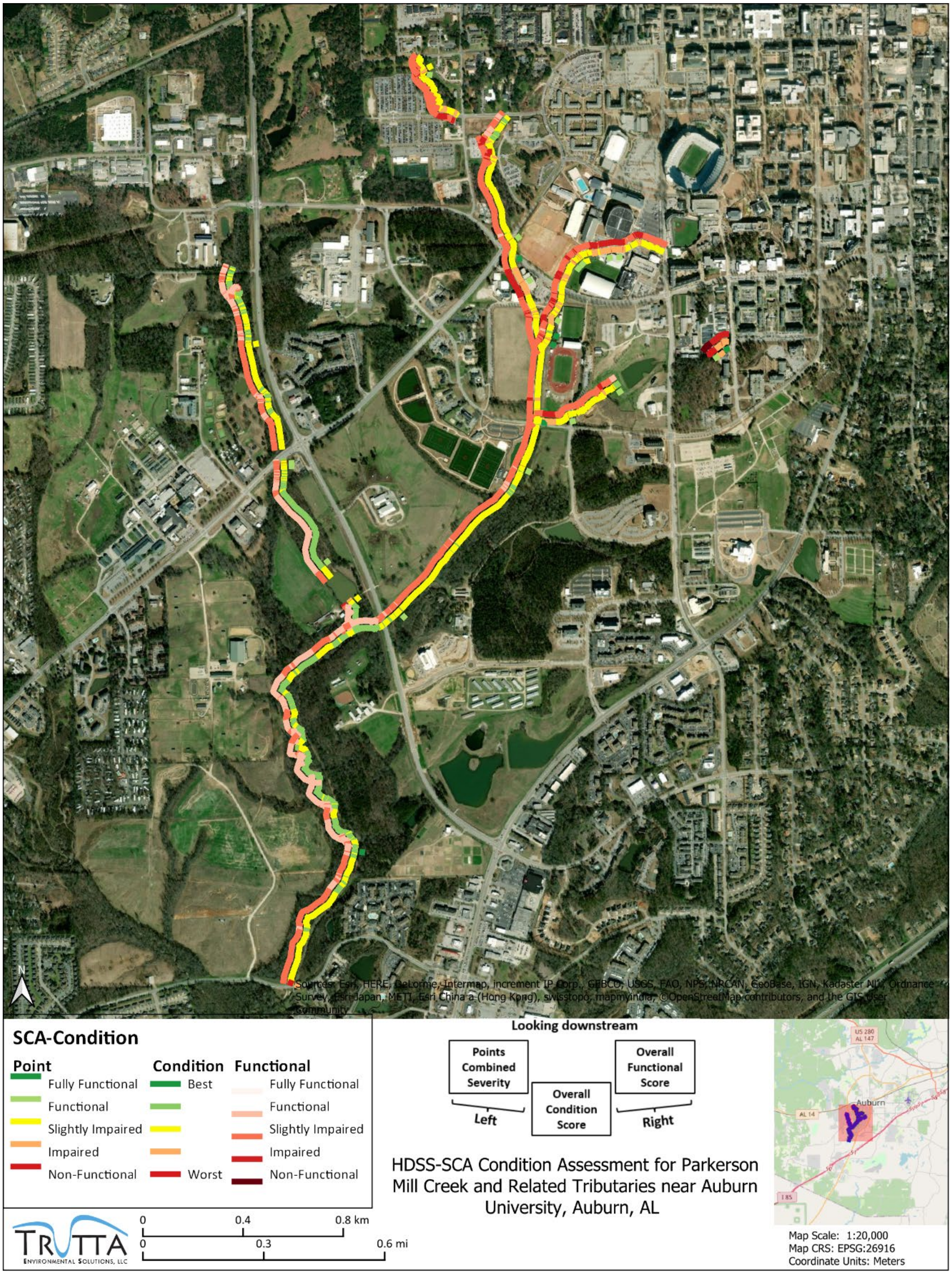


Figure 30: Map of HDSS-SCA Condition, overall Functional, and combined point scores along Parkerson Mill Creek and related tributaries, Auburn, AL.

When considering Functional scores for the stream corridor at the project level, the riparian element was in the best condition, while also having the greatest percent Non-functional (Figure 31). The riparian had over 5.5 km scored as Fully Functional while streambanks had approximately 50 m and no sections of the streambed scored as Fully Functional (Table 11). Left and right streambanks consistently scored as Impaired, 56.6% and 48.8%, respectively, while the streambed consistently scored as Slightly Impaired (57.5%). Although the number of meters scored as Impaired and Non-functional in the riparian (2,302 m), streambank (8,080 m), and streambed (349 m) elements, we observed a limited number of meters (680 m) in which all five elements were scored as Impaired or Non-Functional (Figure 32). Additionally, a portion of the streambed immediately upstream of an impoundment, where the water surface elevation often fluctuates due to rainfall events was non-scoreable due to not having a defined channel.

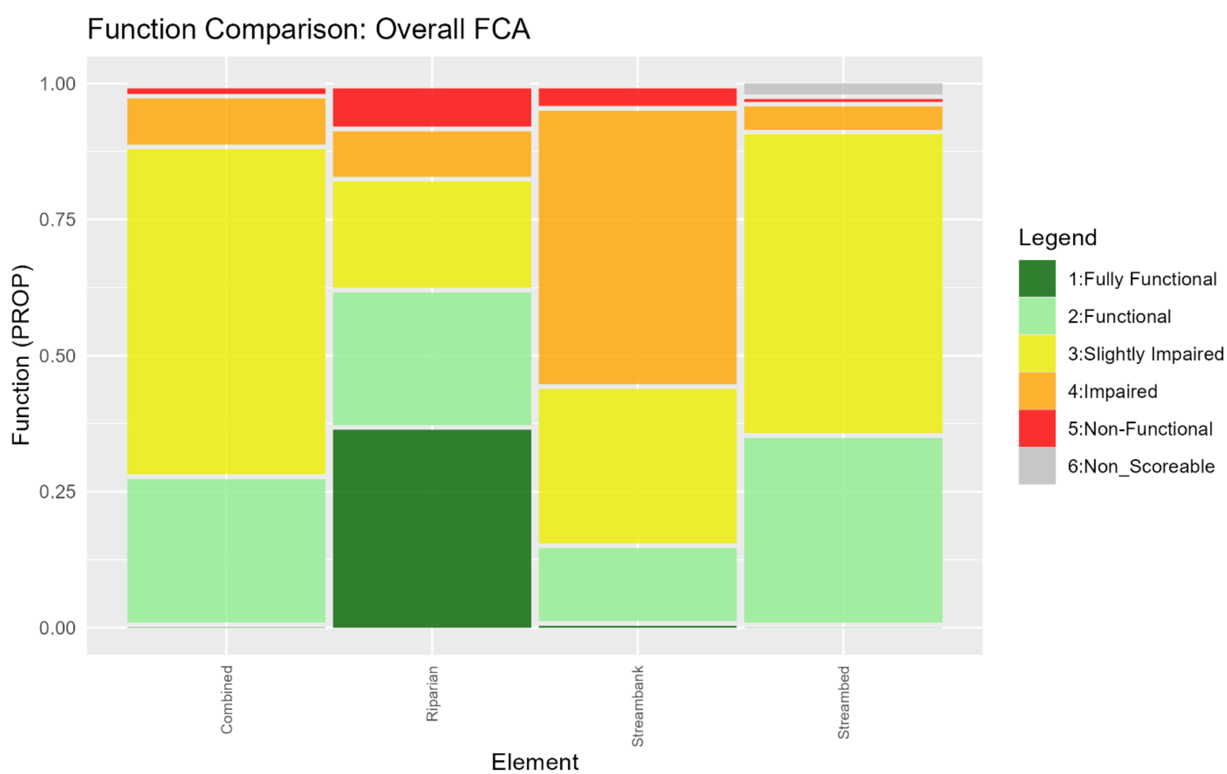


Figure 31: Overall functional comparison of all areas surveyed along Parkerson Mill and related tributaries. Combined is all five functional elements combined (left and right streambank and riparian areas and streambed) into a single value. Left and right streambank and riparian values were grouped for this analysis to provide a single value for streambank and a single value for riparian.

Table 11: Overall Functional Rating scores along Parkerson Mill and related tributaries.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	2,327	32.2	5	0.1	0	0.0	42	0.6	3,179	44.0
Functional	2,477	34.3	1,005	13.9	2,566	35.6	1,014	14.0	1,201	16.6
Slightly Impaired	1,303	18.1	1,882	26.1	4,153	57.5	2,406	33.3	1,647	22.8
Impaired	635	8.8	4,083	56.6	317	4.4	3,521	48.8	617	8.5
Non-functional	476	6.6	243	3.4	32	0.4	233	3.2	574	8.0

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

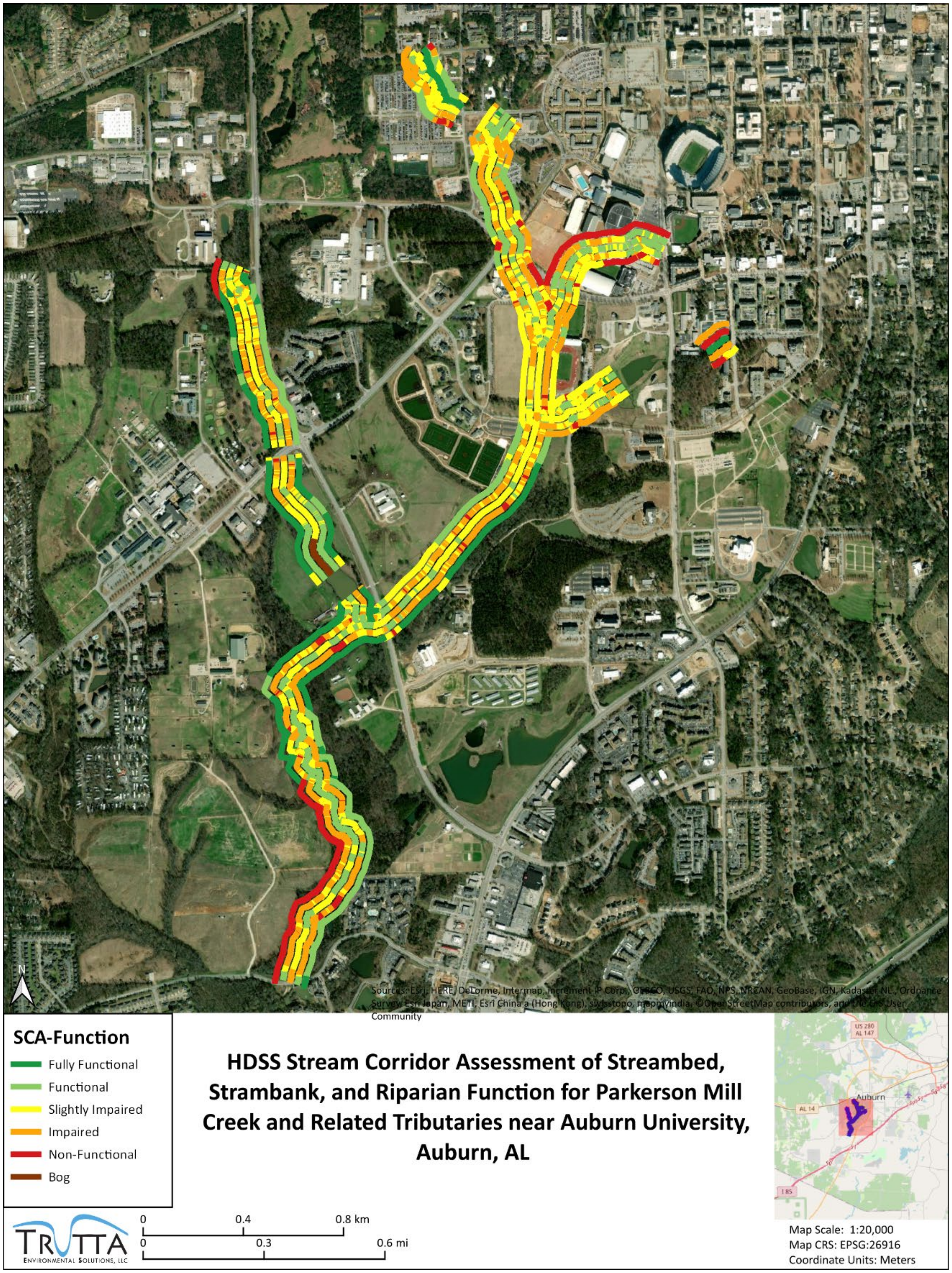


Figure 32: Overview map of HDSS-SCA streambed, streambank, and Riparian Function along Parkerson Mill Creek and related tributaries, Auburn, AL.

At the project level, a total of 282 discrete points were documented within the Complexity category (Class - Natural Features, e.g., large woody debris) accounting for the majority of points (Table 12). Of these 282 points, only 20 had a severity rating of Moderate or greater (Table 13). These 20 points would likely have an impact on the overall condition of the stream corridor. The majority of these points fell into the Pipe and Road categories which include points such as exposed pipes (n=4) and outfalls (n=5) and culverts (n=5), respectively. Spatially, most infrastructure discrete point features were in the upper portions of the watershed while natural features and Intermittent features were generally evenly distributed throughout the basin (Figure 33).

Table 12: Overall count of all discrete point features by category along Parkerson Mill and related tributaries.

Category	Total	Complexity	Construction	Dam	Pipe	Road	Trash
Parkerson Mill	282	149	3	2	65	47	16

Table 13: Count of discrete point features with a severity rating of three (i.e., moderate) or greater, by type along the Parkerson Mill and related tributaries.

Category	Total	Bridge	Culvert	Dam	Exposed Pipe	In-Stream Construction	Outfall
Parkerson Mill	20	1	5	2	4	3	5

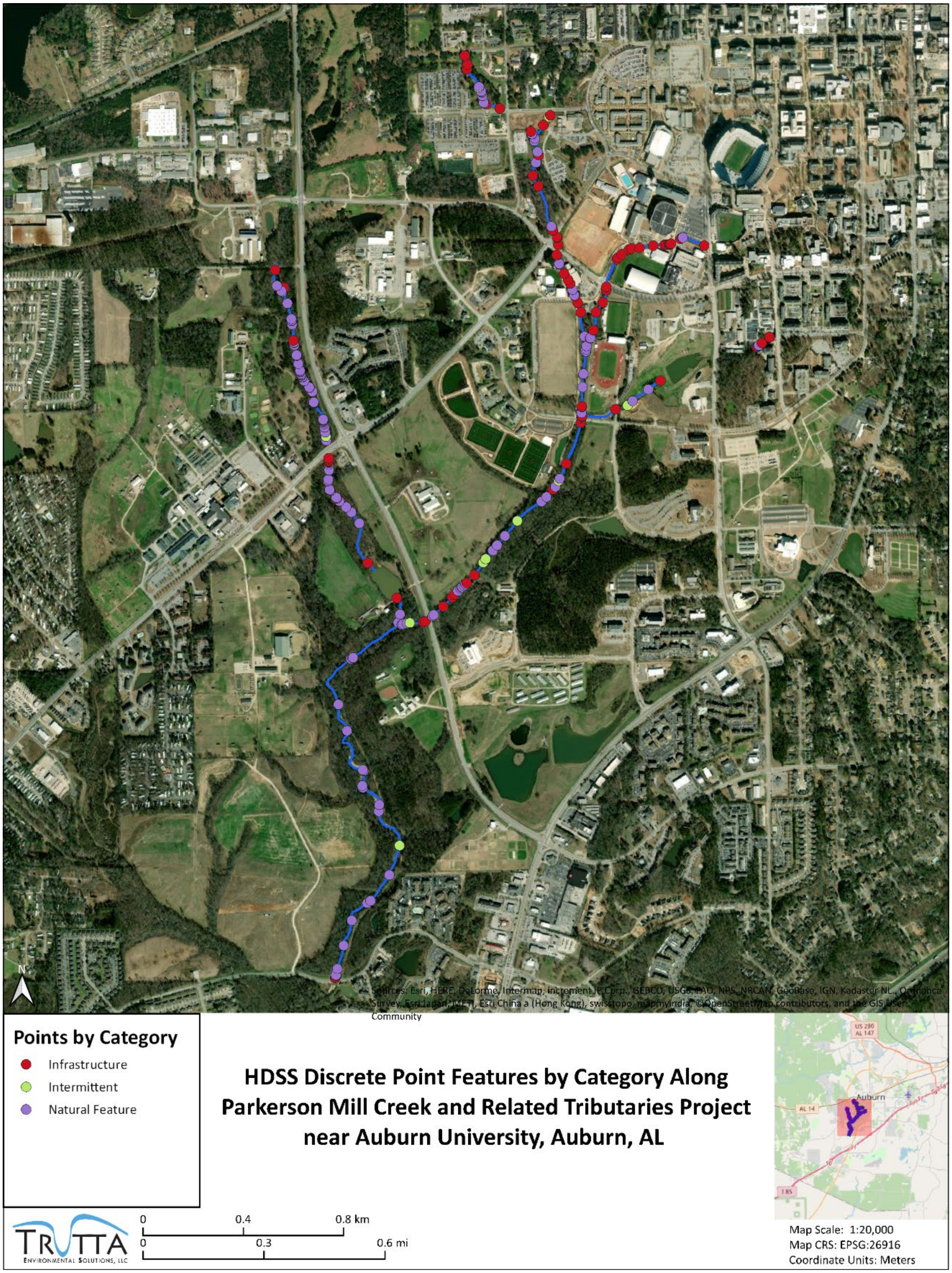


Figure 33: Discrete Point Features classified by Category along Parkerson Mill Creek and related tributaries near Auburn University, Auburn, AL.

When viewing the extent of modification to the stream corridor at the project level, the majority of the surveyed area was Unmodified with only a small percentage being classified as Highly Modified and Modified, 3.6% and 3.7% respectively (Figure 34). When assessing each of the individual elements of streambed and left and right streambank, the left streambank had nearly twice the distance documented as Modified compared to the right streambank (Table 14). Spatially, the most upstream portions of the watershed generally had more Modified and Highly Modified modifications when compared to most downstream segments (Figure 35). This likely reflects the impacts of hydrologic modification by the stormwater flows throughout the system.

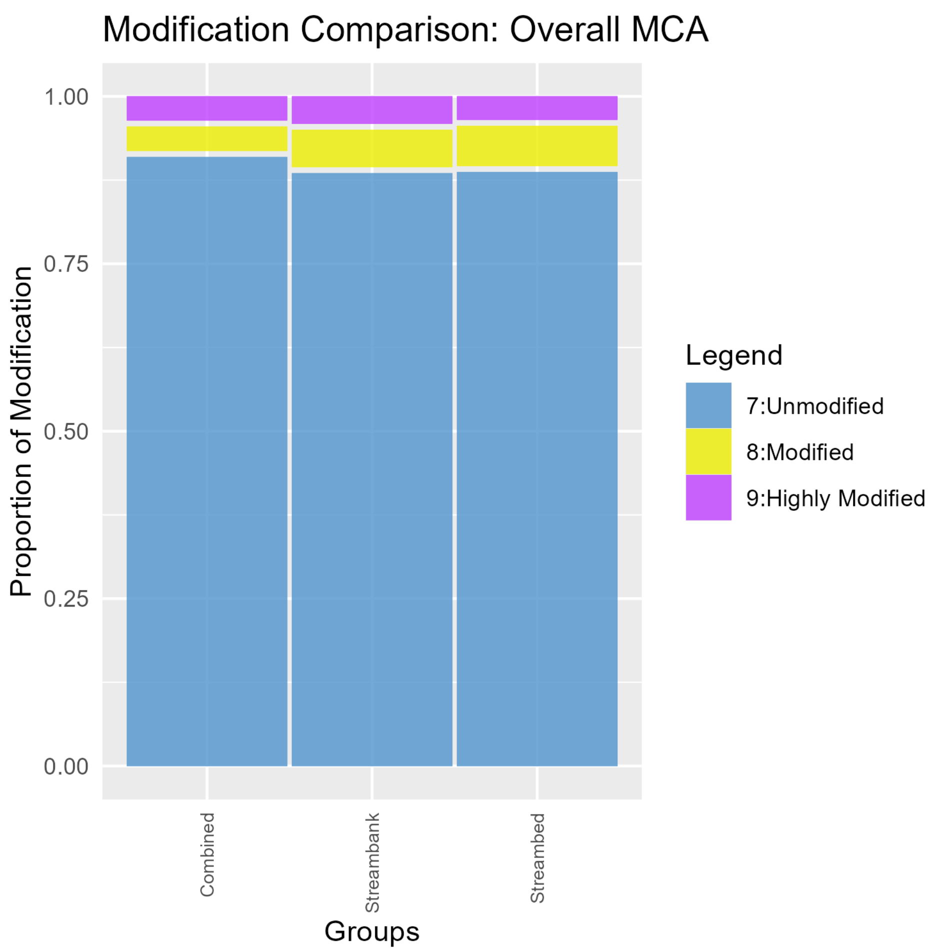


Figure 34: Combined and overall modification condition assessment comparison of elements of streambed and streambank modification for all areas surveyed combined along Parkerson Mill and related tributaries. Combined is all three modification elements combined (left and right streambank and streambed) into a single value. Note- left and right streambank values were combined for this analysis to provide a single value for streambank.

Table 14: Modification Rating scores for the Parkerson Mill Creek project.

Modification	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	6,370	88.3	6,525	90.4	6,654	92.2
Modified	552	7.6	437	6.1	259	3.6
Highly Modified	296	4.1	256	3.5	303	4.2

RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

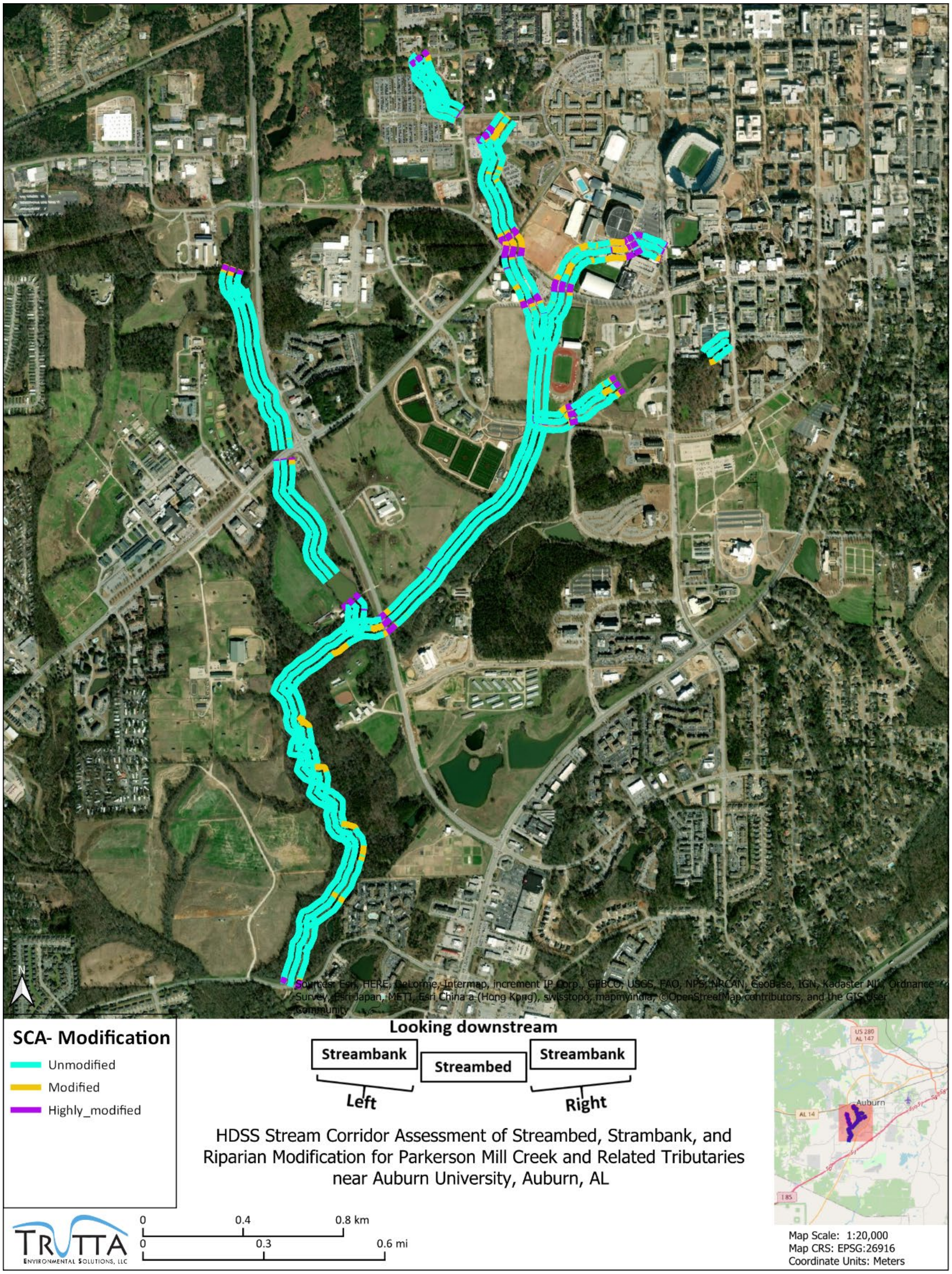


Figure 35: Overview map of HDSS-SCA streambank and Riparian Modification along Parkerson Mill Creek and related tributaries, Auburn, AL.

The overall project score which considers both the river and the streams can be considered a snapshot of the condition of Parkerson Mill Creek and relevant tributaries during the survey. This score would most appropriately be used to compare to the Overall Condition score of other locales that had also been surveyed and scored using the HDSS methodology. This would give an indication of the status of the river and stream corridors within the city/university and the areas that may need management. A second use may be to compare conditions over time as repeated surveys are conducted. With repeated surveys, changes related to the combination of positive management actions and negative development pressures would be captured over time and provide a positive or negative trend for the conditions within the city/university.

Mainstem vs Tributary Streams Level

Clear differences were observed between the Overall Condition of the mainstem Parkerson Mill Creek and its tributary streams (Figure 36). The Parkerson Mill Creek scored better than the tributary streams along the Poor and Very Poor metrics (Table 15). The Parkerson Mill Creek had 5% of its length scored as Poor and Very Poor, while nearly 17% of the tributary streams fell into these categories. Similarly, 95% was scored as Sub-optimal and Average for Parkerson Mill Creek while only 83% of the tributary streams were rated in these categories. These trends were consistent with both the Corridor Function and Points Severity on the corridors, with the tributary streams scoring poorer function and greater impact from points for the given length. When comparing the Combined Function Score between the mainstem Parkerson Mill creek and all tributaries combined, 27.4% of the corridor Function scores along Parkerson Mill creek were Functional or better, while 27.9% of the tributary stream were classified into the Functional or better groups (Figure 36; Table 15; Table 16).

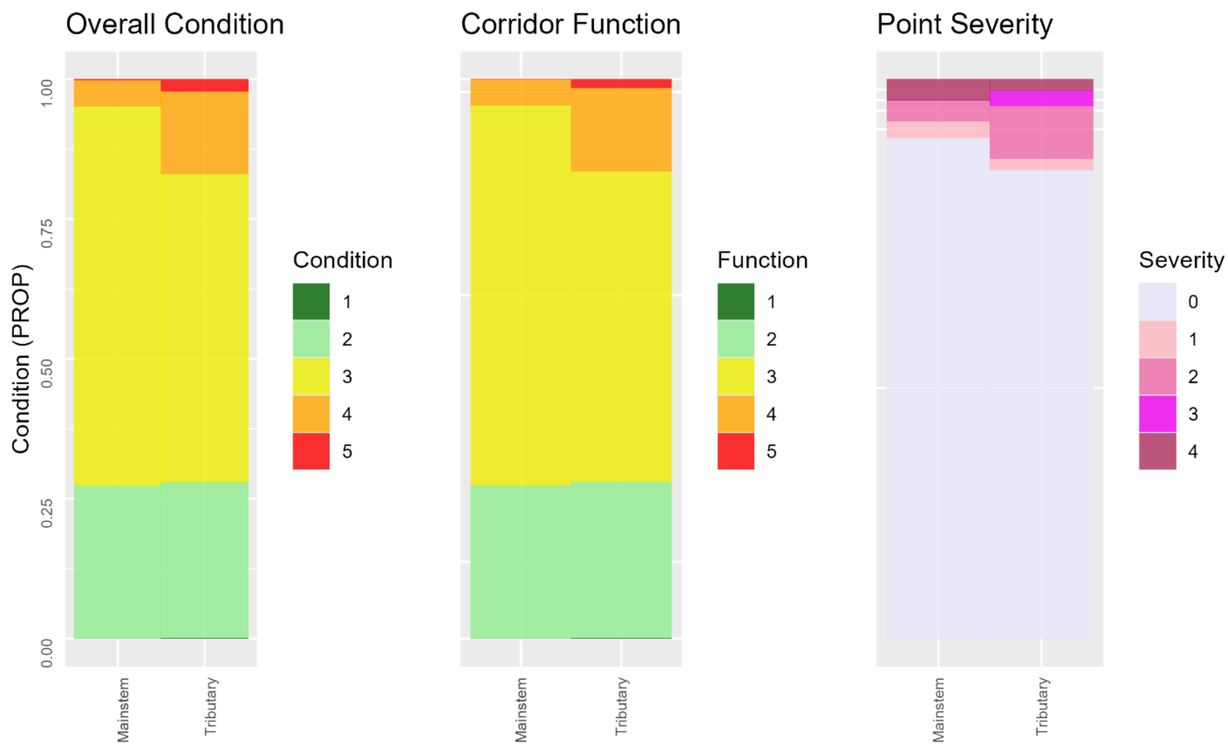


Figure 36: Overall Condition, Corridor Function and Point Severity comparing the mainstem Parkerson Mill Creek versus the combined tributaries surveyed.

Table 15: Overall Condition, Corridor Function and Point Severity Scores along Parkerson Mill.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	0	0.0	1	0	0.0	0	120	2.8
2: Sub Optimal	1,174	27.4	2	1,175	27.4	1	4	0.1
3: Average	2,905	67.8	3	2,912	68.0	2	5	0.1
4: Poor	200	4.7	4	198	4.6	3	0	0.0
5: Very Poor	6	0.1	5	0	0.0	4	5	0.1

Table 16: Condition, Function and Point Severity Scores along the related tributaries.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	3	0.1	1	3	0.1	0	124	4.2
2: Sub Optimal	818	27.9	2	819	27.9	1	3	0.1
3: Average	1,616	55.1	3	1,629	55.5	2	14	0.5
4: Poor	434	14.8	4	438	14.9	3	4	0.1
5: Very Poor	62	2.1	5	44	1.5	4	3	0.1

Differences among the Functional elements of streambed, streambanks, and riparian were also recorded between mainstem and tributaries. These differences were most obvious among the elements of Riparian and Streambed (Figure 37; Table 17; Table 18). For the tributaries, a greater proportion of the streambed (nearly 8%) and riparian areas (≥ 24%) were classified as Impaired or Non-functional when compared to the streambed (2.5%) and riparian areas (< 10%) for Parkerson Mill Creek. The Fully Functional classification occurred most within the functional element of Riparian for both mainstem and tributary streams. However, the riparian scores for the tributary streams were generally worse than those observed on the mainstem.

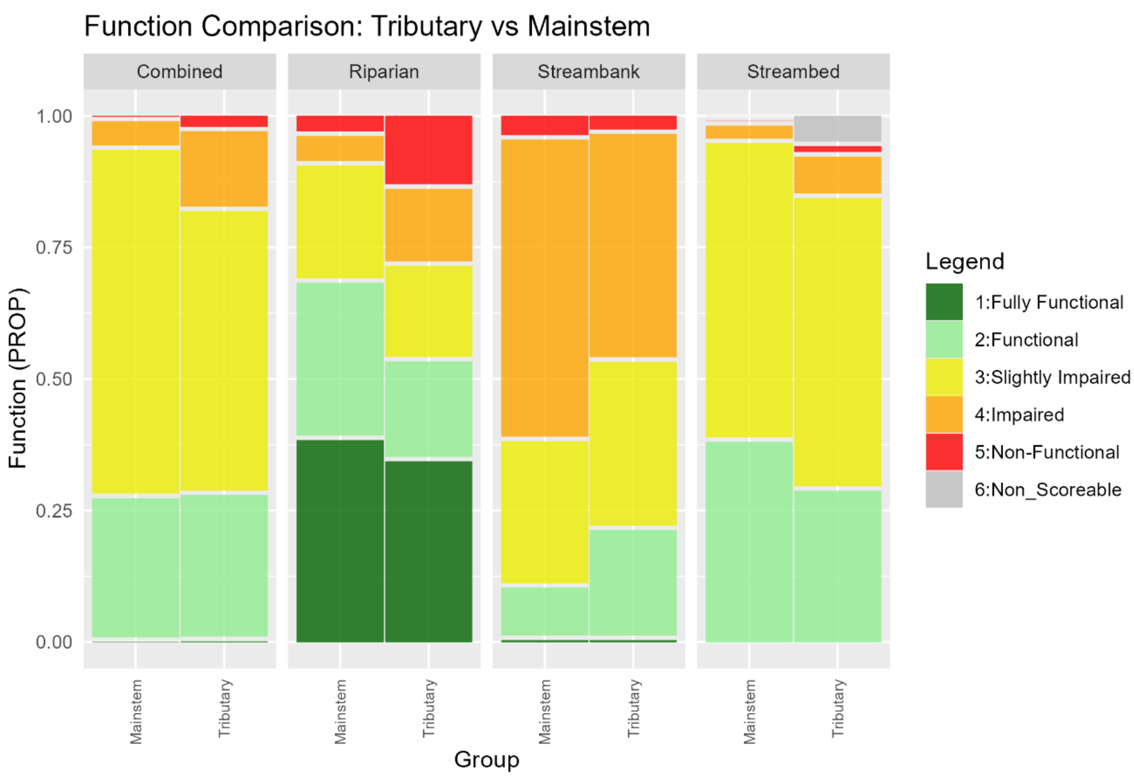


Figure 37: Overall functional comparison of tributaries versus the mainstem along Parkerson Mill and related tributaries. Combined is all five functional elements combined (left and right streambank and riparian areas and streambed) into a single value. Left and right streambank and riparian values were grouped for this analysis to provide a single value for streambank and a single value for riparian.

Table 17: Stream Corridor Functional Element Scores along the mainstem Parkerson Mill Creek.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	1,570	36.6	0	0.0	0	0.0	28	0.7	1,845	43.1
Functional	1,599	37.3	406	9.5	1,692	39.5	396	9.2	979	22.8
Slightly Impaired	711	16.6	983	22.9	2,487	58.0	1,413	33.0	1,190	27.8
Impaired	194	4.5	2,677	62.5	106	2.5	2,345	54.7	222	5.2
Non-functional	211	4.9	219	5.1	0	0.0	103	2.4	49	1.1

Table 18: Stream Corridor Functional Element Scores for tributary streams along Parkerson Mill Creek.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	757	25.8	5	0.2	0	0.0	14	0.5	1,334	45.5
Functional	878	29.9	599	20.4	874	29.8	618	21.1	222	7.6
Slightly Impaired	592	20.2	899	30.7	1,666	56.8	993	33.9	457	15.6
Impaired	441	15.0	1,406	47.9	211	7.2	1,176	40.1	395	13.5
Non-functional	265	9.0	24	0.8	32	1.1	130	4.4	525	17.9

The type, frequency, and impact of discrete Points on the stream corridor varied between the tributary streams and the mainstem. A greater number of discrete Points were observed in the tributary streams than in the mainstem creek (Table 19). Additionally, a greater number of points with a severity rating of Moderate or greater were observed in streams than on the mainstem (Table 20). The type of points was also different, with all points classified as Moderately Severe or greater were Infrastructure (e.g., Roads and Pipes) on the mainstem, while Infrastructure (Pipes and Dams) and Intermittent (e.g., Construction) were recorded along the tributary streams.

Table 19: Overall count of all discrete point features by category along the mainstem river versus all tributaries combined, within the CHAT.

Category	Total	Complexity	Construction	Dam	Pipe	Road	Trash
Mainstem	134	67	0	0	33	25	9
Tributary	148	82	3	2	32	22	7

Table 20: Count of discrete point features, with a severity rating of three (i.e., moderate) or greater, by category along the mainstem river versus all tributaries combined, within the CHAT.

Category	Total	Complexity	Construction	Dam	Pipe	Road	Trash
Mainstem	8	0	0	0	2	6	0
Tributary	12	0	3	2	7	0	0

The extent of modification to the system was slightly greater along the tributary streams compared to the mainstem. For Streambed modification scores, 91.5% of the Parkerson Mill Creek mainstem was scored as unmodified while 88.7% of the tributaries scored as unmodified (Figure 38; Table

21). Additionally, unmodified streambanks along the mainstem ranged from 88.6% to 94.3% while streambanks along tributaries ranged from 87.8 % to 89.1%. The extent of modification was similar between the streambank and streambed elements in both the river and tributary streams.

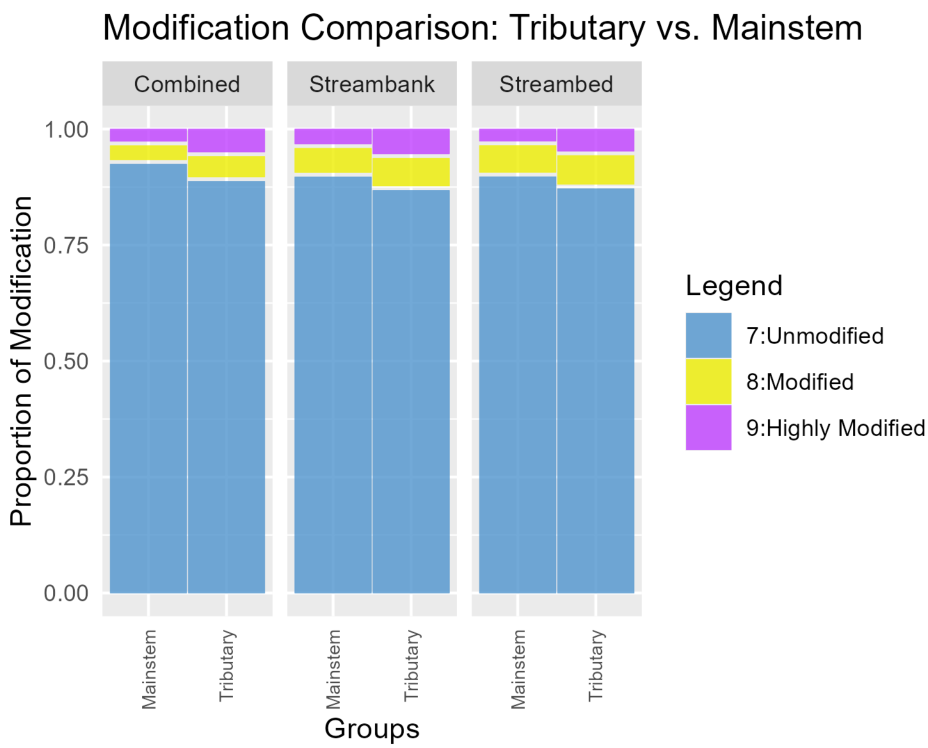


Figure 38: Modification comparison of all mainstem segments combined (i.e., mainstem) versus all tributaries combined (i.e., tributaries) by the stream corridor assessment elements of streambed and streambank for the areas surveyed along Parkerson Mill and related tributaries. Combined is all three modification elements combined (left and right streambank and streambed) into a single value. Note- left and right streambank values were combined for this analysis to provide a single value for streambank.

Table 21: The extent of modification along the Parkerson Mill Creek versus tributaries streams.

Group	Modification	CMA (m)	CMA %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Mainstem	Unmodified	4,040	94.3	3,796	88.6	3,922	91.5	4,040	94.3
Mainstem	Modified	133	3.1	354	8.3	252	5.9	100	2.3
Mainstem	Highly Modified	115	2.7	135	3.2	114	2.7	145	3.4
Tributary	Unmodified	2,653	90.5	2,574	87.8	2,603	88.7	2,614	89.1
Tributary	Modified	132	4.5	198	6.8	185	6.3	159	5.4
Tributary	Highly Modified	148	5.0	161	5.5	142	4.8	158	5.4

Group	Modification	CMA (m)	CMA %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %

CMA = Combined modification Assessment; RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Overall, the surveys clearly showed that the results of the SCA were different between Parkerson Mill Creek compared to the tributary streams. The Corridor Function was more impaired and discrete point features were greater in the tributaries than in the mainstem. Additionally, a modification was slightly more frequent along tributaries compared to the Parkerson Mill Creek mainstem.

Segment Level

The Overall Condition scores for the Parkerson Mill Creek segments were generally in average condition. All segments, except for the AU Beef unit, scored Average or worse for ≥ 62% of the total segment (Figure 39). The AU Beef Unit segment had the highest percentage Optimal and Sub-Optimal scores of 80% followed by Lower Mainstem and The Hub segments, respectively (Figure 39; Table 22; Table 23; Table 24; Table 25; Table 26; Table 27; Table 28; Table 29). The AU Forestry segment demonstrated the worst Overall Condition followed by the Coliseum segment. Combined Corridor Function scores were similar to Overall Condition scores among segments. Additionally, Overall Point Severity scores continued to demonstrate a similar trend as the Overall Function segment scores, highlighting areas in need of management action. The two segments, AU Forestry and Coliseum segments were in the worst Overall Condition and Corridor Function. These ratings were due to restoration efforts currently underway in the AU Forestry segment and the urbanization that has occurred along the Coliseum segment.

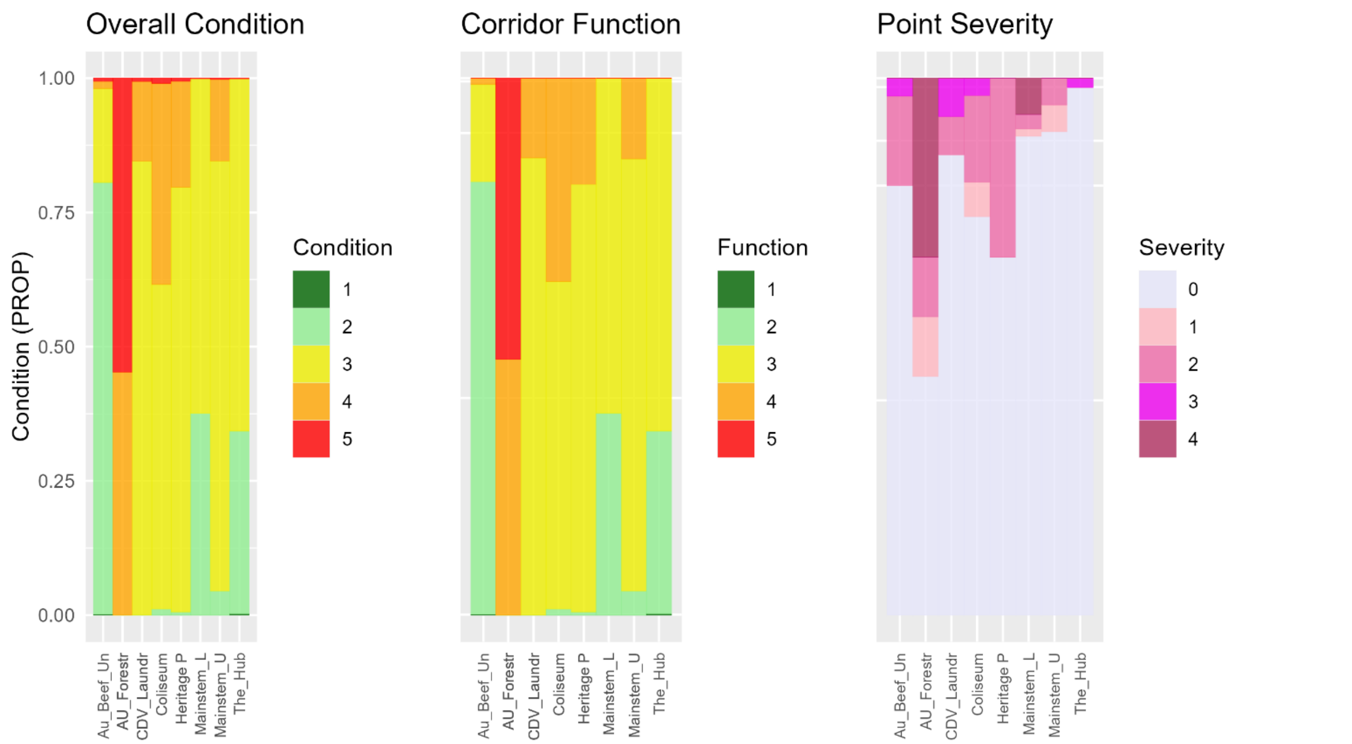


Figure 39: Overall condition, corridor function and point severity among segments surveyed along Parkerson Mill and related tributaries.

Table 22: Overall Condition, Function, and Point Severity Scores along the AU Beef Unit segment of the Parkerson Mill project.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	1	0.1	1	1	0.1	0	24	80.0
2: Sub Optimal	542	80.4	2	543	80.6	1	0	0.0
3: Average	118	17.5	3	122	18.1	2	5	16.7
4: Poor	9	1.3	4	8	1.2	3	1	3.3
5: Very Poor	4	0.6	5	0	0.0	4	0	0.0

Table 23: Overall Condition, Function, and Point Severity Scores along the AU Forestry segment of the Parkerson Mill project.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	0	0.0	1	0	0.0	0	4	44.4
2: Sub Optimal	0	0.0	2	0	0.0	1	1	11.1
3: Average	0	0.0	3	0	0.0	2	1	11.1
4: Poor	38	45.2	4	40	47.6	3	0	0.0

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
5: Very Poor	46	54.8	5	44	52.4	4	3	33.3

Table 24: Overall Condition, Function and Point Severity Scores along the CDV Laundry Forestry segment of the Parkerson Mill project.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	0	0.0	1	0	0.0	0	12	85.7
2: Sub Optimal	0	0.0	2	0	0.0	1	0	0.0
3: Average	273	84.5	3	275	85.1	2	1	7.1
4: Poor	48	14.9	4	48	14.9	3	1	7.1
5: Very Poor	2	0.6	5	0	0.0	4	0	0.0

Table 25: Overall Condition, Function, and Point Severity Scores along the Coliseum segment of the Parkerson Mill project.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	0	0.0	1	0	0.0	0	23	74.2
2: Sub Optimal	8	1.1	2	8	1.1	1	2	6.5
3: Average	436	60.5	3	440	61.0	2	5	16.1
4: Poor	270	37.4	4	273	37.9	3	1	3.2
5: Very Poor	7	1.0	5	0	0.0	4	0	0.0

Table 26: Overall Condition, Function, and Point Severity Scores along the Heritage Park segment of the Parkerson Mill project.

Condition Score	Condition (m)	Cond %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	0	0.0	1	0	0.0	0	4	66.7
2: Sub Optimal	2	0.6	2	2	0.6	1	0	0.0
3: Average	276	79.1	3	278	79.7	2	2	33.3
4: Poor	69	19.8	4	69	19.8	3	0	0.0
5: Very Poor	2	0.6	5	0	0.0	4	0	0.0

Table 27: Overall Condition, Function, and Point Severity Scores along the Lower Mainstem segment of the Parkerson Mill project.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	0	0.0	1	0	0.0	0	66	89.2
2: Sub Optimal	1,115	37.5	2	1,116	37.6	1	1	1.4
3: Average	1,852	62.4	3	1,854	62.4	2	2	2.7
4: Poor	0	0.0	4	0	0.0	3	0	0.0
5: Very Poor	3	0.1	5	0	0.0	4	5	6.8

Table 28: Overall Condition, Function, and Point Severity Scores along the Upper Mainstem segment of the Parkerson Mill project.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	0	0.0	1	0	0.0	0	54	90.0
2: Sub Optimal	59	4.5	2	59	4.5	1	3	5.0
3: Average	1,053	80.1	3	1,058	80.5	2	3	5.0
4: Poor	200	15.2	4	198	15.1	3	0	0.0
5: Very Poor	3	0.2	5	0	0.0	4	0	0.0

Table 29: Overall Condition, Function, and Point Severity Scores along The Hub Heritage Park segment of the Parkerson Mill project.

Condition Score	Condition (m)	Condition %	Function Score	Function (m)	Function %	Point Severity Score	Point Severity (m)	Point Severity %
1: Optimal	2	0.3	1	2	0.3	0	57	98.3
2: Sub Optimal	266	34.0	2	266	34.0	1	0	0.0
3: Average	513	65.6	3	514	65.7	2	0	0.0
4: Poor	0	0.0	4	0	0.0	3	1	1.7
5: Very Poor	1	0.1	5	0	0.0	4	0	0.0

The functional rating among the elements of left and right riparian and streambanks and streambed varied considerably among the segments. When viewing the riparian element, function was relatively good along the Lower Mainstem, the AU Beef Unit, and The Hub segments (Figure 40) with these segments having the greatest proportion of Fully Functional classifications. AU Forestry, Coliseum, and Upper Mainstem, Heritage Park, CVD Laundry, and Upper Mainstem segments had the greatest proportion of Non-Functional and Impaired classifications, respectively (Table 30; Table 31; Table 32; Table 33; Table 34; Table 35; Table 36; Table 37). Among streambanks, only two segments, Heritage Park and Upper Mainstem, had any portion of their streambanks classified as Fully Functional, which only accounted for 4% and 2.1%, respectively. Whereas streambanks had greater than 50% of the segment classified as Slightly Impaired to Non-Functional. As for streambed, AU Forestry was the only segment to be entirely classified as Impaired or Non Functional and no proportion of any segment was classified as Fully Functional. The Functional element of streambed had the greatest proportion of non-scorable in the AU Beef Unit, which was due to the upstream portion of the impounded areas where a defined streambed did not conform to the traditional classification and would be considered a multithreaded channel.

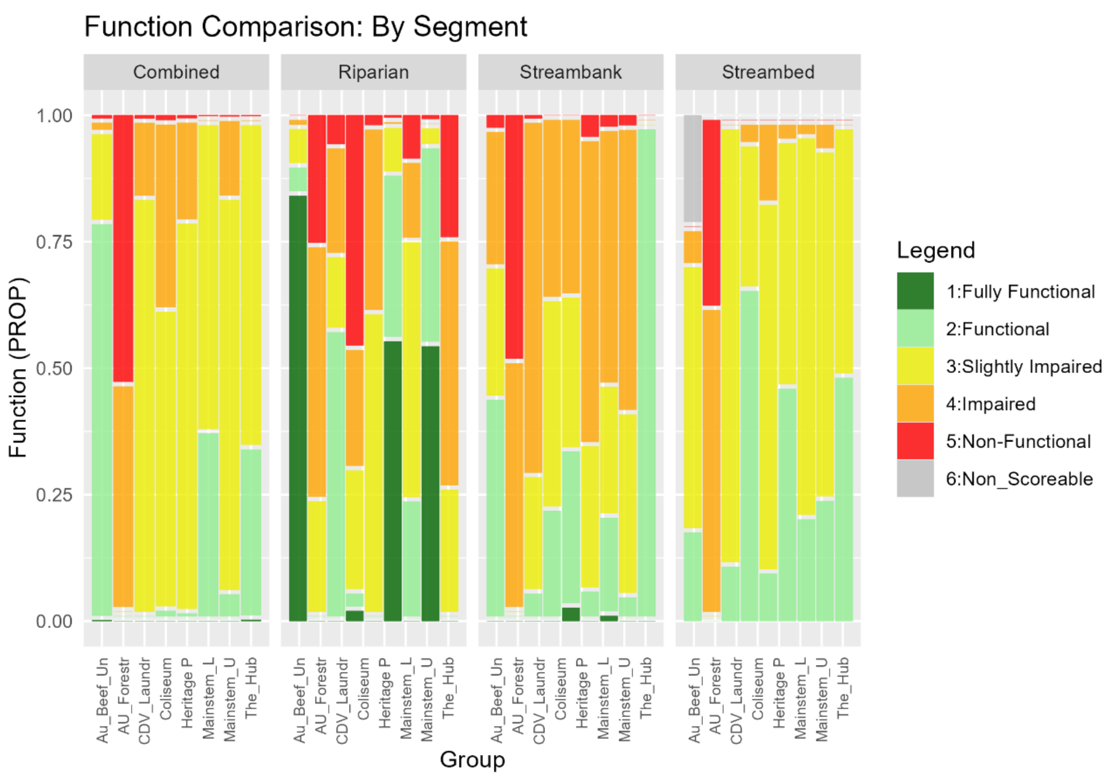


Figure 40: Functional comparison of streambed, streambank, and riparian among segments surveyed along Parkerson Mill and related tributaries. Note- left and right streambank and riparian values were combined for this analysis to provide a single value for streambank and a single value for riparian.

Table 30: Stream Corridor Functional Element scores along the AU Beef Unit segment of the Parkerson Mill Creek Project.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	566	84.0	0	0.0	0	0.0	0	0.0	612	90.8
Functional	65	9.6	341	50.6	122	18.1	257	38.1	0	0.0
Slightly Impaired	37	5.5	121	18.0	359	53.3	229	34.0	56	8.3
Impaired	6	0.9	204	30.3	43	6.4	160	23.7	6	0.9
Non-functional	0	0.0	8	1.2	0	0.0	26	3.9	0	0.0

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Table 31: Stream Corridor Functional Element scores along the AU Forestry segment of the Parkerson Mill Creek Project

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Functional	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Slightly Impaired	26	31.0	0	0.0	0	0.0	0	0.0	12	14.3
Impaired	14	16.7	84	100.0	52	61.9	0	0.0	72	85.7
Non-functional	44	52.4	0	0.0	32	38.1	84	100.0	0	0.0

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Table 32: Stream Corridor Functional Element scores along the CDV Laundry segment of the Parkerson Mill Creek Project.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	0	0.0	8	1.2	0	0.0	26	3.9	0	0.0
Functional	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Slightly Impaired	227	70.3	15	4.6	36	11.1	15	4.6	150	46.4
Impaired	88	27.2	49	15.2	287	88.9	99	30.7	5	1.5
Non-functional	4	1.2	255	78.9	0	0.0	209	64.7	134	41.5

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Table 33: Stream Corridor Functional Element scores along the Coliseum segment of the Parkerson Mill Creek project.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	0	0.0	0	0.0	0	0.0	0	0.0	30	4.2
Functional	37	5.1	111	15.4	489	67.8	201	27.9	0	0.0
Slightly Impaired	322	44.7	341	47.3	207	28.7	266	36.9	29	4.0
Impaired	159	22.1	269	37.3	25	3.5	254	35.2	183	25.4
Non-functional	203	28.2	0	0.0	0	0.0	0	0.0	479	66.4

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Table 34: Stream Corridor Functional Element scores along the Heritage Park segment of the Parkerson Mill Creek project.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	0	0.0	5	1.4	0	0.0	14	4.0	0	0.0
Functional	0	0.0	101	28.9	34	9.7	116	33.2	0	0.0
Slightly Impaired	84	24.1	109	31.2	261	74.8	105	30.1	342	98.0
Impaired	258	73.9	134	38.4	54	15.5	114	32.7	0	0.0
Non-functional	7	2.0	0	0.0	0	0.0	0	0.0	7	2.0

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Table 35: Stream Corridor Functional Element scores along the lower segment of Parkerson Mill Creek.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	1,570	52.9	0	0.0	0	0.0	0	0.0	1,845	62.1
Functional	1,284	43.2	142	4.8	1,417	47.7	156	5.3	675	22.7
Slightly Impaired	98	3.3	738	24.8	1,471	49.5	977	32.9	427	14.4
Impaired	4	0.1	1,922	64.7	82	2.8	1,744	58.7	10	0.3
Non-functional	14	0.5	168	5.7	0	0.0	93	3.1	13	0.4

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Table 36: Stream Corridor Functional Element scores along the upper segment of Parkerson Mill Creek.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	0	0.0	0	0.0	0	0.0	28	2.1	0	0.0
Functional	315	24.0	264	20.1	275	20.9	240	18.3	304	23.1
Slightly Impaired	613	46.6	245	18.6	1,016	77.3	436	33.2	763	58.0
Impaired	190	14.4	755	57.4	24	1.8	601	45.7	212	16.1
Non-functional	197	15.0	51	3.9	0	0.0	10	0.8	36	2.7

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Table 37: Stream Corridor Functional Element scores along the Hub segment of the Parkerson Mill Creek project.

Function	LRp (m)	LRp %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %	RRp (m)	RRp %
Fully Functional	191	24.4	0	0.0	0	0.0	0	0.0	692	88.5
Functional	549	70.2	31	4.0	193	24.7	29	3.7	72	9.2
Slightly Impaired	35	4.5	279	35.7	552	70.6	294	37.6	13	1.7
Impaired	0	0.0	460	58.8	37	4.7	439	56.1	0	0.0
Non-functional	7	0.9	12	1.5	0	0.0	20	2.6	5	0.6

RRp = Right Riparian; RBk = Right Streambank; Sb = Streambed; LBk= Left Streambank; LRp = Left Riparian

Discrete Point Feature frequency and type varied greatly among the segments. Among sites, the total number of DPF identified ranged from 6 in the Heritage Park segment to 74 in Lower Mainstem (Table 38). The number of unique DPF types ranged from 5 in the Heritage Park segment to 9 in the CDV Laundry segment, with half of the segments having 8 unique types. As for severe DPF, the Heritage Park segment was the only segment not to have any DPF with a severity of 3 or greater (Table 39). The lower mainstem had the greatest number of severe DPF followed by AU Forestry and AU Beef Unit segments, respectively.

Table 38: Count of Discrete Point features by type among the segments along Parkerson Mill Creek and its tributaries, Auburn, AL.

Category	Total	Bridge	Culvert	Dam	Ditch	Exposed Pipe	In-Coming Channel	In-Stream Construction	LWD	Log/Deris Jam	Manhole Stack	Seep/Spring	Beaver Dam	Outfall	Side Channel	Trash
AU Beef Unit	30		4	1		5	2		9	7					1	1
AU Forestry	9		2			1		3	1	1	1					
CDV Laundry	14	1	2		1	1	2			1		3		1		2
Coliseum	31	1	8			6	2				1			13		
Heritage Park	6		2						1	1				1		1
Mainstem Lower	74		13		2		10		29	5	1			7		7
Mainstem Upper	60	2	10		4		9		11	3	1			18		2
The Hub	58		2				5		33	11	1	1	1		1	3

Table 39: Count of Discrete Point features with a severity rating of three (i.e., moderate) or greater, by type among the segments along Parkerson Mill Creek and its tributaries, Auburn, AL.

Segment	Total	Bridge	Culvert	Dam	Exposed Pipe	In-Stream Construction	Beaver Dam	Outfall
AU Beef Unit	3			1	2			
AU Forestry	4				1	3		
CDV Laundry	2				1			1
Coliseum	2							2
Mainstem Lower	7		5					2
Mainstem Upper	1	1						
The Hub	1						1	

The extent of modification varied among the segments. Combined modification indicates that greater than 75% of all segments were unmodified (Figure 41). All segments had a Modification of Modified or Highly Modified recorded along their streambed and streambanks, with the AU Forestry segment being the only exception; however, this segment was currently in the early stages of restoration construction. Among segments, the Coliseum segment had the greatest percentage of modification followed by Heritage Park and Upper Mainstem segments. For streambed modification, the Coliseum segment had the greatest percentage (9.7%) of the segment classified as Highly Modified followed by Upper Mainstem (5.8%), AU Beef Unit (4.9%), and Heritage Park

(3.4%) segments (Table 40; Table 41; Table 42; Table 43; Table 44; Table 45; Table 46; Table 47). As for the Modified classification of streambed, the Heritage Park segment had the greatest percentage (15.8%) classified as such, followed by Coliseum (15.4%), and Upper Mainstem (13.6%) segments.

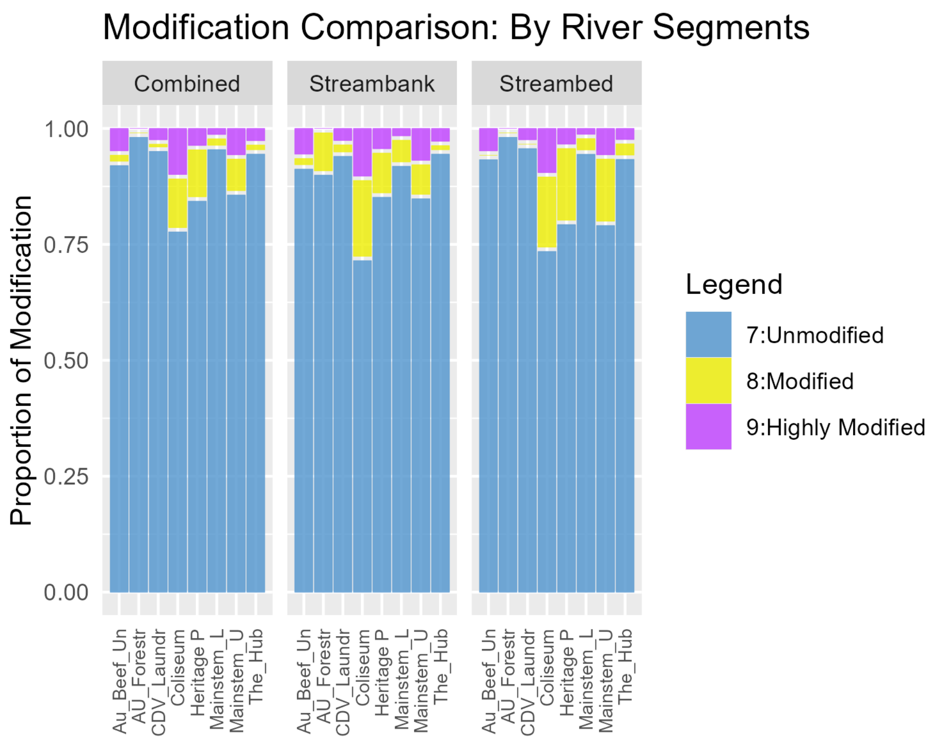


Figure 41: Modification comparison of all stream segments by the stream corridor assessment elements of streambed and streambank for the areas surveyed along Parkerson Mill and related tributaries. Combined is all three modification elements combined (left and right streambank and streambed) into a single value. Note- left and right streambank values were combined for this analysis to provide a single value for streambank.

Table 40: Stream Corridor Assessment combined modification score and individual modification element scores along the AU Beef Unit segment of the Parkerson Mill Creek Project.

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	632	93.8	615	91.2	638	94.7	637	94.5
Modified	9	1.3	18	2.7	0	0.0	0	0.0
Highly Modified	33	4.9	41	6.1	33	4.9	35	5.2

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Table 41: Stream Corridor Assessment combined modification score and individual modification element scores along the AU Forestry segment of the Parkerson Mill Creek Project

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	84	100.0	70	83.3	84	100.0	84	100.0
Modified	0	0.0	14	16.7	0	0.0	0	0.0
Highly Modified	0	0.0	0	0.0	0	0.0	0	0.0

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Table 42: Stream Corridor Assessment combined modification score and individual modification element scores scores along the CDV Laundry segment of the Parkerson Mill Creek Project.

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	313	96.9	308	95.4	315	97.5	311	96.3
Modified	2	0.6	7	2.2	0	0.0	3	0.9
Highly Modified	8	2.5	8	2.5	8	2.5	9	2.8

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Table 43: Stream Corridor Assessment combined modification score and individual modification element scores along the Coliseum segment of the Parkerson Mill Creek project.

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	571	79.2	528	73.2	540	74.9	523	72.5
Modified	77	10.7	121	16.8	111	15.4	119	16.5
Highly Modified	73	10.1	72	10.0	70	9.7	79	11.0

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Table 44: Stream Corridor Assessment combined modification score and individual modification element scores along the Heritage Park segment of the Parkerson Mill Creek project.

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	300	86.0	300	86.0	282	80.8	306	87.7
Modified	36	10.3	31	8.9	55	15.8	30	8.6
Highly Modified	13	3.7	18	5.2	12	3.4	13	3.7

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Table 45: Stream Corridor Assessment combined modification score and individual modification element scores along the lower segment of Parkerson Mill Creek.

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	2,892	97.4	2,660	89.6	2,862	96.4	2,901	97.7
Modified	42	1.4	264	8.9	73	2.5	19	0.6
Highly Modified	39	1.3	46	1.5	38	1.3	50	1.7

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Table 46: Stream Corridor Assessment combined modification score and individual modification element scores along the upper segment of Parkerson Mill Creek.

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	1,148	87.3	1,136	86.4	1,060	80.6	1,139	86.6
Modified	91	6.9	90	6.8	179	13.6	81	6.2
Highly Modified	76	5.8	89	6.8	76	5.8	95	7.2

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Table 47: Stream Corridor Assessment combined modification score and individual modification element scores along The Hub segment of the Parkerson Mill Creek Project.

Modification	CMS (m)	CMS %	LBk (m)	LBk %	Sb (m)	Sb %	RBk (m)	RBk %
Unmodified	753	96.3	753	96.3	744	95.1	753	96.3
Modified	8	1.0	7	0.9	19	2.4	7	0.9
Highly Modified	21	2.7	22	2.8	19	2.4	22	2.8

CMA = Combined Modification Assessment, RBk = Right Streambank; Sb = Streambed; LBk = Left Streambank

Prioritization Examples

HDSS data provides a highly flexible dataset for developing a prioritization schedule for mitigation efforts. The continuous datasets for Function and Modification as well as the point datasets (discrete point features) provide the unique ability to utilize the individual elements (i.e., streambed, left and right streambanks, left and right riparian, and discrete point features) to develop mitigation strategies. However, the HDSS-SCA-Condition Assessment models these individual elements into three unique factor combinations (i.e., Overall Functional score, Overall Condition score, Points Combined score) by standardizing and weighing the elements based on severity and potential impacts on the stream corridor. These three factors provide a more complete picture of the conditions within the entire watershed allowing for a more targeted prioritization approach. Additional criteria such as individual needs, available resources, ease of access, infrastructure proximity, etc. can also be utilized to further refine priorities, however this was not requested for this project. Below we have highlighted a select reaches in need of management action based on the scores from the HDSS-SCA-Condition Assessment factors of Combined

Functional score and Overall Conditions score. A complete listing may be found in the accompanying Appendices.

Utilizing the SCA Condition Assessment factor of Combined Functional score, the stream corridor between the McWhorter Center and Jane B. Moore Field, in the Upper Mainstem segment, had one of the longest and most consistent score of impaired within the basin (Figure 42, Figure 43), with only one other location of similar score and magnitude present (along the northeast section of Biggio Dr.). By using the Combined Functional score, we can easily identify the degree of perturbation (score), as well as the scope and magnitude throughout the basin to develop a prioritization ranking system for the entire basin. Additionally, the Combined Functional classification of Worst for the stream corridor along the AU Forestry segment highlights the current conditions of this segment. However, this is expected since this segment is at an early stage of restoration.

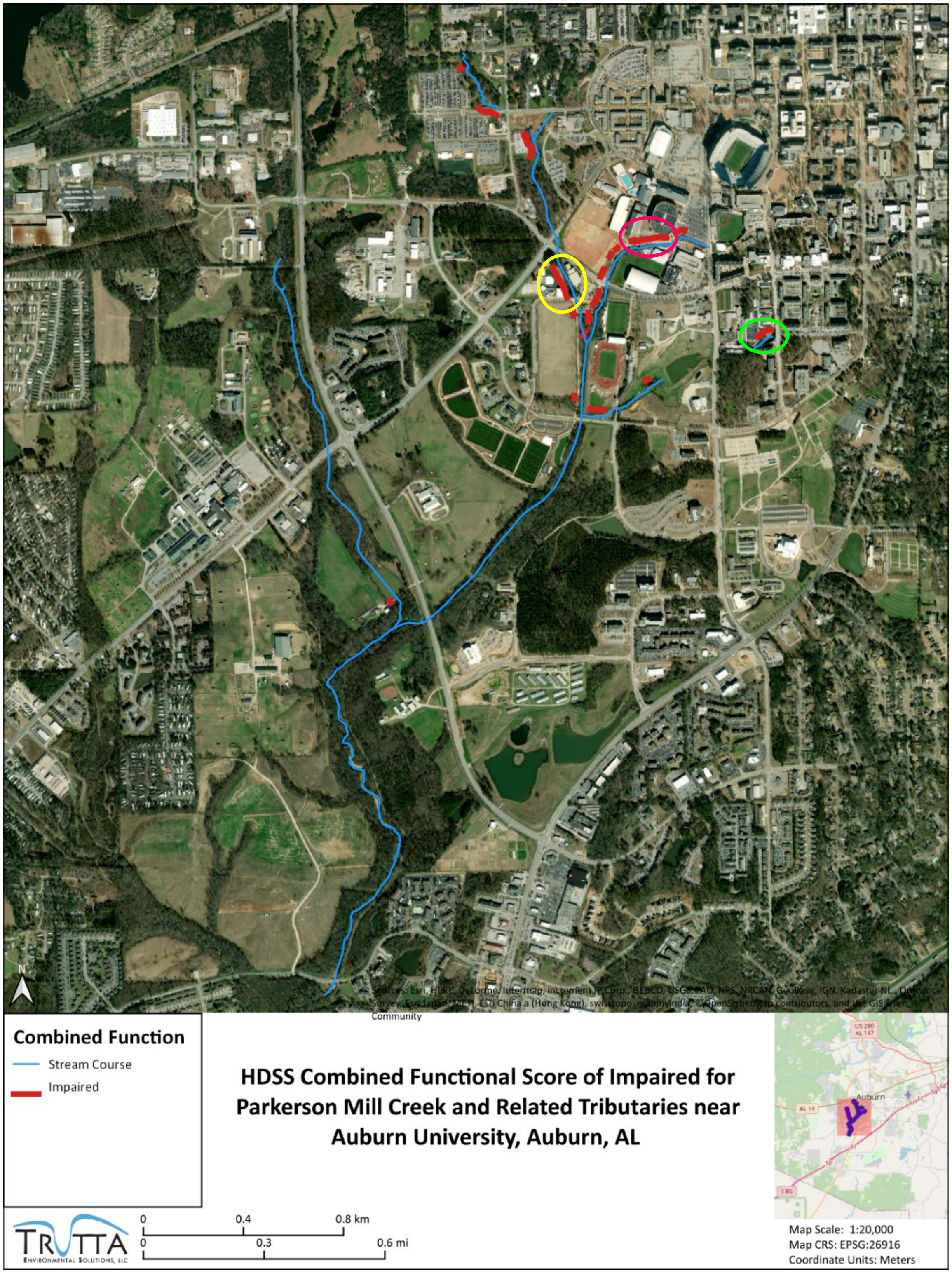


Figure 42: HDSS Combined Functional Score of only Impaired used to identify and prioritize areas in greatest need management action. Specific areas of interest include Jane B. Moore Field (yellow), Biggio Dr. (purple), and AU Forestry (green).

Figure 43: Generalized location between the McWhorter Center and Jane B. Moore Field, where the Combined Functional Score of the stream corridor was consistently Impaired for an extended distance.

Figure 44: StreamView image of in- and near- channel restoration along AU Forestry segment of the survey.

An alternative method for prioritization highlights the results of the Overall Condition scores throughout the basin. This classification utilizes both Discrete Point Features (severity and abundance) and the Combined Functional Score. Therefore, Overall Condition classification highlights problematic infrastructure (and natural features) in combination with problematic stream corridor conditions. In addition to highlighting problematic infrastructure, Overall Condition also highlights problematic natural discrete point features (e.g., log/debris jams) that are negatively affecting the condition of the stream corridor.

Using the Overall Functional score, we can easily identify two areas in need of management action. The stream reach near Pratt-Carden Dr. (Figure 45), along the AU Beef Unit segment (Figure 46), and the reach near the Auburn Soccer Complex, along the Coliseum segment (Figure 47), were two of the worst locations based on the Overall Condition score within the basin. By using the Overall Condition score we can easily identify the degree of perturbation (score), as well as the scope and magnitude throughout the basin to develop a prioritization ranking system for the entire basin. The Overall Condition score of a reach along The Hub segment, was classified as one of the worst reaches; however, this classification was influenced by a natural feature (e.g., log/debris jam) and not infrastructure (Figure 48). Additionally, the AU Forestry segment was again highlighted as one of the worst segments; however, we understand that this reach is currently undergoing a major stream restoration effort.

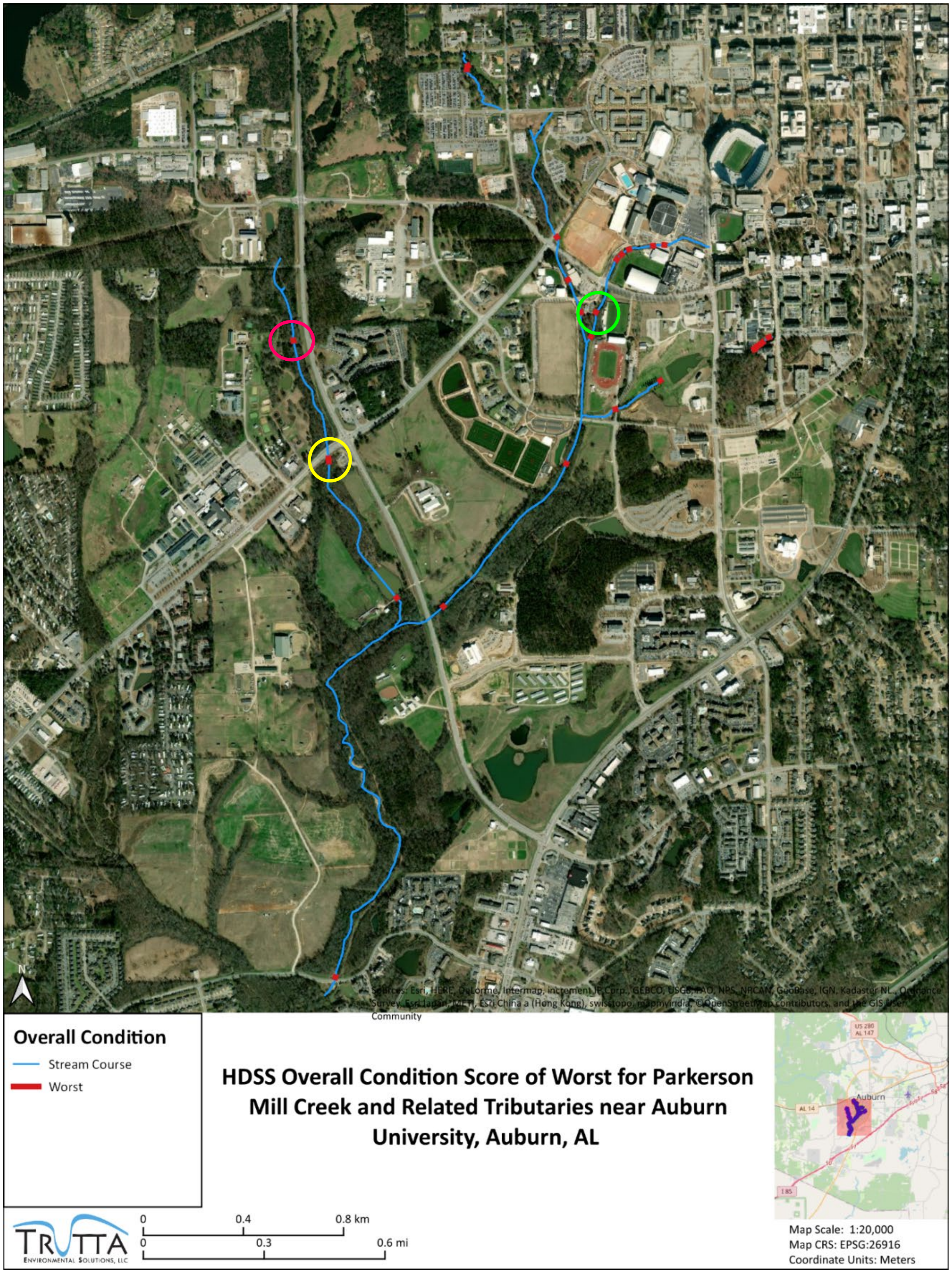


Figure 45: HDSS Overall Condition Score of only the worst reaches used to identify and prioritize areas in greatest need of management action. Specific areas of interest include Pratt-Carden Dr. crossing (yellow), Auburn Soccer Complex. (green), and The Hub (purple).

Figure 46: StreamView image of one of the worst reaches based on the Overall Condition score influenced by infrastructure (e.g., culverts and exposed pipes), along AU Beef Unit segment of the survey.

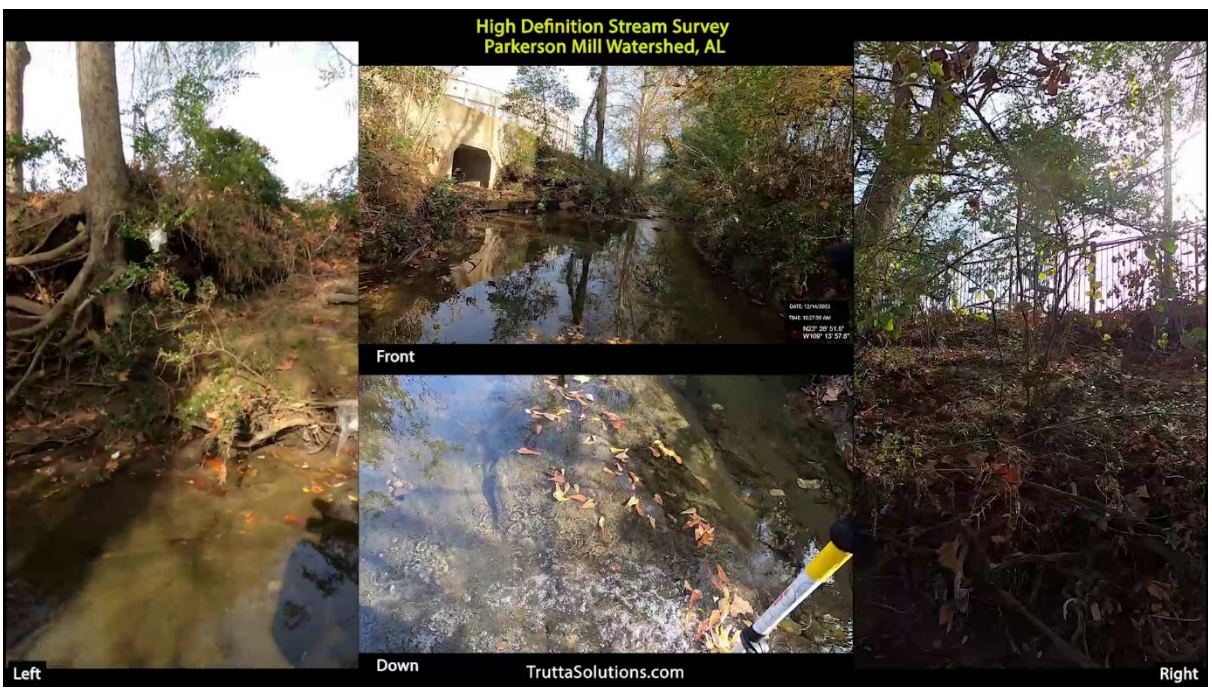


Figure 47: StreamView image of one of the worst reaches based on the Overall Condition score influenced by infrastructure (e.g., culvert), along the Coliseum segment of the survey.

Figure 48: StreamView image of one of the worst reaches based on the Overall Condition score influenced by natural feature (e.g., log/debris jam), along The Hub segment of the survey.

While the combined data from the SCA-Condition Assessment provides a robust framework for watershed management, the individual elements, such as discrete point features, offer a straightforward and effective means for prioritizing management actions or determining necessary interventions. Documenting specific features like seeps and springs is particularly useful for identifying areas that may require further investigation or immediate action. For instance, during the survey, four discrete seep/spring point features were recorded (Figure 49), helping to highlight potential locations of concern that may impact stream health.

At one of these locations, a single seep/spring was documented along the segment referred to as "The Hub" (Figure 50), while a cluster of three seeps/springs were identified along the CDV Laundry segment (Figure 51). In all cases, discolored water was observed slowly percolating from the streambed or streambank, indicating potential contamination or other subsurface issues. These areas, especially where clusters were recorded, could benefit from additional investigation to determine if they represent significant point sources of contamination or other environmental concerns.

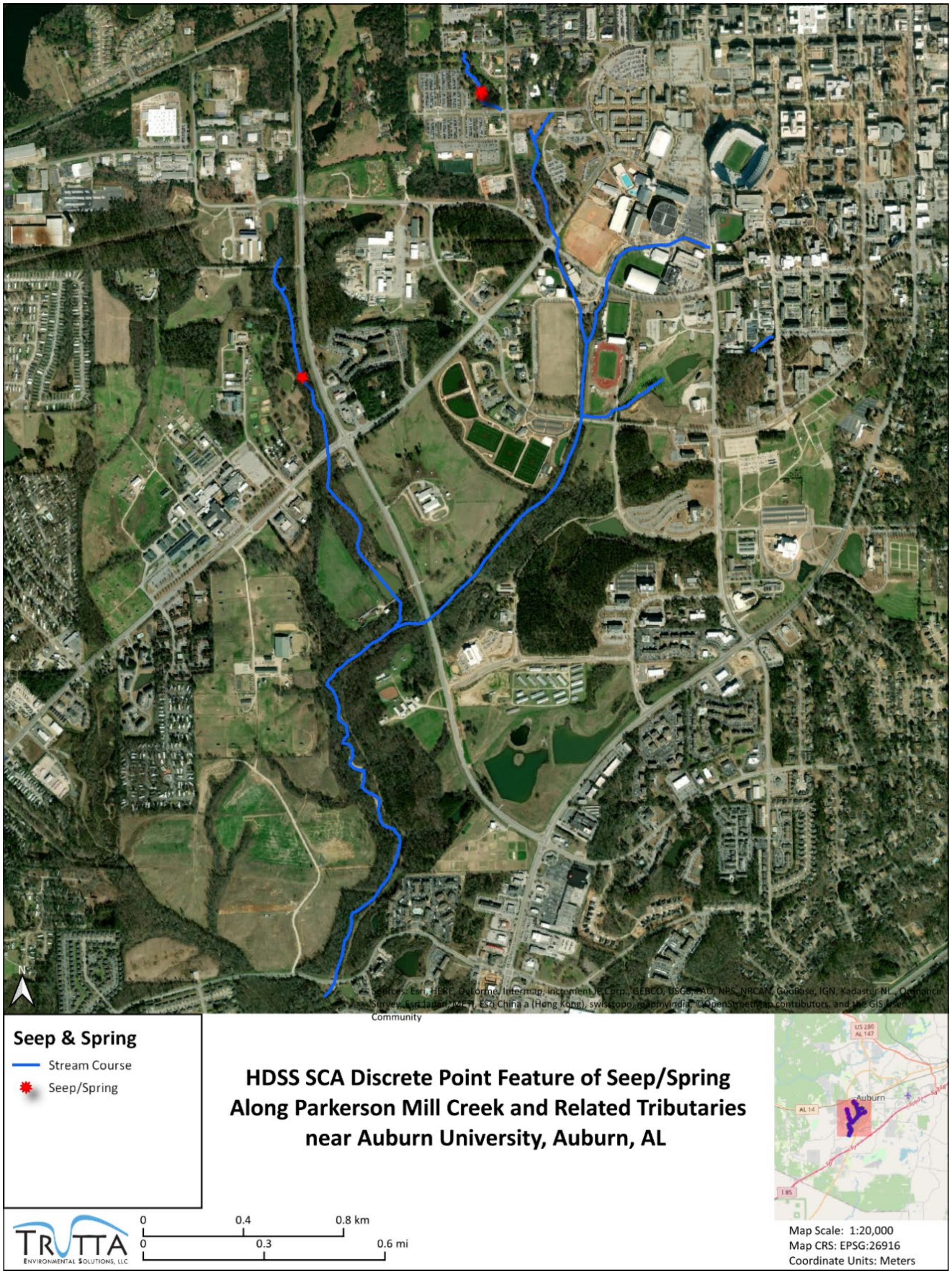


Figure 49: Seep/Spring discrete point feature locations identified along the Parkerson Mill Creek and related tributaries near Auburn University, Auburn, AL.

Figure 50: Image of seep/spring discrete point feature located along the The Hub segment of a related tributary for the Parkerson Mill Creek survey near Auburn University, Auburn, AL.

Figure 51: Individual images a cluster of three seep/spring discrete point features located along the CDV Laundry segment of a related tributary for the Parkerson Mill Creek survey near Auburn University, Auburn, AL. Top photo being the most downstream location and the bottom being the most upstream location.

Discussion

This project centered around two main objectives: (1) conduct HDSS across the streams within the Parkerson Mill Creek watershed to inventory baseline conditions and (2) complete a detailed HDSS-SCA based on the HDSS data to classify, identify, and prioritize streams most in need of remediation. This effort was designed to create a clear, data-driven approach for determining which areas of the watershed required the most immediate attention to restore water quality and reduce the environmental impacts of stormwater discharge.

The HDSS approach has demonstrated significant effectiveness across various projects within the field of environmental management. This innovative method allows for comprehensive and detailed assessments of aquatic systems and their surrounding environments, making it a valuable tool for researchers and practitioners alike. For example, videographic surveys have been used to identify areas that are particularly susceptible to erosion (Connell et al. 2019) and to determine streambank erosion rates (Hensley and Ayers 2018), providing critical insights into the dynamics of erosion processes and their implications for water quality and habitat integrity.

Additionally, the HDSS approach has been used to help with water quality and Total Maximum Daily Load (TMDL) modeling efforts (Connell and Parham 2016, Connell and Parham 2017), which are essential for establishing pollutant limits in water bodies to protect aquatic ecosystems. Moreover, habitat mapping and suitability assessments have benefited from HDSS, as evidenced by multiple studies (Candlish 2010, Parham et al. 2021, Parham et al. 2022, Parham et al. 2022b) that highlight the utility of videographic data in understanding habitat distribution and ecological conditions. Other applications, such as stormwater management (Parham 2017, Parham et al. 2021b), acid mine drainage (Parham et al. 2024), and evaluating project impacts (Parham 2020), further underscore the versatility and effectiveness of the HDSS approach in advancing our understanding and management of water resources and ecosystems.

The task of inventorying and assessing the current conditions within the streams involved conducting the HDSS visual stream corridor survey. This survey utilized advanced videographic technology, combining locational receivers, high-definition video cameras, and sonar to capture detailed information on streambed, streambank, and riparian zone conditions. The majority of streams were documented, providing a continuous, high-resolution dataset that offered a clear picture of the physical conditions across the watershed. Using the video data collected during the stream corridor survey, a detailed HDSS-SCA was conducted to evaluate the overall health of the streams within the Parkerson Mill watershed. Streams were categorized based on their functional condition—fully functional, functional, slightly impaired, impaired, or non-functional—and modification status, such as unmodified, modified, or highly modified. Also, the HDSS approach allowed for the identification of specific features such as erosion points, sediment deposits, stream obstructions, and signs of water quality degradation. These data, when combined with the spatial mapping capabilities of the HDSS system, provided a comprehensive view of the watershed's condition, which is critical for informing subsequent remediation priority recommendations.

Overall Conclusions

The HDSS approach, which integrates video, geospatial data, and mapping into a comprehensive water management tool, offers significant benefits for the management of municipal streams. These benefits stem from its ability to enhance monitoring, prioritization, and decision-making processes for surface water and related environmental issues. Here are ways HDSS contributes to stormwater management:

1. Detailed and Accurate Surface Water Inventory

HDSS provides high-resolution video footage and precise geospatial data of water bodies and surrounding areas. For municipalities, which often face problems such as stream instability and water contamination, this real-time monitoring enables early detection of pollutants, sedimentation, and/or erosion in affected streams. By having a detailed visual record, stream assessments can be more accurate, leading to better-targeted remediation efforts.

2. Enhanced Risk Assessment and Prioritization

Stormwater impacts can vary greatly in terms of environmental impact. HDSS can support a data-driven prioritization scheme, allowing stakeholders to rank degraded sites based on the severity of their impact. This could include prioritizing areas with higher risks of erosion leading to water quality degradation and infrastructure failure. HDSS also allows for dynamic updates to prioritization frameworks, adapting to new data as conditions change over time.

3. Improved Mapping and Visual Documentation for Stakeholder Collaboration

One challenge in managing stormwater impacts is coordinating efforts between agencies and stakeholders, including environmental regulators, land managers, and local communities. The HDSS allows users to create comprehensive, up-to-date maps and visualizations that all stakeholders can easily interpret. This shared data set promotes better collaboration, consensus building, and alignment of management goals across all parties.

4. Cost-Effective and Timesaving

Traditional methods of stream or surface water surveying often require manual inspection and on-the-ground fieldwork, which can be time-consuming and expensive. With HDSS, large watersheds can be covered in a fraction of the time, reducing both labor and resource costs. This efficiency is particularly valuable for stormwater management, where the range of problems, the frequency of occurrence, and the distribution of potential impacts to the stream corridor vary over a large geographic area.

5. Targeted Remediation and Restoration Efforts

By utilizing HDSS data, remediation strategies for stormwater-impacted areas can be more precisely designed. For example, if HDSS reveals patterns of erosion or pollution spreading downstream, restoration activities such as installing silt fences, building wetlands, or rerouting streams can be implemented in the most effective locations. This targeted approach helps optimize both environmental impact and resource use.

6. Long-Term Monitoring and Success Evaluation

HDSS can also be used to track progress over time, allowing for the evaluation of the success of remediation efforts. It enables before-and-after comparisons and provides a historical record of conditions throughout the watershed. This can inform whether mitigation activities, such as restoration or rehabilitation, are working or if further adjustments are needed.

In summary, HDSS offers a powerful, data-rich solution for managing the complex and varied environmental challenges posed by increased urbanization. Its ability to combine visual, spatial, and environmental data improves the ability to make informed decisions, allocate resources efficiently, and ensure the long-term health of surface water ecosystems affected by stormwater.

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