Development of a Rapid Geomorphic Assessment Technique to Support the CHIA/PHC Process: A Focus on Model Improvement for Estimating Sediment Loads

Photos from New River Basin, Scott County, Tennessee

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KFO Director: Earl D. Brady, Jr.
OSM COR: Richard Mann

Report Prepared by:

University of Tennessee - Knoxville
Department of Civil and Environmental Engineering

Project Investigators: Dr. John S. Schwartz
Dr. Eric C. Drumm

Graduate Students: M. Patrick Massey
Daniel Johnson
Joshua Baines
William Cantrell

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Table of Contents

List of Figures

List of Figures

List of Tables

Page

EXECUTIVE SUMMARY

Development of a Rapid Geomorphic Assessment Technique to Support the CHIA/PHC Process: A Focus on Model Improvement for Estimating Sediment Loads

Permitting of coal-mining activities requires a cumulative hydrologic impact assessment (CHIA) to be completed to fulfill the federal requirements of 30 CFR 942.780.21(g). In many designated cumulative impacts areas (CIAs), rivers and streams may be negatively impacted by excessive stream sediment such that they no longer meet State's biocriteria standards for the aquatic life designated use. Because sediment is a major issue that must be addressed in a CHIA, technical staff of the Office of Surface Mining (OSM) would benefit from better assessment and modeling tools. Of particular concern is the New River watershed in the Tennessee CIA Area 8 that drains into the Big South Fork River and National Recreational Area.

The key objectives of this study were to: 1) identify the potential land use disturbances in subwatersheds in the New River basin and evaluate a land use classification scheme that can be effectively used in a sediment delivery model, supported by a statistical analysis relating various GIS and field geomorphic measurements to subwatersheds with varying land use characteristics; 2) evaluate the utility of a rapid geomorphic assessment (RGA) technique developed by the USDA National Sedimentation Laboratory (NSL), to identify unstable stream channels in the Appalachian region caused by land use disturbances, and if applicable in this region, evaluate its usefulness for the CHIA process; 3) evaluate whether the AnnAGNPS sediment delivery model and ConCEPTS sediment transport model can provide useful output to support the CHIA process; and 4) discuss possibilities of improving PHC data collection, to better support the CHIA process utilizing a sediment delivery model. In order to complete these objectives, a study design included collection of GIS and field geomorphic data at streams sites for three reference (undisturbed) subwatersheds (Brimstone Creek, Frozen Head, and Greasy Creek), and four disturbed subwatersheds (Smokey Creek, Montgomery Fork, Ligias Creek, and Bull Creek).

A land use classification scheme was finalized and included the following types: current disturbed mine lands, abandoned mine lands, logging areas, and unpaved or dirt roads. Oil and gas operations and ATV trails were included into the dirt road classifications. Land cover represented undisturbed lands including: forest, pasture, shrub/scrub, grassland, developed land, pasture, and woody wetlands. Logging areas were classified into 100%, 75%, 50% and 25% vegetative cover. Dirt roads were classified into foot paths, low traffic intensity, and high traffic intensity, in which high traffic intensity represented the haul roads. Statistical analysis found that the land use classification scheme distinguished subwatersheds by their use activity. For example, Bull and Smokey creeks were found to be highly correlated with logging activities, and excessive fine sediment in the stream. The three reference streams did not correlate with attributes of excessive stream sediment, and statistically correlated with forest land cover. It was concluded that the land cover/use scheme developed in this study will be applicable as the GIS land use data layer required as input for the AnnAGNPS model.

The RGA field technique provided a key outcome for understanding potential sources of sediment in the New River basin. Most sites surveyed were located in the headwater areas, and they were found to have stable channels, as distinguished by their low RGA scores (less than 20). Because the study sites used in this analysis were located in headwater streams, geologic controls appeared to be a major factor for the channel stability. Therefore, channels do not adjust from land use modifications in headwater areas. The RGA may have limited utility as a geomorphic assessment tool in headwater streams. However, RGA would be appropriately used where the river or streams lies in an active floodplain with alluvium. Results from the RGA survey indicated that bank erosion is not likely a major source of sediment delivered to the stream. This indicates that the AnnANGPS model can be used alone without coupling it with the ConCEPTS model. The ConCEPTS model is used to predict bank erosion and yields from bank mass failures, and routes the sediment through the stream channel by advanced sediment transport functions. A RGA survey in a subwatershed does provide OSM the justification whether to use the ConCEPTS model or not, recommendations for use would be if RGA scores are generally found to be above a score of 20. Otherwise, AnnAGNPS can be used to predict sediment yields from uplands sources.

As part of our field effort to conduct RGA survey, fine bed sediment was also collected and analyzed for particle size characteristics. Fine bed sediment samples collected in lateral deposition areas of streams appeared to be a useful and cost effective analysis for identifying streams potentially impacted by uplands land disturbances. Recent work in East Tennessee has found that the particle size near the 0.016-mm diameter correlated with TDEC's biological impairment indices for an impaired stream condition. This study found when a bed sediment sample had greater than 0.8% of its particles less than 0.016 mm diameter size, the stream site occurred in a disturbed subwatershed. This 0.8% finer of 0.016-mm diameter sediment has utility as an indicator, potentially identifying an impaired stream due to siltation.

Initial evaluation of the AnnAGNPS model in an Appalachian mountainous subwatershed appears that it can provide reasonable estimates of annual sediment yields and potentially identify sediment sources within a subwatershed. Information on sediment sources from different land use activities is vital information for the OSM. In other words, the model can generate a watershed sediment budget estimating the individual amounts of sediment yield generated from logging, mining, dirt roads, and other land cover/uses.

A review of the PHC requirements was completed to evaluate whether better data could be collected to support the CHIA process, and input data for a sediment delivery model. The following assessments and field data needs were discussed in this report:

1.) Rapid geomorphic assessments (RGA) in channels;
2.) Fine bed sediment samples (collected in lateral depositions areas); and
3.) Stream flow and suspended sediment data needs for calibration and verification of a watershed-scale sediment delivery (AnnAGNPS model).

Complete development of the AnnAGNPS and ConCEPTS models is currently in progress as part of our 2007 OSM Applied Science Program grant. For the Phase 2 grant, four subwatersheds will be modeled; they are Montgomery Fork, Smokey Creek, Ligias Creek, and Brimstone Creek. Use of this model to develop watershed sediment budgets will be emphasized, identifying the potential sources of uplands sediment (i.e., mining, logging, dirt roads) that contribute to annual yields in each subwatershed.

1.0 INTRODUCTION

Permitting of coal-mining activities require the completion of a cumulative hydrologic impact assessments (CHIA) to fulfill the federal requirements of 30 CFR 942.780.21(g). In many designated cumulative impacts areas (CIAs), rivers and streams may be negatively impacted by sediment such that they no longer meet State's biocriteria standards for the aquatic life designated use. Of particular concern is the New River watershed in the Tennessee CIA Area 8 that drains into the Big South Fork River and National Recreational Area. Because sediment is a major issue that must be addressed in a CHIA, technical staff with the Office of Surface Mining (OSM) would benefit from better assessment and modeling tools. Sediment loads to streams are generated by many different human disturbances on the landscape, including active surface mining on reclaimed sites, pre-law mine operations (abandoned mine lands), logging activities, oil and gas operations, haul roads, dirt roads used by all-terrain vehicles (ATV), and agriculture. Assessment and modeling tools that help the OSM staff distinguish sediment loads from each disturbance type are needed to improve CIA management efforts. Another key issue is how can field procedures for collecting data for probable hydrologic consequences (PHCs) be improved to support effective use of sediment assessment and modeling tools. Our study explored whether a rapid geomorphic assessment (RGA) technique can be applied effectively to identify whether a channel is stable or not. A RGA provides key information to whether sediments from stream bank erosion are a dominant source of in-channel sediment, and must be included into watershed sediment budgets. Use of a hillslope geomorphic assessment was also explored in support of development of a sediment delivery model, i.e., best selection of land use types. AnnAGNPS, the sediment delivery model used in this study, requires a land use GIS data layer, in which different land use types represent different delivery potentials to the stream.

Outcomes from the geomorphic analysis were evaluated, and findings guided the final selection of land use types incorporated into the AnnAGNPS-ConCEPTS models. A sediment model is needed by OSM so that CHIAs include the potential impacts of stream sedimentation from proposed surface mining activities, and for it to be defensible under a complex set of potential sediment load generators in a watershed (e.g., logging, mine lands, ATV roads, etc.). Meeting a key goal of this study, the AnnAGNPS-ConCEPTS model was demonstrated to OSM technical staff so that they could evaluate the model's utility to support the CHIA process.

2.0 PROJECT OBJECTIVES and OUTCOMES

The project "*Development of a Rapid Geomorphic Assessment Technique to Support the CHIA/PHC Process: A Focus on Model Improvement for Estimating Sediment Loads*" includes four objectives as listed in the proposal. They were as follow:

1.) Identify/summarize the entire range of landscape disturbances (both mining related and non-mining related) impacting sediment yield. The disturbances will be classified based on their potential to generate different sediment yields in terms of sediment flux to the perennial stream channel and particle size distributions. This will include a slope classification scheme for potential sediment yield based on slope geometry and geotechnical index properties.

2) Develop a rapid geomorphic assessment (RGA) technique to identify unstable stream channels resulting from landscape disturbances modifying watershed sediment yields.
3) Compile/summarize data collected from PHCs, and evaluate the summarized data to whether it adequately supports a CHIA sedimentation assessment.
4) Demonstrate how the proposed landscape classification of watershed disturbances (Objective #1), field data collected as a part of a RGA (Objective #2), and PHC data can be incorporated into a hydrologic-based sediment transport model. In addition, identify data gaps for the completion of a verifiable model to estimate sediment yield from cumulative impacts over a range of landscape disturbances.

These four objectives correspond to project outcomes/deliverables. The following outcomes/deliverables proposed were as follow:

1) A report of the development of a land disturbance classification scheme evaluating its potential use in a watershed sediment model. The report will summarize, in general terms, relevant geotechnical properties and sediment yield (RUSLE2) factors and subfactors that are readily available, and identify data gaps that would be needed to model sediment yield and transport in subwatersheds.
2) A report on the potential utility of a rapid geomorphic assessment technique for the CHIA process; with the applied science aim to determine whether a stream channel is stable or unstable, and linking specific bed sediment characteristics to type of land disturbance (i.e., logging, AMLs, current mining permits, off-road vehicle recreation, etc.).
3) A report on the evaluation of PHC data collection protocols with the applied science aim to identify improvements that provide better information for the CHIA process and data that could be efficiently incorporated into a sediment model.
4) A technical transfer demonstration for OSM technical staff on the use of AnnAGNPS-ConCEPTS model for the staff's evaluation as to whether it could be feasibly used in the CHIA process. In addition, all GIS data layers compiled and used to perform this demonstration will be provided to OSM.

Project outcomes are described in Section 4 of this final report.

3.0 SUBWATERSHED SITE SELECTION

The New River watershed, located in East Tennessee, was selected for this study because resource managers at the Big South Fork National Recreational Area (BSFNRA) have expressed concern with excessive sediment loads that enter upstream from the New River (Figure 1). In the New River basin, natural resource extraction (i.e., coal, timber, rock), and other land use activities occur, potentially cause uplands erosion and excessive sediment delivery to the river. Nationally, a prevalent source of excessive sediment in rivers and streams in disturbed watersheds also includes stream bank erosion caused by increased runoff peaks and volumes. However, in the Appalachian region the degree of sediment contribution from bank erosion is not well known. Even though the New River was selected for study, this proposed study evaluating sediment assessment and modeling tools was not intended to be a watershed-specific study, but rather an evaluation of tools that may be applied throughout the Appalachian region. Importantly, sediment data within the New River watershed provides additional information that can be utilized for management purposes by the OSM KFO for CIA Area 8, BSFNRA resource managers, state officials, and the public.

Study subwatersheds were selected on various criteria, including watershed size (area) and whether the subwatersheds were part of the existing CHIA monitoring network. Other criteria included what land use activities are occurring in the subwatersheds, i.e., surface mining, logging, haul roads, ATV trails, dirt (primitive) roads, and agriculture. Each of these land use disturbances contributes sediment as non-point sources to the rivers and streams. Oil and gas operations and their access roads were considered, and they were grouped into the ‘dirt road’ land use category. Current active and non-active, and reclaimed surface mine areas with disturbed land surfaces were considered. In addition, landslide activity was also considered, not as a land use, but rather as a unique area that may contribute greater amounts of sediment to the stream channel. Land cover data from the USGS Seamless database was used for the non-disturbed areas. Spatial information on land cover and land use activities and disturbances were compiled from existing GIS data, provided by the OSM KFO, USGS, and other data sources.

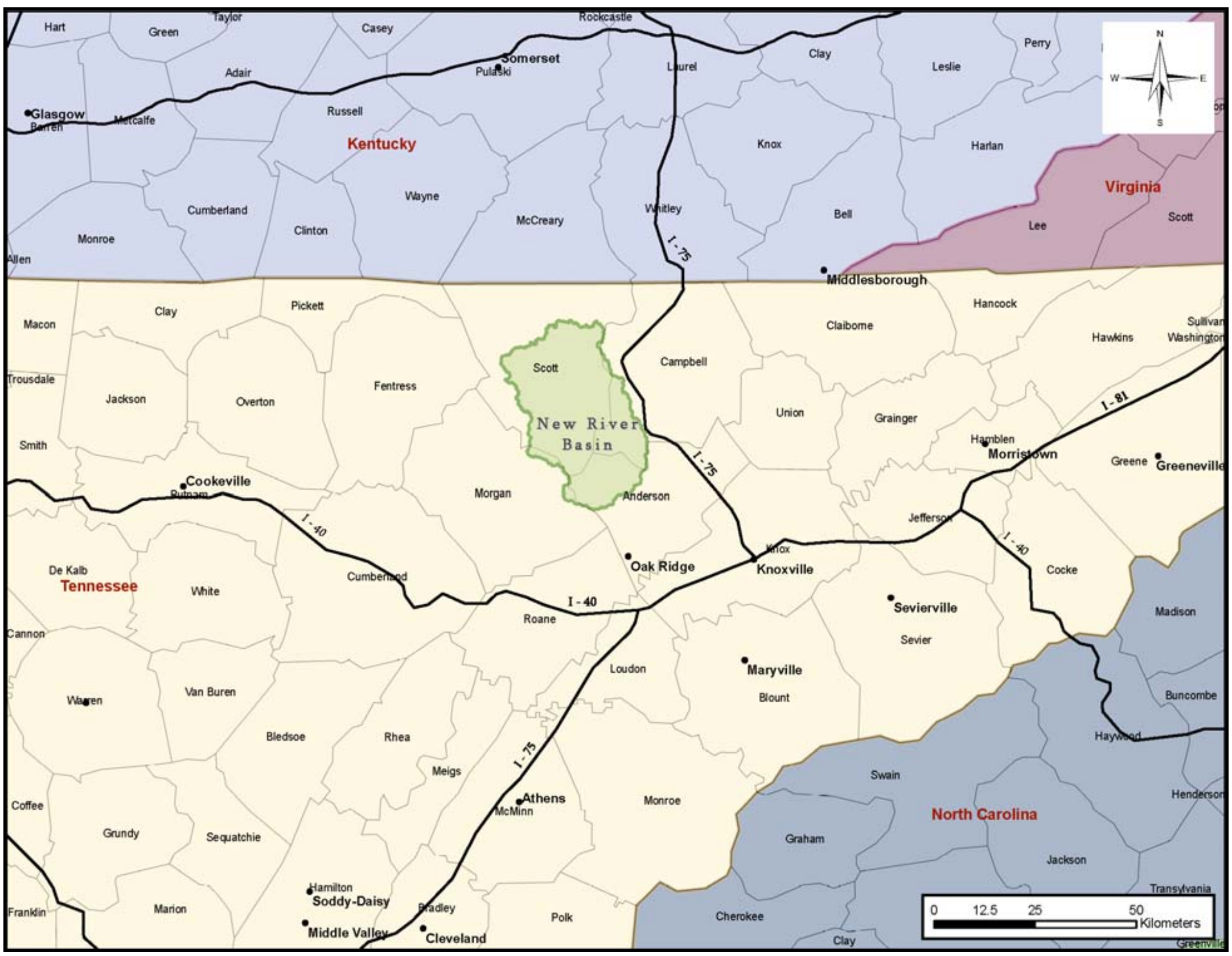


Figure 1. Location of the New River Basin in East Tennessee.

The basic study design was to select three to six subwatersheds with mixed land uses, and three subwatersheds with no or very little disturbed land (Figure 2). The subwatersheds selected with various land use disturbances included: 1) Montgomery Fork, 2) Ligias Fork, 3) Smokey Creek, and 4) Bull Creek. The relatively undisturbed subwatersheds included: 1) Brimstone Creek, 2) Greasy Creek, and 3) Frozen Head. Reference subwatersheds are watersheds that do not contain much, if any, activities that are likely to cause an un-natural amount of erosion and sediment yield on the hillslopes and into the nearby streams. The Bull Creek subwatershed contains a large amount of disturbances in the Big Bull Creek area while the Little Bull Creek contains a lesser amount of disturbances and could be identified as a reference stream. The seven subwatersheds and type of land uses analyzed in this report are listed below in Table 1.

Table 1. Selected study subwatersheds in the New River Basin and associated land use activities/disturbances (2006-2007).

Subwatershed	**Dominant Land Use Activities / Disturbances**	**Watershed Area** (sq. meters)	(acres)	(sq. miles)
Smokey Creek	Logging, current coal mining disturbance, abandoned surface mining, dirt roads	86,751,582	21,437	33.5
Ligias Creek	Logging, current coal mining disturbance, abandoned surface mining, dirt roads	53,104,609	13,122	20.5
Montgomery Fork	Logging, current coal mining disturbance, abandoned surface mining, dirt roads, haul roads	57,435,358	14,193	22.2
Bull Creek	Logging, current coal mining disturbance, abandoned surface mining, dirt roads	27,483,917	6,791	10.6
Brimstone	Reference – slight level logging, dirt roads, abandoned mining	33,572,998	8,296	13.0
Greasy Creek	Reference – slight level logging, dirt roads, abandoned mining	35,851,060	8,859	13.8
Frozen Head trib.	Reference – dirt roads and foot trails	7,911,091	1,955	3.1

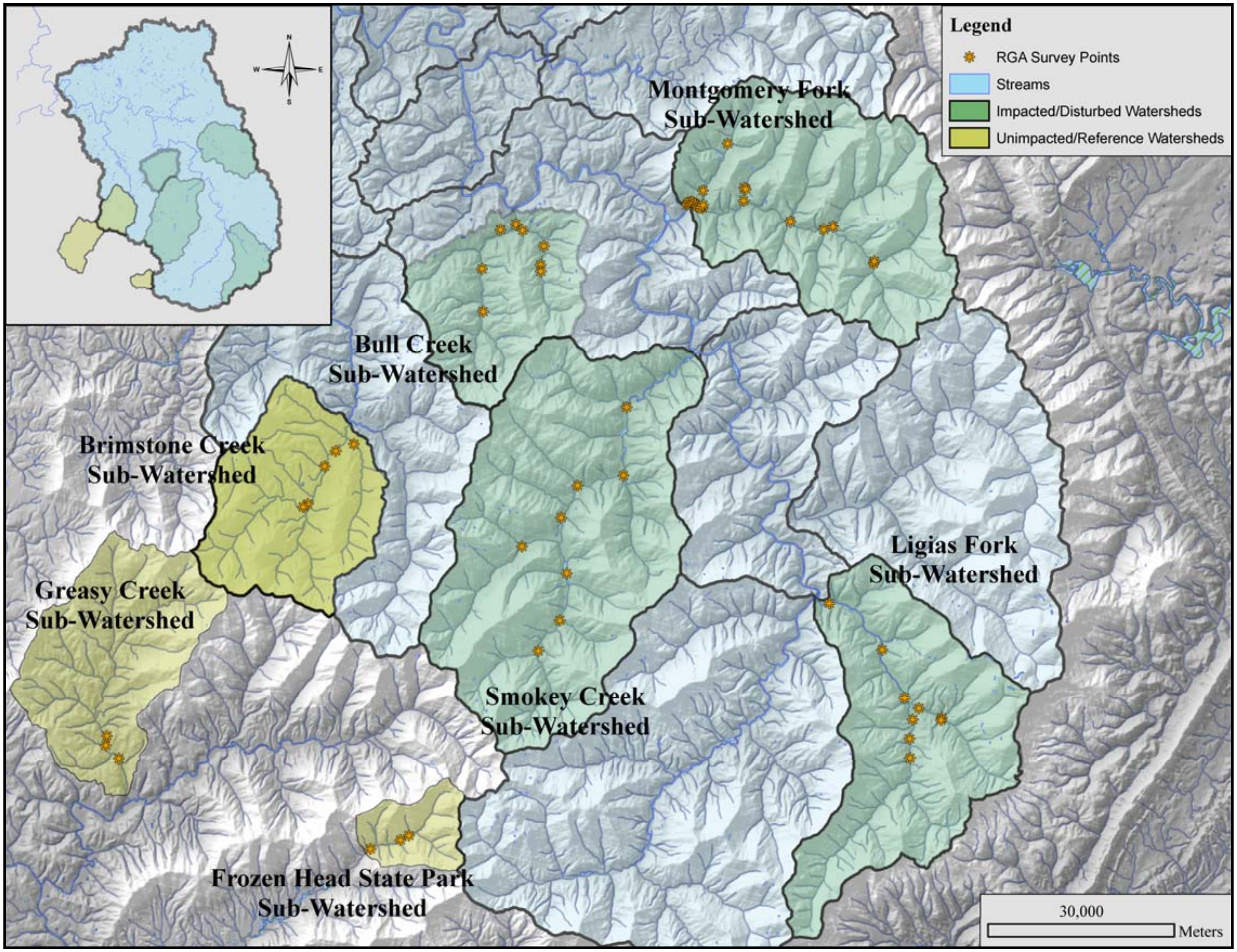


Figure 2. Locations of study subwatersheds in the New River basin.
Yellow subwatersheds are reference (undisturbed) sites, and green subwatersheds are disturbed or impacted sites.

4.0 PROJECT OUTCOMES / DELIVERABLES

4.1 Land Cover\Use Classification for Sediment Delivery Potential

4.1.1 GIS Quantification of Land Cover\Use Types

As part of *Deliverable 1*, a statistical analysis of GIS derived attributes, land use classifications, and in-stream field data was conducted, and results are summarized in Section 4.4.1. The statistical analysis supports development of the AnnAGNPS sediment delivery model by means of generating a useful GIS land use layer. The GIS land use layer is a key input layer for the model, and our goal from the statistical analysis was to refine what land use disturbances and activities potentially generate unique and excessive sediment yields. First, a decision had to be made on testing a group of potentially unique land uses for analysis.

Through discussions with OSM personnel, a review of the literature, and field reconnaissance of the New River watershed, various land use disturbances that potentially could contribute excessive sediment to streams were identified. These land use disturbances included: surface mine lands (current disturbed lands within permitted areas), abandoned mine lands, logging areas, oil and gas operations, unpaved dirt roads, and landslides. Each disturbance type and how the data was evaluated and compiled for the study are described below.

Surface Mine Areas: Surface mine areas include all the permitted areas, whether active or non-active that currently contain disturbed land surfaces. It was assumed that sediment delivery from permitted mine areas is from disturbed land surface areas. Permitted mine areas were represented by polygons in GIS shape files provided by OSM as 2006-2007 GIS raster images. Polygons of disturbed land surface areas were clipped within permitted areas for each specific subwatershed, as interpreted from geo-referenced 2006 and 2007 raster images from Quickbird and Google Earth. This category for surface mine areas does not include the entire polygon for permitted area from the OSM GIS shape file, because this would overestimate the area that contributes to sediment yield. In the following tables and figures, this land use category is referred to "active surface mining", however it refers to active soil erosion occurring at current disturbed sites, and not active coal mining. Data from the GIS attribute table was extracted to a spreadsheet format for further statistical computations. Also note that the areas which represent the mining haul roads were subtracted from the active mined areas because these haul roads were accounted for as a separate land use classification termed high-traffic dirt roads.

Abandoned Mine Areas: The abandoned mine areas include all the un-reclaimed mining benches and scars left in the subwatersheds. It was assumed that the sediment delivery property that is of importance in the abandoned mine areas is disturbed area. Therefore similar to the "permitted mine area" category, abandoned mine areas were represented by polygons of disturbed land surfaces in GIS shape files as interpreted from geo-referenced 2006 and 2007 raster images from Quickbird and Google Earth. Data from the GIS attribute table was extracted to a spreadsheet format for further statistical computations. Note that mining dirt roads were subtracted from the abandoned mined areas because they were accounted for as a separate land use classification termed low-traffic dirt roads.

Logging Areas: Initially, the OSM and Tennessee Wildlife Resources Agency (TWRA) provided GIS information to locate permitted logging activities in New River subwatersheds of interest. Since the data provided from the TWRA only relates to Sundquist and Royal Blue wildlife management areas, another means of representing all the logging within the subwatersheds had to be created. To identify permitted and non-permitted logging activities in the subwatersheds, the 2006 and 2007 raster images from Quickbird and Google Earth were used to create new polygons for additional logging areas identified from the aerial photos.

Logging activity in a mountainous watershed has the potential to be a significant sediment contributor, and sediment yield is likely related to the degree of vegetative cover. Vegetative cover also increases over time as the vegetation in the disturbed area tends to recover. In addition, it would be expected that sediment generation would also be dependent on slope inclination, slope length, area, and slope geometry.

The delivery properties of importance with logging activities include area of timber harvest, and proportion of the logged area that is covered with vegetation. The logging areas were broken into four different groups or bins; they are classified as: 0-25%, 26-50%, 51-75%, and 76-100% percent logging or loss of vegetative cover. To quantify the percent logging, aerial photos were viewed and different levels of logging were captured with GIS polygons, and categorized to represent the four classes noted above. Examples of the different percent logging classifications are shown in Figure 3. Land areas calculated by the GIS software were based on the Quickbird and Google Earth aerial photos for 2006 and 2007.

Natural Gas/Oil Areas: The recovery of natural resources such as natural gas and oil may also cause erosion and excessive sediment yields. With the assistance of OSM, several GIS shape files were used to identify the current natural gas/oil extraction activities throughout the New River Basin. Within the study subwatersheds, gas/oil extraction activities typically took place away from streams (except for the access roads), and occupied a small surface area. To account for the sediment yield produced from natural gas and oil areas, natural gas/oil areas with their access roads were lumped into the 'dirt road' land use category.

Unpaved/Dirt Roads: Unpaved/dirt roads were a land use category recognized as a potential major contributor of sediment to streams. Various road types needed to be identified for the study, i.e., intensity of use and road surface material. In addition to type, road attributes per type included: unpaved/dirt road area, intensity of use, water crossings, and the amount of unpaved/ dirt roads area within 3 meters of the stream. Road types and attributes were found using GIS files, aerial photos, and field reconnaissance.

GIS files received from OSM were used as a basis to classify roads into the following categories: high traffic, low traffic, and foot paths for dirt roads. Using these original shape files as a start, new GIS polygon shape files were created to find and categorize dirt roads into the three different categories based on use intensity. Unpaved road lengths and areas were calculated within GIS and the data exported to a spreadsheet file to get a road area that can be normalized with respect to the area of the entire subwatershed. Water crossings were accumulated by creating a point shape file, which included each location where a road crossed a stream where there is not a culvert or bridge. The identification of the crossings was done both in the field as well as by using the aerial photos. To calculate the length of roads that are within 3 meters of the stream within the GIS, a buffer was created around all the streams then the intersect tool was used to create a layer that has the different road/stream intersections.

Landslides: Landslides are unlike the other land uses in that few have been documented recently and comprehensively over the entire New River watershed. An older map created by the US Corps of Engineers identified landslides for the later 1970's. The only landslide

(a) 0-25% Logged Areas

(b) 26-50% Logged Areas

(c) 51-75% Logged Areas

(d) 76-100% Logged Areas

Figure 3. Examples of percent logging or loss of vegetative cover (Google Earth, 2007).

identified in recent history has been the well-documented High Point landslide in Smokey Creek sub-watershed. Similar to logging, the parameters of interest are the vegetative land cover characteristics. Identification of landslide activity was attempted to be spatially located with the use of the 2006-2007 Quickbird and Google Earth aerial photos. Results found that vegetative cover quickly covered potential sites, and degree of cover made aerial photo interpretation difficult. Identification of landslides is best done by field investigation, which would also be difficult because of the vegetative growth. Because of the dominant vegetative cover, the final conclusion was that landslide areas would not constitute a major source of sediment in our study subwatersheds. However, this does not infer that landslides do not contribute excessive sediment to the stream, but rather they do so only when the ground cover is unvegetated.

The identified land use classifications used for the AnnAGNPS model development included logged areas, "active" and abandoned surface mining, dirt roads, developed land, barren land, forest cover, shrub/scrub, grassland and pasture, and woody wetlands (Tables 2 and 3). Each subwatershed has different attributes, and some have sub-classifications as described below. The land use classifications were identified based on the assumption that the data should be readily available from existing GIS layers and aerial photographs, and would be easily verified in the field. In order to compare land use activities within the identified subwatersheds, the surface area attributed to each land use classification was normalized with respect to the overall subwatershed area.

As a visual demonstration of the different land use activities classified throughout the New River Basin's subwatersheds used in this study (summarized in Tables 2 and 3), Figure 4 was provided. At first glance, Figure 4 contains a large amount of green coloring which represents the deciduous, evergreen, and mixed forest land cover found within this rural region of East Tennessee. The forest land cover was obtained from the U.S. Geological Survey (USGS) National Map Seamless Server. Contained in these variations of natural forest are also reclaimed surface mining sites which have substantial vegetative growth, as observed for this period of study. For active and abandoned surface mining sites, a different method of classification was selected. Found in Figure 4, the active and abandoned mining sites were represented in shades of red. The rural logging industry and its activities were also located within this region and were shown in shades of yellow. Finally, all the unpaved road networks are shown in a very dark shade of red on the Figure 4 map.

4.1.2 Summary of Land Use Characterizations for Study Subwatersheds

A summary of each of the land use characteristics are described below for each of the seven subwatersheds. These data will be used in the statistical analysis found in Section 4.4.1.

Surface Mine Lands: The percent of all the permitted mine areas (normalized by the entire sub-watershed's area) in each subwatershed is shown in Figure 5. The four non-reference sub-watersheds had current disturbed mine lands with active soil erosion as a percent total area as follow: 0.58% of Smokey Creek, 0.46% of Ligias Fork, 0.63% of Montgomery Fork, 0.54% of Bull Creek. Each of the reference subwatersheds (Brimstone Creek, Greasy Creek, and Frozen Head State Park) did not contain any disturbed areas from surface mined lands.

Abandoned Mine Lands: The percent of all the abandoned mine areas (normalized by the entire subwatershed's area) in each sub-watershed is shown in Figure 5. The four non-reference sub-watersheds had permitted mine lands as a percent total area as follow: 4.44% of Smokey Creek, 6.83% of Ligias Fork, 3.17% of Montgomery Fork, 1.42% of Bull Creek. Of the three reference subwatersheds (Brimstone Creek, Greasy Creek, and Frozen Head State Park), Brimstone Creek was the only subwatershed that contained abandoned mining areas, which were found to account for 1.81% of the entire subwatershed's area (Table 4).

Logging Areas: Logging activities were present in all subwatersheds, except for the Frozen Head State Park subwatershed during this analysis (Figure 6). Smokey Creek and Bull Creek subwatersheds contained the largest normalized area of logging activities. Figure 6 also showed the logging area by various severities for each subwatershed. Typically, the higher the percent cover, the more severe or current the logging activities (Table 5).

Table 2. Impacted/Disturbed New River subwatershed land use activity details (2006-2007).

Land Use Classification	Watershed Area Occupied							
	Smokey Creek (m^2)	Smokey Creek (%)	Ligias Fork (m^2)	Ligias Fork (%)	Montgomery Fork (m^2)	Montgomery Fork (%)	Bull Creek (m^2)	Bull Creek (%)
100% Logged	580,098	0.67%	0	0.00%	0	0.00%	307,838	1.12%
75% Logged	2,886,302	3.33%	4,213	0.01%	743,932	1.30%	734,533	2.67%
50% Logged	3,177,084	3.66%	707,456	1.33%	1,159,430	2.02%	2,112,535	7.69%
25% Logged	5,261,740	6.07%	2,176,537	4.10%	4,669,355	8.13%	177,512	0.65%
Abandoned Surface Mining	3,851,843	4.44%	3,624,669	6.83%	1,821,261	3.17%	389,365	1.42%
Active Surface Mining	506,845	0.58%	242,875	0.46%	362,261	0.63%	148,738	0.54%
Dirt Roads - Foot Paths	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Dirt Roads - Low Traffic	833,694	0.96%	335,500	0.63%	320,748	0.56%	445,185	1.62%
Dirt Roads - High Traffic	0	0.00%	372,765	0.70%	174,955	0.30%	133,315	0.49%
Developed, Open Space	1,920,556	2.21%	755,674	1.42%	1,286,000	2.24%	560,874	2.04%
Developed, Low Intensity	44,510	0.05%	26,868	0.05%	872	0.00%	10,373	0.04%
Developed, Medium Intensity	0	0.00%	15,903	0.03%	6,630	0.01%	0	0.00%
Barren Land (Rock/Sand/Clay)	16,628	0.02%	17,565	0.03%	2,689	0.00%	0	0.00%
Deciduous Forest	63,678,228	73.40%	40,069,883	75.45%	45,178,748	78.66%	20,322,251	73.94%
Evergreen Forest	3,254	0.00%	13,959	0.03%	38,483	0.07%	0	0.00%
Mixed Forest	2,212,644	2.55%	3,298,107	6.21%	1,432,744	2.49%	1,694,825	6.17%
Shrub/Scrub	429,477	0.50%	14,328	0.03%	37,868	0.07%	39,795	0.14%
Grassland/Herbaceous	965,015	1.11%	1,361,588	2.56%	164,453	0.29%	325,015	1.18%
Pasture/Hay	296,366	0.34%	71,824	0.14%	9,568	0.02%	27,763	0.10%
Woody Wetlands	87,401	0.10%	0	0.00%	25,550	0.04%	54,001	0.20%
Total	86,751,582	100.00%	53,104,609	100.00%	57,435,358	100.00%	27,483,917	100.00%

Note: active surface mining refers to disturbed land surfaces on surface coal mine sites, whether the permitted area has active or non-active coal mining operations.

Table 3. Reference New River subwatershed land use activity details (2006-2007).

Land Use Classification	Watershed Area Occupied					
	Brimstone Creek (m^2)	Brimstone Creek (%)	Greasy Creek (m^2)	Greasy Creek (%)	Frozen Head SP (m^2)	Frozen Head SP (%)
100% Logged	0	0.00%	0	0.00%	0	0.00%
75% Logged	0	0.00%	0	0.00%	0	0.00%
50% Logged	603,400	1.80%	0	0.00%	0	0.00%
25% Logged	521,068	1.55%	2,736,701	7.63%	0	0.00%
Abandoned Surface Mining	607,920	1.81%	0	0.00%	0	0.00%
Active Surface Mining	0	0.00%	0	0.00%	0	0.00%
Dirt Roads - Foot Paths	0	0.00%	0	0.00%	283,941	3.59%
Dirt Roads - Low Traffic	148,130	0.44%	372,087	1.04%	0	0.00%
Dirt Roads - High Traffic	0	0.00%	0	0.00%	0	0.00%
Developed, Open Space	533,214	1.59%	315,174	0.88%	62,399	0.79%
Developed, Low Intensity	4,605	0.01%	6,360	0.02%	0	0.00%
Developed, Medium Intensity	0	0.00%	0	0.00%	0	0.00%
Barren Land (Rock/Sand/Clay)	0	0.00%	0	0.00%	0	0.00%
Deciduous Forest	27,998,743	83.40%	27,978,023	78.04%	7,524,582	95.11%
Evergreen Forest	105,319	0.31%	190,791	0.53%	0	0.00%
Mixed Forest	2,538,730	7.56%	3,798,266	10.59%	40,169	0.51%
Shrub/Scrub	47,580	0.14%	8,983	0.03%	0	0.00%
Grassland/Herbaceous	188,390	0.56%	140,576	0.39%	0	0.00%
Pasture/Hay	273,577	0.81%	256,926	0.72%	0	0.00%
Woody Wetlands	2,279	0.01%	47,173	0.13%	0	0.00%
Total	33,572,998	100.00%	35,851,060	100.00%	7,911,091	100.00%

Note: active surface mining refers to disturbed land surfaces on surface coal mine sites, whether the permitted area has active or non-active coal mining operations.

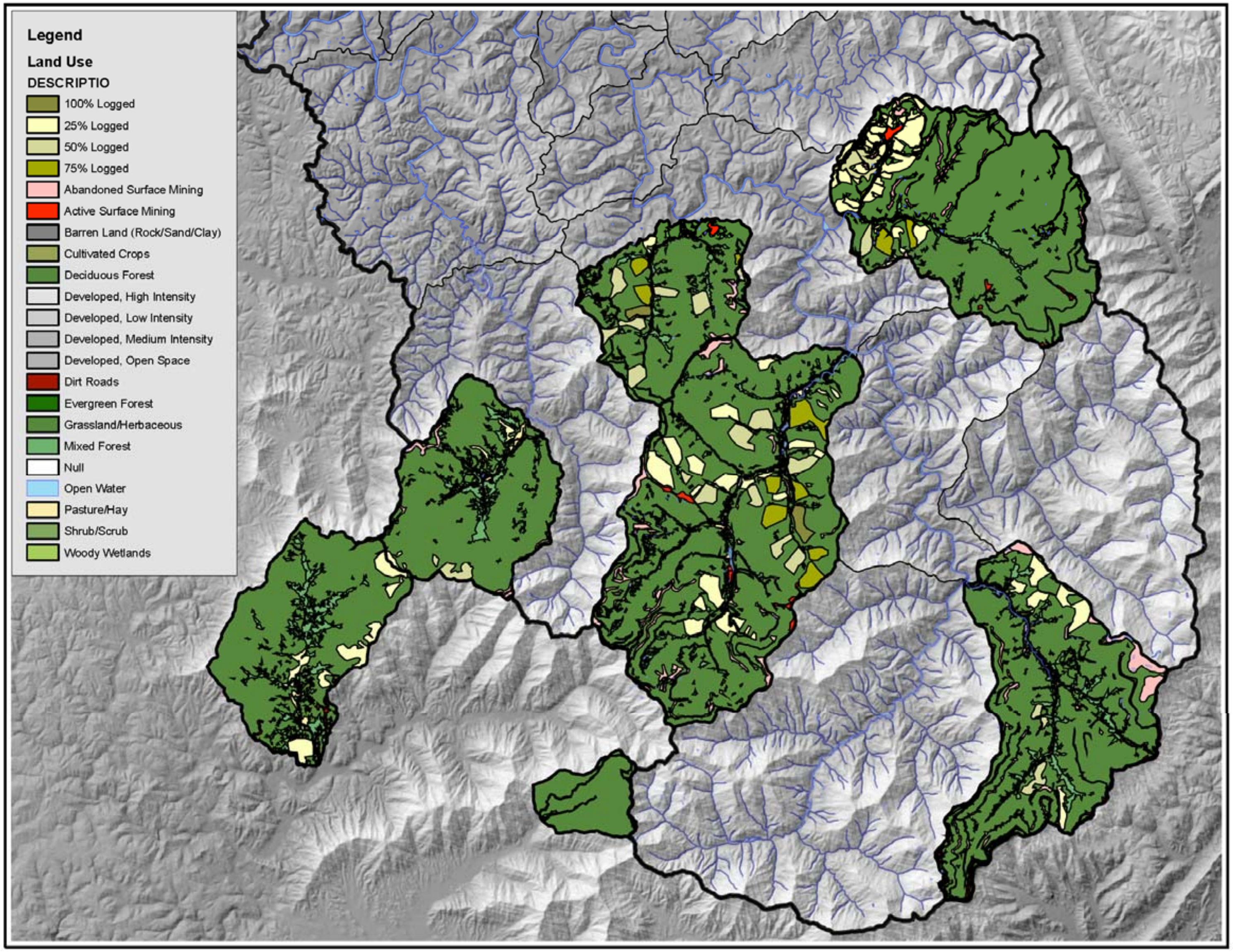


Figure 4. Land use activities defined for the New River subwatersheds of interest. (2006-2007).

Table 4. New River subwatershed surface mining land use activity details (2006-2007).

Sub-watershed	Abandoned Surface Mining Normalized by Area	Active Surface Mining Normalized by Area
Smokey Creek	4.44%	0.58%
Ligias Fork	6.83%	0.46%
Montgomery Fork	3.17%	0.63%
Bull Creek	1.42%	0.54%
Brimstone Creek	1.81%	0.00%
Greasy Creek	0.00%	0.00%
Frozen Head SP	0.00%	0.00%

Note: active surface mining refers to disturbed land surfaces on surface coal mine sites, whether the permitted area has active or non-active coal mining operations.

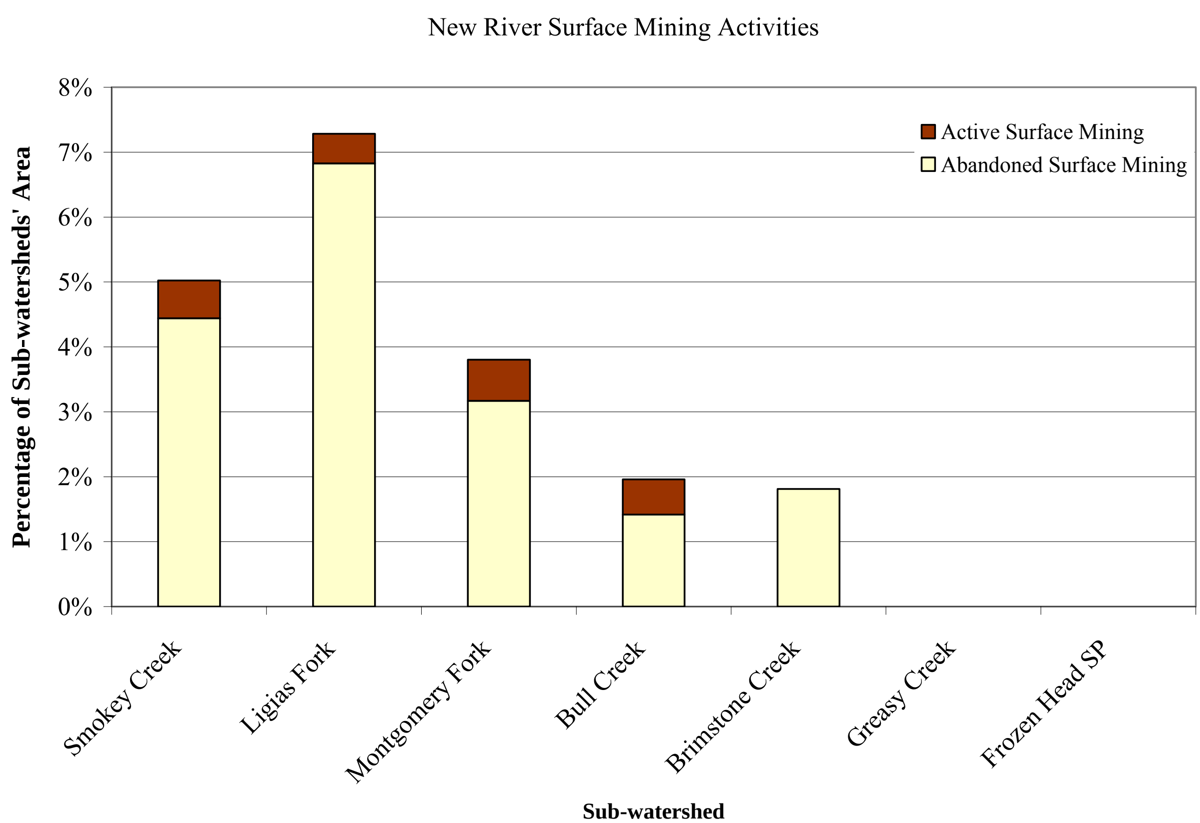


Figure 5: Surface mined lands normalized by total subwatershed area (2006-2007).

Table 5. New River subwatershed forest logging land use activity details (2006-2007).

Sub-watershed	0-25% Logged Normalized by Area	26-50% Logged Normalized by Area	51-75% Logged Normalized by Area	76-100% Logged Normalized by Area
Smokey Creek	6.07%	3.66%	3.33%	0.67%
Ligias Fork	4.10%	1.33%	0.01%	0.00%
Montgomery Fork	8.13%	2.02%	1.30%	0.00%
Bull Creek	0.65%	7.69%	2.67%	1.12%
Brimstone Creek	1.55%	1.80%	0.00%	0.00%
Greasy Creek	7.63%	0.00%	0.00%	0.00%
Frozen Head SP	0.00%	0.00%	0.00%	0.00%

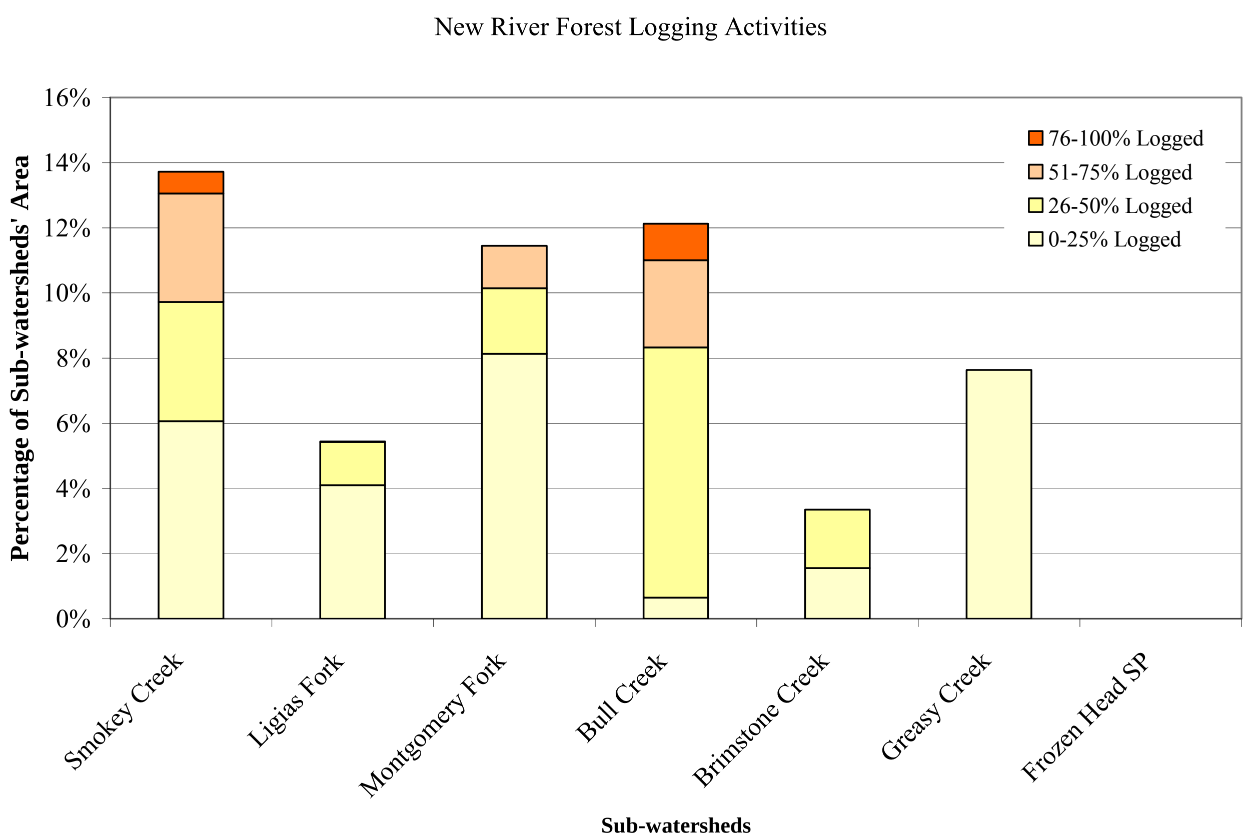


Figure 6: Forest logged lands normalized by total subwatershed area (2006-2007).

Unpaved\Dirt Roads: Unpaved/dirt roads were identified as one of the potential major sources of sediment loads to the streams. Sediment yield varies potentially due to the road type and use. It was observed that paved road systems did not contribute a significant amount of sediment to the streams, so this analysis focused on dirt or unpaved road networks in each sub-watershed. Unpaved/dirt roads would be typically seen as coal or logging haul roads, natural gas/oil access roads, and general rural transportation routes. For the analysis with unpaved/dirt roads category, all roads were defined on the basis of amount of usage. To simplify the analysis, the different material components on the unpaved road systems were grouped together and classified by traffic intensity. Three general categories of dirt roads considered were: high traffic, low traffic, and foot traffic summarized by area (Table 6). The number of road crossings at various streams was also summarized by each subwatershed (Table 7). From the comparison of different unpaved/dirt road categories, Ligias Fork and Bull Creek subwatersheds contained the largest amounts of dirt roads (normalized by subwatershed's area) used for general vehicle transportation, as well as for haul roads. Frozen Head State Park was the only subwatershed to have a total unpaved road network based solely for foot traffic for outdoor recreation. Though the Frozen Head State Park has a large percentage of this foot traffic within dirt road category, it is assumed that these features do not contribute much sediment into the streams.

Table 6. New River subwatershed unpaved/dirt road activity details (2006-2007).

Sub-watershed	Dirt Roads - Foot Paths Normalized by Area	Dirt Roads - Low Traffic Normalized by Area	Dirt Roads - Heavy Traffic Normalized by Area
Smokey Creek	0.00%	0.96%	0.00%
Ligias Fork	0.00%	0.63%	0.70%
Montgomery Fork	0.00%	0.56%	0.30%
Bull Creek	0.00%	1.62%	0.49%
Brimstone Creek	0.00%	0.44%	0.00%
Greasy Creek	0.00%	1.04%	0.00%
Frozen Head SP	3.59%	0.00%	0.00%

Table 7. Unpaved/dirt roads near streams in New River subwatersheds (2006-2007).

Sub-watershed	Length of Streams (km)	Number of Stream Crossings (---)	Heavy Traffic Roads within 3.0m of Stream (%)	Low Traffic Roads within 3.0m of Stream (%)	Foot Traffic Roads within 3.0m of Stream (%)
Smokey Creek	124.89	68	0.00%	0.86%	0.00%
Ligias Fork	98.6	43	0.14%	0.63%	0.00%
Montgomery Fork	85.85	44	0.75%	0.51%	0.00%
Bull Creek	34.62	31	3.06%	1.91%	0.00%
Brimstone Creek	56.37	43	0.00%	0.91%	0.00%
Greasy Creek	60.43	43	0.00%	0.24%	0.00%
Frozen Head SP	13.09	9	0.00%	0.00%	1.37%

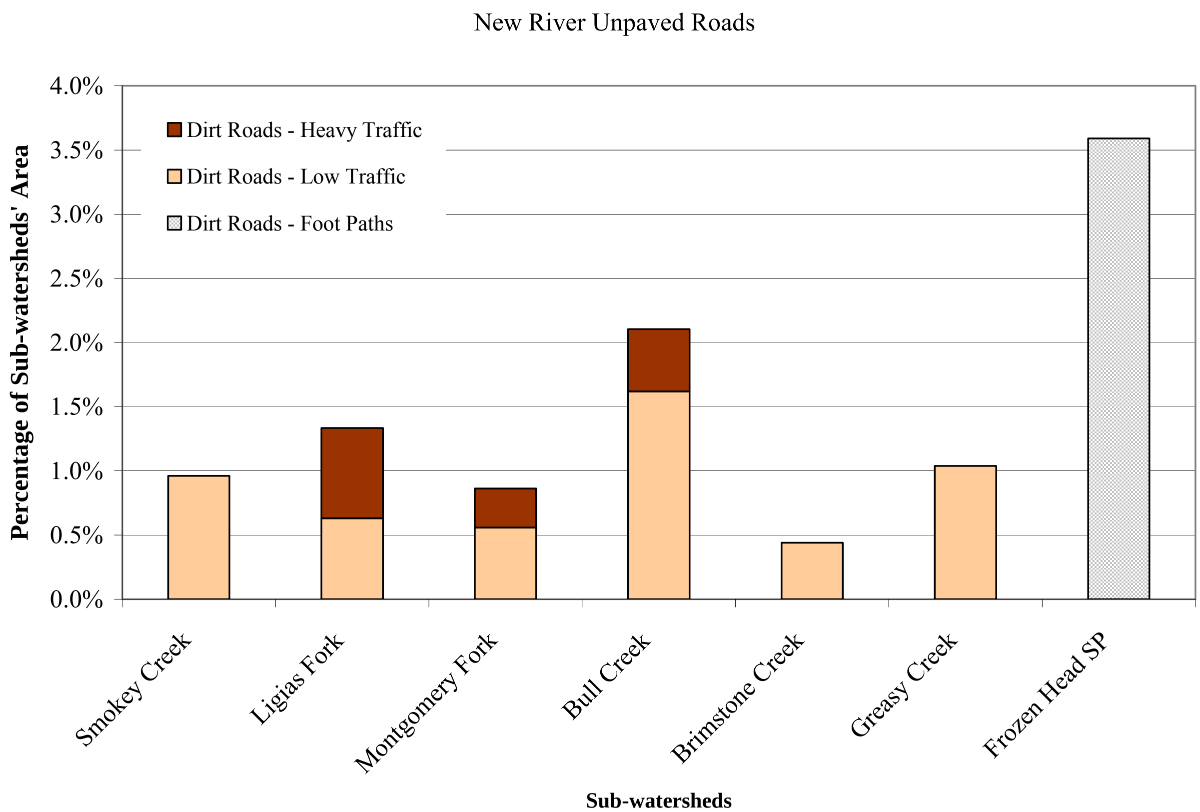


Figure 7: Unpaved/dirt roads normalized by total subwatershed area (2006-2007).

4.1.3 Sediment Model Development: Subwatershed Land Cover Characteristics

Sediment delivery rates are dependent on land cover/use, topography, and soil types. Selecting the land cover\use characteristics are required for the AnnAGNPS sediment delivery model, important to the model performance. Variables include land cover per subwatershed, soil types per subwatershed, soil variables per type, runoff curve numbers per land cover, and RUSLE factors per land cover type. A summary of the AnnAGNPS model input variables is summarized in Appendix A. Land cover GIS layer were created for each subwatershed to be used for the AnnAGNPS model demonstration (Section 4.5).

4.2 Classification of Subwatershed Slopes Based on Slope Geometry and Geotechnical Index Properties

4.2.1 Introduction to Hillslope Classification Scheme

The amount of sediment that is produced on a minimally vegetated slope is dependent upon the slope geometry and the properties of the surface soils. Early in the research, it was felt that the sediment produced during a precipitation event could be correlated to the geomorphology or shape of the slope, and some common geotechnical engineering soil properties. It was desired to develop a classification system that was based on parameters such as:

- Slope shape, as described by the degree of concavity in the directions along the slope and down the slope;
- Height of the slope
- Gradient or slope of the inclined surface
- Soil strength, as estimated by undrained shear strength or cohesion
- Atterberg limits, which are index properties which reflect the plasticity of the soil or the manner in which it reacts with water

After field reconnaissance and performing the Rapid Geomorphologic Assessment (RGA) on the streams (Section 4.3), it became evident that the early thinking on a slope classification would not work well in practice, and that even if shown to correlate well with the sediment produced, would not yield a model that others would implement due to excessive and unreliable data collection. Consequently, the classification of the slopes was reconsidered. The system that was implemented involved the following data elements:

- Agricultural soil classification as provided in GIS layer;
- RUSLE factors for estimating soil loss;
- Gradient or slope of the ground surface as determined from analysis within the GIS;
- Proportion of the surface area that is judged to be concave along the length of the slope;
- Overall relief of the watershed, or elevation difference from the outlet RGA point and the highest peaks found in the watershed.

The first two items above are used in the sediment modeling process, while the latter three items are considered here for the classification of the slopes within the watershed.

4.2.2 Methodology to Hillslope Classification Scheme

To classify the hillslopes with respect to the tendency to produce sediment, a rapid slope assessment (RSA) method was developed. The system was modeled after the RGA method used to characterize the geomorphology of streambeds. The classification system was based on three elements determined from each of the 48 basins for which the RGAs were performed. Table 8 provides the correlation between the RSA basin identification numbers (1-48), the RGA site or field identification (FID) numbers, and name of the subwatershed associated with each. Table 8 also provides the reverse correlation from RSA basin number to RGA site number in the right column. The RSA was estimated for the entire basin down to the RGA site. Not all RGA sites of the total 57 study sites were used for the RSA analysis because some RGA locations were too close in proximity and did not allow for notably different basin delineation.

Three elements or parameters were chosen as a reasonable representation of the geometry and shape of the landforms, yet the can be determined rapidly and relatively objectively from existing GIS layers. These elements are:

Table 8. Correlation of RSA basins and RGA basins with associated subwatersheds used in the classification of hillslopes.

RGA/FID Basin Number and corresponding RSA Basin Number					RSA Basin Number and corresponding RGA/FID Basin Number			
RGA or FID Basin Number	SITE ID	RSA Basin ID Number	Sub-Watershed		RSA Basin ID Number	SITE ID	RGA or FID Basin Number	Sub-Watershed
0	BBC 1	17	Montgomery Fork		1	GCR 1	9	Bull Creek
1	BBC 2	46	Smokey Creek		2	GCR 3	11	Bull Creek
2	BBC 3	3	Bull Creek		3	BBC 3	2	Bull Creek
3	BC 1	10	Greasy Creek		4	MFCS 1	28	Bull Creek
4	BSC 1	18	Brimstone		5	MFCS 10	29	Brimstone
5	BSC 2	28	Ligias Fork		6	LF 2	23	Brimstone
6	BSC 3	11	Greasy Creek		7	GCR 2	10	Brimstone
7	FB 1	37	Montgomery Fork		8	LBC 2	19	Ligias Fork
8	GB 1	26	Ligias Fork		9	RC 3	37	Montgomery Fork
9	GCR 1	1	Bull Creek		10	BC 1	3	Greasy Creek
10	GCR 2	7	Brimstone		11	BSC 3	6	Greasy Creek
11	GCR 3	2	Bull Creek		12	SC 1	39	Greasy Creek
12	GGB 1	41	Smokey Creek		13	SF 1	45	Ligias Fork
13	GGB 2	32	Frozen Head		14	JC 3	16	Ligias Fork
14	IC 1	22	Bull Creek		15	LBC 1	18	Brimstone
15	JC 2	27	Ligias Fork		16	PCC 1	34	Montgomery Fork
16	JC 3	14	Ligias Fork		17	BBC 1	0	Montgomery Fork
17	JOE 1	24	Ligias Fork		18	BSC 1	4	Brimstone
18	LBC 1	15	Brimstone		19	SC 2	40	Bull Creek
19	LBC 2	8	Ligias Fork		20	RC 2	36	Bull Creek
20	LBC 3	29	Montgomery Fork		21	LBC 4	21	Bull Creek
21	LBC 4	21	Bull Creek		22	IC 1	14	Bull Creek
22	LF 1	23	Ligias Fork		23	LF 1	22	Ligias Fork
23	LF 2	6	Brimstone		24	JOE 1	17	Ligias Fork
24	LF 3	39	Montgomery Fork		25	SC 3	41	Ligias Fork
25	LF 4	40	Smokey Creek		26	GB 1	8	Ligias Fork
26	LF 5	30	Montgomery Fork		27	JC 2	15	Ligias Fork
27	LF 6	42	Smokey Creek		28	BSC 2	5	Ligias Fork
28	MFCS 1	4	Bull Creek		29	LBC 3	20	Montgomery Fork
29	MFCS 10	5	Brimstone		30	LF 5	26	Montgomery Fork
30	MKC 1	45	Smokey Creek		31	SC 5	43	Montgomery Fork
31	NPFF 1	43	Smokey Creek		32	GGB 2	13	Frozen Head
32	NPFF 2	48	Montgomery Fork		33	SHC 1	46	Frozen Head
33	NPFF 3	34	Frozen Head		34	NPFF 3	33	Frozen Head
34	PCC 1	16	Montgomery Fork		35	SC 4	42	Montgomery Fork
35	RC 1	38	Montgomery Fork		36	SC 6	44	Montgomery Fork
36	RC 2	20	Bull Creek		37	FB 1	7	Montgomery Fork
37	RC 3	9	Montgomery Fork		38	RC 1	35	Montgomery Fork
38	SB 1	47	Smokey Creek		39	LF 3	24	Montgomery Fork
39	SC 1	12	Greasy Creek		40	LF 4	25	Smokey Creek
40	SC 2	19	Bull Creek		41	GGB 1	12	Smokey Creek
41	SC 3	25	Ligias Fork		42	LF 6	27	Smokey Creek
42	SC 4	35	Montgomery Fork		43	NPFF 1	31	Smokey Creek
43	SC 5	31	Montgomery Fork		44	WC 1	47	Smokey Creek
44	SC 6	36	Montgomery Fork		45	MKC 1	30	Smokey Creek
45	SF 1	13	Ligias Fork		46	BBC 2	1	Smokey Creek
46	SHC 1	33	Frozen Head		47	SB 1	38	Smokey Creek
47	WC 1	44	Smokey Creek		48	NPFF 2	32	Montgomery Fork

- Gradient or slope of the ground surface as determined from analysis within the GIS;
- Overall relief of the watershed, as determined as the difference in elevation from the outlet RGA point and the mean of 2 to 3 highest peaks found in the watershed; and
- Proportion of the surface area that is judged to be concave along the length of the slope, expressed as a percentage of the total watershed (sub-watershed) surface area

Each of these elements is discussed below, followed by the discussion of the determination of the RSA score.

Gradient Score (GS): For each RSA/RGA basin, the 30-m digital elevation map (DEM) data from the USGS Seamless Database was processed within the GIS to calculate the slope or gradient of the hillslopes. The value of the gradient or change in slope over the 30-m interval, was expressed as a slope percentage and assigned to each area over which it was determined (Figure 8). The calculated gradients were then assigned to one of the ranges or "bins" of gradient values as shown in Table 9. A score was assigned to each bin, with the greater slopes assigned a higher score reflecting the greater tendency to produce sediment. The GS score was based on the integer 3 to the power of the bin value, factored by the proportion of the basin area with hillslopes of that that slope gradient value or:

$$\text{Gradient Score} = \text{GS} = \sum_{i=1}^{4}\left[3^{i} \times \text{Area}_{i}^{Normalized}\right]$$

where: i = Bin value = 1, 2, 3, or 4 depending upon the range in which the determined hillslope gradient falls

$\text{Area}_i^{\text{Normailized}}$ = Area corresponding to bin i normalized by the total area of the RGA basin

Since all of the sub-watersheds were predominantly in the range 8 to 35 percent slope, with only a relatively small percentage of surface area falling in the other ranges, the Gradient Scores did not cover a large range, varying only from about 20 to 28.

Relief Factor (RF): It was assumed that the greater the change in elevation or relief within a watershed, the more likely that sediment would be produced. The overall relief of the watershed was determined as the difference in elevation between the outlet RGA point and the mean of 2 to 3 highest peaks found in the watershed. The Relief Factor was determined as:

$$\text{Relief Factor} = RF = \frac{\text{relief (in feet)}}{\text{1000 feet}}$$

Valley Score (VS): For each RGA basin, a sufficient number of coordinates to define the boundaries of the basin were located in the Google Earth web-based GIS. The Terrain feature was used, and the view tilted and rotated to view the basin looking upstream from the RGA point. Examples are shown in Figures 9 and 10.

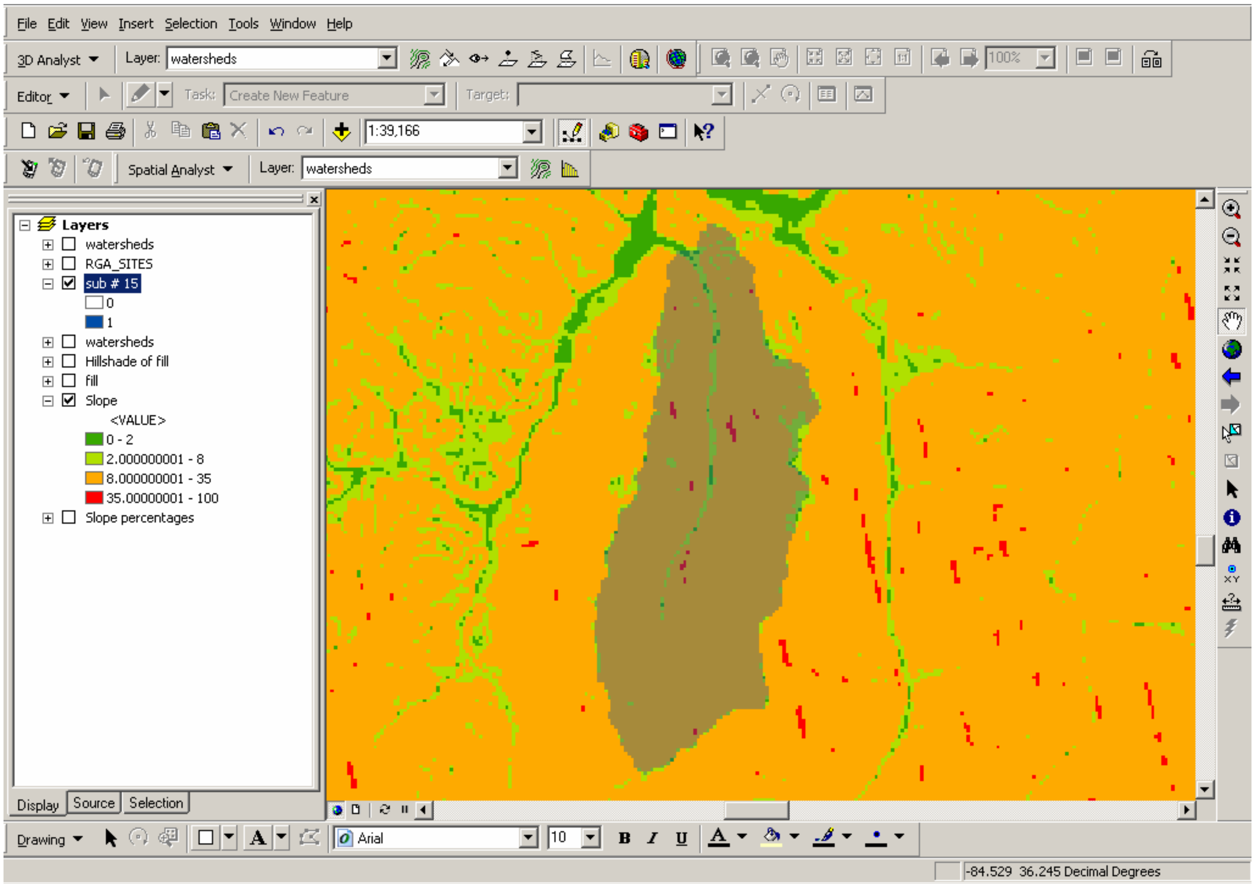


Figure 8. Calculated gradients and associated areas for RSA Basin #15. The majority of Basin 15 (shaded in center of screen) is in the 8-35% slope range, but the basin shading has affected the orange coloring towards brown.

Table 9. Determination of Gradient Score assigned to hillslopes.

Range of Gradients	Channel Morphology	Bin Value	Gradient Score
0 - 2 percent	Pool-riffle morphology	1	$3^1 = 3$
2 – 8 percent	Step pool morphology – low gradient headwaters	2	$3^2 = 9$
8 – 35 percent	Step pool morphology – high gradient headwaters	3	$3^3 = 27$
Greater than 35 percent	Approximation of 20-degree “steep” slope OSM definition	4	$3^4 = 81$

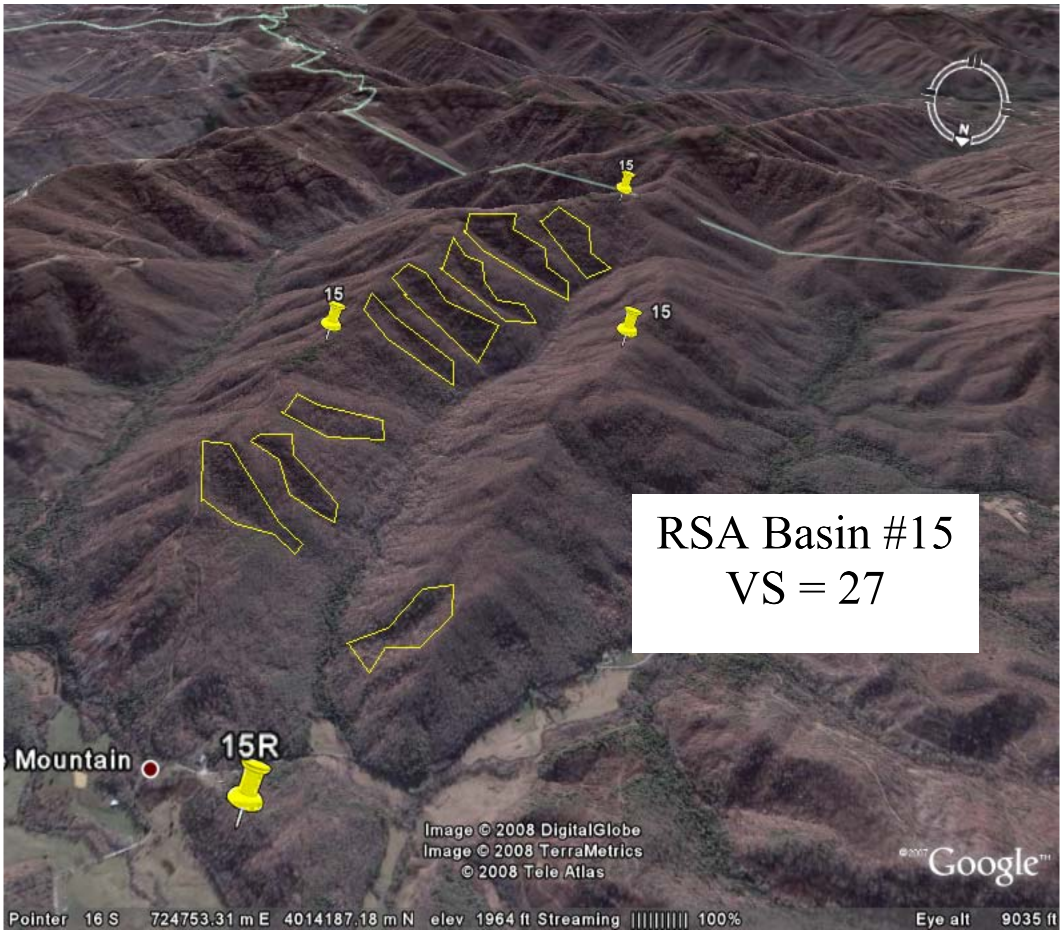


Figure 9. Typical view of RSA basin #15 looking upstream from the RGA point (suffix R) used to determine the Valley Score (Google Earth with the terrain tilted).

Based on this view, a virtual "fly-over" of the watershed could be performed. The percentage of the surface area thought to be of concave or valley shape (Figure 11b) was then estimated, and the percentage assigned to a range or "bin" as summarized in Table 10.

The areas considered to be concave are highlighted in the examples shown in Figures 9 and 10. While the estimation of the percent of a basin area determined to be concave may be somewhat subjective, because the percentages were placed in bins it was not important that the exact area be determined, only the appropriate bin or range. For example, in Figure 9 the concave areas were determined to be between 20 and 30 percent of the total basin area, while the concave areas in Figure 10 are less than 20 percent falling in the 10 to 20 percent range.

The Valley Score was determined for each subwatershed as:

$$\text{Valley Score} = VS = 3^{i}$$

where: i = Bin value = 1, 2, 3, or 4 depending upon the range in which the valley percentage was determined

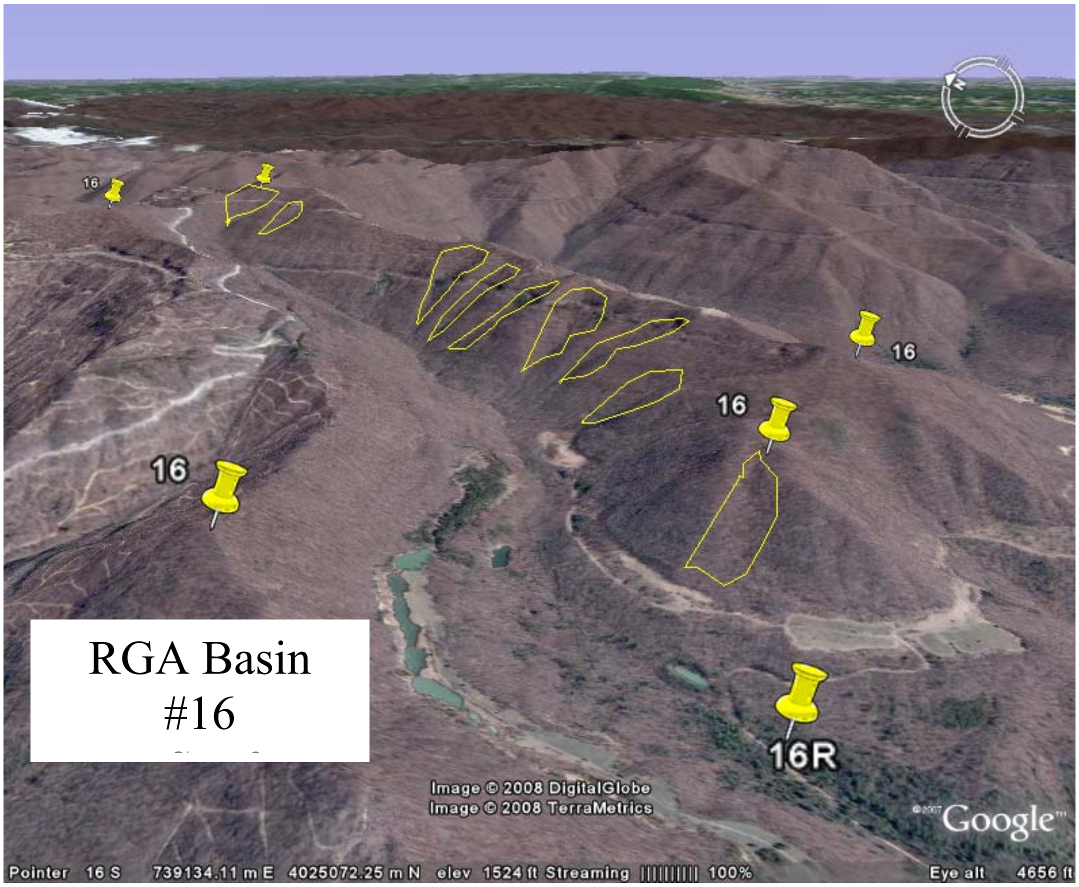


Figure 10. Typical view of RSA basin #16 looking upstream from the RGA point (suffix R) used to determine the Valley Score (Google Earth with terrain tilted).

Figure 12 is a frequency diagram of the Valley Score results, indicating the number of basins that were scored in each of the ranges of percent concave area. For example, 25 of the 48 basins scored in range 3 corresponding to 20 to 30 % concave area.

Rapid Slope Assessment Score. The RSA total score was then determined from the GS, RF, and VS sub-scores as:

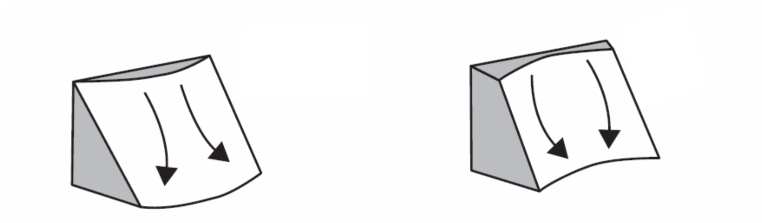
$$RSA = GS + (\mathrm{RF} * \mathrm{VS})$$

where:

GS = Gradient Score
RF = Relief Factor
VS = Valley Score

The total RSA scores for the 48 subwatersheds ranged from 21 to 160, as depicted in Figure 13, and a frequency diagram for the RSA results is shown in Figure 14. The results for each basin are summarized in Table 11. Figures 13 and 14 suggest that the RSA method provides good resolution of the score based on the three selected elements, in spite of the fact that the GS data was all within a relatively narrow range.

The Rapid Slope Assessment is a convenient means to quantify how the shape of the ground surface may contribute to the production of sediment, and was used in the subsequent statistical analysis of the factors affecting the sediment in the streams of the subwatersheds.



a) Convex b) Concave

Figure 11. Assumed definitions of convex and concave slope geometry.

Table 10. Determination of Valley Score.

Range of percent concave or valley area	Bin Value	Valley Score
0 – 10 percent	1	$3^1 = 3$
10 -20 percent	2	$3^2 = 9$
20 – 30 percent	3	$3^3 = 27$
Greater than 30 percent	4	$3^4 = 81$

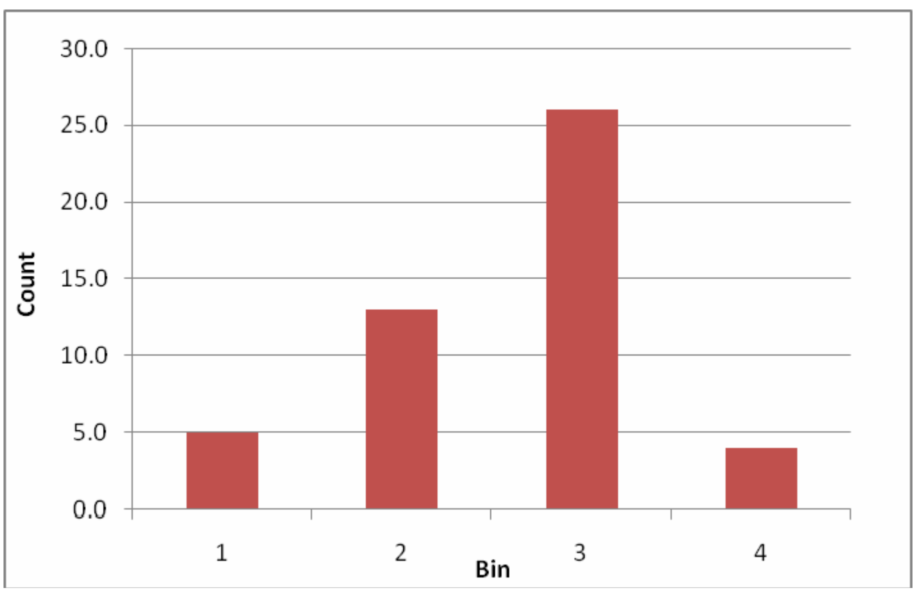


Figure 12. Frequency graph of Valley Score watershed count for various bins values (Bin 1 = 0-10%, Bin 2 = 10-20%, Bin 3 = 20-30%, and Bin 4 = >30%).

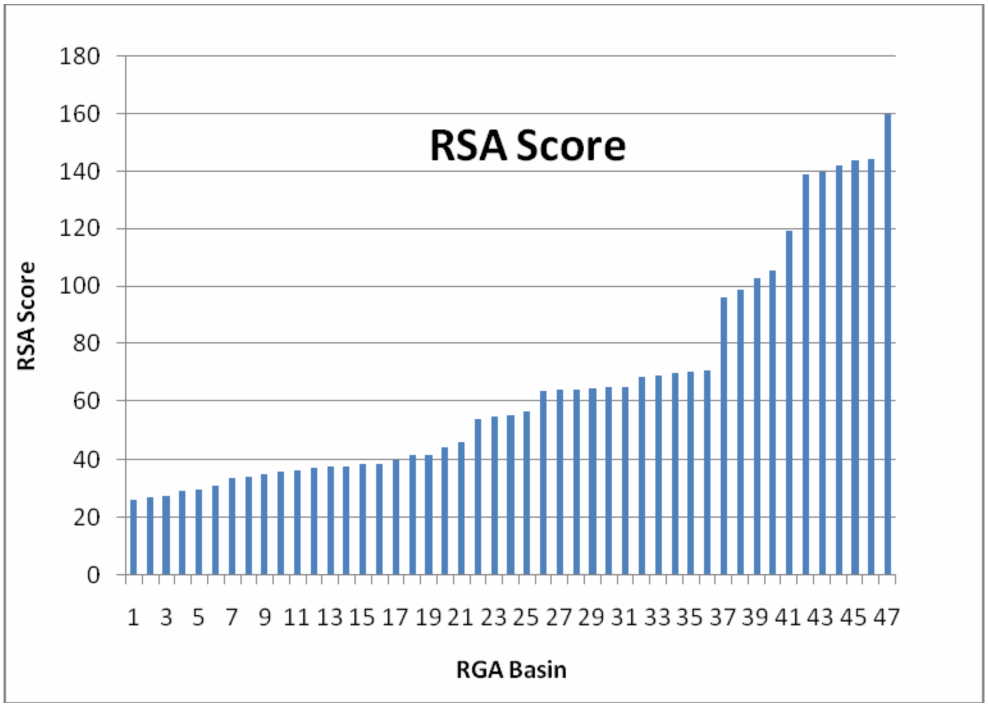


Figure 13. Distribution of RSA Scores.

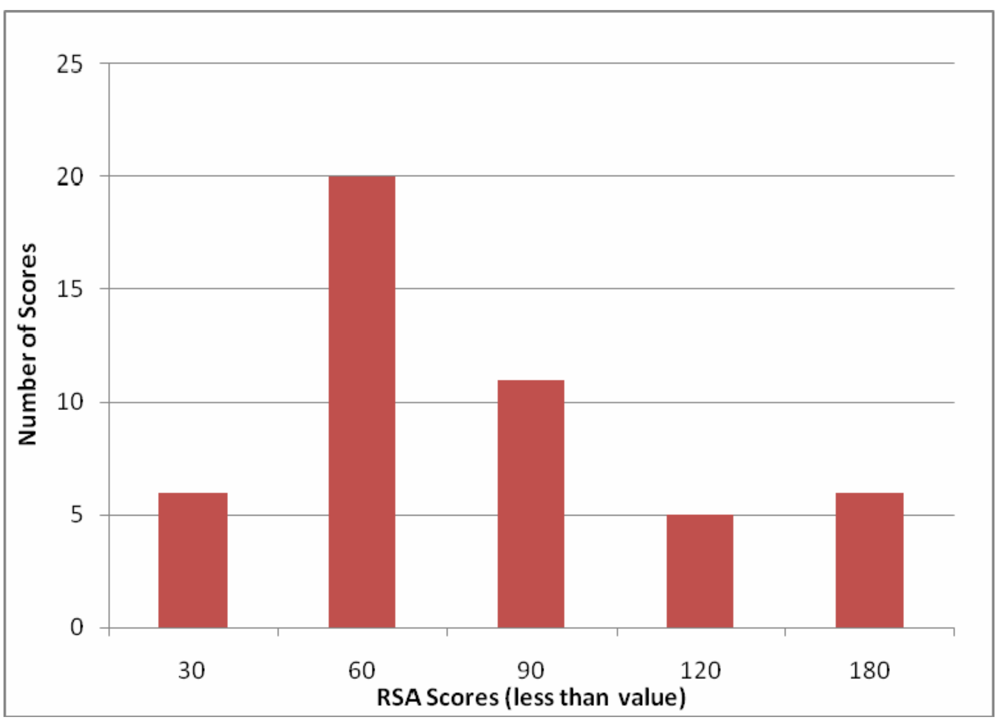


Figure 14. Frequency graph of final RSA Scores.

Table 11. Summary of RSA basin scores.

RGA or FID Basin Number	Sub-Watershed	RSA Basin ID Number	SITE ID	RSA Sub-Basin	Gradient Score	RF = Relief Factor	Valley Score	RSA Score
0	Montgomery Fork	17	BBC 1	17	25.5	0.42	9	29
1	Smokey Creek	46	BBC 2	46	26.1	1.41	27	64
2	Bull Creek	3	BBC 3	3	25.0	0.35	27	34
3	Greasy Creek	10	BC 1	10	21.5	0.62	9	27
4	Brimstone	18	BSC 1	18	25.1	1.39	9	38
5	Ligias Fork	28	BSC 2	28	26.9	1.67	9	42
6	Greasy Creek	11	BSC 3	11	20.1	0.18	3	21
7	Montgomery Fork	37	FB 1	37	26.4	0.98	81	106
8	Ligias Fork	26	GB 1	26	25.7	1.05	9	35
9	Bull Creek	1	GCR 1	1	25.9	1.43	81	142
10	Brimstone	7	GCR 2	7	25.0	1.07	27	54
11	Bull Creek	2	GCR 3	2	24.7	1.25	9	36
12	Smokey Creek	41	GGB 1	41	26.2	1.40	27	64
13	Frozen Head	32	GGB 2	32	28.0	0.58	3	30
14	Bull Creek	22	IC 1	22	26.5	1.11	27	57
15	Ligias Fork	27	JC 2	27	25.1	1.61	27	68
16	Ligias Fork	14	JC 3	14	23.7	0.82	3	26
17	Ligias Fork	24	JOE 1	24	25.7	1.19	9	36
18	Brimstone	15	LBC 1	15	26.2	1.08	27	55
19	Ligias Fork	8	LBC 2	8	26.5	1.46	81	145
20	Montgomery Fork	29	LBC 3	29	25.1	0.79	3	28
21	Bull Creek	21	LBC 4	21	26.4	0.58	27	42
22	Ligias Fork	23	LF 1	23	25.9	1.43	9	39
23	Brimstone	6	LF 2	6	25.9	1.40	81	139
24	Montgomery Fork	39	LF 3	39	27.2	1.64	81	160
25	Smokey Creek	40	LF 4	40	26.0	1.44	27	65
26	Montgomery Fork	30	LF 5	30	26.4	0.94	81	103
27	Smokey Creek	42	LF 6	42	25.4	1.48	27	65
28	Bull Creek	4	MFCS 1	4	24.1	1.10	9	34
29	Brimstone	5	MFCS 10	5	23.5	0.90	81	96
30	Smokey Creek	45	MKC 1	45	27.2	1.62	27	71
31	Smokey Creek	43	NPFF 1	43	26.5	1.53	9	40
32	Montgomery Fork	48	NPFF 2	48	27.1	1.58	27	70
33	Frozen Head	34	NPFF 3	34	27.1	1.44	81	144
34	Montgomery Fork	16	PCC 1	16	27.5	1.14	9	38
35	Montgomery Fork	38	RC 1	38	26.4	0.67	27	45
36	Bull Creek	20	RC 2	20	24.2	0.83	27	47
37	Montgomery Fork	9	RC 3	9	26.6	1.04	27	55
38	Smokey Creek	47	SB 1	47	27.1	1.60	27	70
39	Greasy Creek	12	SC 1	12	25.1	1.42	81	140
40	Bull Creek	19	SC 2	19	26.2	0.90	81	99
41	Ligias Fork	25	SC 3	25	27.1	1.37	27	64
42	Montgomery Fork	35	SC 4	35	26.8	1.23	9	38
43	Montgomery Fork	31	SC 5	31	27.3	1.54	27	69
44	Montgomery Fork	36	SC 6	36	26.1	1.15	81	119
45	Ligias Fork	13	SF 1	13	26.1	1.64	3	31
46	Frozen Head	33	SHC 1	33	27.7	1.37	27	65
47	Smokey Creek	44	WC 1	44	26.0	1.41	9	39

4.3 Stream Channel Properties: Use of the Rapid Geomorphic Assessment

4.3.1 Method Descriptions for RGA and Bed Sediment Collection

Rapid Geomorphic Assessment (RGA): Use of a Rapid Geomorphic Assessment (RGA) provides a means to interpret whether a channel is stable or unstable through a field visual technique in which a channel stability score is computed. The RGA is a quick means of determining the current stability and geomorphic characteristics of a stream's reach. Whether a channel is deemed stable or unstable provides the necessary information to choose sediment model selection. For example if a watershed consists primarily of stable channels, sediment delivery to the streams will be dominated by upland sources. Therefore the AnnAGNPS model can be applied without the ConCEPTS model. ConCEPTS is a sediment transport and bank failure model, which computes sediment yields from bank erosion and mass failure sources. If a watershed consists of many unstable channels, the coupled AnnAGNPS-ConCEPTS model would be used to predict watershed sediment yields.

This section constitutes the effort for *Deliverable 2*, in which a RGA approach developed by Dr. Andrew Simon in collaboration with various scientists at the USDA National Sedimentation Laboratory (NSL), in Oxford, Mississippi was applied and evaluated for the Appalachian region. Successful application of the RGA has been applied to various watersheds within the United States, however not in the Appalachian highlands. The initial objective for this effort was to modify the existing NSL's RGA approach if needed for this geographical region, and develop a new RGA. After an initial evaluation of the NSL's RGA approach, it was found not needed to be modified. Value of not modifying the approach lies in that RGA channel stability scores obtained in the New River could be compared to the NSL's national database.

Provided in Figures 15 and 16 are examples of the RGA forms used at each stream site within the New River Basin. Figure 15 is used to determine a stream stability score (from 0.0 to 36.0) or what is referred to as an RGA score in this document. Figure 16 is used to record the measurements taken from the modified pebble counts at each stream reach. The procedures and variables identified in Figures 15 and 16, as well as the usefulness and applicability of the RGA procedures are further explained within this section of the report.

The RGA procedure for each site on a stream contains several steps that need to be accomplished to properly represent a stream reach. For each site analyzed in this project, and for future projects, the RGA form must be filled out for every site. To properly obtain a complete RGA on a stream reach, Table 12 summarizes all the variables that must be recorded.

Note that a stream's reach is defined by an approximate length equal to 6 to 10 channel widths. The RGA form has a particular amount of information recorded. Table 13 indicates all the parameters that are necessary to the completion of the RGA form and how the data should be filed. For a RGA site to be completed quickly, the slope of each channel in the New River Basin was estimated for each reach using a K & E Hand Level, a 1.5-m PVC rod to mount hand level, and a stadia rod.

One of the most critical portions of the RGA form is the channel stability ranking scheme, which scores the stream site's geomorphic characteristics and the channels stability. There are a total of nine categories in the RGA's channel stability ranking scheme that must be answered to characterize the stream's reach.

CHANNEL-STABILITY RANKING SCHEME

Station #________________ **Station Description**______________________________

Date ____________ **Crew** ______________ **Samples Taken**________________________

Pictures (circle) upstream downstream cross section **Slope**_________

1. Primary bed material

Bedrock	Boulder/Cobble	Gravel	Sand	Silt Clay	
0	1	2	3	4	____

2. Bed/bank protection

Yes	No	(with)	1 bank protected	2 banks	
0	1		2	3	____

3. Degree of incision (Relative ele. Of "normal" low water; floodplain/terrace @ 100%)

0-10%	11-25%	26-50%	51-75%	76-100%	
4	3	2	1	0	____

4. Degree of constriction (Relative decrease in top-bank width from up to downstream)

0-10%	11-25%	26-50%	51-75%	76-100%	
0	1	2	3	4	____

5. Streambank erosion (Each bank)

	None	fluvial	mass wasting (failures)	
Left	0	1	2	____
Right	0	1	2	____

6. Streambank instability (Percent of each bank failing)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	0	0.5	1	1.5	2	____
Right	0	0.5	1	1.5	2	____

7. Established ripirian woody-vegetative cover (Each bank)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	2	1.5	1	0.5	0	____
Right	2	1.5	1	0.5	0	____

8. Occurrence of bank accretion (Percent of each bank with fluvial deposition)

	0-10%	11-25%	26-50%	51-75%	76-100%	
Left	2	1.5	1	0.5	0	____
Right	2	1.5	1	0.5	0	____

9. Stage of channel evolution

I	II	III	IV	V	VI	
0	1	2	4	3	1.5	____

TOTAL ____

Figure 15. Field form for the Rapid Geomorphic Assessment.

CHANNEL-STABILITY PARTICLE COUNT FORM

Station #__________ Station Description____________________

Date ________ Crew _________

Location/Description ______________________________
(pool, riffle, 1 of 3, additional samples?)

1 ____	26 ____	51 ____	76 ____
2 ____	27 ____	52 ____	77 ____
3 ____	28 ____	53 ____	78 ____
4 ____	29 ____	54 ____	79 ____
5 ____	30 ____	55 ____	80 ____
6 ____	31 ____	56 ____	81 ____
7 ____	32 ____	57 ____	82 ____
8 ____	33 ____	58 ____	83 ____
9 ____	34 ____	59 ____	84 ____
10 ____	35 ____	60 ____	85 ____
11 ____	36 ____	61 ____	86 ____
12 ____	37 ____	62 ____	87 ____
13 ____	38 ____	63 ____	88 ____
14 ____	39 ____	64 ____	89 ____
15 ____	40 ____	65 ____	90 ____
16 ____	41 ____	66 ____	91 ____
17 ____	42 ____	67 ____	92 ____
18 ____	43 ____	68 ____	93 ____
19 ____	44 ____	69 ____	94 ____
20 ____	45 ____	70 ____	95 ____
21 ____	46 ____	71 ____	96 ____
22 ____	47 ____	72 ____	97 ____
23 ____	48 ____	73 ____	98 ____
24 ____	49 ____	74 ____	99 ____
25 ____	50 ____	75 ____	100 ____

Figure 16. Field form for stream bed pebble counts, conducted with the RGA .

Table 12. Summarized details of the RGA field data required at each stream reach.

RGA Field Data Requirements:
1. Complete the RGA Form for every site
2. Take GPS recording of each site's location
3. Take a surveyed slope of each site's stream reach at the Thalweg positions
4. Collect a Particle Count (Wolman Pebble Count) of the site if the reach is in a riffle, if the site reach is located in a pool, then collect a Particle Size Bulk Sample
5. Take upstream photographs of the RGA site
6. Take downstream photographs of the RGA site
7. Take photographs to represent the RGA site's cross section

Table 13. Summarized details of the RGA form's required data.

Object	Information Required
River	River or stream name required, as found on Topographical maps
Site Identifier	Site number as given by pre-determined numbering scheme
Date	Month/Day/Year
Crew	Initials of personnel present
Samples Taken	Number of Particle Counts, Particle Size Bulk Sample
Pictures	Upstream, Downstream, & Cross-sectional views
Slope	As calculated using distance/drop of thalweg
Pattern	Label as: Meandering (a stream following a sinuous path), Straight (a stream that has a straight course), or Braided (where the channel splits into a number of different smaller channels with islands separating them)

Observing the nine different categories in the channel stability ranking scheme, the first measurement is defining the *Primary Bed Material* of the stream site's reach. The five different primary bed material categories are: Bedrock, Boulder/Cobble, Gravel, Sand, and Silt Clay. As the bed material gets smaller in diameter, the value in the RGA form increases, which indicates that the channel has more potential to change geomorphologically as the bed material, is more easily scoured during large flows in the stream. The bedrock bed material is quite noticeable on a stream reach and should be recorded if it is seen to be throughout a majority of the stream reach. The boulder/cobble category is defined by a bed material that has a majority of aggregates that are greater than 64.0 mm in diameter. The gravel bed material is defined by a majority of bed particles that contain a median diameter between 64.0 mm and 2.00 mm. The sand bed material is defined by a majority of bed particles that contain a median diameter between 2.00 mm to 0.63 mm. Finally, the silt/clay bed material is defined by a majority of bed particles that contain a median diameter less than 0.63 mm.

The *Bed/Bank Protection* is a two part question that grades the site's stream reach based on artificial protection. To answer this question, first determine whether the bed is protected by an artificial substance like rip rap or concrete, then note whether if there are one or two banks protected by an artificial substance like rip-rap or concrete. If there is no artificial protection whatsoever found in at the stream site (like most of the sites in the New River sub-watersheds) the total score of the bed/bank protection should be one. If a site had only one bank protected, the bed/bank protection would have a score of 3.0.

The *Degree of Incision* classification scores the stream site on the degree of geomorphic occurrences of channel deeping over time. This question is determined by dividing the depth of water at the deepest point at the cross-section (of the stream site) by the vertical bank height. This measurement at all the stream sites in various New River sub-watersheds gave a degree of incision of 0 to 10% which contains a very high score of 4.0 in this category, which is an indication of channel instability. This is one example of the original RGA form that may not agree with the extreme landscape of the Appalachian Mountains and its streams. As the RGA analysis was preformed in the New River Basin, it was suggested that the streams are a product of the area's geology and this variable would indicate the occurrence of several stream's geomorphologic changes when a very high bank in comparison to the streams shallow average active depth is a normal characteristic in the Appalachian areas.

The *Degree of Constriction* classification is a score that represents the amount of un-natural changes around the stream's environment have occurred. In other words, the degree of constriction is largely influenced around structures in or adjacent to the stream, which impede its natural course of travel. This category is an approximate percent of the site's stream reach that decreases in top-bank width from up to downstream.

The *Stream Bank Erosion* category is used to characterize the type of current erosion that is taking place on the left and right banks looking upstream. Note that the traditional RGA Form suggests looking downstream to classify the left and right banks, but to keep all measurements consistent (especially with the ConCEPTS model), we decided to define the left and right banks for each cross-section by looking upstream. This question should answer what type, if any, erosion is relevant for the left and right banks. Fluvial erosion is defined as a slow erosional process at the banks. Fluvial erosion is commonly seen where there is open soil that is not shielded by vegetation in the stream is slowly being undercutted. Mass wasting is the movement of large amounts of material from the bank(s).

Stream Bank Instablility is an approximate percentage given to each bank to indicate the percentage of stream reach that exhibits mass wasting of the banks. Note that the left and right banks, like that of the Stream Bank Erosion category, are defined by looking upstream of the channel.

Established Riparian Woody-Vegetation Cover is an approximate percentage of permanent vegetation (omitting grass) grown on each stream bank, for the entire stream reach analyzed.

Occurrence of Bank Accretion is another approximate percentage of stream reach banks (both left and right banks looking upstream) that contains fluvial deposition (fines, sands, gravels).

The last category is the *Stage of Channel Evolution* defines the geomorphological stage of the channel at the present time (Figure 17; Table 14). There are a total of six different stages with Stage I representing stable bank conditions and Stages IV and V indicating a very unstable channel. The following are the different stages thoroughly defined by the RGA Form instructions. Note that throughout the various streams in the impacted and un-impacted subwatershed of the New River Basin, a large number of streams were found to be a Stage I channel. A few other streams in highly disturbed areas near to open waters exhibited other stages of channel evolutions, but most were not defined consistently for continuous reaches throughout a stream.

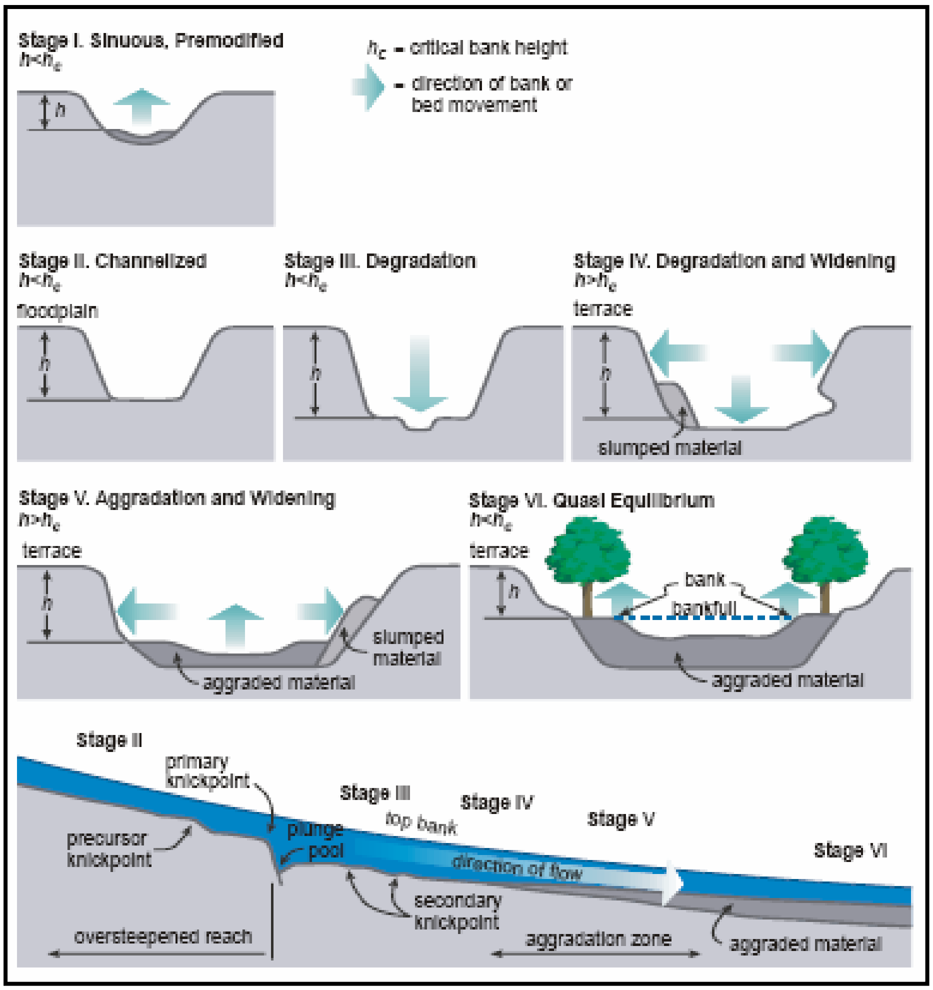


Figure 17. Stages of the channel evolution model illustrated by geomorphic processes associated with channel adjustment following a disturbance (Simon *et al*. 2002).

Table 14. Description of stages defined in the channel evolution model.

Stage of Channel Evolution Number	Stage of Channel Evolution Name	Description
I	Pre-Modified	Stable bank conditions, no mass wasting, small, low angle bank slopes. Established woody vegetation, convex upper bank, concave lower bank.
II	Constructed	Artificial reshaping of existing banks. Vegetation often removed, banks steepened, heightened and made linear.
III	Degradation	Lowering of channel bed and consequent increase of bank heights. Incision without widening. Bank toe material removed causing an increase in bank angle.
IV	Threshold	Degradation and basal erosion. Incision and active channel widening. Mass wasting from banks and excessive undercutting. Leaning and fallen vegetation. Vertical face may be present.
V	Aggradation	Deposition of material on bed, often sand. Widening of channel through bank retreat; no incision. Concave bank profile. Filled material reworked and deposited. May see floodplain terraces. Channel follows a meandering course.
VI	Restabilisation	Reduction in bank heights, aggradations of the channel bed. Deposition on the upper bank therefore visibly buried vegetation. Convex shape. May see floodplain terraces.

To complete the RGA channel stability ranking scheme, all of the 9 categories are summed up to characterize the stability of a stream with a numerical value.

Bed Sediment Collection: After an RGA site was located, various tasks were taken to complete analyze environmental variables for the stream reach's characteristics and stability. However, results from bed sediment collection are directly incorporated into the RGA score, but were collected to characterize bed sediment to meet study objectives.

The first sets of tasks to be completed at each site were to download the location coordinates of the site on our GPS equipment and to find a bed sediment sample. Note that two types of particle size distributions are collected at each stream site, one is the Modified Wolman Pebble Count, which characterizes the larger size of material transported within a stream's channel and the other type of stream bed characterization is the sediment samples that represent the very fine particles transported within the stream during large flows. For the fine sediment samples collected, it was critical to quickly obtain a sample before any other stream measurements were taken. If a fine sediment samples were taken before the Modified Wolman Pebble Count and other stream measurements, which require heavy movement throughout the channel, the possibility of stirring up a location where fine sediment sampling is ideal would be alleviated. Throughout this document, the finer sediment samples will be referred to as sediment samples (which are collected with a sediment sampler instrument and measured through sieve and hydrometer analysis) and the larger bed materials measured within the stream through the Modified Wolman Pebble Count will be referred to as pebble counts.

Beginning with the sediment samples collected, there are special protocols developed to collect and analyze the fine bed sediments. The first task requires a careful visual study of the stream site to determine ideal locations where a sediment sample can be collected. For each RGA site, a sediment sample should be found within the appropriate reach lengths (6-10 channel widths long). In some scenarios, a healthy amount of fine sediment is difficult to find and it may not be possible to collect a sediment sample within 6-10 channels width away from the RGA site established. For a scenario where a healthy sediment sample cannot be collected with one scoop near to the RGA site, walk upstream of the RGA site until a sediment sample is found and make a note of the location of sample location in respect to the RGA site.

The methods that were used for various streams in the New River Basin for collecting fine sediment samples to obtain a diverse collection of different sediment sizes are very important to the study. The collection of fine sediment within the channel environment indicates a history of fine particles that are transported by the stream during high flow, which is a product of large storm events. When a large precipitation event passes over an area the runoff caused from the storm water will transport fine clays and silts from the hillslopes due to various land disturbances. The fine sediment will enter into the local stream with the large flow rate in the streams till the storm waters recede. When the flow and velocity of a channel decrease, the fine particles from the hillslopes begin to settle in areas where the velocity of the stream becomes minimal. The depositional points where very fine sediment settles from a series of large storm events can be used to indicate how severe hillslope disturbances are related to the streams.

All the fine sediment collected was found in depositional areas within the stream channels for this project. Depositional areas are locations within the channel that have smaller inconsistent velocities in comparison to the overall stream movement during average flow conditions. In other words, the depositional areas were the sediment samples were collected are on point bars, side bars, or behind objects like large boulder in the stream that shield the natural flow. As far as collecting sediment samples, the easiest location to obtain a healthy sediment sample is on point bars, if a point bar is not found near an RGA site, a near by side bar is the next area where healthy samples are most likely to occur. Finally, if a point bar or side bar cannot be located near the RGA site for a sediment sample location, look behind large object (boulders, logs) within the stream that interrupt the flow. The sediment accumulation behind objects in the stream is usually small and a large sample with one scoop may be a difficult task. All three deposition points mentioned above should all contain the same fine sediment accumulations. Every stream site is different and will contain different hydraulic characteristics. For most sediment samples collected within the New River, most were found on side bars and behind large objects within the stream.

After a sediment sample is located, a stainless steel sediment sampler that is 20.2 cm long and has an inside diameter of 7.1 cm was used to collect each sample. The correct procedure in using the collecting fines with the sediment sample is very simple. For every site, the stainless steel sediment sampler would be used to scoop up a representative sediment distribution from a depositional point in the stream reach with one single scoop. In order to not lose any fine material, the mouth of the sediment sampler would be oriented to face the upstream flow.

Once the material from the sediment sampler was acquired, the fine sediments (and usually water from the stream) were carefully poured into a plastic container with the RGA site and date were marked. All remaining sediment particles that remained in the sediment sampler after the initial dispense were carefully rinsed out, so as to not affect future samples.

Stream Particle Counts (Modified Wolman Pebble Count): The latter procedure to characterize the large materials transported by the stream during large storm events is through the Modified Wolman Pebble Counts. Pebble counts within the stream were completed after fine sediment was sampled, so that movement within the stream would alter a depositional area. The Modified Wolman Pebble Count is slightly altered from the original Wolman Pebble Count, which used a 10 by 10 grid to collected particles in the stream. The modified Wolman Pebble Count that was used for the New River Basin analysis stretched a 30 meter tape measure across a stream channel or point bar if available and 100 particles were measured at equal intervals.

4.3.2 Results: Channel Stability Indices and Bed Sediment Properties

RGA total scores per subwatershed and site, and the individual nine metrics are summarized in Table 15. A lower score indicates a more stable channel, and the highest possible score is 36 for a very unstable channel. The USDA NSL considers a score less than 20 a stable channel (A. Simon, *pers. comm*.). Overall, scores that ranged from 5 to 17, therefore all sites were found to be stable. This analysis also suggests that in the Appalachian region, geology is a major control on channel structure and stability. Thus, disturbances on the landscape from logging, mining, etc do not initiate a "disequilibrium" condition in channels within the watershed. Also from this data, it can be concluded that sediment from the bank erosion is only a minor source in these mountainous headwater streams. *This result suggests the focus of sediment modeling to quantify the suspended sediment loads is from uplands sources, and the AnnAGNPS model will be a useful tool, once calibrated, to estimate sediment loads as a function of land use activities within a study subwatershed*. RGA scores were also included in the statistical analysis, with results described in Section 4.4. Site summaries of stream characteristics from the field surveys, which include other basic field observations, can be found in Appendix C.

The stability of the channel can also be seen from the bed sediment characteristics, in which the D50 and D84 from the pebble counts found mostly gravel and cobble size classes (Table 16). This size class of bed material would be expected in the Appalachian mountain streams. Pebble count metrics were included the statistical analysis, with results described in Section 4.4.

For each site visited in each subwatershed, within the New River Basin, a few critical data points are summarized per watershed. For each site, the RGA score (which is a standardized numerical value to grade channel stability in the U.S.) was compared to two different stream bed (pebble counts) size classes, D50 and D84. The D50 and D84 of the pebble counts are the 50th and 84th largest diameter particle collected out of a total of 100 particles measured using the modified Wolman pebble count procedure. For the fine sediment, the D50 is the median percent finer diameter of the particles collected in depositional points within the stream environment. The percent weight of the total fine sediment sample that contains particles less than 0.016 mm is a good measurement of the clays in the sediment collected and is significant in that it can be harmful to biota and may be a good indication of the severity of hillslope disturbances.

The fine sediment results from the particle size distributions indicate that the median grain size in the sand range (2-3 mm). This data will be used to compare with land use characteristics.

Table 15. A summary of study site RGAs, total and nine assessment metric scores.

GPS Site ID	Watershed	RGA SCORES: **1.** Primary Bed Material	**2.** Bed/bank Protection	**3.** Degree of Incision	**4.** Degree of Constriction	**5.** Bank Erosion	**6.** Bank Instability	**7.** Riparian Vegetation	**8.** Bank Accretion	**9.** Channel Evolution	TOTAL RGA SCORES
BSC 1	Brimstone Creek	1	1	4	0	1/1	0/0.5	0/0	0/0	0	8.5
BSC 2	Brimstone Creek	1	0	4	0	0/0	0/0	0/0	0/0	0	5.0
BSC 3	Brimstone Creek	1	0	3	0	1/0	0.5/0	0/0	0.5/1	0	7.0
IC 1	Brimstone Creek	0	1	4	0	0/0	0/0	0/0	0/0.5	0	5.5
JOE 1	Brimstone Creek	1	1	2	0	0/0	0/0	0/0	0.5/0.5	0	5.0
BBC 1	Bull Creek	1	1	3	0	0/0	0/0	0/0	0.5/0.5	0	6.0
BBC 2	Bull Creek	0	1	4	1	1/1	0/0	2/0	1.5/0.5	3	15.0
BBC 3	Bull Creek	1	1	4	0	1/1	0.5/0.5	0/0	0.5/0.5	0	9.0
BC 1	Bull Creek	1	1	4	2	1/1	0.5/1.5	0/0	1/1	3	17.0
LBC 1	Bull Creek	1	1	3	0	0/1	0/0	0/0	0/0	0	6.0
LBC 2	Bull Creek	1	1	3	0	1/1	0/0	1/1	0.5/0.5	1.5	11.5
LBC 3	Bull Creek	0	2	4	0	0/0	0/0	0/0	1/1	0	8.0
LBC 4	Bull Creek	1	1	4	0	0/0	0/0	0/0	0.5/1	0	7.5
NPFF 1	Frozen Head	1	1	4	0	0/0	0/0	0/0	0/0	0	6.0
NPFF 2	Frozen Head	1	1	3	0	0/0	0/0	0/0	0/0	0	5.0
NPFF 3	Frozen Head	1	1	3	0	0/0	0/1	0/0	0.5/0.5	0	7.0
GCR 1	Greasy Creek	1	1	4	0	0/1	0.5/0.5	0/0	0/0	0	8.0
GCR 2	Greasy Creek	2	1	4	0	1/0	0/0	0/0	0/0	0	8.0
GCR 3	Greasy Creek	1	1	4	0	0/1	0/0	0/0	0/0	0	7.0
FB 1	Ligias Fork	1	1	3	1	1/1	0.5/0.5	0.5/0	1/1	0	11.5
GGB 1	Ligias Fork	1	1	3	0	0/0	0/0	0/0	0.5/0.5	0	6.0
GGB 2	Ligias Fork	1	3	4	0	0/0	0/0	0/0	0/0.5	0	8.5
LF 1	Ligias Fork	1	1	3	0	1/0	0/0	0/0	1/1.5	0	8.5
LF 2	Ligias Fork	1	1	4	1	0/0	0/0	0/0	1/1	0	9.0
LF 3	Ligias Fork	1	1	3	0	0/0	0/0	0/0.5	1/1	0	7.5
LF 4	Ligias Fork	1	1	3	1	1/0	0/0	0/0.5	0.5/1	0	9.0
LF 5	Ligias Fork	1	1	3	1	0/1	0/0.5	0.5/0	0.5/0.5	3	12.0
LF 6	Ligias Fork	1	1	3	0	0/1	0/0	0/0	0.5/0.5	0	7.0

Table 15 *continued* ….

GPS Site ID	Watershed	RGA SCORES 1. Primary Bed Material	2. Bed/bank Protection	3. Degree of Incision	4. Degree of Constriction	5. Bank Erosion	6. Bank Instability	7. Riparian Vegetation	8. Bank Accretion	9. Channel Evolution	TOTAL RGA SCORES
GB 1	Montgomery Fork	1	1	4	0	0/0	0/0	0/0	1/0.5	0	7.5
JC 1	Montgomery Fork	1	1	3	0	0/1	0/0	0/0	0.5/0.5	0	7.0
JC 2	Montgomery Fork	0	1	4	0	0/0	0/0	0.5/0.5	1/1	0	8.0
JC 3	Montgomery Fork	1	1	2	0	0/0	0/0	0/0	1/1	0	6.0
MFCS 1	Montgomery Fork	1	1	4	0	1/1	0/0.5	0/0	1/1	0	10.5
MFCS 2	Montgomery Fork	1	1	1	1	1/1	0/0	0/0	2/0	0	8.0
MFCS 3	Montgomery Fork	1	1	4	0	1/0	0/0	1/0.5	1/1	0	9.5
MFCS 4	Montgomery Fork	1	1	4	0	1/0	0/0	0.5/0.5	2/2	0	10.0
MFCS 5	Montgomery Fork	4	1	2	0	1/0	1/0	0/0	2/0	4	15.0
MFCS 6	Montgomery Fork	2	1	4	0	1/1	0.5/0	0/0	1/1	0	9.5
MFCS 7	Montgomery Fork	1	1	4	2	0/0	0/0	1/0	1.0/0.5	0	10.5
MFCS 8	Montgomery Fork	2	1	3	0	1/1	0/0	0/5/0	0.5/1.5	0	10.5
MFCS 9	Montgomery Fork	1	2	4	0	1/1	0/0	0/0	0.5/0.5	0	10.0
MFCS 10	Montgomery Fork	2	1	4	0	0/0	0/0	0/0	1.5/0.5	0	10.0
MKC 1	Montgomery Fork	1	1	3	0	1/0	0/0	0/0	0.5/1.5	0	8.0
PCC 1	Montgomery Fork	1	1	4	0	1/0	0/0	0.5/0.5	1/1	0	10.0
RC 1	Montgomery Fork	2	1	3	0	0/0	0/0	1/0.5	2/1.5	0	11.0
RC 2	Montgomery Fork	1	1	4	0	0/1	0/0	1/0.5	2/2	0	12.5
RC 3	Montgomery Fork	1	1	4	0	0/0	0/0	0.5/0	2/2	0	10.5
SB 1	Montgomery Fork	0	1	4	2	1/0	0/0	0/0	0.5/0.5	0	9.0
WC 1	Montgomery Fork	0	1	4	0	0/1	0/0	0/0	1/1	0	7.0
SC 1	Smokey Creek	2	1	4	0	1/1	0/0	0/0	0/0	0	9.0
SC 2	Smokey Creek	1	1	3	0	0/1	0/0	0/0	1.5/1.5	0	9.0
SC 3	Smokey Creek	1	1	1	0	0/0	0.5/0	0.5/1	0.5/0.5	0	8.0
SC 4	Smokey Creek	1	1	4	0	0/1	0/1.5	0/0	0.5/0.5	0	9.5
SC 5	Smokey Creek	1	1	3	1	1/1	0.5/0	0/0	0/0.5	0	9.0
SC 6	Smokey Creek	1	1	4	0	2/0	0/0	0/0	1/1	0	10.0
SF 1	Smokey Creek	1	1	4	0	1/0	0.5/0	0/0	0.5/0.5	0	8.5
SHC 1	Smokey Creek	1	1	4	0	1/0	0/0	0/0	0.5/0.5	0	9.0

Table 16. Stream survey data consisting of RGAs, Wolman pebble counts, and particle size distributions for fine bed sediment samples (2007).

SITE NO. (---)	Watershed (---)	CHANNEL RGA SCORE (0 - 36)	PEBBLE COUNT D50 (mm)	PEBBLE COUNT D84 (mm)	FINE SEDIMENT D50 (mm)	FINE SEDIMENT % Wt < # 100 sieve (%)	FINE SEDIMENT % Wt < # 200 sieve (%)	FINE SEDIMENT % Wt < 0.016 mm (%)
GB1	Montgomery	7.5	22.0	45.0	--	--	--	--
JC1	Montgomery	7.0	24.0	50.0	3.75	0.62	0.11	0.08
JC2	Montgomery	8.0	16.0	32.0	1.50	1.59	0.61	0.03
JC2-A	Montgomery	--	--	--	1.60	2.30	0.91	0.13
JC3	Montgomery	6.0	12.0	24.0	0.75	3.07	1.33	0.11
MFCS1	Montgomery	10.5	30.0	88.0	--	--	--	--
MFCS2	Montgomery	8.0	N/A	N/A	--	--	--	--
MFCS3	Montgomery	9.5	56.0	107.0	--	--	--	--
MFCS4	Montgomery	10.0	56.0	116.0	--	--	--	--
MFCS5	Montgomery	15.0	N/A	N/A	--	--	--	--
MFCS6	Montgomery	9.5	N/A	N/A	--	--	--	--
MFCS7	Montgomery	10.5	60.0	132.0	--	--	--	--
MFCS8	Montgomery	10.5	N/A	N/A	--	--	--	--
MFCS9	Montgomery	10.0	105.0	220.0	--	--	--	--
MFCS10	Montgomery	10.0	24.0	49.0	--	--	--	--
MKC1	Montgomery	8.0	38.0	114.0	2.10	2.47	0.87	0.10
PCC1	Montgomery	10.0	34.0	87.0	2.00	6.93	2.90	0.39
RC1	Montgomery	11.0	16.0	38.0	2.75	5.99	1.54	0.23
RC1-A	Montgomery	--	--	--	3.50	0.78	0.20	0.53
RC2	Montgomery	12.5	14.0	34.0	5.70	0.63	0.15	0.14
RC3	Montgomery	10.5	12.0	32.0	3.00	1.50	0.67	0.11
SB1	Montgomery	9.0	25.0	107.0	4.00	2.49	0.58	0.66
WC1	Montgomery	7.0	41.0	104.0	4.00	0.98	0.28	0.06
FB1	Ligias	11.5	48.0	158.0	0.85	5.67	0.88	0.19
GGB1	Ligias	6.0	56.0	232.0	1.75	2.08	0.65	0.20
GGB2	Ligias	8.5	38.0	118.0	3.25	0.29	0.12	0.00
LF1	Ligias	8.5	46.0	88.0	3.00	8.50	2.52	0.20
LF2	Ligias	9.0	44.0	87.0	1.00	0.97	0.19	0.04
LF3	Ligias	7.5	34.0	178.0	2.60	2.40	0.98	0.22
LF4	Ligias	9.0	45.0	110.0	4.00	1.23	0.26	0.16
LF5	Ligias	12.0	49.0	104.0	1.50	2.53	0.93	0.09
LF5-A	Ligias	--	--	--	2.50	1.35	0.23	0.20
LF6	Ligias	7.0	60.0	170.0	2.45	0.20	0.04	0.01
SF1	Smokey	8.5	45.0	104.0	1.10	7.48	2.55	0.27
SHC1	Smokey	9.0	39.0	94.0	3.50	0.69	0.17	0.08
SC1	Smokey	9.0	30.0	58.0	0.21	24.43	7.55	1.09
SC2	Smokey	9.0	40.0	96.0	2.95	2.47	0.57	0.10
SC3	Smokey	8.0	38.0	96.0	2.25	2.43	0.85	0.09
SC4	Smokey	9.5	46.0	102.0	1.75	2.72	1.01	0.10
SC5	Smokey	9.0	34.0	74.0	3.10	1.17	0.35	0.04
SC6	Smokey	10.0	45.0	112.0	1.95	8.47	3.73	0.43
SC6-A	Smokey	--	--	--	3.00	1.12	0.34	0.24
BC1	Bull	17.0	47.0	94.0	0.80	3.93	1.54	0.23
BBC1	Bull	6.0	54.0	106.0	6.85	1.12	0.32	0.51
BBC2	Bull	15.0	26.0	59.0	2.50	1.82	0.62	0.06
BBC3	Bull	9.0	52.0	114.0	2.90	2.34	0.48	0.91

Table 16. *continued….*

SITE NO. (---)	Watershed (---)	CHANNEL RGA SCORE (0 - 36)	PEBBLE COUNT D50 (mm)	PEBBLE COUNT D84 (mm)	FINE SEDIMENT D50 (mm)	FINE SEDIMENT % Wt < # 100 sieve (%)	FINE SEDIMENT % Wt < # 200 sieve (%)	FINE SEDIMENT % Wt < 0.016 mm (%)
LBC1	Bull	6.0	52.0	132.0	0.28	23.23	7.76	0.75
LBC2	Bull	11.5	32.0	81.0	2.85	2.45	0.43	0.14
LBC3	Bull	8.0	30.0	80.0	1.55	3.96	1.08	0.28
LBC4	Bull	7.5	36.0	82.0	1.95	0.70	0.14	0.08
BSC1	Brimstone	8.5	38.0	98.0	2.80	2.40	0.36	0.11
BSC2	Brimstone	5.0	34.0	94.0	2.15	4.73	0.38	0.51
BSC3	Brimstone	7.0	33.0	94.0	3.50	0.98	0.17	0.17
JOE1	Brimstone	5.0	50.0	124.0	2.90	2.90	1.03	0.31
JOE1-A	Brimstone				5.10	1.33	0.34	0.06
IC1	Brimstone	5.5	42.0	88.0	4.25	1.30	0.32	0.07
NPFF1	Frozen Head	6.0	38.0	110.0	3.00	1.21	0.32	0.15
NPFF2	Frozen Head	5.0	44.0	114.0	3.50	2.97	0.67	0.61
NPFF3	Frozen Head	7.0	52.0	128.0	5.10	0.80	0.19	0.07
GCR1	Greasy	8.0	44.0	126.0	2.75	2.13	0.40	0.18
GCR2	Greasy	8.0	30.0	54.0	11.50	2.54	0.42	0.18
GCR3	Greasy	7.0	46.0	90.0	2.80	4.29	0.55	0.21

Note: Site numbers with an "A" represents a second fine bed sediment sample at the primary site with a RGA score. MFCS sites are located at surveyed cross-sectional locations used in the ConCEPTS model, only pebble counts were conducted.

to determine whether there are any correlations between in-stream fine sediment and land use characteristics (Section 4.4). Evaluation of the sediment data for correlations will be done by statistical ordination techniques because of the high variability that occurs with this type of environmental data.

4.4 Subwatershed Sediment Delivery: Relationships between Land Cover\Use, Hillslope Geomorphology, and Stream Stability and Bed Sediment

4.4.1 Statistical Analysis of Land Cover Attributes, RGA/RSA Scores, and Bed Sediment

The following datasets were compiled for statistical ordination analysis: land cover\use characteristics derived from GIS analysis (Section 4.1), valley slope and geomorphic characteristics (Section 4.2); and RGA and bed sediment particle size characteristics (Section 4.3). This analysis constitutes the final effort for *Deliverable 1*. The basic idea was to compile the hillslope and channel geomorphic, stream bed sediment, and other watershed data in order to test whether land use categories selected represented unique land areas with different sediment delivery characteristics. The objective of this effort was to justify the land cover/use categories used for the AnnAGNPS sediment delivery model.

Statistical Ordination Methodologies. Two statistical ordination techniques were used to analyze land use, geomorphic, and bed sediment data; they were a principal components analysis (PCA) and a canonical correspondence analysis (CCA). Ordination analyses were performed with PC-ORD™ version 5.0. A PCA was performed on land use attributes in order to distinguish whether subwatersheds selected for the study were unique and to observe which attributes correlate with subwatershed ordination clusters. A second PCA was performed on geomorphological attributes in order to test whether subwatersheds were unique as distinguished by RGA scores, RSA scores, and selected geomorphic and bed sediment attributes. A CCA was performed on land use and geomorphic attributes in order to uniquely distinguish subwatersheds in ordination space along geomorphic attribute axes. A second CCA was performed on land use and bed sediment attributes in order to uniquely distinguish subwatersheds in ordination space along bed sediment attribute axes. A list of ordination codes for the land cover/use attributes used in the PCA can be found in Table 17.

Principal Components Analysis (PCA): Data from Tables 2 and 3 consisting of percent area of land cover/use types per subwatershed were used to observe similarity/dissimilarity among subwatersheds based on land cover/use characteristics (Figure 18). On Figure 18, reference subwatersheds (Greasy Creek, Brimstone Creek, and Frozen Head) clustered on the right side of the ordination plot. These subwatersheds clustered together primarily due to forest land cover attributes primarily, as observed by eigenvector lines for evergreen and deciduous forests. In addition, ordination position of Frozen Head was influenced by foot traffic dirt roads, indicated by a higher percentage of this land use type than found in other subwatersheds. Bull and Smokey creeks orientated on the upper left side of the plot, in which land use eigenvector lines included logging, and low-intensity dirt roads. Montgomery Fork and Ligias Creek orientated towards the lower left side of the plot, in which land use eigenvectors included high-intensity dirt (haul) roads and middle-intensity developed land. PCA axis 1 and 2 explained 63.0% of the variance in this dataset.

A second PCA ordination was conducted using geomorphological attributes, listed by ordination code in Table 17, and data that can be found in Table 16 (Figure 19). Frozen Head and Ligias Creek orientated along four eigenvector lines (RSA, channel slope, bed sediment pebble count diameter 50% and 84% finer). These two subwatersheds positioned on the lower right side of the plot had steep valley characteristics and higher gradient stream channel compared to the other subwatersheds. Greasy and Brimstone creeks orientated along the eigenvector FineD50 (bed fine sediment sample, median diameter), in which these two reference watersheds had a larger D50 for fine sediment than other subwatersheds. Interestingly, these two subwatersheds were reference study sites. In contrast, Smokey Creek and Montgomery Fork were the two watersheds identified in Figure 18 as heavily impacted by logging, orientated along eigenvectors for excessive fine sediment and unstable channels. Excessive fine sediment is observed by four eigenvectors (bed fine sediment sample, % passing #100 and #200 sieves; and 0.016 mm diam. % finer; and a lateral deposition field score). Unstable channels orientate along the RGA score. Montgomery Fork was influenced by channel width (eigenvector: widthch), but it also orientated to the left side of the plot indicating some degree of influence from excessive fine sediment attributes. Ligias Creek appears to be minimally impacted by fine sediment attributes, and more influenced by valley geomorphic characteristics (RSA). PCA axes 1 and 2 explain 65.2% of the variance in this dataset.

Table 17. Ordination codes used in the PCA and CCA statistical analyses.

Analysis Category	Ordination Code	Attribute Description
Land Cover / Use Attributes	Log100	100% Logged
	Log75	75% Logged
	Log50	50% Logged
	Log25	25% Logged
	AMLs	Abandoned Surface Mining
	ActivSM	Active Surface Mining
	DirtRd-F	Dirt Roads – Foot Traffic
	DirtRd-L	Dirt Roads – Low Traffic
	DirtRd-H	Dirt Roads – High Traffic (including haul roads)
	Dev-OS	Developed, Open Space
	Dev-LI	Developed, Low Intensity
	Dev-MI	Developed, Medium Intensity
	Barren	Barren Land (rock/sand/clay)
	ForestDe	Deciduous Forest
	ForestEv	Evergreen Forest
	ForestMx	Mixed Forest
	ShrubS	Shrub/Scrub
	Grassld	Grassland/Herbaceous
	Pasture	Pasture/Hay
	Wwetlnds	Woody Wetlands
Geomorphological / Bed Sediment Attribute	RGA	Rapid geomorphology assessment, field scores
	RSA	Rapid slope assessment, field scores
	slopech	Average channel slope, measured in field
	widthch	Average channel width, measured in field
	PebD50	Bed sediment pebble count; median diam. (50% finer)
	PebD84	Bed sediment pebble count; diameter 84% finer
	latdep	Lateral deposition of fine sediment, field scores in Appendix C.
	Fine200	Bed fine sediment sample, % passing #200 sieve
	Fine100	Bed fine sediment sample, % passing #100 sieve
	FineHyd	Bed fine sediment sample, 0.016 mm diam. % finer

Canonical Correspondence Analysis (CCA): Subwatersheds were orientated in ordination space based on data for percent area of land cover/use types per subwatershed (Tables 2 and 3) along geomorphological eigenvectors (data from Table 16) in order to test the utility of RGA scores, RSA scores, and other geomorphic attributes distinguishing unique subwatersheds (Figure 20). The basic aim of this analysis was two-fold, one was to observe whether the rapid geomorphic assessments (RSA and RGA) would be useful in the Appalachian region to identify stable and unstable streams, and two to observe whether the land cover/use scheme selected for the model distinguished unique fine sediment conditions in the stream. On Figure 20, Frozen Head orientates strongly with the channel slope (slopech) and dirt road foot paths. Uniquely, the reference subwatersheds positioned on the right side of the plot, and the impacted subwatersheds on the left side. RGA scores appear to distinguish channel stability along an axis from Bull Creek (less stable) to Greasy Creek (more stable). Interestingly, logging, dirt road heavy traffic (haul roads) and active surface mining were positioned along this axis in the less stable area on Figure 20, in which Bull and Montgomery creeks were found in this ordination space. It appears that the RGA has some utility to distinguish the impacts of logging primarily on channel stability. However, the RSA score did not appear as a geomorphic attribute that influenced positioning of subwatersheds in ordination space. The RSA eigenvector did not project on axes 1 and 2 in Figure 20, only the RGA and 'slopech' eigenvectors projected.

A second CCA was performed in which subwatersheds were orientated based on data for percent area of land cover/use types per subwatershed (Tables 2 and 3) along fine bed sediment eigenvectors (data from Table 16) in order to test the utility of the fine bed sediment collection technique to distinguish disturbed subwatersheds from logging, mining or other land use

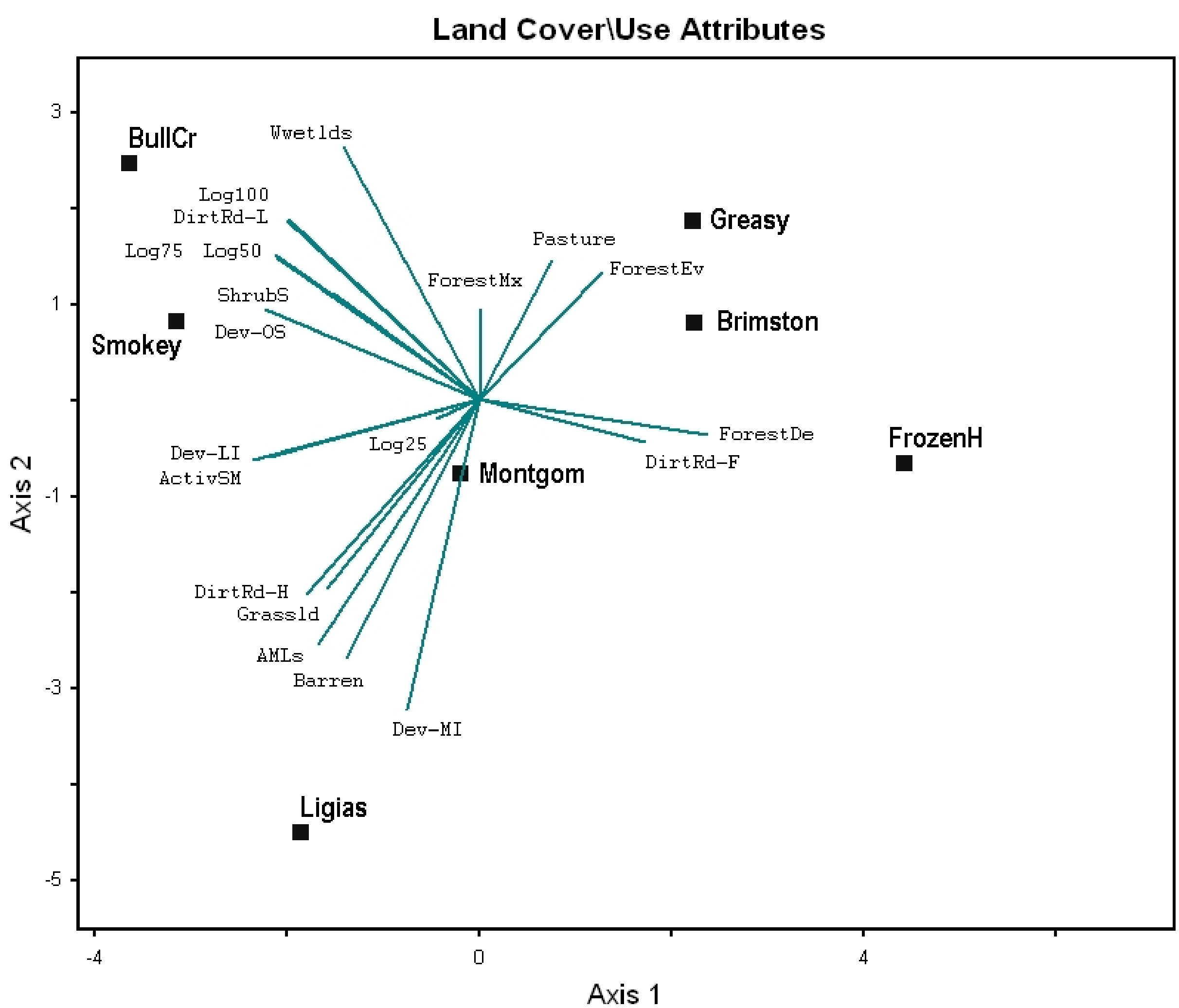


Figure 18. PCA ordination of land cover/use attributes per subwatershed.

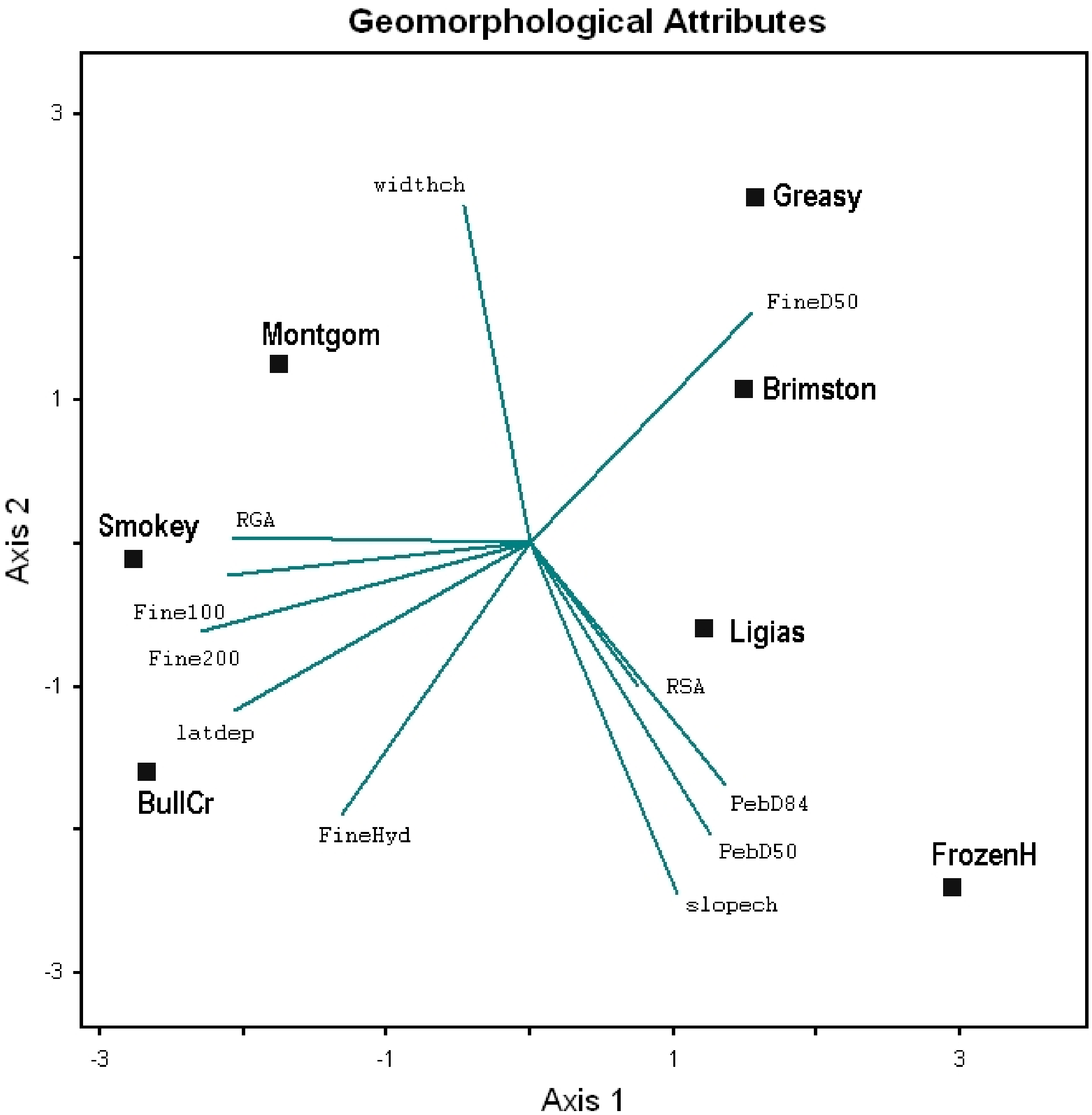


Figure 19. PCA ordination of geomorphological/bed sediment attributes per subwatershed.

activities (Figure 21). On Figure 21, reference subwatersheds orientated on the right side of the plot and strongly influenced by the larger median diameter fine sediment (eigenvector: FineD50). Disturbed subwatersheds orientated on the left side of the plot and strongly influenced by fine sediment attributes, greater amount of fine sediments that passed through #100 and #200 sieves (eigenvectors: Fine100 and Fine 200), and a fine sediment lateral deposition field score (eigenvector: latdep). It appears that the fine bed sediment collection technique has some utility to distinguish the impacts of logging, mining, and haul roads on the levels of fine sediments that reach the stream.

Pearson's Correlation Analysis: A Pearson's correlation analysis was conducted on data for percent area of disturbed land uses (AMLs, AcSM, Log100, Log75, Log50, Log25, DirtRd) and geomorphological/bed sediment attributes (RSA, RGA, PebD84, PebD50, FineD50, Fine 100, Fine200, FineHyd). A summary of the statistical significant correlations between land use and bed sediment are summarized in Table 18. RGA and RSA scores did not produce significant correlations of any consequence. Of the bed sediment attributes, median diameter from pebble counts were inversely correlated with 50% and 25% logged areas, and % area of dirt roads (Table 18). Thus, the greater area of this disturbed land uses, the finer (smaller) the median diameter of the bed sediment, as measured from pebble counts. This could possibly be an indication of sedimentation.

Fine sediments were significantly correlated with 100% and 75% logged areas, but not 50% and 25% logged areas (Table 18). Fine sediments were collected in lateral bed deposition areas, and characterized by size classes as follow: % passing through #100 and #200 sieves, and %

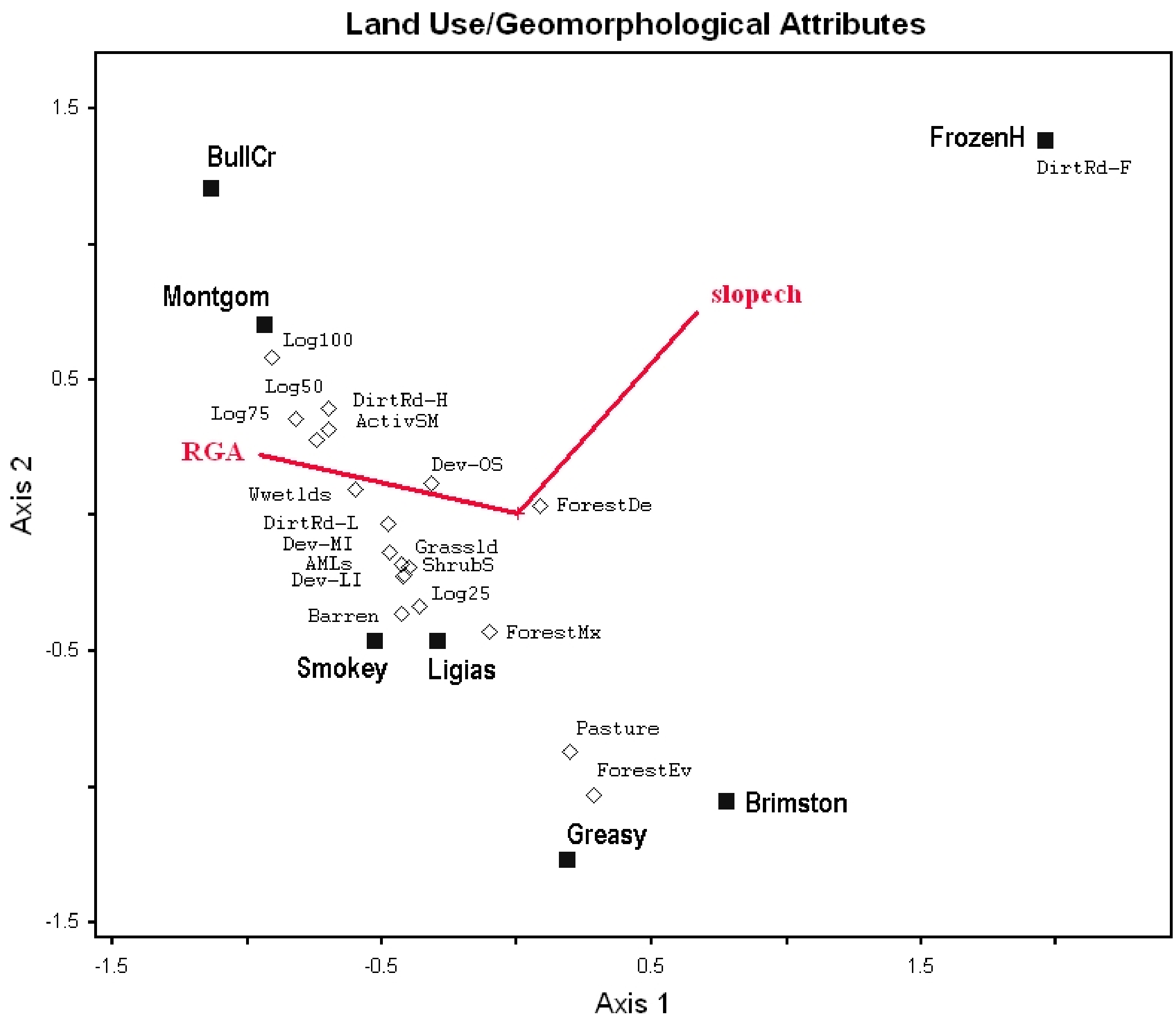


Figure 20. CCA ordination of land cover/use attributes and geomorphological attributes per subwatershed.

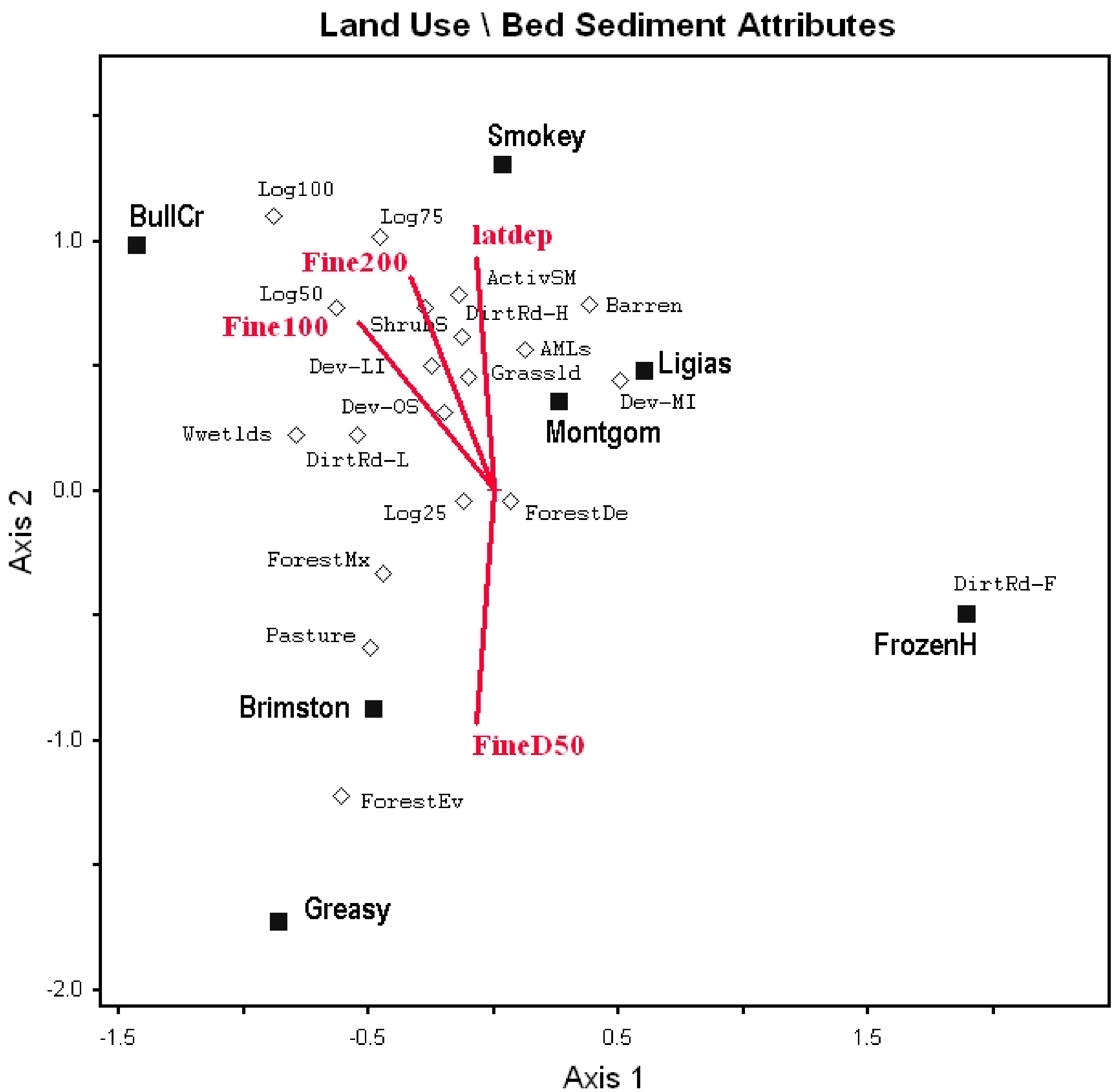


Figure 21. CCA ordination of land cover/use attributes and fine bed sediment attributes per subwatershed.

finer than 0.016 mm. It was only the severely logged sites (100% - 75% cleared of trees) that appeared to contribute to fine sediments to stream beds. Fine sediments were not correlated with % areas of abandoned mine lands, current disturbed mine lands ("active"), and dirt roads.

4.4.2 Evaluation of Data: Land Cover/Uses for AnnAGNPS Model

The land cover/uses as listed in Tables 2 and 3 selected for the statistical analysis found that logging, active and abandoned mine lands, and dirt roads to uniquely correlate with fine sediment characteristics found in the stream (Figures 20 and 21, Table 17). These land use disturbances must be included in the AnnAGNPS model because they were found to potentially

Table 18. Summary of significant relationships among disturbed land use percent areas per subwatershed and bed sediment measurements using a Pearson's correlation analysis.

Correlated Variables	Pearson's r	Significance Level
PebD50 – Log50	-0.318	0.022 **
PebD50 – Log25	-0.440	0.002 *
PebD50 – DirtRd	-0.266	0.047 *
Fine100 – Log100	0.651	< 0.001 **
Fine100 – Log75	0.659	< 0.001**
Fine100 – Log50	0.107	0.252
Fine100 – Log25	-0.036	0.412
Fine200 – Log100	0.607	< 0.001 **
Fine200 – Log75	0.619	< 0.001 **
Fine200 – Log50	0.099	0.269
Fine200 – Log25	-0.055	0.367
FineHyd – Log100	0.537	< 0.001 **
FineHyd – Log75	0.533	< 0.001 **
FineHyd – Log50	0.090	0.288
FineHyd – Log25	-0.125	0.219

relate to stream sedimentation with fines. The key land cover types include forest cover, areas which lands are not eroded where fine sediments are transported to the stream.

The RSA (rapid slope assessment), a product for *Deliverable 1*, was not intended to be a tool for the CHIA, rather a method/protocol for identification of land use classifications that appear to be unique in generating different amounts of sediment yield. It appears from this study's statistical analysis other parameters provide better information (i.e., fine bed sediment measurements) to differentiate stream bed sediment characteristics and sediment yields from watersheds with different land uses. The RSA provided minimal information to select the land use/cover types to be incorporated in the AnnAGNPS model.

Overall, the land use cover/types identified in this study provides the key information needed to develop the land use layer for the AnnAGNPS model. AnnAGNPS model contains a single land use layer, defined by a GIS shape file, in which land cover data was used for its initial development (Section 4.5.1).

4.4.3 Utility of the RGA as a CHIA Tool

Deliverable 2 constitutes an evaluation of the RGA field method to support the CHIA process. RGA scores for individual study sites ranged from 5 to 17 (Table 15). Stream channels with RGA scores below 20 are generally considered stable (according to USDA National Sedimentation Laboratory criteria; Andrew Simon, *pers comm*.). Stream channels with RGA scores below 12 are considered very stable. Only two sites from Montgomery Fork and Bull Creek were RGA scores above 12. Interestingly, Figure 20 showed Montgomery Fork and Bull Creek orientated along a stable-unstable axis by the RGA eigenvector, in which also corrected in ordination space with %logged in subwatersheds. Results from this statistical ordination provide evidence that the RGA could be useful to distinguish unstable channels impacted by watershed disturbances due to land use activities, i.e., logging and other. RGA scores in the reference subwatersheds ranged from 6.0 to 7.7, and disturbed subwatersheds ranged from 8.8 to 10.0. It appears among this limited set of study sites that RGA scores < 8 indicate stable channels, and RGA scores > 8 indicate generally stable channels but possibly impacted by land use disturbances.

In general, the study sites used in this analysis were located in headwater streams where geology appears to be a major factor that controls channel stability. In these headwater streams, channel boundaries (i.e., bedrock, large boulders and cobble) are essentially immobile from hydraulic forces. Therefore, channels do not adjust from land use modifications on the landscape in headwater areas. The RGA may have limited utility as a geomorphic assessment tool in headwater streams. However, not tested in this study, RGA scores would be useful in large streams and river channels, accompanying larger drainage areas with floodplains and alluvium deposits. Several sites not surveyed have been field observed with channel instabilities, including lower reaches in Ligias and Smokey creeks.

Because of the national use of the RGA by the USDA NSL, the RGA is a valuable tool for the CHIA process. Using the NSL criteria, channels with scores over 20 are considered unstable, and scores under 20 are considered stable. The RGA provides a means to assess watersheds with active coal mining to document whether channel instabilities occur near the mine sites. Our professional judgment from the use and evaluation of the RGA found the RGA to be applicable in the Appalachian region. Even though RGA sites in this study were located in stable headwater channels, experience in other rivers and streams in East Tennessee have found the RGA useful in quantifying levels of channel stability (Williams 2005).

In summary, RGA scores in a CHIA watershed guides the approach for sediment modeling. If channels are relatively stable (RGA scores < 20) then it can be assumed that sediment sources are from upland sources only and AnnAGNPS can be used to compute watershed sediment yields. If channels are found to be unstable (RGA scores > 20) then sediment sources from bank erosion could possibility be significant. In these cases, the ConCEPTS model should be applied in unstable areas coupled with watershed use of AnnAGNPS. AnnAGNPS automatically creates an output file for hydrology and uplands sediment that ConCEPTS uses to route water and sediment through stream models (see Section 4.5).

Reference

Williams, K.H. 2005. Linking channel stability and bed sediment characteristics to biological integrity in Tennessee Ridge and Valley streams. MS Thesis; University of Tennessee – Knoxville.

4.5 AnnAGNPS-CONCEPTS Modeling

4.5.1 Description of the AnnAGNPS Model

Introduction: Predicting the long-term process of erosion, sediment yield, and various chemical pollutant movements within a watershed can be an important management tool for large agencies including city municipalities, county officials, state regulators, and various government organizations. Several attempts have been made for decades to create simulation packages to accurately mimic the occurrence and severity of erosion and sediment yield for different areas with different topography, soil, land use management, and hydrological patterns. Several watershed models have been developed recently with the capabilities of powerful computing systems that allow several multifaceted calculations to be solved within a few seconds (e.g., SWAT).

AGNPS General Model Description: There are several computer models available to simulate erosion and sediment transport scenarios through the application of different input parameters occurring within a watershed (Merritt *et al*., 2003). The Agricultural Non-Point Source (AGNPS) pollutant loading watershed simulation model is a powerful tool created to evaluate and manage the severity of surface erosion, nutrient and pesticide transport, and related stream channel reactions caused by the degree of different storm events to the local geography, soil types, hydrology, and land use applications found within the watershed.

The AGNPS pollutant loading watershed model was created through the U.S. Department of Agriculture (USDA), Agriculture Research Service (USDA-ARS) with the assistance of the Minnesota Pollution Control Agency (MPCA) and the Soil Conservation Service (USDA-SCS) in order to collectively attain data and personnel needed to develop and facilitate the program and to successfully create a management tool for watersheds with a greater part of agriculture activities (Young *et al.*, 1989).

Most professionals within the study of hydrology and sediment transport recognize the ability (or inability) to accurately estimate and predict the long-term effects of erosion with many variables that are hard to capture all in one setting. Luckily with the advent of modern technology and Geographical Information Systems (GIS), the process of modeling erosion is beginning to actually be a more realistic achievement. With the continuous growth of technological abilities within the last decade, the AGNPS modeling program has continuously been upgraded and made more powerful. The most up-to-date version of the software AGNPS 4.0 was released June of 2007 and can be downloaded free from the National Sedimentation Laboratories (USDA-ARS-NSL) website. The most recent version of AGNPS has the capabilities to simulate the movement of non-point source pollution (water, sediment, nutrients, and pesticides) and chemical point source pollutants throughout the watershed through different hydraulic scenarios. By using a GIS interface for the program, the watershed is broken into cells based on the Digital Elevation Models (DEMs), land use, and the soil type. Each cell will contain a constant slope, length, elevation, land use cover, management practice, and soil type value. These cells are linked together (called reaches) and then used to simulate the movement of runoff after precipitation events, which carry the non-point source pollution the user is attempting to study. The cells and their corresponding reaches can simulate the movement of water, sediment (by particle size and source), and various chemicals. Currently, the types of chemicals that AGNPS can simulate are nitrogen, phosphorus, organic carbon, and pesticides for agricultural activities.

The Annualized Agricultural Non-Point Source (AnnAGNPS) pollutant loading model is an extension of the AGNPS program and was developed and maintained by the same personnel as the AGNPS model at the National Sedimentation Laboratory in Oxford, MS. The use of the AnnAGNPS model within the AGNPS modeling system, a complete, continuous long-term simulated analysis of a watershed can be used for best management practices to conserve natural environmental resources impacted by human induced land use disturbances.

AnnAGNPS General Model Description: The AnnAGNPS modeling system is an extremely valuable tool for engineering and management practices involving erosion, sediment transport, runoff, and movement of pollutant loadings continuously in a watershed (Borah *et al*., 2006). The AnnAGNPS program has been developed by the United States Department of Agriculture – Agriculture Research Service (USDA-ARS) and the Natural Resources Conservation Service (USDA-NRCS) (Simon *et al*., 2002). Like the AGNPS model, the AnnAGNPS model is written in the ANSI Standard FORTRAN 90 language and was originally developed for management scenarios in agricultural settings to control sediment, nutrient, and pesticide transport to nearby streams. In contrast to the AGNPS program, the AnnAGNPS system is used for long term analysis of pollutant transport, where AGNPS is made for a single event simulation (USDA, 2000). Since the AnnAGNPS pollutant loading model's creation as an extension of the AGNPS model, the AnnAGNPS program has found more popularity among engineers and managers in addition to replacing the basic abilities of the earlier AGNPS modeling package. Note that the AnnAGNPS system can only be ran through the AGNPS program but the AGNPS system does not need the AnnAGNPS system to simulate a single event simulation. The AGNPS modeling software is still currently used by itself for certain scenarios and is continuously updated as is the AnnAGNPS program through the USDA-ARS-NSL, but is not of interest in this document since its abilities alone have been replaced largely by a more valuable model for the implementation and design of best management practices. Even though the AnnAGNPS software was developed for analysis of management scenarios in response to pollutant loads in an agricultural watershed, it is beginning to be implemented into other professional practices like environmental engineers and hydrologists to analyze different disturbances within the watershed and their impact on the streams and biota.

Watershed Characterization. To begin using the AnnAGNPS modeling system, a GIS interface (ESRI ArcView 3.X) must have Digital Elevation Models (DEM), USDA soil layers, and land use (field management) data layers to characterize the watershed of interest. After all the required GIS layers have been collected, they will need to be imported into the modified ArcView GIS program called the AnnAGNPS-ArcView Interface. The AnnAGNPS-ArcView Interface combines several GIS programs into one so that the manipulation of different watershed characteristics can be computed in one single program. The AnnAGNPS-ArcView Interface contains two combined programs to represent the Flow Net Generator, the USDA-ARS TOPAZ Version 3.1 (an automated digital landscape analysis tool which contains three programs under it DEDNM, RASPRO, RASFOR) and AGFLOW to help create grids of the watershed that contain cells with homogeneous characteristics (USDA 2003). The AnnAGNPS program also contains a Windows-based Input Editor to help define all the parameters within the watershed's hydrological calculations. One of the critical sources of information required to properly define reasonable flow cells is a high resolution DEM that covers the entire watershed to be simulated. The DEM layer in the AnnAGNPS-ArcView Interface is used to generate individual cells through the Flow Net Generator that have a uniform slope, length, elevation, and shape. The Flow Net Generator also uses the DEM layer to define all the streams that eventually flow to the outlet of the watershed. Several other GIS layers are required in the AnnAGNPS program to define the land use cover, practices, soil types.

The AnnAGNPS program creates a grid within the watershed that has individual flow cells that contain a homogenous soil type, land use cover, management practice, and topographical (slope, length, and elevation) characteristics to calculate erosion within the watershed. For ease of the program's computations, the most dominant soil type and land use is assigned to each cell polygon that surrounds that area and is used for the process of determining the amount of erosion, sediment yield, runoff, and pollutants transported for a daily storm event in the watershed. In other words, several cells that are connected together in a watershed will only take a single land use, soil type, slope, length, elevation, and management practice that is representative of the area in the watershed it is located. Current soil information used in the AnnAGNPS program can largely be obtained through the USDA-NRCS or be created by the user. The USDA-NRCS contains many files and GIS information around the United States (U.S.) that make the AnnAGNPS program easier to develop for a specific project. The land use cover information in the U.S. is found from the USGS Seamless Data Distribution System but the input parameters to define the land use cover used may have to be specifically modified by the user to characterize a watershed's activities.

The AnnAGNPS pollutant loading model determines the size of each cell by its Critical Source Area (CSA) and Minimum Source Channel Length (MSCL) (Shrestha *et al*., 2005). With the CSA and the MSCL, the user has the option of defining the size of the cell grid to better define a watershed that may have a large variety of different soils, land use, and topography information. The MSCL represents the minimum reach length in meters that connects a set of cells with the same runoff route (usually a stream or tributary with the watershed). The CSA is the minimum area of cells that are created around a reach in hectares. It is recommended that the MSCL value is no smaller than the DEM resolution and that the CSA is no less than the DEM resolution squared.

Hillslope Erosion & Sediment Yield. To estimate the erosion, sediment yield, and runoff, the AnnAGNPS program uses the Revised Universal Soil Loss Equation (RUSLE) Version 1.05, the Hydro-geomorphic Universal Soil Loss Equation (HUSLE), and the USDA-NRCS TR-55 methods used for calculating peak flow, Soil Conservation Service Runoff Curve Numbers (SCS-RCN), and the Time of Concentration (Tc) (Shrestha *et al*., 2005). The AnnAGNPS program uses RUSLE to take land cover, soil, management practices, topography, and precipitation values for each cell and then calculate the daily sheet and rill erosion. RUSLE, like the AnnAGNPS system is used to represent the process of hillside erosion over a long length of time. After the process of rill and inter-rill erosion have been estimated for each cell, HUSLE is used to calculate the sediment yield from each cell to a stream reach after deposition from runoff. Because RUSLE does not assumes any deposition from sheet and rill erosion, the AnnAGNPS pollutant loading model uses HUSLE to create a delivery ratio to determine the amount of deposition occurring from the erosion and sediment yield for five separate soil particles sizes (clay, silt, sand, small and large aggregates) based on each particle's mass fall velocity (Bingner and Theurer, 2003).

Watershed Runoff Simulation. When a storm event is simulated in the AnnAGNPS software, several sets of hydrological calculations are used to create a realistic and accurate hydrological environment. Before runoff, erosion, and sediment yield occur, the AnnAGNPS program accounts for the evapotranspiration from the simulated rainfall as a function of potential evapotranspiration (Penman Equation), and the soil's moisture and the percolation of the soil is computed with the Brooks-Corey equation (USDA, 2000). After evapotranspiration and the soils moisture have been accounted for, three items, SCS-RCN, Tc, and the Storm Distribution Type, are collected from the NRCS Technical Release 55 (TR-55), Urban Hydrology Manual in order to calculate how the watershed reacts to daily hydrological events. (Bingner & Theurer, 2003).

As the AnnAGNPS program simulates daily precipitation events, the 24-hour rainfall is matched to a storm distribution curve from TR-55 that defines the energy of the occurrence uniformly for all cells created in the watershed. Daily runoff amounts, caused from the daily storm events, from each cell in the watershed, are estimated using the SCS Runoff Curve Number (SCS-RCN) technique coupled with soil, land cover, and land management information for each cell by the AnnANGPS model. The AnnAGNPS program takes the SCS-RCN that is entered by the user and uses the related soil retention value and soil moisture adjustment for each RCN and creates algorithms to calculate the runoff generated for the cells within the watershed (Shrestha, *et al*., 2005). Next, the peak flow of runoff within each cell reach is broken up into three categories (overland, concentrated, and channel flow) to better estimate the Tc through the AgFLOW and TOPOAGNPS programs within the AnnAGNPS model through the NRCS TR-55 graphical peak discharge method, which is slightly modified (sometimes called the Extended TR-55 method) by Theurer and Crohshey (1998). AnnAGNPS does have a pond function, in which flows can be routed and detention accounted for during the model simulation.

Hydrological Processes. The most important variable for an accurate representation of a hydrological model is the climate. The climate information can be imported into the AnnAGNPS Input Editor if the user has enough detailed information on the historical weather for his/her project. The required climate variables needed in the AnnAGNPS model are all daily values including maximum temperature, minimum temperature, precipitation, average dew point, sky cover, and wind speed. A majority of the time, most areas of study may not have enough climate data or any historical weather information in close proximity. When the AnnAGNPS model is downloaded free from the USDA-ARS-NSL website, the download also contains the Generation of weather Elements for Multiple applications (GEM) computer model which is developed to help define all the climate data for any location. The GEM program was developed by scientists from the USDA-NRCS, USDA-ARS, and various universities. Currently, the GEM system is programmed and maintained by a specific staff of USDA scientists at the National Water and Climate Center in Portland, Oregon. The GEM is a stochastic weather simulator that produces the entire required climate data needed in the AnnAGNPS modeling software and is generated through statistically represented time series of daily weather values based on the location of the site. Johnson (1996, 2000) declares that GEM has shown to simulate very similar weather conditions for various locations when compared to the true climate data collected at a specific site.

Overall Processes. When the AnnAGNPS program has been set up correctly, the majority of the GIS data layers can be viewed within the system's Input Editor. The Input Editor contains a spreadsheet of all the data collected from various the GIS layers used, individual cell characteristics, reach information important to the cell flow paths, daily climate information, and management practice (USDA, 2000). Depending on the user's extent of simulation, various parameters must be imported into the Input Editor. For a basic simulation of runoff, erosion, and sediment yield within a watershed, the Input Editor will automatically sort all the information within each cell and reach, but data pertaining to the soil, climate, field management, and SCS-RCN for each land use must be entered into the Input Editor before the AnnAGNPS program can fully complete the simulation. Note that if a user wants to simulate a mixture of different pollutants, land use disturbances, and management practices within the watershed, the Input Editor provides the opportunity to evaluate a very complicated scenario if necessary.

After all critical information for each individual cell within the watershed has been processed through the AnnAGNPS model and the corresponding Input Editor, the runoff, erosion, sediment yield, and other chemical pollutants attributable to each cell and reach are calculated with daily climate data, over a continuously long term time period. The overall simulation within the watershed is for all the cells, linked together, to establish a cumulative runoff value containing the hillslope sediment yield and any nutrients, as a result of a storm event on the landscape, down into the streams, which travels to the outlet of the watershed. The ability to estimate suspended sediment (i.e., clays, silts, and sands) transported throughout a watershed is a feature that AnnAGNPS can accurately predict for all cell areas (Merritt et al., 2003).

AnnAGNPS & CONCEPTS. Another unique characteristic of the AnnAGNPS pollutant loading model is its compatibility with the Conservational Channel Evolution and Pollutant Transport System (ConCEPTS) (Langendoen, 2000), which individually models the long term analysis of erosion and sediment transport processes between land and water. ConCEPTS models streams within the watershed and their geomorphologic process as a result of runoff and sediment yield into the channels (Merritt *et al.*, 2003). The ConCEPTS program was also developed and is continuously updated at the National Sedimentation Laboratory in Oxford, MS, but it is represented by a different set of scientists from that of the AGNPS or AnnAGNPS model. With the AnnAGNPS and ConCEPTS programs combined together, a complete, continuous simulated analysis of a watershed can be studied for best management practices. When compared to other computer models that simulate the erosion and sediment yield of land surfaces and streams, an advantage of the AnnAGNPS pollutant loading model, a hillslope erosion model, is its ease of compatibility with a powerful channel sediment transport model (the ConCEPTS model) that together can represent the entire hydrological system of a watershed.

Model Summary. Aside from the standard sediment yield that is calculated in the AnnAGNPS model for each cell, there are additional features included within the program to simulate concentrated sources of impact. The extra features found in the AnnAGNPS pollutant loading model: feedlot simulation for nutrients, gullies for sediment, point sources for nutrients, impoundments for sediment, and irrigation practices can all be applied to the cells in the watershed of interest in order to obtain a more accurate representation of the area's hydrology and pollutants transported (USDA, 2000).

In summary, the AnnAGNPS model is a very powerful tool that is highly data intensive for the accurate representation of soil loss and pollutant transport. The model is a valuable tool for best management practices concerned with environmental and agricultural activities. The processes of hydrology, sediment, nutrient, and pesticide transport are very complex and even more complicated to replicate through calculations. The AnnAGNPS model does not precisely model the exact hydrological and geomorphologic actions in every unique watershed for a single management or land use activity, but it can help determine what sediment, nutrient, and pesticide pollution increase or decrease would occur within the watershed for different disturbances. For example, the use of the AnnAGNPS pollutant loading model has been used in several best management scenarios reminiscent of agricultural usage of the land (Ming-Shu and Xiao-Yong, 2004), stormwater management (Zhen *et al*., 2004), soil and water conservation (Shrestha, *et al*., 2005), and the application of the AnnAGNPS with ConCEPTS models (Simon *et al*., 2002).

It is hard to determine what impacts, to the local streams, increased forms of urbanization, agriculture, surface mining, or logging may bring to a watershed. With the use of the

AnnAGNPS pollutant loading model, the user now has a valuable approach to determine consistent estimates to evaluate the health of a watershed as well as the nearby streams, aquatic life, and residents' quality of life in the specific region. The AnnAGNPS model, like most computer programs that deal with empirical data, is only as good as the input parameters that its calculations are based upon. With the present technological advancements made over the last decade, many types of large scale computations that dealt with several complexities in erosion and sediment yield within a large area were regarded as impractical. Lately, several databases and computing systems have improved these watershed modeling systems and, like the AnnAGNPS system, have become easier to use with technological advancements. The AnnAGNPS model can still be a difficult system with the complexity of input parameters to characterize the watershed, but much advancement have been made and many will come, which will allow the impossibilities and inaccuracies of watershed modeling to become a more reliable source of information.

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4.5.2 Description of CONCEPTS Model

"The Conservational Channel Evolution and Pollutant Transport System (ConCEPTS) is a computer model that simulates open-channel hydraulics, sediment transport, and channel morphology." This software was created at the National Sedimentation Laboratory (NSL) through the United States Department of Agriculture – Agriculture Research Service (USDA-ARS) (Langendoen, 2000). The ConCEPTS model is a one-dimensional hydraulic model capable of computing unsteady flow hydraulics and sediment transport capacity. ConCEPTS is composed of three physical-process components: hydrodynamics for unsteady flow hydraulics, mobile bed dynamics for sediment transport and bed adjustment, and bank erosion and channel widening from fluvial and geotechnical processes (Langendoen, 2000). The ConCEPTS modeling system has been designed to accompany the AnnAGNPS sediment delivery modeling system in absorbing the hydraulic contents collected from the cells in a watershed and representing the channel's response to the collected runoff, sediment, and increased flows during a storm event. The ConCEPTS model then predicts certain parameters that deal with channel morphology and open channel hydraulics, which include bank erosion, failures, mass wasting, and bed aggradations and degradations (Simon *et al.*, 2002).

After AnnAGNPS cells have cumulatively determined the amount of stormwater and sediment runoff characteristics that enters the main stream channel through upstream reaches, the AnnAGNPS creates a set of output files that are loaded into ConCEPTS that contains the flow, peak discharge, time of concentration, and the sediment by particle sizes of clay, silt, and sand into the main stream. ConCEPTS computes open channel hydraulics through iterations of the dynamic or diffusion wave model, dependent on rapidly or gradually varied flow. These equations consist of a continuity equation representing mass conservation of water and a momentum equation representing the conservation of fluid momentum. The model uses the generalized Preissman method of discretization, a forward time finite difference numerical method, to solve for the dynamic and diffusion wave hydrodynamic models. The Saint Venant equations (also referred to as the dynamic wave model) are the open-channel hydraulic-governing equations used in ConCEPTS. When the Saint Venant Equations that represent the mass conservation of water and conservation of fluid momentum are simplified, they produce the diffusion wave model. ConCEPTS switches between these two sets of equations with the use of the generalized Preissman scheme for governance in order to produce accurate and real hydraulic solutions for different stream parameters. Without the combination of two different versions of the Saint Venant Equations, CONCEPTS could calculate invalid results with certain situations (Langendoen, 2000).

Sediment transport is directly related to flow hydraulics, bed-material composition, and upstream sediment contribution (Langendoen, 2000). Through iterations of the mass conservation equations, the model is capable of predicting sediment transportation capacity and bed adjustment through scour and aggradations of sediment. A modification of the sediment transport capacity predictor SEDTRA is used to calculate the total sediment transport by size fraction for 17 predefined size classes with a suitable transport equation for each size fraction (Table 19).

Langendoen (2000) states that to model sediment transport in a stream, the cross-section of the water's depth is divided into two layers in order to simulate the movement of suspended bed sediment (wash load) and the particles that travel near the bed surface (bed load). In order to efficiently determine the sediment transport within the streams, ConCEPTS combines the bed and wash load into a total load approach. The calculation of sediment transport analysis begins with the Mass Conservation of Sediment by Size Fraction with the entrainment and deposition rates computed based on cohesive or cohesionless homogeneous bed material for streams in disequilibrium. The sediment transport load under equilibrium is calculated with a modified sediment transport capacity predictor (SEDTRA) created by Garbrecht *et a.l* (1996) that contains a mixture of transport equations for 13 different sediment size fractions. With the program constantly calculating non-cohesive and cohesive streambed sediment concentrations, ConCEPTS also uses another series of complicated hydraulic equations that also simulates variations in streambed elevation over time and the sediment concentrations for the streambed surface and subsurface layers.

Table 19. Sediment size classes used in CONCEPTS.

Size Class	Lower Bound (mm)	Upper Bound (mm)	Description	Transport Equation
1	0	0.002	Total Clay	Washload
2	0.002	0.004	Very Fine Silt	Washload
3	0.004	0.008	Fine Silt	Washload
4	0.008	0.016	Medium Silt	Laursen
5	0.016	0.031	Coarse Silt	Laursen
6	0.031	0.063	Very Coarse Silt	Laursen
7	0.063	0.125	Very Fine Sand	Laursen
8	0.125	0.25	Fine Sand	Laursen
9	0.25	0.5	Medium Sand	Yang
10	0.5	1	Coarse Sand	Yang
11	1	2	Very Coarse Sand	Yang
12	2	4	Very Fine Gravel	Meyer-Peter and Mueller
13	4	8	Fine Gravel	Meyer-Peter and Mueller
14	8	16	Medium Gravel	Meyer-Peter and Mueller
15	16	32	Coarse Gravel	Meyer-Peter and Mueller
16	32	64	Very Coarse Gravel	Meyer-Peter and Mueller
17	64	128	Small Cobbles	Meyer-Peter and Mueller

Within the ConCEPTS manual, Langendoen (2000) notes that after the sediment transport and streambed's surface adjustments have been calculated, ConCEPTS simulates the bank erosions and the corresponding change in the simulated channel's width due to fluvial erosion and mass bank failure. The fluvial erosion of stream banks is calculated using an excess shear stress approach for cohesive soils, which is based on the shear stress of the stream flow and the shear strength of the bank's soil. A submerged jet test device, developed by Hanson (1990), is a method used to help estimate the detachment rate for the calculation of fluvial erosions within ConCEPTS.

When fluvial erosion heightens and erodes the toe of the channel banks, mass wasting can occur due to the gravitational forces in nature creating enough shear stress to cause banks to fail. Langendoen (2000) states that the two types of bank failures simulated within ConCEPTS is Planar Failure and Cantilever Failure for homogeneous cohesive bank materials, which are the most frequent mass wasting events observed in the Mid-South and Mid-Western U.S. regions.

Channel width adjustments are modeled by incorporating the physical processes for bank retreat through fluvial erosion and mass bank failure (Langendoen, 2000). The model accounts for cohesionless and cohesive bank material, and uses a multi-layer modeling approach to account for vertical differences in soil properties. Lateral bank erosion by fluvial process is based on the relationship of soil density and critical shear stress for soil entrainment. The rate of soil erosion is assumed to be approximately linear with increases in boundary shear stress. Fluvial erosion at the bank toe eventually causes bank instability resulting in mass wasting of the bank material. Bank instability depends on the balance between gravitational forces against the soil mass in a downwards direction and the forces of friction and cohesion that resist mass movement. Vegetation on the bank affects the rate of width adjustment and mass failures, where its influence can be both stabilizing or destabilizing. Bank stability analysis is accomplished by limit equilibrium methods, based on static equilibrium of forces and or moments of a failure block. The forces acting on a failure block include (Figure 22):

1. the weight of the failure block, Ws
2. the weight of surface water on the failure block, Ww
3. the hydrostatic force exerted by the surface water on the vertical slip face, Fw
4. the hydrostatic for exerted by water in the tension crack, Ft
5. the seepage force, Fs
6. the shear force at the base of the failure block, S
7. the total normal force at the base of the failure block, N

To understand bank failure, Langendoen (2000) thoroughly speaks about the two types of bank failure simulated in ConCEPTS, Planer Failure and Cantilever Failure. The Planar Failure simulation divides the banks into cross-section slices with an established failure plane and applies all the surrounding natural forces and pressures to each slice in the horizontal and vertical directions. The geometrical and soil properties are then used to determine an adequate Factor of Safety value based on the shear strength of the bank soils. The calculated Factor of Safety of the bank for different stages simulated in the channel is compared with a modified quadratic fitting process used in ConCEPTS to estimate the minimum Factor of Safety, which determines whether planar failure occurs. The Cantilever Failure simulation also determines a Factor of Safety value that is based on the weight of the overhanging bank and the shear strength of the

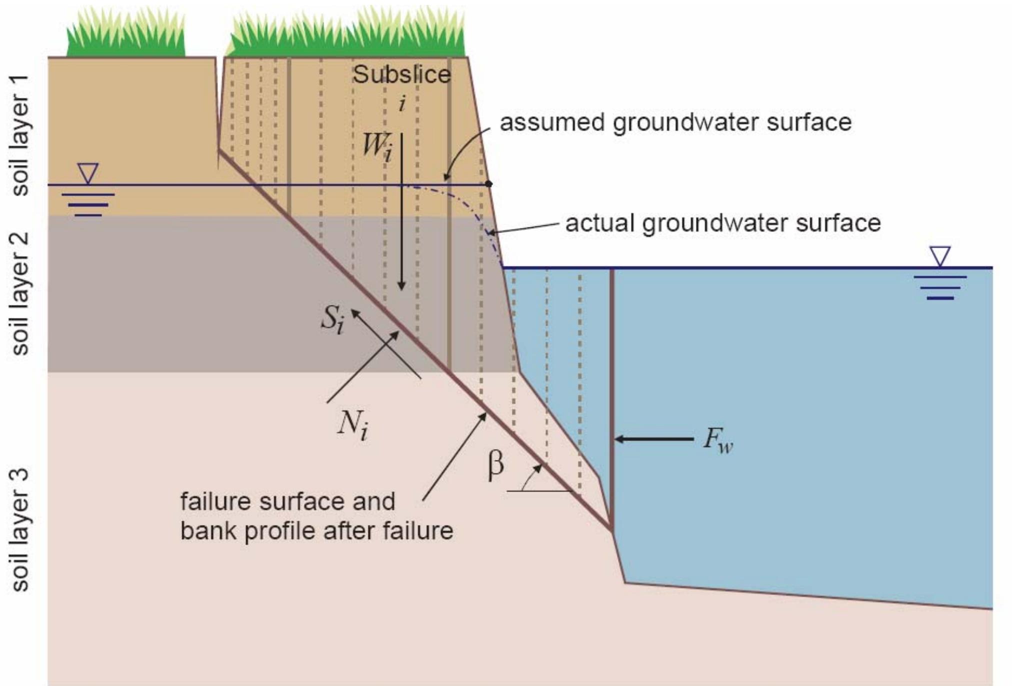

Figure 22. Summary of forces on a failure block used in CONCEPTS bank stability analysis (from Langendoen 2000).

bank soil. When the calculated Factor of Safety is compared to a minimum Factor of Safety value selected by ConCEPTS, the failures of the overhanging bank is determined.

Once the threshold for bank failure is surpassed, the bank block failures and the soil mass enters the channel. It is assumed that the soil mass from the block failure completely enters the channel as a lateral flux of sediment. The lateral flux of sediment is partitioned by size class, and added to the sediment mass governed by conservation laws.

The prediction abilities of ConCEPTS is very powerful in assisting engineers and managers to make long term decisions to better develop designs and reduce impact related to a stream's stability, natural hydraulic capacities, and sediment transport load. When ConCEPTS can be used with a watershed model like AnnAGNPS, a very comprehensive study of erosion and sediment transport can be analyzed from beginning to end. The combination of AnnAGNPS and ConCEPTS has the ability to adequately demonstrate channel evolution due to the watersheds environment over a long period of time (Merritt, Letchen, and Jakeman, 2003).

ConCEPTS was implemented in this project due to the ability of the model to: interpret output directly from the AnnAGNPS program, compute unsteady flow hydraulics, compute in stream sediment transportation, and estimate channel widening due to bank failure. Input data required by ConCEPTS includes: run control data, discharge data at the upstream boundary of the modeling reach, and channel geometry. Input data requirements are discussed in the next section.

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4.5.3 AnnAGNPS Model Input: Montgomery Fork, New River Basin Example

Specific Information Related to the AnnAGNPS Model for Montgomery Fork, New River Basin

Various amounts of information have been collected and used to create the Montgomery Fork (a subwatershed found in the New River Basin) AnnAGNPS pollutant loading model. Initially, all the land use / field cover information that was used within the AnnAGNPS pollutant loading model have been obtained from the USGS Seamless Data Distribution System, which can be found at the following website: ***http://seamless.usgs.gov/***.

The land use / field cover GIS layers were slightly modified to properly execute the AnnAGNPS system. To better define the current land use activities within the Montgomery Fork subwatershed, 2006 and 2007 raster images, as well as OSM permitted mined areas and TWRA logging permit locations were used in GIS. Once a single land use shape file was created for the entire subwatershed, an additional column of information was added to the attribute table for the GIS land use / field cover shape file. The additional column of data added to the land use attribute table is titled “Field_ID” which designates the various categories of land use description (i.e., Mixed Forest has a Field_ID value of 9 where 0-25% Logged areas has a Field_ID of 101). Note that the values placed in the Field_ID column must be in a text format for AnnAGNPS to associate and categorize the various land use activities to make computations using RUSLE and HUSLE parameters, runoff curve numbers, and other numerical values used in the AnnAGNPS Input Editor for hydrologic routing.

The soil GIS layers were obtained from the NRCS Soil Data Mart which can be obtained from the following website: ***http://soildatamart.nrcs.usda.gov/***. Once the GIS shape files of the different soil types are placed into the AnnAGNPS-ArcView Interface, a set of two National Soil Information System (NASIS) comma separated value (.csv) files must be loaded into the AnnAGNPS Input Editor to translate the graphical GIS shape files. The numerical soil information can be obtained by a state soil scientist with the USDA-NRCS. We contacted Doug Slabaugh, located at the USDA-NRCS office in Nashville, TN at the request of Dr. Ron Bingner (AnnAGNPS developer at USDA-ARS-NSL). Doug Slabaugh (soil scientist that AnnAGNPS soil data can be obtain) can be contacted at (615) 277-2550 and also at the email address: ***doug.slabaugh@tn.usda.gov/***. If soil data is required for another part of the U.S., Dr. Ron Bingner can be reached to find the local information.

Mr. Slabaugh of the USDA-NRCS sent a text file (.txt) that contained all the soil information for the New River Basin in units that the AGNPS and AnnAGNPS models can interpret. The soil text file from the USDA-NRCS had to be translated into two different comma separated value files, which separates some the information from the single text file into two different files used by the AnnAGNPS model. Ron Bingner was used to help determine how the two comma separated value files were to be created from the single text file given from the Nashville USDA-NRCS office.

For the use of AnnAGNPS, one comma separated value file should be labeled as: soil_layer.csv which contains several soil types and depths with a large amount of data for each. The second comma separated value file which is called: soil_dat.csv contains a brief amount of parameters for each soil type. These files and their contents can be seen in more detail in the appendix of the report. A multitude of corrections for each soil file were required with the assistance of Ron Bingner's guidance for the AnnAGNPS program to correctly match and identify these numerical tables of soil data with the soil polygon shape files in the AnnAGNPS-ArcView GIS interface.

Organization and the location of certain files in the AnnAGNPS system are very important. The AnnAGNPS program reads the various input parameters and GIS features based its placement within a set of nine folders located in the C:\AGNPS_Watershed_Studies\Folder with the Project Name\. Several of the nine folders that must all be contained in a specific project folder, which is placed in the AGNPS Watershed Studies folder does not need to be tampered with unless a complex programming problem occurs. When establishing all the input data for a project, the 4_ArcView_Datasets folder shall contain the ArcView GIS layers used (must have DEM, land use, and NRCS soils). The AGNPS.apr file (executes the AnnAGNPS-ArcView Interface for the project) and the cell information (a folder created by AnnAGNPS, but named by you, and must be named less than 8 characters) are also contained in the 4_ArcView_Datasets folder. The 5_Weather_Data sets is a good location to store various weather data, but is not a required location for the placement of weather information. For this project, the climate data used for the Montgomery Fork sub-watershed was obtained from a full weather station at the Big South Fork River and Recreation area. The data obtained from this weather station was summarized into daily values for the period of simulation with the AnnAGNPS model. The weather data, like that of the soil data, should be in the form of two .csv files to represent the location of the weather satation and the measured data at that station. Using the AnnAGNPS Input Editor, these two .csv files are combined to make a single file that must be called "DayClim.inp" to store all the climate data for simulations. The 6_Editor_DataSets folder should contain at least four files that are essential for the AnnAGNPS model to execute. The required files are the DayClimate.inp file (the file used to store actual weather data for the model), soil_layers.csv (modified USDA-NRCS NASIS file), soil.dat.csv (modified NASIS file from NRCS), and the AnnAGNPS Input Editor, which is should be saved as AnnAGNPS.inp in the 6_Editor_DataSets folder. The 7_AnnAGNPS_DataSets folder will contain the calculated predictions of runoff, sediment, nutrients, and pesticides from a successful execution of AnnAGNPS. Other various files specifically requested of the program will produce its output to the 7_AnnAGNPS_DataSets folder.

The most important objective in using the AnnAGNPS software is to keep all the files organized in the specified folders noted above and to delicately define the input parameters. After all the GIS shape files, weather data, and soil data have been loaded into a specific AnnAGNPS project folders (within the AGNPS_Watershed_Studies Folder) there are 9 steps to set up the data for model simulation. The 9 AGNPS Data Prep Steps are seen below:

Step 1: Clip DEM
Step 2: Select Watershed Outlet
Step 3: Create TopAGNPS Input Files
Step 4: Execute TopAGNPS
Step 5: Execute AgFlow
Step 6: Import TopAGNPS *.arc Files
Step 7: Intersect Cells with Soils Data
Step 8: Intersect Cells with Field Data
Step 9: Extract Cell and Reach Data

Once the 9-step process to initialize the AnnAGNPS model for proper execution, an AnnAGNPS Input Editor file must be created for the project. The Input Editor contains numerical data that communicates with the geographical shape files for the hydrological calculations for erosion, sediment yield, runoff, and transport of various chemicals and point sources must be organized in the AnnAGNPS Input Editor. For the basic simulation of runoff, erosion, and sediment yield within a watershed, like that of the Montgomery Fork Subwatershed in the New River Basin, 11 different portions of the AnnAGNPS Input Editor must meet the program's minimum requirements for data. The following are the 11 different portions of the AnnAGNPS Input Editor that have been completed for the Montgomery Fork Subwatershed simulation of runoff and sediment yield:

1) AnnAGNPS Identifier Data
2) Cell Data
3) Climate (Daily Climate Data)
4) Management (Field Data & Schedule Data)
5) Non-Crop Data
6) Reach Data
7) Runoff Curve Number Data
8) Simulation Period Data
9) Soil Data
10) Watershed Data
11) Output Options Data

Once all the above data requirements have been met, either by importing various files (e.g., Cell Data, Reach Data, Climate Data, and Soil Data) or by hand typing the various parameters. After the Input Editor's demands have been satisfied, the input file is saved in the 6_Editor_Datasets folder. The next process is to "execute" the AnnAGNPS Pollutant Loading Model. If the program properly executes, like that of the Montgomery Fork simulation shown, a DOS window will pop up running through the daily time step of the simulation. After the model processes for approximately one hour (time can vary depending on the simulation requirements), the AnnAGNPS program produces text files containing the average daily and annual results. AnnAGNPS can also transform the text files into a database file (.dbf) to be imported into

ArcGIS with the cells created by AnnAGNPS (which are created as shape files) to provide a graphical representation of the runoff and sediment yield within the watershed.
Below, the information for the Simulation Period for the AnnAGNPS Input Editor is shown. A 5-year simulation period can provide a good measurement of the average annual erosion and sediment yield produced on a hillslope. The values shown the table below have been manual entered into the AnnAGNPS Input Editor (AnnAGNPS.inp file) for the execution of the Montgomery Fork example simulation demonstrated

AnnAGNPS Input Editor: SIMULATION PERIOD SECTION for New River Basin			
	MONTH	**DAY**	**YEAR**
SIMULATION BEGIN DATE:	1	1	2005
SIMULATION END DATE:	12	31	2008
WATERSHED STORM TYPE:	3	Represents Type II Distribution	
RAINFALL FACTOR:	3320	MJ-mm/ha-hr-yr	
10 YEAR EI:	1362	MJ-mm/ha-hr	
EI NUMBER:	109	Unit less	
ANNUAL K FACTOR CODE:	N		
NUMBER OF INITIALIZATION YEARS:	2		

4.5.4 CONCEPTS Model Input: Field Data Requirements

To begin using the ConCEPTS program several field measurements and hydraulic/ geotechnical parameters need to be obtained. Once the stream's floodplains, banks, and bed characteristics are surveyed in cross-section and in longitudinal distance to each other, soil properties are collected for the bed and banks, and the flow values are obtained for the simulation period, the ConCEPTS program can begin its calculations. After the dimensions and the roughness of the stream's bed, banks, and floodplain have been created in the program, the hydraulic properties of these features adjust with different stage heights and flows in the simulation study period.

Channel geometry, bank and bed sediment composition, and reach lengths are required parameters to define the ConCEPTS model. To establish channel geometry, 10 channel cross-sections were surveyed with respect to the same datum in the Montgomery Fork reach (Figure 23, Appendix E). The 10 different cross-sections labeled MFCS-1 through MFCS-10, with MFCS-1 located just upstream of the Norma Road Bridge and MFCS-10 located just downstream of the Roach Creek and Montgomery Fork junction. A 700-meter longitudinal profile was surveyed along the stream thalweg to establish the hydraulics of the stream and the reach lengths between each cross-section. Additionally both the left and right top of the stream banks and floodplains were also determined for each cross-section in the survey for the ConCEPTS model. Ground water level elevations were assumed to be negligible to the hydraulics simulated with the ConCEPTS model, and they were not identified at the various cross-sections. At each cross-section in the Montgomery Fork survey for the ConCEPTS model, a complete RGA analysis was conducted at each site to store information for the different numerical properties within each study reach. Using documented data obtained from field

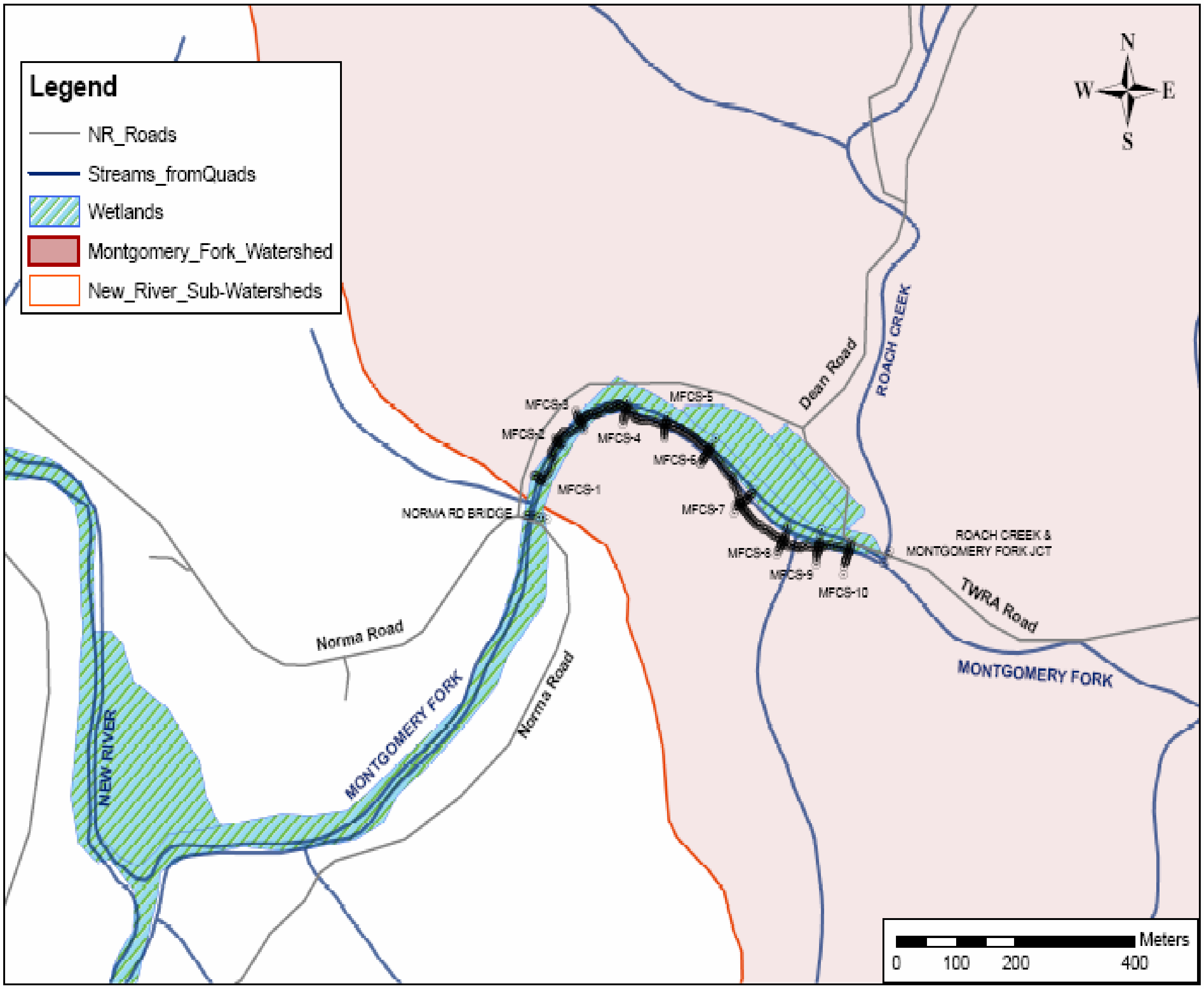


Figure 23. Location map of surveyed CONCEPTS cross-sections on Montgomery Fork.

reconnaissance, the characteristics of the channel, bank, and floodplain properties, like the Manning's n value in the ConCEPTS model, as well as other additional properties that could not be measured were estimated.

Within the ConCEPTS model, several sediment and soil properties related to the geomorphology of the channel have to be defined. For the simulation of Montgomery Fork in the ConCEPTS model, several of the bed and bank properties were either measured or estimated through hydraulic calculations or tables.

For the sediment properties used in the ConCEPTS model, the particle density, porosity, critical shear stress, erodibility, cohesion, friction angle, and suction angle properties were obtained through standardized tables and soil types (Langendoen, 2000). For the grain size distribution of sediment, the modified Wolman pebble count coupled with bed sediment collections were collected to characterize the movement of particles within the stream reach.

Together the Wolman pebble count and the grab samples provide a through sediment distribution of the bed material. The Wolman pebble count allows for classification of the courser material in the bed sediment while the hydro-sieve analysis of the grab sample allows classification of the fine sediment in the reach. Sediment can be defined in multiple layers in the model allowing identification of both the pavement and sub-pavement layers.

Bank sediment compositions, soil profiles, for the left and right bank were developed at each cross section based on a sieve analysis of the bank material (data compiled for Phase 2 report). Other soil properties were based on standard coefficients and practices implemented on similar watersheds and geographic regions. The bank soil data within the ConCEPTS model requires the same information as that of the sediments mentioned earlier, but also requires the bulk density and permeability, which were estimated for the ConCEPTS program. For Phase 2 data, a stainless steel sediment scoop was used to take left and right bank samples at each of the 10 cross-sections of the Montgomery Fork survey. The bank soil was then taken to a geotechnical laboratory at the University of Tennessee and the grain size distribution was developed through a dry sieve and hydrometer analysis.

The hydrology and the upstream sediment contribution (inflow files) were defined by a file imported from the AnnAGNPS model. To establish hydrographs and sediment graphs for the ConCEPTS model, the AnnAGNPS reach value had to be found in respect to the beginning of the channel survey to be simulated in ConCEPTS. Once the inflow data for runoff and sediment were converted from AnnAGNPS to ConCEPTS, the ConCEPTS model was ready to be used.

Found in the Appendix E figures are the different channel cross-sections and thalweg distances between each cross-section inputted into the ConCEPTS model. For the majority of the surveyed cross-sections of Montgomery Fork, the overall method for selecting multiple cross-sections was to alternate riffle and pools between each cross-section if possible. Another objective for selecting the channel cross-sections was to keep the distance between each to be no less than 50 m and no more than 100 m if possible. Appendix E contains the 10 channel cross-sections of Montgomery Fork, looking toward the upstream current, that were placed into the CONCEPTS model with the hydrograph and sedimentgraph produced from current conditions in the entire Montgomery Fork subwatershed.

4.5.5 Results and Demonstration of AnnAGNPS-CONCEPTS Model

Preliminary results and demonstration of the AnnAGNPS and ConCEPTS models for a single New River subwatershed constitutes *Deliverable 4*. This study applied the AnnAGNPS and ConCEPTS models for demonstration and evaluation of its use for the OSM CHIA process only. No final results were planned or conducted. Phase 2 of the project focuses on full development of AnnAGNPS and ConCEPTS models, in which four subwatersheds in the New River basin have been modeled and flow and sediment data collected for model calibration and verification. The four subwatersheds include: Montgomery Fork, Brimstone Creek, Smokey Creek, and Ligias Creek. The Phase 2 report will be completed in September 2008.

Montgomery Fork subwatershed was selected as the model watershed for this Phase 1 effort. This subwatershed was selected because of its land use activities are diverse, including logging, active mining, and heavy haul road use. Two graphical output files produced from the AnnAGNPS model are provided as an example of its potential utility for the CHIA process (Figures 24 and 25). These two figures represent critical sources of annual average runoff and sediment yield quantities in the Montgomery Fork subwatershed. Within a subwatershed, a user

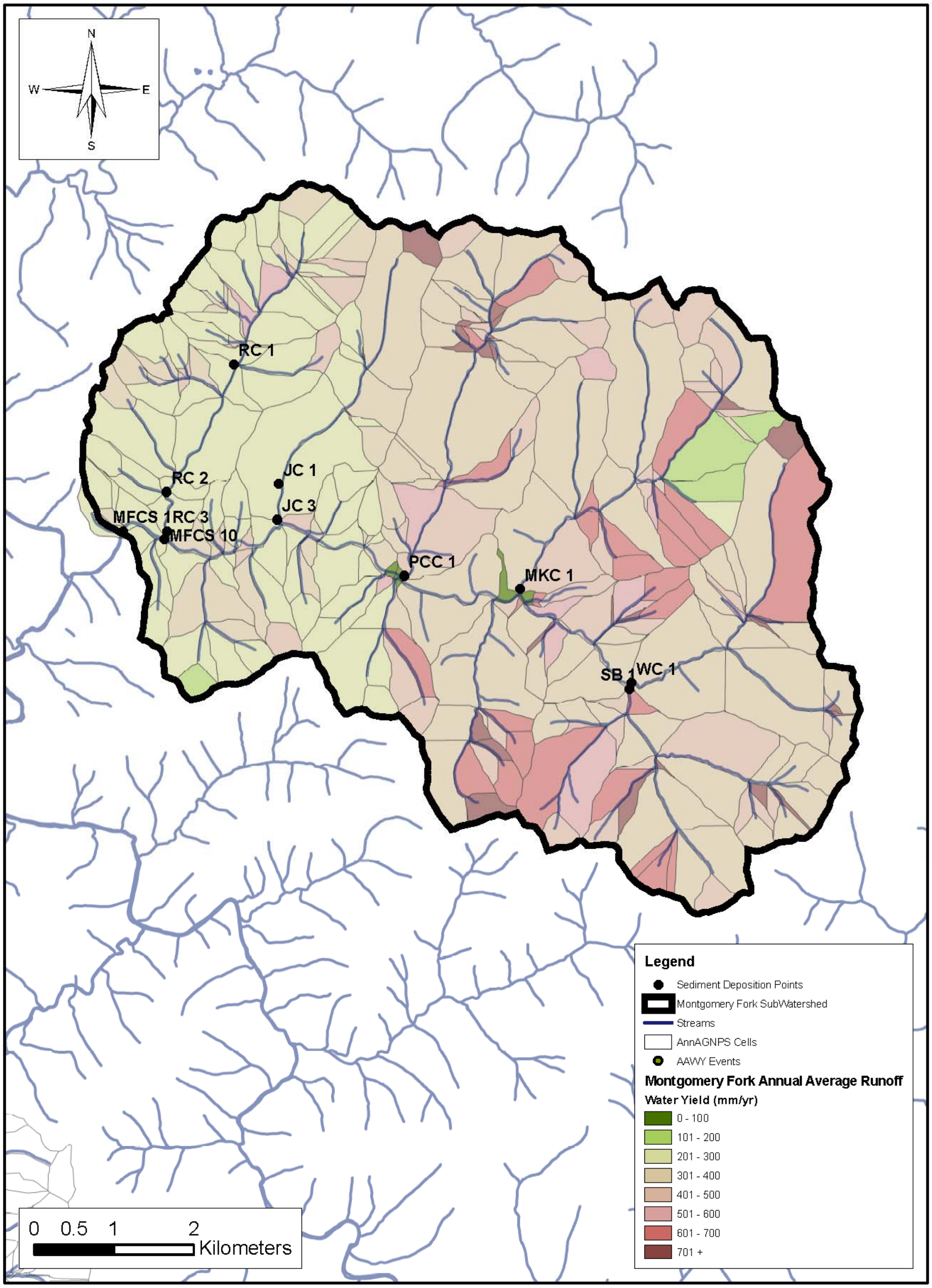


Figure 24: AnnAGNPS runoff predictions in Montgomery Fork subwatershed, New River basin. Legend: Annual average runoff, water yield (mm/yr).

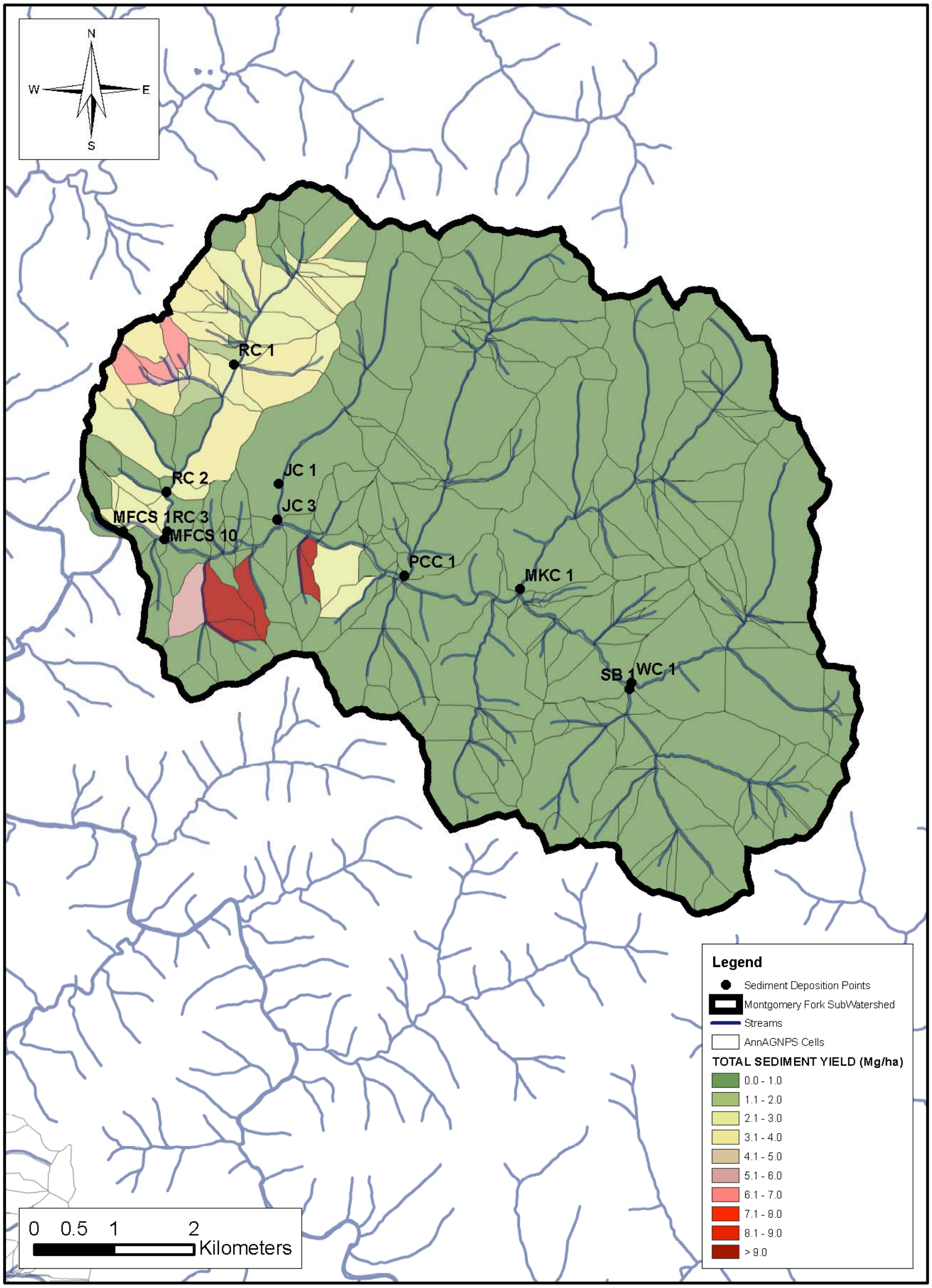


Figure 25: AnnAGNPS sediment yields in Montgomery Fork subwatershed, New River Basin. Legend: Total sediment yield (Mg/ha/yr). Note: Mg = metric ton.

can observe spatially areas with high and low annual sediment yields, and yield output can be tabulated from each flow cell within the subwatershed as well. Typical results from the ConCEPTS model include changes in cross-sectional and longitudinal bed profile (Figure 26). The use of ConCEPTS for the CHIA process would involve investigations in unstable reaches where it was important to know how much sediment over time would enter the stream from bed and bank erosion. Besides the graphical output on changes in cross-sectional and longitudinal bed profile, output includes tabulated values for daily sediment loads per particle size class. The ConCEPTS model includes sedimentation contributions from bank erosion, whereas AnnAGNPS does not only accounting for upland sources of sediment to streams.

A preliminary demonstration of the AnnAGNPS-ConCEPTS models was given to Mr. Rick Mann and Ms. Sheila Walton of the Office Surface Mining, Knoxville Field Office, on June 12, 2007. The basic data layers for model inputs and field data collection were described, and shown in a PowerPoint presentation. A final demonstration of the he AnnAGNPS-ConCEPTS models was conducted for the OSM staff in Knoxville, TN on April 10, 2008.

4.6 Evaluation of PHC Data Collection

An evaluation of PHC data collection by industry and how it could be improved to better support CHIA was completed as *Deliverable 3*. Under Title 30 of the Code of Federal Regulations (CFR), probable hydrological consequences (PHC) are defined in §780.21(f), in which surface mining application shall "contain a determination of the probable hydrological consequences of the proposed operation upon the quality and quantity of surface and groundwater under seasonal flow conditions for the proposed permit and adjacent area." In addition, the PHC determination shall be based on baseline, hydrological, geological, and other information collected for the permit application and may include data statistically representative of the site. In particular, 30 CFR §780.21(f)(3)(iv)(A) requires PHC to determine the potential impacts from a proposed operation on sediment yields from the disturbed area. The applicant is required to develop a surface water monitoring plan under 30 CFR §780.21(j), in which reports shall be submitted to the regulatory authority every three months. The regulatory authority may require additional monitoring.

Integral with the PHC is the hydrologic reclamation plan (HRP) under 30 CFR §780.21(f)(h) and 30 CFR §784.14(e)(g), in which remedial treatment and reclamation practices are to be implemented to control hydrological impacts. Remedial treatment and reclamation practices are described in 30 CFR §816.45, 30 CFR §816.46, and 30 CFR §816.47, as sediment control measures, siltation structures, and discharges structures, respectively. Discharge structures are to be designed to limit sediment discharges to 0.5 mg/L peak settable solids during a 10-year, 24-hour event.

Under this effort, different types of approved SMCRA permits were reviewed, including surface mines, haul roads, and coal washing and loading facilities, in which hydrological and water quality data were evaluated with respect to the CHIA process [30 CFR §780.21(f)(4)(g)]. In addition, an evaluation was conducted to explore whether existing PHC data and other potentially useful data could be easily collected that would support calibration of a sediment delivery models, in this study the AnnAGNPS model.

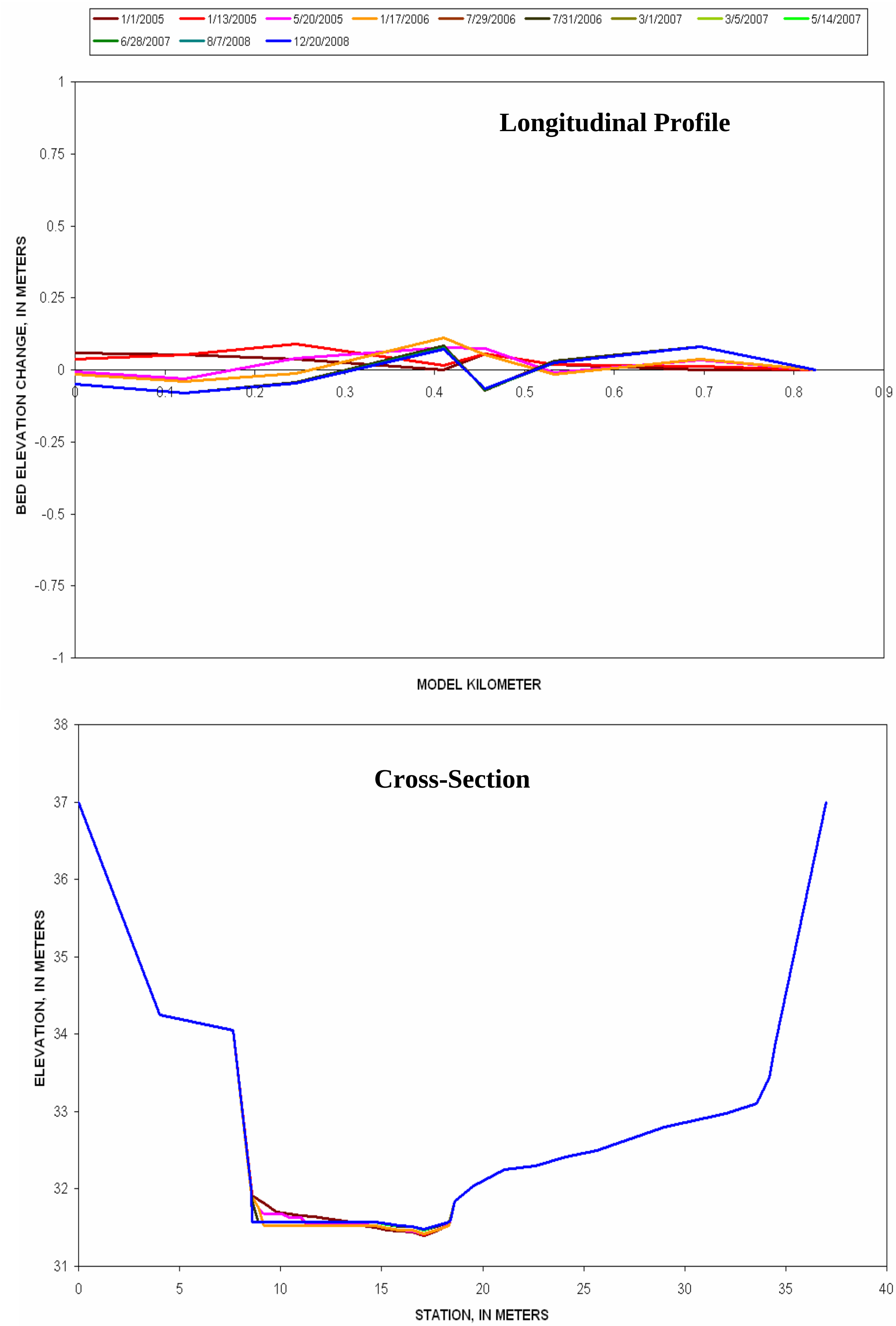


Figure 26: Example of CONCEPTS model output in a New River subwatershed. Colored lines represent channel bed/ban for different dates over time.

4.6.1. Current Data Collected by Industry

The data collected by industry for a PHC currently includes: stream identification, stream flows, and water quality data before, during and after mining activities. In addition, information is provided on proposed sediment pond locations and size specifications, SEDCAD output for flow and sediment, and water quality data post construction. The water quality data typically includes taking grab samples at baseflow, and the water is analyzed for pH, acidity, alkalinity, bicarbonate, specific conductivity, hardness, total suspended solids (TSS), total dissolved solids (TDS), chloride, calcium, magnesium, sodium, aluminum, copper, zinc, nickel, iron, manganese, and sulfate. Very few samples were collected during stormflow events.

Review of the sample PHCs found data compiled as described above, but no data analysis or comparisons were conducted. In rare cases, high TSS values were observed where these high TSS results occurred during or following a precipitation event.

4.6.2 Evaluation for Support of Sediment Model and CHIA Needs

A review of the PHC requirements was completed, and the following are discussion points that would support improved analysis of potential sedimentation impacts in streams:

1.) Rapid geomorphic assessments (RGA) in channels;
2.) Stream bed sediment samples (fine sediments in lateral depositions areas); and
3.) Data needs for a watershed-scale sediment delivery model.

It should be noted, the current PHC data collection for baseflow water quality should remain. That data includes: stream identification, stream flows, and water quality data before, during and after mining activities. This baseflow water quality data provides useful baseline data, mostly related to issues involving stream acidification and metal toxicity from mine wastes.

Rapid Geomorphic Assessments (RGA): From this study, and other supporting work (e.g., Williams, 2005), RGA can identify unstable channels due to land use disturbances (Sections 4.3 and 4.4). In addition, a large body of research by the USDA National Sedimentation Laboratory has shown that streams with RGA scores above 20 can be considered as unstable, a watershed likely subjected to some uplands disturbance. The RGA is a general watershed assessment tool. It would be applied within CHIA subwatersheds just upstream of major tributaries, and within 0.5 to 1.0 km downstream in tributaries that drain any coal mining operation. The frequency of every five years is recommended for comprehensive RGA surveys throughout CHIA watersheds. However if a major coal mining operation is in progress, RGAs at the downstream tributary site(s) should be conducted annually at that location.

Implementation of the RGA requires trained personnel in the geosciences. To obtain useful RGA scores, mining permittees would need to hire trained individuals for PHC data collection. Implementation of RGAs would be more valuable for the CHIA process than a general PHC requirement, in which RGAs were conducted by trained OSM personnel. However, with OSM oversight, RGA implementation may be accurately conducted for PHC data collection for sites immediately downstream of the coal mining operations.

Fine Bed Sediment Samples: Fine bed sediment samples collected in lateral deposition areas of streams appears to be useful and cost effective means to identify streams potentially impacted by uplands land disturbances, including coal mining operations. Evidence to support this finding is shown in a data analysis illustrated in Figure 27. Figure 27 represents the bin

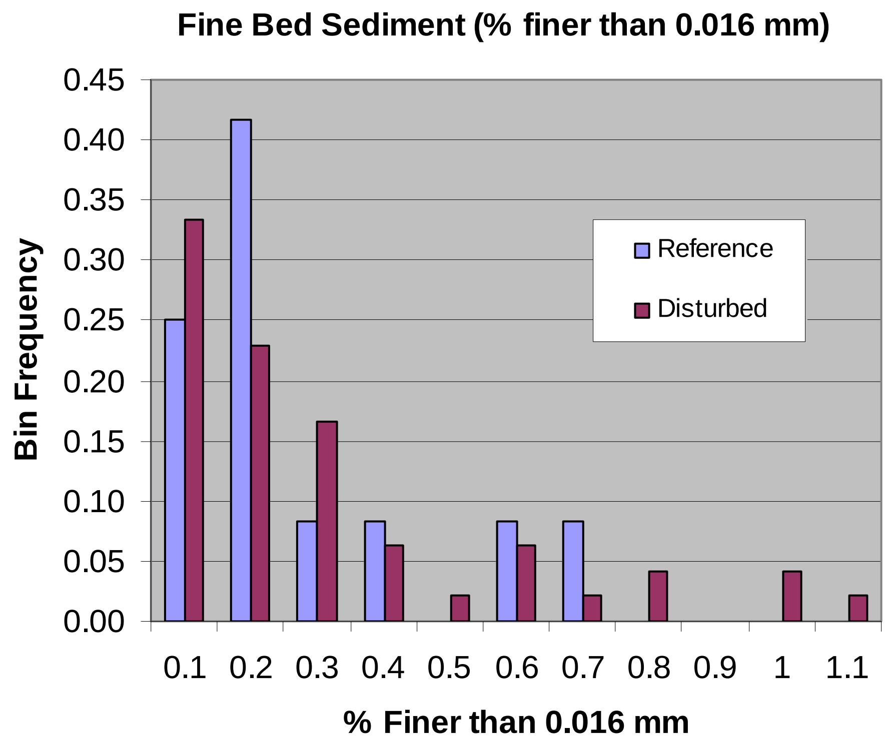


Figure 27. Frequency of occurrence of fine bed sediment, % finer than 0.016 mm by weight, for the study reference and disturbed subwatershed sites. Frequency of occurrence was normalized by number of sites within each subwatershed category (12 reference sites, and 48 disturbed sites).

frequency for fine sediments finer than 0.016 mm diameter by weight, conducted on our study's field samples by hydrometer analysis for reference and disturbed subwatersheds (Section 4.3.1). The importance of the 0.016 mm size class is that Williams (2005) found that it correlated with biological impairment in streams in East Tennessee. Biological impairment was quantified by the TDEC protocols for rapid bioassessments using RPBIII statutory limits. The data used for Figure 27 are those in Table 15, and obtained from original particle size distribution plots in Appendix D. In general, sampled sediment finer than 0.016 mm were represented by a small portion of the total sample, less than 1.1 percent (Figure 27, Appendix D). Most sediment particles were above 0.1 mm in size. However, this technique examined differences between disturbed and undisturbed watersheds, testing whether fine sediments settle during floods in the lateral deposition zones. Although, fine sediment portions by weight are small, they do indicate a potential siltation problem. In Figure 27, data for reference (undisturbed) and disturbed subwatersheds overlapped, where fine sediment with a % finer greater than 0.8 appeared to mark a threshold between reference and disturbed subwatersheds. Collection of fine bed sediment in lateral deposition would be a useful PHC metric to identify whether fine sediments are reaching stream channels downstream of coal mining operations. Bed sediment samples should be collected in tributaries that drain coal mining operations, located approximately 0.5 to 1.0 km downstream and not influenced by other land use activities. Fine bed sediment samples are recommended to be collected quarterly during active coal mining operations, and annually following reclamation until the permit is released.

The PHC protocol for collecting, analyzing, and interpreting results of fine sediment samples on the stream bed are as follows:

1) Collected fine bed sediment samples in lateral deposition zones, the lee end of point bars, behind boulders or large woody debris, or laterally near banks immediately downstream of a rapid channel width expansion. These are areas in the stream that form hydraulic recirculation zones during flooding, in which fine sediment deposits.
2) Analysis the bed sediment samples following ASTM methods to generate a particle size distribution (PSD) curve. ASTM methods are specifically Standards Volume 4.08, Method D 422063.
3) Identify on PSD curve the value for % finer than 0.016 mm. Report value, if greater than 0.8% it is likely the stream is being impacted by excessive fine sediment delivery.

It should be cautioned that the threshold of 0.8 % finer of 0.016 mm sediment was observed for subwatersheds in the New River basin. Other hydrological units may differ in a threshold value based on differences in geology, soils, and vegetation cover. It would be recommended that at least three reference streams be included in the PHC protocols, in order to compare the stream under question with non-disturbed streams.

Watershed-scale Sediment Delivery Model: The sediment delivery model selected for this study was the AnnAGNPS model (Section 4.4). This model would be a useful tool for OSM's CHIA process because of its capability to estimate changes in sediment yield from proposed new mining permits (Section 4.5). In order to calibrate and verify model output for stream discharge and sediment loads, several data collected from the PHC process would support improved model output. The field measurement data include: rainfall and air temperature, flow discharges during storm events, and total suspended solids (TSS) samples during storm flows. Weather stations with automatic data loggers can be purchased and installed at minimal cost. Two weather stations should be located near the permitted site, one at a high elevation location and a second station near the subwatershed outlet. Measurement of stream discharge and TSS should occur at the designated sample location that drains areas impacted by mining activities, likely the outlet of the detention pond. Measurement of a stage by a pressure transducer (or other device) that records data allows for discharge hydrographs to be computed over time. TSS samples are recommended to be collected by flow-weighted composite sampler so a total sediment load can be computed per storm event. One storm hydrograph semi-annually is recommended.

In addition, stream discharge and TSS samples should be collected at nearest CHIA subwatershed outlet. Discharge can be obtained by recording flow stage with a pressure transducer and automatic data logger type device. A single cross-section is surveyed near the stage recorder, and discharge measured at varying flow depths using USGS standard methods. A stage-discharge relationship is developed at the cross-section so that discharge can be computed for all stages recorded by the pressure transducer. Pressure transducers are easily purchased and installed. Grab samples for TSS should be collected at this stage recorder site, and data compiled for varying flow stages. It is critical to have samples taken during high flows following precipitation events greater than 1.2-inch in 24 hours. Discharge and TSS data are used to calibrate and verify the AnnAGNPS model.

5.0 CONCLUSION

As a conclusion, the following summary findings are listed below:

- The land cover/use classification scheme identified in this study appears adequate for AnnAGNPS model in the Appalachian region, based on the study's statistical analysis and preliminary findings of model performance. The land cover/use scheme consists of: logged areas (100%. 75%, 50%, and 25% vegetated cover classifications), current disturbed mine lands (active erosion, soil exposed), abandoned surface mining, dirt roads (high and low traffic, foot trails), developed land (medium and low intensity, and open space), barren land, forest cover (deciduous, evergreen, and mixed), shrub/scrub, grassland/herbaceous cover, pasture/hay lands, and woody wetlands. Land use classifications and geomorphic field measurements uniquely correlated with subwatersheds by PCA ordination statistical analysis, providing evidence that the land use types identified generate distinct sediment yields. Of the geomorphic metrics, the RGA, reach channel slope, and fine sediment amounts found in lateral stream deposition areas were the most important geomorphic variables. The RSA approach was not found to be as important.
- The RGA protocols, described in Section 4.3 would be useful as a tool for the CHIA process in the Appalachian region of the United States. Although this study collected data from the New River basin, East Tennessee, other data from Williams (2005) and the USDA National Sedimentation Laboratory support this conclusion. The key use of RGAs would be to determine what level of stable or unstable channels occur in CHIA subwatersheds. If channels are predominantly stable (RGA scores < 20), the AnnAGNPS would be applied without the ConCEPTS model to estimate annual sediment yields. If unstable channels occur in the CHIA subwatershed (RGA scores > 20), the AnnAGNPS should be applied with the ConCEPTS model to estimate annual sediment yields, accounting for bank erosion sources of stream sediment. This study found in headwater areas most stream channels were stable due to geologic controls. However, bank erosions problems were observed in lower subwatershed areas containing floodplains with alluvium. Overall, the RGA is a useful field assessment tool to evaluate whether coal mining operations are having an impact on channel stability downstream of their hydrological influence.
- As conducted in this study, protocols for collecting and analyzing fine bed sediments would be useful for the CHIA process and as a PHC measurement. Protocols are described in Section 4.3.1, and specific PHC recommendations are described in Section 4.6.2. This methodology appears to be capable of detecting fine sediment levels above what would be found in reference (undisturbed) streams, therefore indicating fine sediments are reaching the stream from sediment sources in disturbed upland areas.
- Preliminary results from the use of the AnnAGNPS and ConCEPTS models demonstrated reasonable estimates of annual sediment yields can be generated for different land use scenarios, answering questions such as: 1) what would be the sediment yield increase from a new coal mine operation in a subwatershed, and 2) what are the proportional contributions of sediment yields from all possible uplands sources and bank erosion sources.
- Complete evaluation of the AnnAGNPS and ConCEPTS models is currently in progress as part of our 2007 OSM Applied Science Program grant, and a final report will be completed in September 2008. For this Phase 2 grant, four subwatersheds will be modeled; they are

Montgomery Fork, Smokey Creek, Ligias Creek, and Brimstone Creek. Models will be calibrated and verified with field measurements. Use of this model for development of watershed sediment budgets will be emphasized in the final report.

APPENDIX A: AnnAGNPS SEDIMENT MODEL DATA INPUTS

In the following section, the soil and land use data that were required by the AnnAGNPS Input Editor can be found below. The characterization of the land use data was hand typed into the Input Editor while the soil information can be imported as two different files: soil_layers.csv and soil_dat.csv. Both of the soil files required can be found in the appendix. Note for all tables below that summarize the sediment delivery properties needed by AnnAGNPS are all in SI units or are a standard value within a range that the program prompts the user to select.

For the Runoff Curve Number section of the AnnAGNPS Input Editor, the following land use/cover curve number (CN) values for each Hydrological Group (A through D) are summarized. These values have been manual entered into the AnnAGNPS Input Editor (AnnAGNPS.inp file) for the execution of the Montgomery Fork example simulation demonstrated.

Table A1. USDA-NRCS Runoff Curve Numbers used in the New River AnnAGNPS model.

AnnAGNPS Field ID	Land use / Land cover Description	Curve Numbers for Hydrologic Soil Groups			
		A	B	C	D
1	Open Water	0	0	0	0
2	Developed Open Space	47	69	79	86
3	Developed, Low Intensity	51	68	79	84
4	Developed, Medium Intensity	77	85	90	92
5	Developed, High Intensity	81	88	91	93
6	Barren Land (Rock/Sand/Clay)	68	79	86	89
7	Deciduous Forest	36	59	72	79
8	Evergreen Forest	36	59	72	79
9	Mixed Forest	36	59	72	79
10	Shrub/Scrub	34	48	65	73
11	Grassland/Herbaceous	39	61	74	80
12	Pasture/Hay	49	69	79	84
13	Cultivated Crops	66	74	80	82
14	Woody Wetlands	38	62	78	82
101	25% Logged	39	63	75	80
102	50% Logged	45	67	78	82
103	75% Logged	59	77	82	89
104	100% Logged	74	82	88	94
201	Active Surface Mining	77	86	91	94
202	Abandoned Surface Mining	49	66	76	82
301	Dirt Roads	72	82	87	89

Another required section of the AnnAGNPS Input Editor, is the relationship of the different land use values with the RUSLE Cover-Management Factor (C-Factor). The AnnAGNPS program calculates the RUSLE C-Factor by analyzing multiple values seen in the Non-Crop Data Section of the AnnAGNPS Input Editor (Table A.2). The values shown the table below have been manual entered into the AnnAGNPS Input Editor (AnnAGNPS.inp file) for the execution of the Montgomery Fork example simulation demonstrated.

Table A2: AnnAGNPS Input Editor: NON-CROP DATA SECTION for New River Basin.

Non-Crop ID	Non-Crop Description	Annual Root Mass	Annual Cover Ratio	Annual Rain Fall Height	Surface Residue Cover
2	Developed Open Space	0	0.000	0.000	0
3	Developed, Low Intensity	4484	0.800	0.030	25
4	Developed, Medium Intensity	4484	0.900	0.030	50
5	Developed, High Intensity	4484	0.900	0.030	50
6	Barren Land (Rock/Sand/Clay)	0	0.000	0.000	100
7	Deciduous Forest	5605	0.950	6.096	45
8	Evergreen Forest	5605	0.950	6.096	45
9	Mixed Forest	5605	0.950	6.096	45
10	Shrub/Scrub	6726	0.950	6.096	45
11	Grassland/Herbaceous	2242	0.950	0.030	80
12	Pasture/Hay	2242	0.950	0.030	80
13	Cultivated Crops	4484	0.800	0.030	50
14	Woody Wetlands	6726	0.950	6.096	45

The Management Field Data section of the AnnAGNPS Input Editor is required in order to estimate the erosion and sediment yields produced from runoff on the hillslopes (Table A.3). The Management Field Data creates a relationship of the different land use values with average characteristics. The values shown the table below have been manual entered into the AnnAGNPS Input Editor (AnnAGNPS.inp file) for the execution of the Montgomery Fork example simulation demonstrated.

Table A3: AnnAGNPS Input Editor: MANAGEMENT FIELD DATA SECTION for New River Basin

Management Field ID	Field Land Use Type	Management Schedule ID	Percent Rock Cover	RUSLE Sub P-Factor	Interrill Erosion Code
2	URBAN	6	0	1	2
3	URBAN	3	30	1	3
4	URBAN	2	55	1	3
5	URBAN	1	80	1	3
6	URBAN	13	100	1	3
7	FOREST	11	25	1	4
8	FOREST	11	25	1	4
9	FOREST	11	25	1	4
10	FOREST	12	25	1	4
11	PASTURE	10	20	1	3
12	PASTURE	9	20	1	3
13	URBAN	7	15	1	2
14	FOREST	12	25	1	4

Soil data from the USDA NRCS is used as a data layer in AnnAGNPS, in which a shape file is obtained to spatially designated soil types throughout the modeled watershed. Table A.4 is a summary table specifically for Montgomery Fork subwatershed, and Table A.5 is a summary table of all soil types found in the New River Basin.

Table A.4. Montgomery Fork Watershed USDA-NRCS Soil Information.

NRCS AREA SYMBOL	MUSYM	MUKEY	AREA (sq. meters)	Percent Area Coverage
TN013	Be	524243	6,471,852	11.27%
TN013	CaE	524247	702,062	1.22%
TN013	CuF	524254	118,853	0.21%
TN013	Ea	524257	554,926	0.97%
TN013	JgF	524267	10,228,228	17.81%
TN013	MkF	524269	12,803,862	22.29%
TN013	MpF	524271	8,938,852	15.56%
TN607	GsF	530677	4,009,601	6.98%
TN607	GpF	530678	8,063,161	14.04%
TN607	Ac	530679	2,496	0.00%
TN607	Pp	530680	609,027	1.06%
TN607	LgD	530685	26,560	0.05%
TN607	ShD	530688	910,466	1.59%
TN607	LgE	530694	493,006	0.86%
TN607	Bm	530695	3,002,044	5.23%
TN607	GpE	632725	500,391	0.87%
TOTAL			**57,435,385**	**100.00%**

Table A.5. Soil Types Available within the New River Basin (1 of 4).

NRCS Soil ID MUSYM	NRCS Soil Name	NRCS Soil Texture
Ac	Allegheny	loam
AeD2	Allen	loam
AfD	Allen	loam
AkC	Armuchee	channery silty clay loam
AkD	Armuchee	channery silty clay loam
AkE	Armuchee	channery silty clay loam
AoD2	Armuchee	channery silty clay loam
AoE2	Armuchee	channery silty clay loam
ApE	Armuchee	silt loam
At	Atkins	silt loam
BaF	Bethesda	channery loam
Be	Bethesda	channery silt loam
Bg	Bloomingdale	silt loam
Bh	Bloomingdale	silt loam
Bm	Bethesda	channery loam
BrF	Bland	silty clay loam
CaC	Claiborne	silt loam
CaD	Claiborne	silt loam
CaE	Claiborne	silt loam
CbB	Capshaw	silt loam
Cd	Cedarbluff	loam
Ce	Chenneby	silt loam
CgB	Collegedale	silt loam
CgC	Collegedale	silt loam
CgD	Collegedale	silt loam
ChC3	Collegedale	silt loam
ChD3	Collegedale	silt loam
CkE	Collegedale	silt loam
CoB	Collegedale	silt loam
CoC	Collegedale	silt loam
CoC2	Collegedale	silt loam
CoD2	Collegedale	silt loam
CrD	Colbert	silt loam
CrD2	Collegedale	silt loam
CrE2	Collegedale	silt loam
CuF	Cutshin	channery silt loam
Cw	Craigsville	cobbly loam
CyE2	Cynthiana	flaggy silty clay loam
DeD	Dewey	silt loam
DwC	Dewey	silt loam
DwD	Dewey	silty clay loam
DwE	Dewey	silt loam
DyC2	Dewey	silt loam
DyD2	Dewey	silty clay loam

Table A.16. Soil Types Available within the New River Basin (2 of 4)

NRCS Soil ID MUSYM	NRCS Soil Name	NRCS Soil Texture
Ea	Ealy	Loam
En	Ennis	silt loam
EoB	Etowah	Loam
EoC	Etowah	Loam
EtB	Etowah	silt loam
EtC	Etowah	silt loam
EvB	Etowah	Loam
FaC	Fullerton	gravelly silt loam
FbD	Fullerton	gravelly silt loam
FbF	Fullerton	gravelly silt loam
FeC	Fullerton	gravelly silt loam
FeD	Fullerton	gravelly silt loam
FeE	Fullerton	gravelly silt loam
FmC	Fullerton	gravelly loam
FoC	Fullerton	gravelly loam
FoD	Fullerton	gravelly loam
FoE	Fullerton	gravelly loam
GnC	Gilpin	silt loam
GnD	Gilpin	silt loam
GpE	Gilpin	silt loam
GpF	Gilpin	silt loam
GrD	Gladeville	flaggy silty clay loam
GrF	Gilpin	silt loam
GsF	Gilpin	silt loam
Ha	Hamblen	silt loam
Hb	Hamblen	silt loam
He	Heiskell	silt loam
HeB	Hendon	silt loam
HeC	Hendon	silt loam
JeC	Jefferson	gravelly loam
JeD	Jefferson	gravelly loam
JfC	Jefferson	Loam
JfD	Jefferson	Loam
JgF	Jefferson	gravelly loam
JnC	Jefferson	gravelly loam
JnD	Jefferson	gravelly loam
JnF	Jefferson	cobbly loam
LbB	Lily	Loam
LbC	Lily	Loam
LbD	Lily	Loam
LgC	Lily	Loam
LgD	Lily	Loam
LgE	Lily	Loam
LmC	Lily	Loam

Table A.16. Soil Types Available within the New River Basin (3 of 4)

NRCS Soil ID MUSYM	NRCS Soil Name	NRCS Soil Texture
LmD	Lily	loam
LmE	Lily	loam
LoB	Lonewood	silt loam
LoC	Lonewood	silt loam
LoD	Loyston	channery clay
LoE	Loyston	channery clay
LsF	Loyston	flaggy clay
LtC	Loyston	channery clay
LtD	Loyston	channery clay
LyC	Lily	fine sandy loam
MaD	Minvale	gravelly loam
Me	Melvin	silt loam
MkF	Muskingum	silt loam
MnC	Minvale	gravelly silt loam
MnD	Minvale	gravelly silt loam
MpF	Muskingum	silt loam
MsE	Minvale	loam
MtD	Minvale	loam
MvC	Montevallo	channery silt loam
MvD	Montevallo	channery silt loam
MvE	Montevallo	channery silt loam
Pe	Pettyjon	silt loam
Ph	Pettyjon	silt loam
Pp	Pope	loam
RaC	Ramsey	loam
RaD	Ramsey	loam
RaF	Ramsey	loam
Ro	Rockdell	gravelly loam
RrE	Ramsey	loam
SaB	Sequatchie	loam
SeB	Sequoia	silt loam
SeC	Sequoia	silt loam
SeC2	Sequoia	silt loam
SeC3	Sequoia	silt loam
SeD	Sequoia	silt loam
SeD2	Sequoia	silt loam
SeD3	Sequoia	silt loam
SeE2	Sequoia	silt loam
SfC	Salacoa	silt loam
SfD	Salacoa	silt loam
SgD	Salacoa	gravelly loam
ShC	Shelocta	silt loam

Table A.16. Soil Types Available within the New River Basin (4 of 4)

NRCS Soil ID MUSYM	NRCS Soil Name	NRCS Soil Texture
ShD	Shelocta	silt loam
ShE	Shelocta	silt loam
Sk	Shady	loam
Sn	Steadman	silt loam
Sw	Swafford	loam
TaF	Talbott	gravelly loam
TbB	Tasso	silt loam
TnC	Townley	silt loam
TnD	Townley	silt loam
WbD	Waynesboro	loam
Wh	Whitwell	loam
WnC	Wernock	silt loam
WrB	Wernock	silt loam
WrC	Wernock	silt loam
Ww	Whitwell	loam

APPENDIX B: GPS LOCATIONS OF FIELD STUDY SITES

Table B.1. GPS site UTM coordinates for all RGA study sites in the New River Basin.

GPS		UTM COORDINATES		
Site ID	**Watershed**	**Easting**	**Northing**	**Elevation**
(---)	**(---)**	**(m)**	**(m)**	**(m)**
BSC 1	Brimstone Creek	724066	4014829	399.0
BSC 2	Brimstone Creek	723488	4013568	425.0
BSC 3	Brimstone Creek	724437	4015349	381.0
IC 1	Brimstone Creek	725053	4015581	404.0
JOE 1	Brimstone Creek	723332	4013459	409.0
BBC 1	Bull Creek	729450	4020049	396.0
BBC 2	Bull Creek	729407	4021496	479.0
BBC 3	Bull Creek	730039	4022813	365.0
BC 1	Bull Creek	730555	4022988	381.0
LBC 1	Bull Creek	731513	4022265	394.0
LBC 2	Bull Creek	730784	4022796	379.0
LBC 3	Bull Creek	731401	4021629	432.0
LBC 4	Bull Creek	731407	4021409	401.0
NPFF 1	Frozen Head SP	726633	4002211	474.0
NPFF 2	Frozen Head SP	726923	4002369	507.0
NPFF 3	Frozen Head SP	725620	4001905	439.0
GCR 1	Greasy Creek	717068	4004955	251.0
GCR 2	Greasy Creek	716623	4005404	378.0
GCR 3	Greasy Creek	716657	4005721	357.0
FB 1	Ligias Fork	745026	4006342	452.0
GGB 1	Ligias Fork	745010	4006255	469.0
GGB 2	Ligias Fork	744253	4006655	438.0
LF 1	Ligias Fork	741210	4010193	408.0
LF 2	Ligias Fork	743011	4008626	374.0
LF 3	Ligias Fork	744046	4006282	456.0
LF 4	Ligias Fork	743938	4005627	468.0
LF 5	Ligias Fork	743772	4007003	436.0
LF 6	Ligias Fork	743954	4004977	471.0

Table B.1 continued ….

GPS		UTM COORDINATES		
Site ID	Watershed	Easting	Northing	Elevation
(---)	(---)	(m)	(m)	(m)
GB 1	Montgomery Fork	741023	4022820	418.0
JC 1	Montgomery Fork	738320	4024237	421.0
JC 2	Montgomery Fork	738372	4024182	423.0
JC 3	Montgomery Fork	738304	4023789	391.0
MFCS 1	Montgomery Fork	736370	4023646	367.0
MFCS 10	Montgomery Fork	736889	4023545	371.7
MFCS 2	Montgomery Fork	736403	4023704	367.5
MFCS 3	Montgomery Fork	736443	4023746	368.7
MFCS 4	Montgomery Fork	736520	4023749	369.5
MFCS 5	Montgomery Fork	736574	4023738	369.0
MFCS 6	Montgomery Fork	736646	4023699	369.5
MFCS 7	Montgomery Fork	736716	4023605	370.0
MFCS 8	Montgomery Fork	736781	4023573	370.7
MFCS 9	Montgomery Fork	736835	4023570	371.2
MKC 1	Montgomery Fork	741339	4022921	477.0
PCC 1	Montgomery Fork	739890	4023088	394.0
RC 1	Montgomery Fork	737758	4025733	455.0
RC 2	Montgomery Fork	736918	4024137	400.0
RC 3	Montgomery Fork	736927	4023644	380.0
SB 1	Montgomery Fork	742711	4021671	483.0
WC 1	Montgomery Fork	742741	4021748	476.0
SC 1	Smokey Creek	734326	4016826	382.0
SC 2	Smokey Creek	732652	4014181	399.0
SC 3	Smokey Creek	732095	4013103	410.0
SC 4	Smokey Creek	732053	4009619	449.0
SC 5	Smokey Creek	732287	4011204	436.0
SC 6	Smokey Creek	731326	4008590	451.0
SF 1	Smokey Creek	734213	4014525	390.0
SHC 1	Smokey Creek	730765	4012125	438.0

APPENDIX C: STREAM FIELD DATA per RGA STUDY SITE

FIELD DATA LEGEND

1. STUDY BANK HEIGHT (METERS):
   Is the tallest bank of the measured left and right banks.
2. STUDY BANKFULL HEIGHT (METERS):
   Is the shortest height of the left and right banks.
3. RATIO OF BANK HEIGHT TO STUDY BANKFULL HEIGHT:
   Is the study bank height divided by the study bankfull height.
4. STUDY ROOT DEPTH (METERS):
   Is the depth of roots seen on largest/tallest stream bank.
5. RATIO OF ROOT DEPTH TO BANK HEIGHT:
   Is the study root depth divided by the study bank height.
6. AVERAGE ROOT DENSITY (%):
   Is the percent of root coverage on both banks at each site.
7. WEIGHTED ROOT DENSITY (%):
   Is the average root density multiplied by the ratio of root depth to bank height.
8. AVERAGE SURFACE PROTECTION (%):
   Is the average amount of vegetation coverage on both banks seen to protect the banks from erosion due to shear stress of the flow.
9. AVERAGE THICKNESS OF RIPAIRIAN VEGITATION (0 Thick – 4 None):
   Is the average amount of noticeable riparian vegetation on the banks, estimated on a scale from 0.0 to 4.0.
10. LAND USE DISTURBANCE (0 None – 4 Disturbed):
    Is the severity of noticeable land use disturbances that could cause land erosion and/or sediment pollution to be transported to the stream site estimated on a scale from 0.0 to 4.0.
11. UN-NATURAL WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed):
    Is the severity of noticeable wetland/stream disturbances that could cause land erosion and/or sediment pollution to be transported to the stream site estimated on a scale from 0.0 to 4.0.
12. AMOUNT OF COAL FOUND (0 None – 4 Very Noticeable):
    Is the degree of noticeable coal deposited into the measured stream site estimated on a scale from 0.0 to 4.0.
13. HILL SLOPE VEGETATION (0 Thick – 4 None):
    Is the visible thickness of vegetation seen protecting the environment from eroding above the banks or transporting a large amount of sediment off the floodplain of the channel that is estimated on a scale from 0.0 to 4.0.
14. HILL SLOPE SCOUR (0 None – 4 Major):
    Is the visible severity of debris flow from a steep hill side that creates a direct flow path into the stream estimated on a scale from 0.0 to 4.0.
15. STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major):
    Is the severity of noticeable structures or human activities that could be causing erosional disturbances while crossing near the stream site estimated on a scale from 0.0 to 4.0.
16. STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major):
    Is the severity of noticeable structures or human activities that could be causing erosional disturbances adjacent to the stream site estimated on a scale from 0.0 to 4.0.

17. STREAM ALTERATIONS (0 None – 4 Major):
    Is the estimated severity of noticeable human alterations made to modify the natural hydraulic path of the stream estimated on a scale from 0.0 to 4.0.
18. AVERAGE SLOPE OF CHANNEL (%):
    Is the approximate gradient of the stream at that particular site measured from an upstream and a downstream thalweg measurement.
19. CHANNEL WIDTH / DEPTH RATIO:
    Is the channel's width divided by the approximate depth of water measured at the deepest point of the cross-section of stream site.
20. STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor):
    Is a measurement for high gradient streams to determine the degree of sediment movement and deposition within the stream. It is a visible measurement of the amount of sediment surrounds and covers the rocks that characterize the stream bed. It is measured on a scale from 0.0 to 4.0.
21. POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor):
    Is a measurement for low gradient streams to determine the mixture of substrate material at the bed of the channel. Firmer sediment or aquatic plants found on the bottom of the channel indicates optimal conditions for organism. Muddy uniform or bedrock found in the channel bed represents a poor environment for organism. It is measured on a scale from 0.0 to 4.0.
22. SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor):
    Is a measurement for both high and low gradient streams to visibly estimate the amount of sediment that has collected and is causing the stream to change its shape. If there is a large amount of sediment deposition, then there is a large amount of sediment transported in the stream. It is measured on a scale from 0.0 to 4.0.
23. CHANNEL RGA SCORE: (0.0 Very Stable Stream – 36.0 Unstable Stream):
    Is a measurement that estimates the stream's geomorphic stability by answering 9 different categories which define the stream and its characteristics. RGA stands for Rapid Geomorphic Assessment and it rates the stream based on a scale from 0.0 to 36.0.

SITE DATA FOLLOWS:

STREAM SAMPLE SITE NO.: BSC-1
STREAM NAME: Brimstone Creek

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-06-2007
GPS LOCATION OF SITE: E 0724066, N 4014829
WATERSHED NAME: Brimstone Creek (Reference)
SAMPLES TAKEN: 2 – Sediment Samples BSC-1 & BSC-1A

BRIEF DISCRIPTION OF SITE: Site is located off of Brimstone Road and is just upstream of the 2nd bridge crossing on Brimstone Road.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** BSC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 75
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 75
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 75

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.5
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.5
Note: Agriculture impacts seen

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.5

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.5
Note: Bridge just downstream

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0

STREAM ALTERATIONS (0 None – 4 Major): 0.5

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.8%

ACTIVE CHANNEL WIDTH (METERS): 8.5
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 8.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 56
MEADIAN (mm): 39
MODE (mm): 4
D16 (mm): 9
D50 (mm): 38
D84 (mm): 98
D90 (mm): 125

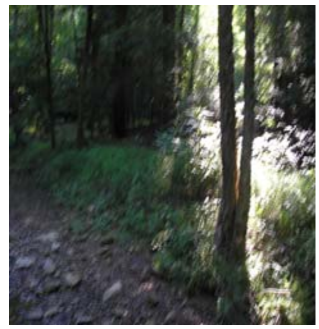
STREAM SAMPLE SITE NO.: BSC-2
STREAM NAME: Brimstone Creek

STREAM DATA COLLECTED BY: PM / KN
DATE OF SAMPLING AT SITE: 08-14-2007
GPS LOCATION OF SITE: E 0723488, N 4013568
WATERSHED NAME: Brimstone Creek (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located downstream of the junction of Joe Creek and Brimstone Creek.

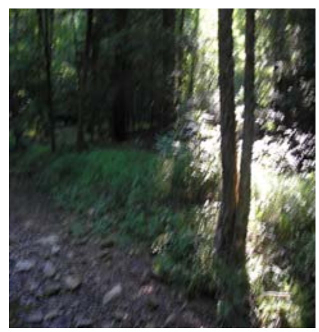
UPSTREAM PHOTO:





DOWNSTREAM PHOTO:





**** CONTINUED -- STREAM SAMPLE SITE NO.:** BSC-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 90
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 90
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.40%

ACTIVE CHANNEL WIDTH (METERS): 9.3
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 5.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 50
MEADIAN (mm): 36
MODE (mm): 12
D16 (mm): 8
D50 (mm): 34
D84 (mm): 94
D90 (mm): 107

STREAM SAMPLE SITE NO.: BSC-3
STREAM NAME: Brimstone Creek

STREAM DATA COLLECTED BY: PM / DJ
DATE OF SAMPLING AT SITE: 08-16-2007
GPS LOCATION OF SITE: E 0724437, N 4015349
WATERSHED NAME: Brimstone Creek (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located between Indian Creek junction with Brimstone Creek and downstream of the BSC-1 site.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** BSC-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 65
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.8
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 2.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.5

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.53%

ACTIVE CHANNEL WIDTH (METERS): 11.0
ACTIVE CHANNEL DEPTH (METERS): 0.25

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 7.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
  MEAN (mm): 47
  MEADIAN (mm): 34
  MODE (mm): 2
  D16 (mm): 5
  D50 (mm): 33
  D84 (mm): 94
  D90 (mm): 104

STREAM SAMPLE SITE NO.: JOE-1
STREAM NAME: Joe Creek

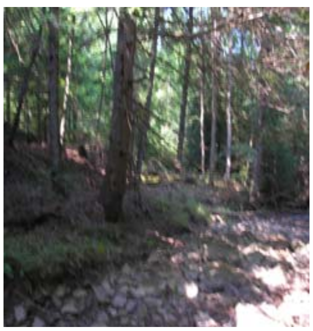
STREAM DATA COLLECTED BY: PM / KN
DATE OF SAMPLING AT SITE: 08-13-2007
GPS LOCATION OF SITE: E 0723332, N 4013459
WATERSHED NAME: Brimstone Creek (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of the Brimstone Creek and the Joe Creek junction. This site is parallel to a logging trail in the back of the Brimstone Watershed.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.**: JOE-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 80
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.5

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.55%

ACTIVE CHANNEL WIDTH (METERS): 9.5
ACTIVE CHANNEL DEPTH (METERS): 0.35

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.5

CHANNEL RGA SCORE: 5.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 68
- **MEADIAN (mm):** 52
- **MODE (mm):** 24
- **D16 (mm):** 12
- **D50 (mm):** 50
- **D84 (mm):** 124
- **D90 (mm):** 134

STREAM SAMPLE SITE NO.: IC-1
STREAM NAME: Indian Creek

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-06-2007
GPS LOCATION OF SITE: E 0725053, N 4015581
WATERSHED NAME: Brimstone Creek (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of the first bridge on Brimstone Road.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** IC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 80
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 2.5
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.85
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.35
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.5
Note: ATV Trail nearby

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.5

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 1.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.10%

ACTIVE CHANNEL WIDTH (METERS): 7.5
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 5.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 54
MEADIAN (mm): 44
MODE (mm): 24
D16 (mm): 14
D50 (mm): 42
D84 (mm): 88
D90 (mm): 109

TREAM SAMPLE SITE NO.: BBC-1
STREAM NAME: Big Bull Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 06-29-2007
GPS LOCATION OF SITE: E 0729450, N 4020049
WATERSHED NAME: Bull Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located within a logging area. The site is just off of the logging trail, which runs parallel to Big Bull Creek.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** BBC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 2.0
Note: Logging and ATV trails nearby.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Some minor trail crossings.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.0

STREAM ALTERATIONS (0 None – 4 Major): 2.0
Note: Trail causing stream to widen.

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.9%

ACTIVE CHANNEL WIDTH (METERS): 7.5
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.5

CHANNEL RGA SCORE: 6.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 60
MEADIAN (mm): 54
MODE (mm): 4
D16 (mm): 6
D50 (mm): 54
D84 (mm): 106
D90 (mm): 115

STREAM SAMPLE SITE NO.: BBC-2
STREAM NAME: Big Bull Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 06-29-2007
GPS LOCATION OF SITE: E 0729407, N 4021496
WATERSHED NAME: Bull Creek
SAMPLES TAKEN: 1 – Sediment Sample

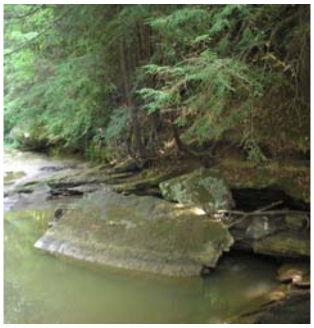
BRIEF DISCRIPTION OF SITE: Site is located upstream of BBC-1 in a residential community where a large amount of ATV activity and logging are seen. The site is beside of a gravel logging road and is downstream of where it crosses the stream.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:





**** CONTINUED -- STREAM SAMPLE SITE NO.:** BBC-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 90
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 2.0
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 75
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 75

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 2.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 2.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 2.0 (Due to Logging)

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 3.0
Note: Dirt Road above the stream.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 3.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 3.0
Note: Dirt road above

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 4.0
Note: Dirt/ Gravel road

STREAM ALTERATIONS (0 None – 4 Major): 2.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 3.0%

ACTIVE CHANNEL WIDTH (METERS): 17
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 4.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 4.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 4.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 15.0 / 36.0

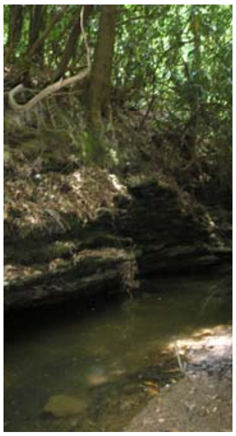
CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 33
MEADIAN (mm): 27
MODE (mm): 38
D16 (mm): 8
D50 (mm): 26
D84 (mm): 59
D90 (mm): 67

STREAM SAMPLE SITE NO.: LBC-1
STREAM NAME: Little Bull Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 06-29-2007
GPS LOCATION OF SITE: E 0731513, N 4022265
WATERSHED NAME: Bull Creek
SAMPLES TAKEN: 1 - Sediment

BRIEF DISCRIPTION OF SITE: Site is located upstream of a TWRA/logging trail that crosses the Little Bull Creek.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** LBC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 90
ESTIMATED LEFT BANK SLOPE (DEGREES): 90
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 2.5
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Trail DS

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 1.0
Note: TWRA/logging Trail

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Note: TWRA/logging Trail

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.8%

ACTIVE CHANNEL WIDTH (METERS): 5.5
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 6.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 71
MEADIAN (mm): 53
MODE (mm): 12
D16 (mm): 12
D50 (mm): 52
D84 (mm): 132
D90 (mm): 140

STREAM SAMPLE SITE NO.: LBC-2
STREAM NAME: Little Bull Creek

STREAM DATA COLLECTED BY: PM / TM
DATE OF SAMPLING AT SITE: 08-13-2007
GPS LOCATION OF SITE: E 0730784, N 4022796
WATERSHED NAME: Bull Creek (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of the Big Bull and Little Bull Creek junction, which is within a pasture with cattle.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** LBC-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 50
ESTIMATED LEFT BANK SLOPE (DEGREES): 20
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED RIGHT BANK ROOT DENSITY (%): 25
ESTIMATED LEFT BANK ROOT DENSITY (%): 25
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 30
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 30

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 3.5
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 3.5

LAND USE DISTURBANCE (0 None – 4 Disturbed): 3.0
Note: Cattle found in stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 3.0 (Cattle)

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 2.5

HILL SLOPE SCOUR (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 2.0 (Cattle)

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.42%

ACTIVE CHANNEL WIDTH (METERS): 7.0
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 3.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 4.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 3.0

CHANNEL RGA SCORE: 11.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 43
MEADIAN (mm): 33
MODE (mm): 2
D16 (mm): 6
D50 (mm): 32
D84 (mm): 81
D90 (mm): 94

STREAM SAMPLE SITE NO.: LBC-3
STREAM NAME: Little Bull Creek

STREAM DATA COLLECTED BY: PM / TM
DATE OF SAMPLING AT SITE: 08-13-2007
GPS LOCATION OF SITE: E 0731401, N 4021629
WATERSHED NAME: Bull Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of LF-1 and is further back into the trail that parallels Little Bull Creek.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** LBC-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 90
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 10.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 8.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.8
ESTIMATED RIGHT BANK ROOT DENSITY (%): 70
ESTIMATED LEFT BANK ROOT DENSITY (%): 40
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 90

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.5
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.5

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0 (due to logging)

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5
Note: Trail parallel to stream

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 2.72%

ACTIVE CHANNEL WIDTH (METERS): 6.5
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 8.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 43
MEADIAN (mm): 31
MODE (mm): 4
D16 (mm): 6
D50 (mm): 30
D84 (mm): 80
D90 (mm): 96

STREAM SAMPLE SITE NO.: LBC-4
STREAM NAME: Little Bull Creek

STREAM DATA COLLECTED BY: PM / TM
DATE OF SAMPLING AT SITE: 08-13-2007
GPS LOCATION OF SITE: E 0731407, N 4021409
WATERSHED NAME: Bull Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of LF-3 and is further back into the trail that parallels Little Bull Creek.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** LBC-4

ESTIMATED RIGHT BANK SLOPE (DEGREES): 80
ESTIMATED LEFT BANK SLOPE (DEGREES): 80
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.25
ESTIMATED LEFT BANK HEIGHT (METERS): 1.25
BANKFULL HEIGHT (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 80
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.5

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5
Note: Due to the small trail that follows the creek.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 3.13%

ACTIVE CHANNEL WIDTH (METERS): 7.5
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 7.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 46
MEADIAN (mm): 36
MODE (mm): 4
D16 (mm): 6
D50 (mm): 36
D84 (mm): 82
D90 (mm): 100

STREAM SAMPLE SITE NO.: BBC-3
STREAM NAME: Big Bull Creek

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-10-2007
GPS LOCATION OF SITE: E 0730039, N 4022813
WATERSHED NAME: Bull Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of the Big and Little Bull junction which leads into the New River. This site is located off of farm land in a property owner's backyard.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** BBC-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 2.0
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.75
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 75
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 75

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Agriculture/Cattle near.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.20%

ACTIVE CHANNEL WIDTH (METERS): 9.5
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 3.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 65
MEADIAN (mm): 53
MODE (mm): 52
D16 (mm): 10
D50 (mm): 52
D84 (mm): 114
D90 (mm): 132

STREAM SAMPLE SITE NO.: BC-1
STREAM NAME: Bull Creek

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-10-2007
GPS LOCATION OF SITE: E 0730555, N 4022988
WATERSHED NAME: Bull Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located downstream of the junction of Little Bull and Big Bull Creeks.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** BC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 90
ESTIMATED RIGHT BANK HEIGHT (METERS): 3.0
ESTIMATED LEFT BANK HEIGHT (METERS): 3.0
BANKFULL HEIGHT (METERS): 3.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 2.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 75
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 50
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 50

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 2.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 2.0 (Logging nearby)

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 2.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 2.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 2.0

HILL SLOPE SCOUR (0 None – 4 Major): 2.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 3.0
Note: Bridge upstream causing blockage

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 2.0
Note: Dirt roads for logging

STREAM ALTERATIONS (0 None – 4 Major):

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.1%

ACTIVE CHANNEL WIDTH (METERS): 7.0
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 4.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 4.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 3.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 4.0

CHANNEL RGA SCORE: 17.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 55
MEADIAN (mm): 48
MODE (mm): 2
D16 (mm): 10
D50 (mm): 47
D84 (mm): 94
D90 (mm): 111

STREAM SAMPLE SITE NO.: NPFF-1
STREAM NAME: North Prong Flat Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-01-2007
GPS LOCATION OF SITE: E 0726633, N 4002211
WATERSHED NAME: Frozen Head (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located off a hiking trail that goes to Emory Falls.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** NPFF-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.4
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.4
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.5

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 3.04%

ACTIVE CHANNEL WIDTH (METERS): 7.0
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 2.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 6.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 64
- **MEADIAN (mm):** 40
- **MODE (mm):** 8
- **D16 (mm):** 8
- **D50 (mm):** 38
- **D84 (mm):** 110
- **D90 (mm):** 140

STREAM SAMPLE SITE NO.: NPFF-2
STREAM NAME: North Prong Flat Fork

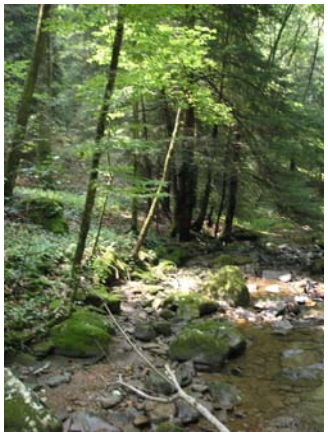
STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-01-2007
GPS LOCATION OF SITE: E 0726923, N 4002369
WATERSHED NAME: Frozen Head (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of NPFF-1 and the first set of waterfalls on the hiking trail to Emory Falls.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** NPFF-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 2.0
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.75
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 6.94%

ACTIVE CHANNEL WIDTH (METERS): 7.5
ACTIVE CHANNEL DEPTH (METERS): 0.25

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 5.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 65
- **MEADIAN (mm):** 46
- **MODE (mm):** 4
- **D16 (mm):** 4
- **D50 (mm):** 44
- **D84 (mm):** 114
- **D90 (mm):** 142

STREAM SAMPLE SITE NO.: NPFF-3
STREAM NAME: North Prong Flat Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-11-2007
GPS LOCATION OF SITE: E 0725620, N 4001905
WATERSHED NAME: Frozen Head (Reference)
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located at the outlet of the reference watershed within the Frozen Head State Park.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** NPFF-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 30
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.8
ESTIMATED LEFT BANK HEIGHT (METERS): 1.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.5 (Camping nearby)

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 6.05%

ACTIVE CHANNEL WIDTH (METERS): 9.0
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 7.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 72
- **MEADIAN (mm):** 52
- **MODE (mm):** 4
- **D16 (mm):** 9
- **D50 (mm):** 52
- **D84 (mm):** 128
- **D90 (mm):** 158

STREAM SAMPLE SITE NO.: GCR-1
STREAM NAME: Greasy Creek

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 07-27-2007
GPS LOCATION OF SITE: E 0717068, N 4004955
WATERSHED NAME: Greasy Creek near Warburg
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of a bridge and wetland area. The site is just off of the Greasy Creek Road.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** GCR-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 3.5
ESTIMATED LEFT BANK HEIGHT (METERS): 2.5
BANKFULL HEIGHT (METERS): 2.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 2.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.5 (Road Parallel)

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.83%

ACTIVE CHANNEL WIDTH (METERS): 13.0
ACTIVE CHANNEL DEPTH (METERS): 0.3

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 2.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 8.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 63
- **MEADIAN (mm):** 45
- **MODE (mm):** 12
- **D16 (mm):** 10
- **D50 (mm):** 44
- **D84 (mm):** 126
- **D90 (mm):** 147

STREAM SAMPLE SITE NO.: GCR-2
STREAM NAME: Greasy Creek

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 07-27-2007
GPS LOCATION OF SITE: E 0716623, N 4005404
WATERSHED NAME: Greasy Creek near Warburg
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located beside Greasy Creek Road. A white house sits on the left side of the creek looking upstream.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** GCR-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.8
ESTIMATED LEFT BANK HEIGHT (METERS): 3.0
BANKFULL HEIGHT (METERS): 1.8
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.6
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.9
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 85

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.5
Note: Road to the right; House to the left.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.85%

ACTIVE CHANNEL WIDTH (METERS): 10.0
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 8.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 33
MEADIAN (mm): 31
MODE (mm): 20
D16 (mm): 10
D50 (mm): 30
D84 (mm): 54
D90 (mm): 64

STREAM SAMPLE SITE NO.: GCR-3
STREAM NAME: Greasy Creek

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 07-27-2007
GPS LOCATION OF SITE: E 0716657, N 4005721
WATERSHED NAME: Greasy Creek near Warburg
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located off of Greasy Creek Road. The site is downstream of a wetland / floodplain area. The site is found at the end of a dirt driveway across the stream and into a field.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** GCR-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 45
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 2.5
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 75
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 80
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.5 (Driveway Crossing)

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.5

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.5

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.27%

ACTIVE CHANNEL WIDTH (METERS): 13.0
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 7.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 54
- **MEADIAN (mm):** 47
- **MODE (mm):** 16
- **D16 (mm):** 14
- **D50 (mm):** 46
- **D84 (mm):** 90
- **D90 (mm):** 106

STREAM SAMPLE SITE NO.: LF-1
STREAM NAME: Ligias Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 06-18-2007
GPS LOCATION OF SITE: E 0741210, N 4010193
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of bridge with culverts. About 20 meters upstream of bridge.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** LF-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 90
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 3.5
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 50

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 2.0
Note: Paved Bridge Crossing downstream.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 2.0
Note: Paved Bridge Crossing downstream.

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 4.0
Note: Paved Road and Open Agricultural Field on both sides.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.53%

ACTIVE CHANNEL WIDTH (METERS): 11.0
ACTIVE CHANNEL DEPTH (METERS): 0.3

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 4.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 8.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 52
MEADIAN (mm): 47
MODE (mm): 6
D16 (mm): 14
D50 (mm): 46
D84 (mm): 88
D90 (mm): 97

STREAM SAMPLE SITE NO.: LF-2
STREAM NAME: Ligias Fork

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 06-18-2007
GPS LOCATION OF SITE: E 0743011, N 4008626
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of LF-1 and parallel to the same road.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** LF-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 45
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.5
ESTIMATED LEFT BANK HEIGHT (METERS): 2.5
BANKFULL HEIGHT (METERS): 2.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 2.3
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.3
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.5

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.5
Note: Trail not used often.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.5
Note: Slight Trail seen.

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.0
Note: Paved state route parallel to stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.76%

ACTIVE CHANNEL WIDTH (METERS): 17.0
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 52
MEADIAN (mm): 44
MODE (mm): 44
D16 (mm): 14
D50 (mm): 44
D84 (mm): 87
D90 (mm): 100

STREAM SAMPLE SITE NO.: LF-3
STREAM NAME: Ligias Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 06-25-2007
GPS LOCATION OF SITE: E 0744046, N 4006282
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located just upstream of first Ligias Fork Road crossing.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** LF-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 30
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.75
ESTIMATED LEFT BANK HEIGHT (METERS): 2.75
BANKFULL HEIGHT (METERS): 1.75
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.50
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.50
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Road for logging parallel to stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.0
Note: Due to dirt road.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.62%

ACTIVE CHANNEL WIDTH (METERS): 11.0
ACTIVE CHANNEL DEPTH (METERS): 0.3

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 3.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 7.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 82
MEADIAN (mm): 37
MODE (mm): 2
D16 (mm): 8
D50 (mm): 34
D84 (mm): 178
D90 (mm): 240

STREAM SAMPLE SITE NO.: GGB-1
STREAM NAME: Graves Gap Branch

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 06-25-2007
GPS LOCATION OF SITE: E 0745010, N 4006255
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located just upstream of the Bill Patterson Bridge (which is off of Bill Patterson Lane that comes to a dead-end at a cemetery).

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** GGB-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 1.75
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Bridge seen downstream.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 2.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 1.0
Note: Swinging Bridge & Driveway Bridge.

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Note: SR-116 is parallel to stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 2.38%

ACTIVE CHANNEL WIDTH (METERS): 8.0
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 0.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.5

CHANNEL RGA SCORE: 6.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 117
MEADIAN (mm): 58
MODE (mm): 18
D16 (mm): 8
D50 (mm): 56
D84 (mm): 232
D90 (mm): 364

STREAM SAMPLE SITE NO.: FB-1
STREAM NAME: Flat Branch

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 06-25-2007
GPS LOCATION OF SITE: E 0745026, N 4006342
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located just downstream of the State Route 116 Bridge crossing.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** FB-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 90
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 2.0
Note: Near SR-116 and a loose gravel road.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 2.0
Note: Upstream bridge crossing.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 4.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 2.11%

ACTIVE CHANNEL WIDTH (METERS): 5.5
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 4.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 4.0

CHANNEL RGA SCORE: 11.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 80
MEADIAN (mm): 48
MODE (mm): 14
D16 (mm): 8
D50 (mm): 48
D84 (mm): 158
D90 (mm): 192

STREAM SAMPLE SITE NO.: GGB-2
STREAM NAME: Graves Gap Branch

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 8/8/2007
GPS LOCATION OF SITE: E 0744253, N 4006655
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located just upstream of the Ligias Fork and Graves Gap Branch junction and just upstream of the Ligias Fork Road / Trail.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** GGB-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.75
ESTIMATED LEFT BANK HEIGHT (METERS): 3.0
BANKFULL HEIGHT (METERS): 1.75
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 75
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Road and Houses near.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.5 (Driveway DS)

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0

STREAM ALTERATIONS (0 None – 4 Major): 2.0 (LT Bank Modified)

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.79%

ACTIVE CHANNEL WIDTH (METERS): 8.5
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.5

CHANNEL RGA SCORE: 8.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 61
MEADIAN (mm): 39
MODE (mm): 18
D16 (mm): 8
D50 (mm): 38
D84 (mm): 118
D90 (mm): 145

STREAM SAMPLE SITE NO.: LF-4
STREAM NAME: Ligias Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-08-2007
GPS LOCATION OF SITE: E 0743938, N 4005627
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of LF-3 on the TWRA and Coal Creek ATV trail. Just above the second creek crossing.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** LF-4

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.25
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 75
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: ATV Trail

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: ATV Trail

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.5

HILL SLOPE SCOUR (0 None – 4 Major): 0.5

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 2.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 2.0

STREAM ALTERATIONS (0 None – 4 Major): 1.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.06%

ACTIVE CHANNEL WIDTH (METERS): 12.0
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 2.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.5

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 60
MEADIAN (mm): 46
MODE (mm): 4
D16 (mm): 6
D50 (mm): 45
D84 (mm): 110
D90 (mm): 120

STREAM SAMPLE SITE NO.: LF-5
STREAM NAME: Ligias Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 08-08-2007
GPS LOCATION OF SITE: E 0743772, N 4007003
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located behind the Pilot Church on SR-116.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** LF-5

ESTIMATED RIGHT BANK SLOPE (DEGREES): 80
ESTIMATED LEFT BANK SLOPE (DEGREES): 20
ESTIMATED RIGHT BANK HEIGHT (METERS): 4.00
ESTIMATED LEFT BANK HEIGHT (METERS): 1.25
BANKFULL HEIGHT (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 3.25
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.00
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 65
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 2.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 3.5
Note: Logging and Trail Crossings upstream

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 3.0 (upstream)

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 3.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.5

STREAM ALTERATIONS (0 None – 4 Major): 1.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.83%

ACTIVE CHANNEL WIDTH (METERS): 14.0
ACTIVE CHANNEL DEPTH (METERS): 0.25

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 3.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 3.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 4.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.5

CHANNEL RGA SCORE: 12.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 67
MEADIAN (mm): 50
MODE (mm): 2
D16 (mm): 17
D50 (mm): 49
D84 (mm): 104
D90 (mm): 121

STREAM SAMPLE SITE NO.: LF-6
STREAM NAME: Ligias Fork

STREAM DATA COLLECTED BY: PM / DJ
DATE OF SAMPLING AT SITE: 08-15-2007
GPS LOCATION OF SITE: E 0743954, N 4004977
WATERSHED NAME: Ligias Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of LF-4 and off the Coal Creek ATV Trail No. 10. The site is also just upstream of the Phillips Branch junction of Ligias Fork.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** LF-6

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.75
BANKFULL HEIGHT (METERS): 1.75
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.5
Note: ATV Trails nearby.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.43%

ACTIVE CHANNEL WIDTH (METERS): 16.0
ACTIVE CHANNEL DEPTH (METERS): 0.25

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 7.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 89
MEADIAN (mm): 60
MODE (mm): 2
D16 (mm): 10
D50 (mm): 60
D84 (mm): 170
D90 (mm): 200

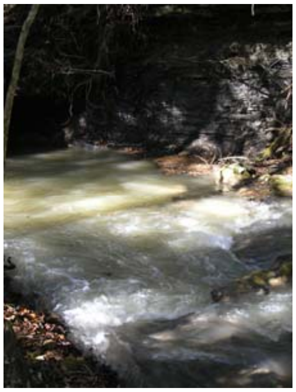
STREAM SAMPLE SITE NO.: JC-1
STREAM NAME: Jenney Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 02-28-2007
GPS LOCATION OF SITE: E 0738320, N 4024237
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE

BRIEF DISCRIPTION OF SITE: Site is located at a sharp bend just upstream of the TWRA bridge/culvert road/trail at a riffle.

UPSTREAM PHOTOS:


DOWNSTREAM PHOTOS:




BED CHARACTER PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** JC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 70
ESTIMATED RIGHT BANK HEIGHT (METERS): 0.5
ESTIMATED LEFT BANK HEIGHT (METERS): 1.0
BANKFULL HEIGHT (METERS): 0.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 0.0
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 4.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 2.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 1.2

ACTIVE CHANNEL WIDTH (METERS): 5.0
ACTIVE CHANNEL DEPTH (METERS): 0.3

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 3.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): N/A
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 7.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 31
- **MEADIAN (mm):** 25
- **MODE (mm):** 20
- **D16 (mm):** 8
- **D50 (mm):** 24
- **D84 (mm):** 50
- **D90 (mm):** 60

STREAM SAMPLE SITE NO.: JC-2
STREAM NAME: Jenney Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 02-28-2007
GPS LOCATION OF SITE: E 0738372, N 4024182
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE

BRIEF DISCRIPTION OF SITE: Site is located at a riffle which is just downstream of the TWRA bridge/culvert road/trail. This stream is high gradient with large boulders.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** JC-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 30
ESTIMATED RIGHT BANK HEIGHT (METERS): 3.0
ESTIMATED LEFT BANK HEIGHT (METERS):1.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 3.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
The culverts due to a TWRA dirt road/trail can possible alter the environment of the stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 4.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 4.8

ACTIVE CHANNEL WIDTH (METERS): 6.0
ACTIVE CHANNEL DEPTH (METERS): 0.3

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 3.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): N/A
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 8.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 20
MEADIAN (mm): 17
MODE (mm): 10
D16 (mm): 6
D50 (mm): 16
D84 (mm): 32
D90 (mm): 36

STREAM SAMPLE SITE NO.: JC-3
STREAM NAME: Jenney Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 02-28-2007
GPS LOCATION OF SITE: E 0738304, N 4023789
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE

BRIEF DISCRIPTION OF SITE: Site is a riffle that is located downstream of the TWRA bridge/culvert road/trail and just upstream of the Jenney Creek – Montgomery Fork junction. This stream is high gradient with large boulders.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.**: JC-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 45
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS):2.5
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 2.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 3.7

ACTIVE CHANNEL WIDTH (METERS): 4.25
ACTIVE CHANNEL DEPTH (METERS): 0.25

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): N/A
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 6.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 15
- **MEADIAN (mm):** 12
- **MODE (mm):** 4
- **D16 (mm):** 4
- **D50 (mm):** 12
- **D84 (mm):** 24
- **D90 (mm):** 30

STREAM SAMPLE SITE NO.: RC-1
STREAM NAME: Roach Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 03-07-2007
GPS LOCATION OF SITE: E 0737758, N 4025733
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 2 – SEDIMENT SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 150 meters downstream of a dirt logging road that loops onto the loose gravel coal haul road.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

BED CHARACTER PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** RC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 20
ESTIMATED RIGHT BANK HEIGHT (METERS): 0.5
ESTIMATED LEFT BANK HEIGHT (METERS): 0.5
BANKFULL HEIGHT (METERS): 0.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.4
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.4
ESTIMATED RIGHT BANK ROOT DENSITY (%): 30
ESTIMATED LEFT BANK ROOT DENSITY (%): 30
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 50
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 50

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 2.0
There is a vast amount of fallen trees into the stream. May be caused from roads and activity above the stream.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 4.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 3.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 2.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 1.3

ACTIVE CHANNEL WIDTH (METERS): 5.50
ACTIVE CHANNEL DEPTH (METERS): 0.20

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 3.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): N/A
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 11.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 20
- **MEADIAN (mm):** 16
- **MODE (mm):** 6
- **D16 (mm):** 6
- **D50 (mm):** 16
- **D84 (mm):** 38
- **D90 (mm):** 42

STREAM SAMPLE SITE NO.: RC-2
STREAM NAME: Roach Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 03-07-2007
GPS LOCATION OF SITE: E 0736918, N 4024137
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 200 meters upstream from the coal haul road bridge and approximately 50 meters adjacent from a dirt logging road that is off the main coal haul road.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** RC-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 40
ESTIMATED LEFT BANK SLOPE (DEGREES): 80
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 3.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 50
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 50
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 30

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 2.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 3.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 4.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 2.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Dirt road found parallel to stream at sample site.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 1.3

ACTIVE CHANNEL WIDTH (METERS): 7.50
ACTIVE CHANNEL DEPTH (METERS): 0.35

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 3.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): N/A
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 12.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 20
MEADIAN (mm): 14
MODE (mm): 6
D16 (mm): 6
D50 (mm): 14
D84 (mm): 34
D90 (mm): 38

STREAM SAMPLE SITE NO.: RC-3
STREAM NAME: Roach Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 03-07-2007
GPS LOCATION OF SITE: E 0736927, N 4023644
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 150 meters upstream of the Roach Creek and Montgomery Fork junction.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.**: RC-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 3.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.8
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.8
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 4.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 2.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 1.2

ACTIVE CHANNEL WIDTH (METERS): 9.50
ACTIVE CHANNEL DEPTH (METERS): 0.20

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): N/A
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.5

CHANNEL RGA SCORE: 10.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 18
- **MEADIAN (mm):** 12
- **MODE (mm):** 8
- **D16 (mm):** 4
- **D50 (mm):** 12
- **D84 (mm):** 32
- **D90 (mm):** 42

STREAM SAMPLE SITE NO.: PCC-1
STREAM NAME: Puncheon Camp Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 03-09-2007
GPS LOCATION OF SITE: E 0739890, N 4023088
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE

BRIEF DISCRIPTION OF SITE: Site is a riffle located below a dirt TWRA trail and above the Puncheon Camp Creek and Montgomery Fork junction.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** PCC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 45
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED RIGHT BANK ROOT DENSITY (%): 50
ESTIMATED LEFT BANK ROOT DENSITY (%): 50
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 50
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 50

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 1.8

ACTIVE CHANNEL WIDTH (METERS): 6.50
ACTIVE CHANNEL DEPTH (METERS): 0.20

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 10.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 46
- **MEADIAN (mm):** 35
- **MODE (mm):** 28
- **D16 (mm):** 10
- **D50 (mm):** 34
- **D84 (mm):** 87
- **D90 (mm):** 95

STREAM SAMPLE SITE NO.: GB-1
STREAM NAME: Greens Branch

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 03-09-2007
GPS LOCATION OF SITE: E 0741023, N 4022820
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 100 meters above the Montgomery Fork and Greens Branch junction.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** GB-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 70
ESTIMATED LEFT BANK SLOPE (DEGREES): 85
ESTIMATED RIGHT BANK HEIGHT (METERS): 3.0
ESTIMATED LEFT BANK HEIGHT (METERS): 3.0
BANKFULL HEIGHT (METERS): 3.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 3.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 3.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 70
ESTIMATED LEFT BANK ROOT DENSITY (%): 85
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 6.3

ACTIVE CHANNEL WIDTH (METERS): 7.00
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 7.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 28
- **MEADIAN (mm):** 22
- **MODE (mm):** 8
- **D16 (mm):** 10
- **D50 (mm):** 22
- **D84 (mm):** 45
- **D90 (mm):** 55

STREAM SAMPLE SITE NO.: MFCS-1
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-20-2007
GPS LOCATION OF SITE: E 0736370, N 4023646
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 56 meters upstream of the Norma Road Bridge.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 35
ESTIMATED LEFT BANK SLOPE (DEGREES): 35
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 2.0
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 75
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 2.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Coal Haul Road runs parallel to the stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 2.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Coal Haul Road runs parallel to the stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.5

ACTIVE CHANNEL WIDTH (METERS): 16.50
ACTIVE CHANNEL DEPTH (METERS): 0.45

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 3.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 10.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 47
MEADIAN (mm): 31
MODE (mm): 6
D16 (mm): 6
D50 (mm): 30
D84 (mm): 88
D90 (mm): 124

STREAM SAMPLE SITE NO.: MFCS-2
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-20-2007
GPS LOCATION OF SITE: E 0736403, N 4023704
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a pool located approximately 63 meters upstream of the MFCS-1.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 45
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.5
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Coal Haul Road runs parallel to the stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Coal Haul Road runs parallel to the stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 1.0

ACTIVE CHANNEL WIDTH (METERS): 11.50
ACTIVE CHANNEL DEPTH (METERS): 0.60

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 2.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.5

CHANNEL RGA SCORE: 8.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): N/A
MEADIAN (mm): N/A
MODE (mm): N/A
D16 (mm): N/A
D50 (mm): N/A
D84 (mm): N/A
D90 (mm): N/A

STREAM SAMPLE SITE NO.: MFCS-3
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-20-2007
GPS LOCATION OF SITE: E 0736443, N 4023746
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 47 meters upstream of the MFCS-2. A vast amount of coal found around site. Coal found is also very large in size.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 45
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.8
ESTIMATED LEFT BANK HEIGHT (METERS): 2.1
BANKFULL HEIGHT (METERS): 1.8
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Coal Haul Road runs parallel to the stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 4.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Coal Haul Road runs parallel to the stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.85

ACTIVE CHANNEL WIDTH (METERS): 18.00
ACTIVE CHANNEL DEPTH (METERS): 0.80

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 9.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 63
- **MEADIAN (mm):** 57
- **MODE (mm):** 32
- **D16 (mm):** 10
- **D50 (mm):** 56
- **D84 (mm):** 107
- **D90 (mm):** 124

STREAM SAMPLE SITE NO.: MFCS-4
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-23-2007
GPS LOCATION OF SITE: E 0736520, N 4023749
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 80 meters upstream of the MFCS-3.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-4

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 40
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.3
ESTIMATED LEFT BANK HEIGHT (METERS): 1.0
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.5
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.5

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Dirt Driveway runs parallel to the stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0
Four wheeler trail across creek.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 2.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Dirt Driveway runs parallel to the stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.01

ACTIVE CHANNEL WIDTH (METERS): 17.00
ACTIVE CHANNEL DEPTH (METERS): 0.50

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 3.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 3.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.5

CHANNEL RGA SCORE: 10.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 70
- **MEADIAN (mm):** 56
- **MODE (mm):** 56
- **D16 (mm):** 18
- **D50 (mm):** 56
- **D84 (mm):** 116
- **D90 (mm):** 138

STREAM SAMPLE SITE NO.: MFCS-5
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-23-2007
GPS LOCATION OF SITE: E 0736574, N 4023738
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a pool located approximately 70 meters upstream of the MFCS-4. A vast amount of decomposing leaves and sediment found in this pool.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-5

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.3
BANKFULL HEIGHT (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.10
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.25
ESTIMATED RIGHT BANK ROOT DENSITY (%): 45
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Dirt Driveway runs parallel to the stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Dirt Driveway runs parallel to the stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.26

ACTIVE CHANNEL WIDTH (METERS): 15.00
ACTIVE CHANNEL DEPTH (METERS): 0.90

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 4.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 4.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 3.0

CHANNEL RGA SCORE: 15.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): N/A
MEADIAN (mm): N/A
MODE (mm): N/A
D16 (mm): N/A
D50 (mm): N/A
D84 (mm): N/A
D90 (mm): N/A

STREAM SAMPLE SITE NO.: MFCS-6
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-24-2007
GPS LOCATION OF SITE: E 0736646, N 4023699
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a pool located approximately 83 meters upstream of the MFCS-5. Shallow pool with a uniform distribution of approximately 25mm pebbles. Site is located in front of house.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-6

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 3.0
ESTIMATED LEFT BANK HEIGHT (METERS): 2.0
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.75
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 40
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 40

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Dirt Driveway runs parallel to the stream.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Dirt Driveway runs parallel to the stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.57

ACTIVE CHANNEL WIDTH (METERS): 19.00
ACTIVE CHANNEL DEPTH (METERS): 1.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 9.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): N/A
MEADIAN (mm): N/A
MODE (mm): N/A
D16 (mm): N/A
D50 (mm): N/A
D84 (mm): N/A
D90 (mm): N/A

STREAM SAMPLE SITE NO.: MFCS-7
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-24-2007
GPS LOCATION OF SITE: E 0736716, N 4023605
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 1 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 97 meters upstream of the MFCS-6. This riffle is very constricted with a rock wall on the right bank and a bedrock bed.

UPSTREAM PHOTO:


UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:


DOWNSTREAM PHOTO:


**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-7

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 20
ESTIMATED RIGHT BANK HEIGHT (METERS): 6.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.2
BANKFULL HEIGHT (METERS): 1.2
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 4.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.1
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 10
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 50

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 4.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 3.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 2.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.50

ACTIVE CHANNEL WIDTH (METERS): 10.00
ACTIVE CHANNEL DEPTH (METERS): 0.8

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 2.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 4.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.5

CHANNEL RGA SCORE: 10.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 74
- **MEADIAN (mm):** 61
- **MODE (mm):** 2
- **D16 (mm):** 8
- **D50 (mm):** 60
- **D84 (mm):** 132
- **D90 (mm):** 160

STREAM SAMPLE SITE NO.: MFCS-8
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-25-2007
GPS LOCATION OF SITE: E 0736781, N 4023573
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a pool located approximately 92 meters upstream of the MFCS-7.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-8

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 35
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 1.3
BANKFULL HEIGHT (METERS): 1.3
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 50
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 2.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.70

ACTIVE CHANNEL WIDTH (METERS): 13.00
ACTIVE CHANNEL DEPTH (METERS): 0.6

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 3.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.5

CHANNEL RGA SCORE: 10.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** N/A
- **MEADIAN (mm):** N/A
- **MODE (mm):** N/A
- **D16 (mm):** N/A
- **D50 (mm):** N/A
- **D84 (mm):** N/A
- **D90 (mm):** N/A

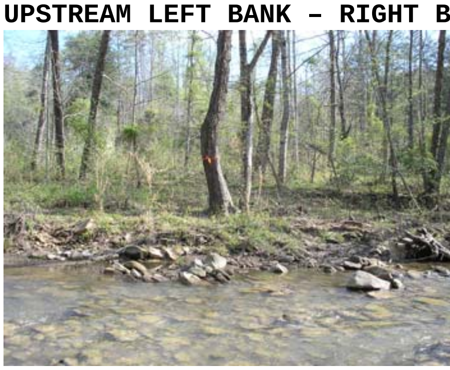
STREAM SAMPLE SITE NO.: MFCS-9
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-25-2007
GPS LOCATION OF SITE: E 0736835, N 4023570
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 62 meters upstream of the MFCS-8. This cross-section looks to have some old structures created several years ago on the left bank.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:



DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-9

ESTIMATED RIGHT BANK SLOPE (DEGREES): 40
ESTIMATED LEFT BANK SLOPE (DEGREES): 20
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.7
ESTIMATED LEFT BANK HEIGHT (METERS): 1.7
BANKFULL HEIGHT (METERS): 1.7
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 0.8
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.8
ESTIMATED RIGHT BANK ROOT DENSITY (%): 75
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0
Old mortar and rock structure along left bank.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 2.0
Old mortar and rock bank protection / structures on left bank

STREAM ALTERATIONS (0 None – 4 Major): 1.0

AVERAGE SLOPE OF CHANNEL (%): 0.16

ACTIVE CHANNEL WIDTH (METERS): 16.50
ACTIVE CHANNEL DEPTH (METERS): 0.8

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.5

CHANNEL RGA SCORE: 10.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 118
- **MEADIAN (mm):** 107
- **MODE (mm):** 6
- **D16 (mm):** 18
- **D50 (mm):** 23
- **D84 (mm):** 87
- **D90 (mm):** 166

STREAM SAMPLE SITE NO.: MFCS-10
STREAM NAME: Montgomery Fork

STREAM DATA COLLECTED BY: PM
DATE OF SAMPLING AT SITE: 04-25-2007
GPS LOCATION OF SITE: E 0736889, N 4023545
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – SEDIMENT SAMPLE & 2 – BANK SAMPLES

BRIEF DISCRIPTION OF SITE: Site is a riffle located approximately 53 meters upstream of the MFCS-9. This site is also located just downstream of the Roach Creek and Montgomery Fork Junction.

UPSTREAM PHOTO:

UPSTREAM LEFT BANK – RIGHT BANK PHOTOS:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** MFCS-10

ESTIMATED RIGHT BANK SLOPE (DEGREES): 80
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.6
ESTIMATED LEFT BANK HEIGHT (METERS): 5.0
BANKFULL HEIGHT (METERS): 1.6
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 3.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 2.0
Water truck from Coal Mining comes to the Roach Ck & MF Jct. to refill off of the TWRA road crossing Roach Creek.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 2.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0
HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 2.0
TWRA Dirt Road Crossing Roach Creek upstream of MFCS-10.

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
TWRA Road runs parallel on left side of stream.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (%): 0.20

ACTIVE CHANNEL WIDTH (METERS): 19.00
ACTIVE CHANNEL DEPTH (METERS): 0.6

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 10.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 33
- **MEADIAN (mm):** 24
- **MODE (mm):** 12
- **D16 (mm):** 12
- **D50 (mm):** 24
- **D84 (mm):** 49
- **D90 (mm):** 62

STREAM SAMPLE SITE NO.: WC-1
STREAM NAME: Wheeler Creek

STREAM DATA COLLECTED BY: PM & TM
DATE OF SAMPLING AT SITE: 06-22-2007
GPS LOCATION OF SITE: E 0742741, N 4021748
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located off of a TWRA trail toward the outer portion of the watershed. This stream is one of two streams that form the Montgomery Fork.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** WC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 3.0
ESTIMATED LEFT BANK HEIGHT (METERS): 5.0
BANKFULL HEIGHT (METERS): 3.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 2.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 4.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.4%

ACTIVE CHANNEL WIDTH (METERS): 9.0
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 7.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 60
- **MEADIAN (mm):** 42
- **MODE (mm):** 14
- **D16 (mm):** 11
- **D50 (mm):** 41
- **D84 (mm):** 104
- **D90 (mm):** 140

STREAM SAMPLE SITE NO.: SB-1
STREAM NAME: Spring Branch

STREAM DATA COLLECTED BY: PM & TM
DATE OF SAMPLING AT SITE: 06-22-2007
GPS LOCATION OF SITE: E 0742711, N 4021671
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located off of a TWRA trail toward the outer portion of the watershed. This stream is one of two streams that form the Montgomery Fork.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** SB-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 30
ESTIMATED LEFT BANK SLOPE (DEGREES): 30
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.5
ESTIMATED LEFT BANK HEIGHT (METERS): 2.5
BANKFULL HEIGHT (METERS): 2.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 50
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 2.1%

ACTIVE CHANNEL WIDTH (METERS): 10.0
ACTIVE CHANNEL DEPTH (METERS): 0.1

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.0

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 48
- **MEADIAN (mm):** 25
- **MODE (mm):** 11
- **D16 (mm):** 7
- **D50 (mm):** 25
- **D84 (mm):** 107
- **D90 (mm):** 133

STREAM SAMPLE SITE NO.: MKC-1
STREAM NAME: McKinney Creek

STREAM DATA COLLECTED BY: PM & TM
DATE OF SAMPLING AT SITE: 06-22-2007
GPS LOCATION OF SITE: E 0741339, N 4022921
WATERSHED NAME: Montgomery Fork
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located off of a TWRA Trail nearing the outer portion of the Montgomery Fork Watershed. This stream is a tributary that enters into the Montgomery Fork Stream.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.**: MKC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 20
ESTIMATED LEFT BANK SLOPE (DEGREES): 90
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 5.0
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 25
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0 (ATV Trails near)

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0 (Dirt Trail)

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 1.0 (Trail)

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 3.2%

ACTIVE CHANNEL WIDTH (METERS): 7.5
ACTIVE CHANNEL DEPTH (METERS): 0.3

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.5
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 8.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 74
- **MEADIAN (mm):** 39
- **MODE (mm):** 16
- **D16 (mm):** 10
- **D50 (mm):** 38
- **D84 (mm):** 114
- **D90 (mm):** 162

STREAM SAMPLE SITE NO.: SF-1
STREAM NAME: Straight Fork

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 07-02-2007
GPS LOCATION OF SITE: E 0734213, N 4014525
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located just upstream of where Straight Fork flows into Smokey Creek. This site is located in the Sundquist Wildlife Management Area.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** SF-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.5
ESTIMATED LEFT BANK HEIGHT (METERS): 2.0
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0
Note: There is a culvert DS.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 2.0
Note: There is a dirt road/trail parallel to the right.

STREAM ALTERATIONS (0 None – 4 Major): 2.0 Due to Culvert DS

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.41%

ACTIVE CHANNEL WIDTH (METERS): 9.5
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.5

CHANNEL RGA SCORE: 8.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 57
MEADIAN (mm): 46
MODE (mm): 6
D16 (mm): 10
D50 (mm): 45
D84 (mm): 104
D90 (mm): 126

STREAM SAMPLE SITE NO.: SC-1
STREAM NAME: Smokey Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 07-02-2007
GPS LOCATION OF SITE: E 0734326, N 4016826
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located in the Sundquist Wildlife Management Area. It is just upstream of a culvert bridge in the stream.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.**: SC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 6.0
ESTIMATED LEFT BANK HEIGHT (METERS): 6.0
BANKFULL HEIGHT (METERS): 6.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 5.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 5.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 0.5
Note: There is a paved road parallel, but it is not close.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.65%

ACTIVE CHANNEL WIDTH (METERS): 17.0
ACTIVE CHANNEL DEPTH (METERS): 0.4

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 35
MEADIAN (mm): 31
MODE (mm): 2
D16 (mm): 8
D50 (mm): 30
D84 (mm): 58
D90 (mm): 66

STREAM SAMPLE SITE NO.: SC-2
STREAM NAME: Smokey Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 07-02-2007
GPS LOCATION OF SITE: E 0732652, N 4014181
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located downstream of SC-1 and is beside the Smokey Creek Road.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** SC-2

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 10
ESTIMATED LEFT BANK HEIGHT (METERS): 3.5
BANKFULL HEIGHT (METERS): 3.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 9.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 2.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0
Note: Dirt Road/Trail crossing downstream.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.0
Note: Gravel Road parallel to stream (Smokey Creek Road).

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.21%

ACTIVE CHANNEL WIDTH (METERS): 13.0
ACTIVE CHANNEL DEPTH (METERS): 0.5

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 1.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 4.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 56
MEADIAN (mm): 42
MODE (mm): 2
D16 (mm): 6
D50 (mm): 40
D84 (mm): 96
D90 (mm): 124

STREAM SAMPLE SITE NO.: SC-3
STREAM NAME: Smokey Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 07-16-2007
GPS LOCATION OF SITE: E 0732095, N 4013103
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located parallel to the Smokey Creek Road. Site is upstream of a driveway crossing and downstream of the first bridge that crosses over Smokey Creek.

UPSTREAM PHOTO:

DOWNSTREAM PHOTO:

**** CONTINUED -- STREAM SAMPLE SITE NO.:** SC-3

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 5.5
ESTIMATED LEFT BANK HEIGHT (METERS): 2.0
BANKFULL HEIGHT (METERS): 2.0
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 3.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 50
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 2.5
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.5

LAND USE DISTURBANCE (0 None – 4 Disturbed): 3.0
Note: Tar & Gravel Rd to the right and Pasture to the left.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.5
Note: Driveway crossing downstream.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 3.0

HILL SLOPE SCOUR (0 None – 4 Major): 1.5

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.5
Note: Gravel Road parallel to stream (Smokey Creek Road).

STREAM ALTERATIONS (0 None – 4 Major): 1.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.35%

ACTIVE CHANNEL WIDTH (METERS): 13.5
ACTIVE CHANNEL DEPTH (METERS): 0.25

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 3.0

CHANNEL RGA SCORE: 8.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 49
MEADIAN (mm): 39
MODE (mm): 4
D16 (mm): 9
D50 (mm): 38
D84 (mm): 96
D90 (mm): 115

STREAM SAMPLE SITE NO.: SC-4
STREAM NAME: Smokey Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 07-13-2007
GPS LOCATION OF SITE: E 0732053, N 4009619
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of TWRA Trail in the Sundquist Wildlife Management Area.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** SC-4

ESTIMATED RIGHT BANK SLOPE (DEGREES): 60
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 0.75
BANKFULL HEIGHT (METERS): 0.75
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.5
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 0.5
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 50
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 2.0
Notes: Due to coal and logging.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.5
Note: Dirt Road/Trail crossing.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.5

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0
Note: Trails crossing and parallel.

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.05%

ACTIVE CHANNEL WIDTH (METERS): 8.5
ACTIVE CHANNEL DEPTH (METERS): 0.2

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 0.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 0.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 0.5

CHANNEL RGA SCORE: 9.5 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 63
MEADIAN (mm): 47
MODE (mm): 4
D16 (mm): 6
D50 (mm): 46
D84 (mm): 102
D90 (mm): 152

STREAM SAMPLE SITE NO.: SC-5
STREAM NAME: Smokey Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 07-13-2007
GPS LOCATION OF SITE: E 0732287, N 4011204
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located upstream of a driveway bridge and parallel to the Smokey Creek Road.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** SC-5

ESTIMATED RIGHT BANK SLOPE (DEGREES): 75
ESTIMATED LEFT BANK SLOPE (DEGREES): 75
ESTIMATED RIGHT BANK HEIGHT (METERS): 2.0
ESTIMATED LEFT BANK HEIGHT (METERS): 1.25
BANKFULL HEIGHT (METERS): 1.25
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.75
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 1.00
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 75
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 1.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 1.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.5
Note: Dirt Road/Trail activity nearby.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.25

HILL SLOPE VEGETATION (0 Thick – 4 None): 1.0

HILL SLOPE SCOUR (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 1.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 3.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 0.30%

ACTIVE CHANNEL WIDTH (METERS): 10.0
ACTIVE CHANNEL DEPTH (METERS): 0.25

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 2.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 1.0

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 41
MEADIAN (mm): 34
MODE (mm): 2
D16 (mm): 8
D50 (mm): 34
D84 (mm): 74
D90 (mm): 87

STREAM SAMPLE SITE NO.: SHC-1
STREAM NAME: Shack Creek

STREAM DATA COLLECTED BY: PM & JB
DATE OF SAMPLING AT SITE: 07-16-2007
GPS LOCATION OF SITE: E 0730765, N 4012125
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 1 – Sediment Sample

BRIEF DISCRIPTION OF SITE: Site is located downstream of a gravel road trail and just upstream of the Dry Creek/Shack Creek Junction.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.:** SHC-1

ESTIMATED RIGHT BANK SLOPE (DEGREES): 45
ESTIMATED LEFT BANK SLOPE (DEGREES): 60
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.5
ESTIMATED LEFT BANK HEIGHT (METERS): 5.0
BANKFULL HEIGHT (METERS): 1.5
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.0
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 4.0
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 90
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 65

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.5
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.5

LAND USE DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Gravel trails & oil well activity nearby.

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 1.0
Note: Gravel trail crossing above.

AMOUNT OF COAL FOUND (0 None – 4 Robust): 0.5

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 2.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0

STREAM ALTERATIONS (0 None – 4 Major): 1.0
Note: Due to gravel road crossing upstream.

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.86%

ACTIVE CHANNEL WIDTH (METERS): 10.0
ACTIVE CHANNEL DEPTH (METERS): 0.15

AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 2.5

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 2.5
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 2.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

CHANNEL RGA SCORE: 9.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
MEAN (mm): 49
MEADIAN (mm): 40
MODE (mm): 6
D16 (mm): 8
D50 (mm): 39
D84 (mm): 94
D90 (mm): 114

STREAM SAMPLE SITE NO.: SC-6
STREAM NAME: Smokey Creek

STREAM DATA COLLECTED BY: PM & KN
DATE OF SAMPLING AT SITE: 08-14-2007
GPS LOCATION OF SITE: E 0731326, N 4008590
WATERSHED NAME: Smokey Creek
SAMPLES TAKEN: 2 – Sediment Samples

BRIEF DISCRIPTION OF SITE: Site is located at the very back of the Smokey Creek Watershed and at the end of the Smokey Creek Road.

UPSTREAM PHOTO:



DOWNSTREAM PHOTO:



**** CONTINUED -- STREAM SAMPLE SITE NO.**: SC-6

ESTIMATED RIGHT BANK SLOPE (DEGREES): 90
ESTIMATED LEFT BANK SLOPE (DEGREES): 70
ESTIMATED RIGHT BANK HEIGHT (METERS): 1.75
ESTIMATED LEFT BANK HEIGHT (METERS): 3.75
BANKFULL HEIGHT (METERS): 1.75
ESTIMATED RIGHT BANK ROOT DEPTH (METERS): 1.65
ESTIMATED LEFT BANK ROOT DEPTH (METERS): 3.50
ESTIMATED RIGHT BANK ROOT DENSITY (%): 100
ESTIMATED LEFT BANK ROOT DENSITY (%): 100
ESTIMATED RIGHT BANK SURFACE PROTECTION (%): 100
ESTIMATED LEFT BANK SURFACE PROTECTION (%): 100

THICKNESS OF RIPAIRIAN VEGITATION – RIGHT BANK (0 Thick – 4 None): 0.0
THICKNESS OF RIPAIRIAN VEGITATION – LEFT BANK (0 Thick – 4 None): 0.0

LAND USE DISTURBANCE (0 None – 4 Disturbed): 0.0

WETLAND/ STREAM DISTURBANCE (0 None – 4 Disturbed): 0.0

AMOUNT OF COAL FOUND (0 None – 4 Robust): 1.0

HILL SLOPE VEGETATION (0 Thick – 4 None): 0.0

HILL SLOPE SCOUR (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES CROSSING STREAM (0 None – 4 Major): 0.0

STRUCTURES / ACTIVITIES ADJACENT TO THE STREAM (0 None – 4 Major): 1.0

STREAM ALTERATIONS (0 None – 4 Major): 0.0

AVERAGE SLOPE OF CHANNEL (PERCENT): 1.17%

ACTIVE CHANNEL WIDTH (METERS): 10.0
ACTIVE CHANNEL DEPTH (METERS): 0.1

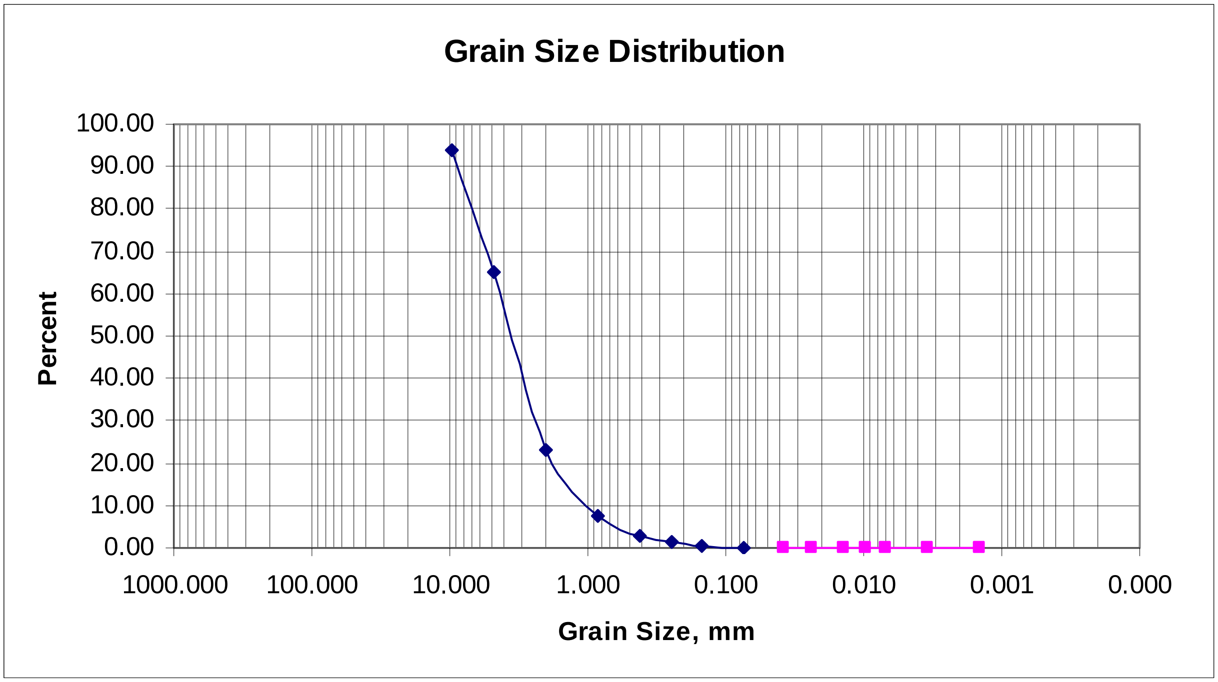
AVAILABILITY OF LATERAL DEPOSITION POINTS (0 None – 4 Abundant): 3.0

STREAM EMBEDDEDNESS (0.0 Optimal – 4.0 Poor): 1.0
POOL SUBSTRATE CHARACTORIZATION (0.0 Optimal – 4.0 Poor): 1.0
SEDIMENT DEPOSITION (0.0 Optimal – 4.0 Poor): 2.0

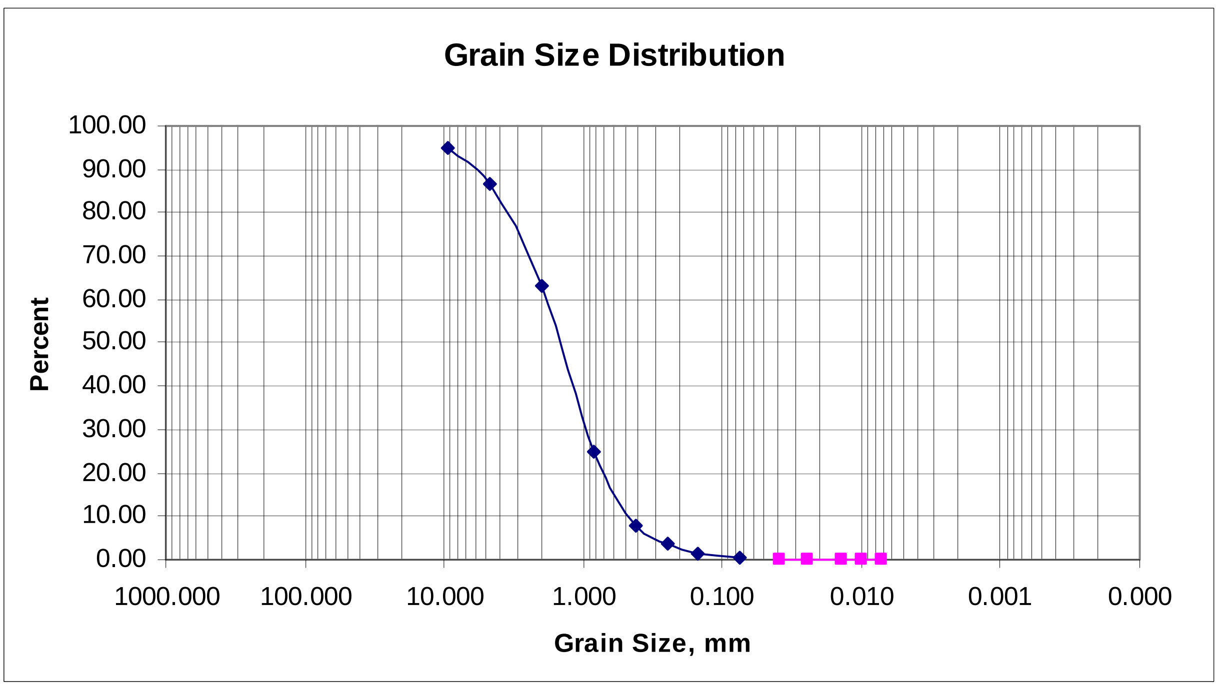
CHANNEL RGA SCORE: 10.0 / 36.0

CHANNEL-STABILITY PARTICLE COUNT
- **MEAN (mm):** 57
- **MEADIAN (mm):** 45
- **MODE (mm):** 2
- **D16 (mm):** 4
- **D50 (mm):** 45
- **D84 (mm):** 112
- **D90 (mm):** 120

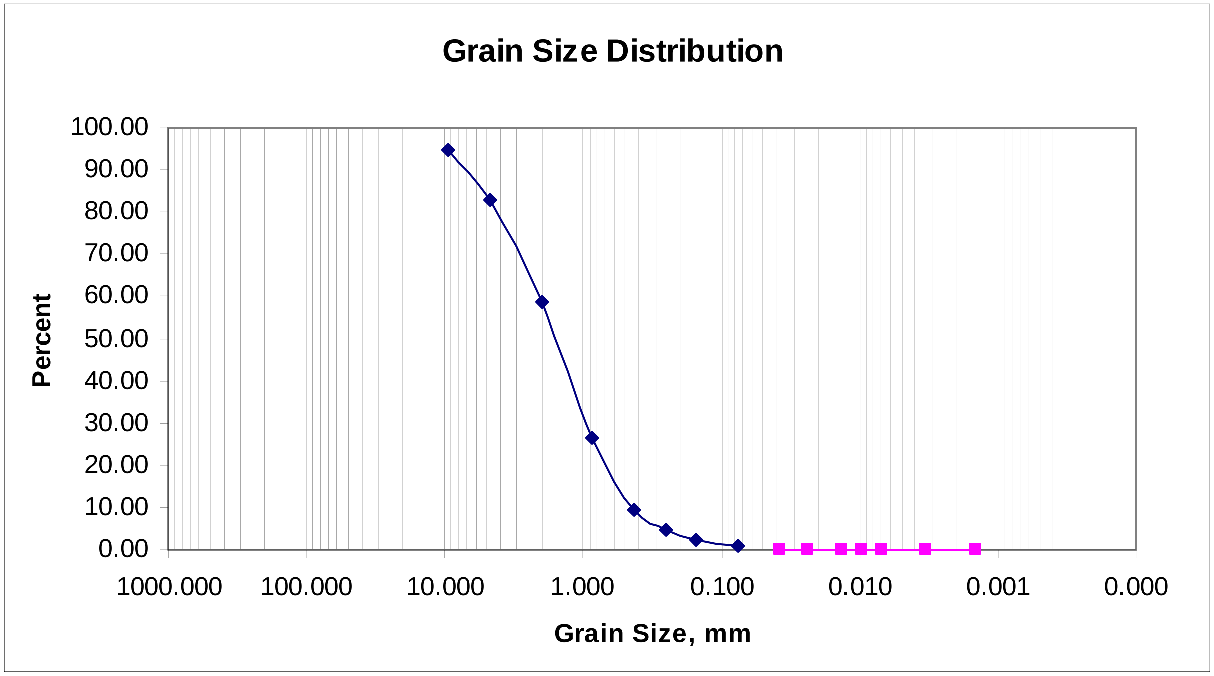
APPENDIX D: FINE BED SEDIMENT PARTICLE SIZE DISTRIBUTIONS



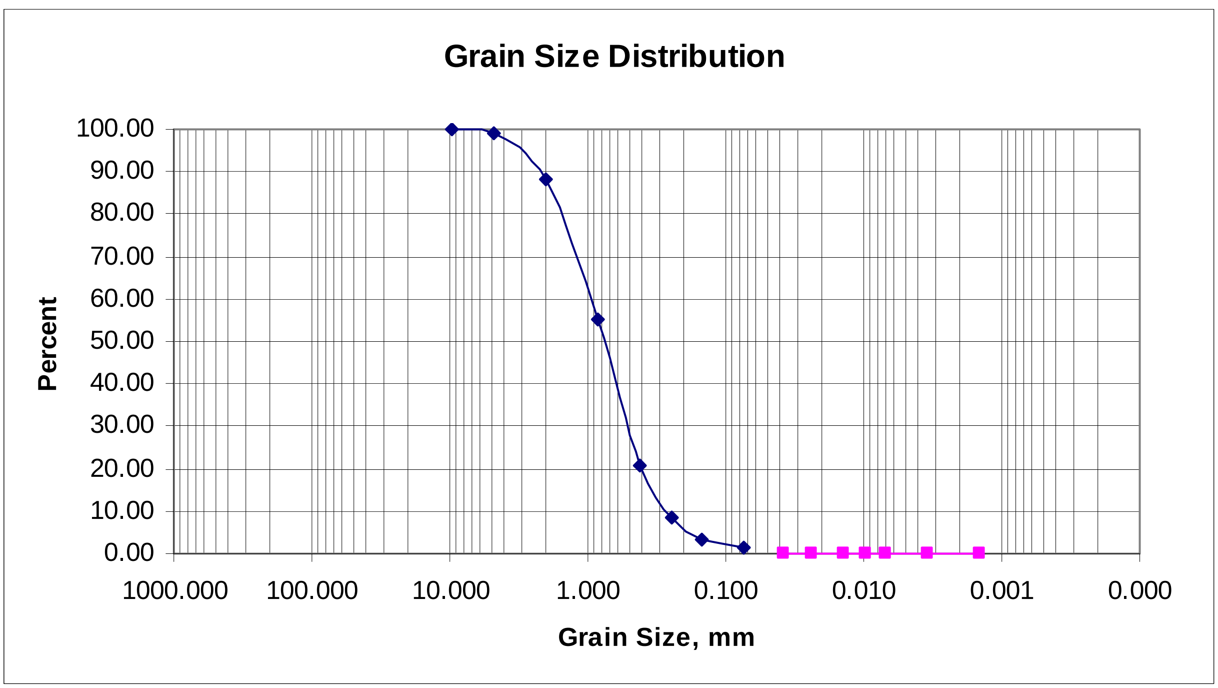
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
JC-1	Montgomery	3.75	0.62	0.11	0.08



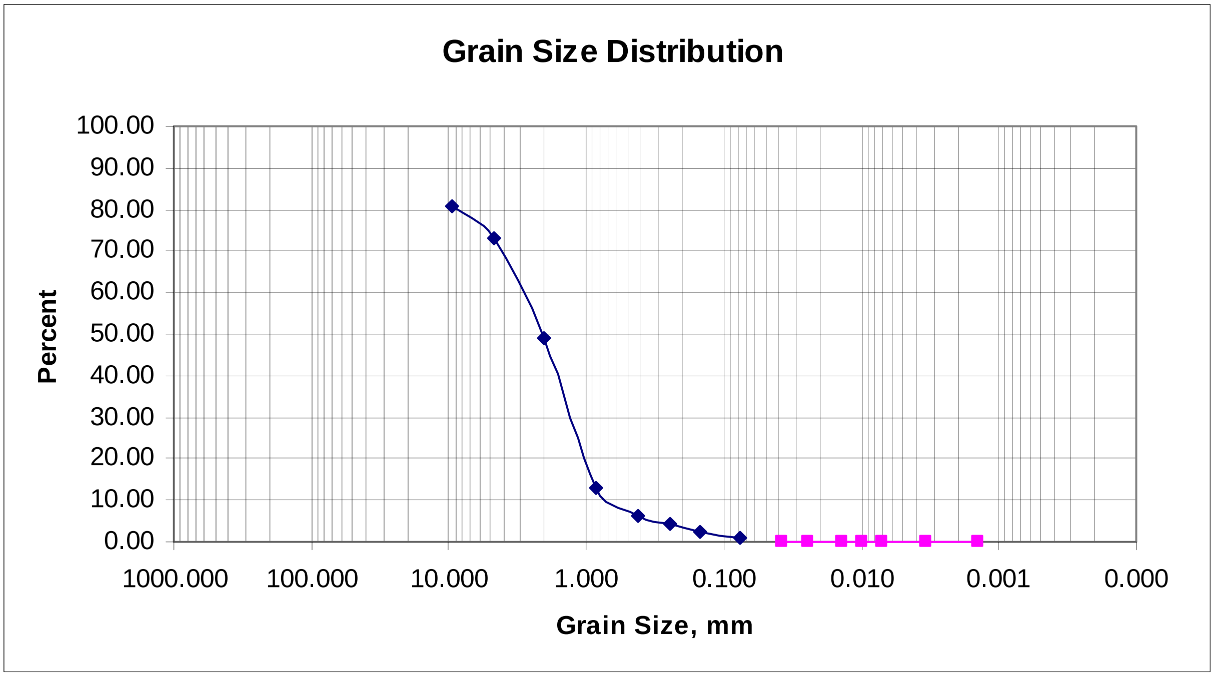
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
JC-2	Montgomery	1.50	1.59	0.61	0.03



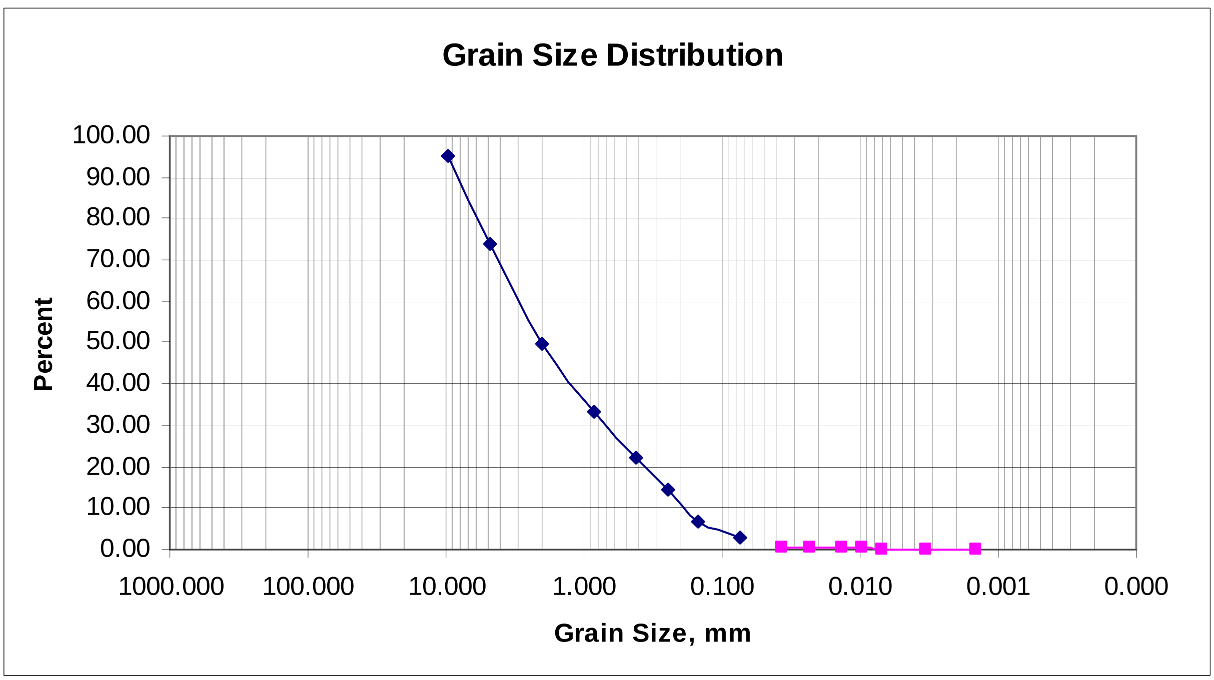
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
JC-2A	Montgomery	1.60	2.30	0.91	0.13



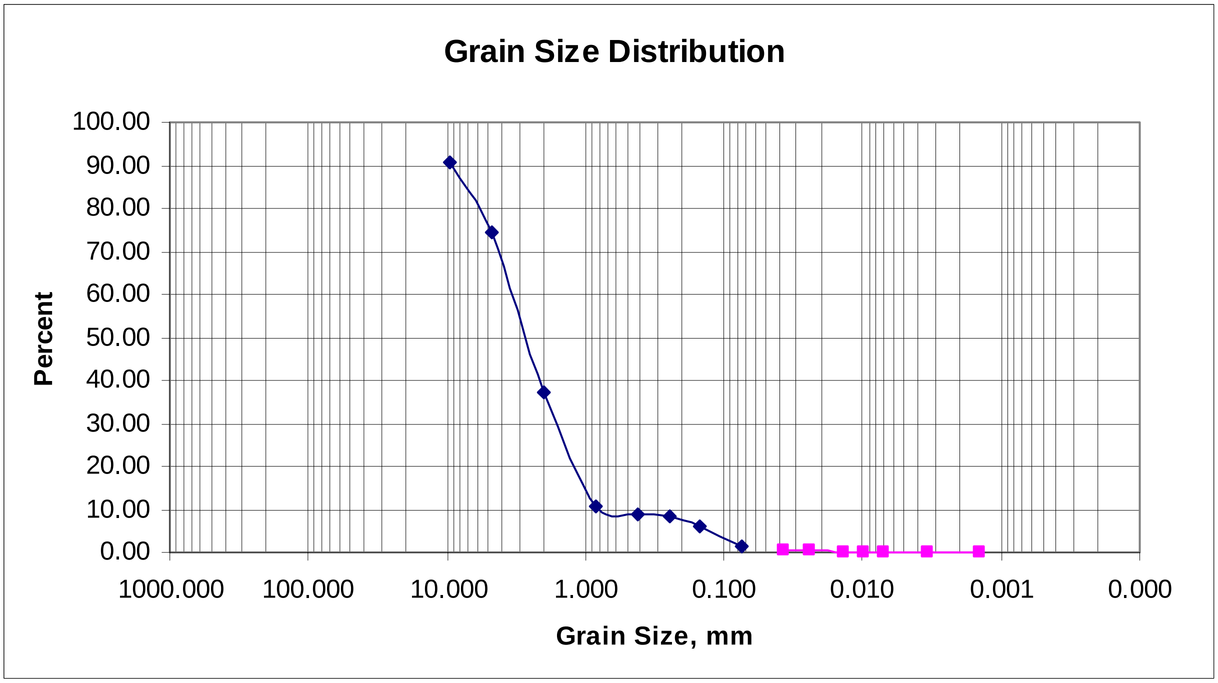
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
JC-3	Montgomery	0.75	3.07	1.33	0.11



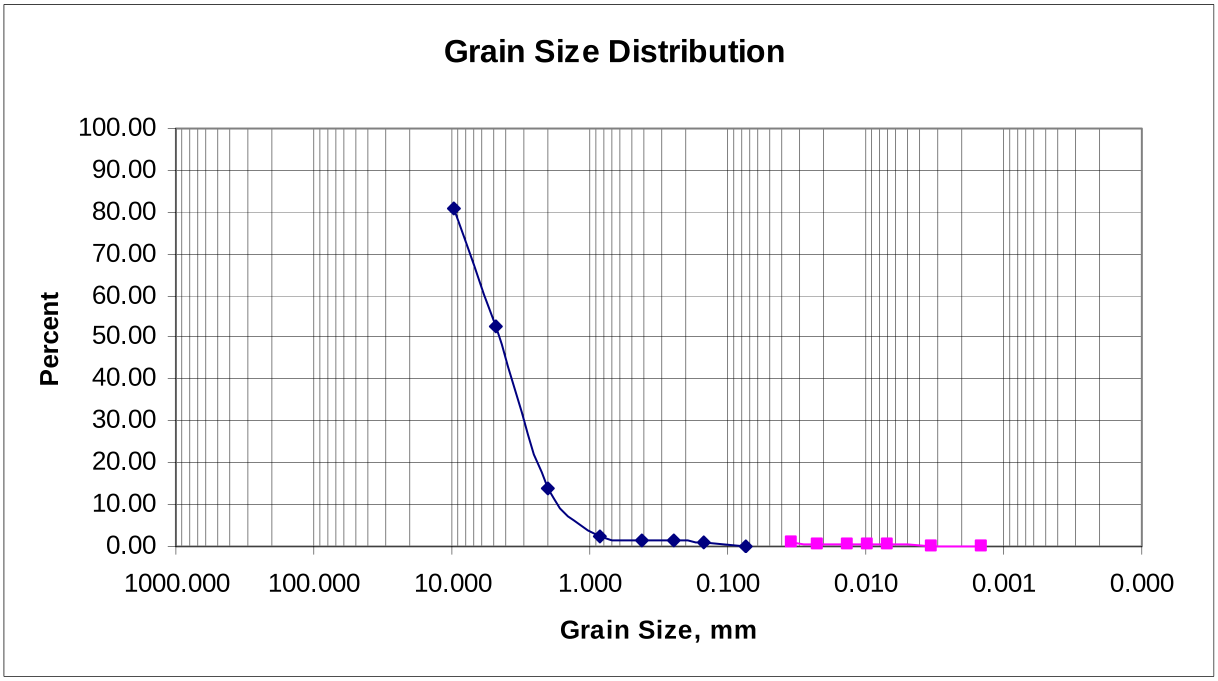
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
MKC-1	Montgomery	2.10	2.47	0.87	0.10



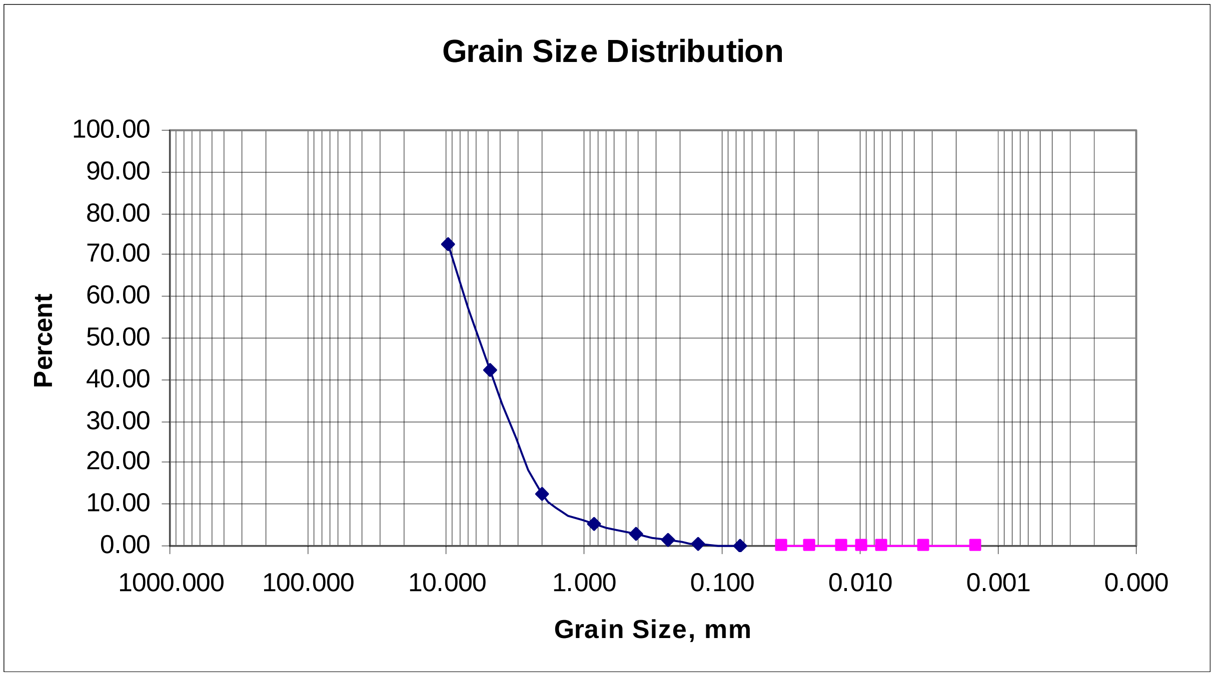
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
PCC-1	Montgomery	2.00	6.93	2.90	0.39



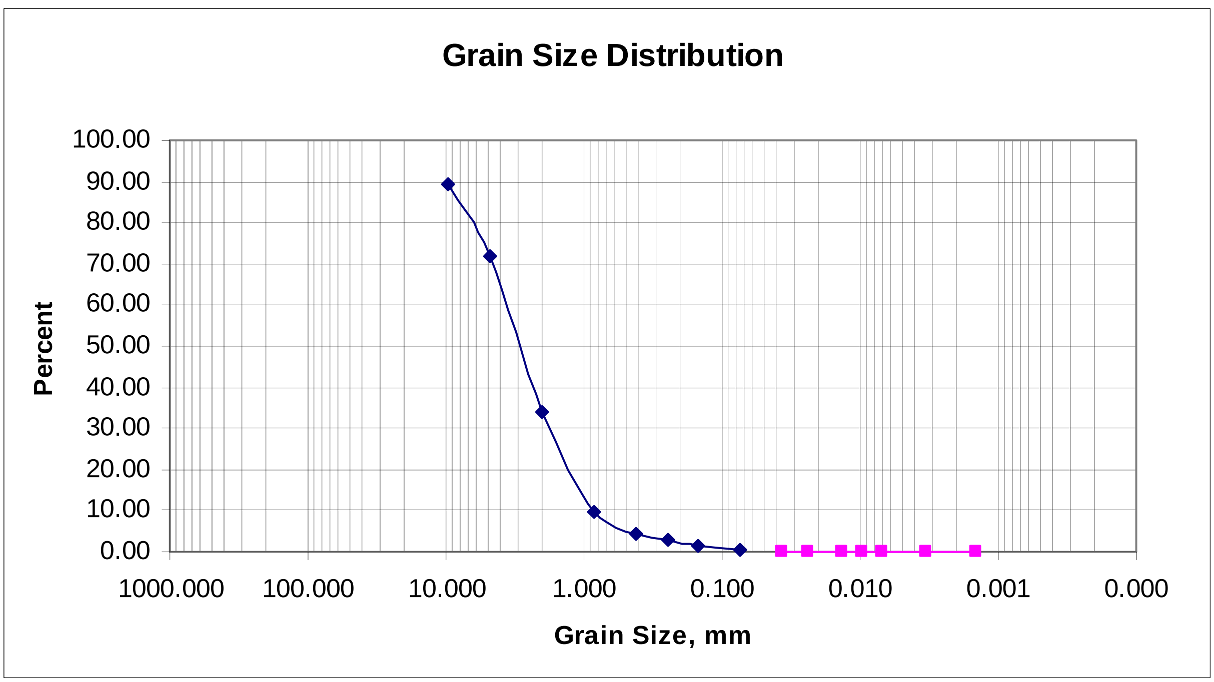
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
RC-1	Montgomery	2.75	5.99	1.54	0.23



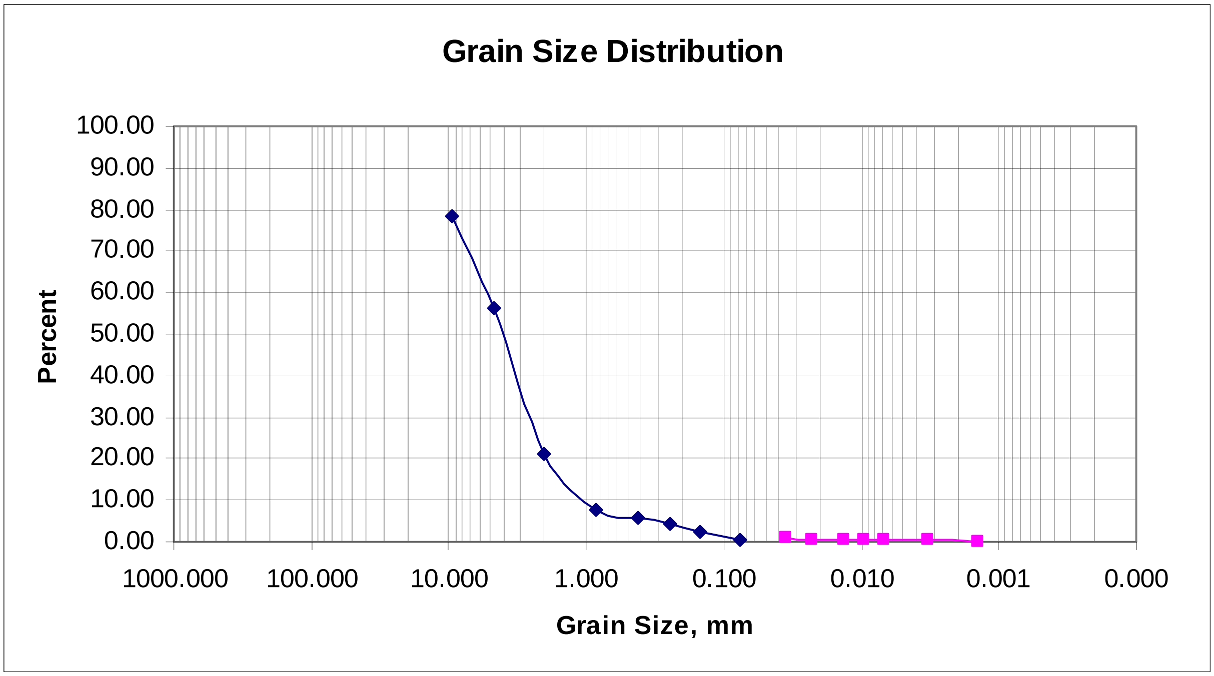
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
RC-1A	Montgomery	3.50	0.78	0.20	0.53



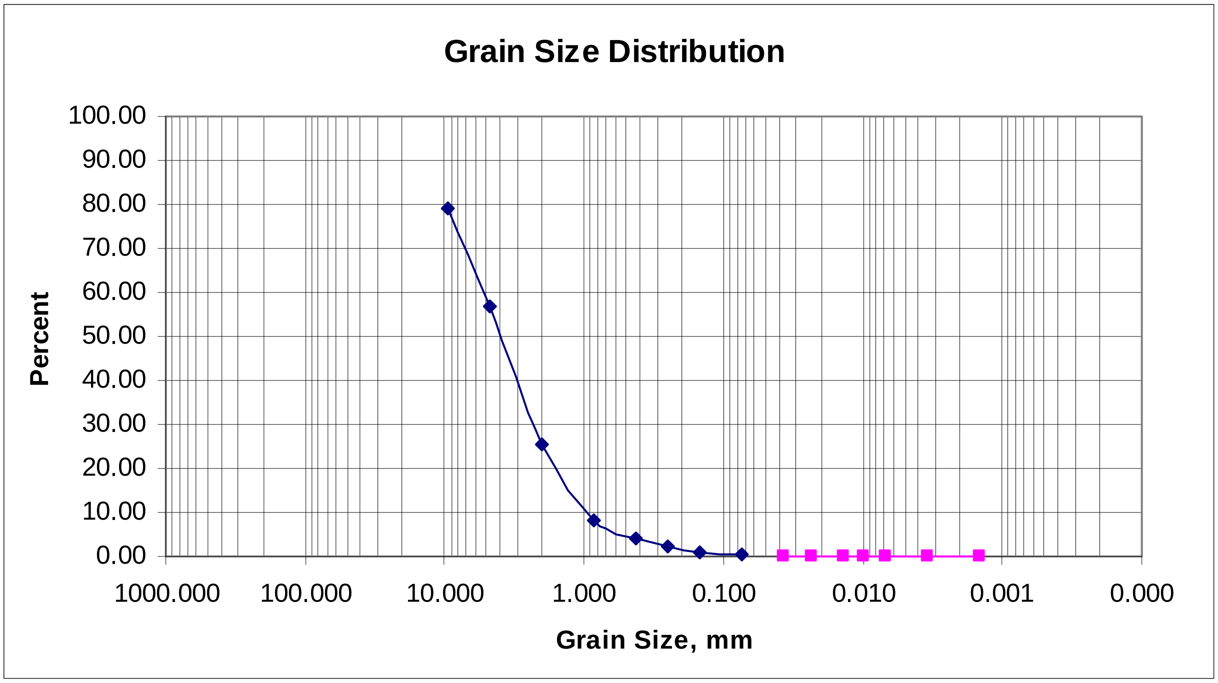
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
RC-2	Montgomery	5.70	0.63	0.15	0.14



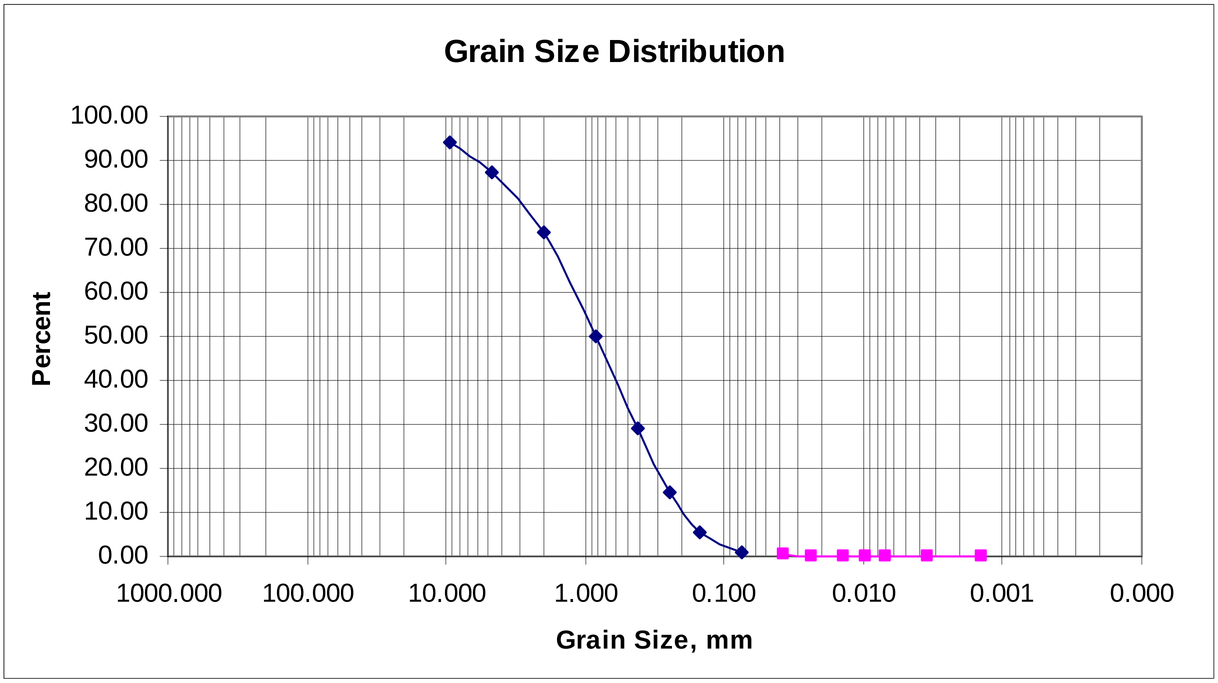
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
RC-3	Montgomery	3.00	1.50	0.67	0.11



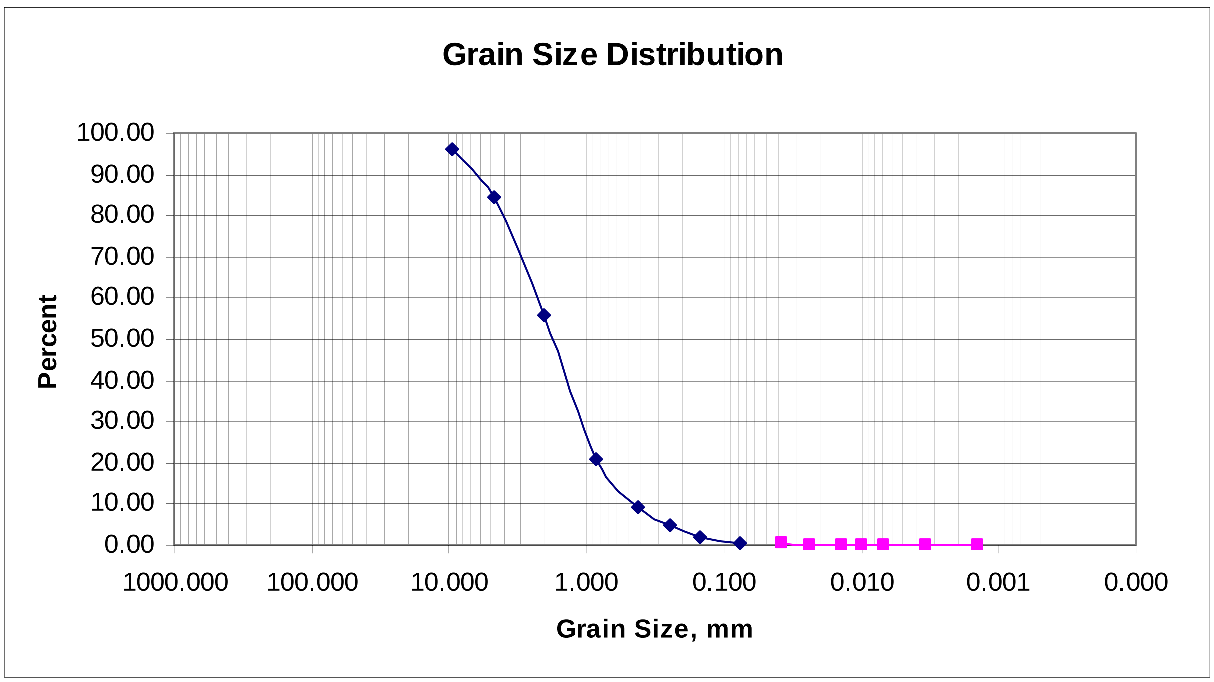
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SB-1	Montgomery	4.00	2.49	0.58	0.66



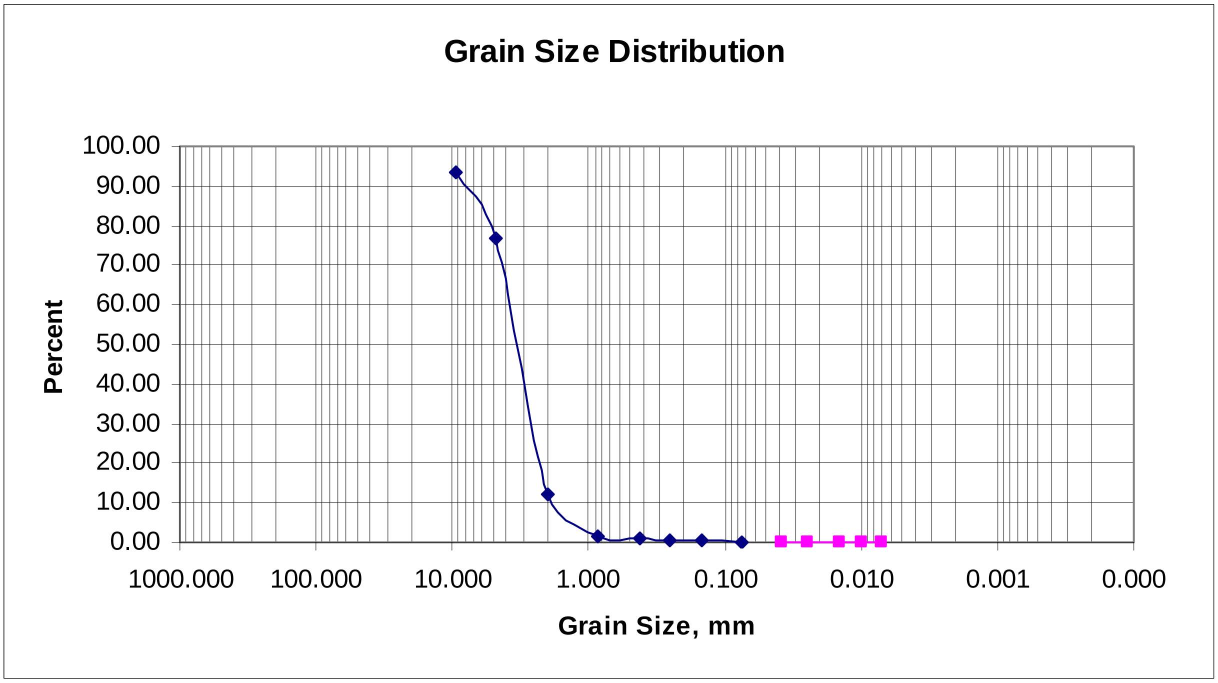
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
WC-1	Montgomery	4.00	0.98	0.28	0.06



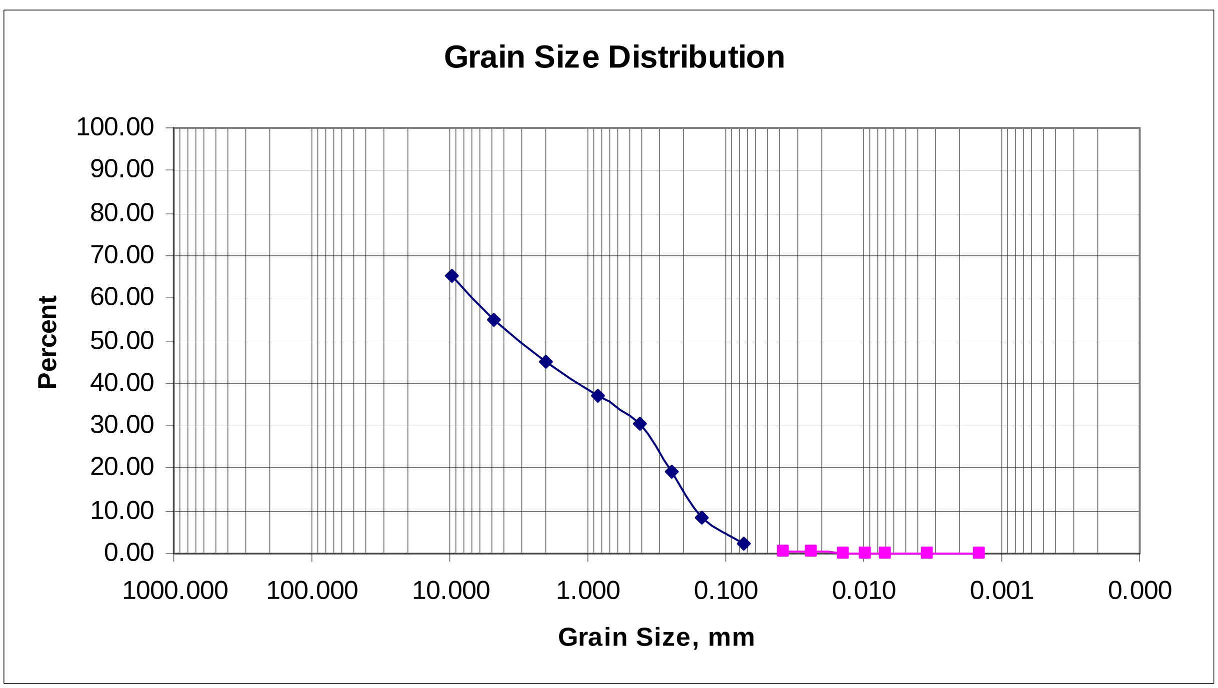
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
FB-1	Ligias	0.85	5.67	0.88	0.19



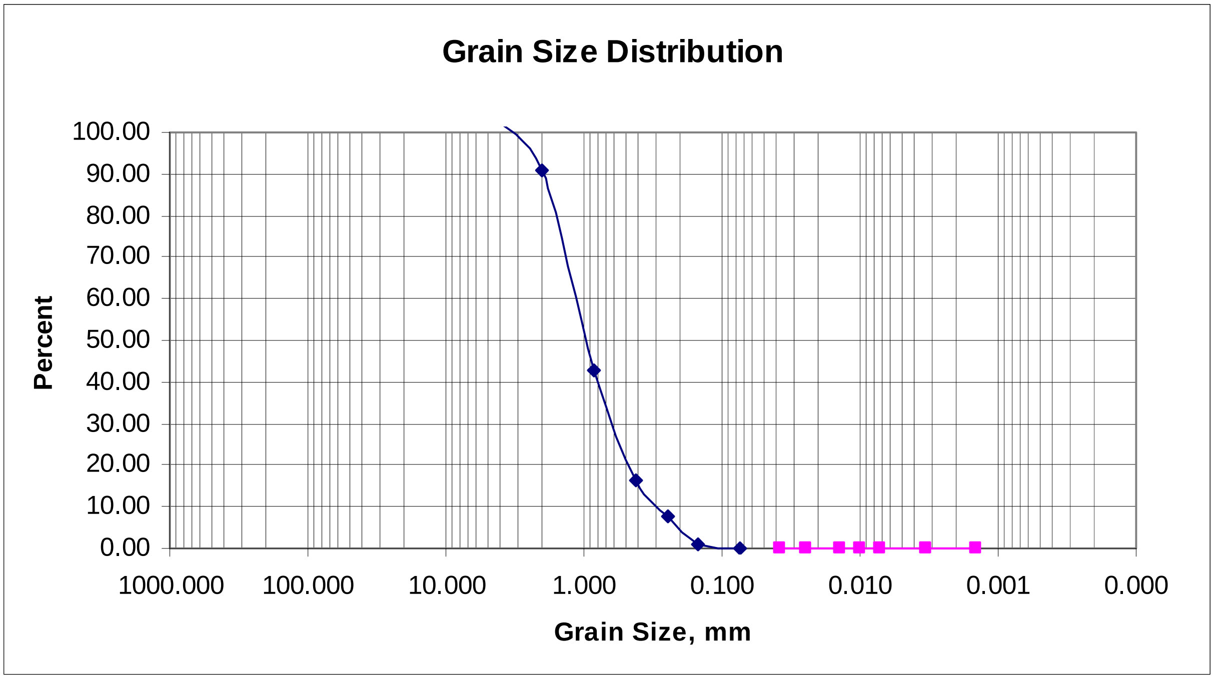
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
GGB-1	Ligias	1.75	2.08	0.65	0.20



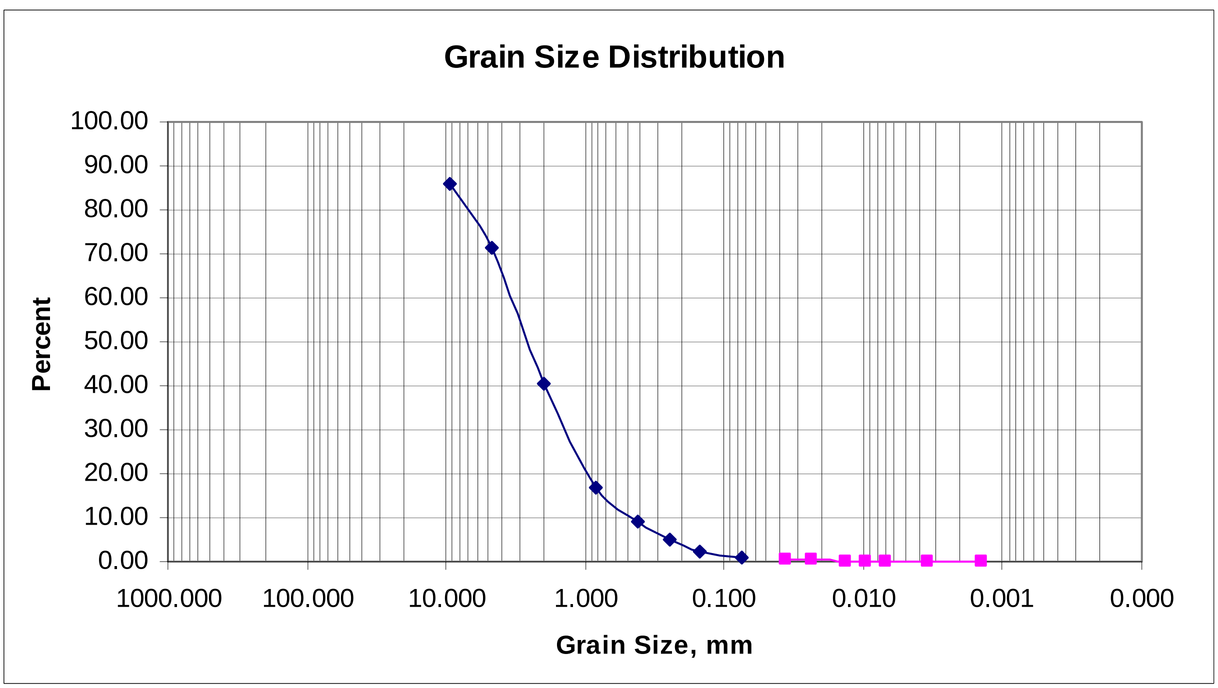
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
GGB-2	Ligias	3.25	0.29	0.12	0.00



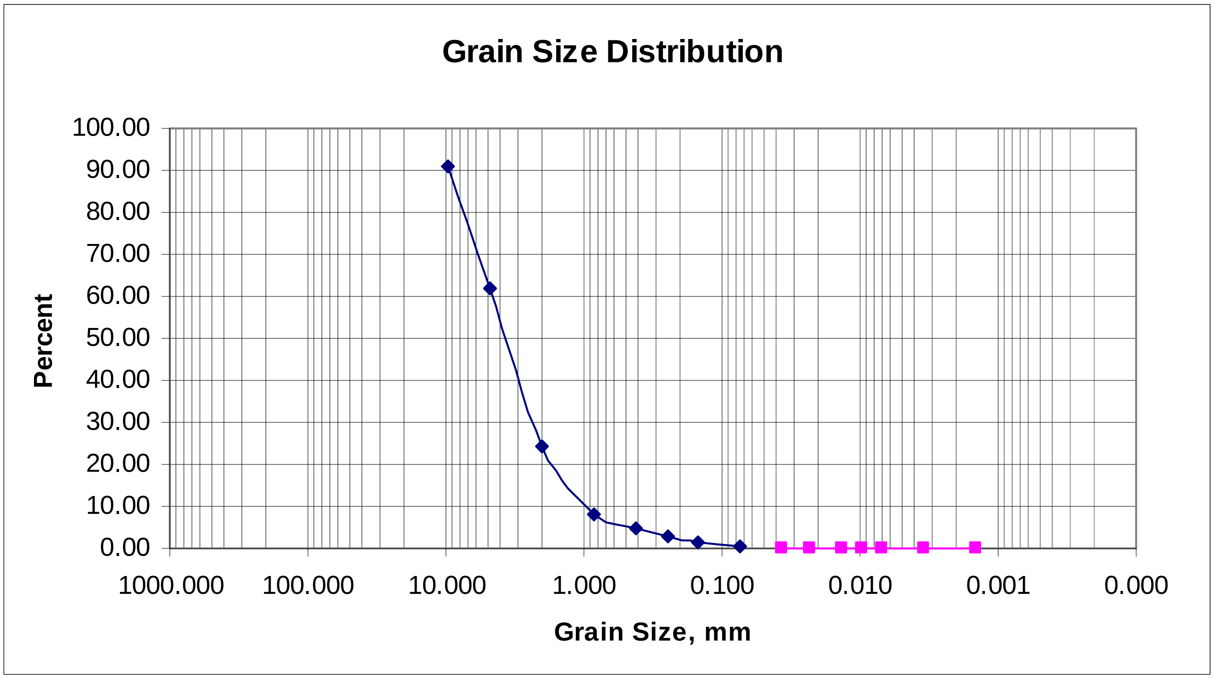
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LF-1	Ligias	3.00	8.50	2.52	0.20



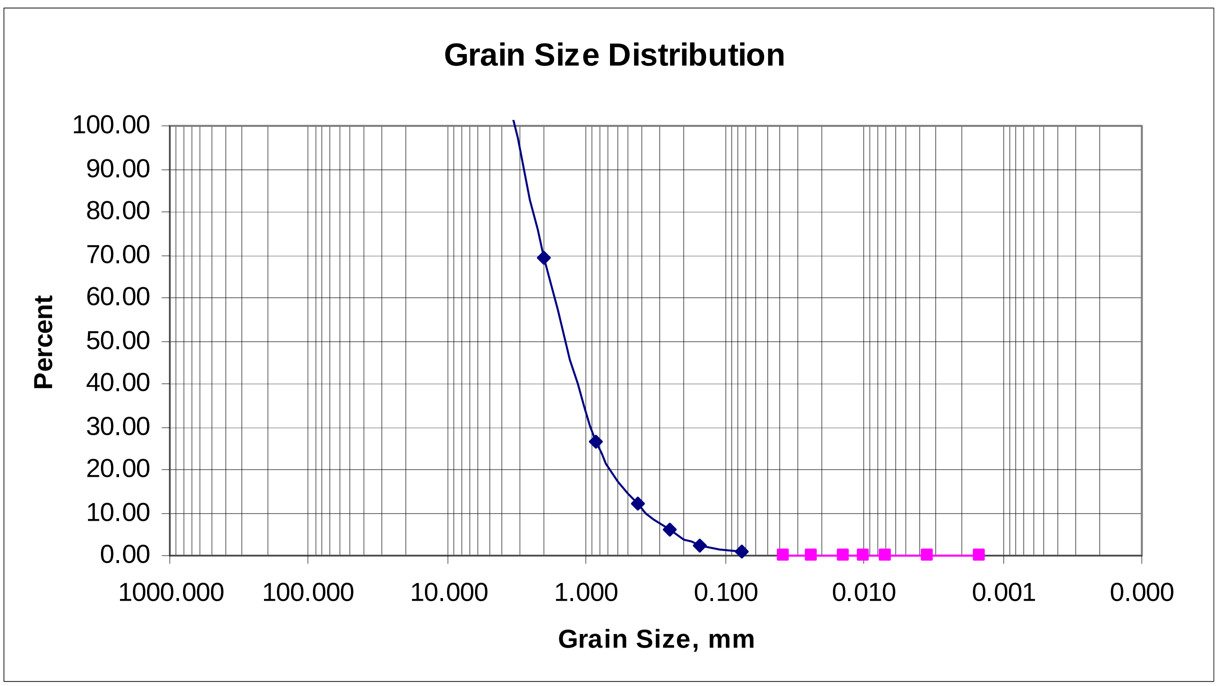
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LF-2	Ligias	1.00	0.97	0.19	0.04



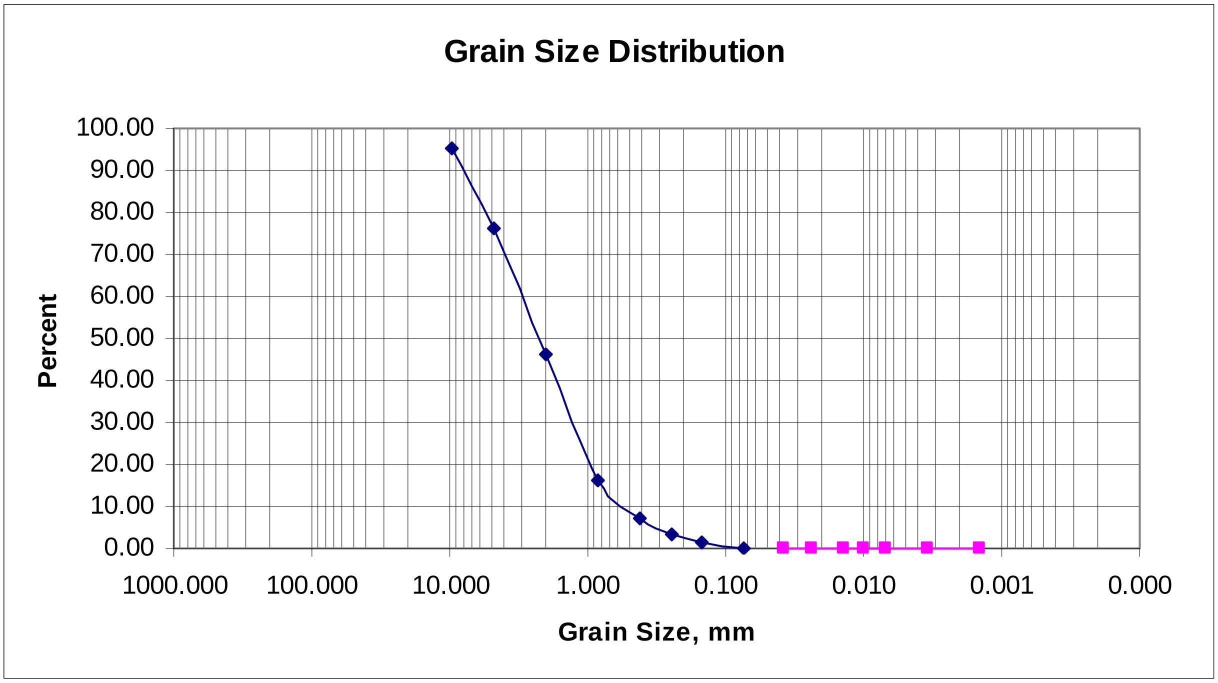
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LF-3	Ligias	2.60	2.40	0.98	0.22



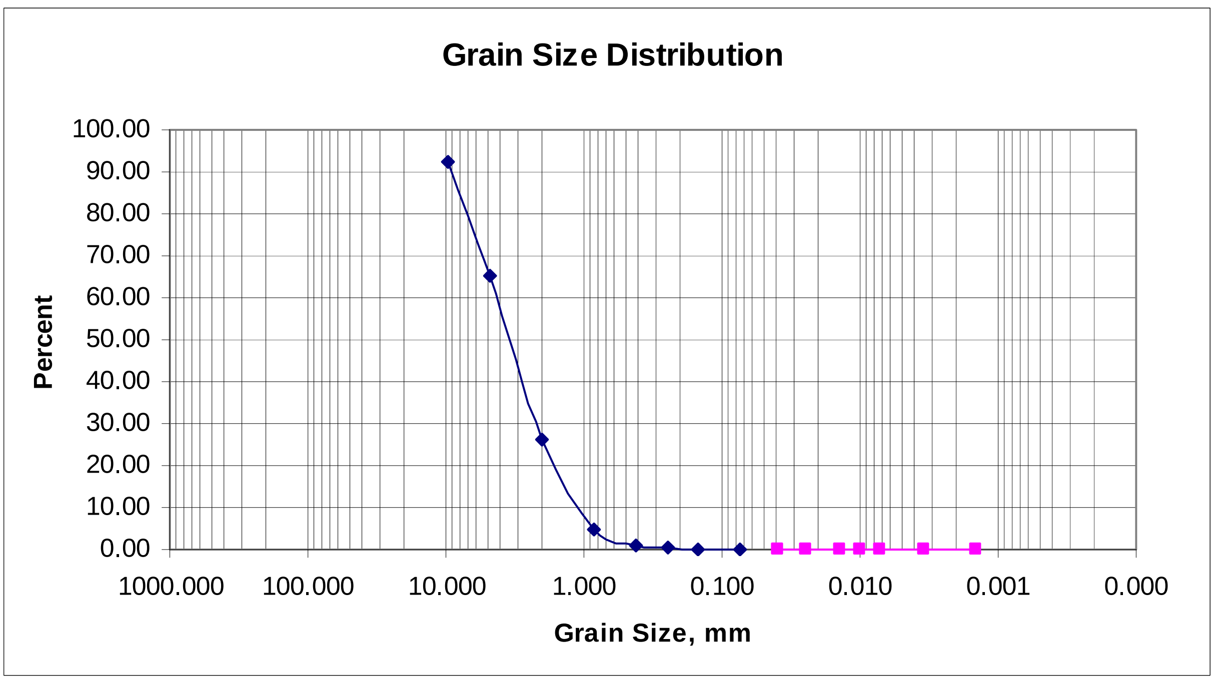
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LF-4	Ligias	4.00	1.23	0.26	0.16



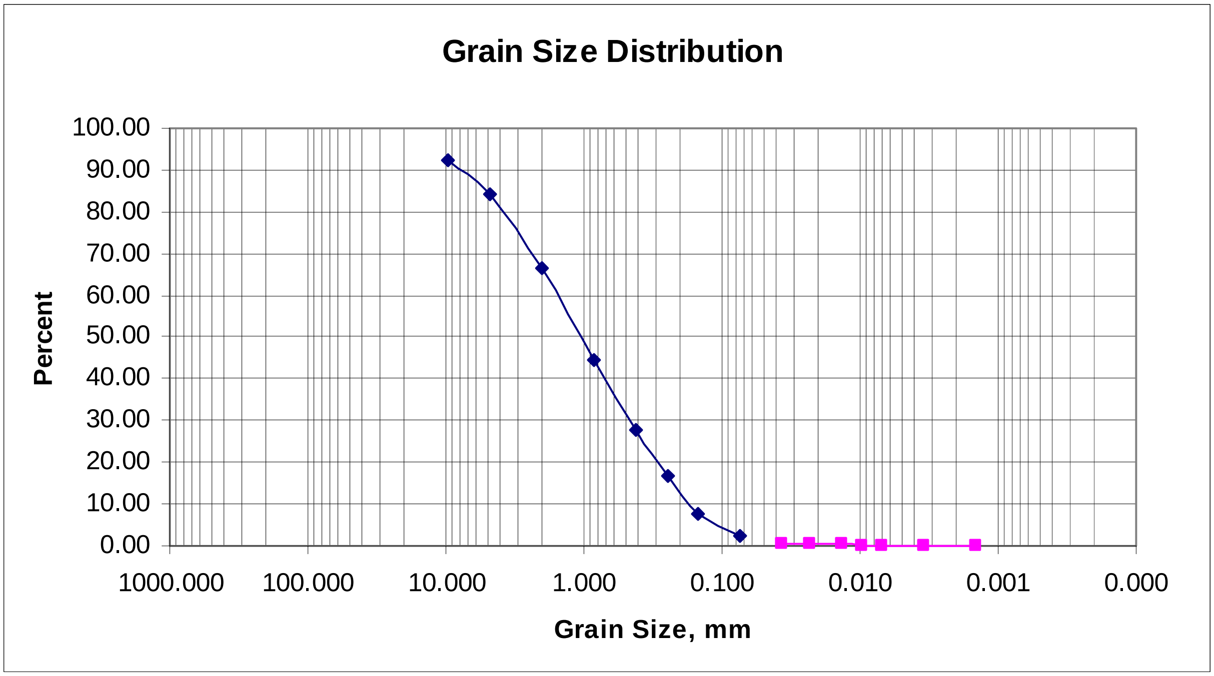
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LF-5	Ligias	1.50	2.53	0.93	0.09



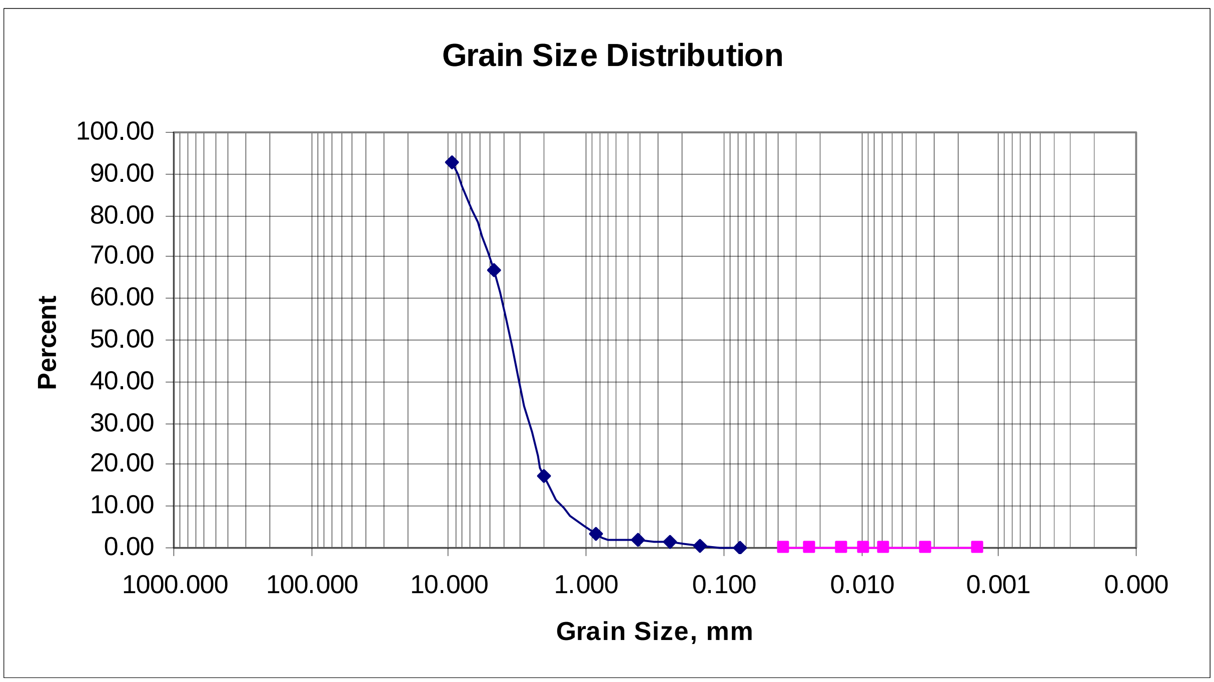
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LF-5A	Ligias	2.50	1.35	0.23	0.20



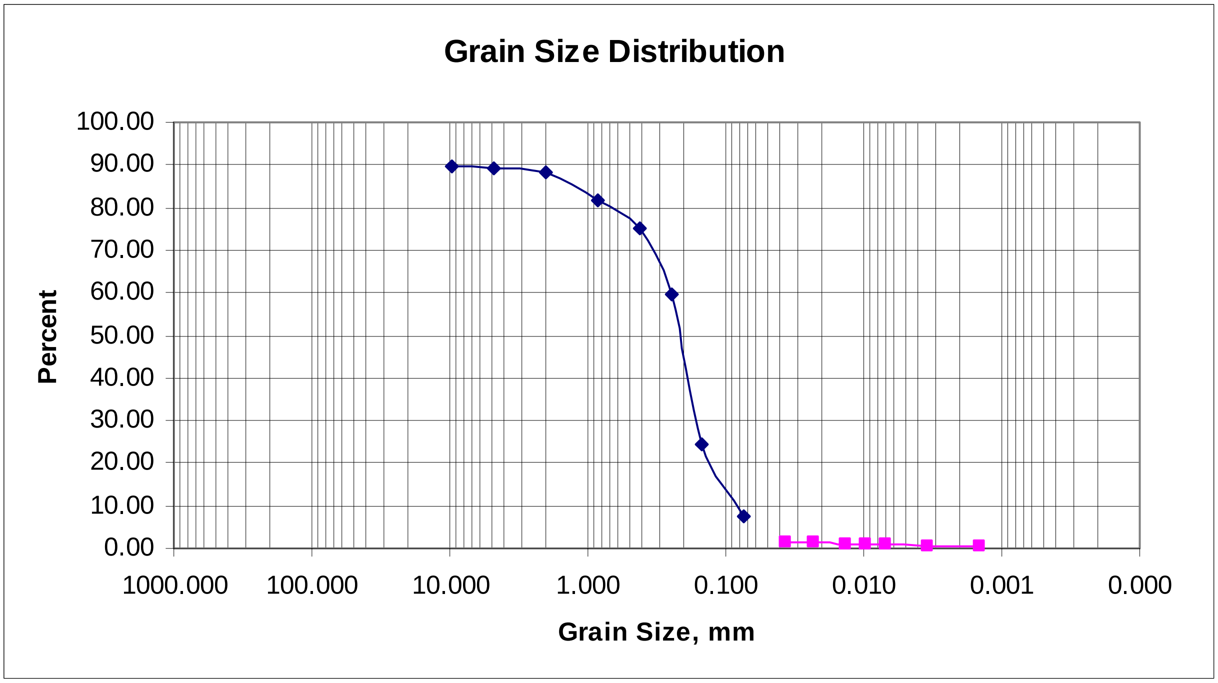
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LF-6	Ligias	2.45	0.20	0.04	0.01



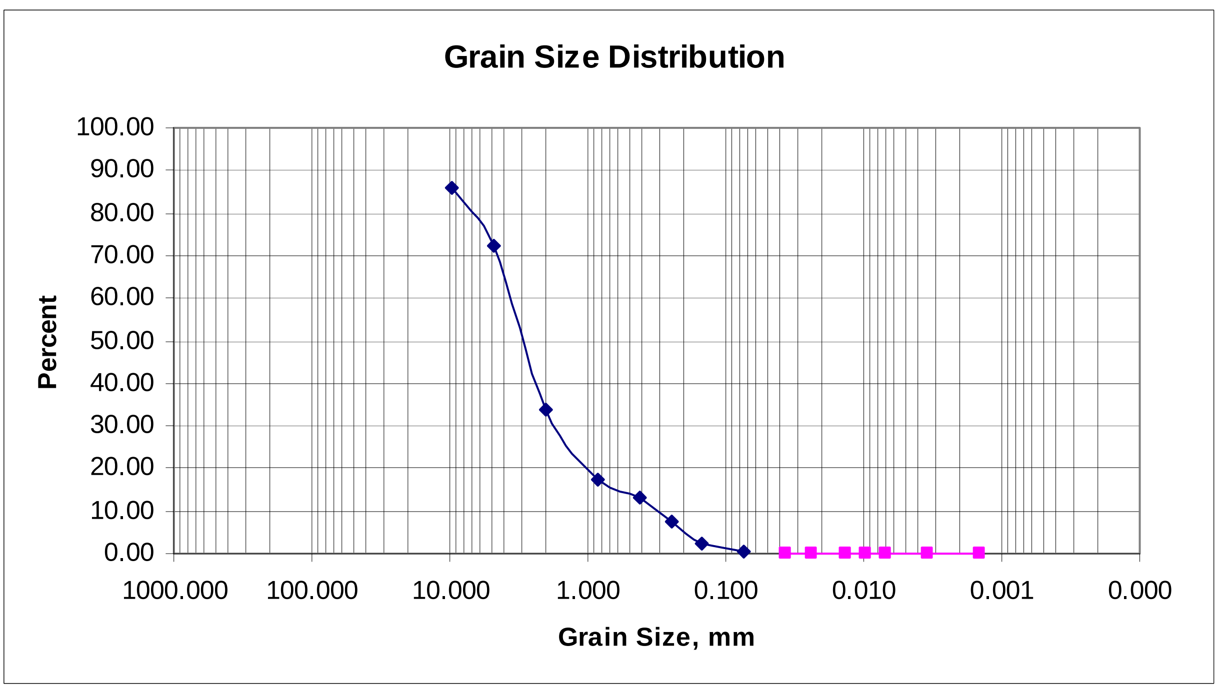
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SF-1	Smokey	1.10	7.48	2.55	0.27



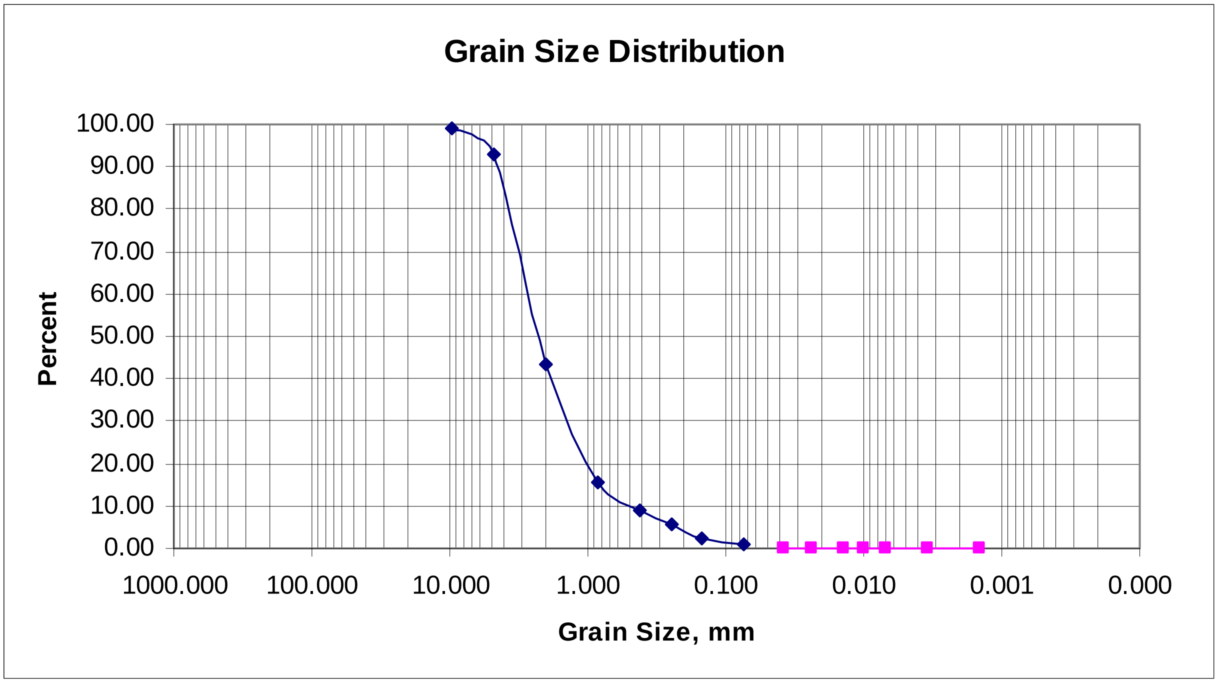
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SHC-1	Smokey	3.5	0.69	0.17	0.08



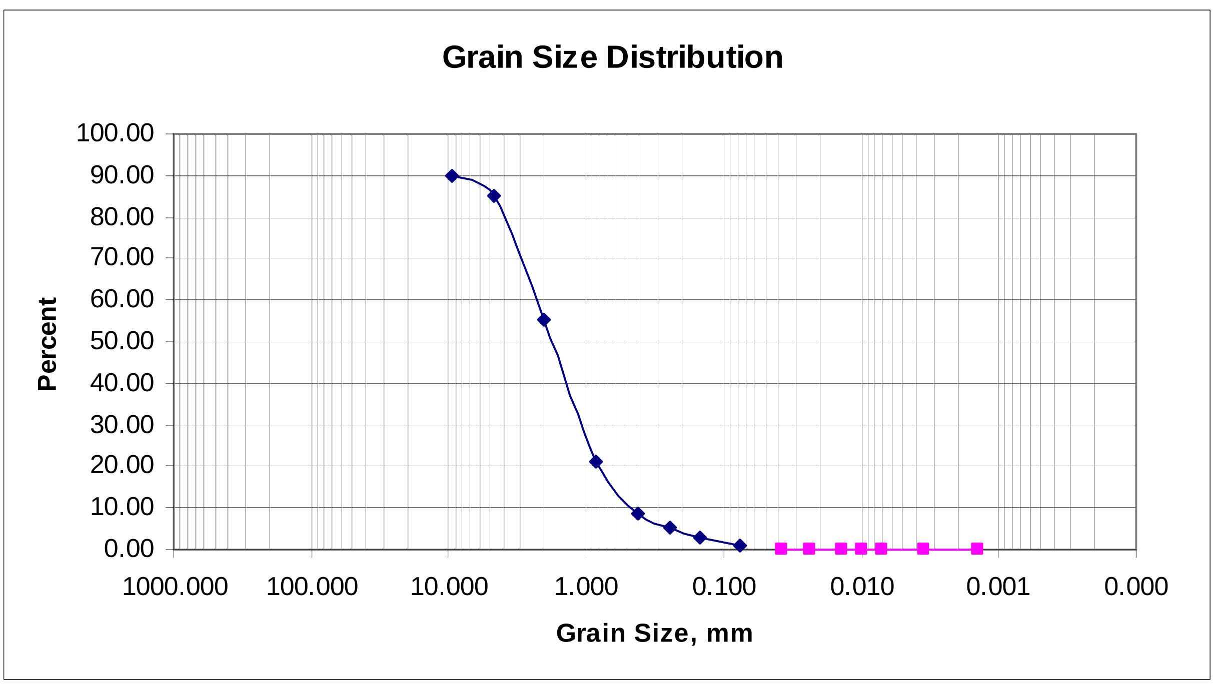
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SC-1	Smokey	0.21	24.43	7.55	1.09



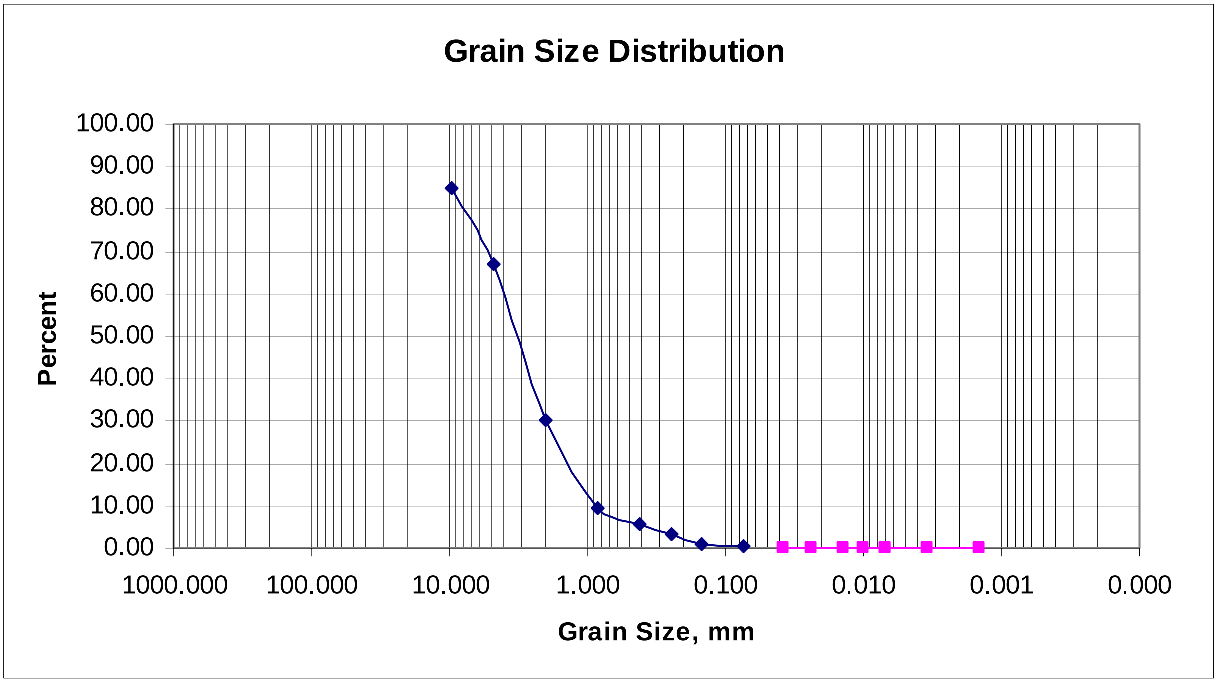
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SC-2	Smokey	2.95	2.47	0.57	0.10



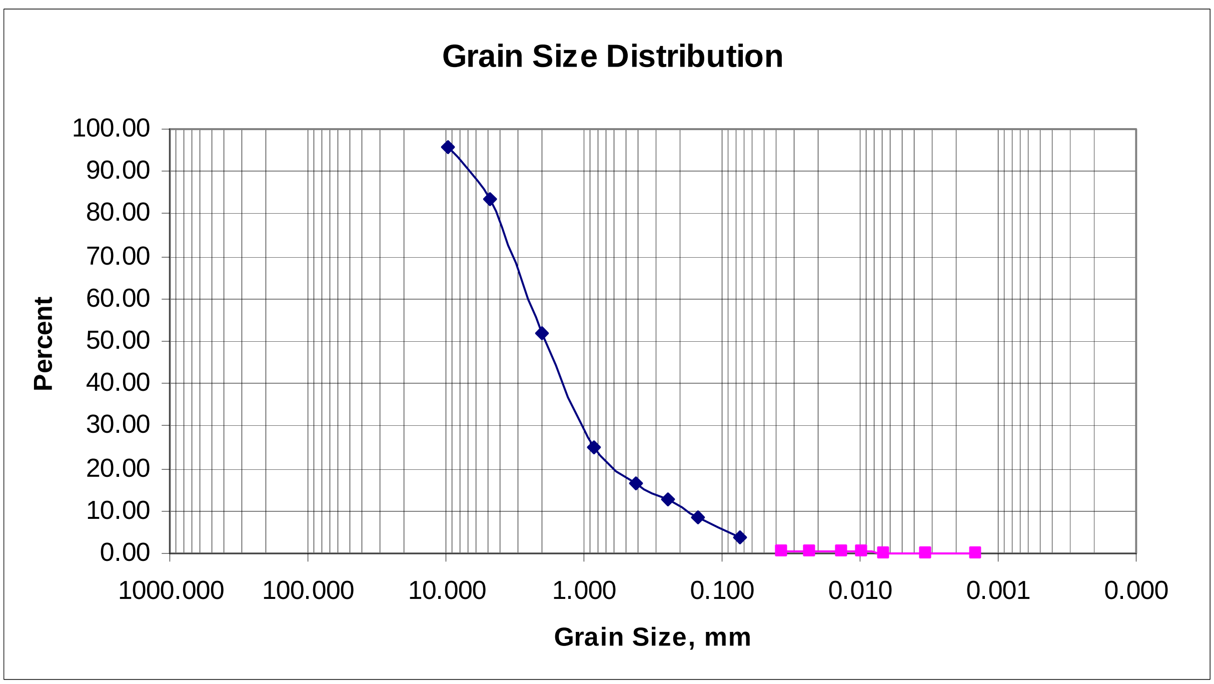
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SC-3	Smokey	2.25	2.43	0.85	0.09



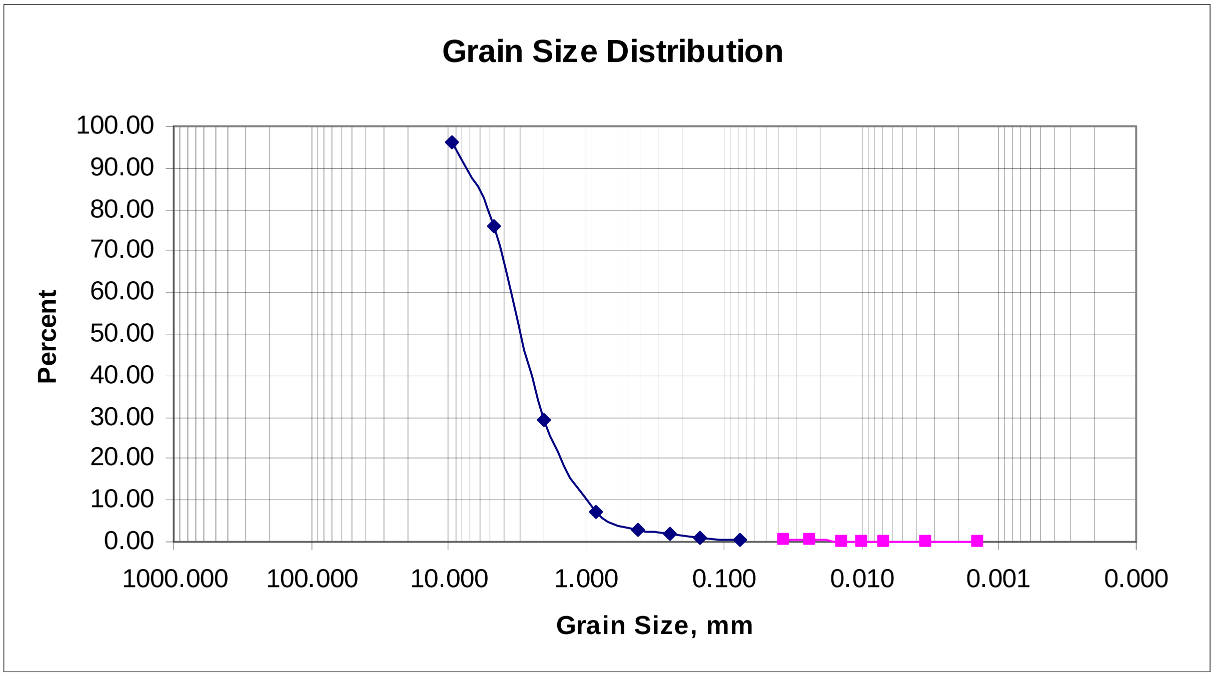
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SC-4	Smokey	1.75	2.72	1.01	0.10



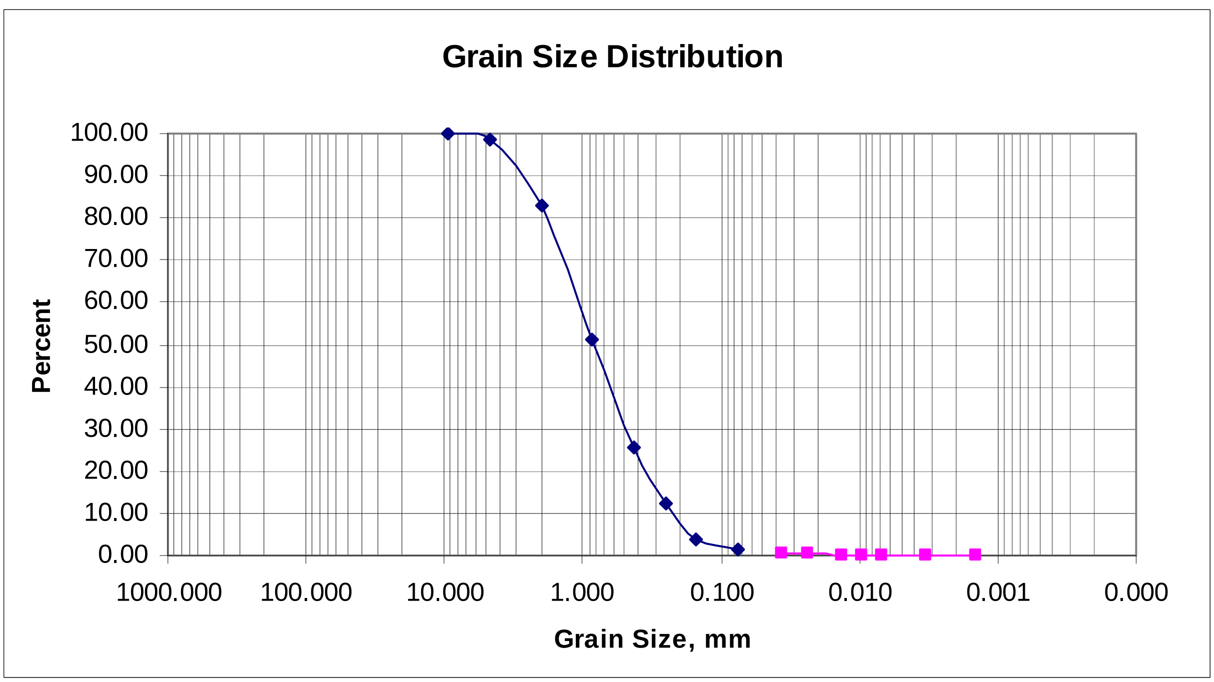
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SC-5	Smokey	3.10	1.17	0.35	0.04



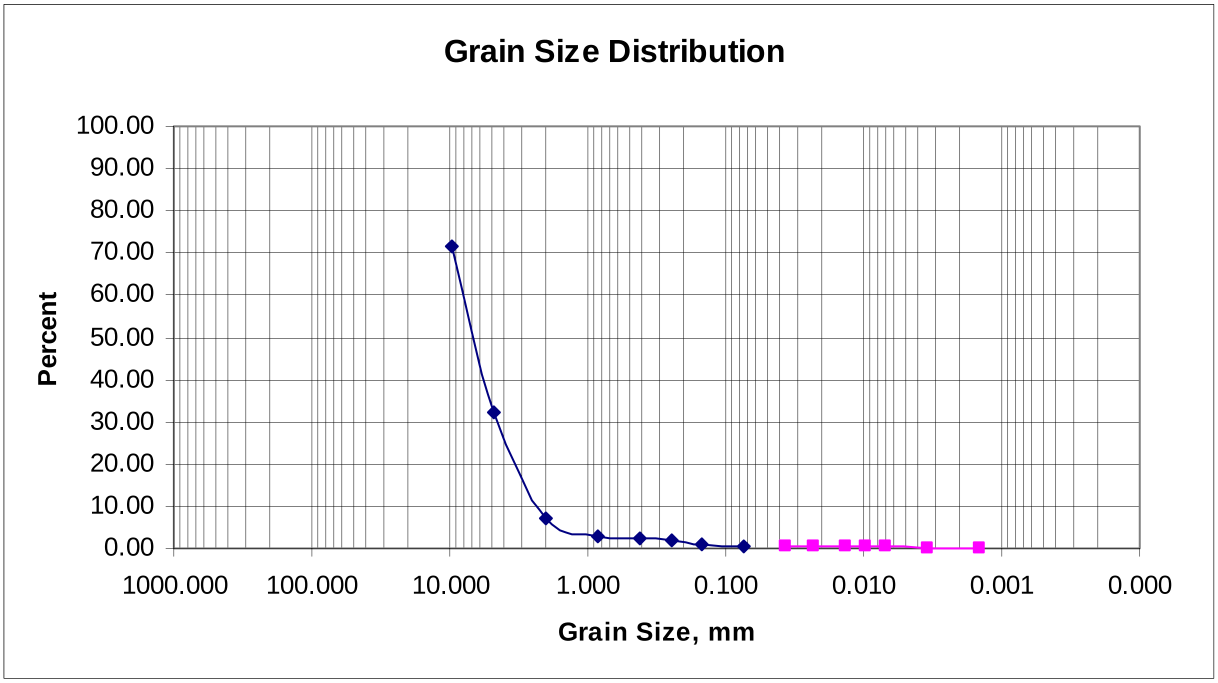
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SC-6	Smokey	1.95	8.47	3.73	0.43



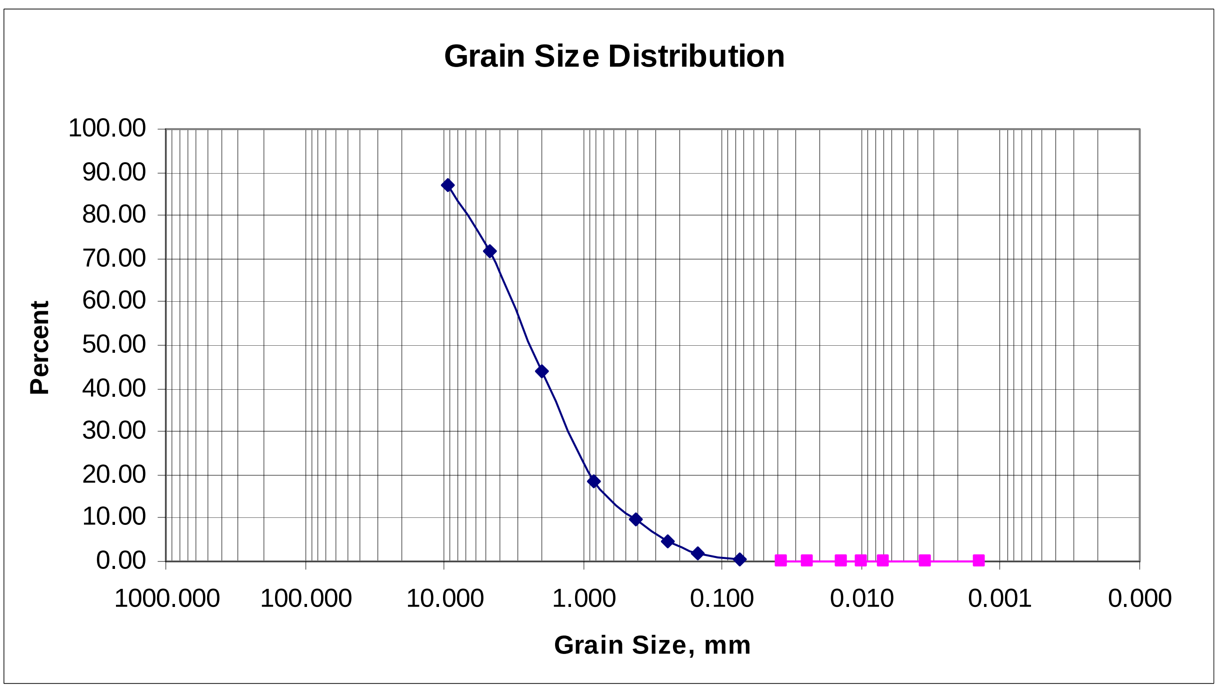
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
SC-6A	Smokey	3.00	1.12	0.34	0.24



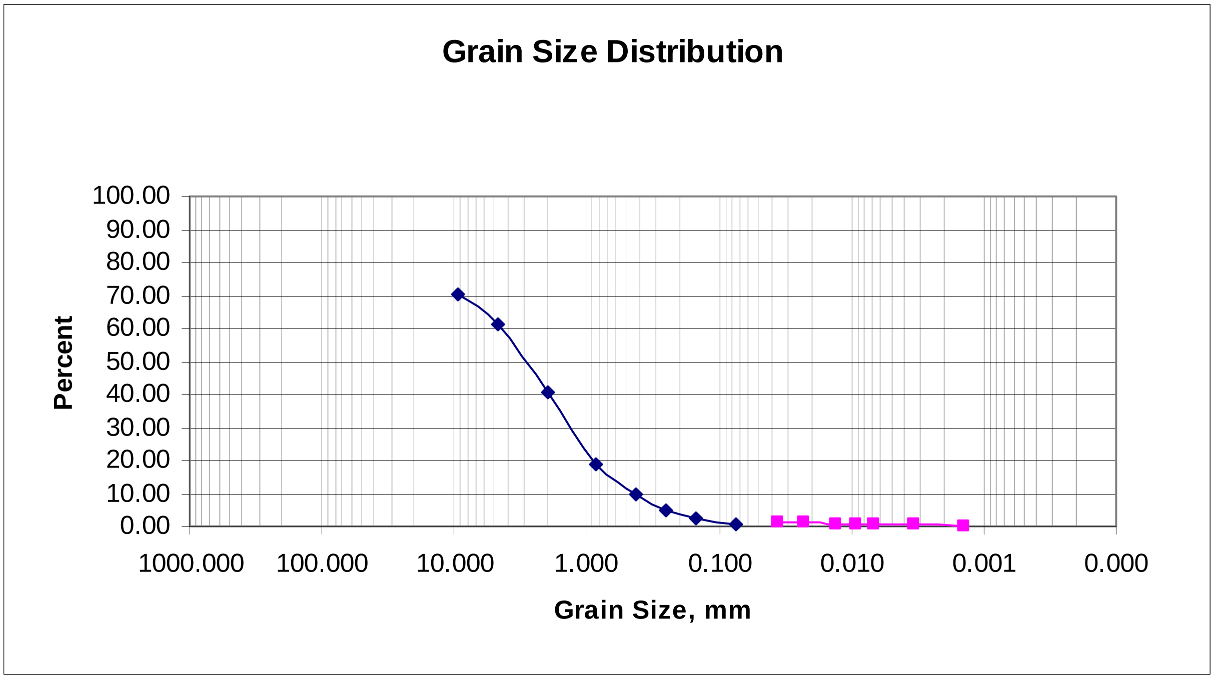
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
BC-1	Bull	.80	3.93	1.54	0.23



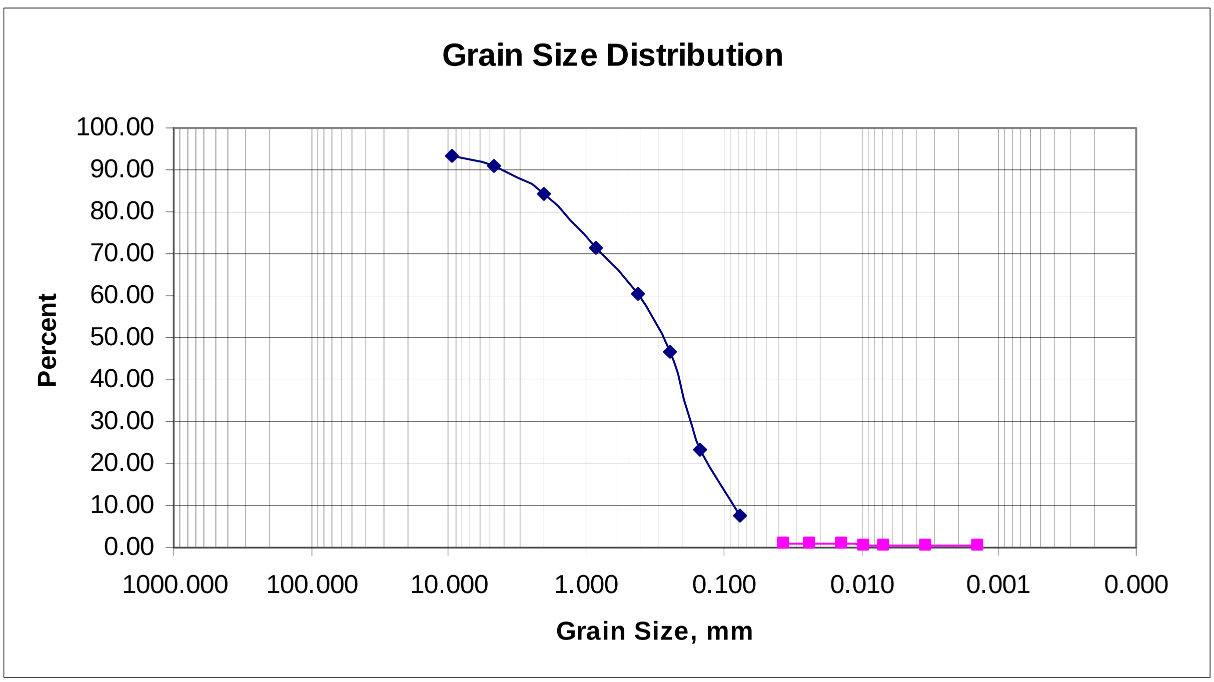
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
BBC-1	Bull	6.85	1.12	0.32	0.51



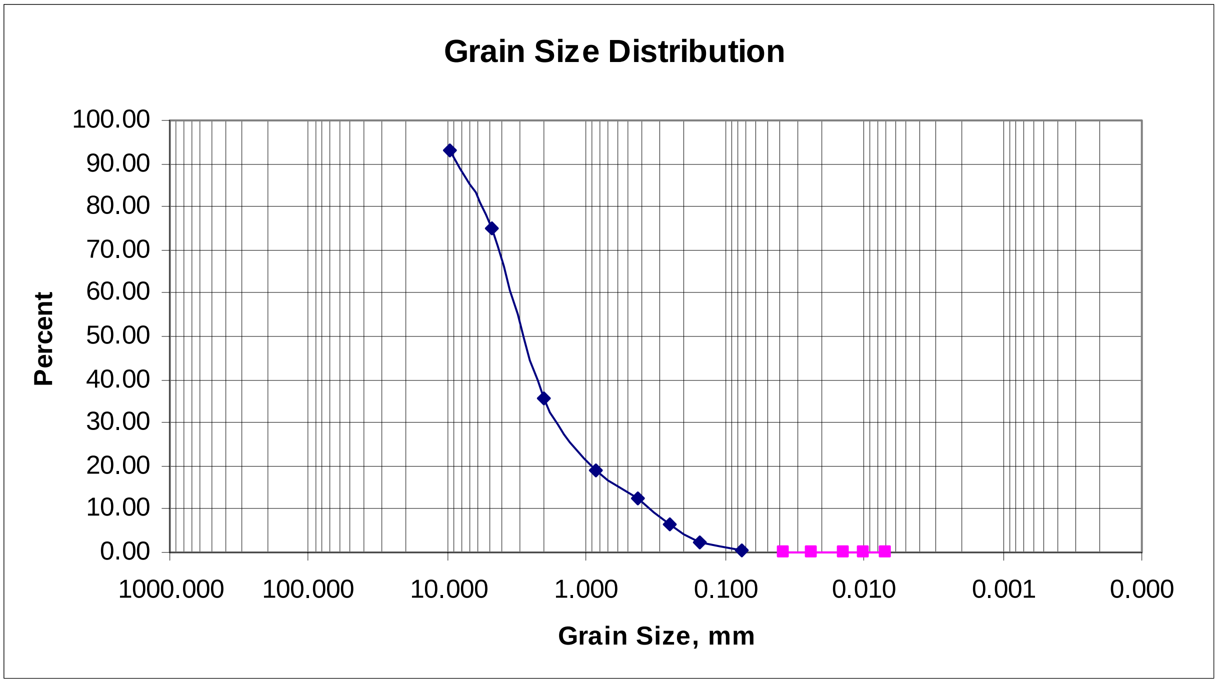
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
BBC-2	Bull	2.50	1.82	0.62	0.06



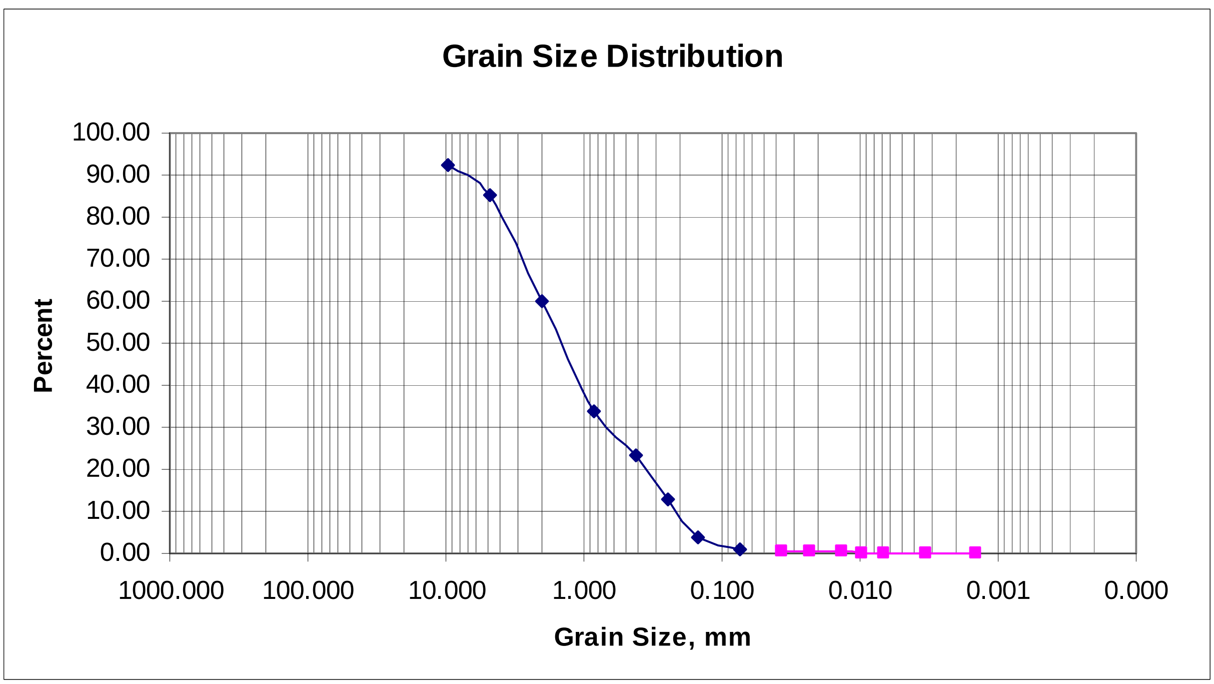
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
BBC-3	Bull	2.90	2.34	0.48	0.91



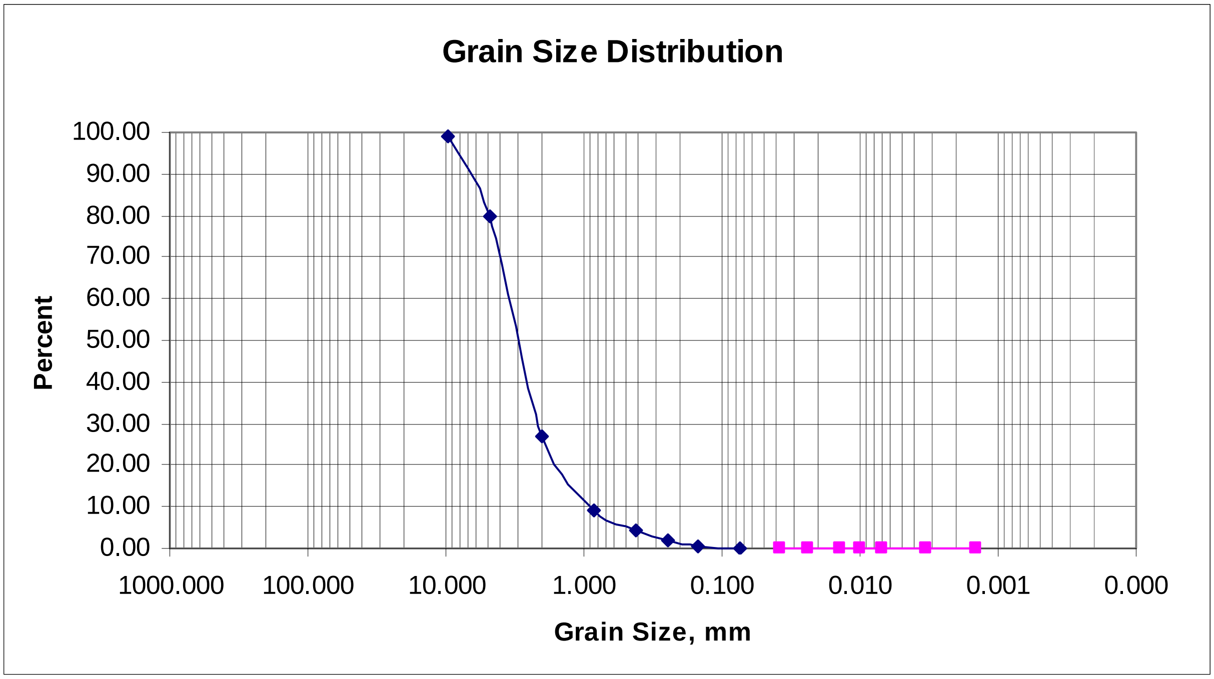
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LBC-1	Bull	0.28	23.23	7.76	0.75



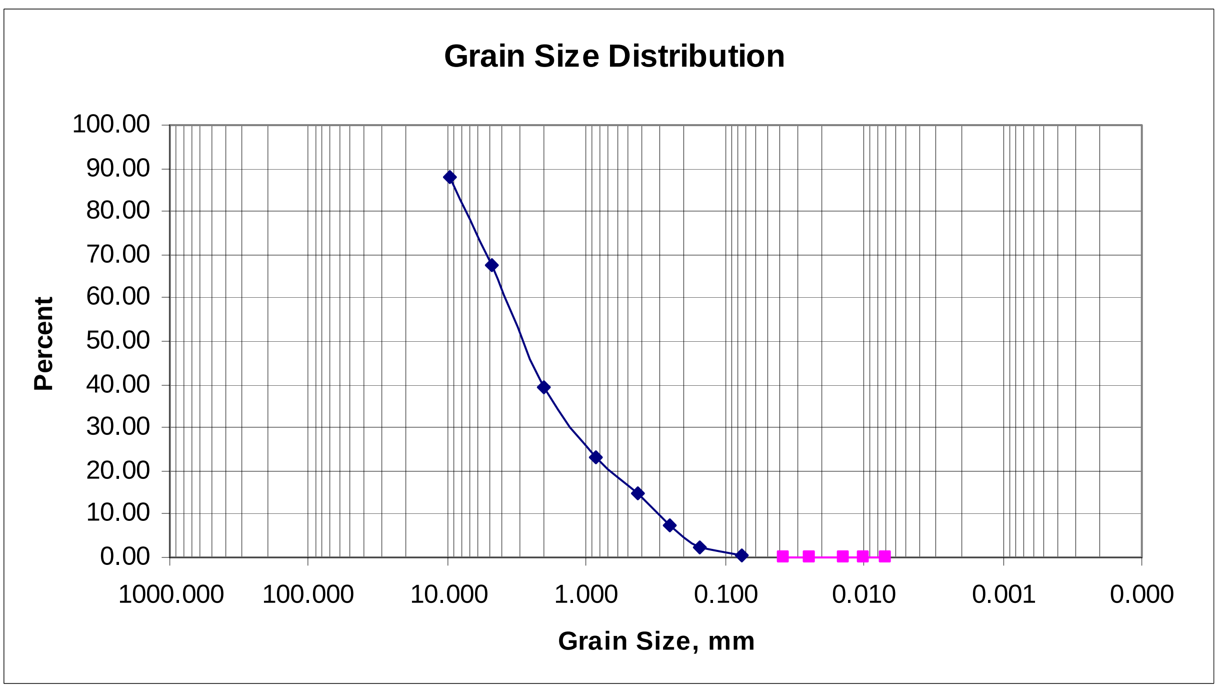
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LBC-2	Bull	2.85	2.45	0.43	0.14



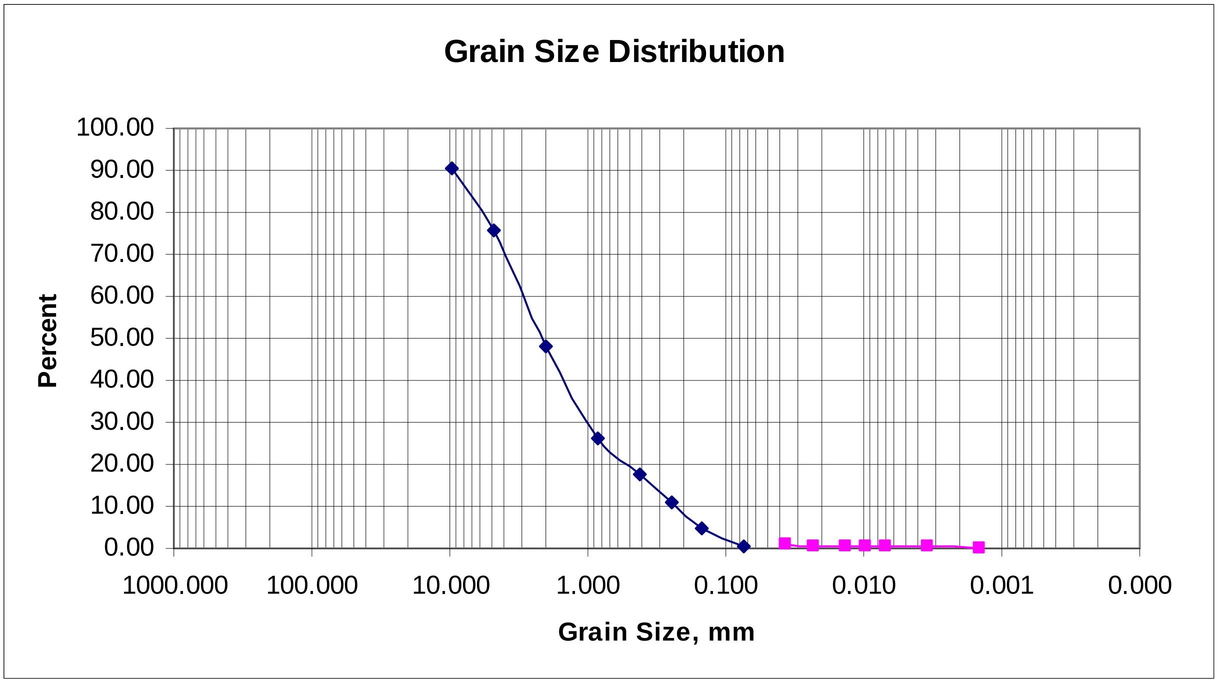
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LBC-3	Bull	1.55	3.96	1.08	0.28



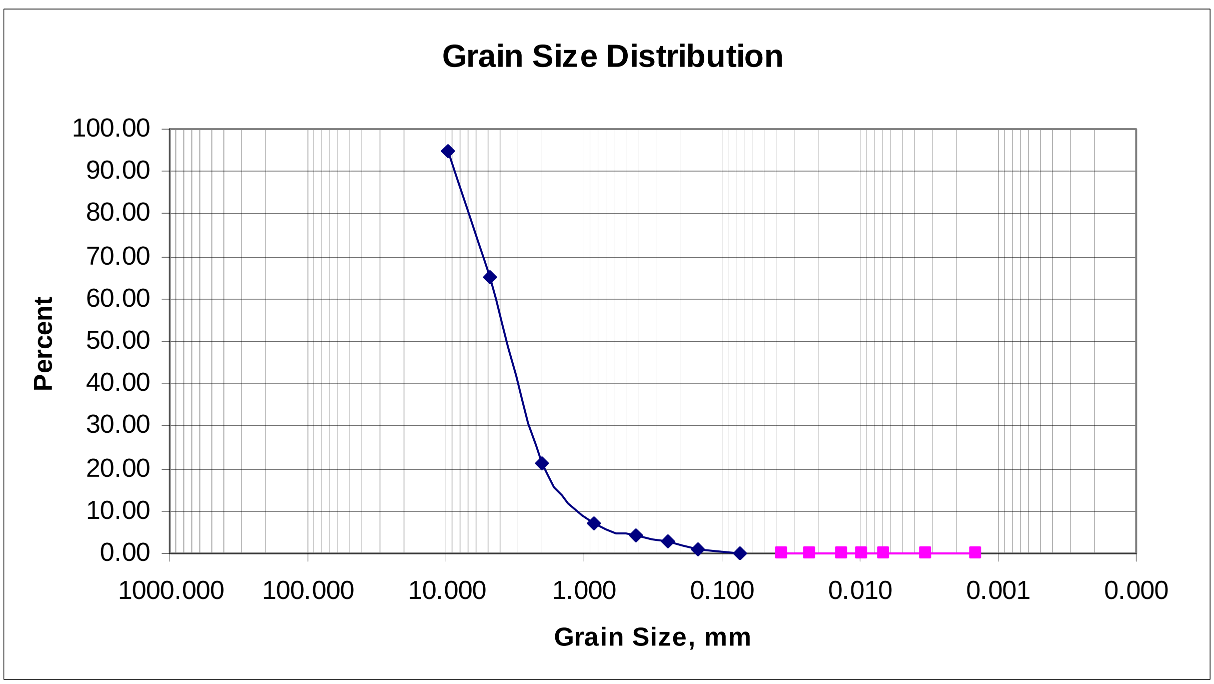
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
LBC-4	Bull	1.95	0.70	0.14	0.08



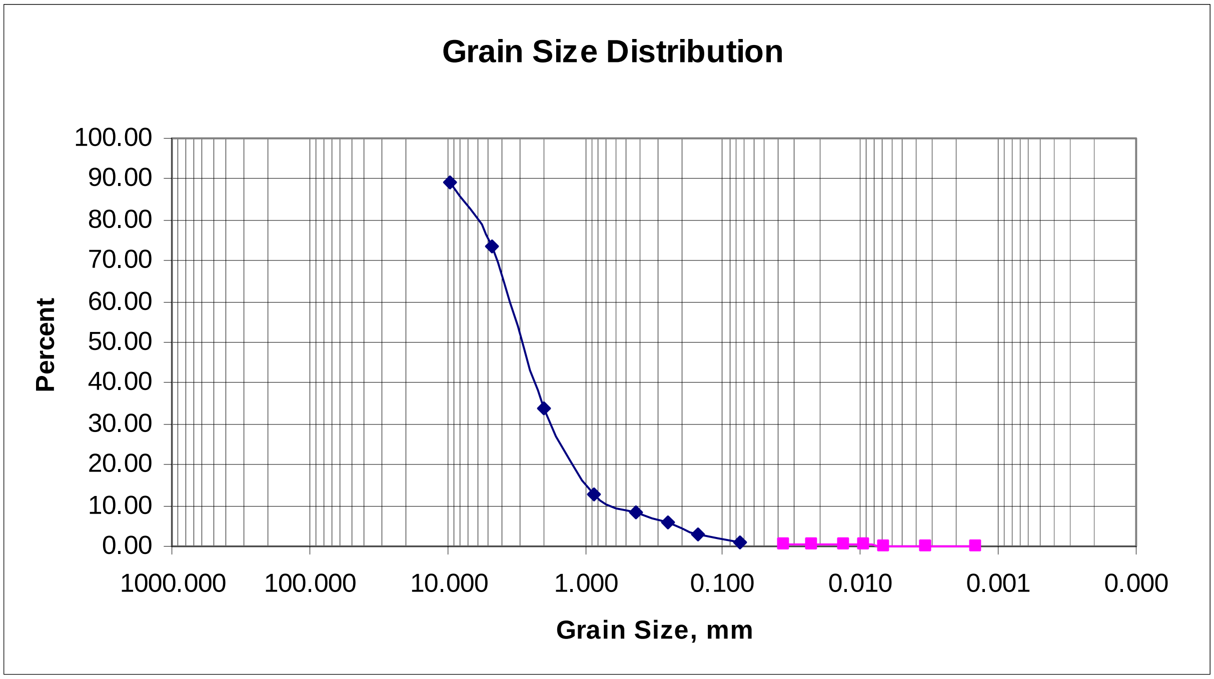
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
BSC-1	Brimstone	2.80	2.40	0.36	0.11



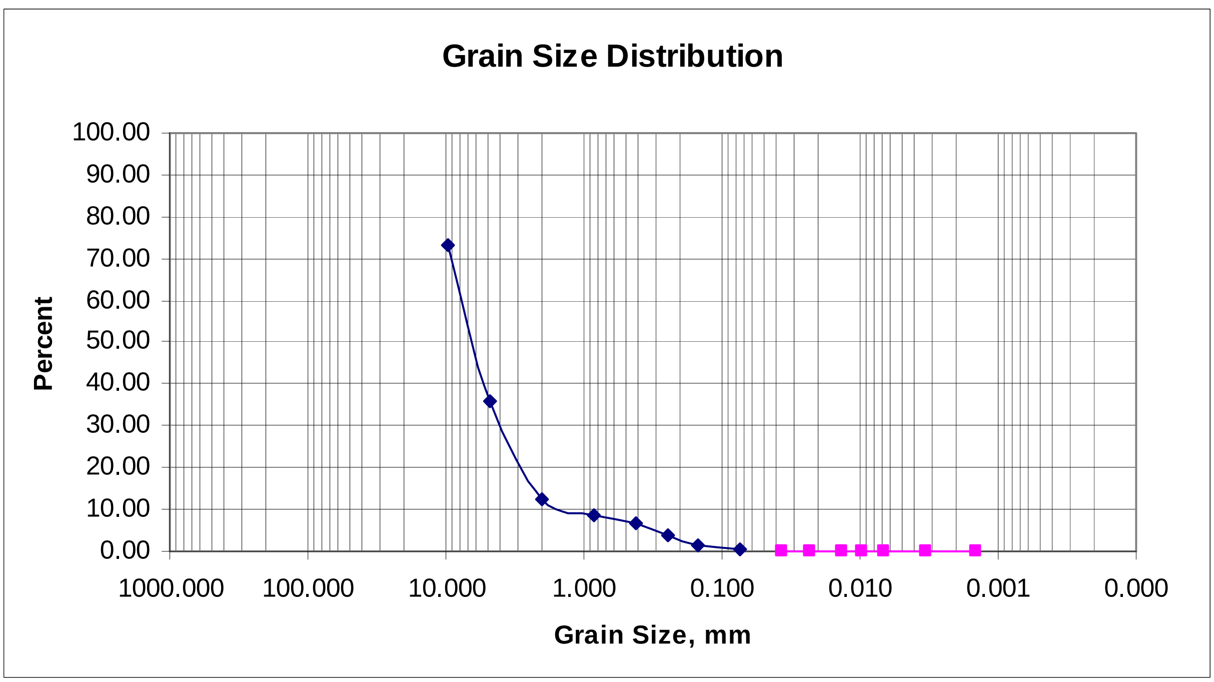
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
BSC-2	Brimstone	2.15	4.73	0.38	0.51



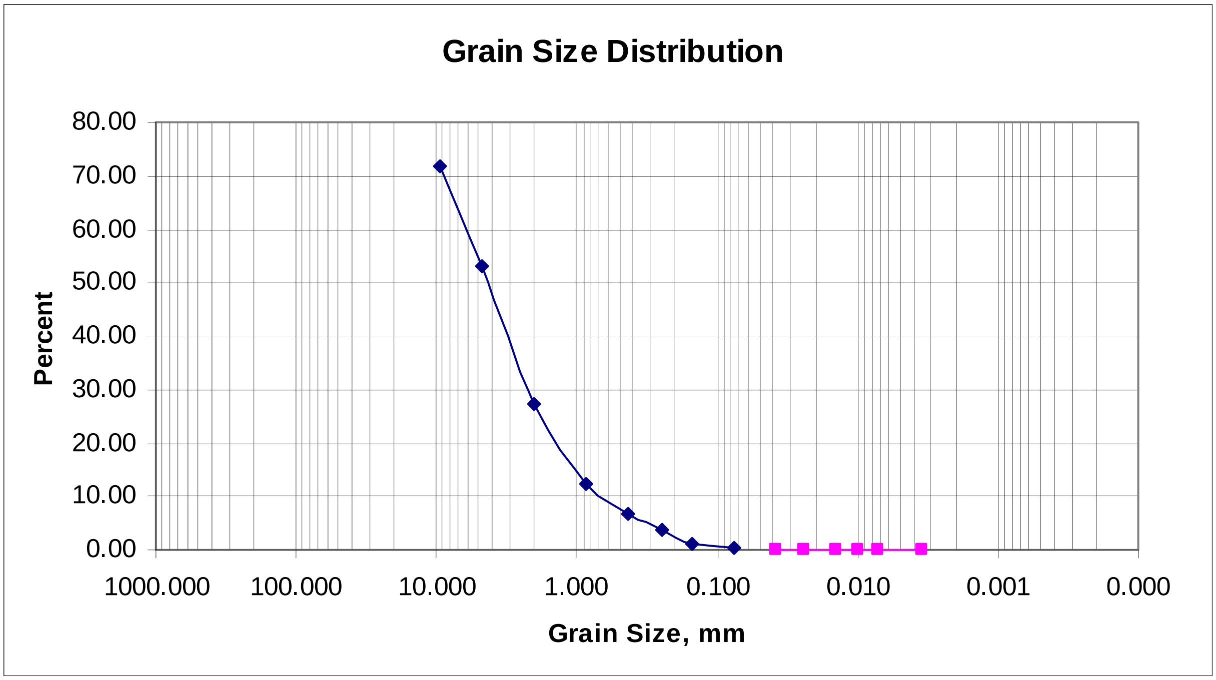
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
BSC-3	Brimstone	3.50	0.98	0.17	0.17



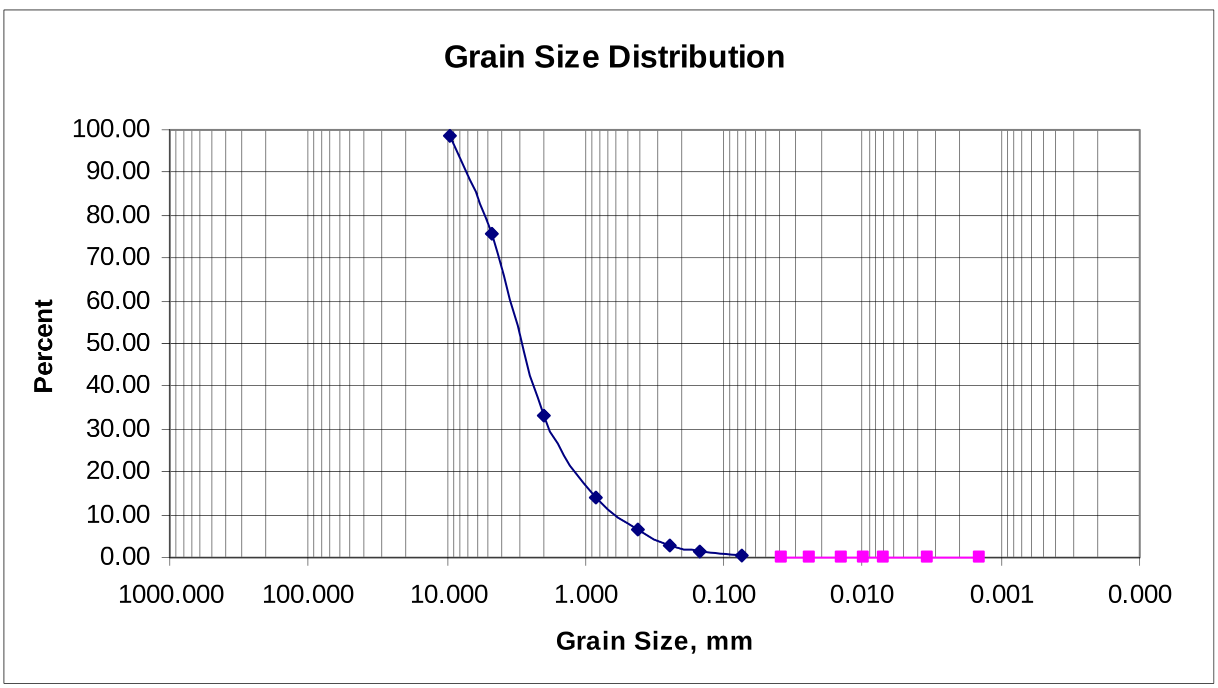
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
Joe-1	Brimstone	2.90	2.90	1.03	0.31



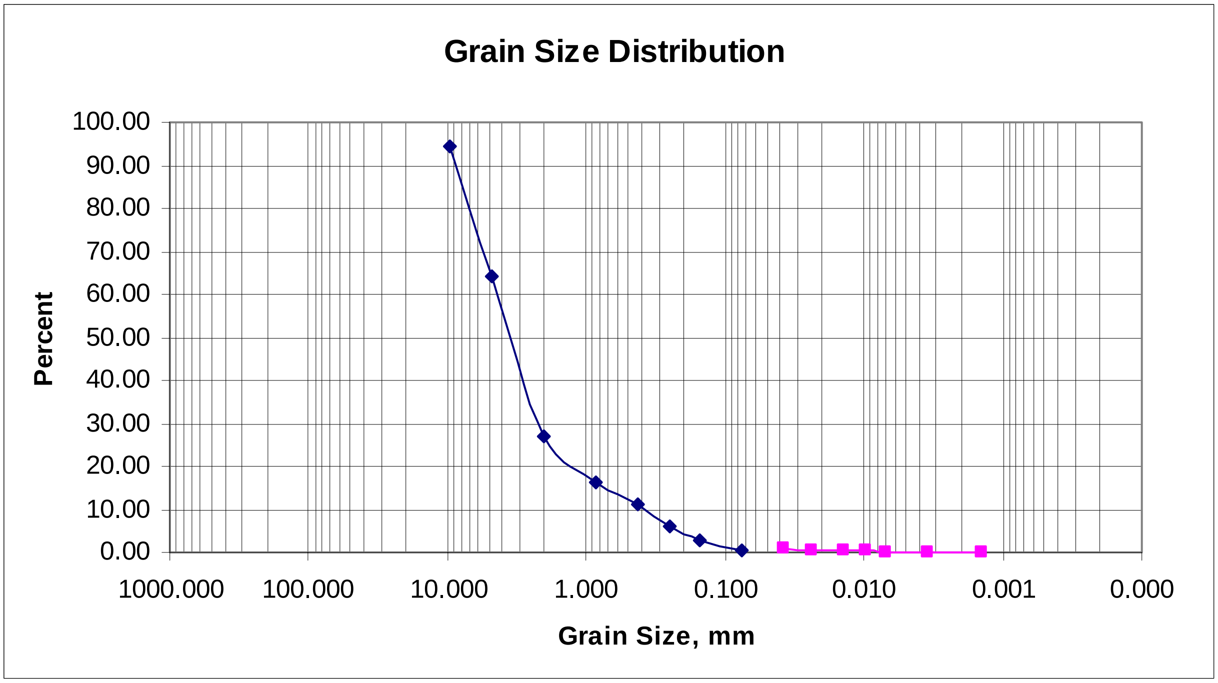
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
Joe-1A	Brimstone	5.10	1.33	0.34	0.06



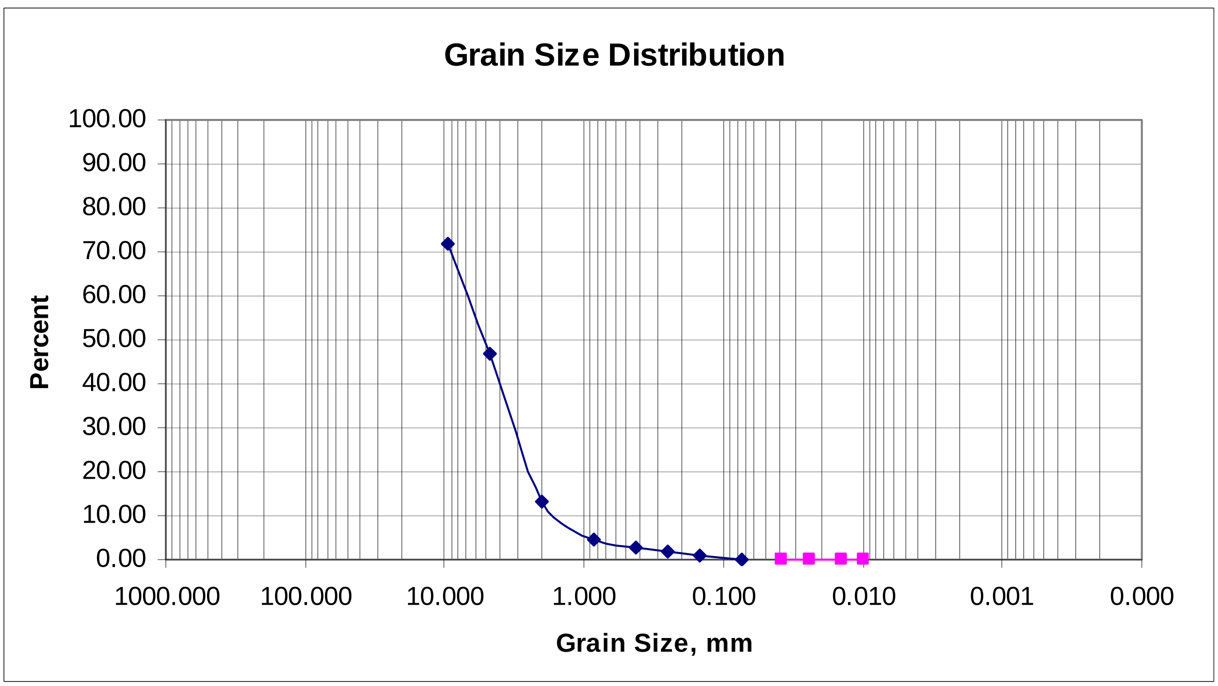
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
IC-1	Brimstone	4.25	1.30	0.32	0.07



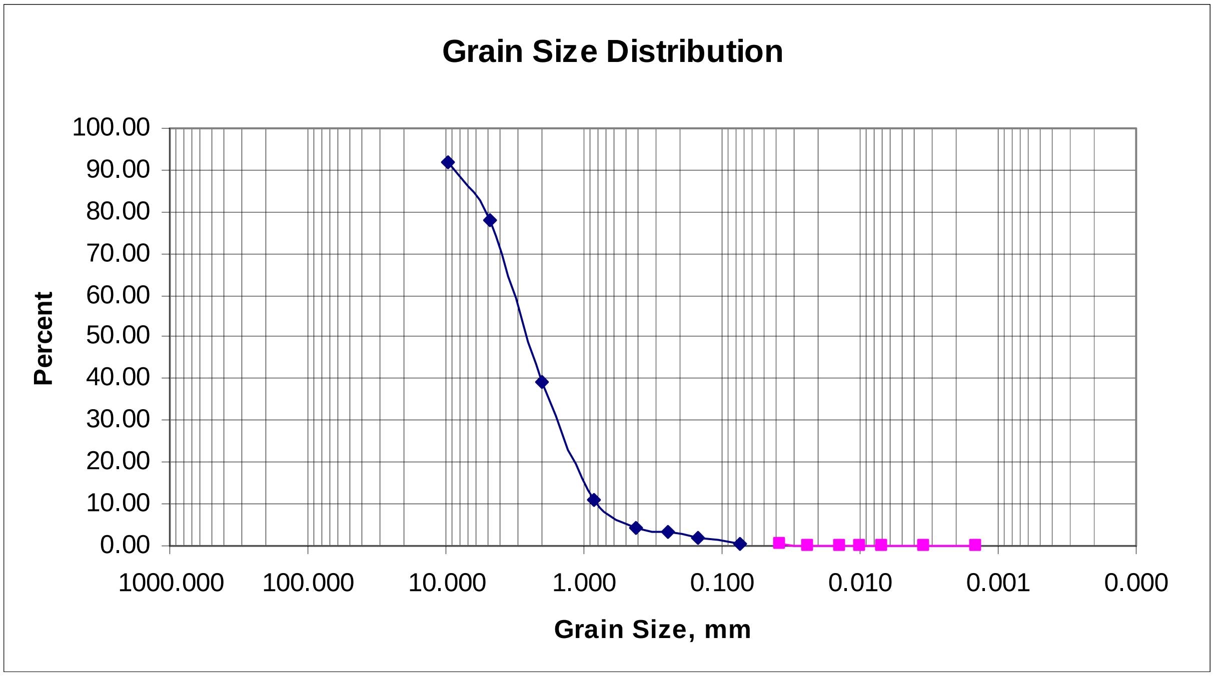
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
NPFF-1	Frozen Head	3.00	1.21	0.32	0.15



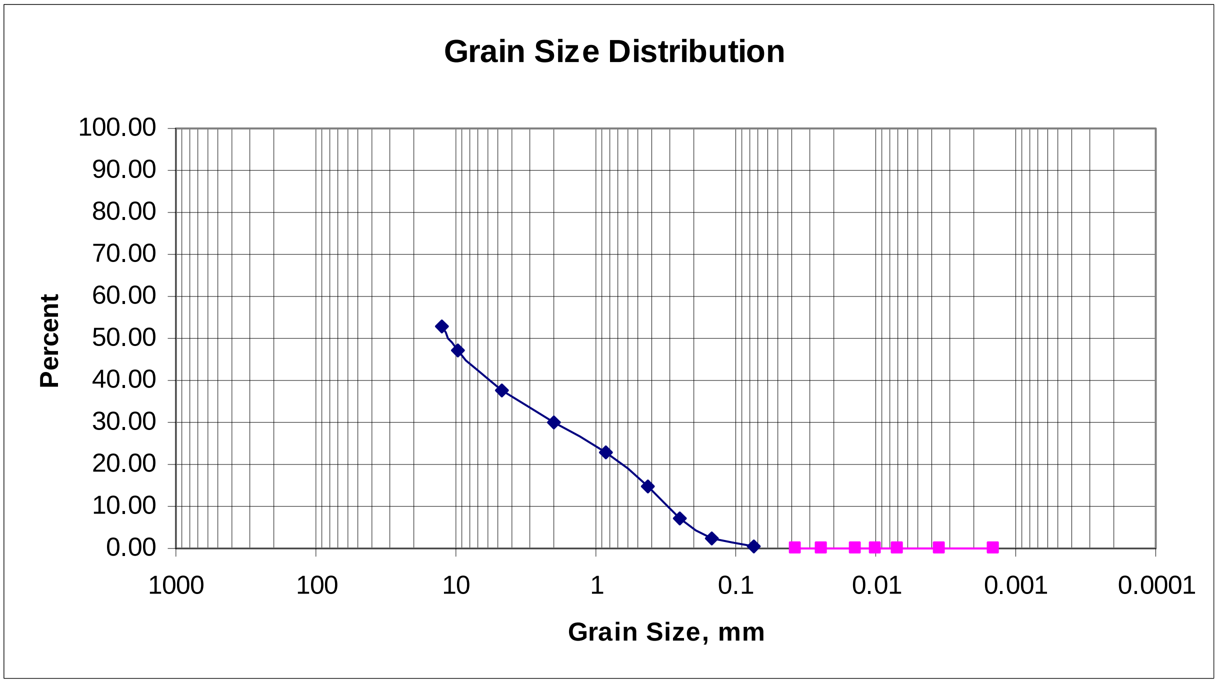
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
NPFF-2	Frozen Head	3.50	2.97	0.67	0.61



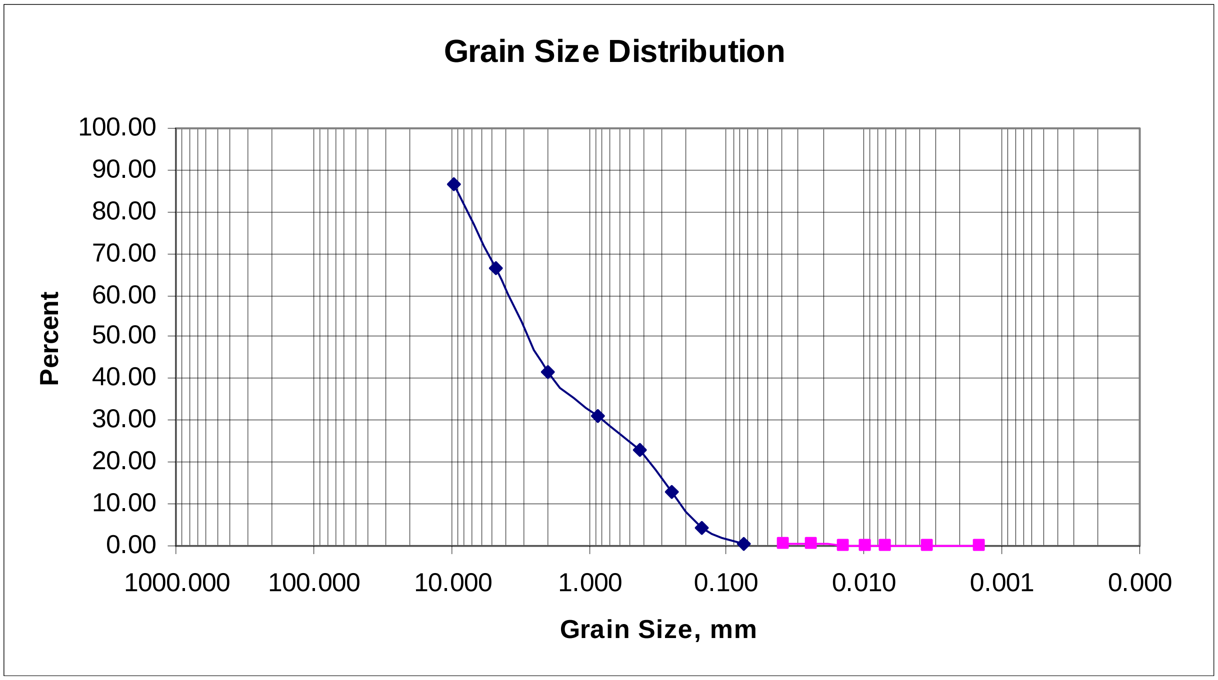
Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
NPFF-3	Frozen Head	5.10	0.80	0.19	0.07



Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
GCR-1	Greasy	2.75	2.13	0.40	0.18



Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
GCR-2	Greasy	11.5	2.54	0.42	0.18



Site ID	Watershed	D50 (mm)	% Finer than # 100 Sieve	% Finer than # 200 Sieve	% Finer than 0.016 mm
GCR-3	Greasy	2.80	4.29	0.55	0.21

APPENDIX E: CONCEPTS MODEL: FIELD INPUT DATA

Figure E1: April 2007 Montgomery Fork Cross-section No. 1

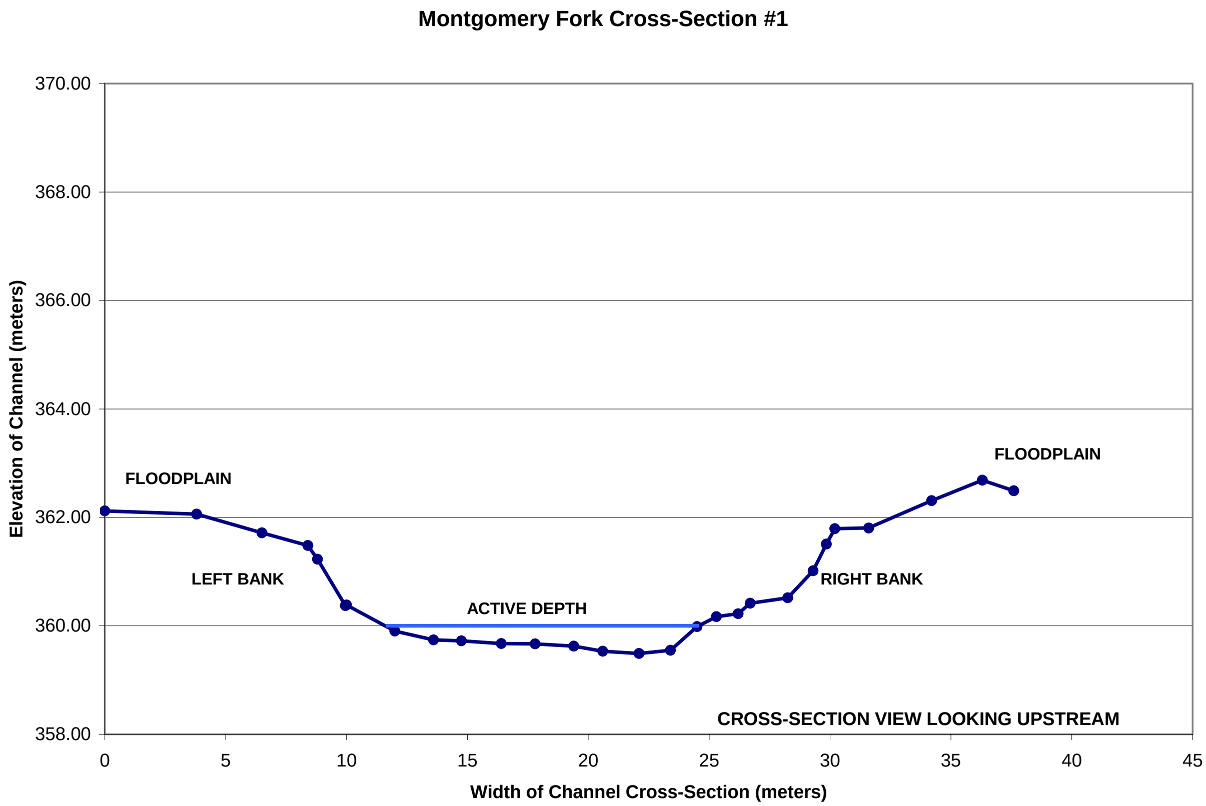


Figure E2: April 2007 Montgomery Fork Cross-section No. 2

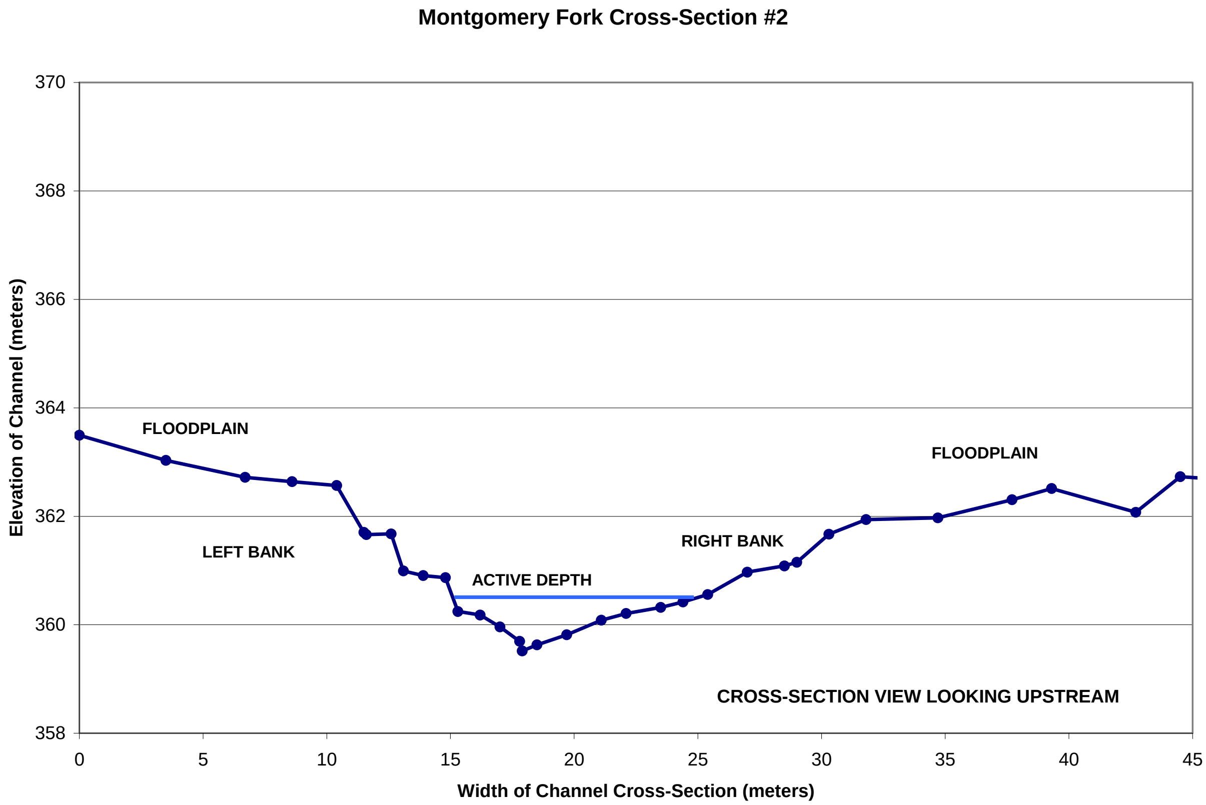


Figure E3: April 2007 Montgomery Fork Cross-section No. 3

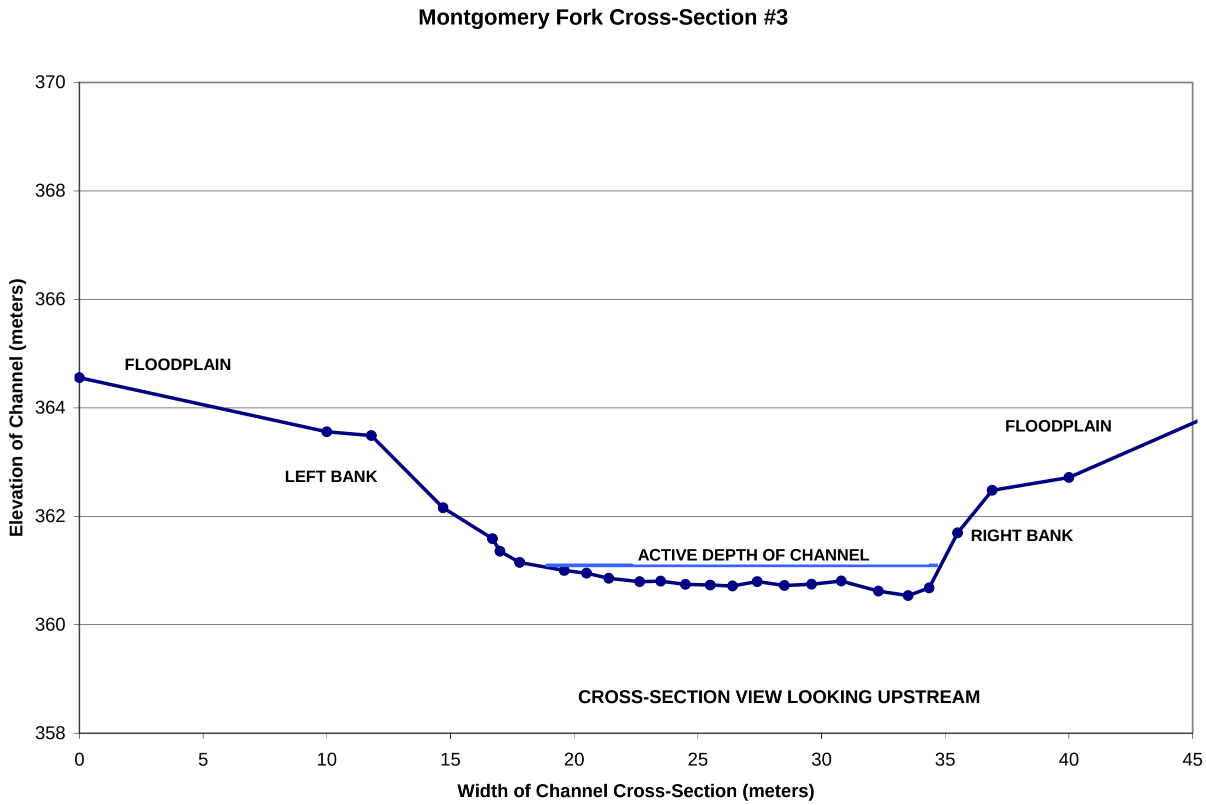


Figure E4: April 2007 Montgomery Fork Cross-section No. 4

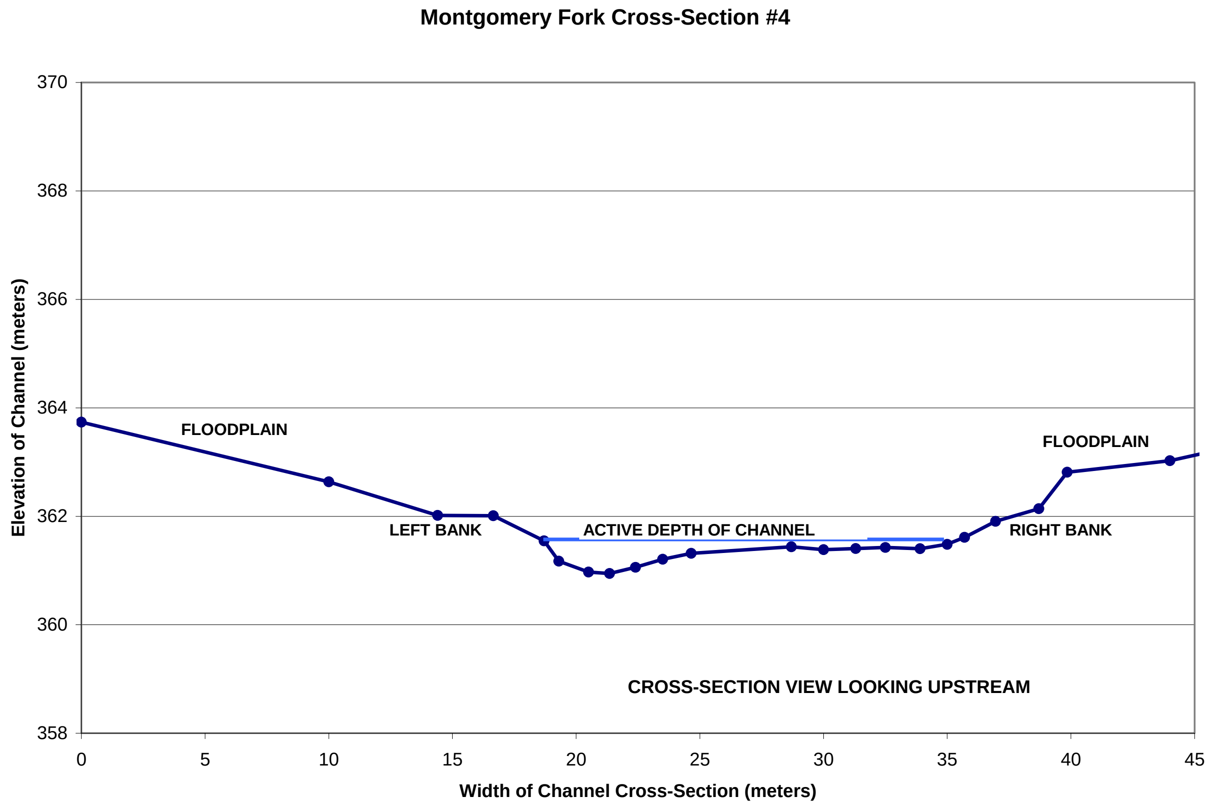


Figure E5: April 2007 Montgomery Fork Cross-section No. 5

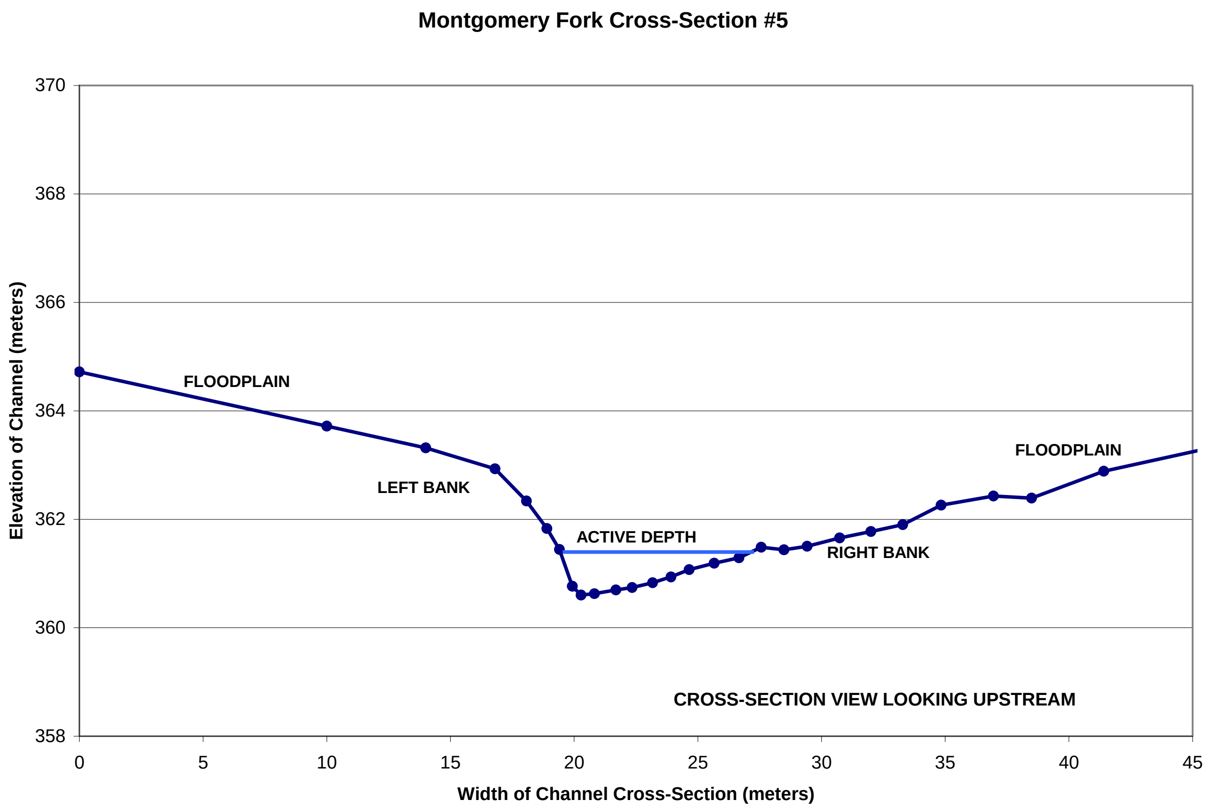


Figure E6: April 2007 Montgomery Fork Cross-section No. 6

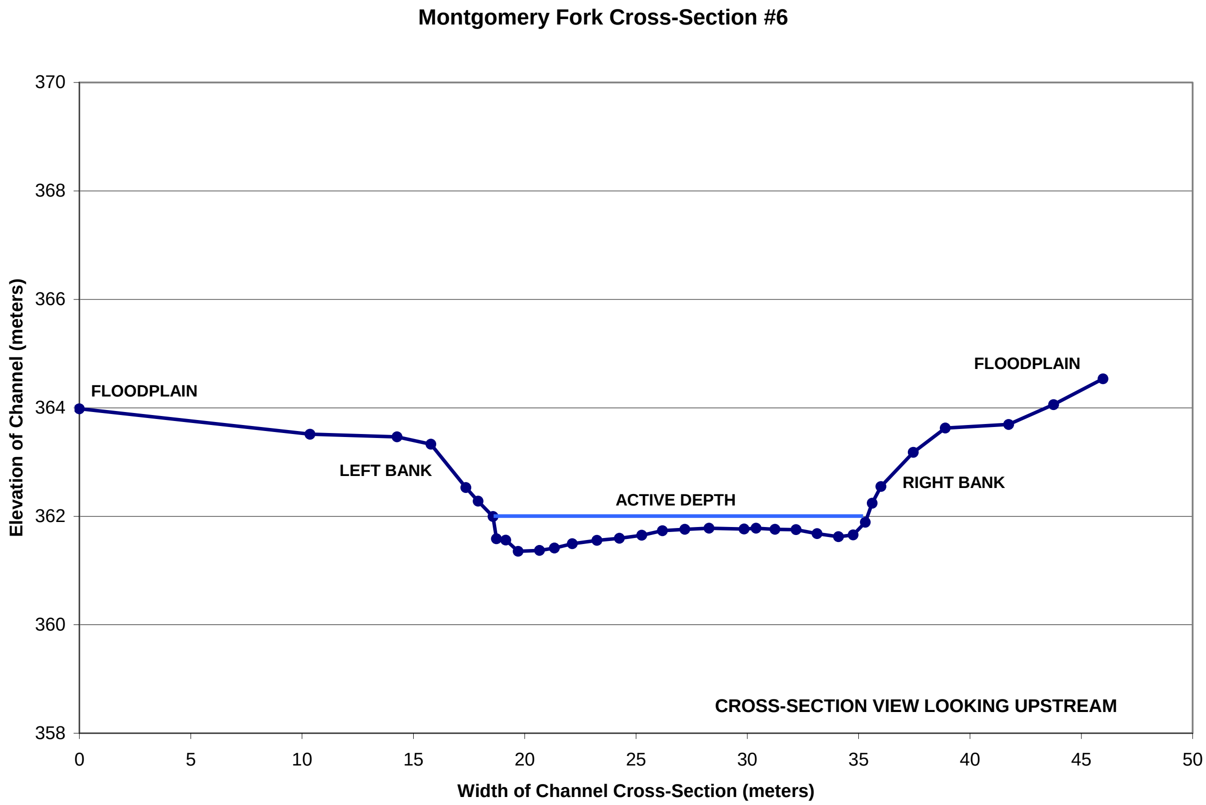


Figure E7: April 2007 Montgomery Fork Cross-section No. 7

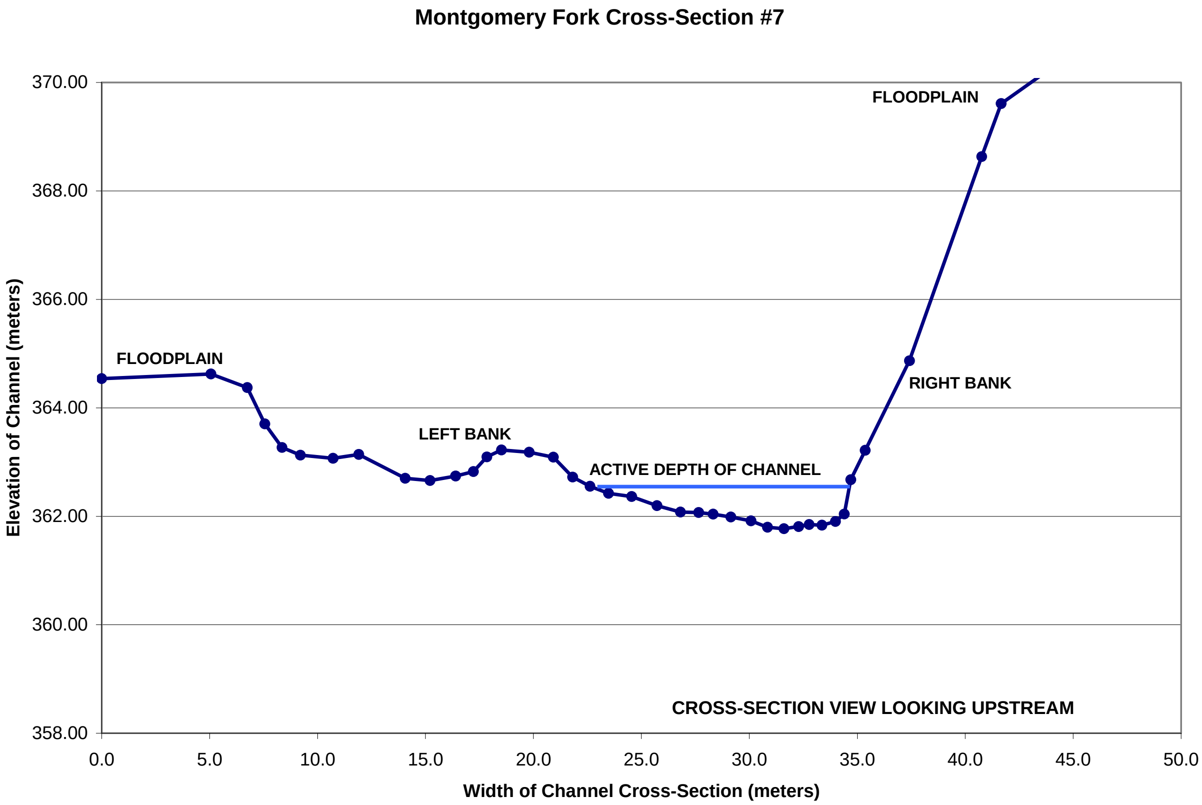


Figure E8: April 2007 Montgomery Fork Cross-section No. 8

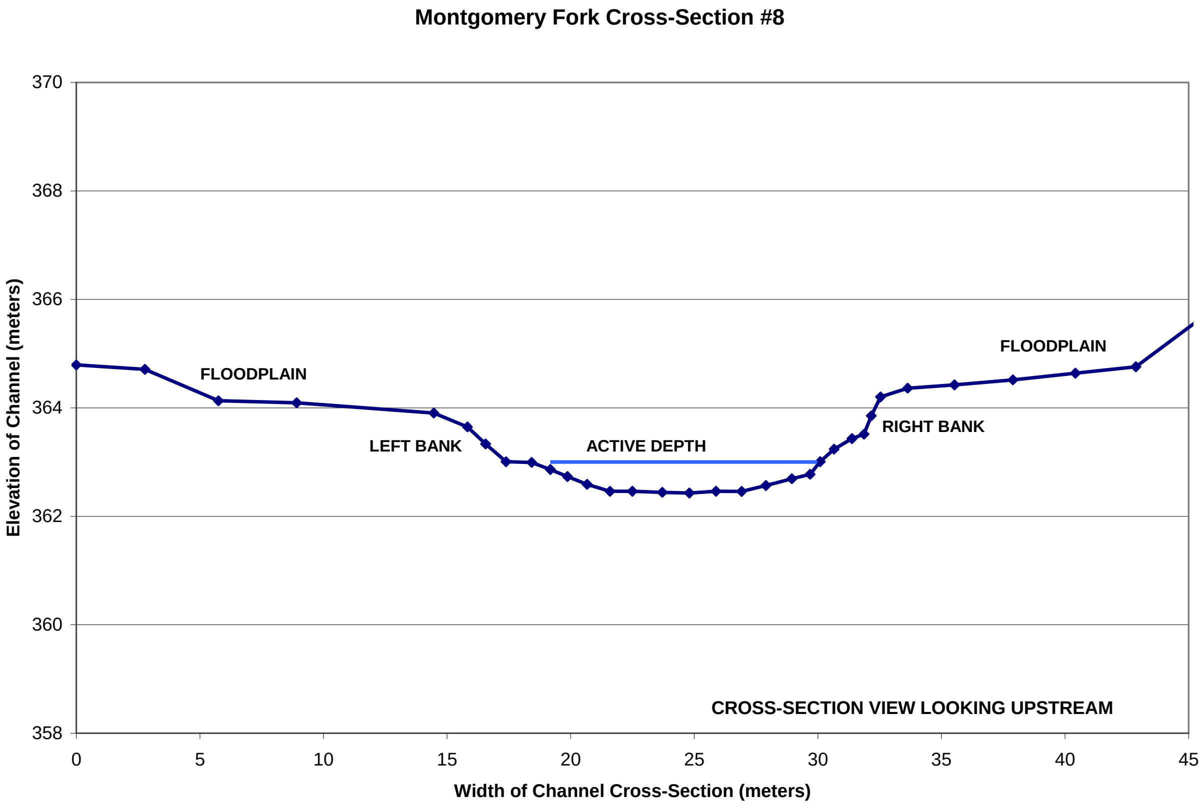


Figure E9: April 2007 Montgomery Fork Cross-section No. 9

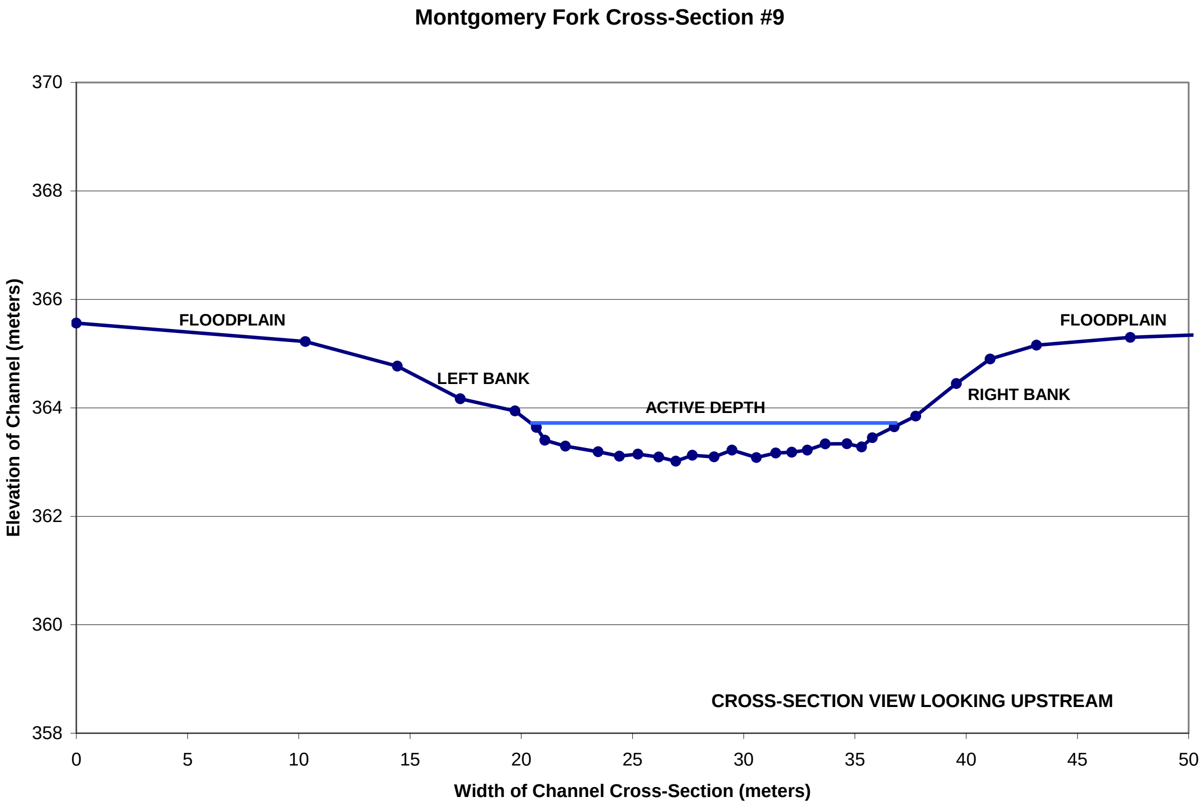
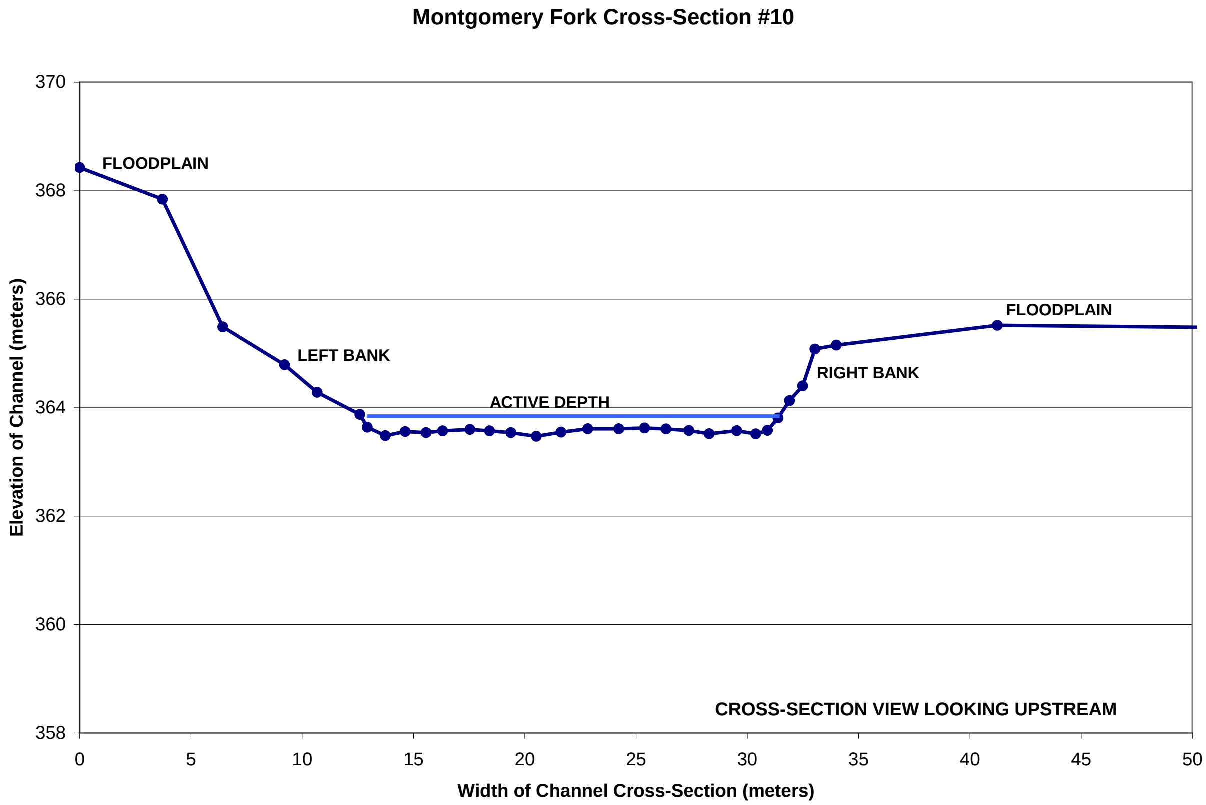
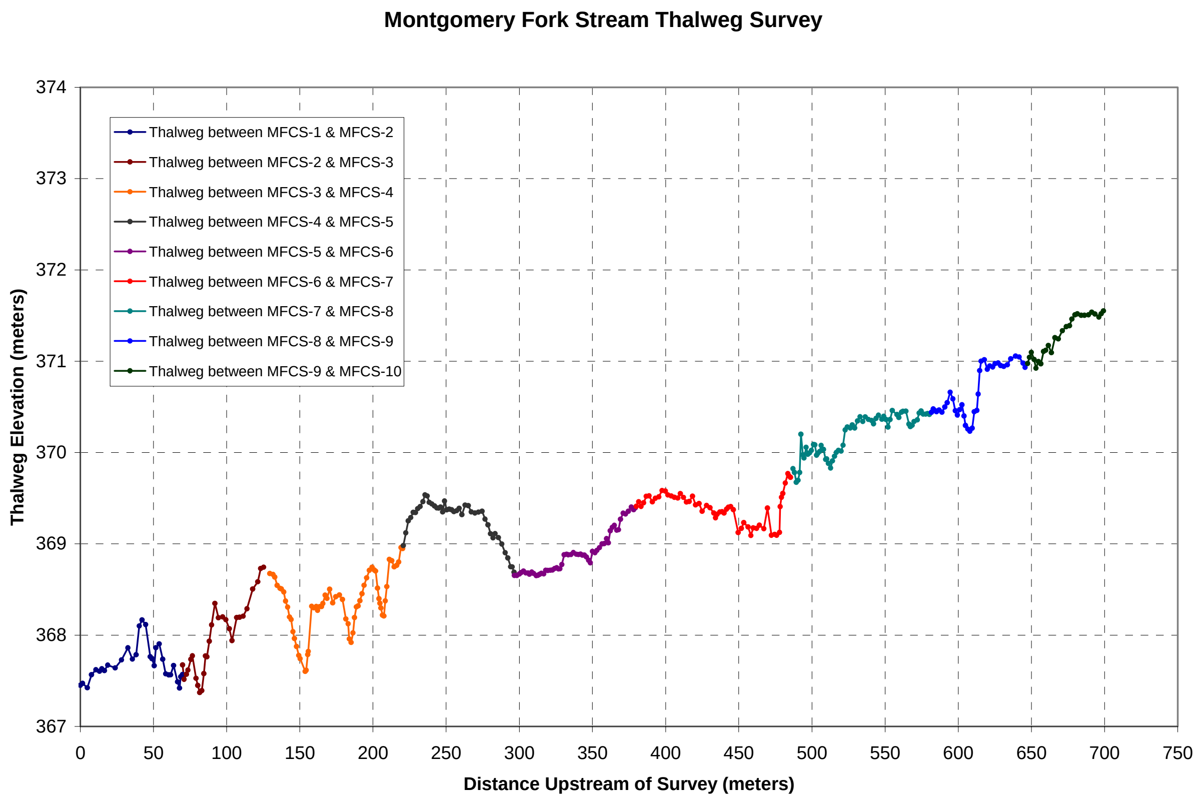


Figure E10: April 2007 Montgomery Fork Cross-section No. 10



The next two figures shown below represent the thalweg survey conducted on the section of Montgomery Fork's stream modeled within the CONCEPTS program. For the first of the two figures below, the thalwegs between each cross-section are shaded with a different color to help visualize the riffles and pools throughout the stream in respect to where the cross-sections have been taken. As can be seen in the figure below, MFCS-2, 5, 6, and 8 are located in deep pools (indicated by low points in elevation), where the other 6 cross-sections are found in riffles (where the channel has a peak increase in bed elevation).

Figure E11: April 2007 Montgomery Fork Thalweg Measurements between cross-sections



The figure found below represents the average slope of the Montgomery Fork channel simulatd in the CONCEPTS model. The values plotted are the thalweg values measured from MFCS-1 (most downstream) point to MFCS-10 (the most upstream Montgomery Fork cross-section measured).

Figure E12: April 2007 Montgomery Fork Thalweg Survey of Study Reach