Appendix I

Pre- and Post-construction Monitoring Plan

Flat Creek Watershed Aquatic Ecosystem Restoration Detailed Project Report

Draft Monitoring Plan

US Army Corps of Engineers
Mobile District

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1. Introduction

This Monitoring Plan was developed to evaluate the performance of restoration measures implemented as the Recommended Plan for the Flat Creek watershed, developed in the Flat Creek Watershed Aquatic Ecosystem Restoration Detailed Project Report (Detailed Project Report). Monitoring will be conducted on one occasion prior to construction and on two occasions post-construction (one year after construction and three years after construction). Ecosystem restoration objectives were established in the Detailed Project Report to establish achievable, measurable criteria to evaluate restoration implementation, identify any required adjustments, and determine if changes to structures, operations, and/or management are needed. This Monitoring Plan includes biological monitoring requirements for the two stream restoration sites included in the Flat Creek Tentatively Selected Plan.

As detailed in the Detailed Project Report, the pre-construction monitoring event and 2 post-construction monitoring events will be included as part of the cost-share implemented under the U.S. Army Corps of Engineers (USACE) Continuing Authorities Program (CAP), with 65 percent of the costs for ecosystem restoration paid by USACE, and the other 35 percent paid by the non-federal sponsor (in this case, the City of Gainesville). Any additional post-construction monitoring past the 3 years will be entirely the responsibility of the non-federal sponsor. After the monitoring period, the City of Gainesville, as the non-federal sponsor, will be responsible for all long-term management, operations, and maintenance of the restoration measures implemented as part of the Tentatively Selected Plan. A description of this long-term management plan is included in Section 7 of the Detailed Project Report (Plan Implementation). The technical approach to monitoring and the performance standards for the Tentatively Selected Plan are described in this Monitoring Plan.

2. Technical Approach

2.1 Sampling Stations

The Tentatively Selected Plan for Flat Creek includes two stream restoration sites – 32 and 33 (see Figure 2-1). Biological monitoring will be conducted at each of these locations as part of the monitoring plan (see Table 2-1). The sampling reach will begin at the downstream end of the restoration area, and will extend the length prescribed in Georgia Department of Natural Resources (GADNR) Standard Operating Procedures (SOPs) for biological monitoring. Descriptions and photographs of each monitoring station are provided below.

TABLE 2-1
Monitoring Station Descriptions
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Station ID	Location in Watershed	Location	Monitoring Required
FC-32	Upper Flat Creek	Near Atlanta Highway / Dorsey Street	Biological
FC-33	Upper Flat Creek	Near Atlanta Highway / Hilton Drive	Biological

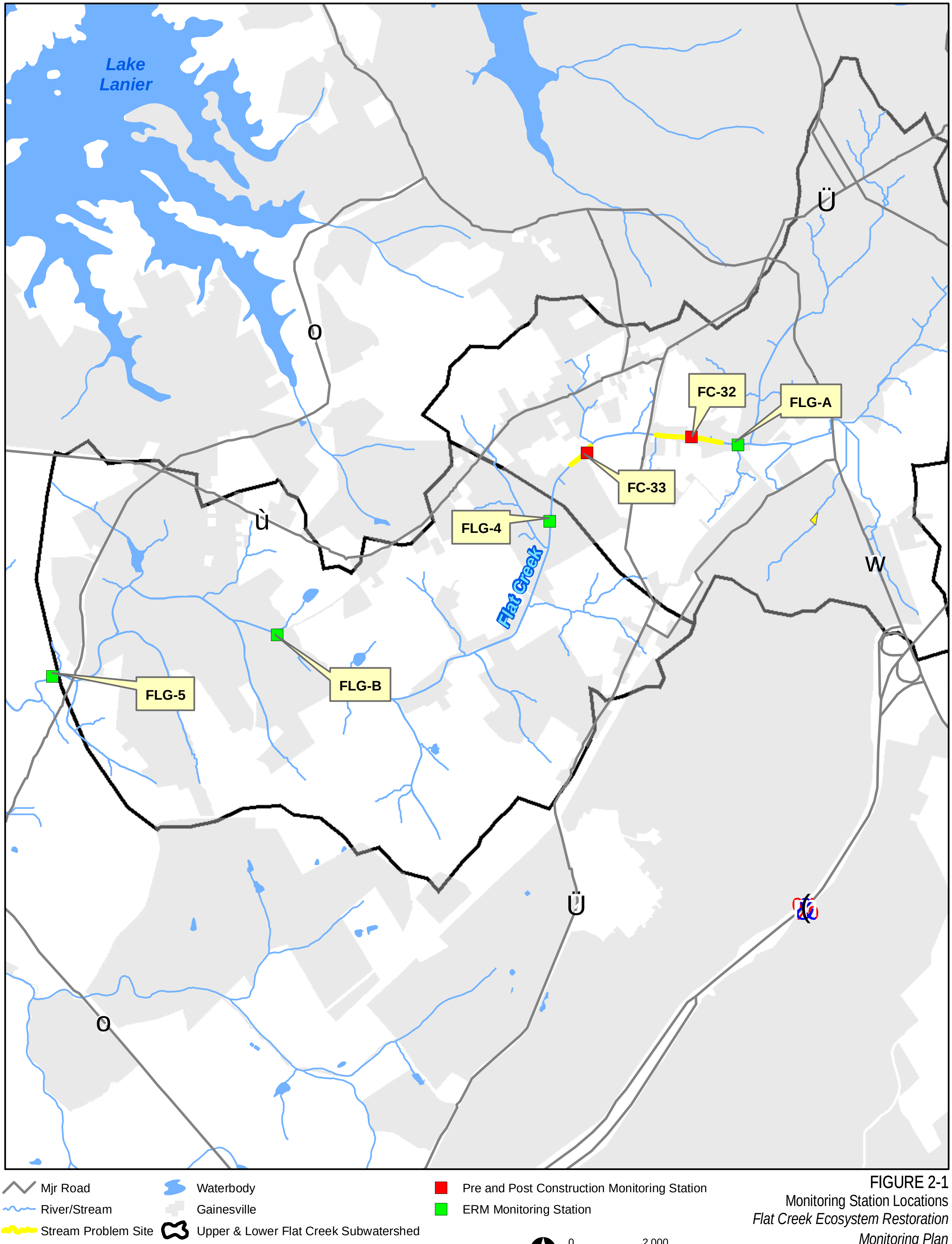

FIGURE 2-1
Monitoring Station Locations
Flat Creek Ecosystem Restoration
Monitoring Plan

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2.1.1 Station FC-32

Station FC-32 (Figure 2-2) is located on the mainstem of Flat Creek, and has a drainage area of 2.60 square miles. The station is located at the downstream end of the proposed stream restoration site (Alternative 32), near the intersection of Atlanta Highway and Dorsey Street. At this location, the bankfull width is approximately 25 feet and banks are approximately 9 feet tall. Most of the riparian buffer has been affected by clearing and maintained residential lawns. The stream reach associated with Station FC-32 has a history of local flooding complaints. Many areas show signs of severe bank erosion and embedded substrate.

2.1.2 Station FC-33

Station FC-33 (Figure 2-3) is also located on the mainstem of Flat Creek, and has a drainage area of 3.06 square miles. The station is located at the downstream end of the proposed restoration site (Alternative 33) near the intersection of Atlanta Highway and Hilton Drive. The bankfull width is approximately 21 feet. The stream exhibits bank erosion in several areas. Most of the riparian buffer has been affected by clearing. Many areas show signs of moderate to severe bank erosion, sedimentation, and embedded substrate.

FIGURE 2-2
Station FC-32
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

FIGURE 2-3
Station FC-33
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

2.1.4 Existing ERM Monitoring Stations

In addition to the sampling stations described above, additional biological monitoring data will be available from the City of Gainesville's continued monitoring of four sampling sites on Flat Creek (see Figure 2-1). Monitoring data from these stations, the Ecosystem Response Model (ERM) stations, were used to project the benefits of restoration alternatives in the Detailed Project Report. Monitoring at the ERM stations (sampled during odd years) is not included or funded as part of this Monitoring Plan; however, the City will provide results from biological monitoring of these sites to evaluate the success of the Tentatively Selected Plan. The data obtained may be used for ERM analysis and to compare habitat unit results to predicted benefits from the Detailed Project Report. The additional ERM sampling site data will be helpful in further evaluating the overall ecosystem restoration improvements achieved through implementation of the Tentatively Selected Plan.

2.2 Monitoring Schedule

Figure 2-4 shows the proposed schedule for biological monitoring, which is dependent on construction completion. In accordance with GADNR seasonal sampling requirements, physical habitat and benthic macroinvertebrate assessments will be conducted between mid-September and the end of February, and fish sampling will be conducted between early-April and mid-October (GADNR, 2005 and 2007). At least one pre-construction and two post-construction monitoring events will be conducted to assess the performance of the Tentatively Selected Plan. Based on the seasonal requirements outlined above, and assuming construction begins in June 2012, preconstruction monitoring would occur between October 2011 and May 2012. Post-construction monitoring will be conducted one year after construction and three years after construction, for two post-construction monitoring events.

2.3 Biological Monitoring Methods

Biological monitoring, including assessments of physical habitat and fish and benthic macroinvertebrate communities, will be conducted by at least two aquatic biologists familiar with the most current GADNR sampling and data analysis protocols (GADNR, 2005 and 2007). As specified in the protocols, fish and benthic macroinvertebrate sampling should be conducted on separate field events. One pre-construction and two post-construction monitoring events will occur at each station.

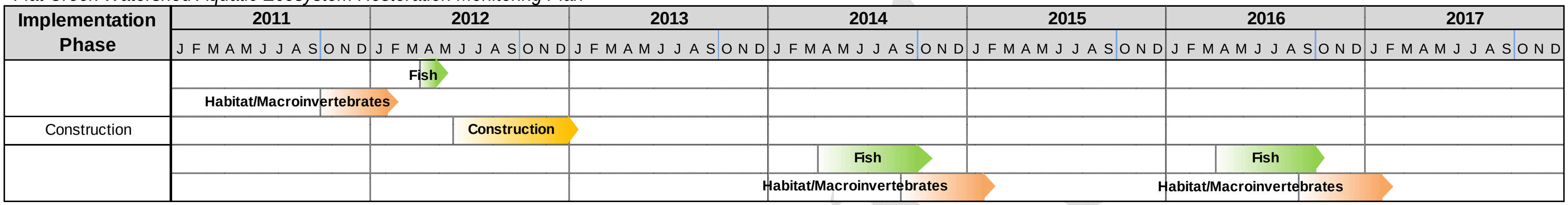
2.3.1 Physical Habitat Assessment

Physical habitat assessments will be conducted at sampling stations (Table 2-1), following procedures outlined in *Standard Operating Procedures: Macroinvertebrate Biological Assessment of Wadeable Streams* (GADNR, 2007). The assessment involves rating 10 parameters, out of possible 20 points each, to evaluate substrates, habitat availability, riparian corridors, and streambank conditions.

Field Methods

Roughly 200 meters of stream will be evaluated for physical habitat at each station. Consistent with GADNR (2007) and historical monitoring in the Flat Creek watershed, the monitoring reach will be evaluated using protocols for riffle/run-prevalent systems, typically found above the Fall Line. Two qualified team members will individually evaluate 10 physical habitat assessment parameters (Table 2-2), following field sheets provided in GADNR (2007), and the results will be averaged. If the total habitat scores deviate by 30 or more points, the team members will review their assessments. If agreement on the scores cannot be reached, then the field team leader has the authority to make the final decision.

FIGURE 2-4
Pre- and Post-Construction Tentative Monitoring Schedule
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan



Data Analysis

A total habitat score will be calculated by summing the average scores of each parameter, with the highest possible total score being 200 points. According to GADNR (2007), physical habitat scores are no longer compared to reference reach scores to develop a qualitative assessment, as in previous draft protocols (that is, qualitative assessments such as "comparable to reference" or "dissimilar to reference"). However, GADNR (2007) categorizes individual metric scores into one of four qualitative condition categories: poor, marginal, suboptimal, and optimal. Scores between 0 and 25 percent of the highest score are considered poor, between 26 and 50 percent marginal, between 51 and 75 percent suboptimal, and higher than 75 percent optimal. These qualitative condition categories will be used when interpreting results to evaluate conditions at each station and to make comparisons among stations.

TABLE 2-2
Habitat Assessment Parameters for Riffle/Run Systems
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Parameter	Parameter Description
Epifaunal substrate/instream cover	Measures availability of actual substrates available as refugia or feeding sites, or sites for spawning and nursery functions for aquatic organisms.
Embeddedness	Measures the degree to which cobble, boulders, and other rock substrate are surrounded by fine sediment.
Velocity/depth combinations	Measures a stream's characteristic velocity/depth regime.
Channel alteration	Measures large-scale alteration of instream habitat that affects stream sinuosity and causes scouring.
Sediment deposition	Relates to the amount of sediment that has accumulated and the changes that have occurred to the stream bottom as a result of deposition.
Frequency of riffles	Estimates the frequency or occurrence of riffles as a measure of sinuosity.
Channel flow status	The degree to which the channel is filled with water during base or average annual flow periods.
Bank vegetative protection	Measures the amount of the stream bank that is covered by vegetation.
Bank stability	Measures the existence of, or the potential for, detachment of soil from the upper and lower stream banks and its movement into the stream.
Riparian vegetative zone	Measures the width of natural vegetation from the edge of the upper streambank out through the floodplain.

Stream stability will be evaluated at each monitoring station using both parameters from the habitat assessment and the Rosgen bank erosion hazard index and near bank stress procedures (Rosgen, 2006). Stability and erosion potential will be evaluated to assess the overall channel stability at each cross-section. Because each restoration project has its own critical values, the values that determine the geomorphic threshold for a particular stream must be determined on a case-by-case basis. Adjustments that do not exceed the critical values may be attributed to changes within, or along, the channel that signal increased stability, such as added vegetation on the banks.

2.3.2 Benthic Macroinvertebrate Sampling

Benthic macroinvertebrates will be sampled at each stream restoration station between mid-September and the end of February, following qualitative techniques described in *Standard Operating Procedures: Macroinvertebrate Biological Assessment of Wadeable Streams* (GADNR, 2007). This assessment is a multi-habitat approach that maximizes efficiency of field work and analysis. It is consistent with USEPA's rapid bioassessment protocols (RBPs [Barbour, et al., 1999]) and involves obtaining samples collected from the various habitats for analysis and data evaluation. Multi-habitat assemblages provide the broad-based information necessary to make the best assessment of biotic integrity as it relates to stream conditions.

TABLE 2-3
Benthic Macroinvertebrate Protocols for Riffle/Run Streams
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Habitat	Number of Jabs or Kicks
Fast riffle	3
Slow riffle	3
Woody debris/snags	5
Undercut banks/root mats	3
Coarse particulate organic matter / leaf packs	3
Sand or bottom substrate	3
Macrophytes (if any)	3

Source: GADNR (2007)

Field Methods

Sampling will be conducted over a 100-meter reach, at least 100 meters upstream of any road crossing where possible. The number of jabs or kicks to be collected from each habitat type is shown in Table 2-3. The major habitat types at each site—undercut banks, rocks, vegetation, sand, riffles, runs, and pools—and the proportion of each habitat type sampled will be recorded on the field sheets. Sampling will be conducted downstream to upstream, at 20 different locations in the reach, by collecting leaf packs, jabbing a D-frame net into the woody snags, undercut banks, bottom substrate, or macrophyte habitats or using a kicknet to collect a sample from a riffle habitats. One team member will be responsible for the D-frame sampling (jabs). The other field team member will track the number of jabs to establish a consistent level of effort across stations and according to GADNR (2007), compile the material in a sieve bucket, check large debris for organisms, and elutriate the sieve bucket to reduce the silt content. The organisms collected will be bagged, preserved in 10 percent formalin, and shipped to a laboratory certified to conduct macroinvertebrate identification. In situ measurements of dissolved oxygen, temperature, pH, and specific conductance will be made during the macroinvertebrate sampling to document adverse water chemistry parameters that might affect the aquatic communities.

Sampling techniques for each habitat type are detailed below.

Riffle Kicks. Riffle kick net samples will be collected from both fast and slow riffles in riffle/run stream systems. A 1-square-meter riffle area will be disturbed using kicks, and organisms will be collected in the kick net. This technique is intended primarily to collect species that require highly oxygenated waters such as those in the Ephemeroptera, Plecoptera, and Trichoptera orders. If six riffle areas are not present, allocated kicks will be redistributed among the remaining habitats.

Woody Debris and Snags. Woody debris/snags samples include the collection of organisms found in and on rocks and logs. These habitat types will be washed, scraped into buckets, and poured through a 500-micron net. This technique is used to collect small organisms from species in the family Chironomidae, Baetidae, Hydroptilidae, as well as Oligochaetes and other scrapers/grazers.

Undercut Banks and Root Mats. The undercut banks/root mats samples will be collected from three different bank areas, including mud banks and root mats when available. Bank samples are particularly important for collection of species that prefer low-current environments.

Coarse Particulate Organic Matter and Leaf Packs. Sampling of coarse particulate organic matter and leaf-packs will consist of collecting clumps of leaves, small sticks, and parts of logs. Most material will be collected from rocks or snags and will not include new leaf fall. Leaf packs are important for collecting shredder organisms, such as species in the orders Plecoptera and Trichoptera.

Sand or Bottom Substrate. Three sand kick samples will be collected with a fine-mesh net bag (500-micron) or kick net. The bag or net will be held open near the substrate while sandy habitats just upstream are vigorously agitated. This technique is especially useful for collecting small organisms, such as species in the family Chironomidae, which inhabit sandy substrates.

Macrophytes. Submerged, floating, or emergent vegetation often occurs along the shore zone and in channel beds. Samples will be collected by dragging a sweep net in an upstream direction through the vegetation if present. If macrophytes are not present, the allocated sample jabs will not be redistributed, as with the other techniques.

Chain-of-Custody and Shipping Procedures

To establish the documentation necessary to trace sample possession from the time of collection, a Chain-of-Custody (COC) record, which can be obtained from the laboratory, will be completed for the benthic macroinvertebrate sampling event. To maintain the COC record, every person who has custody of the sample at any time will sign, date, and note the time on the COC record. Samples will not be left unattended unless placed in a secured and sealed container with the COC record inside the container.

The COC record will include special instructions for the laboratory to follow, such as composite preparation or clean metal analysis, which will be consistent with the contract. If discrepancies are identified, the field team leader will inform the project manager before the samples are analyzed. The following special instructions will be included on the COC forms:

- **Benthic Macroinvertebrates—**Identify samples to the lowest taxonomic level possible and complete the Georgia RBP assessment for the metrics listed in the contract.

Sample Labeling and Shipment

Benthic macroinvertebrate samples will be placed in a zip-seal bag and preserved with 10 percent formalin after collection at each station. For each benthic macroinvertebrate sample, the following information will be marked on the outside of the bag:

- Field team leader name
- Flat Creek

- CH2M HILL/USACE
- Date
- Station number
- Station identifier

A labeled tag will be inserted into the benthic macroinvertebrate sample with the same information. Waterproof paper will be used to prepare the tag, and the labels on both bags and tags will be marked with indelible ink. After the samples have been labeled and preserved, they will be double-bagged with a 1-gallon zip-seal bag and then a 2-gallon bag. The outer bag will then be sealed with duct tape.

Benthic macroinvertebrate samples will be stored in coolers and remain in the custody of the field team leader until the cooler is full or ready for shipment. Coolers prepared for shipping will be packed to minimize movement of samples and will include vermiculite in case of leakage. Each shipping container will contain a COC form with the analytical directions for the laboratory. Benthic macroinvertebrate samples will be shipped to the laboratory within 5 days of collection.

Data Analysis

Macroinvertebrates will be identified to lowest possible taxonomic level and enumerated by an entomologist certified to conduct macroinvertebrate assessments. Data analysis techniques will follow procedures described in the SOP (GADNR, 2007), which include evaluation of multiple metrics according to Ecoregion 45a (Southern Inner Piedmont), in which the samples will be collected. The metrics for Ecoregion 45a are outlined in Table 2-4. Each metric category represents a different component of community structure or function and provides a measure of biotic integrity. Results will be entered into spreadsheets provided by GADNR that calculate a multi-metric benthic macroinvertebrate index score. Each individual metric will be scored on a 100-point scale, and the final score will be an average of the metric scores. Reference conditions are inherent in the formulas used to calculate the metric scores. Qualitative condition categories based on the benthic macroinvertebrate index score are pending with GADNR. Until GADNR makes further information available, data analysis will include a comparison of scores among stations and an evaluation of the percentage of the highest possible score for each sampling station.

TABLE 2-4
Southern Inner Piedmont – Benthic Macroinvertebrate Metrics
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Metric	Metric Category
Plecoptera Taxa	Richness
% Trichoptera	Composition
% *Chironomus* & *Cricotopus*/Total Chironomidae	Composition
Tolerant Taxa	Tolerance/Intolerance
% Scraper	Functional Feeding Group
Clinger Taxa	Habit

Source: GADNR, 2007

2.3.3 Fish Sampling

Fish sampling will be conducted between early April and mid-October in accordance with *Standard Operating Procedures for Conducting Biomonitoring on Fish Communities in Wadeable Streams of Georgia* (GADNR, 2005) and RBP V (Plafkin et al., 1989; Barbour et al., 2000). The methodology, detailed below, involves a fish community survey using standard field techniques, species identification, enumeration, specimen external examination, and assignment of ratings to a variety of fish community attributes (metrics), which are summed to obtain an overall measure of biotic integrity.

Field Methods

Fish will be sampled at all stations (Table 2-1). Backpack electrofishing will be used to sample representative habitats, including riffles, runs, and pools, in each sample reach. Electrofishing may be supplemented by seining under appropriate conditions, and the unit sampling effort (the minutes spent electrofishing) will be comparable among stations. GADNR (2005) recommends sampling reaches equal to 35 times the mean standard width to decrease variability in IBI scores. Fish sampling will progress upstream, so as not to disturb sediments and decrease visibility, and team members will be careful not to walk through the sampling area prior to sampling. A trained biologist will operate the shocker and be assisted by another team member who will help capture stunned fish, carry a live bucket for all captured fish, and maintain multiple live tanks (coolers) on the bank by changing the water frequently. Sampling team members assisting in fish sampling will use proper protective equipment, such as waders and rubber gloves.

After backpack electrofishing is completed, the lead fisheries biologist will select areas to use a minnow seine, which is particularly effective in collecting darters, minnows, and other smaller fish generally not as vulnerable to electrofishing. Two seining methods will be used: kick sets and downstream hauls. For kick sets, the minnow seine will be set perpendicular to the current so that the lead line of the seine is situated on the bottom of the stream. Two field members will hold the net, while a third will kick and disturb the substrate causing fish to move downstream, away from the disturbance, into the net. Downstream hauls require two field members to sweep the net downstream, through runs and pools, slightly faster than the current, keeping the lead line close to the bottom. The net will be either lifted midstream or hauled on to the bank when possible.

After sampling is complete, fish will be identified and enumerated in the field to the greatest extent practical, with some voucher specimens being preserved in 10 percent formalin for laboratory confirmation of species identification. All other specimens will be released live at the collection site. A data sheet that includes size, weight, and external anomalies of the species collected will be completed at each station, along with detailed notes on habitat and surrounding watershed conditions. In addition, in situ measurements of dissolved oxygen, temperature, pH, and specific conductance will be made during the fish sampling to document any adverse water chemistry parameters that might affect the aquatic communities.

Data Analysis

The index of biotic integrity or IBI (Karr et al., 1986) will be used to evaluate the integrity of the fish communities at each sampling station. The IBI, which is used as the model for EPA's RBP (Barbour et al., 1999; and Plafkin et al., 1989), integrates a broad range of fish community attributes into an assessment of stream biotic integrity. The methodology involves species identification, enumeration, and external examination of the collected fish, and assignment of ratings to various fish community attributes (metrics), which are summed to obtain an overall measure of biotic integrity. IBI scores will be calculated based on rating 13 metrics of fish community structure in 5 broad categories: species richness, species composition, trophic function, species abundance, and physical condition. The IBI assumes that each metric correlates either positively or negatively with increased stream degradation. The 13 metrics integrate attributes of the entire fish community that are differentially sensitive to various levels of stream perturbation. These metrics were modified from Karr et al. (1986) and are used by the GADNR in its fish sampling protocols (GADNR, 2005). The final IBI scores will be used to determine the overall qualitative conditions of the fish communities, ranging from excellent to very poor. The 13 metrics rated in this assessment and their descriptions/rationale are listed in Table 2-5.

TABLE 2-5
IBI Metrics Used to Evaluate Fish Communities in Piedmont Streams
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Metric	Description/Rationale
Species Richness and Composition	
1. Number of native species	This number decreases with increasing environmental degradation, and is considered to be one of the most powerful IBI metrics. Hybrid and introduced fishes are not included.
2. Number of benthic invertivore species	This metric is a count of all species of darters, sculpins, and madtoms. These species typically feed and reproduce in benthic habitats, and are sensitive to degradation from channelization, siltation, and DO reduction. Species number decreases with increasing degradation.
3a. Number of native sunfish species	These pool-dwelling species decrease in number with increasing siltation and degradation of pool habitats and instream cover. This metric is an effective measure of losses of instream cover and pool habitat and of decreases in the terrestrial food supply due to disruption of the riparian zone (Ohio EPA, 1987). This metric is used for watersheds less than 15 square miles.
3b. Number of native centrarchid species	Similar to the native sunfish species metric, except this metric is used for watersheds greater than 15 square miles.
4. Number of native insectivorous cyprinid species	Minnow species typically comprise a large proportion of the fish community and decrease in number with increasing physical and chemical habitat degradation. Introduced minnow species are not included because they often occur in degraded habitat conditions.
5. Number of native round-bodied sucker species	Suckers are known to be sensitive to habitat modification, sedimentation, and changes in water quality. In addition, the relatively long life span of most sucker species provides a long-term assessment of past and present environmental conditions.
6a. Number of sensitive species	Intolerant or sensitive species include those that are highly or moderately intolerant of water quality and habitat degradation. They are among the first to disappear following a disturbance. This metric is used for watersheds less than 15 square miles.
6b. Number of intolerant species	Similar to the number of sensitive species metric, except this metric is used for watersheds greater than 15 square miles.

TABLE 2-5
IBI Metrics Used to Evaluate Fish Communities in Piedmont Streams
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Metric	Description/Rationale
Trophic Composition	
7. Evenness	Evenness measures the equity of the proportion of each species in the sample. The greater the equity between species, the more diverse and healthy the fish community should be. This metric is measured by comparing the observed diversity in a sample to a theoretical maximum diversity.
8. Percentage of individuals as *Lepomis* species	Given the tolerant nature of fish in this genus, an overabundance of these species can be indicative of water quality degradation.
9. Percentage of individuals as insectivorous cyprinids	The relative abundance of these species decreases with degradation, in response to reductions in the invertebrate food supply.
10a. Percentage of individuals as generalist feeders and herbivores	Generalists are opportunistic feeders, consuming significant quantities of both plant and animal materials. Generalists often become abundant in small, highly degraded streams, as specific components of the food base become less reliable. Herbivores consume plant materials (specifically algae), which may become abundant as stream canopy decreases. A dominance of these two trophic guilds in a community could indicate a degraded system
10b. Percentage of individuals as top carnivores	These species (e.g., bass, pickerel) feed as adults primarily on fish, other vertebrates, or crayfish, and indicate a trophically diverse community. Their proportion decreases with increasing degradation.
11. Percentage of individuals as benthic fluvial specialists	The species classified as benthic fluvial specialists (darters, madtoms, sculpins, suckers, and some cyprinids) are insectivorous species that forage and reproduce on the stream bottom. A significant loss of these species could be indicative of increased sedimentation and degradation of the benthic habitat.
Fish Abundance and Condition	
12. Number of individuals per 200 meters	This metric standardizes comparison of fish abundance. Sites with greater disturbance generally support fewer fish. Highly tolerant and exotic species are excluded because these species may actually increase in abundance under certain disturbance conditions, such as stream channelization.
13. Percentage of individuals with external anomalies	Sites with severe environmental degradation often yield a high number of fish in poor health, as manifested by heavy parasitism, damaged fins, lesions, or other external physical deformities.

Source: GADNR, 2005

2.3.4 Biological Monitoring Field Equipment

Table 2-6 lists the sampling equipment required for the biological sampling.

TABLE 2-6
Biological Sampling Equipment
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Sampling Equipment	Quantity	Sampling Equipment	Quantity
Fish Sampling		***General Equipment***	
Backpack electroshocker	1	Collection permit	1
Shocker wand	1	Ice	
Shocker tail	1	Chain-of-custody forms	6
Extra battery for shocker	1	FedEx shipping forms	3
Empty cooler	1	Custody seals	6
Aquarium bubblers	2	Camera	1
Rubber gloves	2 pair	Memory card	1
Fish collection nets (dip nets)	2	Packing tape (rolls)	2
Seine net (10 by 6 feet)	1	Analyte-free water (1-gallon containers)	2
5-gallon bucket	2	Ziploc freezer bags (1-gallon, 20 per box)	2
1-gallon plastic jar	1/station	Ziploc freezer bags (2-gallon, 20 per box)	2
Data sheets	1/station	Paper towels (rolls)	2
Pliers	1	Latex gloves (box)	1
Plastic ruler	2	Phone list	1
Benthic Macroinvertebrate Sampling		Sampling plans	1
500-micron D-frame nets	2	Field Safety Instruction	1
500-micron kick net	1	Tree tags	6
Sieve bucket	2	Vermiculite	2 bags
Sorting pans and plastic trays	4	***Personal Equipment***	
Formalin (1-gallon containers)	3	Rain Gear	
Scrub brush	2	Hat	
Tweezers	4	Gloves	
Winterized gloves	2	Rubber boots	
Empty coolers	6	Sunblock	
Habitat assessment data sheets	2	Pens (waterproof ink)/pencils	
Squirt bottles	2	Field sheets	
In Situ Water Quality Monitoring		Compass/global positioning system unit	
Meter for in situ measurements	1	Field notebook	
		Thermos	
		Waders, hip boots	
		Potable water	1 gallon

3. Performance Standards

Identification of performance standards is critical to documenting achievement of improvements in aquatic ecosystems with regard to the established restoration objectives. An overview of tracking methods used during monitoring is presented below, along with associated objectives from Section 2 of the Detailed Project Report. In the context of this project, success is defined as the fulfillment of ecosystem restoration objectives in accordance with the overall project objectives. Table 3-1 lists the restoration success criteria for Flat Creek. Success with regard to each criterion will be determined through monitoring. If monitoring results demonstrate concerns or the performance standards are not met at monitoring milestones (3 years after construction), remedial actions to correct the problem would be identified as part of the monitoring data evaluation. If the results from a monitoring event show significant problems have developed, the USACE would be notified and, after consultation between the USACE and the City of Gainesville, appropriate remedial actions would be taken.

3.1 Biological Monitoring

Biological monitoring will be conducted at Stations FC-32 and FC-33 to document ecosystem restoration improvements from pre- to post-construction conditions. The performance standards listed in Table 3-1 include success criteria related to physical habitat improvements, as well as enhancement of fish and macroinvertebrate communities.

Physical habitat assessments are used to track changes that occur as a result of stream enhancement. Potential habitat improvement is determined during conceptual planning to estimate the near- and long-term expected changes after the project. The habitat assessment protocol published by GADNR (2007) will be used to determine the habitat scores of the pre-and post restoration conditions at Stations FC-32 and FC-33.

Successful habitat improvement is measured as an increase in habitat score from pre-construction to post-construction conditions, including an improvement to the “Optimal” category for frequency of riffles and velocity/depth combinations, as well as a 5 percent increase in metric score for bank stability, vegetative cover, riparian buffer zone, and average physical habitat score for all stations (Table 3-1). Typically, habitat assessment scores increase immediately after construction due to multiple habitat improvements that may include an improvement in epifaunal substrate, frequency of riffles, velocity/depth combinations, and bank stability. However, some vegetative metrics may temporarily decline while the restored site is established, including bank vegetative protection and riparian vegetative zone. These vegetative metrics are ultimately expected to improve within 3 years as native plantings and volunteer seedlings mature on banks and in the riparian corridor.

Success for fish and benthic macroinvertebrate communities is established as a metric score improvement of 5 percent from pre-construction to post-construction for evenness and number of native species (Table 3-1). As with physical habitat, biological communities may be temporarily impacted during the first year after construction while the ecosystem reestablishes. However, after 3 years, restored conditions are expected to be more favorable to support robust biological communities.

3.2 Other Long-Term Monitoring

As described previously in Section 2.1.4, the City of Gainesville conducts long-term biological monitoring at four ERM stations within the Flat Creek watershed. Monitoring of the ERM stations (sampled during odd years) is not included or funded as part of this Monitoring Plan; however, the City will provide results from biological monitoring of these sites. The data obtained may be used for ERM analysis and to compare habitat unit results to predicted ERM scores from the Detailed Project Report. The additional ERM sampling site data will be helpful in further evaluating the overall ecosystem restoration improvements achieved through implementation of the Tentatively Selected Plan.

TABLE 3-1
Monitoring Requirements and Performance Standards
Flat Creek Watershed Aquatic Ecosystem Restoration Monitoring Plan

Flat Creek Ecosystem Restoration Objective	Measurable Performance Standard
Physical Habitat Assessment	
Create sustainable riffle/pool habitats in affected stream reaches by constructing instream habitat features. Use rock/grade control, at locations in the National Ecosystem Restoration Plan to provide for an adequate frequency of riffles (76 to 100 percent of reach covered by riffles) and diverse velocity/depth regimes (fast-shallow, fast-deep, slow-shallow, and slow-deep).	Physical habitat parameter scores for “frequency of riffles” and “velocity/depth combinations” in the “Optimal” category for all physical habitat assessors within 3 years of construction.
Reduce bank erosion at the National Ecosystem Restoration Plan locations by one physical habitat condition category within 3 years of construction.	Increase in “bank stability” and “bank vegetative cover” parameters by 5 percent within 3 years of construction.
Implement stream channel restoration measures, including both stream stabilization and grade control, in highly degraded areas of the watershed.	Increase in average physical habitat score by 5 percent within 3 years of construction.
Plant native, woody vegetation along disrupted riparian corridors, at a density to achieve 60 percent cover of woody species within 3 years of construction.	Increase in “riparian buffer zone” physical habitat parameter by 5 percent within 3 years of construction.
Fish Community Assessment	
Increase the species richness and evenness of native fish in the watershed by 5 percent within 3 years of construction.	Increase in the “evenness” metric and number of native fish species by 5 percent within 3 years of construction.
Benthic Macroinvertebrate Assessment	
Increase the species richness and evenness of native benthic macroinvertebrates in the watershed by 5 percent within 3 years of construction.	Increase in the number of taxa and “evenness” of benthic macroinvertebrate species by 5 percent within 3 years of construction.

4. References

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