THESIS

A GEOMORPHIC CLASSIFICATION

OF EPHEMERAL STREAMS IN ARID REGIONS

Submitted by

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ABSTRACT

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Current stream classifications do not adequately describe ephemeral streams in arid regions because these environments are characterized by high spatial and temporal variability of complex hydrologic interactions. To investigate the influence of channel form on riparian vegetation in the arid southwestern United States, I test a geomorphic classification for ephemeral streams based on the degree of confinement and the composition of confining material. I present five stream types: 1) *bedrock* channels entirely confined by exposed bedrock and void of persistent alluvium; 2) *bedrock with alluvium* channels at least partially confined by bedrock but containing enough alluvium to create bedforms that persist through time; 3) *incised alluvium* channels bound only by unconsolidated alluvial material into which they are incised; 4) *braided* washes that exhibit multi-thread, braided characteristics regardless of the degree and composition of confining material; and 5) *piedmont headwater* 0-2nd order streams confined only by unconsolidated alluvium and which initiate as secondary channels on piedmont surfaces. The objectives of this thesis were to i) validate distinct differences of channel geometry among the five stream types and ii) examine localized differences in geometry of the five stream types across watersheds with varying characteristics. Eighty-six study reaches were surveyed on the U.S. Yuma Army Proving Ground (YPG) and eighteen study reaches on Barry Goldwater Air Force Range (BMGR) in southwestern Arizona. Non-parametric permutational multivariate analysis of variance (PERMANOVA) for all 101 study reaches indicates significant differences

(P<0.001) in channel geometry between the five stream types with regard to width-to-depth ratio, stream gradient, shear stress, and unit stream power. PERMANOVA results indicate no significant differences in channel geometry of individual stream types within watersheds of differing characteristics. A linear discriminant function of the four physical driving variables derived from 86 study reaches at YPG predict stream type with a 73% external hit rate for the 15 study reaches at BMGR. Classification and regression tree (CART) analysis identify thresholds for distinguishing stream types and indicates the relative importance of variables such that: width-to-depth ratio (W/D) correctly distinguishes 93.8% of braided channels (W/D > 91.2), shear stress (τ) correctly distinguishes 95.2% of bedrock channels (τ > 151.6 Pa), and unit stream power (ω) correctly distinguishes 68% of piedmont headwater channels ($\omega \leq 35.63$ W/m^2). The resulting classification will provide a basis for examining relationships between channel characteristics, hydrologic process, riparian vegetation and ecosystem sensitivity of ephemeral streams in arid regions of the American Southwest.

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DEDICATION

I dedicate this thesis to my wife, Marissa Sutfin, who provided me with endless support, time, effort, patience and understanding while I worked for several months in the desert to collect data and countless months behind a computer thereafter. Your support and partnership make this thesis and all that I accomplish possible.

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1. INTRODUCTION

Fluvial systems in arid regions are highly susceptible to physical disturbances associated with land use and climate change. Changes in hydraulics and hydrologic flow regimes associated with climate change affect channel characteristics and the accessibility of water for riparian and aquatic ecosystems in dryland channels (Bull, 1997; Bacon et al., 2010). Anthropogenic disturbances associated with land-use practices (e.g., roads, grazing, military training) alter physical geometry of streams and impact ecosystems, possibly exacerbating climate-induced changes. Examination of the relationship between the physical and biological characteristics of arid, fluvial systems is crucial in assessing disturbance and the ecological sensitivity of watersheds. Further understanding of these arid systems will facilitate well-informed land-use management decisions. However, significant connections between hydrologic and geomorphic drivers and ecological sensitivity of arid-region ephemeral streams are hindered by limited datasets. A dearth of terminology and ways to classify ephemeral streams remains a primary disadvantage in understanding the structure and function of arid-region channels

This thesis is a portion of a larger interdisciplinary project for the Strategic Environmental Research and Development Program (SERDP) to develop a classification for the ecological sensitivity of ephemeral fluvial systems on military lands in the Sonoran desert of the southwestern United States. The classification system was developed through intensive fieldwork at the Yuma Proving Ground (YPG) and was tested on a separate dataset of study reaches at Barry M. Goldwater Air Force Range (BMG) in southern Arizona. While limited public access preserves these sites to some degree, military training procedures and unpaved roads impact the fluvial system. Access to highly restricted military lands in these xeric environments provides study areas of limited impact that allow assessment of ecological sensitivity with regard to natural and potential anthropogenic disturbances. Development of a classification system that aids in the assessment of the ecological sensitivity of watersheds using watershed and stream channel characteristics will allow military personnel to avoid areas that may be highly sensitive, facilitate well informed land-use management decisions, and contribute to the collective understanding of the geomorphology, hydrology, and ecology of ephemeral streams in arid regions. This thesis presents a geomorphic stream classification for arid-region ephemeral channels to facilitate the development of a classification for ecosystem sensitivity of riparian areas in the desert environment of the American Southwest.

Various stream classifications in the literature describe physical attributes of channels and stream processes used for monitoring and restoration purposes. Present classifications refer primarily to characteristics of perennial streams, which maintain a range of regular recurrence intervals and flow magnitude responsible for shaping channel geometry and riparian habitat. Although I do not cover them all in this brief review, the stream classifications discussed are those most influential in the literature and those that inspire the classification presented here. One approach to river classification focuses on planform. Although Leopold, Wolman and Miller (1964) acknowledge that separation of river pattern is somewhat arbitrary because classifications define segments within a continuum, they categorize rivers by three planforms: 1) *straight*, 2) *meandering*, and 3) *braided*, to which anastomosing rivers were later added. Leopold et al. (1964) define sinuosity as the ratio of channel length over down-valley distance, such that channels are classified as *meandering* when the sinuosity is >1.5 and *braided* with the presence of multiple shifting channels. Schumm (1977) later classified streams by the dominant mechanisms of sediment transport: 1) bedload dominated, 2) suspended-load dominated, or 3) mixed bed channels. Montgomery and Buffington (1997) describe streams with respect to bedforms as seen in a longitudinal profile. They describe a sequence of relative frequency of occurrence of each stream type with progressively increasing distance downstream. The downstream progression begins in steep uplands where colluvial processes tend to dominate and moves downstream through progressively increasing occurrence of i) cascade, ii) step-pool, iii) plane-bed, iv) pool-riffle, and v) dune-ripple morphology. Rosgen (1994) presents perhaps one of the most complicated stream classifications, widely used by U.S. government agencies, which includes measures of gradient, bed material, width/depth ratio, sinuosity, and lateral constraint, resulting in over 35 stream types. Inherent within his stream classification, Rosgen defines the *entrenchment ratio* as the ratio between the floodprone width (the width of the channel or valley at two times the bankfull stage) and the bankfull width. Although the classification presented here borrows a version of this entrenchment ratio and uses similar measures to describe channel types, I attempt to simplify the categories of stream types to aid in the assessment of ecosystem sensitivity of arid ephemeral streams, by incorporating reach-scale physical characteristics most influential to riparian vegetation in xeric environments. Current stream classifications can be used to assist in assessment of ecosystem sensitivity of perennial streams and some aspects of current stream classifications can be useful in classifying ephemeral channels. However, stream classifications do not adequately describe ephemeral streams in detail, especially with regard to riparian ecology in arid regions.

Although not a distinct classification, it is important to recognize Stanley Schumm's (1977) contribution to understanding changes in fluvial process and form with increasing distance from the headwaters through the basin model, which divides a basin into three longitudinal zones: 1) the erosional zone where basin material is derived, 2) the transfer zone through which material is transported, and 3) the depositional zone. This idea of varied process associated with location in the stream network was continued by Montgomery's (1999) presentation of process domains driven by coupled processes between hillslopes and stream segments. Polvi et al. (2011) applied the concept of process domains to riparian ecosystems and vegetation communities. Although researchers utilized stream classifications for ecological applications and restoration efforts, limited work has attempted to develop or modify stream classification for ephemeral streams. As a result, terminology inherent in current stream classifications and assumptions based on perennial flow do not apply to ephemeral streams. Consequently, appropriate terminology is limited in discussion of dryland channels that do not flow on an annual basis. Examples are *bankfull stage* and *bankfull width,* which are associated in hydrologic, geomorphic, and ecological literature with a channel-forming flow that occupies the entire channel on average every 1.5 years. Because ephemeral streams may experience decades between flows and continuous aggradation between large floods, and because ephemeral streams are commonly deeply incised, identification of a *bankfull stage* is either not applicable or not useful. Although terminology regarding ephemeral channels is not well established, researchers have classified ephemeral streams. Shaw and Cooper (2008) identify three ephemeral stream types with regard to riparian vegetation communities, hydrologic process and access to groundwater, reach-scale hydraulics, and drainage area. The goal of the larger project of which this thesis is a part (i.e., assessment of ecological sensitivity), adapts a similar approach by Wohl et al. (2007) to examine the influence of watershed and reach-scale characteristics, while expanding upon the efforts of Shaw and Cooper (2008) to assess the sensitivity of riparian vegetation communities in arid-region ephemeral streams.

The research presented here focused on watershed and channel characteristics that influence hydraulics, hydrologic interactions and riparian vegetation communities in xeric regions to develop a geomorphic classification for ephemeral streams. Development of a valid stream classification based on physical drivers will assist in the development of a classification system for ecological sensitivity. Physical basin characteristics (e.g., drainage area, hillslope, lithology) influence weathering and erosion rates, grain size distributions, sediment supply, sediment transport, soil properties, stratigraphy, and channel characteristics. Channel characteristics in turn influence sediment transport and supply, grain size distributions, and stratigraphy (Bull, 1997; Knighton, 1998). These basin and channel characteristics shape the environment and hydrologic processes that support riparian and aquatic habitat (Collins et al., 1981; McAuliffe, 1994; Stanley et al., 1997; Montgomery. 1999; Tooth, 2000; Friedman and Lee, 2002; Snelder, et al., 2004; Snelder et al., 2005; Camporeale, 2006; Shaw and Cooper, 2008). Many of these characteristics are captured in changes of channel planform, the degree of channel confinement, and the composition of confining material. The preliminary classification on which my work is based posited distinct differences in biodiversity and ecological sensitivity among four stream types that have now been extended to five: 1) bedrock, 2) bedrock and alluvium, 3) incised alluvium, 4) braided, and 5) piedmont headwater channels. The stream classification presented here defines channels in a predominantly transport-limited system with regard to the relative degree of confinement and the composition of the confining material.

This classification follows concepts of Schumm's (1977) basin model of erosive to depositional zones, where a continuum exists from primarily erosive bedrock channels in the upland headwaters to primarily depositional braided washes in the lowlands. Similar to Montgomery and Buffington's (1997) downstream progression, the five stream types presented here are expected to occur in relation to distance from upland headwaters. The relative frequency of occurrence is expected to increase with increasing distance from the mountainous uplands in the following order: bedrock, bedrock with alluvium, incised alluvium, piedmont headwater, and braided washes. The geomorphic classification presented here examines cross sectional profile with regard to width-to-depth ratio and the ratio between valley-to-channel width, similar to metrics in the Rosgen classification including entrenchment ratio (Rosgen, 1994). This thesis tests distinct differences in channel geometry among the five stream types proposed in the classification and examines relationships between channel geometry and broad-scale basin characteristics.

1.1 Background

1.1.1 Characteristics of ephemeral streams in arid regions

Spatial and temporal relationships of fluvial processes in dryland rivers vary greatly from those in humid fluvial systems (Graf, 1988a; Reid and Larrone, 1995; Tooth, 2000; Bull and Kirkby, 2002; Reid and Frostick, 2011). When compared to their perennial counterparts, ephemeral channels have greater downstream increases in width with associated increases in stage (Graf, 1988a; Reid and Larrone, 1995; Hooke and Mant, 2002). Arid-zone rivers experience a channel-forming flow approximately every 10 years, as opposed to typical 1.5 recurrence intervals for bankfull stage in temperate rivers (Bull and Kirkby, 2002). Although flows that occupy the entire channel of arid-region ephemeral streams may occur more frequently, channel-forming flows occur in a range of 1 to 32 years (Graf, 1988a). Large floods play an important role in the channel geometry and floodplain structure of ephemeral streams because the relationship between recurrence interval and discharge is far from linear (Graf, 1988b; Goodrich et al., 1997). Low infiltration rates in sparsely-vegetated, arid regions result in high rates of sheet wash, sediment entrainment, hillslope erosion and Hortonian infiltration-excess overland flow as the dominant runoff process (Dunne and Leopold, 1978; Graf, 1988a; Knighton, 1998; Tooth, 2000; Bull and Kirkby, 2002; Reid and Frostick, 2011).

Limited subsurface flow slows weathering of subsurface materials, slows soil development, and limits clay content and soil cohesion. Lack of cohesive silt and clay and abundance of unconsolidated material in ephemeral channels result in high erosion rates, high sediment concentrations, gravel- to mixed-bed channels, and predominantly transport-limited systems (Graf, 1988a; Bull and Kirkby, 2002). In addition, sparse vegetation and the lack of armoring in ephemeral streams allow bedload transport values an order of magnitude greater than near-perennial streams of similar size that experience higher flows (Reid, 2002; Reid and Frostick, 2011). Despite rapid response to high intensity storms, Bull and Kirkby (2002) state that arid rivers maintain relatively the same type of channel and flow characteristics throughout time. However, some argue that ephemeral streams are in non-equilibrium (Graf, 1988a; Hooke and Mant, 2002) because they respond to infrequent flows with progressive cutting and filling (Patton and Schumm, 1981). Determination of steady state versus dynamic equilibrium is dependent upon the scale at which one examines an ephemeral stream system. Aggradation and incision of ephemeral streams occur simultaneously in a given system as a negative feedback with adjustments in sediment supply, local slope, and knickpoint migration (Patten and Schumm, 1981; Graf, 1988a). Sheetflow convergence into incised channels results in temporary scour (Graf, 1988a; Bull, 1997), but gives way to a threshold of critical power where the channel experiences a shift from degradation to aggradation (Bull, 1997) at what Hooke (1967) terms the intersection point on alluvial fans. This aggradation of unconsolidated alluvium in ephemeral washes maintains limited surface area of relatively higher infiltration rates compared to low permeability of adjacent uplands (McDonald et al., 2004; McDonald et al., 2009).

In the context of a geomorphic classification, the most defining characteristic of arid-region ephemeral streams is the high spatial and temporal variability of precipitation, infiltration, connectivity, and flow. Flashy, segmented floods maintain and reshape channel geometry at infrequent, irregular intervals and make defining characteristics and conducting meaningful research difficult. Although arid environments produce Hortonian overland flow as a result of low infiltration rates on piedmont and mountainous bedrock uplands, high infiltration rates in alluvial washes and sporadic flows maintain predominantly transport limited systems that slowly aggrade over the course of decades to centuries until large floods completely refigure channel geometry.

1.1.2 Transmission losses

Researchers have observed large decreases in unit discharge between upstream and downstream gauges in arid ephemeral streams (Babcock and Cushing, 1941; Cornish, 1961; Keppel and Renard, 1962; Lane et al., 1971; Walters, 1989; Hughes and Sami, 1992; Constantz et al, 1994; Bull, 1997; Tooth, 2000), later referred to in the literature as transmission losses. Transmission losses can be as great as 17-29% (Graf, 1988a) and 75% (Knighton and Nanson, 1994). Goodrich et al. (1997) suggest that this large-scale, non-linear watershed response with increasing drainage area occurs because of partial storm coverage across watersheds and transmission losses, which include evapotranspiration and high infiltration rates. Ephemeral washes hundreds of meters wide and composed primarily of unconsolidated alluvium experience high infiltration rates during precipitation and flows, causing decreases in unit discharge with increases in contributing drainage area (Babcock and Cushing, 1941; Graf, 1988a; Goodrich et al., 1997; Tooth, 2000). These transmission losses into dry beds decrease sediment transport capacity, causing aggradation in ephemeral streams that increases volumes of unconsolidated alluvial reservoirs. Continued delivery and deposition of sediment in wide braided washes commonly leads to the development of secondary channels perched above main-stem channels within large braided channel complexes. These perched channels may persist through time and convey parallel flows at relative elevations higher than seemingly abandoned surfaces until large flows remove decades of accumulated sediment and completely restructure channel geometry (Graf, 1981 and 1988a). High transmission losses and spatial variability in precipitation result in discontinuity of channelized flow for any given rainfall. Thornes (1977) referred to this flow variability in three phases of flow: *asynchronous tributary flow* in tributaries that flow into a dry main stem channel; *axial flow* that persists within the main stem for some length downstream; and *fully integrated flow* exhibited by flow within all tributaries and the main stem channel. High transmission losses and variability of flow result in progressive channel aggradation in arid ephemeral streams and the movement of sediment through the fluvial network in pulses (Keppel and Renard, 1962; Graf, 1988a; Reid and Frostick, 2011).

Transmission losses have implications not only for sediment transport and resulting channel geometry, but also for surface-groundwater interactions of xeroriparian systems. Early researchers who observed transmission losses in arid ephemeral washes considered implications for groundwater recharge (Babcock and Cushing, 1941; Cornish, 1961). Hughes and Sami (1992) were among the first to examine moisture conditions underlying unconsolidated alluvial channels using neutron probe access tubes, and to quantitatively estimate maximum water storage beneath the channel. Their findings revealed immediate moisture response at the greatest depth in each profile and detected lateral flow beneath the unconsolidated alluvium at the contact with the underlying material. This suggests that despite temporal and spatial variability of precipitation and flows, storage beneath unconsolidated coarse alluvium may reserve water necessary to support extensive xeroriparian vegetation communities. Additionally, McDonnell (1990) and Brooks et al. (2009) have shown that precipitation at the onset of the wet season can remain in soil micropores and continue to support vegetation throughout the year in both humid and semi-arid environments.

Further implications for soil moisture storage to support xeroriparian vegetation include impermeable layers that create localized, perched water tables (Bull, 1997: Reid and Frostick; 2011). Knighton and Nanson (1994) observed limited infiltration in ephemeral washes due to fine sediment sealing from overbank clay-rich deposits at the waning, tail end of flows. Impermeable layers such as $CaCO_3$ or fine sediment sealing from overbank clay-rich deposits and the infiltration of muddy water at the receding limb of ephemeral flows (Graf, 1988a; Knighton and Nanson, 1994; Bull, 1997; Reid and Frostick, 2011) can result in decreased infiltration and decreased transmission losses. Decreased infiltration rates associated with these impermeable lenses and perched water tables facilitate lateral and downstream transport of water and sediment in temporary channels that are commonly elevated above abandoned surfaces within wide, ephemeral, braided washes (Graf, 1981 and 1988a).

Transmission losses in streambeds of unconsolidated alluvium distinguish braided channels from those confined primarily by bedrock (i.e., bedrock, bedrock with alluvium) or desert pavement (i.e., piedmont headwaters) because continuous aggradation creates riparian habitat across wide valley bottoms in the form of banks and bars. These braided washes distribute stream power across wide areas and create a positive feedback where deposition of unconsolidated alluvium increases infiltration, high transmission losses, and the possibility for shallow groundwater storage.

1.1.3 Upland hydrology and desert pavement

High infiltration rates characteristic of ephemeral washes contrast with adjacent upland surfaces on dissected or abandoned alluvial fan and piedmont surfaces (Graf, 1988a; McDonald et al., 2009; Reid and Frostick, 2011). These upland surfaces in arid environments are characterized by desert pavement, which influences runoff and flow regime and is partly responsible for the flashy hydrograph characteristic of ephemeral channels (Bevens, 2002; Bull and Kirkby, 2002; Graf, 1988a). Eolian silt becomes trapped in fractures of lithic fragments, pores, and interstitial spaces on abandoned fluvial surfaces and accumulates beneath an armor layer of coarse, tightly-bound, pebble- to cobble-sized clasts. This layer of fine, wind-blown silt accumulates over hundreds to thousands of years, forcing surficial clasts to rise vertically through shrink-swell processes. This creates a relatively impermeable A_z vesicular horizon between the rocks on the surface and the underlying parent material (McFadden et al., 1987). This silty, clay-rich horizon beneath the protective layer of overlying clasts maintains low infiltration rates that limit percolation and the vertical distribution of moisture (McFadden et al., 1987; McAuliffe, 1994; McFadden et al., 1998; Young et al., 2004; Wood et al., 2004), contributing to Hortonian excess overland flow and flashy hydrographs (Tooth, 2000; Bull and Kirkby, 2002).

Low infiltration rates of desert pavement increase surface runoff and sheet flow as well as the potential for channelized flow in microtopographic depressions across upland surfaces and within preexisting channels (Graf, 1988a; Reid and Frostick, 2011). Microtopographic highs and lows that reflect relict alluvial fan channels on piedmont surfaces are thus likely to become preferential flow paths that accumulate runoff, further encouraging channel incision. A positive feedback occurs where increasing flow depth increases bed shear stress, enhancing the ability of flows to mobilize sediment and scour piedmont surfaces (Graf 1988; Knighton, 1998). Increases in flow resistance across the surface associated with increases in stem counts on grasslands (as opposed to shrublands) dissipate erosional energy and allow time for additional infiltration (Graf, 1988a; Tooth, 2000; Reid and Frostick, 2011). Conversely, limited flow resistance encourages runoff and erosion that can result in more persistent flow paths such as rills and gullies (Graf, 1988a; Abrahams et al., 1995) or the *piedmont headwater* channels described by the classification presented here. Incised channels convey flow and accumulate exposed fine material that act as local soil-moisture reservoirs and facilitate growth of riparian vegetation.

1.1.4 Basin characteristics and sediment supply

Physical characteristics of contributing watersheds drive the hydrologic flow regime and sediment dynamics of streams by influencing the grain size, chemical composition, quantity, and transport of sediment (Dunne and Leopold, 1978; Graf, 1988a; Birkeland, 1999; Reid and Frostick, 2011). Drainage area has been correlated with sediment yield (Schumm and Hadley, 1957; Graf, 1988a). A positive correlation exists between aggradation of alluvial fans and basin drainage area (Graf, 1987; Whipple and Trayler, 1996; Al-Farraj and Harvey, 2005; Hashimoto et al., 2008), suggesting that accumulation of alluvium is partly a function of drainage basin size. Major sources of sediment supply in ephemeral streams are mass movements or hillslope processes, floodplain sources, and erosion of the channel (Bull, 1997; Hooke and Mant, 2002).

Mass wasting that influences channel geometry, process domains, and riparian vegetation is more likely to occur in steeper headwaters (Montgomery, 1999; Polvi et al., 2011). Like their humid counterparts, ephemeral gravel-bed rivers and alluvial fan systems in arid regions tend to display downstream fining (Bull, 1977, Blair and McPherson, 1994; Powell, 1998), with the exception of tributary confluence input that may disrupt the downstream continuum. Abundance of fine material makes low-gradient segments more sensitive to changes in sediment and water supply than high gradient reaches (Knighton, 1998; Wohl et al., 2007). This increased response to sediment flux in low-gradient reaches makes riparian habitat and biodiversity in these segments of perennial streams more sensitive to anthropogenic and natural hydrologic disturbance (Ryan, 1997; Wohl et al., 2007). Despite many differences between perennial and arid-region ephemeral streams, similarities can be expected with regard to sensitivities to changes in grain size.

Grain sizes associated with distinct lithologies dictate relative erodability of rock types and resulting composition of associated soils. Coarse-grained rocks (e.g., granite, gabbro) are more susceptible to weathering, erode more rapidly, and produce clays more readily than finer-grained rock types (e.g., rhyolite, basalt) (Birkeland, 1999). In addition to lithologic controls on erodability, sediment yield, grain size, and water retention (Bull, 1977; Hooke and Mant, 2002), the rock types present within a contributing watershed influence the chemical composition of soils (Birkeland, 1999; Schaetzl and Anderson, 2005) and available clay content. Increased clay content, transmission losses, and fine-grained deposition at the receding limb of flows can lead to development of relatively impermeable horizontal laminae within streambed stratigraphy (Frostick and Reid, 1977; Ronan et al., 1998; Reid and Frostick, 2011). These stratigraphic sequences can influence hydrologic distribution of available moisture for plants by limiting vertical distribution and downward percolation, increasing lateral distribution of water, and creating localized perched water tables. Additionally, high levels of calcium carbonate and silica in basin lithology can precipitate from flows to produce impermeable lenses of calcrete and silcrete laminae, respectively (Imeson and Varstraten, 1981; Stokes et al., 2007). In turn, soil chemistry dictates not only weathering patterns and horizon development in a given soil profile, but also the development of isotropic hydraulic conductivity and the resulting availability of nutrients for riparian vegetation.

Floods and sediment dynamics associated with basin characteristics and the hydrologic flow regime within a given watershed are primary drivers of channel form, ecological patterns, and sensitivity of riparian areas along ephemeral streams. Following floods that may completely restructure channel geometry, ephemeral streams respond with complex drying patterns that drastically change available aquatic and riparian habitat (Stanley et al., 1997). Therefore, high-magnitude flows dictate the spatial distribution and age of riparian vegetation (Friedman and Lee, 2002). High-magnitude flows, for example, can completely eradicate species from a stream network (Collins et al., 1981; Ward and Blaustein, 1994), but they can also significantly improve ecosystem productivity (Stanley et al., 1997). River Environment Classifications (REC) that use physical drivers of watershed characteristics have proven to be more effective for eco-hydrological classification of rivers than previous climate-based approaches (Snelder et al., 2004; Snelder et al., 2005). The success of the REC approach may be attributed to consideration of river networks as hierarchical systems where larger controls influence progressively smaller-scale characteristics (Newberry, 1995; Montgomery, 1999, Dollar et al., 2006; Beechie et al., 2010). We expect to see, for example, the following influence from large-scale controls down to small aspects of riparian biota: tectonics and climate, lithology, topography, hydrology, geomorphology, physical habitat, and riparian and aquatic species. Although it does not take into account the influence of tributaries, the river continuum concept (Vannote, 1980) similarly illustrates the hierarchical relationships in aquatic ecology with progressive distance downstream. This hierarchical concept relates not only to ecological patterns, but also reflects the influence of watershed physical attributes and the lithotopographic template upon which ecosystem structure and function develop (Montgomery, 1999; Beechie et al., 2010; Polvi et al., 2011). Basin characteristics associated with lithology and hydrologic response in turn influence sediment transport, bank cohesion, vegetation patterns, and channel geometry (McAuliffe, 1994).

Hierarchical relationships within the context of lithology and watershed hydrology influence weathering rates, chemistry, sediment dynamics, channel confinement and the development of impermeable lenses in channels downstream. These watershed characteristics further influence hydrologic response and the ability of ephemeral streams to transport sediment and adjust channel geometry. In addition to these physical controls on the creation and maintenance of riparian habitat, grain size and chemical composition of sediment may influence availability of water and nutrients for riparian vegetation.

1.1.5 Channel geometry and riparian structure

Channels in arid-zone rivers experience a flow responsible for shaping and maintaining channel geometry approximately every 1 in 10 years rather than the typical 1.5 recurrence interval for bankfull stage in temperate rivers (Graf, 1988a; Bull and Kirkby, 2002). Although drainage densities tend to be high in arid regions, high transmission losses, spatial variability of precipitation, and high evaporation commonly result in drainage networks that are not well connected (Tooth, 2000), as described above by Thornes' (1977) three phases of ephemeral flow.

Timing, frequency, duration, and magnitude of flows in ephemeral streams are responsible for maintaining channel geometry and stability that control the type and availability of riparian habitat. Large floods, which constitute the majority of flows in Sonoran ephemeral channels (Bull and Kirkby, 2002), may serve as the most influential factor for biodiversity in streams because channel geometry and floodplains can be completely restructured and entire populations of species can be completely expelled from the channel (Ward and Blaustein, 1994). These floods typically scour and reshape the channel, removing sediment that has taken decades to aggrade (Graf, 1988a). Flash floods initiated by small-scale, fast-moving convective storms that cover only a portion of a drainage basin (Graf, 1988a; Goodrich et al., 1997) have minimal effect on the entire watershed because flows are small compared to those in the main stem and may never reach the main channel due to transmission losses. Confluences of main stem channels with tributaries may, however, capture a portion of these disturbances and are likely to respond to fluctuations in water and sediment discharge. High-intensity rainfall of convective storms creates additional natural disturbances that affect sediment supply and transport, including hillslope processes such as debris and mudflow.

Bedrock channels common in upland mountainous areas of the arid southwestern U.S. exhibit characteristics much different than those in lower gradient piedmont settings. High stream gradients facilitate stream power capable of moving large boulders and flushing bedrock channels clean of alluvium. Relatively lower gradient bedrock channels accumulate alluvial sediment that persists through time and space. Although chemical corrosion and physical abrasion of bedrock channels are responsible for maintaining channel form, lithology and weathering rates of various rock types should not be viewed as the sole control on bedrock channel geometry (Wohl, 1998). The presence of sediment is required to abrade and incise bedrock channels, but abundant alluvium in bedrock channels protects the bed from continued degradation and channel incision (Sklar and Dietrich, 2006). Because bedrock channels are present in the desert environments of the southwestern U.S. primarily in mountainous uplands, drainage areas tend to be small compared to other channel types found in more lowland settings. Alluvial-bed channels confined and partially confined by bedrock, however, are relatively common in piedmont regions and exhibit stream gradients and channel geometry more similar to channels incised through unconsolidated alluvium.

Rapid channel incision and the formation of rills and gullies in arid regions of the American Southwest have received much attention since the turn of the 20th century (Schumm and Hadley, 1957; Leopold et al., 1964; Dunne and Leopold, 1978; Graf, 1981, Graf, 1988a). Land use and climatic changes have been identified as possible forces that exacerbate these phenomena (Leopold, 1965; Graf, 1988a). As rills and gullies form, they create a positive feedback, which focuses runoff into channels, increases flow depth, increases shear stress, and increases the ability of the channel to incise further (Leopold et al., 1964; Knighton, 1998). Researchers have equated headcut migration of knickpoints in gully formation to local channel adjustments as the channel tends toward equilibrium (Leopold and Emmett, 1965; Patton and Schumm, 1975). Limited transport capacity, local gradient, and transmission losses into unconsolidated alluvium of incised channels cause cycles of aggradation between periods of incision.

Flow depth and velocity decrease when streams transition from single thread to braided channels (Leopold et al., 1964; Graf, 1981; Bull, 1997). This transition into an autogenic shifting behavior may occur following channel expansion with increasing accommodation space, abrupt decrease in channel gradient, high infiltration losses, or abundant sediment input. As flows spread out and stream gradient decreases, width/depth ratios commonly increase downstream while unit discharge commonly decreases (Bull and Kirkby, 2002; Reid and Frostick, 2011) as a result of transmission losses (Knighton, 1998; Graf, 1988a). Braided channels typically develop what Graf (1988b) defines as compound channels in which smaller, more frequent flows create a meandering pattern across the braided wash as they aggrade the channel by depositing sediment in response to transmission losses. Higher flows or floods then access much or all of the braided wash as the channel transitions to multithread, braided characteristics.

Decreased transport capacity associated with transmission losses and flow obstruction by vegetation creates a positive feedback for in-stream aggradation of alluvium in braided channels (Graf, 1988a; Merritt and Wohl, 2003; Reid and Frostick, 2011). Thick deposits of alluvium can absorb and store large volumes of water accessible by riparian vegetation (Stanley et al., 1997). Thicker units of accumulated alluvium have been correlated with more abundant vegetation and greater biotic diversity (Shaw and Cooper, 2008). Although streams with coarse grain sediment are typically more ecologically productive than those composed of finer silt and clay sized particles (Allan, 1995; Waters, 1995), accumulation of silt and clay in soils alters subsurface water movement and facilitates storage of water for riparian vegetation (McAuliffe, 1994; Brooks et al., 2009). Several centimeters of silt, for example, are enough to retain moisture for weeks to several months (Jacobson et al., 2000 as cited in Camporeale et al., 2006). Additionally, the filling of pore spaces with fine sediment on streambeds following transmission losses at the tail end of flows (Knighton, 1998; Bull and Kirkby, 2002; Reid and Frostick, 2011) can result in complex layering that limits subsurface flow (Ronan et al., 1998) and possibly stores water closer to the surface. Because water availability is the largest limiting factor for riparian vegetation in arid environments, the highest density of plant growth corresponds to the areas that experience the most frequent stream flow (Bull, 1997) or areas where water is more easily accessed. Establishment of riparian species highly affects channel geometry and hydraulics through positive feedbacks in which increased channel roughness associated with riparian vegetation (Tooth, 2000; Reid and Frostick, 2011) decreases velocity and increases deposition of alluvium (Bull, 1977; Knighton, 1998; Graf, 1981; Graf, 1988a; Comporeale et al., 2006). Increasing abundance of unconsolidated alluvium then facilitates the growth of in-channel bars, establishment of riparian vegetation, and increased channel roughness.

High variability in time, space and magnitude of flows distinguishes ephemeral channels in arid regions from perennial streams, creating logistical challenges for research and hurdles in communication regarding terminology already established in the literature. Large floods that scour and reshape the channel occur infrequently, on the order of decades to centuries, whereas smaller flows that continually aggrade channels are responsible for present channel geometry and the structure of riparian habitat. Laterally confined bedrock channels and channels incised through well-developed desert pavement experience a positive feedback that facilitates greater flow depths and channel incision. Feedback mechanisms also exist between sediment dynamics and establishment of riparian vegetation, in which vegetation stabilizes banks and bars, decreased flow velocity at the boundaries results in aggradation, channel geometry adjusts accordingly, and structure and function of riparian habitat are maintained.

2. REGIONAL SETTING

The larger project of which this thesis is a part aims to classify arid ephemeral streams in the Sonoran Desert region of the southwestern United States by examining study areas on the United States Army Yuma Proving Ground (YPG, >3300 km^2) and Barry M. Goldwater Air Force Range (BMGR, >6800 km^2). The Sonoran desert as defined by Brown et al. (2007) spans a portion of the U.S. boundary with Mexico and covers the southwestern portion of Arizona, extending west into southern California (Figure 1). Preliminary watershed classification of the Sonoran Desert includes only the U.S. portion for accessibility of data and logistical reasons. Both military bases are located in southwestern Arizona. The primary study area and source of the original dataset for the stream classification was the northwestern corner of YPG, approximately 80 km (50 mi) north of Yuma, AZ, which sits at 63 m (207 ft) elevation (Figure 1). Additional fieldwork and data used for verification and testing of the classification system were collected to the east-southeast of YPG at the eastern side of BMGR, approximately 193 km (120 mi) east of Yuma, AZ and 121 km (75 mi) southwest of Phoenix, AZ at 339 m (1112 ft) elevation (Figure 1).

2.1 Climate

Monsoonal summer storms, small convective storms, and dissipating tropical storms create temporally and spatially variable precipitation in the Sonoran desert region. A distinct dry season occurs from April to July and a wet season occurs from November to March, but the majority of precipitation falls as monsoonal summer rain in the months of July to September (Figure 2) (National Weather Service, 2012; Western Regional Climate Center, 2012a). National

Weather Service (NWS) climate records based on data from 1961 to 1990 indicate that Yuma, AZ has a mean annual average rainfall of 8.1 cm (3.2 inches) and daily average temperatures with a minimum of -4.4°C (24°F) and a maximum of 50°C (122°F). NWS data from 1961-1990 indicate annual average rainfall of 19.6 cm (7.7 inches) in Phoenix, Arizona, where much more precipitation occurs in the winter months compared to that received by Yuma, AZ. Daily average temperatures in Phoenix have a minimum of -7.2°C (19°F) and a maximum of 50°C (122°F). The Western Regional Climate Center (2012a; 2012b) records from 1954 to 2005 indicate total average annual rainfall at the Yuma Proving Ground is 9.5 cm (3.74 inches), whereas records from 1892 to 2005 indicate total average annual rainfall in Gila Bend (approximately 30 km north of BMGR) is 15.6 cm (6.13 inches). Although minimum temperatures reach below freezing, long-term mean annual average precipitation records do not indicate any regular precipitation as snowfall in Yuma or Phoenix. NWS monsoonal rainfall data between July and September for Phoenix, AZ from 1896 to 2012 indicate an annual average of 6.8 cm (2.71 in) and for Yuma, AZ from 1876 to 2012 indicate an annual average of 3.3 cm (1.29 in). The research area in BMGR reflects climate conditions between those in Phoenix and Yuma but more similar to Phoenix because Gila Bend, AZ has an elevation of 225 m (738 ft) and annual average precipitation of 17.5 cm (6.9 in).

2.2 Geology

Following the end of the Laramide orogeny around 26-28 million years ago, a mid-Tertiary orogeny produced volcanic mountains of rhyolitic and andesitic composition, including breccias, tuffs, and flows (Eberly and Stanley, 1978). An unconformity in the sedimentary sequence of the late Miocene occurred approximately 17-20 million years ago. Inland-sea marine deposits of the late Miocene (12-13 million years ago), including a clastic marine wedge and the Pliocene Bouse formation, were deposited on top of this unconformity. Consolidated sedimentary deposits including evaporites are the product of continental sedimentation from a closed interior drainage network that began approximately 10.5 to 6 million years ago (Eberly and Stanley, 1978). The block-fault episode of the late Miocene created the Basin and Range Province, complete with horst and graben and half-graben sequences that produced primarily northwest-southeast striking features presently expressed as intrusive igneous and volcanic mountains ranges. Erosional episodes of this period created topographic lows in which lacustrine and fanglomerate deposits composed of weathered fragments of sedimentary and volcanic origin formed. These abundant Quaternary alluvial-filled valleys are underlain by approximately 3 km of Cenozoic sedimentary formations (Eberly and Stanley, 1978). The region is now characterized primarily by sharp igneous and metamorphic bedrock peaks that pierce the surface of alluvial sediment composing piedmont and bajada complexes. Eolian material and accumulation of silt facilitate the formation of extensive desert pavement across gently sloping alluvial piedmont surfaces (Bacon et al., 2008). High drainage density facilitates an abundance of channels that have incised through Pleistocene gravels, commonly exposing a distinct contact between red Pleistocene soils and younger alluvial deposits.

2.3 Vegetation

Abundant vegetation is restricted to the riparian zone, where phreatophytes such as tamarisks (*Tamarix* spp.) and palo verde (*Cercidium* spp.) acquire water from the alluvial valley fill. Common xeroriparian vegetation includes *Olneya tesota* (iron wood), *Cercidium floridum* and *Cercidium microphyllum* (palo verde), *Prosopis* spp. (mesquite), *Ambrosia dumosa* (white bur sage), *Lerraea tridentada* (creosote bush), and *Krameria grayi* (white ratany), while uplands are dominated by *Larrea tridentata* and various cacti including *Fouguieria* (ocotillo), *Carnegiea* (saguaro), and *Opuntia* (cholla).

2.4 Land surface characteristics

Like many arid environments of the American Southwest, this region of the Sonoran Desert is characterized by high spatial and temporal variability of precipitation, surface infiltration rates, and discharge in ephemeral channels. Wide spatial variability present across various surface types reflects heterogeneous soil characteristics that result in highly variable infiltration rates (McDonald et al., 2004; Bacon et al., 2008; McDonald et al., 2009). The majority of surfaces in the study areas (i.e., YPG and BMGR) are; a) exposed bare bedrock of primarily intrusive and extrusive igneous lithology, b) unconsolidated alluvial sediments in relatively more frequently disturbed (i.e., natural hydrologic and anthropogenic disturbances) washes, and c) desert pavement on relict alluvial fan and piedmont surfaces (Figure 3).

2.5 Land use

YPG and BMGR are used for military training purposes, which primarily include vehicle maneuvering, light and heavy artillery fire, ground-troop deployment and tactical exercises, aircraft maneuvering, and aerial release of artillery, heavy equipment, and bombs. YPG is primarily used for tactical ground exercises, heavy artillery testing, and aerial release of heavy equipment, whereas BMGR is primarily used for aerial maneuvering, air-to-surface artillery engagement, and testing of heavy artillery. These military exercises are focused on specific zones of each military base where access is highly restricted, but other areas used in the past have been opened for limited access. Tactical ground exercises were focused on the piedmont uplands in the past, but disturbance of desert pavement and cryptobiotic soils has encouraged relocation of exercises. Most active roads through the area are focused within the dry washes. Military land-use managers are interested in determining ecosystem sensitivity of various land surfaces to identify areas with the least sensitivity on which to focus military exercises.

3. OBJECTIVE AND HYPOTHESES

The research project of which this thesis is a part is driven by the need to identify spatial differences in riverine ecological communities on arid lands in the southwestern U.S. We posit that channel characteristics and access to water are the primary influences on riverine ecological communities in this region. The primary goals of this thesis research are to: 1) assess the distinct differences in channel geometry among the five proposed stream types, 2) quantify physical characteristics of channels that may influence biodiversity, and 3) examine potential relationships between broad contributing watershed characteristics and localized channel geometry. These goals will be met through examination of two distinct objectives and hypotheses that focus on correlations between independent predictor variables and resulting stream type. These hypotheses aim to test distinct differences in channel geometry as a basis for stream classification, examine potential correlations among basin characteristics and channel geometry, and provide the basis for additional investigation concerning xeroriparian vegetation community structure and associated ecosystem sensitivity. Objectives, hypotheses, rationale, and a brief explanation of how the hypotheses will be tested are described here, while details of statistical analyses are described in the *Methods* portion.

3.1 Objective 1

The primary objectives of this research are to validate distinct channel geometry between five proposed stream types to evaluate the usefulness of the proposed geomorphic channel classification. The conceptual model that drives this classification is designed to describe the geomorphic characteristics of ephemeral channels in the mountainous, piedmont, and basin environments of the Sonoran desert in the southwestern United States. The classification divides the fluvial systems of this region into five characteristic geomorphic stream types from erosive headwaters to relatively low gradient alluvial washes: 1) montane *bedrock* channels entirely confined by exposed bedrock and void of persistent alluvium (Figure 4A); 2) upper piedmont *bedrock with alluvium* channels at least partially confined by bedrock but containing enough alluvium to create bedforms that persist through time (Figure 4B); 3) *incised alluvium* channels bound only by unconsolidated alluvial material into which they are incised (Figure 4C); 4) depositional *braided* washes that exhibit multithread channels and braided characteristics regardless of the degree and composition of confining material (Figure 4E); and 5) *piedmont headwater* 0-2nd order streams (derived from 30-m DEMs) confined only by unconsolidated alluvium and which initiate as secondary channels on piedmont surfaces (Figure 4D). These five channel types represent a downstream progression for channels that head in the mountains (1) or on the piedmont (5), downstream channel segments on the piedmont that have larger drainage area and numerous tributaries (2 and 3), and larger channels in the alluvial basins between mountain ranges (4). Surveyed channel geometry and local reach-scale hydraulics calculated from field data are used to test for similarities and distinct differences between the five ephemeral stream types. Other investigators will assess the usefulness of the classification in terms of its ability to distinguish distinct riverine biological communities, based on riparian vegetation (i.e., canopy cover, life form, and growth form).

$H1_{null}$: The five stream types proposed in the classification do not exhibit significantly different means for variables pertaining to geomorphic characteristics and channel geometry.

$H1_{alterate}$: The five stream types proposed in the classification exhibit significantly different means pertaining to geomorphic characteristics and channel geometry.

Rationale: The five proposed channel types (i.e., bedrock, bedrock with alluvium, incised alluvium, braided washes, and piedmont headwater channels) are inspired by Schumm's 1977 conceptual *basin model* of the fluvial system. Schumm characterized upland headwaters as predominantly *erosional zones*, whereas *zones of deposition* characterize relatively large rivers occurring in lowland environments. Transitional processes occur in intermediate *transfer zones* along the progressive spectrum from erosive headwaters to depositional environments. The distinct environments in which each of the five stream types occur are expected to influence differences in hydraulic characteristics and channel geometry. Channel geometry is represented here by width/depth ratio (*W/D*), channel gradient or slope (*S*), and the ratio between valley width and channel width (W_v/W_c) or entrenchment ratio. Calculated hydraulic variables examined in this study include shear stress, dimensionless shear stress, stream power, unit stream power, and median grain size. The five channel types described earlier are based on a downstream progression beginning at steep, erosive, bedrock headwater channels with small drainage areas, through relatively moderately-sloped dissected piedmont, and finally to low gradient, depositional braided alluvial basins with much larger drainage areas. Previous work in arid regions indicates that width-to-depth ratios commonly increase downstream, while discharge commonly decreases downstream (Bull, 1997; Bull and Kirkby, 2002). Decreases in unit discharge downstream occur in part as a result of transmission losses. Decreased channel gradient creates a transport-limited system that favors aggradation and accumulation of alluvium. Although large floods can remove in-channel sediment that has accumulated over many years, decreased discharge and high transmission losses downstream are likely to cause sediment to move in slugs or pulses (Graf, 1988a). Channel gradient is expected to be higher in headwater channels and lowest in braided valley washes. Likewise, decreasing unit stream power and transport capacity with increasing distance from the mountain front are expected to result in larger grain sizes in headwaters and downstream fining. As stream power decreases with decreasing gradient, the fluvial system transitions from one of degradation and incision to one of aggradation at some inflection point. This aggradation commonly results in widening of the channel as the planform shifts to a braided stream, causing *W/D* ratios to increase downstream (Leopold et al., 1964; Graf, 1981; Graf, 1988a; Reid and Frostick, 2011). Important distinctions being tested with this hypothesis are the differences in channel geometry between headwaters (i.e., bedrock and piedmont) and those between stream types in the transfer zone (i.e., bedrock with alluvium and incised alluvium).

3.2 Objective 2

An additional objective in this research was to examine correlations between watershed characteristics and channel geometry associated with each channel type. If the stream types described in objective 1 are significantly different, examination of the influence of watershed characteristics on stream type is possible. To examine the possibility of characterization of watersheds for military personnel and land-use managers using readily accessible data, 10-digit Hydrologic Unit Code (HUC) boundaries in the U.S. Sonoran desert were classified using preliminary cluster analysis of watershed characteristics. Categorization of HUC characteristics was used to investigate possible relationships between basin and channel characteristics associated with each stream type within various HUC classes. Although significant relationships between HUC and channel characteristics could facilitate prediction of stream type, this outcome is not expected at such a coarse resolution of watershed characteristics. Failure to find significant differences between stream type and HUC class should indicate a robust classification that can be applied across watersheds in different regions of the Sonoran desert with various characteristics.

$H2_{null}$: Individual stream types nested within the three HUC classes do not exhibit significantly different means for variables pertaining to channel geometry.

$H2_{alternate}$: Individual stream types nested within the three HUC classes exhibit significantly different means with regard to channel geometry.

The second alternative hypothesis ($H2_a$) can also be stated as: Each stream type does not exhibit significantly different means (with regard to channel geometry) between HUC classes.

Rationale: The sediment derived from a given watershed is a function of basin characteristics. Weathering rates, sediment supply, sediment transport, grain size, and soil chemistry are functions of lithology, slope, drainage area, and drainage density (Dunne and Leopold, 1978; Graf, 1988a; Birkeland, 1999; Hooke and Mant, 2002). These relationships suggest that basin characteristics influence the hydrologic flow regime, hydrologic interactions between channels and upland surfaces, grain size distribution, soil moisture content, the rate of sediment accumulation, and therefore channel characteristics. Lithologic composition and sediment yield are important factors of surface-subsurface hydrologic interactions (Graf, 1988a; Bull, 1997) because grain-size distributions of alluvial fill influence spatial variability of soil water retention (Graf, 1988a; Birkeland, 1999; Hillel, 2004; Brooks et al., 2009). Coarse-grained lithologies (e.g., intrusive igneous) weather more readily to clay-sized particles, which have higher water-retention capacity than larger particles commonly produced from fine-grained volcanic lithologies (Birkeland, 1999; Hillel, 2004). The influence of watershed characteristics is compounded by interactions between variables. Hillslope, for example, influences fluvial dynamics because sediment supply increases where hillslope and channel processes are highly coupled. Additionally, chemical composition of various lithologies influences the chemistry of soils and available nutrients for plants. Watershed characteristics used here include hillslope, lithology, precipitation, and stream gradient.

3.3 Objective 3

An additional objective of this study was to identify the most important variables and possible thresholds in distinguishing stream types. Identification of the strongest variables and thresholds that exists between various stream types will provide a more complete and thorough understanding of the classification and how the stream types differ. Examination of strength in univariate variables used to distinguish stream types from one another provides rational for variable selection and multivariate analyses. More sophisticated multivariate statistical techniques discussed in the methods portion of this thesis provide relative importance of variables in the model and help identify thresholds among variables to distinguish stream types from one another.

4. MATERIALS AND METHODS

4.1 Site selection and preliminary analysis

Cluster analysis was performed to classify watersheds of the Sonoran desert (Brown et al., 2007) within the United States so that study sites could be identified within different, randomly selected watershed classes in YPG and BMGR (Figure 5). With input and guidance from CSU Ecology PhD student Jeremy Shaw, I used ArcMap to develop a GIS model that summarizes spatial characteristics within the 10-digit (162 km^2 – 1012 km^2 (40,000 – 250,000 acres)) Hydrologic Unit Code (HUCs) Watershed Boundary Dataset (WBD), as determined by the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD) (USGS, 2010). Additional datasets used for spatial analysis and watershed classification include Oregon State's Parameter-elevation Regressions on Independent Slopes Model (CLIMATE GROUP, 2012) average annual precipitation, USGS 30-m digital elevation models (DEMs) from the National Elevation Dataset (NED) (Gesch et al., 2002; Gesch, 2007), USGS NHD high-resolution hydrography flowlines, and geologic layers from the Arizona Geological Survey. DEMs with 30-m resolution were used because access to 10-m DEMs is restricted in some regions of the U.S and this approach was examined to establish a tool for land-use managers using easily accessible data. Additionally, 10-m DEMs require much more computational power to summarize 10-digit HUCs, particularly for preliminary analysis of the entire U.S. portion of the Sonoran desert.

The GIS model summarized 144 Sonoran HUCs for all four characteristics (i.e., hillslope, lithology, precipitation, stream gradient) using the following criteria: 1) classifying precipitation into five categories (<10cm, 10-20 cm, 20-30 cm, 30-40 cm, >40cm), 2) calculating and categorizing average stream gradient within the HUC into 3 classes (<2%, 2-4%, and >4%), 3) calculating and categorizing hillslope gradient into two classes (<5% gradient and >5% gradient), and 4) categorizing geology and lithology into three classes with regard to weathering characteristics. Precipitation categories identified ranges that resulted in the most spatial variability of regions across the Sonoran desert (generally < 40 cm average annual rainfall). These precipitation categories capture regional and topographic effects that may influence hydrologic regime, channel geometry, and vegetation community structure. Stream gradient was divided into the three classes (i.e., <2%, 2%-5%, and >5%) used in prior ecosystem watershed classifications (Wohl et al., 2007) and related to the three basin model zones defined by Schumm (1977) (i.e., erosional, transport, and depositional). Stream gradient thresholds are identified as a distinguishing characteristic between i) steep mountainous headwaters within the erosional zone, ii) transitional channels within the transfer zone, and iii) lower gradient channels within the depositional zone. Stream gradient categories may also reflect differences with stream type associated with flashiness and their relative spatial distribution on the landscape.

The division in hillslope-gradient categories above and below 5% was identified as a threshold for the relative spatial distribution and occurrence of stream types, such that channels on low gradient piedmont are distinguished from those in steeper, erosional mountainous uplands. HUCs dominated by steep mountainous uplands are expected to have much higher frequency of bedrock and bedrock with alluvium channels, whereas HUCs with little mountainous uplands and abundant piedmont are expected to have more piedmont headwater and braided channels. Similarly, hillslope was somewhat correlated with three defined classes in lithology. Lithologic controls on weathering, which associate coarse-grained rocks with relatively faster weathering rates (Birkeland, 1999), were the primary considerations with regard to watershed lithology in each HUC type. Lithology was grouped into three general grain-size categories that reflect relative erodability, resistance to weathering, and resulting grain-size distribution: i) fine-grained bedrock (primarily extrusive volcanics and fine-grained sedimentary claystones and mudstones such as shale and limestone); ii) coarse-grained bedrock (intrusive igneous and coarse-grained sedimentary rocks such as sandstones and conglomerates); and iii) unconsolidated alluvium (sand, cobbles, silt), which is generally comprised by gently sloping piedmont surfaces. HUCs dominated by unconsolidated alluvium associated with broad piedmont surfaces were also dominated by the lower hillslope gradient classes (i.e., <5%). Likewise, HUCs dominated primarily by bedrock had greater percentage of hillslopes above 5%.

ESRI ArcMap model builder was used to organize a framework to characterize the physical characteristics of each HUC within the contiguous U.S. Sonoran desert (Brown et al., 2007). Hillslopes were classified into the gradient categories listed above within each HUC using the *slope tool* to analyze 30-m DEMs. In addition to the GIS watershed classification model, code was written in MATLAB to read, sum, and order areas within the two slope classes for over 1.5 million slope polygons. Similarly, the slopes of *USGS NHD* high-resolution hydrography flowlines (derived from 30-m DEMs at the approximate 1:24,000 scale) were calculated using 30-m DEMs to produce average stream gradients within each watershed. Following spatial analysis, the *summary statistics tool* was used to summarize physical attributes in all 144 HUCs prior to classification into categories.

Following GIS spatial analysis of watershed data for the U.S. Sonoran desert, cluster analysis performed by Jeremy Shaw classified the 144 HUC classes (Figure 5). Only three of the seven watershed types identified by the classification and cluster analysis occur in accessible areas on both YPG and BMGR. The western U.S. Marine-operated portion of BMGR has restricted access and is dominated by one HUC type not present within YPG. Although other variables listed above were involved in the classification, the most distinct differences between the three HUC classes that occur on YPG and BMGR reflect the relative hillslope and the presence of mountainous uplands, and to a lesser extent, lithology. Categories were distinguished in this way as either 1) dominated by steep, fine-grained bedrock, mountainous uplands, 2) dominated by low-gradient unconsolidated alluvial fill, or 3) represented by intermediate hillslopes with a relatively even mixture of unconsolidated alluvium and bedrock uplands. The four watershed types classified by the cluster analysis outside of YPG and BMGR varied primarily by amount of annual average precipitation in southeastern California. The three HUC types described above that occur on both YPG and BMGR were used for the remaining analyses outlined in the rest of this thesis.

As a result of travel and clearance restrictions on YPG, 10-digit HUCs were not randomly selected. Instead, the northwestern arm of YPG was selected because it hosted the three watershed types immediately adjacent to one another within a "safe zone" accessible by researchers. Yuma Wash represents the HUC land-cover class dominated by extrusive volcanic bedrock uplands. Gould Wash represents the HUC class identified by a relatively even mixture of bedrock uplands and unconsolidated alluvium. Mohave Wash represents the HUC dominated by unconsolidated alluvial sediment, which is evident by very broad bajada complexes and piedmont surfaces composed of well-developed desert pavement and dark desert varnish. Study reaches were selected upon visual examination in the field to equally represent each stream type within each of the three HUCs. Selection of study reaches that exhibited evidence of possible transitional states between stream types was avoided, but attempts were made to select study sites that represented the full range of variability in physical characteristics of each stream type (e.g., stream gradient, lithology, width/depth ratio) seen in the field at YPG.

Restricted access on BMGR was also a determining factor in identifying HUCs to represent the three classes. Because the western Marine-operated portion of BMGR was highly restricted and contained limited HUC types, three HUCs on the eastern U.S. Air Force-operated side of BMGR were selected within Area B, between test ranges, and to the northwest of the BMGR boundary, formerly part of BMGR and currently designated as part of the Sonoran Desert National Monument. The three 10-digit HUCs selected for research sites on BMGR include Painted Rocks Wash (dominated by gently-sloped, unconsolidated piedmont), Sand Tank Wash (an intermediate mix of steep mountainous uplands and lower gradient piedmont), and Upper Midway Wash (dominated by steep mountainous uplands).

4.2 Data collection and fieldwork

Channel geometry and reach characteristics were surveyed for 86 reaches on the U.S. Army Yuma Proving Ground using a Laser Technology TruPulse 360B laser range finder. Data collection in YPG equally represented each stream type (i.e., bedrock headwaters, piedmont headwaters, bedrock with alluvium, incised alluvium, and braided washes) within each HUC class defined by the preliminary watershed classification described above, with the exception of i) two additional study reaches and ii) less representation of braided washes. Within each watershed type, six bedrock, six bedrock with alluvium, six incised alluvium, four braided, and six piedmont headwater study reaches were surveyed, with one additional piedmont headwater and braided channel in the Mohave Wash HUC (Figure 6). Possible study reaches were identified using remotely sensed imagery (NAIP, 2007) prior to initial field work and were subject to change at my discretion, depending on accessibility, how well the reaches fit into each stream class, and how well the reaches represented the characteristics of that particular channel.

Study reach locations were typically selected immediately upstream of the confluence of a tributary where possible, but special consideration was given to avoid significant confluences with tributaries (i.e., > 0.5 times reference width) through the length of the reach. Braided reaches comprise a smaller sample size because this channel type occurs relatively less frequently, is more difficult to characterize, and introduces additional considerations and challenges with regard to scale. Because braided washes are so wide (200-600 m wide), possible study sites were limited and typically difficult to define as a reach length without significant disturbance as a result of large tributary confluences or changes in channel characteristics. Reach surveys conducted at BMGR included one study reach of each of the five stream types within each of the three HUC classes, totaling 15 study reaches. Reach surveys include i) channel gradient, ii) valley slope, iii) pebble counts, and iv) four cross sectional profiles.

4.2.1 Cross-sectional profiles

Data collection of channel geometry was based on a *reference stage*, as a representation of the channel-forming flow and conditions responsible for maintaining current channel geometry. Because aggradation and degradation may occur simultaneously during a flood (Patton and Schumm, 1975, 1981; Graf, 1988a) and cumulative aggradation may occur from relatively small flows between large events, contemporary channel geometry may not be truly representative of the hydraulic conditions and flows most responsible for continuous maintenance of the channel. Although this may be the case, 344 surveyed cross sections at YPG (404 including BMGR) are assumed to represent a wide range of variability within each stream type and to capture relative differences in channel geometry.

I use c*hannel width* to refer to the width of the channel at identified channel-forming *reference flows*, based primarily on the height of depositional surfaces and staining on bedrock as stage indicators. Although the reference flow stage identified in the field as a channel-forming flow may not represent the large floods responsible for scouring and shaping the channel prior to numerous depositional events, this stage represents the flow responsible for progressive aggradation and flushing of sediment that maintains current riparian structure and function associated with contemporary vegetation community structure. In other words, the present channel conveys and stores the water and sediment necessary to support the current structure of xeroriparian vegetation, which is of primary interest in this study. In this respect, reference flow stages and channel widths identified in this study can be thought to represent not a specific event with a distinct range of magnitude or recurrence interval, but rather the hydrologic and geomorphic conditions responsible for maintaining the floodplain, riparian habitat, and vegetation community structure. Field observations of dead ironwood with trunks buried from aggradation on abandoned surfaces (Figure 7) indicate that although these hardy trees may persist for decades to hundreds of years and provide positive feedback for bar formation, complete restructuring of channel morphology during large floods can alter channel geometry necessary to sustain riparian vegetation communities.

Cross sectional profiles provide information about channel geometry for estimates of width-to-depth ratio (*W/D)*, ratio of valley to channel width (W_V/W_C), shear stress (τ), dimensionless shear stress (τ*), stream power (Ω), and unit stream power (ω). Each study reach is characterized by four cross sectional profile surveys approximately four channel-widths apart, with the exception of braided washes. Considering the challenges in identifying braided study reaches mentioned above in section 4.2, cross-sectional profiles of braided reaches were spaced one width of the entire wash (referred to herein as *wash width*), rather than four channel widths apart. A GPS equipped with NAIP imagery was used to measure the width of braided washes and navigate transects perpendicular to the down-wash direction. Imagery on the GPS was also used to identify the extent and initiation of channels selected for study reaches.

A laser range finder was used to acquire relative changes in horizontal and vertical distance between two consecutive points along cross sectional profiles and these distances were recorded in field books. Individual measurements between only two consecutive points along a cross section allowed flexibility in adjusting the angle and view of each portion along the entire transect. Although the vertical and horizontal accuracy of the laser range finder was 10 cm, close observation and careful data collection ensured minimal error associated with the measurements made with this tool. Errors were minimized by i) standing between the two points at a location off the transect along a line perpendicular to the transect, ii) adjusting the location and angle of each shot to ensure small elevation changes were captured and taken into account, and iii) shooting the distance between two points numerous times if needed. The first two of these methods (i.e., i and ii) minimize the change in vertical angle from the topographic surface and the change in horizontal rotational angle between each point, respectively.

Data points for each cross-sectional survey were recorded primarily at changes in topography, the top of depositional surfaces, transitions in staining on bedrock surfaces, and changes in grain size. Wood and debris captured in vegetation from past flows, changes in slope, the height of depositional surfaces and bars, organic debris on bedrock and banks, staining on bedrock, and changes in vegetation were used to examine the possible range of flow depths to identify the most likely stage responsible for maintaining current channel geometry. Relative water tolerance and dependence of specific riparian species on water availability are commonly used to distinguish relative frequency of surface inundation. However, the use of location and relative distance of various vegetation species from the active channel proved to be misleading as a proxy for reference flow stage because of low frequency and high spatial and temporal variability of flows. In addition to the height of depositional surfaces as proxies for reference flow stage, the presence of fine-grained deposits was used as a possible indicator of overbank surfaces. The degree of desert varnish and desert pavement development was used as an indicator of relative surface abandonment and identification of upland surfaces.

4.2.2 Pebble counts

Pebble counts of at least 100 clasts were taken at every study reach with the exception of bedrock channels void of alluvium. A 100-m survey tape was laid out across the channel perpendicular to flow, and surficial clasts were measured within the channel width. Intervals at which clasts were measured were scaled according to channel width so that pebble counts could be completed along one transect in braided reaches and less than or equal to four transects corresponding with each cross sectional survey for all other reach types. Using a modified Wentworth scale, each pebble was classified by the length of the b-axis into one of eight grain-size categories: silt (<0.33 mm, exhibiting cohesive properties), sand (0.33 to 2 mm), fine pebble (2 mm to 8mm), medium pebble (8 mm to 16mm), coarse pebble (16mm to 32 mm), small cobble (32 mm to 64 mm), large cobble (64 mm to 128 mm), and boulder (>128 mm). Size class was recorded for each clast counted along the tape measure at the predetermined interval (ranging from 5 cm to 1 m) for each reach. No attempt was made to excavate and sieve grain size distributions beneath the relatively active channel beds. While sieves and hydrometers were not used to distinguish between sand and finer particles, cohesion of sediment on the dry channel bed was interpreted as reflecting a significant amount of particles finer than sand, and thus identified as silt. Observations of grains finer than sand were excluded from calculations of median grain size.

4.2.3 Stream gradient

Longitudinal streambed profiles for all streams types but braided reaches were surveyed in the field at consecutive points along the best approximation of the thalweg. GIS-derived slopes were preferred for stream gradient calculations in braided reaches because of the large scale of braided washes and difficulty in achieving accurate thalweg slope estimates. Longitudinal profiles for braided reaches were calculated using 5-m digital terrain models (DTM) (McDonald and Hernandez, 2011) and 10-m digital elevation models (DEM) (ALRES, 2012) for YPG and BMGR, respectively. Longitudinal profiles were conducted for a distance at least one reference-width in length both upstream and downstream of the upstream-most and down-stream most cross sections, respectively. Points were surveyed at topographic breaks, changes in grain size, and bends in the channel.

4.2.4 Valley and piedmont slope

Valley slope surveys were conducted on uplands adjacent to many study reaches or calculated using GIS and 5-m DTMs and 10-m DEMs for YPG and BMGR, respectively (McDonald and Hernandez, 2011; Arizona Land Resource Information System, 2012). However, valley slope was not applicable along some study reaches that were immediately adjacent to steep uplands and bedrock outcrops. GIS-derived valley slopes were preferred for valley/piedmont slopes because they eliminate discrepancies involving microtopographic features resulting from secondary erosion on the piedmont surface. Consequently, valley slopes for the dataset from BMGR were not surveyed in the field but rather were calculated in ArcMap from a 10-m DEM (ALRES, 2012).

4.3 Data Analysis

Reach surveys were used to calculate channel geometry and reach-scale hydraulics that could be used to distinguish differences between the five stream types. A total of eight indicator variables (i.e., stream gradient, width/depth ratio, the ratio of valley to channel width, shear stress, dimensionless shear stress, median grain size, stream power, and unit stream power) were calculated and checked for cross correlation and validity in consideration for use as predictor variables in multivariate analysis.

4.3.1 Spatial Analysis

Spatial analyses of reach-scale and basin physical characteristics were performed using ESRI ArcMap software. As mentioned above, longitudinal profiles of braided study reaches and valley slopes were derived from digital elevation data. Comparison of valley/piedmont slopes for differences among stream type proved to be difficult as a result of unequal sample sizes (i.e., 33 valley slope measurement out of 86 study reaches) and was not included in the statistical analysis. Spatial analysis used to classify HUC types by basin characteristics used in the preliminary cluster analysis is described in section 4.1.

4.3.2 Reach-scale hydraulics

Hydraulic driving forces were quantitatively estimated using the proxy of shear stress, dimensionless shear stress, stream power, and unit stream power obtained from surveyed channel geometry and a reference flow stage. Flow depth was based on surveyed reference stage indicators -- erosional and depositional features that indicate proxies for flow stage. Cross-sectional area (*A*) of the channel at each transect was calculated using a mid-point approach that sums the product of depth (*h*) averaged between two consecutive survey points and the horizontal distance (*x*) between the same two consecutive measurements.

Equation 1. $$A = \sum_i \left[\frac{(h_{i+1} + h_i)}{2} \times (x_{i+1} - x_i) \right]$$ cross sectional area

Average flow depth (*h*) for the reference flow stage was estimated by dividing the cross sectional area (*A*) by the reference flow width (*w*).

Equation 2. $$h = A/w$$ average flow depth

Wetted perimeter (*P*) was calculated using the Pythagorean theorem to estimate the cross sectional length of bed surface as a straight line between two consecutive survey points.

Equation 3. $$P = \sqrt{\left[(x_{i+1} + x_i)^2 + (y_{i+1} + y_i)^2 \right]}$$ wetted perimeter

where *x* is the horizontal position of a given point and *y* is the vertical position. Hydraulic radius (*R*) was calculated using the following equation:

Equation 4. $$R = A/P$$ hydraulic radius

Shear stress (τ) can be approximated as

Equation 5. $$\tau = \gamma RS$$ shear stress

where γ is the specific weight of water, R is the hydraulic radius, and S is channel bed slope. To incorporate grain size in the analysis of hydraulics, dimensionless shear stress (τ^*) was calculated.

Equation 6. $$\tau^* = \frac{RS}{1.65 d_{50}}$$ dimensionless shear stress

where d_{50} is the median grain size. To calculate stream power and unit stream power, average velocity (V) and discharge (Q) were calculated. Estimates of Manning's roughness coefficient (n) used an adapted version of the Cowan method (1956) for a range of values for the five stream types (Arcement and Schneider, 1989).

Equation 7. $$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$ Manning's roughness coefficient

where n_b is the base roughness coefficient based on composition of the streambed and median grain size, n_1 is an additive factor for surface irregularities, n_2 is an additive factor for variations in the shape and size of the channel cross section, n_3 is an additive factor for obstructions, n_4 is an additive factor for vegetation and flow conditions, and m is the sinuosity of the channel. The additive factors of the Cowan method were estimated using notes and photographs taken in the field compared with descriptive charts that accompany Arcement and Schneider (1989) method procedures. All study reaches for four of the stream types (i.e., braided, bedrock with alluvium, incised alluvium, and piedmont headwater) had roughness values within the range of 0.03 to 0.05 and bedrock channels had roughness values up to 0.06. Although estimates of Manning's roughness coefficients tend to be high when using the Arcement and Schneider (1989) method, detailed calculations of reach hydraulics are not needed for sediment transport estimates and these values provide relative comparisons between stream types. These ranges of Manning's roughness coefficient values were used to calculate a range of velocities and discharges using the Manning equation for each study reach (Manning, 1889 as cited in Knighton, 1998) unassociated with particular recurrence intervals.

Equation 8. $V = (k/n)R^{2/3}S^{1/2}$ Manning equation (1889)

where *R* is hydraulic radius, *S* is slope, *A* is cross sectional area, *n* is Manning's roughness coefficient, and *k*=1 when using SI units. Given that

Equation 9. $Q = VA \Rightarrow V = Q/A$ continuity equation

and substituting Equation 8 into Equation 7 we have

Equation 10. $Q = (k/n)AR^{2/3}S^{1/2}$ modified Manning equation

Discharge estimates were used to calculate stream power (Ω) and unit stream power (ω) as a proxy for hydraulic driving forces.

Equation 11. $\Omega = \gamma QS$ stream power

Equation 12. $\omega = (\gamma QS)/w = \Omega/w$ unit stream power

The analyses outlined by the equations above were calculated using the cross sectional survey data for each transect. Each study reach was defined by reach averages of every variable from all four cross sections within the respective reach. These calculations provide first-order approximations because of the error inherent in the nature of the data collection and uncertainties in channel geometry and the identified reference flow regarding depth of bed scour and fill during and after flows. Additionally, Manning's roughness coefficients and associated unit stream power estimates provide a range of possible values, depending on changes in vegetation, obstructions, and channel irregularities that may occur between or during flows. This range of flows is not associated with any particular recurrence interval, but rather provides estimates of flows and the resulting driving forces responsible for shaping and maintaining the current channel geometry and riparian vegetation community structure.

Width-to-depth ratios (*W/D*) were calculated using the channel width associated with reference flow stage identified in the field and average depth of the cross sectional profile. Multiple threads along braided reaches were included in the cross sectional area, total channel width, and *W/D* calculations by summing the areas and widths of each channel and determining average depth (*h*) by plugging the sums into equation 2.

Equation 13. $h = \Sigma [A_i] / \Sigma [w_i]$ average flow depth (braided reaches)

where *i* indicates measurements of a single channel within the multithread braided reach.

The ratio between valley width and channel width (W_v/W_c) was calculated for all stream types except braided using a method based on Rosgen's (1994) entrenchment ratio. Entrenchment ratio is defined by the ratio between the floodprone width (the width of the channel or valley at two times the maximum bankfull stage) and the bankfull width. Because bankfull stage is not defined in this study, the width and stage associated with the reference flow was used. The ratio between valley width and channel width (W_v/W_c) was calculated for braided reaches by measuring the width of the braided wash projected above all channel bars and abandoned surfaces (typically lower in relative elevation than more active channel segments) to cover the width of the incised valley (Figure 8). This floodprone width should capture the maximum channel width for a probable maximum flood of particular interest to riparian ecologists in terms of hydrologic disturbance of braided washes and potential for subsurface hydrologic interactions within unconsolidated alluvial fill.

4.3.3 Statistical analysis

Statistical analyses were performed using MATLAB, R-studio statistical software, and Salford Systems to view summary statistics, check assumptions, check for cross correlation between variables, determine in-group and between-group relationships, and verify the conceptual geomorphic stream classification using three multivariate statistical analyses. The *plotmatrix* and *corr* functions in MATLAB were used to examine correlations between all eight possible predictor variables to minimize cross correlation and reduce the number of final predictors needed for an effective classification. MATLAB was used to create quantile-quantile plots using the *qqplot* function (Figure 9), examine residual plots for visual assessment of equality of variance (Figure 10), and conduct Lilliefors two-sided goodness-of-fit test for univariate normality (alpha=0.01) using the *lillietest* function. Multivariate normality was examined using Royston's Multivariate Normality Test (Royston, 1982, 1983, 1992; Mecklin and Mundfrom, 2005) conducted with the *Roystest* function in MATLAB (Trujillo-Ortiz et al, 2007). To verify homogeneity of covariance matrices (homoscedasticity), Box’s M statistic was conducted using the *Mboxtest* function in MATLAB (Trujillo-Ortiz et al., 2002). The Multivariate Bootstrap Bartlett’s Test (*mbbtest* function in MATLAB, Trujillo-Ortiz et al., 2011) was also used with 1000 bootstraps as a non-parametric alternative to examine homoscedasticity.

The *anova1* function in MATLAB was used to conduct one-way analysis of variance (ANOVA) and multiple comparisons and contrasts between variable means for each stream type to examine the strength of each variable in distinguishing among classes and to identify strong predictors for discriminant analysis. Hypotheses 1 and 2 were tested using non-parametric permutational multivariate analysis of variance (PERMANOVA) (Anderson, 2001; Anderson, 2005) to examine distinct differences in channel geometry among stream types in all HUCs and within the three HUC classes. Euclidean distance measures were used in PERMANOVA to compare observations of each predictor within a given class to all other observations in all classes. The *adonis* function in the *Vegan* package of R-Studio (Oksanen et al., 2011) used 9999 permutations to calculate p-values (probabilities) for testing H1 and H2. Linear discriminant analysis was conducted using *moment* calculations in the *lda* function of the *MASS* package in R-Studio statistical software. The discriminant function was developed using the four predictor variables for the 86 study reaches as YPG while the 15 study reaches at BMGR were left out as a external validation dataset. *Internal validation* of the discriminant function was conducted using *predict* in the *MASS* package of R-studio to predict the stream type of the 86 study reaches used to develop the discriminant function. *External validation* of the discriminant function was conducted by predicting the stream type for 15 study reaches surveyed at BMGR. Internal and external validation result in *optimal* and *actual hit rates* (Manly, 2000), respectively. Hit rates indicate the ratio of successful predictions of stream type over the total number of classification attempts.

Salford Systems was used to conduct a classification and regression tree (Breiman et al., 1984; CART, 1998; De'ath and Fabricius, 2000) analysis of all 101 study reaches to determine the relative strength of variables, identify thresholds for distinguishing stream types, and validate the use of specific variables chosen for multivariate analyses. Gini indices were used in the CART analysis and input parameters are listed in *Appendix E*. The CART was pruned from a larger tree with more nodes to improve interpretability. Thresholds and the relative order of variables to distinguish between stream types were not manipulated but were instead determined by the CART analysis. Coordinates and sensitivity are used for receiver operator curves to assess the performance of the CART analysis model.

Logarithmic base-10 transformations were the most appropriate transformation to satisfy univariate assumptions of normality and homogeneity of variance (including addition of a constant (0.01) to W_v/W_c and subtraction of a constant (0.1) from *W/D* before the $\log_{10}$ transformation was conducted) for all 101 study reaches surveyed at YPG and BMGR. The Lilliefors test indicates univariate normality on six out of eight variables from study reaches at YPG, excluding d_{50} and *W/D*, at a significance level of alpha=0.01. Inclusion of data from BMGR prevents normality of valley-to-channel width (W_v/W_c). Quantile-quantile plots graphically indicate a relatively normal distribution of all data with the exception of some skewness on the high end of W_v/W_c, d_{50} and *W/D* (Figure 9). Residual plots of observed versus expected values of all transformed data illustrate relatively consistent variance between stream types and HUBs, with some exception of unit stream power, which satisfies the assumption of univariate equality of variance (Figure 10). Although univariate normality was met for five-out-of-eight variables, multivariate normality was assessed separately to meet multivariate assumptions.

4.4 Variable selection

Various analyses outlined in section 4.3.3 were conducted to examine the correlation and strength of the eight variables as possible predictors and the cumulative power of groups of variables for correctly distinguishing between stream types.

4.4.1 Correlation

A correlation matrix and test of the null hypothesis that there is no correlation between individual pairings of all eight possible predictor variables indicates that correlations at the alpha

= 0.01 level occur between stream gradient and most other variables (i.e., all but median grain size) (Table 1). Similarly, there are numerous correlations between all variables which incorporate stream gradient (i.e., τ, τ^*, Ω, ω), suggesting elimination of some variables to minimize cross correlation.

4.4.2 One-way ANOVA with multiple comparisons and contrasts

Individual one-way analysis of variance (ANOVA) and multiple comparisons and contrasts were conducted between stream-type group means for each of the eight channel characteristic variables (i.e., ω, τ, W/D, S, Ω, W_v/W_c, τ^*, d_{50}) to examine the strength of each variable in distinguishing among stream types and to identify strong predictors for discriminant analysis. ANOVA tests (H_{null} = all stream types have the same mean for each variable) indicate that in-group means of each predictor variable varied significantly for all five stream types (p-value $\leq$ 0.001), with the exception of median grain size (d_{50}, p-value = 0.147) (Table 2).

Multiple comparisons and contrasts to compare the in-group means of each variable between the five stream types indicated that the variables of greatest strength in determining stream type are W/D, S, τ, Ω, and ω (Figure 11, Table 2, Table 3). As mentioned above, bedrock channels (BK) are easily distinguished from other stream types and have mean values significantly different from all other stream types for unit stream power, shear stress, dimensionless shear stress, W/D, and stream gradient. Bedrock with alluvium (BA) are most similar to incised alluvium channels with a significant difference only in W/D. Width/depth ratio distinguishes BA channels from all stream types with the exception of piedmont headwater channels. Incised alluvium (IA) channels are similar to both BA and BD channels with regard to every variable except i) W/D and ii) stream gradient and W/D, respectively. All stream types are distinguished from IA channels with regard to *W/D* ratio, and mean unit stream power differs significantly from BK and piedmont headwater channels (PH). Braided channels differ from BK, BA, and PH channels with regard to gradient, *W/D*, stream power, and unit stream power. Piedmont headwater channels differ most from BK and BD channels with regard to gradient, *W/D*, stream power, and unit stream power, and do not have significant differences in mean gradient from BA and IA channels. There was no significant difference in the means of d_{50} among stream types (p-value=0.08), but one-way ANOVA with comparisons and contrasts indicated a significant difference between HUCs.

One-way ANOVA and multiple comparisons and contrasts indicate minimal differences in channel geometry between HUC classes. However, d_{50} and W_v/W_c exhibit significant difference at the 95% confidence level (p-values=0.04 and p=0.02, respectively) between HUC classes (Table 4). The ratio between valley width and channel width in Yuma HUC varied significantly from Gould and Mohave Washes. Gould Wash HUC has a higher d_{50} than Mohave and Yuma HUCs.

Because d_{50}, τ^*, and W_v/W_c lack power to distinguish stream types from one another, these variables were eliminated as possible predictor variables. Exclusion of W_v/W_c and variables including grain size data (i.e., d_{50}, τ^*) was considered early in the process because data were not collected for all reaches (i.e., bedrock reaches without alluvium). To reduce the likelihood of confounding cross correlation between variables, measures of stream competence (i.e., shear stress, stream power, dimensionless stream power) were reduced to shear stress and unit stream power. Unit stream power was chosen over stream power because it includes a scaling factor that incorporates the width of the channel. Shear stress was maintained because it encompasses depth of flow. Although the range of estimated Manning's roughness coefficients (*n*) is helpful in comparing differences in the orders of magnitude between stream types, the lower estimates of ω and Ω (i.e., based on n=0.06 for bedrock channels and n=0.05 for all other stream types rather than n=0.03) were used to examine the strength of stream power as a predictor for stream type. The lower range of stream power estimates associated with higher Manning's n values were used to incorporate potential effects on channel roughness from vegetation and continuous streambed adjustment during flows. Because stream power provides similar information and offers no additional scaling factor or information, it was eliminated from further analyses. Stream gradient fulfilled all univariate and multivariate assumptions and was kept as a significant variable for multivariate statistical analyses. The variables retained for additional multivariate analyses were *W/D, S, τ,* and *ω*.

4.4.3 Multivariate assumptions

Before multivariate statistical analyses were conducted, major assumptions including multivariate normality and homogeneity of covariance matrices were examined. Relatively high values for stream power, unit stream power, and *W/D* characteristic of braided reaches appear to skew the data beyond attainability of multivariate normality. When braided reaches were omitted from the data, multivariate normality was attained via Royston's Multivariate Normality Test for various combinations of all variables (with the exception of W_v/W_c, median grain size, and dimensionless shear stress). Discriminant analysis can be sensitive to multivariate normality (Manly, 2000), so a portion of this analysis excludes braided channels because they prevented the assumption of normality within the dataset. Because braided reaches exhibit channel geometry and characteristic features easily distinguishable from other stream types in the field and in aerial imagery (section 5.1), narrowing the scope of the PDA for prediction of the other four stream types is acceptable and warranted. However, Manly (2000) makes the point that discriminant analysis can still be useful on data that do not meet the assumption of normality if the predictive power is high.

Slight deviations from multivariate normality are not necessarily crucial for MANOVA and unnecessary for PERMANOVA and CART, but PERMANOVA can be sensitive to equal dispersion or homoscedasticity (De’ath and Fabricius, 2000; Anderson, 2001; Huberty and Olejnik, 2006). Although univariate homogeneity of variance was relatively satisfied through visual assessment (Figure 10), homoscedasticity was not met between stream gradient, width/depth, shear stress, and unit stream power under Box’s M test. However, this may be a result of sensitivity to normality by Box’s M test. The non-parametric alternative test of homoscedasticity, Multivariate Bootstrap Bartlett’s Test, indicates homogeneity of covariance matrices at the 95% confidence level ($0.023 \leq$ P-value ≤ 0.046, mean p-value = 0.033 after 30 iterations).

5. RESULTS

5.1 Study reach characteristics

The 86 study reaches surveyed represent a wide range of variability in channel characteristics seen in the field within each of the five stream types in the three HUCs at YPG. Contributing drainage areas (i.e., 1.4 x 10^{-5} km^2 to 225.3 km^2 with a mean area of 12.7 km^2) (Table 5) and stream gradients (i.e., 0.004 to 0.578 with a mean slope of 0.072) (Table 6) capture the progression of stream types beginning at small, steep mountainous uplands and ending in broad, braided alluvial valleys. Other variables from 86 study reaches on YPG ranged from *W/D* of 3.16 to 452.4 m/m, shear stress of 4.2 to 1049.8 Pa, and unit stream power values of 62.2 to 521.9 W/m^2 (Table 6). Comparison of the same variables for a total of 101 study reaches surveyed at YPG and BMGR show similar results (Table 7). Boxplots illustrate relative differences in the five stream types with respect to all eight variables, particularly for *W/D, S,* τ, and ω (Figure 12). Differences with respect to the eight variables among the three HUC classes represented in this study are not as pronounced (Figure 13). Distinct stream types with respect to numerous variables include bedrock, braided, and piedmont headwater channels. Representative cross-sectional profiles for each of the five stream types (Figure 8, Figure 14) illustrate differences in typical channel geometry. Many variables provide distinct differences with which to distinguish particular stream types from others. The most pronounced examples of distinct differences in channel geometry are bedrock and braided channels (Table 7, Figure 12).

Bedrock channels and braided washes stand out as two end-member stream types with mean values for many variables significantly different from those of other stream types. Bedrock channels have relatively much higher gradients and lower *W/D* ratios, whereas braided channels have much lower gradients and higher *W/D* ratios compared to the other stream types (Figure 12, Table 7). Significantly high unit stream power, which distributes stream power across the width of the channel, identifies bedrock channels (mean ω = 1952 W/m^2 compared to a range for all other stream types of 44 to 483 W/m^2) as the dominant stream type with regard to stream competence (Table 7).

5.2 Multivariate analysis

Reach-scale variable indicators examined in multivariate analyses of each study reach include four metrics of channel geometry and hydraulics: stream gradient, width-to-depth ratio, shear stress, and unit stream power. Natural groupings of stream types are evident in a three-dimensional scatter plot of all study reaches including all four variables of interest (Figure 15) and a plot of unit stream power versus width-to-depth ratio (Figure 16). Braided reaches and bedrock reaches are easily distinguished from other stream types due to the relationships discussed in section 5.1. Piedmont headwater channels are most variable, whereas bedrock with alluvium and incised alluvium channels are more closely related and difficult to distinguish. PERMANOVA was conducted to test H1 and H2, as described in section 3.1 and 3.2. Predictive discriminant analysis (PDA) was conducted to validate variables used to distinguish stream type and to investigate the possibility of predicting stream types based on physical attributes of channel geometry and associated hydraulics. CART analysis was used to identify the relative strength of variables, thresholds of those variables between stream types, and the ability to distinguish stream types from one another using the thresholds defined by the CART.

5.2.1 PERMANOVA test of hypothesis one

$H1_{null}$: The five channel types proposed in the classification do not exhibit significantly different means for variables pertaining to channel geometry (i.e., *W/D, S, τ,* and *ω*).

PERMANOVA was conducted to test H1 and examine the validity of the stream classification based on reach-scale channel geometry. The analysis was conducted on the entire dataset of 101 study reaches at YPG and BMGR with regard to stream gradient, width-to-depth ratio, shear stress, and unit stream power. Results indicate that the multivariate means with regard to channel geometry are not equal for all five stream types (p-values = 0.0001, F-statistics = 362.47), leading to rejection of $H1_{null}$. The five stream types do not have the same means with respect to *W/D, S, τ,* and *ω*.

5.2.2 PERMANOVA test of hypothesis two

$H2_{null}$: Individual stream types nested within the three HUC classes do not exhibit significantly different means for variables pertaining to channel geometry (i.e., *W/D, S, τ,* and *ω*).

PERMANOVA was conducted to test H2 and examine distinct differences in channel geometry associated with watershed characteristics (i.e., analysis of precipitation, lithology, hillslopes, and average stream gradient classified and described in section 4.1) at the NHD 10-digit HUC scale. PERMANOVA was conducted on the entire dataset of 101 study reaches at YPG and BMGR with regard to stream gradient, width-to-depth ratio, shear stress, and unit stream power. Results indicate that means of variables with regard to channel geometry associated with each stream type are not significantly different among each HUC class (p-values = 0.113, F-statistics = 2.12). These results lead to the failure to reject $H2_0$ that the means of channel geometry are equal for each stream type within the three HUC classes. Results indicate that channel geometry of individual stream types does not vary between HUC classes with different watershed characteristics.

5.2.3 Discriminant analysis

Predictive discriminant analysis (DA) was conducted on stream types with regard to S, W/D, τ, and ω. A linear discriminant function was developed using the 73 study reaches at YPG and four stream types (excluding braided reaches in order to achieve multivariate normality). HUC class was not considered or included in the linear discriminant function. Internal validation to predict the stream type of the same 73 YPG reaches resulted in a 71% optimal hit rate. External validation of the linear discriminant function to classify 15 separate study reaches surveyed at BMGR resulted in an actual hit rate of 68%. Although inclusion of braided reaches prevented the assumption of normality, PDA conducted on the entire YPG dataset of 86 study reaches including braided channels resulted in higher hit rates for both internal and external validation (Table 8).

Internal (86 study reaches at YPG) and external validation (using the 15 study reaches surveyed at BMGR) including braided reaches resulted in average hit rates of 76% and 73%, respectively. Bedrock, braided, and piedmont headwater channels were correctly classified in every case for the external validation (100% hit rate). Most of the DA misclassifications in the internal validation and all of the misclassifications in the external validation exist within the classification of BA and IA channels. In external validation, bedrock with alluvium and incised alluvium channels were confused for one another or misclassified as piedmont headwater channels. Similar misclassifications occurred with the internal validation. A single incised alluvium channel was misclassified as a braided reach (MIA1) and only one braided reach was misclassified (GBD4 classified as IA, 92% BD hit rate). Possible reasons for misclassifications of MIA1 and GBD4 are discussed in further detail in section 6.2.1. Two bedrock reaches were misclassified as bedrock with alluvium channels (89% BK hit rate) and two piedmont headwater channels were misclassified as BA and IA reaches (89% PH hit rate). All other misclassifications occurred within prediction of bedrock with alluvium and incised alluvium study reaches, such that these stream types were either confused for one another or misclassified as piedmont headwater channels.

5.2.4 Classification and regression tree (CART)

CART analysis conducted with the same four channel geometry and hydraulic variables determined the relative strength of each variable in the following order: W/D, S, τ, and ω (Figure 17). Because the CART was pruned from a larger tree with more nodes to improve interpretability, S does not appear in the smaller tree and so does not retain its variable strength. Stream gradient was originally listed as the second-most important variable because of its ability to distinguish between BA and IA channels. However, sample sizes were so small at the terminal node where S appeared in the CART that interpretability and applicability were limited. Braided reaches are distinguished at 93% success from other stream types by $W/D > 91.23$. Bedrock reaches are distinguished at 95% success by $\tau > 151.62$ Pa. Unit stream power was relatively successful (68%) at distinguishing piedmont headwater channels ($\omega < 35.6$ W/m^2) from BA and IA channels. Receiver operator curves (ROC) illustrate the performance of the model to distinguish each channel type using the CART results (Figure 18). Success rates for correctly identifying bedrock (97.5%), bedrock with alluvium (77.4%), incised alluvium (75.1%), braided (97.9%), and piedmont headwater channels (87.3%) are labeled in the ROC (Figure 18).

6. DISCUSSION

Stream classifications provide guidance to understanding and measuring the physical response in channel geometry and aquatic and riparian habitat with regard to anticipated frequency and magnitude of flows. A dearth of data concerning the temporal and spatial variability of ephemeral streams in arid regions currently limits understanding of channel response and associated riparian habitat and restricts vocabulary necessary to discuss these relationships. Development of the geomorphic ephemeral stream classification presented here is a step toward further understanding differences between ephemeral streams and the physical processes responsible for creating and maintaining channel form and riparian vegetation community structure. Results here indicate significant differences in ephemeral channels within the southwestern U.S. with regard to channel confinement and location of relative occurrence across southern Arizona. Differences in channel geometry between stream types are based only on order-of-magnitude estimates, suggesting that higher resolution analysis (e.g., LiDAR) could be combined with subsurface hydrologic monitoring to provide insight into hydrologic and fluvial processes responsible for these differences. Future work can expand upon this stream classification to understand how channel geometry influences surface-subsurface hydrologic interactions that support riparian communities in arid regions and the numerous feedbacks that occur between vegetation and reach-scale hydraulics. Connections between distinct channel form and hydrologic process associated with each stream type can assist in the assessment of riparian vegetation communities and ecological sensitivity.

6.1 Error and assumptions

The work presented here defines differences in stream types with limited accuracy in order-of-magnitude estimates as a result of i) human error, ii) identification of *reference flows*, iii) accuracy of the field survey methods, and iv) calculations of hydraulics using general estimates of Manning's roughness coefficient (*n*). However, relative comparisons of the five stream types indicate significant differences in channel geometry and resulting estimates of hydraulics. These distinct differences validate the classification and allow relatively accurate prediction of the occurrence of stream type.

Error in the survey methods reflects the 10-cm accuracy of the laser range finder. As discussed in the methods section, 4.2.1, error was minimized using meticulous techniques in the field. However, cumulative error in wide cross sectional profiles limits the applicability of a laser range finder and the resulting data. Wide braided washes that required hundreds of survey points introduce the possibility of increased cumulative error in relative elevation across the entire wash. Therefore, cross sectional surveys of the widest braided washes in the study (i.e., > 650 m) may contain error that limits the accuracy of vertical relationships between perched channels and abandoned surfaces. Small-scale measurements of elevation within relatively active threads, however, have the accuracy necessary to match the elevation of interpreted reference flows on opposing banks and calculate channel geometry and hydraulics.

In addition to measurement and calculation errors associated with the methods, statistical assumptions provide some level of uncertainty. Regardless of sensitivities to normality, predictive discriminant analysis that fails to meet this assumption (conducted on all five stream types in comparison to the analysis of only four stream types) indicates higher hit rates validated both internally and externally. These PDA results indicate that the discriminant function is capable of predicting the correct stream type with 73% accuracy regardless of the failure to meet the assumption of normality. Additionally, CART analysis and ROC indicate distinct channel geometry among stream types and similar prediction rates as the linear discriminant function, validating the performance of the PDA analysis.

6.2 Stream classification

Results of this research indicate that the conceptual basis of the stream classification with regard to channel confinement is valid. The inaccuracies present in PDA classification indicate difficulties in distinguishing bedrock with alluvium and incised alluvium channels, erroneously confusing these two stream types or misclassifying them primarily as piedmont headwater channels. This may be attributed to the high variability in stream gradient, shear stress, and unit stream power of piedmont headwater channels (Figure 12). Perhaps the strict definition of PH channels (i.e., 0-2nd order streams that initiate on the piedmont) is specific enough for land-use managers to distinguish them from other channel types. PDA analysis with exclusion of PH channels results in a decrease in external validation hit rate (58%), suggesting that designation of PH channels is necessary to distinguish other stream types from one another and that composition of confining material is of importance. CART analysis and ROC indicate similar prediction rates and validate distinct channel geometry among the five stream types. Although higher accuracy and a larger dataset may produce increased precision in distinguishing channel types from one another, the results presented here indicate that the five stream types have significantly different channel geometry. These differences likely affect hydrologic processes and riparian ecosystem function.

6.2.1 Stream characteristics

The research presented here was designed to capture the full range of variability within the stream types in the research areas. However, channels that were difficult to classify, particularly those that appear to be transitional between one stream type and another (e.g., braided to incised alluvium), were avoided where possible. Examples of study reaches in transitional states include an incised alluvium channel segment in the Mohave Wash HUC (Figure 19) and a small-scale braided reach in the Gould Wash HUC (Figure 20). The incised alluvium reach (MIA1) occurs at a position of channel confinement that forces a braided channel into a single thread before it transitions back into a braided segment. This IA reach contains bed topography such as low relief gravel bars that resemble braided characteristics, but the channel maintains the defining single-thread characteristic of an incised alluvium channel. The braided study reach in a transitional state (GBD4) contains evidence of incision that has forced abandonment of instream-bars with desert varnish development. This reach is visible as an outlier in the braided class, but does not fall completely into the incised alluvium class. Additionally, GBD4 does not seem to affect the classification of braided channels with regard to PDA hit rate. No streams were incorrectly classified as braided in external validation and only MIA1 was incorrectly classified as braided in internal validation, although this may be expected as a result of its braided-like characteristic. Consequently, it is possible that a range of stream characteristics was not fairly represented and, had the full spectrum of streams been surveyed (i.e., all the channel segments within the entire study area), normal distribution of all variables and more accurate prediction would be likely.

Additional considerations with regard to stream classification include the complexity of braided reaches and perched multithread channels. Distinction between the downstream continuations of braided systems from parallel tributaries is commonly difficult, particularly when there is conflicting evidence regarding the most recent flow (Figure 8). Close examination in these cases typically reveals evidence of *asynchronous tributary flow* (Thornes, 1977; section 1.1.3 of this thesis), commonly resulting in deposition following transmission losses at the confluence of tributaries with the dry unconsolidated alluvial bed of a braided wash. Conversely, evidence also exists for *axial flow* (Thornes, 1977), where flow persists in the main stem although not present in all tributaries. Evidence for this type of discontinuous flow is present as truncated depositional fans of fine slackwater deposits at the mouth of tributaries where they join Yuma Wash (Figure 21).

The degree of desert-pavement development affects surface hydrology and characteristics of adjacent channels, which may be reflected in channel geometry. Areas with very well developed desert varnish and desert pavement appear to have more deeply incised channels (e.g., Yuma Wash HUC within YPG, all of YPG compared to BMGR), whereas ephemeral channels in areas with less developed varnish and desert pavement are much less incised. For example, Yuma Wash HUC at YPG contains much darker varnish, more developed desert pavement and seemingly more highly incised channels than Gould and Mohave Washes. These characteristics are correlated with significantly lower valley-to-channel width ratios and a much higher average stream gradient (0.084) compared to Mohave Wash (0.031) and Gould Wash (0.029) (Figure 13). Because desert pavement is characterized by an A_z horizon, which results in relatively low infiltration rates and flashy response to precipitation, the degree of desert pavement development likely influences runoff and exacerbates preferential flow paths on piedmont surfaces. Sheet flow as a result of low infiltration rates likely concentrates runoff into well-developed channels and microtopographic lows, creating a positive feedback between flow depth and channel incision.

Perhaps additional metrics that examine the relative development of desert pavement in various watersheds would be helpful in comparing channel geometry associated with stream type across HUC classes. Additionally, comparison of the study areas at YPG and BMGR indicates much higher development of desert varnish and pavement at YPG (Figure 22). Limited development of desert pavement at BMGR appears to be related to the spatial discontinuity of broad braided channels. Braided channels commonly exist in the study area at BMGR as only short segments before developing distributary channels and eventually disappearing into unconsolidated alluvium, a phenomenon referred to in Australian literature as *flood-out zones* (Tooth, 1999). Although difficulties in measuring channel geometry of *flood-outs* prevent the type of classification presented here, these types of channel segments warrant attention and should perhaps be added as a sixth stream type.

6.2.2 Watershed/HUC characteristics

Rejection of $H2_0$ indicates that the stream classification presented here maintains distinction with regard to channel geometry and is valid across broad-scale watershed characteristics defined by the classification of 10-digit HUCs. Results of PERMANOVA analysis including data from YPG and BMGR indicate that the five stream types maintain distinct channel geometry in regions with different degrees of desert pavement development. Examples of differences in HUC class with regard to reach characteristics are the comparison and contrast results from one-way ANOVA analysis, which indicated significant differences in Wv/Wc and d_{50} between HUC classes. This is likely a result of relative coverage of unconsolidated alluvium versus bedrock mountainous uplands captured in the lithology term of the preliminary HUC classification and cluster analysis described in section 4.1. As a HUC dominated primarily by bedrock mountainous uplands, Yuma Wash HUC contains well-developed desert varnish and pavement at high elevations above the channel bed (e.g., typically 6-8 m).

Prediction of the occurence of stream types based on watershed characteristics may require higher resolution watershed data on a local scale. For example, a range of relatively large drainage areas (i.e., 162 km^2 – 1012 km^2 (40,000 – 250,000 acres)) defines the scale for 10-digit HUCs in comparison with the range of contributing drainage area for each study reach (i.e., 1.4×10^{-5} km^2 to 225.3 km^2, with a mean area of 12.7 km^2). Although 10-digit HUCs are predefined and readily accessible to land-use managers, the large scale at which they are characterized averages broad watershed characteristics and eliminates local variability in watershed characteristics that may otherwise provide the basis for predicting the occurrence of stream type. Characterization of watershed attributes within localized contributing drainage areas, rather than 10-digit HUCs, for each study reach may be an effective way to examine relationships between reach-scale channel geometry and watershed characteristics.

6.2.3 Improvements and recommendations

Many steps can be taken to improve and expand upon this classification to better facilitate understanding of ephemeral fluvial systems in arid regions and application for land-use management. Additional research to expand the sample size will improve statistical power and predictive capabilities of a discriminant function by allowing the dataset to approach normality and incorporating characteristics that were possibly not accounted for in this study. Increased sample size in other arid regions would provide assessment of the robustness and applicability of this classification across the American Southwest and arid regions of the world. Investigation of geomorphic and hydrologic process associated with physical drivers in arid-region ephemeral systems will provide invaluable insight into the development of stream types and associated riparian communities. Inclusion of study reaches in spatial and temporal geomorphic states of transition may be an effective way to examine the physical processes associated with various stream types and to identify distinct thresholds in channel form.

Investigation of spatial variability associated with longitudinal transitions in stream type may also provide significant insight into physical drivers. For example, braided channels were difficult to locate at BMGR, because unconfined channels frequently resulted in *flood-outs* such that all signs of defined channels and surface flow disappeared as a result of transmission losses. This phenomenon was not encountered at YPG, but perhaps existed in more restricted, open regions outside of the research area and in surrounding areas outside the boundaries of the military base. These observations warrant further investigation and the possibility of a sixth stream type (i.e., *flood-outs*).

Numerous examples of distributary channels that result in either *flood-out zones* or a transition back into tributary networks at BMGR made it difficult to locate braided study reaches with defined channels. Defined braided reaches were located at what seemed to be only partially confined zones that were bound by mountainous uplands, in which bedrock beneath shallow alluvium likely forced subsurface flow to the surface to create defined braided channel patterns. In this case, it is possible that surface flow occurs during intense storms and only during large floods. A good example of this occurs at the braided reach in the Painted Rocks HUB at BMGR (PRBD1), where mountainous uplands confine a braided system. The sequence of cross sectional profiles illustrates a downstream progression from more incised channels at river right of the upstream cross sections (PRBD1d) to more typical braided wash characteristics at the downstream-most cross section (PRBD1a). As the confinement of bedrock uplands decreases and accommodation space increases, infiltration appears to result in a *flood-out* zone downstream of the study reach where the wash becomes entirely unconfined (Figure 23).

Transmission losses into unconsolidated material in reaches with little to no confinement appear to limit the development of distinct channels. As confining uplands give way to more broad, expansive piedmont, increased accommodation space appears to allow sheet flow and limits the occurrence of highly incised channels where well-developed desert pavement is not present. Increasing accommodation space effectively allows runoff access to more surface area, resulting in greater width-to-depth ratios that are indicative of braided channels. Work by Dust and Wohl (2010) identifies thresholds for braiding, which distinguish channel types with regard to width-to-depth ratio and unit stream power (Figure 16). Perhaps a similar threshold exists for *flood-out zones*, such that accommodation space becomes infinitely large and shallow sheet flow easily infiltrates into unconsolidated alluvium, leaving no trace of surface or channelized flow.

I will conduct further investigation regarding the influence of watershed attributes on channel geometry and stream type to examine the possibility of predicting the occurrence of stream type from remote locations. Delineation of contributing drainage areas at a single point within each study reach will be conducted to summarize watershed characteristics and examine possible correlations with stream type. This approach should provide further insight into physical drivers of each stream type and possibly facilitate prediction of stream type using easily accessible data such as DEMs and local lithology. If successful, this technique will be an invaluable tool for land-use management and military personnel.

6.3 Future work and implications

Although the geomorphic classification of ephemeral streams presented here does not examine geomorphic and hydrologic processes in a quantitative manner, its emphasis on the hydrologic constraints inherent in the degree of channel confinement and composition of confining material present an effective way to classify desert channels of the American Southwest with regard to xeroriparian vegetation communities and ecological sensitivity. Co-investigators of the larger interdisciplinary group are currently investigating hydrologic processes associated with each stream type. The geomorphic classification provides the basis for further investigation regarding surface-subsurface hydrologic interactions including: i) depth of unconsolidated alluvium, ii) residence time of seasonal water storage within alluvium, iii) subsurface bedrock topography, and iv) the presence of perched water tables. Future work will expand upon the stream classification to understand how channel geometry influences surface-subsurface hydrologic interactions that support riparian vegetation communities in arid regions and possibly provide insight into numerous feedbacks that occur between vegetation and reach-scale hydrology.

Further understanding of the physical drivers and hydrologic processes will inform riparian vegetation surveys, vegetation recruitment experiments, investigations of plant physiology, and a classification of ecological sensitivity. The stream classification provides a way of viewing ephemeral streams in arid regions with regard to present channel geometry that supports ecological structure and function of riparian habitat and vegetation communities. The degree of confinement, composition of confining material, and identified reference flows, regardless of recurrence interval, can be used to examine the current structure of riparian communities and classify the ecological sensitivity of each stream type. Anticipated i) correlations between riparian vegetation communities and stream types and ii) accurate prediction of the occurrence of each stream type using localized watershed characteristics will facilitate *a posteriori* classification of ecological sensitivity for land-use management and military personnel.

7. CONCLUSION

The most defining characteristic of arid-region ephemeral streams is the high spatial and temporal variability of precipitation, infiltration, hydrologic connectivity, and flows that occur within and adjacent to these channels. Flashy, segmented floods that maintain and reshape channel geometry at infrequent, irregular intervals make it difficult to define channel geometry and to investigate interactions between channel process and form. High infiltration losses and sporadic flows maintain primarily transport-limited systems in alluvial channels that slowly change channel geometry through aggradation over the course of decades to centuries. The physical conditions and channel geometry, which persists until large floods completely refigure the channel, maintain current riparian habitat and vegetation community structure. Height of depositional surfaces and staining on bedrock were used to identify *reference flows* associated with current riparian habitat and estimate relative differences in channel geometry and reach-scale hydraulics for 101 study reaches on YPG and BMGR in southwestern Arizona.

Examination of the relative strengths of eight independent variables (i.e., W/D, S, τ, ω, Ω, W_v/W_c, τ^*, d_{50}) and univariate relationships between five stream types (i.e., bedrock, bedrock with alluvium, incised alluvium, braided, and piedmont headwater channels) indicate stream gradient, width-to-depth ratio, shear stress, and unit stream power are the strongest predictors of stream type. Non-parametric permutational multivariate analysis of variance (PERMANOVA) indicates significant differences in the five stream types with regard to the four independent variables (i.e., W/D, S, τ, ω) pertaining to channel geometry and reach-scale hydraulics (p-value = 0.001). PERMANOVA results (p-value = 0.16) also indicate that stream types maintains distinct channel geometry across three 10-digit HUC classes characterized by broad watershed characteristics.

Linear discriminant analysis using discriminant functions from 86 study reaches at YPG correctly predicted 78% of the stream types for those 86 reaches (78% optimal hit rate). The same discriminant functions derived from 86 study reaches at YPG correctly predicted the stream types for 73% of the 15 study reaches surveyed at BMGR (73% actual hit rate). These results validate distinct differences in channel geometry among the five stream types.

Results presented here can be used to examine i) prediction of stream type based on localized watershed characteristics, ii) hydrologic and geomorphic processes associated with each stream type, and iii) correlations between riparian vegetation communities associated with physical characteristics of each ephemeral stream type. Significant differences in channel geometry associated with the five stream types, despite differences in watershed characteristics at the 10-digit HUC scale, provide insight into the possibility of land-use management tools that can be used to identify sensitivity of riparian ecosystems. Further examination of relationships between stream types and localized watershed characteristics that contribute to a specific location may improve effectiveness in predicting the occurrence of stream types and expected sensitivity of riparian ecosystems in specific areas. This may in turn prove to be invaluable in land-use management on military lands, other regions of the southwestern U.S., and arid regions around the world.

8. FIGURES

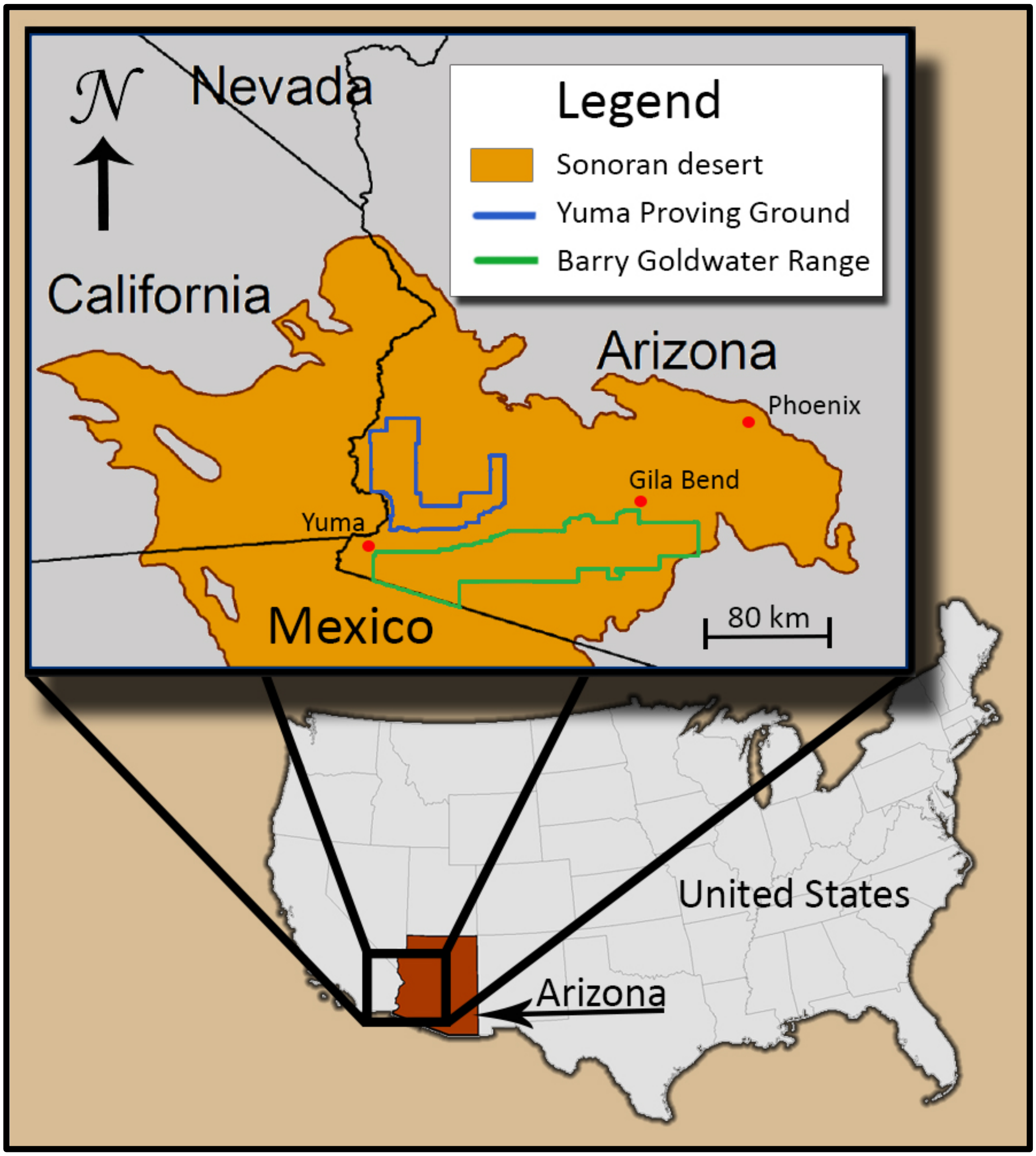

Figure 1. Location of Yuma Army Proving Ground and Barry Goldwater Air Force Range in southern Arizona within the extent of the U.S. Sonoran Desert, as defined by Brown et al. (2007).

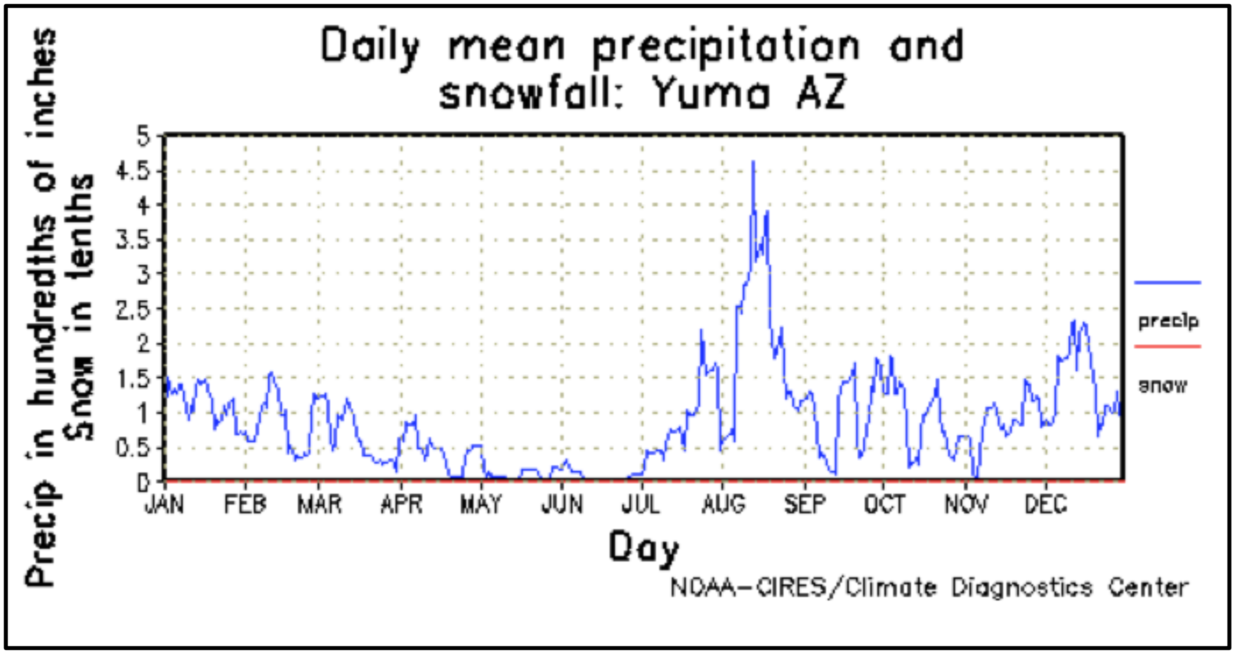

Figure 2. US National Weather Service records for average daily precipitation in Yuma, Arizona (NWS, 2012).

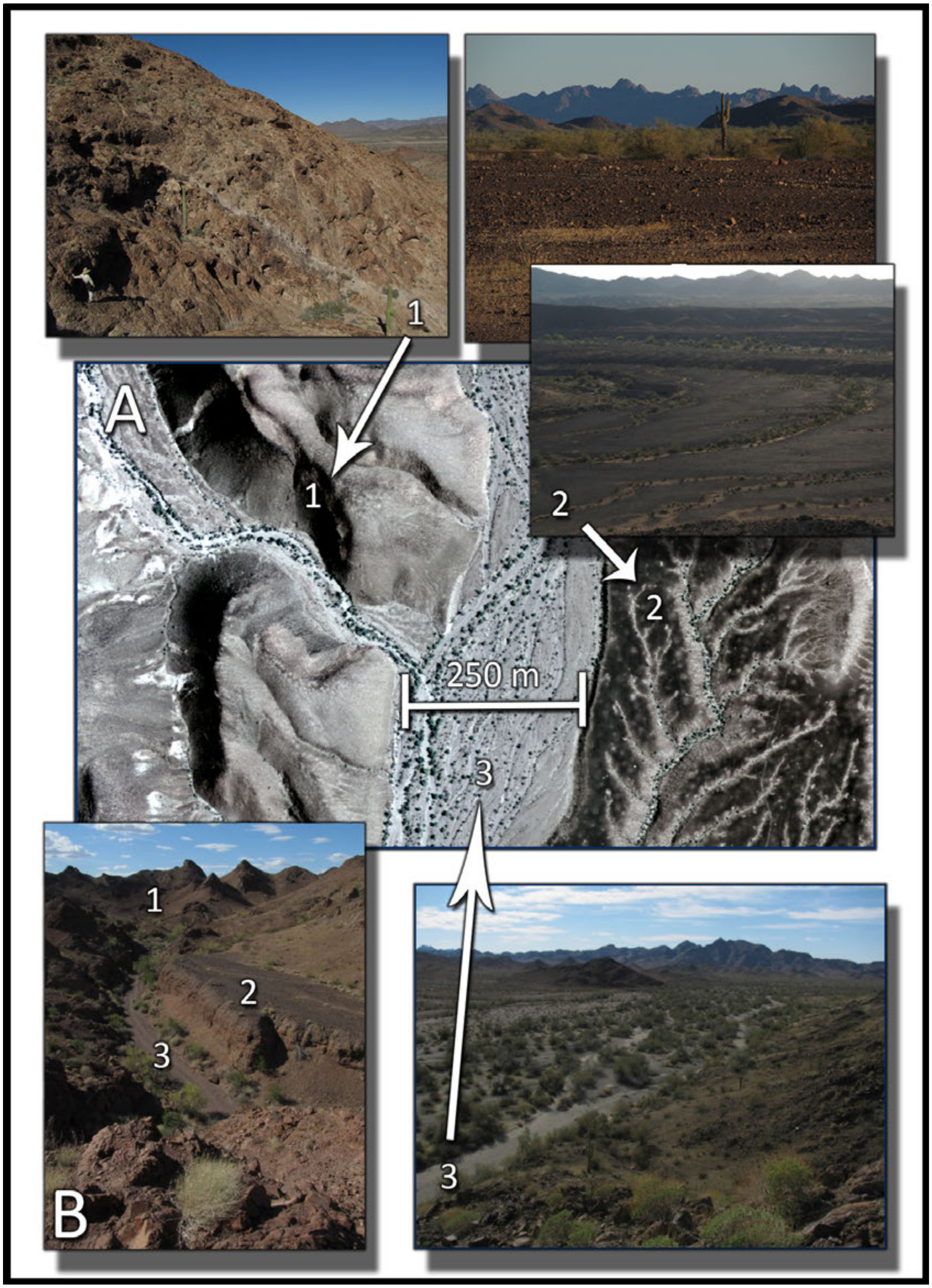

Figure 3. Land surface characteristics in the study area of southwestern Arizona include 1) bedrock uplands, 2) desert pavement, and 3) alluvial washes. A photograph (B) depicts an example of the spatial proximity of which these surfaces commonly occur and arrows point toward an aerial NAIP (National Agriculture Imagery Program) image (A) illustrating the spatial relationship of the three primary land surfaces that dominate the landscape in YPG, BMGR, and much of the greater Sonoran desert. Note the person at the lower left frame of image 1 for scale.

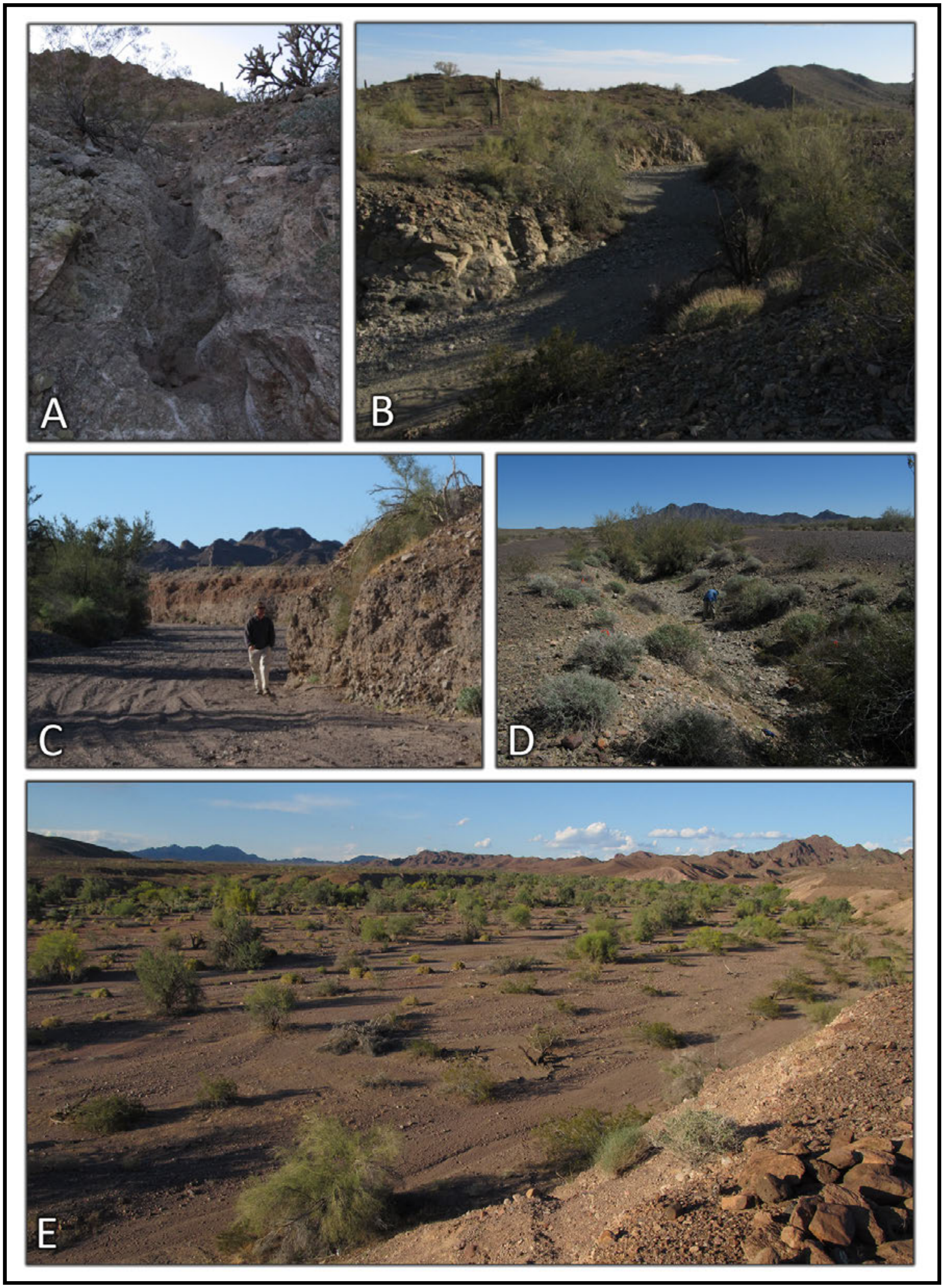

Figure 4. The five ephemeral stream types presented here include bedrock (A), bedrock with alluvium (B), incised alluvium (C), piedmont headwater (D), and braided (E) channels.

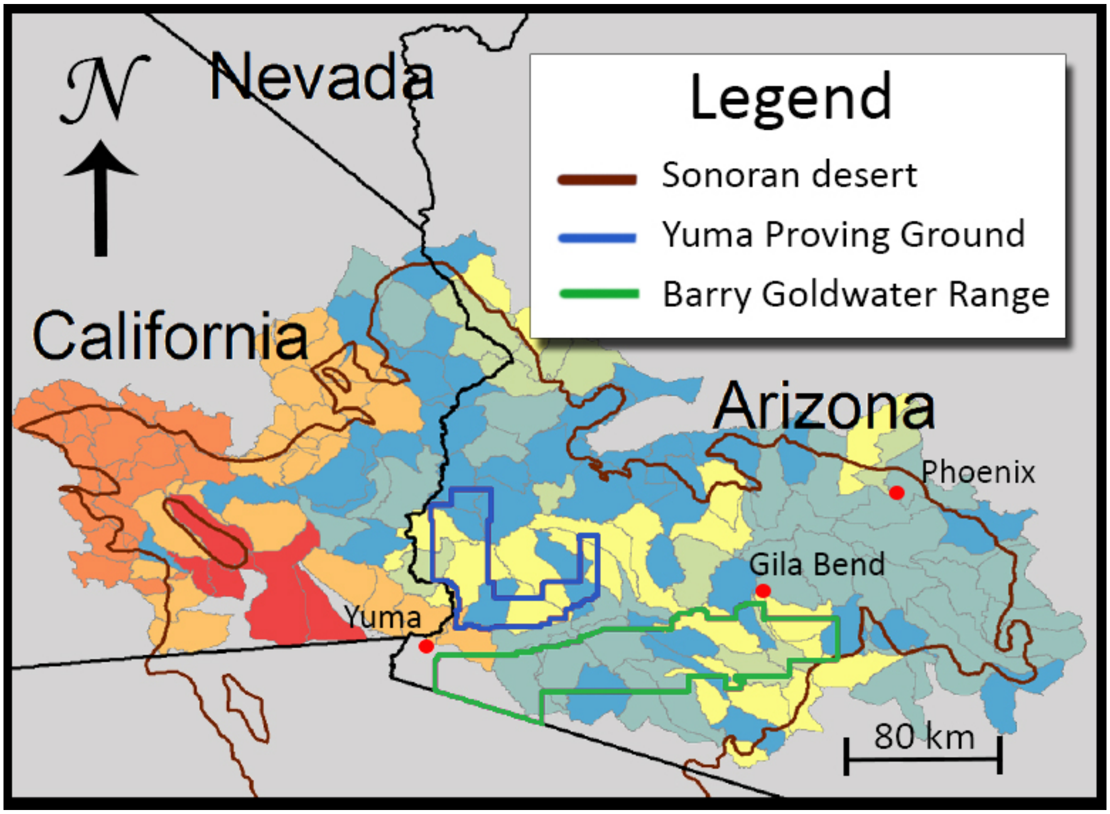

Figure 5. Resulting seven watershed classes, illustrated by a color ramp (i.e., red, orange, orange-yellow, yellow, green, blue-green, and blue), of NHD 10-digit HUCs following spatial analysis (conducted with guidance from Jeremy Shaw) and cluster analysis (done by Jeremy Shaw) of 144 HUCs within the Sonoran desert.

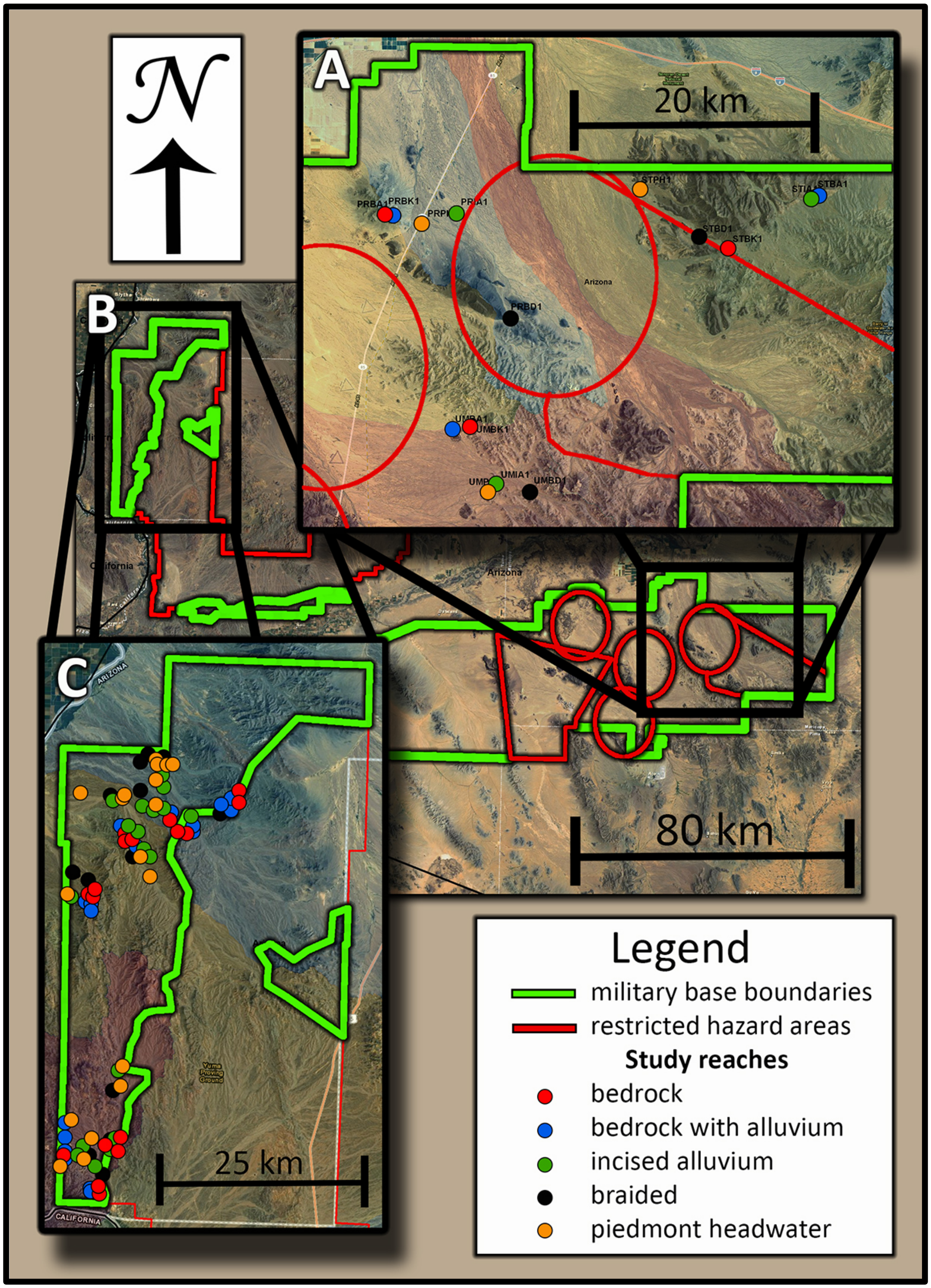

Figure 6. A map of the study areas in southern Arizona (B) shows the relative location of 101 study reaches in BMGR (A) and YPG (C). NAIP imagery depicts the differences in relative development of desert varnish and desert pavement, such that YPG contains much darker varnish and more developed desert pavement. Red, blue, and yellow overlay of the research areas in YPG (C) and BMGR (A) indicate different HUC classes in which study reaches were equally distributed.

Figure 7. Photograph of buried ironwood trunks on an infrequently inundated or relatively abandoned alluvial surface within a braided wash.

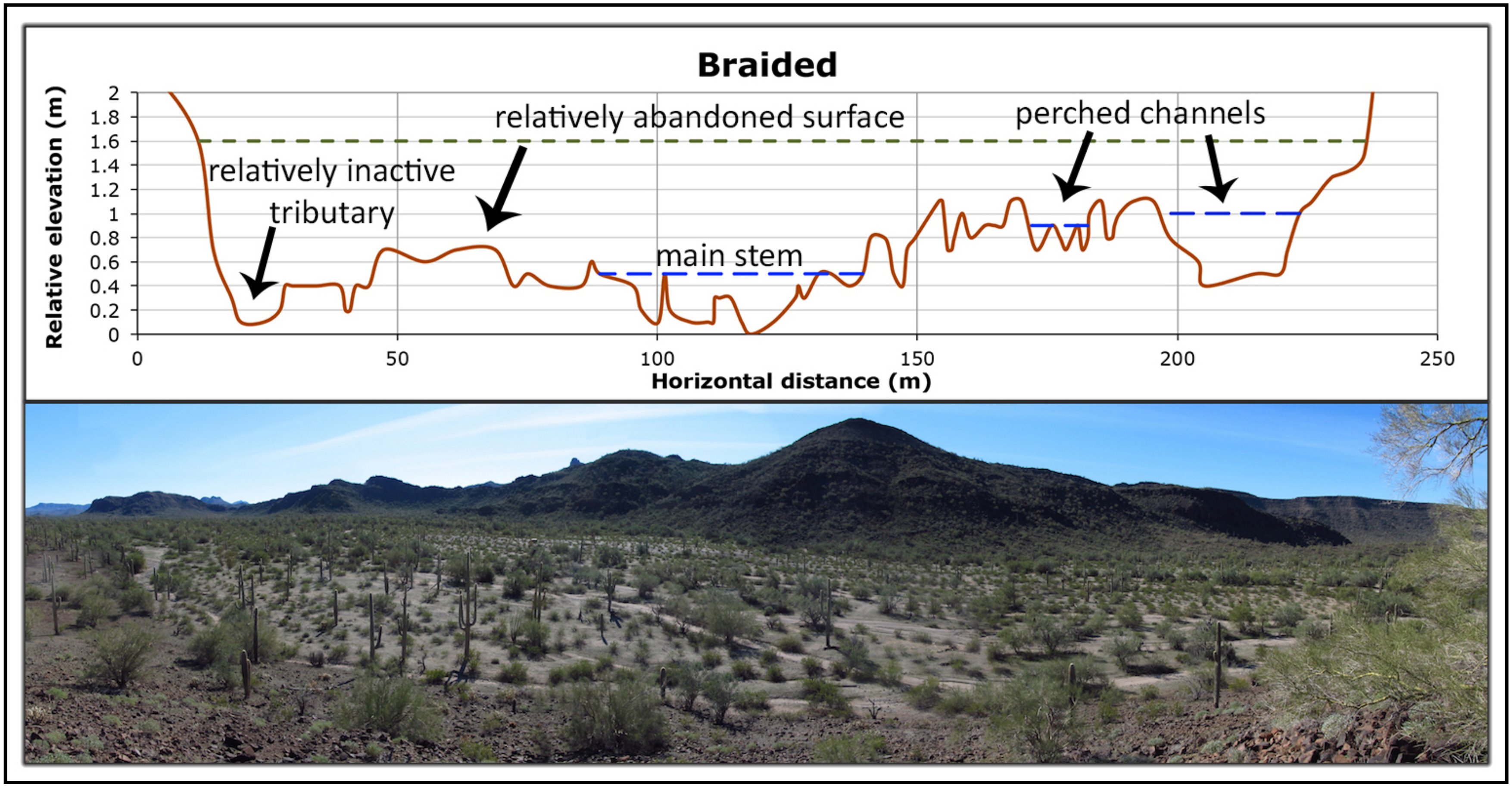

Figure 8. The upper frame is a cross sectional profile from Mohave Wash HUC in YPG (MBD3c) illustrating typical features of a braided channel and the ratio between valley width (upper short-dashed green line) to channel or wash width (lower long-dashed blue line) (W_v/W_c). Valley width is the length of the green dashed line (at an elevation approximately two times the maximum depth of the highest thread within the braided wash) over the total length of the blue dashed lines (the sum of channel widths at the identified reference flow). The photograph depicts the view of a braided wash in the Sand Tank Wash HUC in BMGR (STBD1) from an abandoned desert pavement surface at valley right.

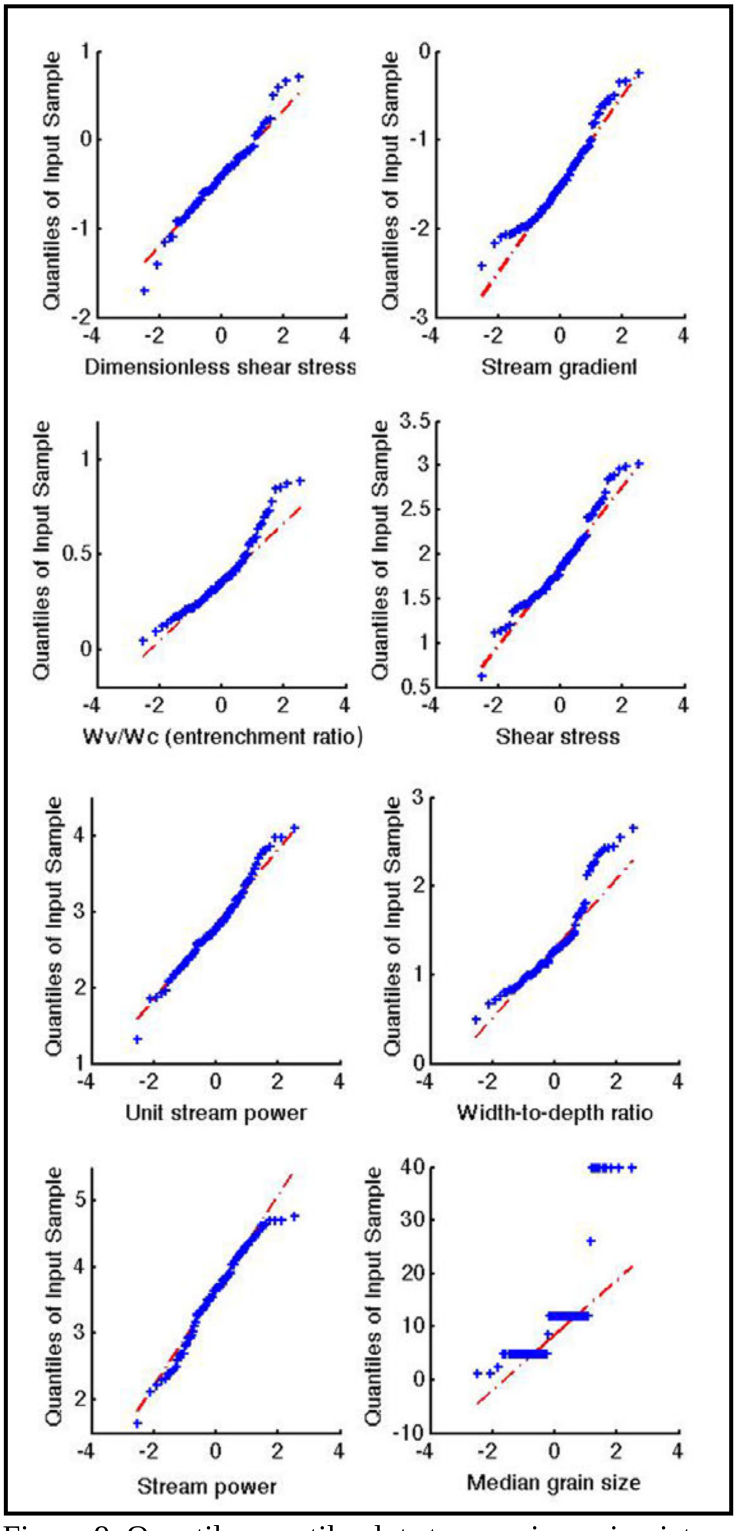

Figure 9. Quantile-quantile plots to examine univariate normality for each of the eight variables of interest (*τ*, S, W_v/W_c, τ, ω, W/D, Ω, d50*). Univariate normality is more accurately achieved when the blue data points fall closer along the red line. Note the categorical grouping of the median grain size data.

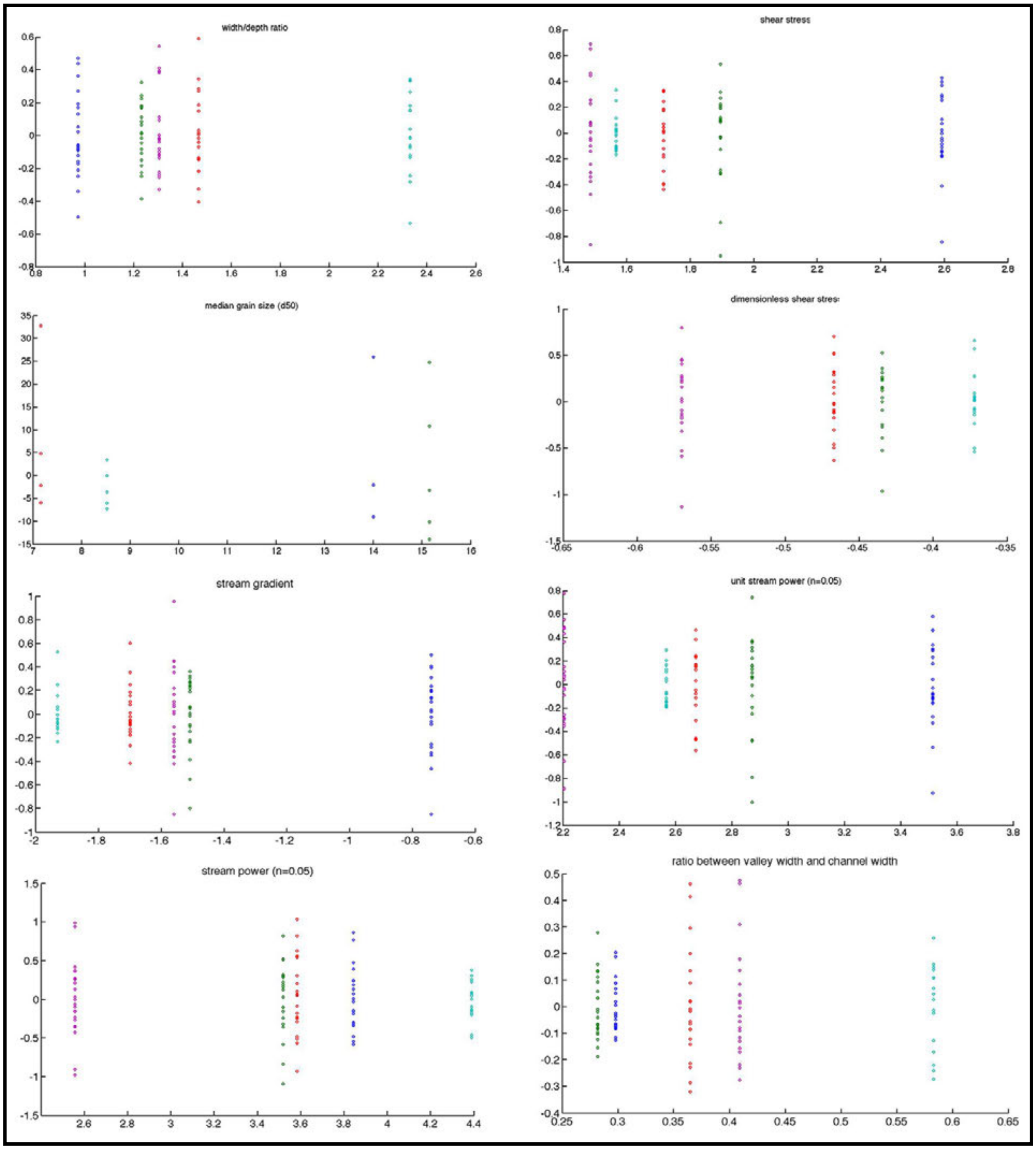

Figure 10. Residual plots of expected values (i.e., mean for each stream type) versus observed values (i.e., each observation minus the mean for each respective stream type) to examine equality of variance among stream types for the eight log-transformed variables of interest. Relatively equal spread between stream types indicates homogeneity of variance.

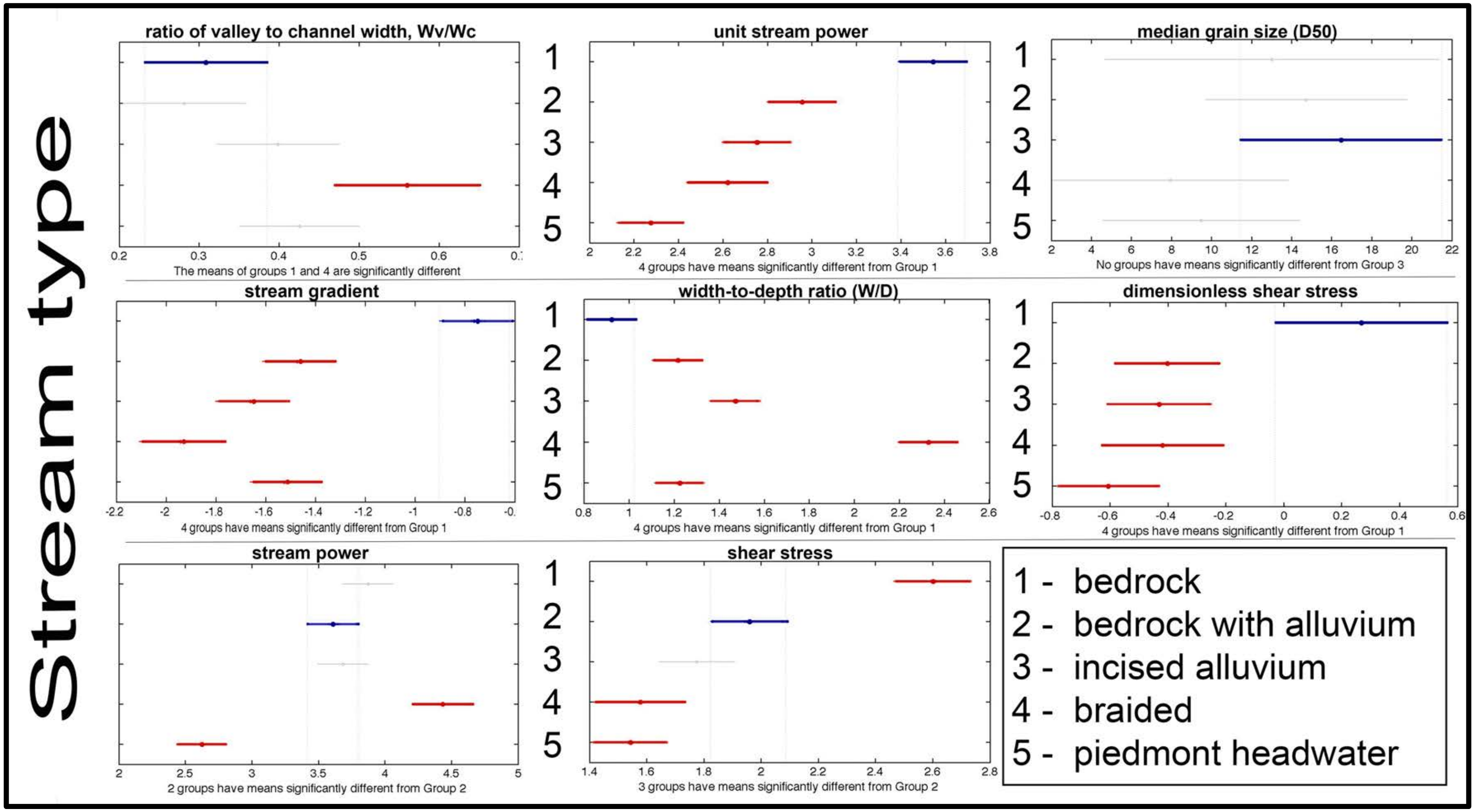

Figure 11. Multiple contrasts and comparisons for eight log-transformed variables of channel characteristics between stream types: 1) bedrock, 2) bedrock with alluvium, 3) incised alluvium, 4) braided, and 5) piedmont headwater. Horizontal axis denotes log-transformed values for each variable.

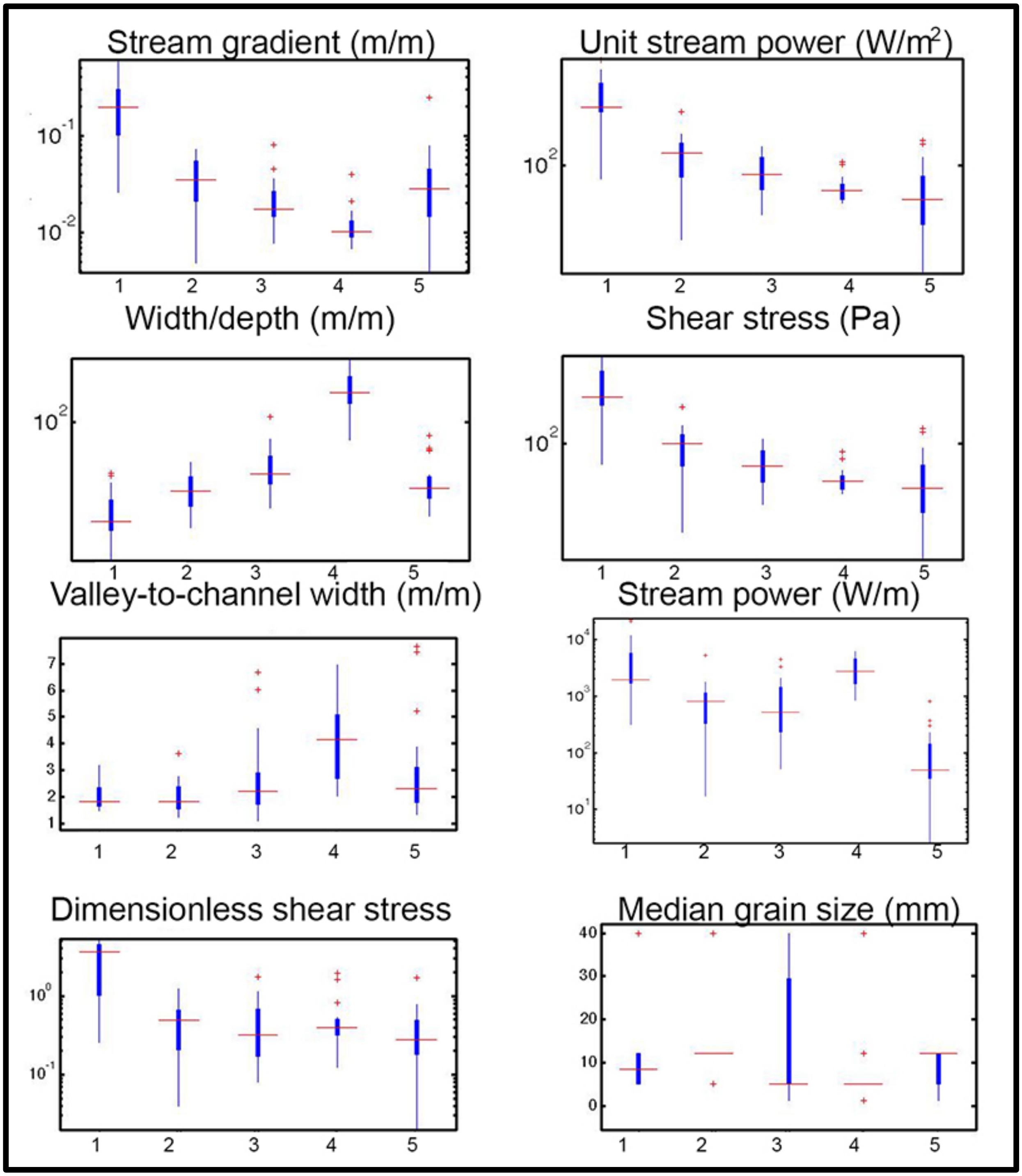

Figure 12. Box plots of 8 variables (*S, ω, W/D, τ, W_v/W_c, Ω, τ^*, $d50$*) organized by stream type on the horizontal axis; bedrock (1), bedrock with alluvium (2), incised alluvium (3), braided (4), and piedmont headwater (5) channels for 101 study reaches surveyed at YPG and BMGR. Red lines indicate the mean, box ends are the 25th and 75th percentiles, whiskers extend the full range, and red crosses are outliers.

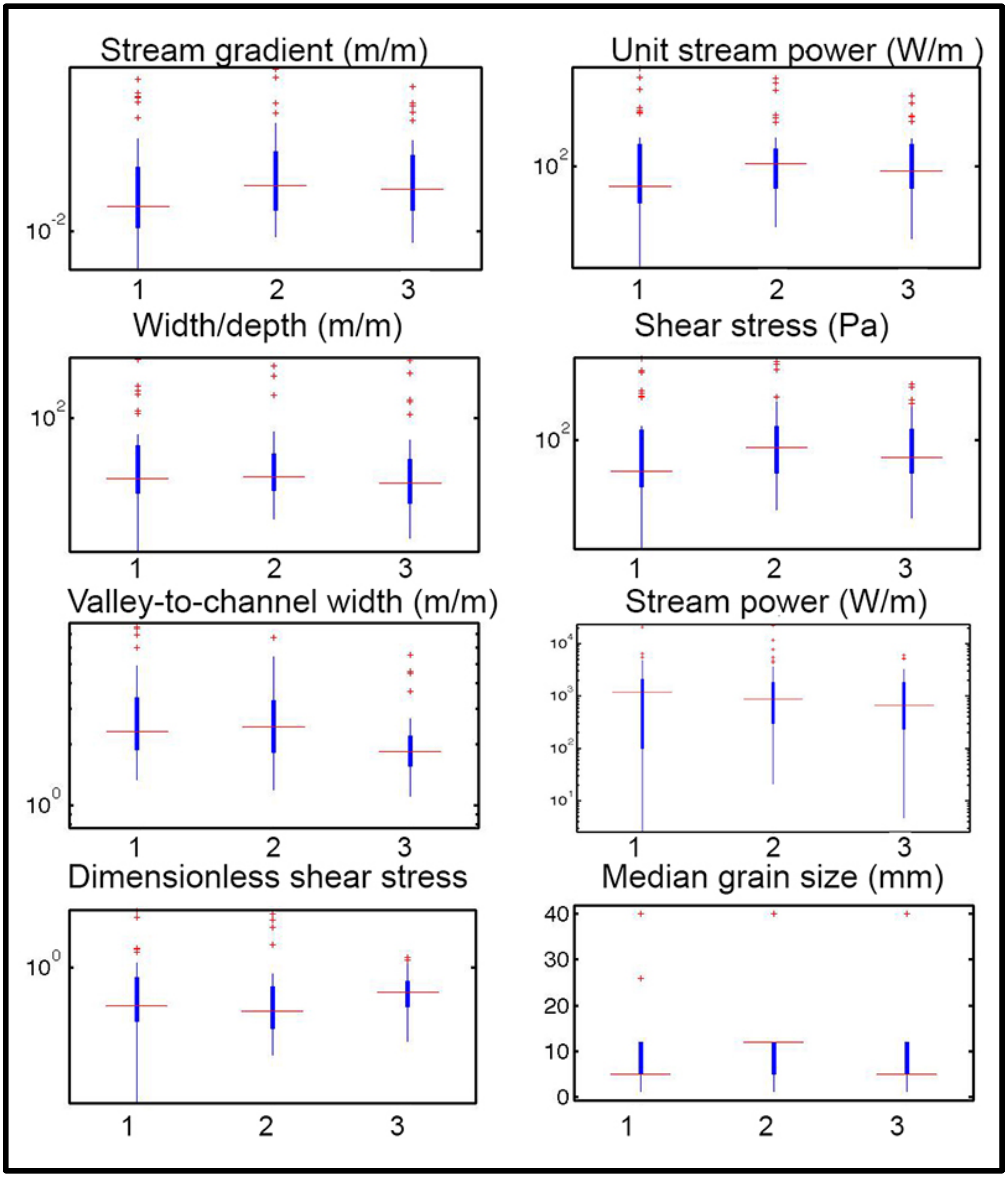

Figure 13. Box plots of 8 variables (W_v/W_c, Ω, τ^*, $d50$, S, W/D, ω, τ) organized by HUC class for 101 study reaches surveyed at YPG and BMGR. Horizontal axis denotes HUC class; dominated by unconsolidated alluvium (1), mountainous uplands (3), or a relatively even combination of unconsolidated alluvium and mountainous uplands (2).

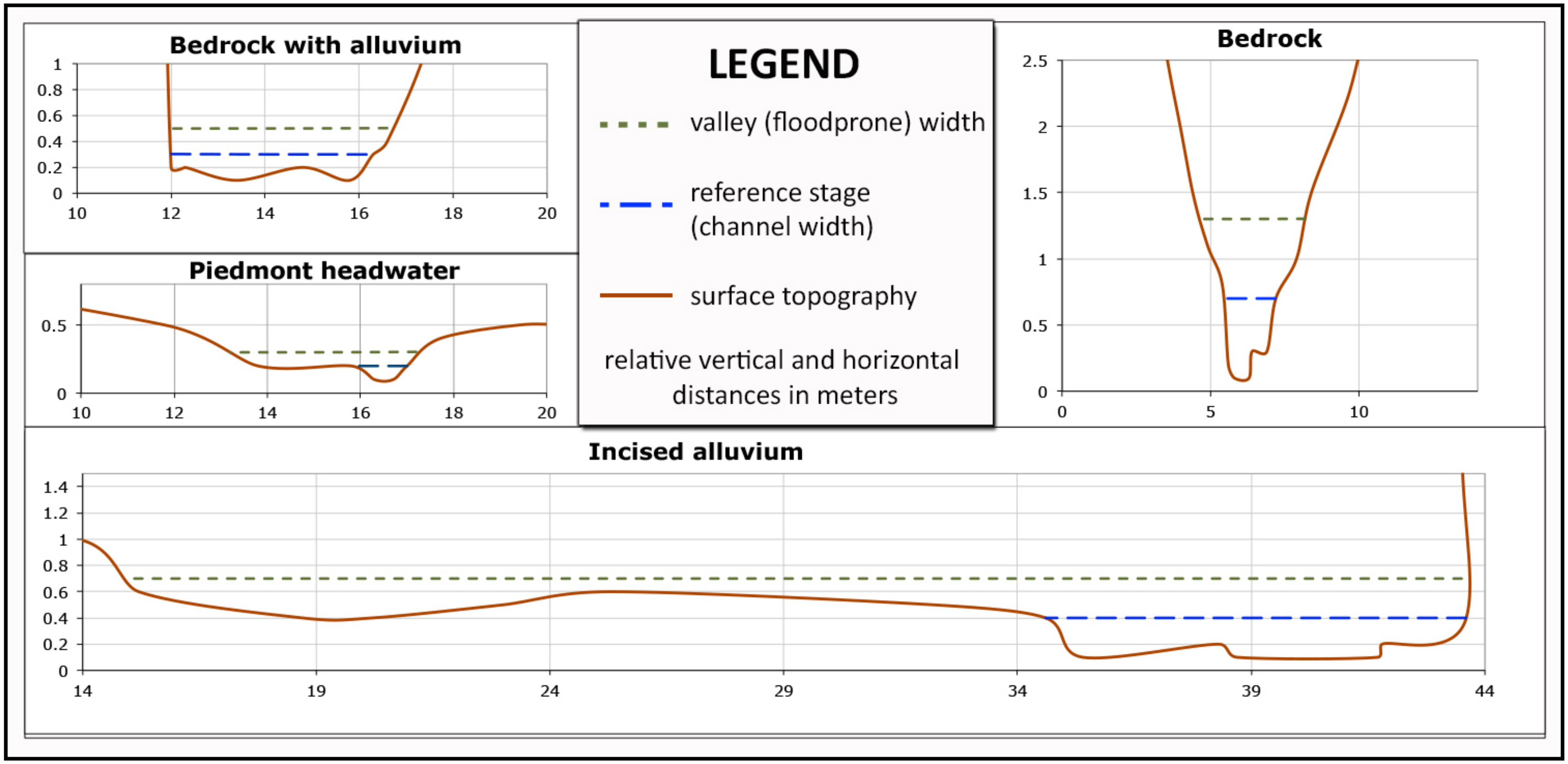

Figure 14. Representative cross-sectional profiles for bedrock, bedrock with alluvium, piedmont headwater, and incised alluvium stream types. Figures are in relative scale to one another with vertical and horizontal axes in meters. Refer to Figure 8 for a typical cross section of a braided wash at a significantly different scale.

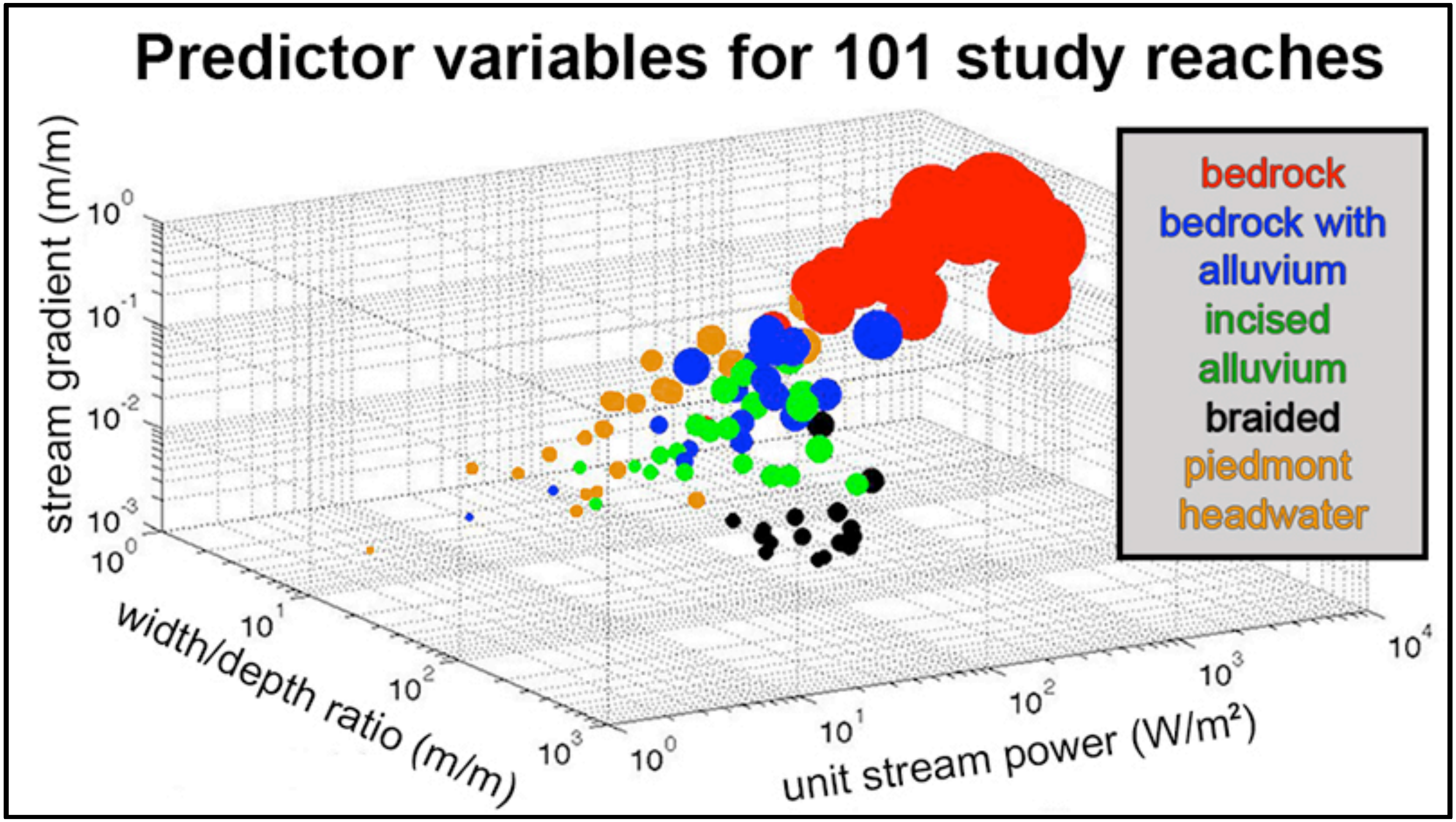

Figure 15. A three-dimensional scatter plot of unit stream power, shear stress, stream gradient, and *W/D* illustrates natural grouping among stream types. Size and color of markers representing 101 study reaches indicate relative shear stress and stream type, respectively.

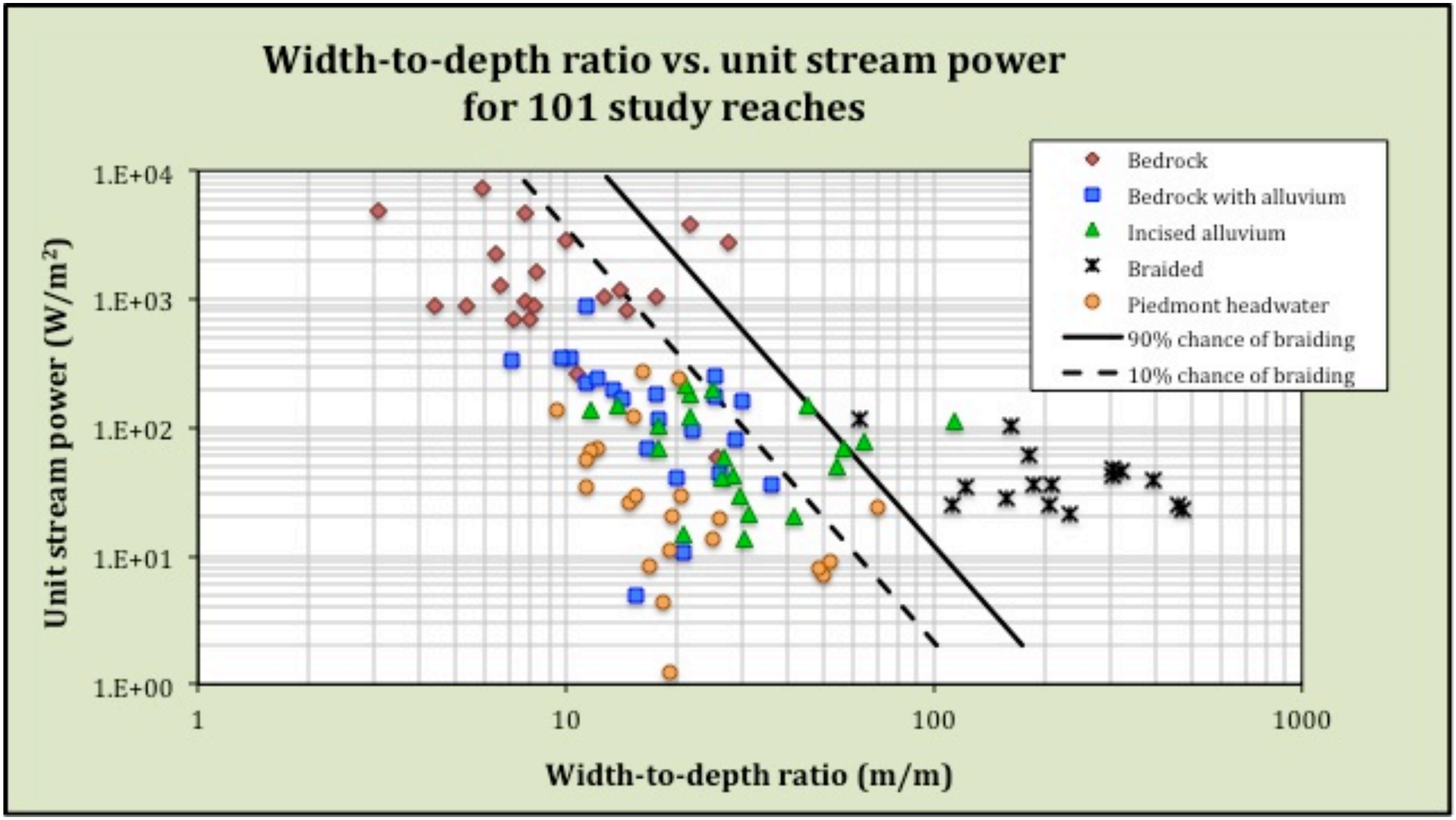

Figure 16. A plot of unit stream power vs. width-to-depth ratio for all 101 study reaches at YPG and BMGR indicates significant grouping between stream types. Dashed and solid lines adapted from Dust and Wohl (2010) indicate thresholds for 10% and 90% probability of braiding respectively. Data from this thesis agree with expected values for bedrock channels and thresholds for braiding from Dust and Wohl (2010) with regard to the braided reaches. The obvious incised alluvium and braided outliers are MIA1 and GBD4, respectively, which are discussed in section 6.2.1 of this thesis. Additional incised alluvium channels that fall above the braided threshold may call into question the validity of these thresholds in this environment.

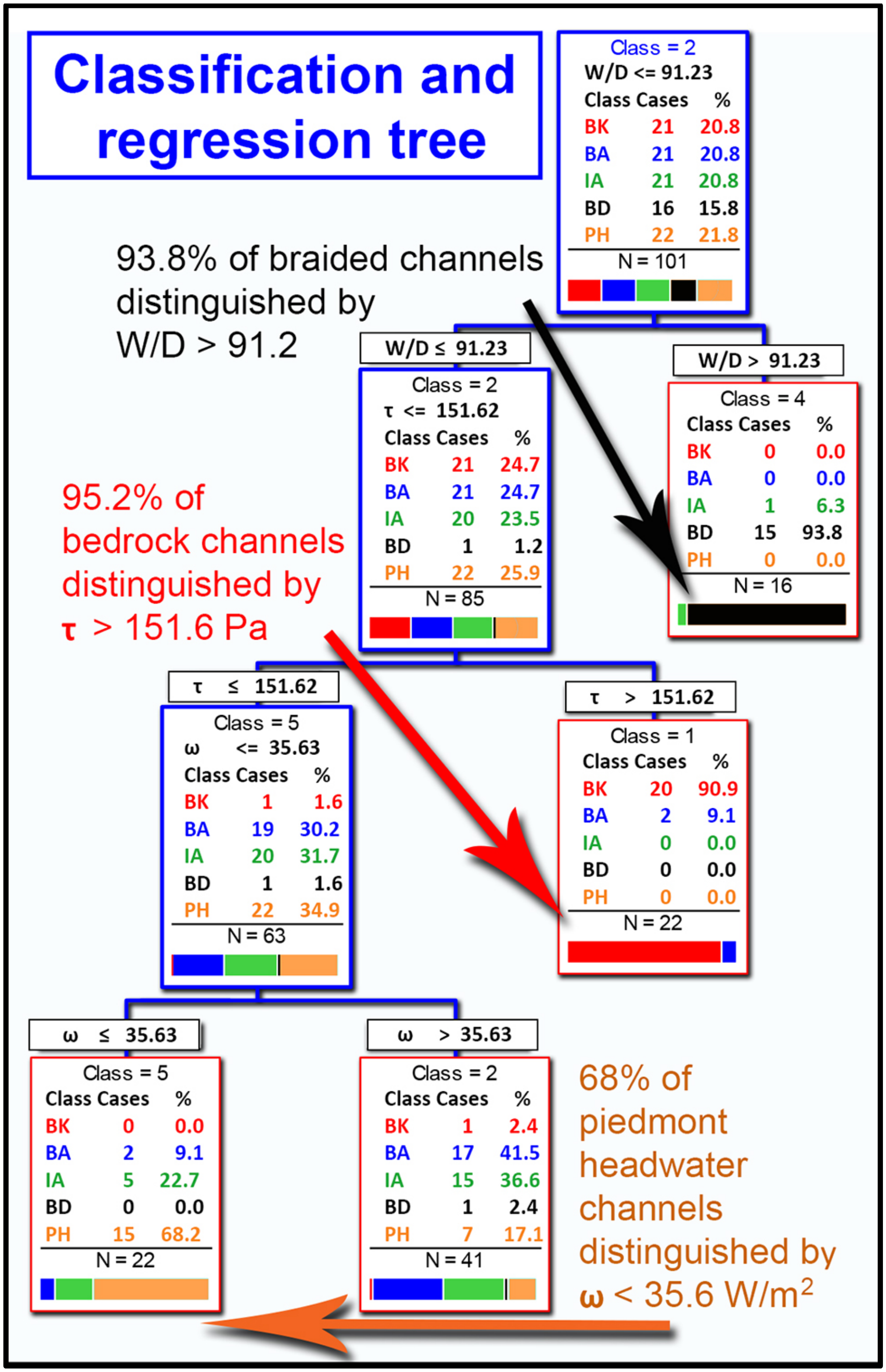

Figure 17. Classification and regression tree (CART) identifying thresholds in *W/D*, *τ*, and *ω* used to distinguish the five streams types from one another. CART results were pruned down from more nodes to improve interpretability. Variable importance listed from strongest to weakest: *W/D*, *τ*, and *ω*.

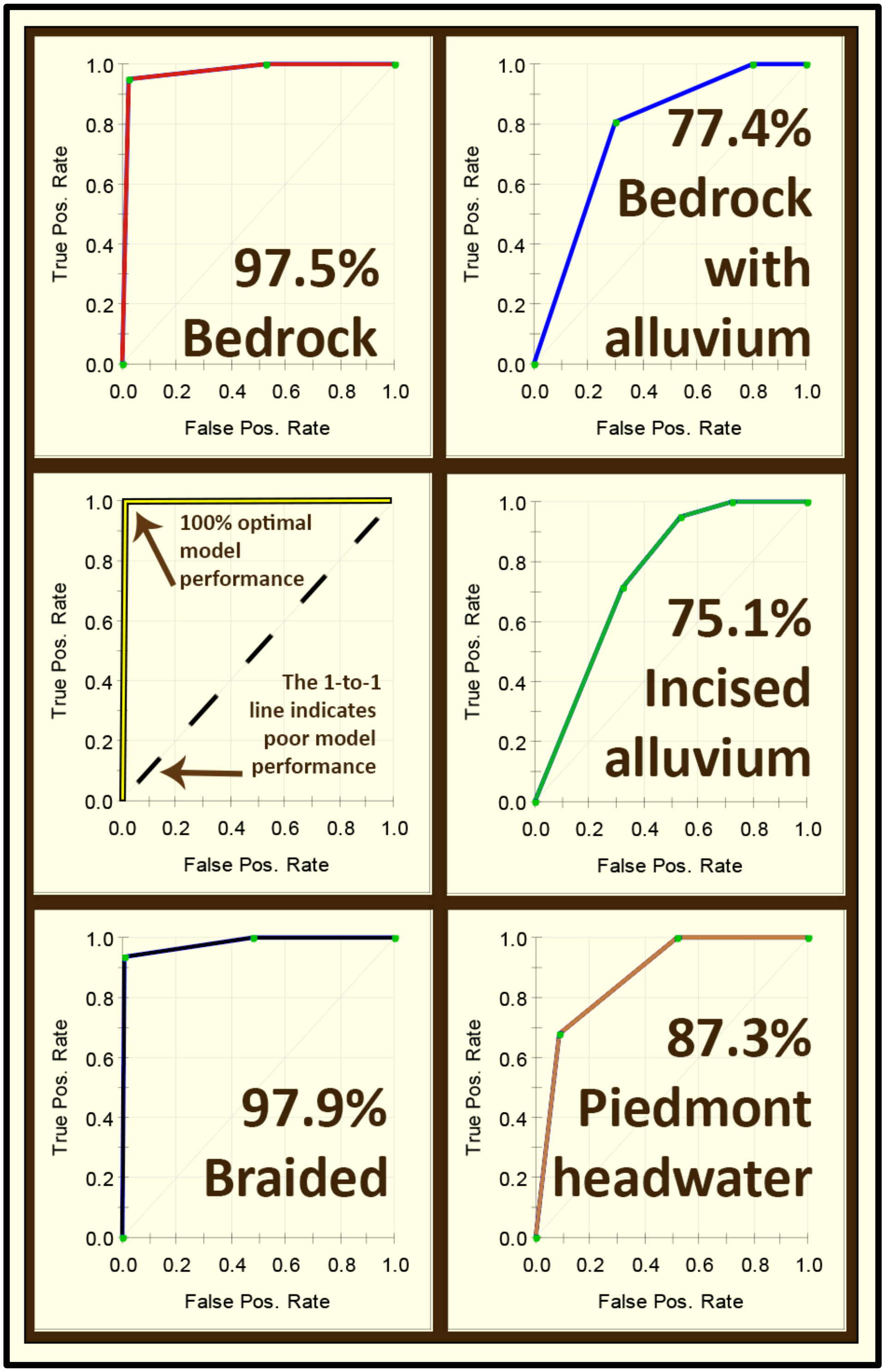

Figure 18. Receiver operating characteristic (ROC) curves identify the success in correctly determining each stream type based on thresholds identified by the CART in Figure 17. The higher the true positive rate (correct identification) becomes while the false positive rate remains small, the more successful the model is for that stream type.

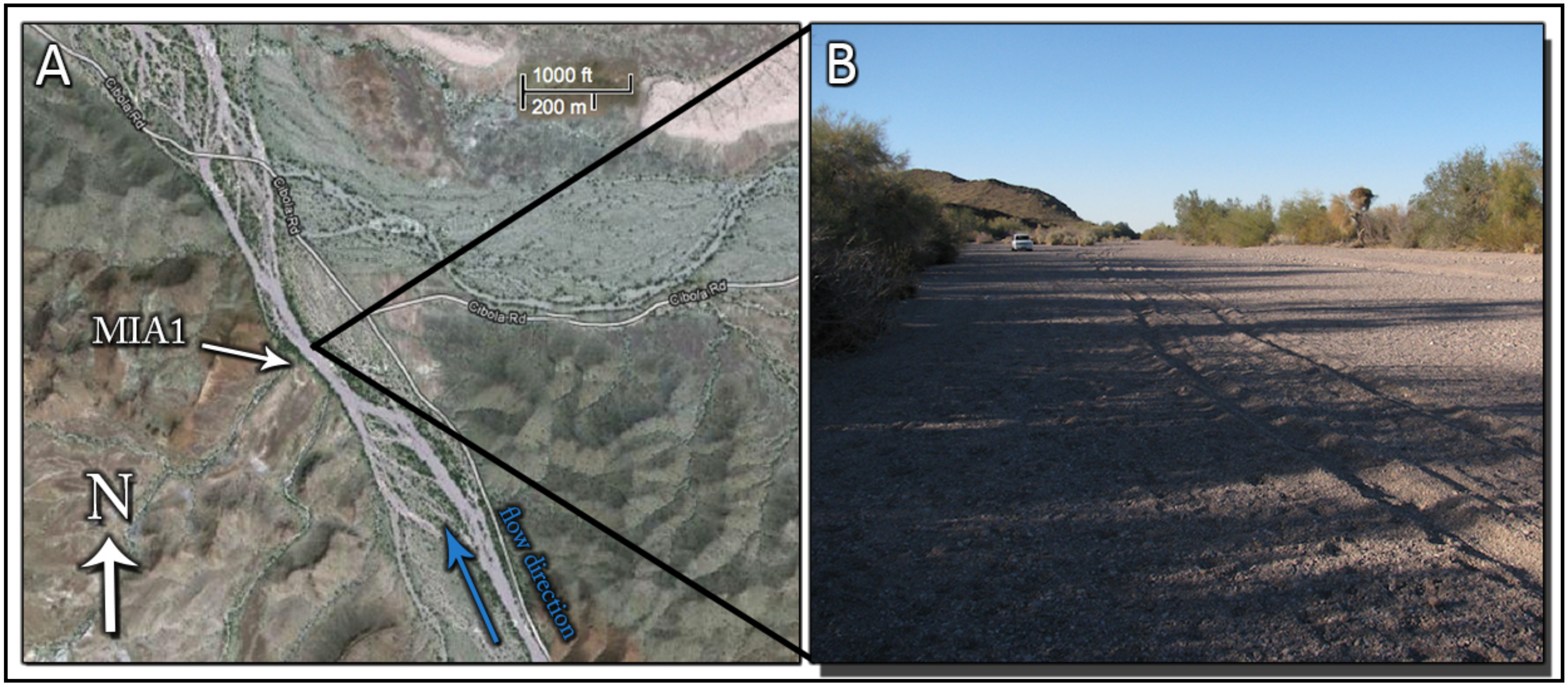

Figure 19. Aerial Google imagery (A) depicts a spatial transition where a somewhat braided reach becomes confined into a single thread, incised alluvium study reach in Mohave Wash HUC, MIA1 (B), and fully transitions into a braided wash downstream. The blue arrow indicates direction of flow and the white arrow labeled as “MIA1” indicates the location of the study reach. Photograph (B) provides a view looking downstream from the center of the study reach (MIA1c).

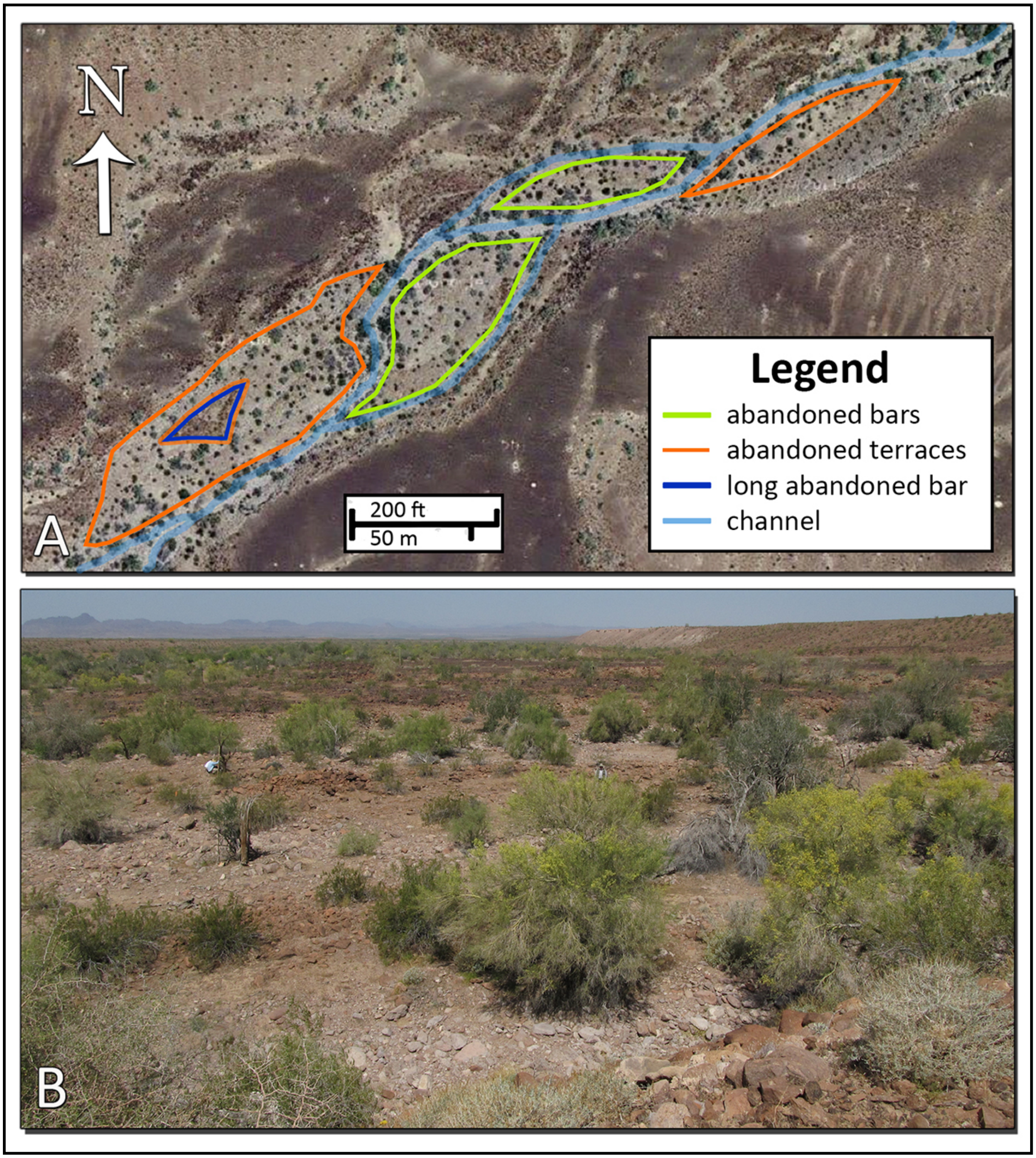

Figure 20. Aerial Google imagery and field observations suggest a small braided reach in Gould Wash HUC at YPG, GBD4 is in a temporally transitional state, such that the multiple threads have begun to incise.

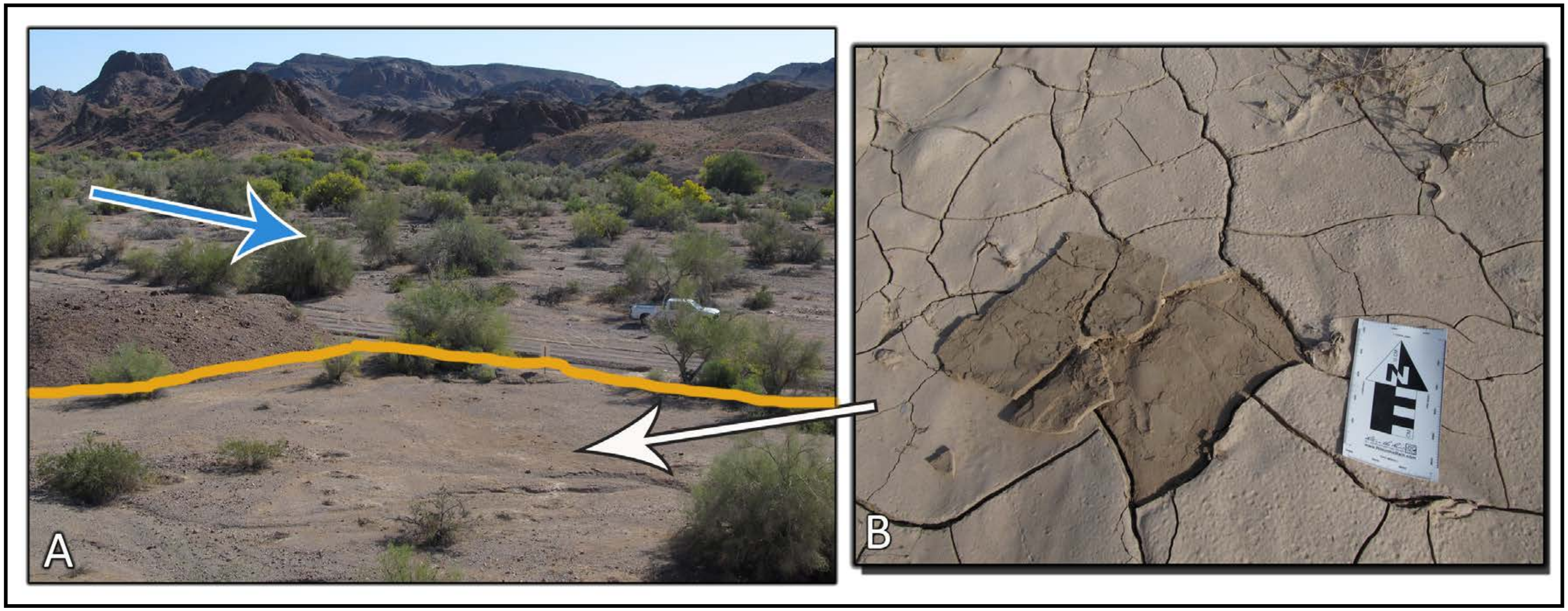

Figure 21. Photograph (A) depicts a truncated fan of fine slackwater deposits present at the mouth of a tributary to Yuma Wash, YPG. The orange line outlines the lateral and terminal boundary of the fine-grained deposits (B) truncated by the braided wash, which flows in the direction of the blue arrow.

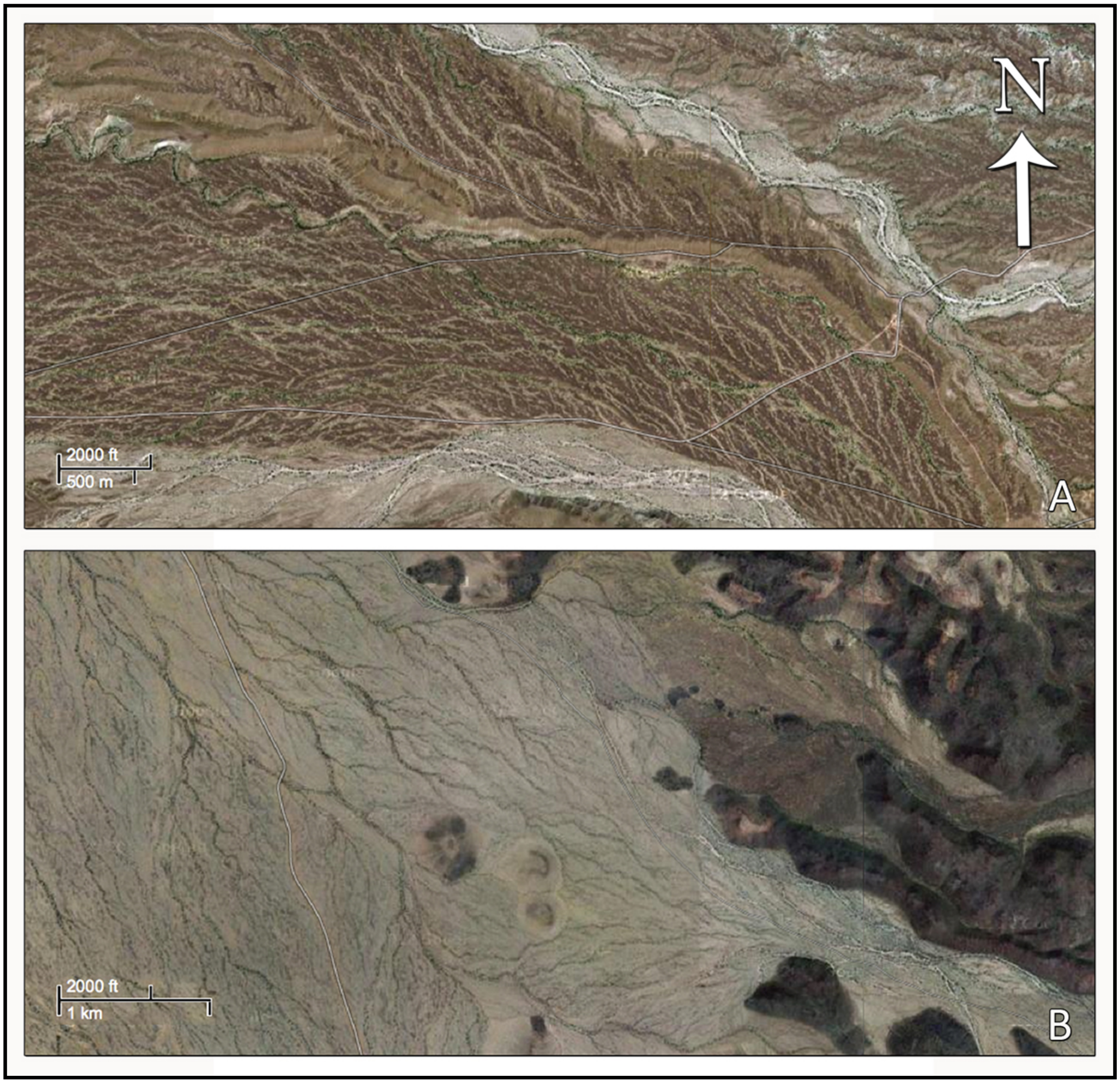

Figure 22. Aerial Google images of YPG (A) and BMGR (B) provide comparison of relative desert pavement development. YPG has much more developed desert pavement, visible as dark orange to brown desert varnished surfaces, compared to BMGR. The lower frame of BMGR (B) depicts little to no desert varnish across the majority of the frame covered by lowland wash surfaces. Bedrock upland surfaces at the right side of the frame show the contrast of dark desert varnish. The lower right corner of frame B reveals a transitional zone occurring at the downstream end of a braided wash (flowing west-northwest), where increased accommodation space results in distributary channels, which later form a tributary network downstream (center of frame B).

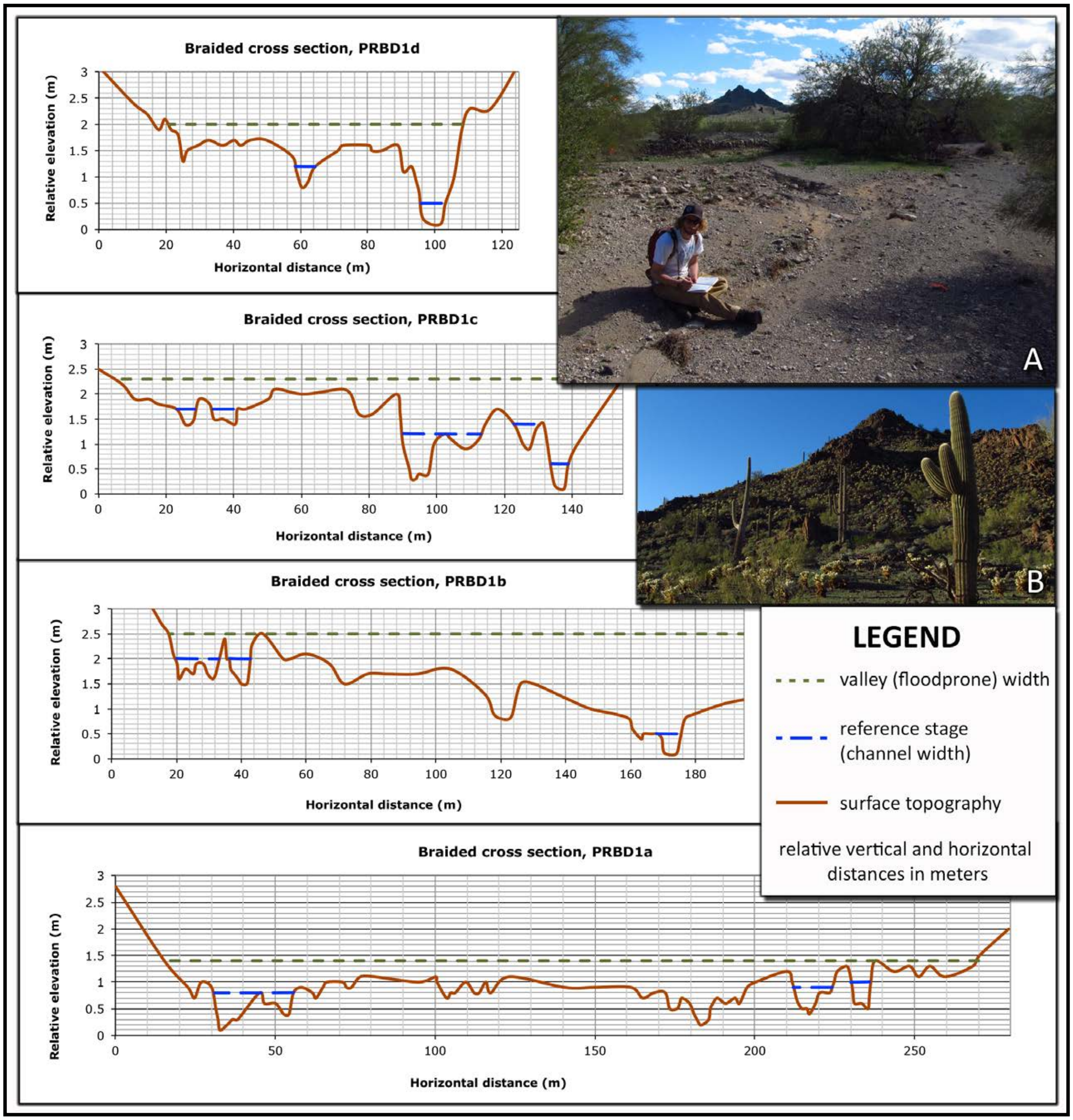

Figure 23. Progressive cross sectional profiles of the braided study reach in Painted Rocks HUC illustrate more highly incised channels beginning upstream (PRBD1d) and a widening of the braided wash with increasing distance downstream toward (PRBD1a). Photographs include views looking upstream along the main stem at PRBD1c (A) and toward the confining upland at river left near PRBD1c (B).

9. TABLES

Table 1. A matrix of coefficients of determination (r^2) between eight variables of channel geometry. Numbers underlined and in bold indicate correlation between variables with significance at the 99% confidence level (p-values < 0.01).

Matrix of coefficients of determination (r2) between variables for 101 study reaches at YPG and BMGR								
	S	W/D	Wv/Wc	τ	d50	τ*	Ω	ω
S		**0.07**	0.03	**0.82**	0.01	**0.55**	**0.25**	**0.66**
W/D	**0.07**		**0.13**	0.06	0.07	0.00	0.02	0.04
Wv/Wc	0.03	**0.13**		0.04	0.00	0.02	0.00	0.01
τ	**0.82**	0.06	0.04		0.03	**0.62**	**0.56**	**0.91**
d50	0.01	0.07	0.00	0.03		0.05	0.00	0.02
τ*	**0.55**	0.00	0.02	**0.62**	0.05		**0.31**	**0.58**
Ω	**0.25**	0.02	0.00	**0.56**	0.00	**0.31**		**0.59**
ω	**0.66**	0.04	0.01	**0.91**	0.02	**0.58**	**0.59**	

Table 2. Results of one-way ANOVA with multiple comparisons and contrasts for tests of differences in means of eight variables among stream type.

One-way ANOVA with multiple contrasts and comparisons for the null hypothesis that means for all stream types are equal (all 101 study reaches)			
	P-values	**F-statistic**	**Number of stream-type groups with significantly different means**
width/depth ratio, *W/D* (m/m)	<0.0001	86.57	4
ratio of valley to channel width, W_v/W_c (m/m)	0.0001	9.32	2
stream gradient, *S* (m/m)	<0.0001	43.54	3
shear stress, τ (Pa)	<0.0001	44.79	3
dimensionless shear stress, τ*	0.0001	8.41	2
median grain size, d_{50} (mm)	0.0796	2.17	-
stream power, Ω (W/m)	<0.0001	44.77	3
unit stream power (n=0.05 or 0.06), ω (W/m^2)	<0.0001	40.10	3

Table 3. Multiple contrasts and comparisons indicate the ability of eight channel characteristics to distinguish stream types. Variables listed in each box of this table are able to distinguish the two stream types associated with that column and row.

Variables with significantly different means between stream types					
	Bedrock (BK)	**Bedrock with alluvium (BA)**	**Incised alluvium (IA)**	**Braided (BD)**	**Piedmont headwater (PH)**
Bedrock (BK)	-	S, W/D, τ, τ*, ω	S, W/D, τ, τ*, ω	S, W/D, τ, τ*, Ω, ω, Wv/Wc	S, W/D, τ, τ*, Ω, ω
Bedrock with alluvium (BA)	S, W/D, τ, τ*, ω	-	W/D	S, W/D, τ, Ω, ω, Wv/Wc	τ, Ω, ω
Incised alluvium (IA)	S, W/D, τ, τ*, ω	W/D	-	W/D, Ω	W/D, Ω, ω
Braided (BD)	S, W/D, τ, τ*, Ω, ω, Wv/Wc	S, W/D, τ, Ω, ω, Wv/Wc	W/D, Ω	-	S, W/D, Ω, ω
Piedmont headwater (PH)	S, W/D, τ, τ*, Ω, ω	τ, Ω, ω	W/D, Ω, ω	S, W/D, Ω, ω	-

Table 4. Results of one-way ANOVA with multiple comparisons and contrasts for tests of differences in means of eight variables among HUC class.

One-way ANOVA with multiple contrasts and comparisons for the null hypothesis that means for all HUCs are equal (all 101 study reaches)			
	P-values	**F-statistic**	**Number of HUC types with significantly different means**
width/depth ratio (*W/D*)	0.812	0.21	-
ratio of valley to channel width, W_v/W_c	0.0222	3.98	2
stream gradient, *S* (m/m)	0.1895	1.70	-
shear stress, τ (Pa)	0.2554	1.39	-
dimensionless shear stress, τ^*	0.6572	0.42	-
median grain size, d_{50} (mm)	0.0352	3.48	2
stream power, Ω (W/m)	0.7801	0.25	-
unit stream power (n=0.05 or 0.06), ω (W/m^2)	0.3849	0.97	-

Table 5. Table of contributing drainage areas for 86 study reaches surveyed at YPG.

Mean drainage area by stream type for 86 study reaches surveyed at YPG	
Stream type	**Drainage area (km^2)**
Bedrock	0.0755
Bedrock with alluvium	0.6789
Incised alluvium	9.5613
Braided	68.0669
Piedmont headwater	0.0802

Table 6. Mean values for eight variables from 86 study reaches surveyed at YPG.

Means for all stream types (86 study reaches at YPG)						
	Bedrock	Bedrock with alluvium	Incised alluvium	Braided	Piedmont headwater	All stream types
width/depth ratio (W/D)	9.4	17.4	36.6	234.8	20.1	53.0
ratio of valley to channel width, W_v/W_c	2.1	2.0	2.9	3.8	3.0	2.7
stream gradient, S (m/m)	0.223	0.039	0.025	0.013	0.048	0.072
shear stress, τ (Pa)	486	106	65	40	47	154
dimensionless shear stress, τ*	2.756	0.499	0.517	0.475	0.370	0.677
median grain size, d50 (mm)	13	14	16	7	9	12
stream power, Ω (W/m)	5415.8	1096.7	1104.8	3273.4	137.83	2119.6
unit stream power (n=0.05 or 0.06), ω (W/m^2)	2084.2	208.5	101.1	47.0	62.2	521.9

Table 7. Mean values for eight variables from 101 study reaches surveyed at YPG and BMGR.

Variable means for all stream types at YPG and BMGR (101 study reaches)						
	Bedrock	**Bedrock with alluvium**	**Incised alluvium**	**Braided**	**Piedmont headwater**	**All stream types**
width/depth ratio (W/D)	11.2	18.6	34.4	243.7	23.8	57.1
ratio of valley to channel width, W_v/W_c (m/m)	2.0	2.0	2.6	4.1	2.9	2.6
stream gradient, S (m/m)	0.229	0.038	0.023	0.013	0.042	0.071
shear stress, τ (Pa)	471	99	60	39	43	146
dimensionless shear stress, τ*	2.941	0.510	0.479	0.557	0.390	0.693
median grain size, d50 (mm)	12	14	15	7	9	11
stream power, Ω (W/m)	4995.3	974.4	960.5	3058.6	122.1	1952.1
unit stream power (n=0.05 or 0.06), ω (W/m^2)	1952.4	191.4	89.0	44.5	54.8	483.2

Table 8. Resulting hit rates for external validation (15 BMGR study reaches) of predictive linear discriminant analyses excluding and including braided channels.

Linear discriminant analysis success rate						
Variables included	**Bedrock**	**Bedrock with alluvium**	**Incised alluvium**	**Braided**	**Piedmont headwater**	**All stream types**
Log transformed without braided reaches						
ω, τ, S, W/D	1.00	0.33	0.33	-	1.00	0.68
Log transformed with braided reaches						
ω, τ, S, W/D	1.00	0.33	0.33	1.00	1.00	0.73

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11. APPENDICES

11.1 *Appendix A*. Raw survey data and coordinates for 101 reach surveys

Table 9. Reach identification codes and nomenclature. Reach identification codes are composed of a consecutive sequence of abbreviations for 1) the HUC in which they are located, 2) the stream type, and 3) an identification number respectively. Reach surveys are listed in this appendix alphabetically as listed below. An example of a bedrock reach in Gould HUC is GBK1

Reach identification codes						
HUC			**Stream type**			**Reach No.**
Gould (YPG)	G		bedrock	BK		The number at the end of the reach code indicates an individual identification for stream types surveyed within the same HUC
Mohave (YPG)	M		bedrock with alluvium	BA		
Painted Rocks (BMGR)	PR		incised alluvium	IA		
Sand Tank (BMGR)	ST		braided	BD		
Upper Midway (BMGR)	UM		piedmont headwater	PH		
Yuma (YPG)	Y					

Table 10. Explanation of abbreviations used in cross sectional survey data tables

Key for raw survey data	
abbreviation used	definition/explanation
D-2-pts	Relative distance between two points is the primary survey method, which includes the relative vertical and horizontal position for each consecutive survey point with regard to the last survey point regardless of the location of the surveyor
Pt-2-pt	Point-to point is a secondary survey method which involves moving the shooting position of the surveyor to each consecutive, preceeding point along the transect. This methods results in relative horizontal and vertical distance from the surveyors eye with regard to the preceeding survey point.
Single point	A secondary survey method such that surveys are conducted from a single point along the cross section
vert (m)	relative elevation of each survey point
hor (m)	relative horizontal position of each survey point
5-m DTM	profile data derived from 5-m resolution digital terrain model in GIS
10-m DEM	profile data derived from 5-m resolution digital elevation model in GIS
DTM and DEM data	horizontal and vertical survey data derived from 5-m digital terrain model (DTM) and 10-m digital elevation model (DEM) are cumulative
2ndary channel	Partial survey conducted along two parallel secondary channel segments within the study reach

Table 11. A key for grain size classes (measured along the b-axis) and abbreviations used.

Pebble count class sizes and key			
Size class	Abbreviation	range (mm)	
clay-to-silt	st		<0.5
sand	sd (fs)	>0.5	<1
coarse sand	cs	>1	<2
fine pebble	fp	>2	<4
medium pebble	mp	>8	<16
coarse pebble	cp	>16	<64
small cobble	sc	>64	<128
large cobble	lc	>128	<256
boulder	B	>256	
organic matter or debris	Org (org)		
woody debris	wood (W)		
bedrock	BK (bk)		

GBA1

GBA1a cross section shooting D-2-pts. starting river right		GBA1b cross section shooting D-2-pts. starting river right		GBA1c cross section shooting D-2-pts. starting river right		GBA1d cross section shooting D-2-pts. starting river right		GBA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-3.2	7.3	-2.6	4.9	-7	19	-13.1	31.4	-0.2	8.4
-2.7	6.9	-0.8	6.6	-1.7	6.3	-1.3	6	-0.7	12
-0.7	1.4	-1.9	3.8	-1.1	1.1	-0.5	2.2	-0.6	8.3
-0.3	0.7	-1.2	2.6	-1.9	4.8	-0.5	1.1	-0.5	7.6
-0.2	0.3	-0.2	0.3	-1.9	3.5	-0.4	1.1	-0.9	2.5
-0.5	0.9	-0.3	0.3	-0.4	0.1	-0.2	1.5	-0.3	8.1
0.3	0.2	-0.2	0.1	-0.2	0.3	0	0.5		
-0.2	0.3	-0.4	-0.1	-0.4	0.1	0.1	0.4		
-0.2	0.3	-0.1	0.2	-0.5	0.7	-0.1	0.2		
-0.4	0.2	0.2	0.8	-0.1	0.8	-0.1	0.4		
-0.1	0.2	-0.1	0.7	0	0.7	0.2	0.1		
-0.4	0.3	0.1	0.6	0.1	1	0	0.6		
0	0.2	0.3	0.4	0.3	0.4	-0.2	0.3		
0.1	0.2	1	1.5	0.1	0.5	-0.1	0.9		
0.4	-0.1	0.5	1	0.6	0.8	0.1	0.4		
0.3	0.1	1.2	5.5	0.5	1.4	0.1	0.3		
0.1	0.3	2.6	11.5	0.1	2.1	0.4	0.6		
0.4	0.2	9.4	26.7	1.3	29.2	0.8	1.2		
0.9	1.3	19.6	39.3	18	41	1	1.7		
0.5	1.2	8	14			2.5	9.3		
0.5	1.3					4.7	9.9		

GBA1 Pebble Count conducted every 1/2m along all 4 cross sections																	
Bk	cp	cp	mp	cp	cp	mp	mp	mp	cp	fp	bk						
mp	fp	fp	mp	cp	fp	fp	cp	cp	cp	fp	sd						
Bk	cp	cp	cp	mp	cp	bk	Bk	Bk	cp	mp	fp						
sc	fp	fp	mp	sc	mp	sc	fp	fp	fp	fp	fp						
fp	cp	cp	fp	fp	mp	sd	cp	cp	st	cp	cp						
mp	cs	sc	cp	cp	mp	cp	sc	sc	sd	fp							
sc	bk	mp	cp	lc	mp	cp	fp	fp	cp	cp							
sc	mp	fp	mp	fp	fp	sd	cp	cp	cs	cs							
fp	sc	cp	cp	fp	fp	mp	sc	sc	cp	cs							
Bk	cp	cp	lc	cp	lc	bk	lc	lc	fp	cs							

GBA2

GBA2a cross section shooting D-2-pts. starting river right		GBA2b cross section shooting D-2-pts. starting river right		GBA2c cross section shooting D-2-pts. starting river right		GBA2d cross section shooting D-2-pts. starting river right		GBA2 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1.1	3	-1.4	2.7	-0.5	0.9	-3.8	8.2	-0.6	16.2
-0.7	0.6	-0.8	1.3	-1.2	1.5	-1.3	3.9	-0.3	10.1
-0.7	0.2	-0.7	0.7	-0.7	0.3	-0.2	0.5	-0.5	8.5
-0.3	0.1	-0.3	0.7	-0.7	0	-0.7	0.5	-0.7	9.1
-0.2	0.2	-0.3	0.1	-0.2	1	-0.4	0.5	0	10.2
-0.3	0.2	-0.2	0.3	-0.3	0.3	-0.4	0.3	-0.6	11.7
0.2	1.1	-0.2	0.4	-0.2	0.7	-0.2	0.1	0.1	8.2
0.1	1	-0.2	0.1	-0.1	0.6	-0.2	0.4	-0.3	14.2
0	0.6	-0.1	0.3	0	0.9	-0.1	0.4		
0.1	0.6	-0.3	0.9	0	0.6	-0.2	0.6		
0.2	0.4	0.1	0.4	-0.2	0.8	0	1.4		
0.3	1	0	1	0.2	0.7	0.1	0.8		
0.6	1	0	0.7	0.2	0.3	0.2	0.4		
0.2	0.8	0.1	0.4	0.1	0.3	0.2	0.3		
1.8	2	0.1	0.5	0.2	0.2	0.1	0.7		
2.6	4.3	0.1	0.4	0.8	1.3	0.2	1.1		
		0.1	0.3	0.6	1.4	0.7	1.6		
		0.3	0.2	1.5	2.4	0.3	0.6		
		0.1	0.8	4.1	7.6	1.5	1.5		
		0.3	0.8			1.8	3.6		
		0.2	0.1						
		0.7	1.8						
		1.6	2.5						
		2.6	3.1						
		6.1	10.1						

GBA2 Pebble Count conducted every 10 cm																	
fp	cs	sd	fp	mp	fp	cp	fp	fp	cp	cp	fp	sc	fp	sc			
cp	mp	fp	cp	cp	fp	fp	sc	sc	Bk	mp	fp	cp	fp	mp			
mp	fp	sc	cp	mp	cp	cp	mp	mp	cp	cp	Bk	lc	sc	cp			
mp	cp	mp	fp	cp	cp	cp	mp	mp	cp	fp	cp	Bk	Bk	cp			
fp	sc	sc	sc	sc	mp	cp	cp	cp	fp	mp	Bk	cp	sd	cp			
sd	fp	mp	mp	mp	sd	cp	fp	fp	Bk	cp	sd	lc	Bk	fp			
cp	fp	cp	fp	fp	cp	cs	fp	fp	mp	mp	cp	lc	lc				
mp	sc	mp	mp	cs	cp	sc	Bk	Bk	mp	sd	Bk	Bk	Bk				
mp	cp	fp	cp	cp	mp	mp	mp	mp	sc	fp	cp	cp	cp				
sd	sd	Bk	sd	cp	fp	cp	mp	mp	Bk	lc	Bk	lc	fp				

GBA3

GBA3a cross section shooting D-2-pts. starting river right		GBA3b cross section shooting D-2-pts. starting river right		GBA3c cross section shooting D-2-pts. starting river right		GBA3d cross section shooting D-2-pts. starting river right		GBA3 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.3	4.3	-1.5	1.2	-2.3	3.3	-0.8	2.6	-0.9	22.6
-0.5	1.3	-1.4	1.8	-1	1	-1	2.8	-0.2	23.5
-0.8	1.8	-0.4	2.1	-0.4	2.1	-0.3	1.3	-1	21.6
-0.9	0.8	-0.5	0.7	-0.3	0.9	-0.3	0.6	-0.4	21.9
-0.2	0.8	-0.1	0.5	-0.3	0.5	0.1	0.3	-0.9	17.3
-0.5	0.6	-0.2	0.4	-0.5	0.5	0.3	1		
0	0.9	-0.2	0.3	-0.4	0.5	0	0.5		
-0.1	0.1	-0.3	0.3	0.1	0.2	-0.3	0.4		
0	1.3	-0.3	0.4	-0.2	1.2	0	0.3		
-0.4	0.9	0.1	0.8	-0.1	0.5	-0.1	0.2		
-0.1	1.8	0.1	0.5	0.1	1.3	-0.6	0.4		
0.1	0.8	0.2	0.4	0.1	0.9	-0.1	0.3		
0	0.5	0	0.4	0	0.5	0.1	0.3		
0.2	0.3	-0.2	0.2	0.1	0.9	0	1.1		
0.3	0.8	0	0.5	0.2	0.6	-0.1	1		
0	0.3	-0.1	0.5	-0.3	0.6	-0.2	1.2		
-0.1	0.2	0.2	0.6	-0.1	0.9	0	0.5		
0	2	0.2	0.2	0.1	0.6	0.4	0.1		
0.2	0.9	-0.1	1.5	0.2	0.1	0.1	0.7		
-0.1	0.3	0.3	1.6	0.9	2.9	0.3	0.7		
0	0.8	2	1	1.2	2.6	0.1	0.4		
0.3	0.8	0.8	1.9	2	4.2	0	1		
0.6	1.2			0	3.9	0.4	1.1		
0.2	1.2					1.7	3.2		
0.4	0.4					1.2	2.1		
0.6	2.6					0.3	0.5		
0.1	1.9					0.2	2.7		
-0.2	4								

GBA3 Pebble Count conducted every 10 cm																	
fp	cp	B	fp	fp	lc	cp	mp	mp	cp	mp	lc	B	sc	sc	sc		
cp	fp	cs	lc	mp	cp	lc	lc	lc	lc	sc	lc	B	B	lc	cp		
fp	B	B	sc	fp	sc	fp	mp	mp	sd	sd	mp	fp	st	sc	cs		
B	fp	B	mp	fp	sd	mp	B	B	cp	mp	B	cp	fp	fp	lc		
mp	cp	fp	cp	sd	cp	cp	fp	fp	fp	fp	mp	cp	cp	B	lc		
fp	fp	fp	mp	fp	B	cs	cp	cp	mp	fp	lc	sc	sc	B	cs		
mp	fp	B	mp	fp	sd	mp	fp	fp	lc	cp	cp	sd	cp	cp			
cp	cp	fp	cp	fp	fp	B	cs	cs	sd	cs	cp	mp	st	fp			
fp	fp	cp	cs	fp	sc	sc	fp	fp	fp	fp	cp	fp	mp	fp			
fp	lc	sc	B	fp	cs	cp	lc	lc	cp	fp	fp	sc	fp	sc			

GBA4

GBA4a cross section shooting D-2-pts. starting river right		GBA4b cross section shooting D-2-pts. starting river right		GBA4c cross section shooting D-2-pts. starting river right		GBA4d cross section shooting D-2-pts. starting river right		GBA4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-3.5	6.6	-24.6	38.2	-7.6	12.3	-12.9	37.7	-0.4	24.5
-1.4	2.8	-3.2	5.9	-2.2	5.1	-4.6	4.7	-0.9	9.5
-0.5	1.8	-1.1	2.6	-2.1	3.1	-1	1.7	0	13.3
0	1.7	-0.5	0.7	-0.1	1.7	0.3	0.3	-1.2	21.4
-0.2	0.7	-0.3	1.2	-0.5	0.7	0.3	0.3	-0.1	4.3
-0.1	1.5	0	1.6	-0.1	2	0	0.6	-0.6	12.9
-0.3	0.5	-0.1	1.4	0.6	1.2	-0.3	0.5	-0.2	8.2
0	1.4	0.2	0.8	0.1	0.6	0	1.1	-0.1	20.1
0.2	0.3	-0.2	0.8	-0.3	0.8	0	1	-1	29.2
-0.1	0.4	0.3	0.7	0.2	0.9	0.6	0.7	-0.3	11.8
0.1	0.4	-0.1	0.9	-0.3	1.3	0.1	0.6	-0.7	22.7
-0.2	0.3	-0.1	0.3	0	1.8	-0.2	0.6		
0	0.5	-0.1	0.6	0.4	0.8	0.1	2.2		
0.1	0.2	0.5	0.5	0.3	1	0.2	0.2		
-0.1	0.2	-0.3	0.8	0.2	2.1	-0.1	2.1		
-0.1	0.7	0	0.9	0.3	3.9	0.2	1.8		
0.1	0.7	0.1	0.8	-0.1	2.7	0.6	7.9		
0.2	0.7	0.2	0.5	0.6	3.3	-0.4	3.9		
-0.2	0.7	0.1	1.3	4	8.6	0.2	5.5		
0.2	0.4	0.1	0.4			4.3	15.1		
0.2	0.5	0.1	0.8						
0.6	1.2	0.5	0.9						
0.2	1.4	3.7	5.4						
0.2	2.6								
0.2	3								
0.9	2.4								
-0.1	5.8								
0.5	1.8								
0.2	4.5								
2.3	4.1								
3.8	6.2								

GBA4 Pebble Count																	
sd	B	B	mp	fp	mp	Bk	Bk	Bk	fp	cp	cp	sc	mp	cp	sc		
sc	B	fp	sd	fp	mp	Bk	cp	cp	Bk	fp	cp	fp	cp	cp			
cp	mp	cp	lc	fp	cs	Bk	mp	mp	sc	lc	mp	sc	sc	sc			
B	sc	lc	cp	B	sc	Bk	cp	cp	mp	sc	cp	mp	cp	fp			
cp	cp	sc	sc	mp	sc	mp	cs	cs	cp	mp	cp	sc	cp	fp			
sc	B	lc	fp	mp	fp	Bk	sc	sc	fp	cp	sc	fp	cp	sc			
cp	fp	cp	cp	cp	fp	cp	Bk	Bk	mp	cp	Bk	fp	Bk	fp			
sc	sc	cp	fp	fp	sd	Bk	sc	sc	fp	mp	fp	cp	cp	fp			
sd	mp	B	lc	sc	cp	Bk	mp	mp	sd	sc	fp	sd	cp	cs			
B	mp	fp	cs	B	Bk	mp	cp	cp	cp	cp	lc	cp	sc	mp			

GBA5

GBA5a cross section shooting D-2-pts. starting river right		GBA5b cross section shooting D-2-pts. starting river right		GBA5c cross section shooting D-2-pts. starting river right		GBA5d cross section shooting D-2-pts. starting river right		GBA5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-2.5	10.7	-1.1	2.6	-1.1	6.6	-2.1	9.4	-0.5	13.9
-1.1	4.8	-0.5	2	-0.8	4	-0.7	3.3	0	5.4
-0.4	1.4	-0.3	2	-0.2	1.3	-0.4	1.7	-0.9	6.4
0	0.9	-0.4	1.2	-0.3	0.8	-0.2	0.3	-0.8	11.4
0	0.8	0.2	0.9	-0.1	0.8	0	0.6	0.2	1.3
-0.1	0.8	0.2	0.4	-0.2	1.2	-0.2	0.1	-0.6	12
-0.2	0.7	1.8	4.3	-0.2	0.3	-0.1	0.4	-0.2	8.1
-0.1	0.7	2.7	8.2	0	0.8	-0.3	0.3		
0	0.5	1	3.1	0.2	0.4	0.1	0.4		
0.1	0.3			0.1	0.1	0.3	0.3		
0.4	1.1			0	0.3	-0.1	0.6	GBA5 Valley/piedmont slope derived from 5-m DEM	
0.9	2.8			-0.1	0.1	0.1	0.6	Vert (m)	Hor (m)
4.2	20.9			0.1	0.7	0.3	1.3	274.55	0
				-0.1	0.4	1.2	4.6	273.71	41.25
				0.3	0.8	2.9	14.9	273.79	68.64
				0.9	3				
				3.3	13.3				

GBA5 Pebble Count conducted every 10 cm between GBA5a & b																	
cp	fp	fp	cp	cp	cp	fp	mp	mp	cp	cp							
sd	mp	mp	cp	cp	cp	fp	fp	fp	sc								
mp	fp	mp	sd	cp	mp	fp	cp	cp	mp								
mp	cp	fp	cp	cp	fp	fp	cp	cp	fp								
mp	cp	cp	fp	fp	fp	sc	cp	cp	cs								
sc	fp	fp	cp	cp	fp	cp	cp	cp	cp								
fp	fp	fp	cp	mp	fp	fp	sc	sc	fp								
sc	cp	fp	mp	Bk	st	mp	sc	sc	cp								
fp	fp	sc	cs	Bk	cp	mp	fp	fp	fp								
fp	mp	lc	cs	fp	cs	cp	fp	fp	fp								

GBA6

GBA6a cross section shooting D-2-pts. starting river right		GBA6b cross section shooting D-2-pts. starting river right		GBA6c cross section shooting D-2-pts. starting river right		GBA6d cross section shooting D-2-pts. starting river right		GBA6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-2.3	3.9	-2.8	5.6	-2.2	4.2	-2.7	5.9	-0.4	7.3
-2.6	1.3	-3.2	4.3	-1.4	2.1	-4	9.9	-0.3	6.6
-0.4	0.5	-2.1	3.8	-1.8	2.8	-3.1	5.5	-0.1	4
-0.2	0.5	0.2	0.4	-1.1	0.9	-1.3	1.6	-0.4	3.2
0	0.9	0	0.4	-1	1.3	-0.8	0.5	0.1	6.4
-0.3	0.4	-0.5	0.2	-0.2	0.5	-0.2	2	-0.7	2.1
-0.4	0.8	0	0.2	-0.4	0.3	-0.1	0.4	0.1	2.8
0	1.1	-0.3	0.1	0.1	0.6	-0.4	0.6	-0.3	1.4
0.1	0.6	-0.2	0.5	-0.1	0.2	0	0.2	0.1	3.8
0	0.8	0.1	0.3	0.1	0.4	-0.2	0.2	-0.3	3
0.1	0.2	0	0.3	0.1	0.1	0	0.3		
0.2	0.3	0.2	0.1	0	0.3	0.4	0.4		
0.2	0.7	0	0.5	0.2	0.2	-0.2	0.2		
0.5	0.5	-0.2	0.3	0	0.5	-0.2	0.5		
0.6	1	0	0.3	0	0.7	0.4	0.8		
-0.7	4.2	0.4	0.3	0.1	0.7	0.3	0.9		
0.3	3.9	0	0.7	0.8	1.6	0	0.4		
		0.3	1.7	-0.2	2.8	0.2	0.8		
		0.2	2.8	0.2	3.8	0.2	0.2		
		-0.1	2.3	0.9	1.1	0	1.7		
		0.6	1.5	0.3	2	0.3	0.9		
		0.8	3.5	0.7	7	-0.2	1.9		
		-0.3	6.5	2.5	9.2	0.6	0.9		
						3.1	6.2		

GBA6 Pebble Count conducted every 10 cm																	
cp	sc	fp	mp	cp	mp	cp	lc	lc	cp	cp	mp	fp	sc	cp			
cp	fp	cp	fp	mp	cs	cp	sc	sc	mp	mp	B	cp	mp	cp			
mp	cp	cp	fp	fp	cp	fp	fp	fp	lc	cp	sc	fp	cp				
cp	cp	cp	cp	fp	fp	mp	sc	sc	fp	sc	fp	mp	cp				
mp	mp	mp	fp	mp	mp	cp	fp	fp	sc	cs	cp	fp	mp				
cp	cs	cp	mp	cp	cs	fp	B	B	B	mp	mp	fp	mp				
sc	fp	mp	fp	mp	mp	sc	cp	cp	B	B	cs	mp	cs				
cp	cp	fp	cp	cs	fp	lc	mp	mp	B	cs	B	cp	cp				
sd	cp	mp	cp	cp	fp	lc	cp	cp	fp	fp	lc	mp	fp				
cp	cp	cp	mp	fp	cs	cp	fp	fp	cp	sc	cs	fp	fp				

GBD1

GBD1a cross section shooting D-2-pts. starting river right		GBD1 survey continued from previous column		GBD1b cross section shooting D-2-pts. starting river right		GBD1c cross section shooting D-2-pts. starting river right		GBD1d cross section shooting D-2-pts. starting river right		GBD1d survey continued from previous column	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	10	0	0	0	0	0	0	-0.4	1.8
0	8.2	-0.9	3.7	-0.6	2	-0.2	15	-0.8	4.7	0.2	2.6
-0.6	1.9	0.1	2.7	-1.2	0.7	-1.2	1.7	-0.2	5.3	0.8	4.4
-1.2	2.5	-0.1	2.3	0	4.2	-1	2.4	-1	2.1	0	8.7
-0.8	1.6	0.3	3.1	0.7	5.6	-0.3	1.9	-0.4	0.2	-0.2	5.5
-0.1	1.3	0	2.2	0.1	2	0.2	3.3	-0.3	0.1	0	7.5
0	3.5	-0.1	1.6	-0.2	1.4	0.1	1.2	-0.3	2.7	-0.3	3.1
0.5	2.7	0.2	4.3	-0.6	1.3	0.4	2.2	0.1	3.8	0	13
-0.2	2.1	-0.2	3.2	0	1.3	0.1	10.1	0.3	2.3	-0.2	8.4
0.1	3.5	0.1	2.1	0.5	1.4	-0.1	6.6	0	3.4	-0.6	2.7
0.2	5.7	0.1	2.7	0.1	1	0.1	13.5	0.2	0.5	-0.1	1.3
-0.2	1.7	0.2	3.8	0.1	1.4	-0.5	7.2	0	4.2	0.3	1.5
0.2	1.9	-0.1	3.7	0.6	2.8	0.1	4.1	-0.1	3.8	0	3.6
-0.1	5.3	0.1	4	-0.1	3.2	-0.1	2.2	0.5	3.1	0	3.2
-0.1	4.1	0	3.2	0	3.3	-0.2	0.9	-0.6	2.6	-0.2	2.3
0	5.7	-0.1	2.9	0	3.5	0	2.1	-0.2	3.8	0	6
-0.1	3.5	-0.3	0.9	-0.3	7.9	0.2	0.7	-0.1	2.4	0.2	2.1
0.2	5.8	-0.3	1.1	-0.5	5	0	4.7	-0.3	1.3	-0.3	6.1
0.5	5.5	0	2.3	-0.6	2.2	-0.4	4.7	0.3	4.4	0.3	2.3
-0.1	3	-0.2	1.1	0.4	2.7	0.1	1.3	-0.6	2.8	0	3.4
-0.4	2.7	-0.1	4	-0.2	1.2	0.2	6	0.2	4.2	0.1	4.4
0.1	1.1	0.4	1.2	-0.3	1.1	-0.1	4.5	-0.4	1.6	-0.2	4.8
-0.3	1.4	0.1	4.9	-0.2	3.3	0.1	5.6	0.3	1.8	-0.4	1.3
-0.1	1.4	-0.3	1.7	-0.1	4.7	-0.3	6.2	-0.1	4.6	0.1	7
0.3	1.9	-0.1	4.2	0.2	5.7	0.1	5.6	0	2.5	-0.2	5.1
0	1.6	0.1	5.7	0.6	3.3	0	7.3	-0.5	2.6	0.5	4.3
-0.2	2.2	0	3.7	0.3	7.4	0	7.3	0	2.6	0.1	2.9
-0.4	0.7	-0.2	2.4	-0.3	5.3	-0.3	7	-0.2	3.3	0.1	2.6
0	3.3	0.4	1.9	0.2	6.9	-0.4	8.9	0	1.5	-0.3	1.5
0.4	1.3	-0.2	1.9	-0.1	4.3	0.3	6	0.5	2.3	0	1
0	0.9	0	2.4	-0.1	7.6	-0.4	2.8	-0.2	3.7	0.2	0.7
0.2	2.1	0.4	1.3	0.6	11	-0.1	10.3	-0.2	3.9	0.6	1.5
0.1	4.9	-0.3	5.9	-0.4	3.9	0.2	2.6	-0.3	1.4	0	3.2
0	2.9	-0.1	6.6	-0.9	2.8	-0.1	2.9	-0.2	4.2	0.1	11.6
-0.1	1.6	-0.1	5.5	0	1.8	0.2	4.3	0.7	0.8	-0.1	18.3
-0.4	1.8	0.1	0.9	0.3	1.2	-0.2	7	-0.2	5.1		
-0.1	2.3	-0.1	8.5	0.1	3.4	-0.2	1.7	0.3	5.1		
0	5.3	-0.1	9.9	-0.1	8.4	0	3.2	-0.2	5.4		
0	3.7	0	5.6	0.6	1.6	0.3	2.6	0.1	7.3		
-0.1	0.7	-0.1	6.3	-0.2	14.3	0.2	7.5	-0.3	7.1		
-0.4	2.1	0.1	5.4	-0.4	7.9	-0.3	1.3	0.1	6.8		

-0.1	2.2	0.3	2.6	0.2	2.4	0.1	5	-0.6	3.3		
0	3.4	-0.3	5.6	-0.3	2.8	-0.3	1.4	-0.1	3.9		
0.3	2.3	-0.3	4.7	-0.1	2.3	0	1.6	0.5	2.2		
-0.3	3.3	-0.5	2.5	-0.2	2.7	0.3	3.2	-0.4	7.7		
-0.1	1.3	0	4.8	-0.1	1.7	-0.1	8	-0.4	8.7		
0	1.1	-0.2	4	0.2	3.3	-0.2	1.2	0	6.3		
0.2	2	0.3	0.8	0.3	1.2	-0.3	2.8	-0.2	4.6		
0.1	3.2	0.4	0.6	0.3	4.9	-0.1	2.9	-0.8	3.2		
-0.1	1.9	0.3	4	0	7.9	0.2	0.9	0.2	1.7		
-0.1	3.7	0.3	5.7	-0.3	1.8	0.1	5.5	0	10.1		
0	4.4	0.8	19	0	3.6	-0.3	2.7	0.4	4.7		
0.1	4.6	0.3	9.9	0.3	10.3	0.8	4	-0.4	5.2		
0	2.3			-0.3	9.2	-0.2	4.7	-0.3	3.4		
-0.4	1.8			0.1	11.7	-0.3	1.3	-0.3	0.5		
-0.2	1.7			-0.3	6	-0.1	2.3	0.2	3.2		
-0.3	1.2			0.2	10	0.2	1.9	-0.1	4.6		
0	2.8			-0.2	8.7	-0.3	4.1	0.2	2.2		
-0.3	1.8			-0.2	11.9	-0.3	1.5	-0.2	1.7		
0.1	3.8			-0.3	6.1	-0.2	6.8	-0.1	3		
0	3.2			0.6	9	0.1	5.9	-0.3	6.4		
0.2	1.5			-0.4	6.8	-0.4	1.7	0.1	4.2		
0.1	1.9			-0.5	1.9	-0.2	6	0.4	3.3		
-0.2	1.5			-0.1	3.1	0.2	1.2	-0.1	11.4		
0	1.2			-0.3	0.4	-0.2	4.4	-0.4	6.3		
0.2	1			0.2	3.3	-0.2	3	0.3	2.5		
0	1.8			0.3	1.5	0	3.3	-0.1	8.5		
-0.2	10.8			0.1	2.6	-0.1	1.4	-0.1	2.1		
-0.1	2.5			-0.3	2.1	0.1	3.2	0.2	5.4		
-0.2	1.3			0.1	6.2	-0.1	2	0.1	6.9		
0.3	2.1			0	3.1	0.5	1.8	-0.3	5.4		
-0.1	5.1			0.2	1.6	-0.5	7.7	0	8.6		
0.1	3.8			-0.2	1.7	0.3	4.1	-0.3	3.4		
-0.1	2.3			0.2	2.1	-0.4	3.3	0.4	3.2		
-0.3	1.1			0.1	4.2	-0.1	1.7	-0.1	7.2		
0	2.2			0	3.7	-0.2	0.9	-0.1	7.2		
-0.1	4.1			-0.3	2.6	0.2	1.5	-0.3	5.4		
0.1	3.1			-0.1	2.1	0.3	3.4	-0.3	1.9		
-0.2	3.5			-0.3	3.2	0	3.8	-0.1	1.9		
0.2	1.5			-0.2	0.5	-0.4	6.5	-0.3	1.9		
0.1	1.9			-0.1	5.7	-0.5	1.8	0	5.2		
-0.3	1.3			-0.2	4.5	0.1	1.1	0.5	1.2	GBD1 longitudinal profile 5-m DTM	
-0.1	1.7			0.5	0.9	0.2	1.1	0.5	0.5		
0.1	2.8			0.2	1.4	-0.2	2.2	0.1	3.8		
0.2	2.8			0.2	2.8	0.2	5.2	-0.2	1		
0.2	6.7			-0.1	3.8	-0.2	6	-1	2.1		
0.3	3.3			0	4.1	-0.4	4.2	-0.1	2.9		
-0.7	3.3			-0.4	3.7	0.2	2.5	0.2	3	Vert (m)	Hor (m)
0.5	2.8			0	2.7	-0.1	3.6	0.1	3.2	281.69	0
-0.5	4			0.1	6.9	-0.4	4.1	-0.1	4.2	279.19	280.23
0	2.3			-0.1	3.7	0	3.3	-0.2	2.2	278.19	419.14

0.3	2.3			0.3	2.6	-0.2	1.9	0.1	3.9	275.85	619.36
-0.5	1.8			0.5	1.3	-0.4	1.3	0.2	4.7	274.34	741.1
0.2	4.5			0	1.4	-0.1	2.7	0.4	3.1	270.65	1211.71
0.1	5.3			0.1	3	-0.2	1.3	0.1	6.8	269.84	1435.95
0	5.4			-0.2	6.9	0	2.9	0	7.8	265.31	1856.93
0.1	2.6			0	3.6	0	5.5	0	11.6	264.16	2047.64
-0.2	2.9			-0.5	7.9	1	-0.1	0	11	261.36	2368.54
0.2	10.3			0.1	2.9	0.9	0.3	-0.8	3.8	258.14	2654.06
-0.5	9.3			-0.3	3.3	1.1	3	0.2	1.5	256.33	2823.39
0.3	2.4			0.3	3.9	0.3	13.8	-0.1	4.6	254.41	3010.46
-0.2	1			0	4.3			-0.4	2.9		
0.1	8.4			-0.4	10.4			0.1	3.5		
0	2.2			-0.2	1.8			0.4	2.4		
-0.5	4			0.1	9.1			0	8.7		
0.5	3.6			0	16.9			-0.1	7.5		
-0.3	5.5			0.7	5.2			-0.3	3.9		
-0.4	7.6			0.3	6.6			-0.5	3.1		
-0.4	5.5			1.3	14.2			0.3	1.1		
0.6	2.9			0.3	5.9			0.1	2.3		

GBD1

GBD1 Pebble Count conducted every 20 cm																	
sd	fp	fp	cp	cs	mp	fp	cs	cs	fp	cp	st	fp	mp				
sc	mp	fp	sd	cp	mp	fp	mp	mp	cs	mp	cs	st	mp				
mp	fp	mp	fp	cp	cp	sd	cp	cp	cp	cs	cp	cp	cp				
mp	fp	sd	sc	cp	fp	cp	sd	sd	sd	mp	st	fp	sd				
sd	cp	cs	mp	sc	mp	sd	fp	fp	fp	sc	mp	cp	sd				
sd	cs	mp	cp	cs	sd	sd	sd	sd	fp	st	sd	sd	sc				
fp	fp	mp	sd	cp	mp	cp	fp	fp	cs	mp	cp	fp	fp				
st	cp	cp	cp	mp	sd	cs	cp	cp	sd	sd	cp	fp	st				
mp	cs	sc	cp	cp	cp	cp	fp	fp	fp	sc	st	fp					
cp	fp	mp	mp	sd	sd	fp	sd	sd	cs	cp	fp	st					

GBD2

GBD2a cross section shooting D-2-pts. starting river right		GBD2b cross section shooting D-2-pts. starting river right		GBD2c cross section shooting D-2-pts. starting river right		GBD2d cross section shooting D-2-pts. starting river right		GBD2 longitudinal profile derived from 5m DTM	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	202.06	0
0.1	15.7	0.1	16.6	0.3	14.2	0.6	28	198.97	286.19
-0.2	6.1	-0.1	3.3	-0.2	2.6	-0.1	3.6	196.89	455.04
-0.5	3.8	-0.7	8.3	-0.3	2	-1.1	1.1	194.26	789.1
-0.7	2.4	0.2	10.2	-0.8	2.1	-1.2	1.4	191.44	1056.07
-0.4	2.6	-0.3	2.5	-1	2.3	-1.3	0.1	189.68	1295.38
0	2.1	-0.6	3.1	-0.5	5.5	-0.4	1.2	187.25	1429.27
-0.6	2.7	-0.5	5.5	0.5	9.2	-0.1	4.3	187.4	1579.03
-0.1	2.2	0.4	2.3	0.2	13.1	-0.1	3.3	184.6	1753.7
0.2	1	0.2	3.4	-0.2	3.6	0.3	1	182.69	1897.46
0.7	2.7	0.6	5.6	0.9	1.3	-0.2	0.7		

-0.1	2.5	0.1	6.2	0	1	0.1	1.2		
-0.1	2.2	-0.3	7.7	0.3	2	0.1	0.9	Valley/piedmont slope 5m DTM	
0.3	1.3	0	9.2	-0.1	2.4	0.2	0.7		
0.1	2	-0.5	13.1	0	8.5	0.2	5.2		
-0.2	4.1	-0.3	12.2	-0.1	4.8	0.3	2.4	Vert (m)	Hor (m)
0.1	8.4	-0.3	1	0	5.9	-0.1	2.9	201.5	0
-0.2	3.4	0	5.1	0.2	7.7	-0.3	1.3	196.7	494
0.2	7.3	-0.9	5.6	0.1	5.6	-0.1	4.3	192.2	997.6
0	5.3	0.2	1.8	0.2	2.7	0	5.7	186.4	1553.5
-0.4	1.7	-0.1	3.8	0.1	2.6	0.2	1.4		
0	1.4	-0.4	3.3	-0.3	1	-0.4	1.3		
0.3	1	0.5	5.9	-0.1	2.6	0	0.8		
-0.3	5.8	0.4	16.8	0.5	5.4	-0.2	1		
0.3	2.1	-0.5	5.6	-0.1	2.7	0	1.4		
0.1	4.9	0.2	10.8	0.1	5.5	0.2	0.8		
-0.2	2	-0.2	7.6	-0.4	5.1	0.2	2.6		
0.2	7.5	0.2	7.4	-0.3	3	-0.1	2.8		
0	8.5	-0.4	10	0.1	6.5	0.6	2.1		
-0.2	9.1	0.2	9.8	0.3	9.3	-0.3	1.4		
-0.1	7.7	-0.1	6.1	-0.2	3.6	0.1	4.3		
-0.1	3.6	-0.2	1.4	-0.5	0.2	-0.1	1.1		
-0.2	1.5	-0.2	2	-0.5	1.3	0.6	5.1		
-0.1	2.8	-0.2	1.2	0.1	5.8	0.1	10.1		
-0.3	3.7	-0.3	6.9	-0.2	5.2	-0.1	9.5		
-0.1	7	0.2	2.4	-0.2	7.6	-0.1	8.2		
-0.1	3.3	-0.2	3.9	0.2	8.5	-0.1	6.9		
0	3.4	0.2	15	-0.2	7.8	-0.3	1.3		
0	3.6	-0.3	3.8	-0.4	5.9	-0.1	2.5		
0.4	2.4	0.1	6.5	0	3.3	0.2	2.2		
-0.2	2.1	-0.2	5.3	0.4	4	-0.2	2.5		
-0.2	3	0.3	3.2	-0.1	5	-0.3	0.7		
0.1	2.3	-0.4	3	-0.2	6.6	-0.1	1.9		
0	5.8	-0.2	2.5	-0.2	3.4	0.3	0.7		
-0.1	4	0	3.2	-0.3	2.8	0	8.3		
0.1	3.6	0.2	9.1	0	3.9	0.1	3.8		
-0.5	6.3	0.1	10.4	0	5.5	0.1	2.5		
0.2	3.7	-0.1	5.7	0.5	1.5	-0.3	3.1		
0	7.9	-0.1	4.1	-0.1	3.4	-0.3	1.2		
-0.4	8	-0.1	1.7	0.3	3.5	0	1.5		
0	2.6	-0.1	0.7	-0.2	10.1	0.3	1.5		
0.2	1.5	-0.3	0.6	-0.1	7.7	-0.3	3.8		
-0.1	8.8	-0.1	0.6	-0.3	3.8	0.2	2.8		
0	6.2	0.1	3.5	0.4	3.6	-0.3	0.9		
-0.4	4.8	-0.3	5.1	-0.2	10.8	0.7	1.7		
-0.1	4.6	-0.2	1.2	0.2	2.3	-0.2	1.2		
0.3	1.5	0	11.3	-0.2	16.2	-0.6	0.8		
0.1	1.7	-0.3	6.2	-0.5	6.7	-0.4	1.1		

0.2	6.5	-0.2	5.9	0.3	2.8	0.1	6.7		
0	5.7	0	2.8	0	6.3	0	6.4		
0.1	7.3	-0.3	3	-0.4	3.2	0.3	3.6		
-0.2	4.3	-0.1	1.6	0	4	0.1	7.5		
-0.1	1	0.5	1.2	0.3	1.3	-0.2	8.5		
-0.2	1.9	0.4	1.1	0.3	4.3	0.5	1.8		
0.1	1.4	0	6.2	0.1	12.9	0.1	2.4		
-0.4	2.3	-0.1	8.2	-0.3	6.9	0	6.1		
0.1	4.3	0	7.3	0.1	3.9	-0.1	5.6		
0	2.5	-0.4	11.5	0.2	3.7	0.2	1.9		
-0.1	3.9	-0.1	2.8	-0.6	5	-0.1	3.2		
0.2	0.6	-0.6	2.3	0.4	4	0	4		
0.3	2	0.1	3.9	-0.2	3	0.2	3.6		
0.1	6.3	0.2	3.3	-0.4	6.3	-0.4	4.9		
-0.1	5.4	0.1	2.2	0.3	2	0.2	2.9		
-0.2	4.9	-0.1	3.6	0	3.7	-0.2	14		
-0.1	6.2	0.3	1.7	-0.7	5.2	-0.1	2.7		
0.2	8.3	0	8.7	0	6.1	-0.1	1.9		
-0.1	1.9	-0.4	6.1	0.3	2.9	0	2.7		
0.1	4.5	0.3	3.8	0	2.8	-0.3	2.6		
0	2.4	-0.2	10.5	-0.2	2.6	-0.1	3.9		
-0.1	6.9	0.2	3.2	0.6	1.9	-0.2	3.6		
-0.3	4.2	-0.1	1.3	0.1	6	0.1	1.5		
-0.2	6	-0.3	1.2	-0.1	8.9	0	2.3		
0.4	2.3	-0.1	2.2	0	18.6	0.1	1.1		
0	7.1	-0.4	2.1	0.5	3.9	-0.4	4.8		
-0.5	3.8	-0.1	5.8	11.4	25.7	0.1	3.9		
0.2	4.1	0.3	1.3	18	54	-0.1	3.7		
-0.5	6.4	0	2.6			0	4.9		
-0.2	10.7	0.1	1			0.4	4		
-0.3	9.2	0.3	1.9			0.1	0.8		
-0.3	2.5	-0.4	2.3			-0.3	8.9		
0.1	6.2	0.1	3.9			0.3	7.6		
-0.1	3.6	0.2	8.5			-0.5	3.1		
0.5	1.1	1.3	8.3			0.4	2.8		
0	2.1					0	3.9		
0.6	1					-0.2	1.3		
-0.4	8.9					-0.2	2.3		
-0.1	1.5					0.3	1.7		
0.6	3.9					-0.2	13.2		
-0.4	8.3					-0.3	12.7		
-0.4	2.5					0	15.2		
-0.1	2.2					0	10.6		
0.2	2.9					-0.1	8.7		
-0.4	2.9					-0.3	3.5		
0.3	5.4					-0.1	5.6		
0.3	9.8					-0.4	2		

-0.1	3					0.5	2.4		
-0.4	1.8					0	3.2		
0.3	2.2					-0.3	1.6		
0.2	4.4					0.1	2.3		
0	4.4					0.6	2.5		
-0.6	1.2					2.5	5.8		
0	3.6					9.5	18.3		
0.2	2.9								
0.5	1.8								
0.1	9.5								
0.2	9.3								
6.9	22.8								
26.1	51.7								

GBD2 Pebble Count conducted 1/2 m																	
fp	fp	cp	cs	mp	fp	cp	sd	sd	sd	mp	fp	cs					
cs	mp	cp	fp	fp	sd	sd	mp	mp	cs	sd	cs	fp					
cs	fp	fp	mp	fp	cp	fp	sd	sd	fp	cs	cs	sd					
sd	cp	sd	cp	fp	fp	lc	cp	cp	cs	sd	sd						
cs	sd	sd	sd	fp	fp	cp	fp	fp	fp	st	cp						
fp	mp	fp	fp	fp	fp	fp	mp	mp	fp	fp	sd						
cp	fp	mp	cs	cs	cp	mp	cs	cs	cs	mp	cp						
sd	mp	mp	fp	sc	mp	sd	sd	sd	sd	mp	cs						
cp	fp	mp	sd	cp	mp	cp	mp	mp	sd	fp	cp						
fp	st	fp	sd	cp	cp	mp	cp	cp	cp	cs	st						

GBD3

GBD3a cross section shooting D-2-pts. starting river right		GBD3b cross section shooting D-2-pts. starting river right		GBD3c cross section shooting D-2-pts. starting river right		GBD3d cross section shooting D-2-pts. starting river right		GBD3 longitudinal profile derived from 5-m DTM	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	225.84	0
-2.6	59	-18	66	-22	185	-0.3	11.6	224.14	193.07
0	10.3	-27	13.1	0	35	-0.8	2.4	221.45	310.73
-0.1	28.2	0	23	0.3	43.5	-1.2	2	220.2	466.02
-0.3	4.8	0	40	-2.1	6.1	-1.7	2.9	219.89	534.27
-0.3	1.9	0.3	15.5	-0.1	2.2	0.2	3.4	217.39	702.03
-0.1	1.7	-0.2	4	-0.3	1.4	0.2	1.6	215.03	858.74
-0.3	0.6	-0.3	4.3	0.2	6.2	-0.1	0.8	214.23	985.42
0	1.6	-0.3	1	0.5	6.5	0.3	3.9	211.5	1134.08
0.3	2.4	-0.4	1.4	0.1	3.5	0.1	3.6	210.17	1257.13
0	2.4	-0.3	1.5	-0.6	2.4	-0.2	4.3	207.91	1373.59
-0.5	3.4	0	2	0.5	6.7	0.1	5		
0.3	3.2	1	2.4	-0.1	6.1	0	6.8		
0.2	2.8	0.2	2	0.3	13.9	-0.3	1.9		
-0.2	2.6	-0.4	2.8	-0.2	4.5	0.2	4.6		

0.3	4.4	-0.4	10.7	-0.5	2.7	-0.5	7.7		
-1	2.6	0.3	11.5	-0.4	0.7	0.1	1.1		
-0.3	3.1	-0.3	3.1	0	3.9	-0.2	1.9		
-0.1	4	-0.6	2.5	0.6	2.9	0.1	0.9		
0.5	3.2	-0.1	5.1	-0.1	4.5	0.3	1.4	GBD3 Valley/piedmont slope 5-m DTM	
0.2	1.6	0.2	2	-0.3	2.4	-0.4	8		
0.4	1.7	0.3	3.1	0.3	4.3	0.1	3.7	Vert (m)	Hor (m)
0	3.1	-0.5	3.6	0.1	5.5	-0.1	0.6	229.32	0
0.2	1.4	0.2	2.6	0.4	7.9	-0.6	0.9	227.13	145.23
-0.4	4.4	-0.2	2	-0.6	3.2	-0.2	1.5	225.04	270.96
0.3	3	0.2	4.5	0.3	7.4	-0.2	0.8	222.61	400.24
0	7.5	-0.7	9.6	-0.8	3.8	-0.1	0.5	217.48	565.66
0	6	0.3	1.7	0	2.1	0.2	0.4		
-0.3	2.5	-0.2	13	0.4	2.5	0.1	0.5		
0.1	7.3	-0.1	3.3	-0.4	2.6	-0.3	0.3		
0	5.8	-0.1	2	0.4	2.6	0	1.1		
-0.3	4.1	-0.4	1.9	-0.5	4.9	-0.1	1.3		
-0.3	0.8	-0.1	1.6	0.2	2.7	0.4	2.2		
-0.7	1.3	0.1	2.6	-0.2	4.1	0.1	1.6		
0	3.7	0.5	6.6	-0.2	1	0.2	1.9		
-0.1	4.6	0.3	2	-0.5	0.8	0	2		
-0.5	5.3	-0.2	5	-0.1	2	-0.1	4.7		
0.1	3.3	-0.5	6	0.3	3	-0.3	1.1		
0.7	0.9	0	3.1	0.3	1.2	0.4	1.3		
0	6.5	-0.1	8.1	-0.2	3.4	-0.2	7.4		
0.4	1.6	0.1	8.3	0	2.2	0.4	2.1		
0.1	3.6	-0.3	8	-0.4	6.3	-0.4	3.7		
-0.6	12	0.3	1.7	-0.3	0.4	0.2	0.8		
0.1	5.5	-0.2	2.9	0.1	2.2	-0.2	1.2		
-0.1	10	-0.4	1.1	-0.1	2.7	-0.4	1.7		
-0.8	5.4	-0.4	6.2	0.2	1.3	0.3	0.5		
-0.3	8.1	0.3	7.6	0.1	8.1	0	1.5		
0.2	0.7	-0.1	4.6	-0.2	3	-0.5	1		
-0.2	2.8	0.3	1.4	0.6	2.4	0.4	0.4		
-0.4	1.2	-0.2	3.2	0.2	4.5	-0.1	2.2		
0.3	4.2	0.4	5.8	-0.1	3.8	0.2	0.6		
-0.2	3.5	0.1	7.7	-0.7	3.8	0.4	1.1		
0.4	1.8	0.1	4.3	-0.1	4	0	3		
0.2	1.9	-0.7	6	0	6.6	0	1.7		
-0.2	2.5	0.5	2.4	-0.3	4.3	-0.3	1.1		
-0.2	3.4	-0.1	9	0.2	0.4	0.1	5.8		
0.7	2.6	-0.4	9.3	0.3	1.7	-0.2	2.6		
0.3	2.5	-0.8	2.7	0.1	1.1	-0.4	1.1		
-0.3	6.3	-0.1	7.1	-0.2	5.8	-0.1	2.5		
-0.6	7.7	0.1	1.6	0	2.9	0.3	3		
0.4	1.1	0.3	6.2	-0.4	4.9	-0.2	3.5		
-0.5	13.6	0.5	3.1	0.1	7.2	0.5	3.2		
-0.5	11.2	-0.5	7.3	-0.1	3.8	0.2	2.9		
-0.5	2	-0.2	5.5	-0.3	2.5	-0.5	3.3		

-0.3	4.9	0.2	8.6	0.1	2.1	0	6.2		
-0.2	2.5	0.2	8.7	0.3	1.3	0.3	2.1		
-0.1	5.3	-0.2	16.1	-0.4	7.7	-0.1	3.7		
0.1	4	-0.1	26.2	0.1	4.1	-0.1	0.6		
0.3	1.2	-0.4	100.6	-0.1	2.6	-0.3	0.4		
-0.2	3.7	7.6	33.3	0.2	2.6	-0.8	1.7		
-0.4	1.4			0.2	6.7	-0.2	1.5		
0.2	4.1			0.3	20.3	0.3	2		
0.3	1.9			0	81	0.3	3		
-0.1	5.4			6	54	0.3	4.8		
-0.1	6.5					0.1	6.1		
-0.5	3.7					-0.2	8.7		
-1	3.1					0	1.8		
0.5	2					0.4	0.7		
0.1	6.8					0.1	3.7		
-0.1	7					-0.3	3.9		
-0.3	9.9					0.2	6.1		
-0.6	8.2					-0.2	2.4		
0.3	3.5					0	3.6		
-0.3	2.3					-0.2	2.8		
0.3	3.9					0.3	1.2		
-0.1	9.2					0.1	3.6		
-0.5	1.6					-0.5	7.7		
-0.1	1.4					0.9	2		
1.4	3.3					0	2.7		
-0.6	10					-0.1	5.9		
0.4	14.9					4.2	7.7		
-0.7	14.6					12.8	16.1		
0	13					15.6	31.9		
0.4	30.6								
6	14								

GBD3

GBD3 Pebble Count conducted every 1/2m along all 4 cross sections																	
sc	cp	mp	sd	cp	sc	fp	fp	fp	mp	cp	cp	sc	mp	cs	sd		
B	fp	cs	cp	sd	fp	cp	cs	cs	fp	cp	mp	cp	cp	mp	mp		
mp	fp	mp	mp	fp	mp	fp	cs	cs	cs	sc	cs	cs	fp	fp	fp		
cs	cp	cs	fp	mp	st	cs	mp	mp	mp	mp	sd	fp	fp	cp	cp		
sd	mp	sc	fp	fp	sc	cp	fp	fp	fp	cs	fp	cs	fp	mp	mp		
cs	sc	fp	cp	cs	sd	cp	fp	fp	cp	mp	cp	cs	fp	cs	cp		
fp	fp	sd	mp	sd	cp	fp	sd	sd	fp	mp	fp	lc	mp	lc			
cp	lc	cp	fp	B	sc	lc	mp	mp	sc	mp	cs	cp	mp	mp			
fp	fp	sd	mp	sd	st	mp	mp	mp	fp	sd	fp	sd	cp	sc			
mp	fp	B	mp	fp	lc	cp	sd	sd	mp	lc	sd	sd	cp	fp			

GBD4

GBD4a cross section shooting D-2-pts. starting river right		GBD4b cross section shooting D-2-pts. starting river right		GBD4c cross section shooting D-2-pts. starting river right		GBD4d cross section shooting D-2-pts. starting river right		GBD4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.4	4.4	-0.1	3	-0.6	6.9	-1.4	9.7	-0.3	19.6
0.1	3.2	0	3.1	0	2.9	-0.2	4.5	-0.2	11.2
-1.5	3.4	-0.6	2.4	-1.4	2.4	0.2	7.4	-0.3	17.9
0	0.8	-0.2	2.3	-0.2	2.5	-0.2	1.8	-0.2	8.7
-0.2	0.5	0.3	2.6	0.2	2.4	-0.1	1.2	-0.7	6.8
-0.1	1.9	-0.4	1.2	0	2.1	-0.1	1.4	-1.3	16.7
-0.5	1.6	0.4	1.5	0.2	3.9	-0.1	0.8	-0.9	15.6
0.2	1.6	-0.4	1.6	0.1	3.5	-0.2	0.5	-0.5	8.1
0.1	0.9	0	0.4	-0.3	1	0	1.5	-0.6	19
-0.2	0.5	0.4	0.1	0.2	1.8	0.2	1.8	-0.2	17.5
0.2	1.2	-0.4	0.5	-0.1	1.1	0.1	1.5	-0.3	13.9
0.2	1.5	-0.3	0.1	-0.5	1.3	0.1	1.2	-0.4	9.4
0.2	0.6	-0.1	0.7	-0.1	0.7	0.1	2	-0.2	15.6
-0.1	0.3	0.2	1.5	0.2	0.6	0	2.3	-0.2	11.1
0.4	1.3	0.2	0.8	-0.2	0.4	-0.2	3.5	-1.1	19.3
0.3	0.3	-0.1	0.7	-0.1	2	0.4	0.6	-0.7	11
-0.3	2.7	-0.1	1.1	-0.2	1.3	0.3	2.3	-0.6	13.4
0.1	1.2	0.1	1.4	0	0.7	-0.2	2.1	-0.6	9.8
-0.3	1.2	0.1	2.1	0.1	0.6	-0.4	1.8	-0.7	12.9
0.1	7.1	0.4	2.7	0	0.9	-0.5	5.6	-0.7	16.8
-0.3	2.9	0	2.1	0.5	1.3	0.2	1.5		
0.1	1.7	-0.2	2	0	1.9	-0.2	1.9	Stream gradient 5-m DTM	
-0.2	1.6	-0.3	1.5	-0.2	0.8	-0.5	1.6		
-0.1	2.9	0	1.6	0.3	0.9	-0.6	1.7	Vert (m)	Hor (m)
-0.3	0.9	0.3	1.5	-0.3	1.1	0.5	2.8	238.99	0
0	1.6	-0.3	1.4	-0.3	1.9	-0.4	3.4	237.52	56.87
0.2	1.3	0.1	2	0.2	2.2	-0.2	0.2	236.82	85.87
0	1.8	0.1	3.3	0.1	2.7	-0.2	2.3	235.26	106.8
0.3	4.2	0.2	0.5	-0.3	3.3	-0.1	0.6	234.33	142.84
-0.2	2.1	-0.2	0.6	0.3	1.4	0	0.7	230.66	211.84
0.1	0.9	0.3	2.2	-0.9	1.6	-0.2	0.5	229.16	289.34
-0.2	0.9	-0.2	1	-0.3	0.7	0.1	0.7	228.53	327.08
0	4.3	0.2	1.5	-0.1	0.5	-0.2	0.8		
0	1.5	0	0.7	0.1	0.8	0.4	2.3	GBD4 Valley/piedmont slope 5-m DTM	
0.3	2.2	0.4	0.1	-0.6	0	0.8	2.2	Vert (m)	Hor (m)
-0.6	2.3	0	1.2	-0.1	0.8	0.1	3	243.57	0
-0.4	1.5	4.2	6.7	0	0.8	3.9	7.9	242.31	63.86
-0.3	0.2			0.2	1.1			239.29	147.71
0.4	0.5			0.3	0.6			237.97	197.51
-0.1	1.2			0.1	1			236.96	241.03

0.3	0.3			0.8	1.3				
-0.2	0.1			0.6	0.5				
0.2	1			0	2.5				
0.1	0.6			4.2	7.9				
0.4	0.9								
0.3	1.2								
0.8	1.6								
5	8.4								

GBD4 Pebble Count conducted every 1/2m along all 4 cross sections																	
B	B	B	sc	fp	mp	B	cs	cs	fp	sc	cp						
sc	lc	cp	cp	cs	mp	lc	fp	fp	B	cp	mp						
cp	sd	lc	lc	B	sd	B	st	st	mp	fp	fp						
cp	sc	sc	B	fp	cs	lc	sc	sc	cp	fp	cs						
mp	sd	lc	sc	sc	fp	B	st	st	lc	fp	fp						
B	B	lc	B	mp	sc	sd	lc	lc	cp	cp	cs						
B	sc	B	sc	mp	cp	lc	cs	cs	B	sc							
lc	fp	fp	B	fp	cp	sc	fp	fp	sc	cp							
fp	sc	lc	cp	cp	lc	st	mp	mp	lc	cp							
sd	mp	cp	sc	fp	fp	sd	fp	fp	B	B							

GBK1

GBK1a cross section shooting D-2-pts. starting river right		GBK1b cross section shooting D-2-pts. starting river right		GBK1c cross section shooting D-2-pts. starting river right		GBK1d cross section shooting D-2-pts. starting river right		GBK1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.4	1.5	-0.5	3.2	-0.1	0.9	-0.1	0.6	3.2	7.9
0.4	1.8	0.2	0.5	-0.1	0.1	-0.2	0.1	1.8	5.4
0	0.9	-0.1	0.2	-0.2	0.2	-0.2	0.5	3.4	6.4
-0.5	0.4	0	0.1	-0.2	0.3	0.1	0.3	2.3	5.5
-0.1	0.2	0.1	0.3	0.2	0.2	0.6	0.8	4.2	6.3
-0.2	0.2	0.2	0.8	-0.3	0.1	-0.8	0.8		
0.1	1	-0.5	0.1	0.1	0.5	-0.2	0.1		
0.2	0.2	0.1	0.6	0	0.6	0.2	0.3		
0.3	0.4	0.3	0.5	-0.3	0.3	-0.1	0.1		
1.1	0.6	0.7	0.6	0.2	0.5	-0.5	0.3		
		0.6	1.1	0.2	0.8	0.1	0.4		
				0.1	0.1	0.2	0.1		
				0.4	-0.1	0.2	0.5		
				0.5	1.2	0.2	0.1		
						0.1	0.1		
						0.3	-0.5		
						0.4	1.2		

GBK1 Pebble Count conducted every 1/2m along all 4 cross sections																	
B	cp	lc	sd	cp	cp	sc	sd	sd	lc	lc	mp						
fp	fp	B	fp	sc	fp	mp	cs	cs	B	lc	mp						
cp	cp	B	sd	lc	cp	lc	cs	cs	B	cs	mp						
mp	sc	B	sd	B	sc	lc	fp	fp	cp	cs	mp						
fp	fp	st	fp	fp	B	cs	cs	cs	cp	mp							
fp	fp	st	mp	cs	cs	fp	cs	cs	cp	cs							
fp	sd	st	cp	mp	B	cs	LB	LB	fp	cs							
fp	sc	fp	mp	fp	lc	fp	cp	cp	fp	cp							
cs	sc	sd	sd	lc	cs	B	sc	sc	cp	mp							
cs	sc	mp	fp	fp	mp	cs	sc	sc	fp	mp							

GBK2

GBK2a cross section shooting D-2-pts. starting river right		GBK2b cross section shooting D-2-pts. starting river right		GBK2c cross section shooting D-2-pts. starting river right		GBK2d cross section shooting D-2-pts. starting river right		GBK2 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.5	2.5	-0.6	3.3	-0.2	3.1	-0.5	3.2	-0.6	9.1
-0.4	1.4	-0.3	1	-0.4	1	-0.3	0.3	-0.1	8.4
-0.7	0.9	-0.8	1.4	-0.5	0.8	-0.1	0.2	-0.4	2.6
-0.7	1.2	-0.3	0.3	-0.4	0.4	-0.3	0.3	-0.8	5.4
-0.5	0.5	-0.4	0.6	-0.3	0.2	-0.2	0.4	0.1	4.3
-0.3	0.7	-0.4	0.4	-0.2	0.4	-0.7	0.2	-0.3	6.1
-0.4	0.3	-0.2	0.4	-0.2	0.8	-0.1	0.2	-0.5	3.7
0	0.5	-0.1	0.3	0	0.5	-0.2	0.4	0	1.2
-0.2	0.1	-0.3	0.4	0.3	0.4	-0.1	-0.1	-0.3	3.3
0	0.5	0	0.4	0.3	0.4	0	0.7	-1.2	1.5
0.1	0.2	0.4	1.1	0.5	0.5	0.1	0.8	0.3	2.6
0.6	0.2	-0.2	0.2	0.6	1.1	0.2	0.2	-0.3	2.3
0.3	0.5	0	0.8	0.8	0.6	0.3	0.2	-0.2	6.1
0.4	0.5	0.1	0.3	0.5	0.6	0.6	1.3		
0.7	0.6	0.2	0.2	0.7	1.6	0.4	1.1		
1.9	1.8	0.3	0.5	1.4	2.2	1.4	2.5		
0.1	2	0.3	0.3	0.8	1.4	1.8	4.1		
		0.2	0.4	2.2	6.3	7	15.4		
		0.5	0.2						
		0.7	1.2						
		2.2	4.6						

GBK2 Pebble Count conducted every 1/2m along all 4 cross sections												
fp	Bk	sc	Bk	cp	cp	mp	Bk	Bk	fp	cp	fp	Bk
cp	Bk	sd	sc	sc	Bk	fp	sd	sd	fp	cs	Bk	fp
sd	Bk	mp	cp	Bk	sc	cp	Bk	Bk	fp	mp	mp	Bk
sc	Bk	fp	fp	cp	mp	fp	mp	mp	Bk	cs	mp	mp
fp	sc	Bk	sc	cp	fp	sc	fp	fp	mp	fp	mp	sd
sc	cp	mp	mp	mp	sc	mp	mp	mp	Bk	cs	fp	cp
fp	sc	cp	fp	sc	fp	mp	mp	mp	cs	fp	cp	fp
Bk	Bk	Bk	Bk	mp	mp	fp	sd	sd	fp	fp	mp	
Bk	sd	cp	sc	sd	cp	Bk	mp	mp	fp	mp	mp	
cp	cp	sc	mp	sc	fp	Bk	fp	fp	sd	fp	mp	

GBK3

GBK3a cross section shooting D-2-pts. starting river right		GBK3b cross section shooting D-2-pts. starting river right		GBK3c RL side channel cross section shooting D-2-pts. starting river right		GBK3d cross section shooting D-2-pts. starting river right		GBK3 rr longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.5	0.7	-0.5	0.9	-0.1	0.5	-1.1	1.7	-0.8	13.7
-0.4	1.4	-0.4	1.3	-0.3	0.2	1.5	2.4	-1.2	7.7
-0.1	0.1	-0.5	0.4	0	0.7	-0.3	1.1	-1.5	16.6
-0.1	0.4	-0.3	0.6	-0.1	0.1	-1.2	-0.3	-6	15.3
-0.3	0	-0.9	0.7	-0.4	0.3	-0.1	0.4	-0.7	12.3
-0.3	0.3	-0.2	0.3	0.1	0.8	-0.2	0.2		
-0.1	0.4	0	0.2	0	0.8	-0.2	1.1		
-0.4	0.3	0.3	0.2	0.3	0.9	-0.1	0.7		
0.1	0.6	0	0.4	0.1	0.5	0	1.2	GBK3 rl 2ndary channel longitudinal profile	
0.4	0.6	-0.2	0.1	0.3	0.8	-0.1	0.2		
0.4	0.8	-0.1	0.4	0.7	0.2	0	0.8		
0.2	0.6	0.4	0.5	0.8	3.3	0.2	0.4	Vert (m)	Hor (m)
0.2	0.4	0.3	0.6			-0.1	0.3	0	0
0.4	0.5	0.3	0.3	2ndary channel		0.3	0.1	-0.8	13.7
1	1.9	0.2	0.3	Vert (m)	Hor (m)	-0.1	0.4	-1.2	7.7
1.7	4.3	0.1	0.4	0	0	0	0.7	-2.5	6.6
		0.6	0.6	-0.6	1.6	0.1	1	-5	15.7
		0.9	1.6	-0.3	1.6	0	6.6	-0.7	12.3
		1.4	3.5	-0.2	0.5	-0.1	0.2		
				-0.1	0.1	-0.1	0.6		
				-0.1	0.2	0.1	0.3		
				-0.4	0.4	0.1	0.5		
				-0.2	1.2	0.2	0.6		
				0.1	1.2	0	1.7		
				0.1	0.9	0.4	1.5		
				0.2	1				
				0.2	1				
				0.2	1				

GBK3 Pebble Count conducted every 10 cm																	
sd	cp	mp	mp	sc	sd	cp	B	B	cp	fp	cp	cp	lc	cp	mp	mp	mp
lc	lc	sd	st	lc	fp	cp	mp	mp	sd	cp	mp	mp	sc	mp	sd	Org	mp
B	sc	B	cp	cp	st	lc	cp	cp	mp	cs	Org	mp	fp	fp	cp	mp	sd
cp	lc	sc	B	mp	sc	sd	mp	mp	fp	B	fp	fp	lc	fp	cp	Org	cp
lc	cp	sd	st	cp	st	lc	cp	cp	mp	fp	cp	cp	cp	mp	fp	sd	sd
lc	cp	sc	lc	fp	B	B	lc	lc	sd	fp	Org	fp	fp	cp	cp	Org	fp
B	cp	fp	sc	mp	cp	cp	sc	sc	B	sd	cp	B	cp	cp	fp	mp	fp
mp	sd	cp	fp	lc	sc	cp	lc	lc	sc	cs	fp	mp	cp	sd	fp	sc	B
cp	mp	lc	sc	mp	cp	lc	cp	cp	sd	fp	fp	fp	sd	fp	fp	fp	sd
mp	fp	lc	sc	sc	sc	lc	cp	cp	sc	sd	sd	sd	cp	mp	Org	B	

GBK4

GBK4a cross section shooting D-2-pts. starting river right		GBK4b cross section shooting D-2-pts. starting river right		GBK4c cross section shooting D-2-pts. starting river right		GBK4d cross section shooting D-2-pts. starting river right		GBK4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.5	1.7	-0.7	1	-1.3	3.4	-0.6	1.7	-0.7	7.2
-0.1	1.5	-0.5	0.9	-0.2	1	-0.4	1.9	-0.8	6.9
-0.4	0.9	-0.4	0.4	-0.2	0.2	-0.1	0.6	-1.1	3.2
-0.3	0.9	-0.2	0.1	-0.3	0.5	-0.4	1	-1.2	9.3
-0.2	0.3	-0.1	0.4	0	0.1	-0.2	0.5	-1.4	9.2
-0.2	0.6	-0.1	0.2	-0.2	0.1	-0.1	0.2	-1.7	11.9
-0.2	0.1	0	0.2	-0.1	0.1	-0.1	0.2		
-0.1	0.4	-0.3	0.2	-0.1	0.5	-0.2	0.2		
0	0.8	-0.2	0.5	-0.2	0.1	-0.1	0.7		
0.2	0.4	0.2	0.4	-0.1	0.3	0	0.7		
0.1	0.1	0.2	0.4	-0.1	0.3	0	0.4		
0.4	0.8	0.2	0.3	0	0.4	0.3	0.5		
0.3	0.3	0.2	0.6	0.3	0.3	0.2	0.5		
0.2	0	0.4	1	0.2	0.4	0.3	0.3		
1.4	0.8	0.3	0.4	0.1	0.4	0.9	1.5		
1	0.9	0.4	1.1	1	0.7	1.2	2.2		
		1.8	0.9	1.5	0.5				

*NOTE: GBK4 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

GBK5

GBK5a cross section shooting D-2-pts. starting river right		GBK5b cross section shooting D-2-pts. starting river right		GBK5c cross section shooting D-2-pts. starting river right		GBK5d cross section shooting D-2-pts. starting river right		GBK5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1.4	2.7	-0.9	5.1	-8	18	-7.2	16.5	-0.1	2.3
-0.3	1.8	-0.8	2	-4	16.7	-4.5	21.9	-0.6	7.3
-0.4	0.4	-0.2	0.3	-1.5	5.6	-1.2	3.2	-0.6	7.3
-0.1	0.4	0.1	0.7	-0.2	1.4	-0.5	0.7	-0.7	7.6
-0.2	0.3	-0.1	0.5	0.3	0.5	-0.2	0.4	-0.4	3.7
-0.1	0.6	-0.2	0.3	-0.5	0.4	-0.2	0.1		
0.1	0.3	-0.1	0.5	-0.1	0.4	-0.2	0.5		
-0.1	0.3	0.1	0.2	-0.5	0.6	-0.2	0.5		
0.1	0.3	-0.2	0.3	-0.1	0.4	0	0.6		
0	0.2	0.2	0.3	-0.2	0.4	0.1	0.4		
0.2	0.5	0.2	0.1	-0.2	0.3	0	0.5		
0.4	2.2	0.6	1.1	-0.1	0.4	0.6	1.2		
1.6	2	1.5	2.7	0.1	0.3	0.9	2.5		
0.9	3	4.2	13.2	0.1	0.4	3.1	8.8		
2.7	3.4	7	16.7	0.2	0.2	7	21		
				0.1	0.5	18	35		
				1	0.9				
				1	1.8				
				1.9	4.3				

*NOTE: GBK5 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

GBK6

GBK6a cross section shooting D-2-pts. starting river right		GBK6b cross section shooting D-2-pts. starting river right		GBK6c cross section shooting D-2-pts. starting river right		GBK6d cross section shooting D-2-pts. starting river right		GBK6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1.2	1.9	-0.4	0.9	-0.4	0.9	-0.5	0.9	-2.1	3.4
0.1	1.1	-0.5	0.8	-0.2	0.6	-0.3	0.4	-1	2.1
-0.2	1.4	-0.1	0.5	-0.4	0.4	-0.3	0.5	-1.4	2.1
0.3	1.9	0.1	0.6	-0.3	0.5	0	0.4	-1.3	2.1
-0.1	0.4	-0.1	0.2	-0.3	0.5	-0.1	0.6	-0.9	1.8
-0.2	0.3	-0.2	0.1	0.1	0.3	-0.2	0.2	-1.7	2.2
0	0.2	-0.2	0.2	0.2	0.1	-0.1	0.8	-1.2	2.3
-0.1	0.4	-0.3	0.3	0.2	0.1	0	1.3	-2.3	5.1
0	0.4	-0.1	0.2	0.7	0.5	0	0.5		
-0.1	0.3	0.3	0.1	1	0.8	0.1	0.2		
0.2	0.1	0.1	0.1			0.3	0.4		
0.1	0	0.2	0.1			0.4	0.5		
0.2	0.5	0.3	0.7			0.7	1		
0.1	0.3	0.7	1.1						
0.2	0.2								
0.3	0.5								
0.5	0.9								
0.9	2.5								

*NOTE: GBK6 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

GIA1

GIA1a cross section shooting D-2-pts. starting river right		GIA1b cross section shooting D-2-pts. starting river right		GIA1c cross section shooting D-2-pts. starting river right		GIA1d cross section shooting D-2-pts. starting river right		GIA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	4.5	0	0	0	0	0	0
-0.2	2.3	-0.3	1.1	-1.4	6.1	-0.3	5.7	0	0
-0.4	1.7	-0.3	1.9	-1	4.1	-0.2	1.4	0.4	13.2
-0.1	3.4	-0.8	1.2	-0.9	2.3	-0.7	1.5	0.2	12.4
-0.1	3.7	-0.5	0.8	-0.9	2.4	-0.5	1	-0.1	9.4
0	2.4	-0.6	0.8	-1.3	1.6	-0.8	1.9	0.3	14.9
-0.1	1.1	-0.1	0.5	-0.3	0.4	-0.4	1	0.6	12.6
-0.3	0.9	0	0.6	-0.3	0.2	0.1	2.5	0.2	12
-0.1	0.5	-0.1	1.4	-0.3	0.4	-0.1	1.9		
-0.3	1.5	0	0.1	0.1	0.7	-0.1	2.1		
0.2	0.9	-0.2	1.1	0.1	0.3	0	2.2		
0.2	0.7	-0.1	0.9	0.1	0.8	-0.2	1	Valley/piedmont slope 5-m DTM	
0.2	0.8	0.2	1.2	0.3	0.6	0	0.7	Vert (m)	Hor (m)
0.5	1	0.2	0.4	0.2	1.4	0	0.7	248.96	0
0.9	1.5	0.1	0.7	0.1	2.8	-0.3	0.7	248.63	28.2
0.9	1.5	0.1	0.8	0.7	2.8	-0.1	1.8	247.63	55.45
0.5	0.9	0.1	0.9	1.3	3	-0.1	1.8	247.29	76.63
0.2	0.6	0.2	0.4	0.1	3.5	-0.1	1.2	245.64	108.8
0	0.9	0.1	1.4			0.2	0.7		
		0.6	1.8			0.2	0.5		
		0.8	2.3			0.1	0.2		
		0.8	4.3			0.4	0.8		
		0				0.9	0.9		
						0.8	0.7		
						0.2	0.4		

GIA1 Pebble Count conducted every 20 cm																	
B	fp	fp	lc	cs	cp	cp	fp	fp	cs	fp	mp	fp					
mp	sc	fp	cp	cs	cp	cp	lc	lc	fp	mp	mp	cp					
sd	cs	cp	cp	cp	cp	sd	sc	sc	sc	mp	fp	cs					
fp	cs	mp	cp	B	B	mp	cs	cs	fp	lc	mp	mp					
fp	fp	fp	B	fp	cp	fp	sc	sc	fp	mp	fp	fp					
fp	B	sc	mp	lc	sc	mp	fp	fp	sc	lc	sd	mp					
fp	mp	cp	fp	fp	sd	mp	cp	cp	mp	fp	mp						
cs	cs	mp	B	sd	cp	sd	fp	fp	cp	mp	sd						
sd	fp	cp	cp	lc	mp	fp	mp	mp	cs	cp	cp						
mp	fp	cp	sd	cs	cp	cp	fp	fp	mp	fp	cp						

GIA3

GIA3a cross section shooting D-2-pts. starting river right		GIA3b cross section shooting D-2-pts. starting river right		GIA3c cross section shooting D-2-pts. starting river right		GIA3d cross section shooting D-2-pts. starting river right		GIA3 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0.1	9.9	0.3	11.9	-4.5	24.1	-3.7	27	-0.1	13.8
0	7.1	-0.2	4	-2	22	-1.2	10.4	-0.4	10.4
-0.4	4.1	-0.6	2	0.3	3.8	-0.4	2.5	-0.1	7.7
-0.7	1.5	-1.2	2.1	-0.4	2.3	-1.1	3.1	-0.5	6.1
-0.7	1.2	-0.1	0.6	-0.5	0.8	-0.7	2.2	-0.3	6.4
-0.4	0.9	0.1	0.7	-1.2	0.4	-0.8	2.9	-0.2	7.7
0.2	2.3	0.1	2	-0.2	0.3	-0.1	2.9	-0.1	9.9
-0.1	0.6	-0.3	1.6	-0.5	0.8	-0.2	1.8	-0.2	7.9
0.2	0.3	0	0.9	-0.1	1.6	-0.2	1.4	-0.3	8.8
-0.3	0.4	-0.3	0.9	0.3	0.8	0	1.3	-0.4	9.3
0	0.3	0.2	0.4	0.1	1.1	-0.2	1.1	-0.3	7.5
-0.2	0.2	-0.3	0.3	0.1	1.2	-0.1	1.1	-0.1	7.5
0	1.3	0.1	0.2	0.1	2.4	0.4	0.7	-0.2	8.5
0.1	1	-0.1	0.3	-0.2	2.2	0.3	0.2	-0.3	8.6
0.2	1.1	0.2	0.3	0	2.5	0.3	0.6		
-0.1	1.6	-0.2	0.3	-0.1	1.1	0	1.9		
0.2	1.6	-0.1	0.5	0.2	2.1	1.1	3.1	Valley/piedmont slope 5-m DTM	
0.3	4.7	0.3	0.6	0.7	3.2	0.2	5		
1.2	5.2	0.2	0.3	-0.1	4.4	0.7	6.3		
5	11.9	0.1	0.8	0.3	4.6	-0.1	7.9	Vert (m)	Hor (m)
6	22	0.1	1.6	1.6	5.6	12	49	295.43	0
		0.1	1.2	0.1	5			293.19	67.35
		-0.2	3.1	0.1	13.3			291.43	134.54
		0.4	1	11.1	42.8			291.31	210.25
		0.3	4.3					290.1	265.11
		0.9	3.4						
		0.9	6.2						
		0.2	5.2						

GIA3 Pebble Count conducted every 10 cm																	
sd	mp	cs	lc	mp	sd	sd	sc	sc	sc	lc	fp						
cp	lc	cp	mp	cp	cp	cp	mp	mp	cp	B	B						
B	sc	cs	B	sc	lc	sc	cp	cp	lc	st	fp						
lc	mp	cp	lc	mp	cp	cp	sc	sc	cp	lc	lc						
mp	B	lc	fp	cs	cs	mp	sc	sc	st	B	lc						
mp	cp	fp	cp	lc	cp	cp	mp	mp	lc	fp	lc						
sd	cp	cp	fp	lc	fp	cp	B	B	sd	B	sc						
sc	lc	cp	fp	sd	cp	lc	cp	cp	B	mp	fp						
lc	sc	mp	sc	B	lc	sc	cp	cp	cp	fp	fp						
sc	fp	cp	sc	cs	lc	sc	cp	cp	fp	fp							

GIA4

GIA4a cross section shooting D-2-pts. starting river right		GIA4b cross section shooting D-2-pts. starting river right		GIA4c cross section shooting D-2-pts. starting river right		GIA4d cross section shooting D-2-pts. starting river right		GIA4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1.2	4.9	-1.2	4.4	-1.1	3.7	-1.7	6.8	-0.1	3.4
-0.8	2.3	-1.6	4.5	-2.4	7.6	-1.3	5.2	-0.3	3.5
-0.4	0.6	-0.3	1.1	-0.4	3.4	-0.5	2.2	-0.6	3.4
-0.2	0.6	-0.3	0.7	-0.1	0.2	-0.2	0.6	-0.1	4.7
-0.3	0.3	-0.2	0.4	-0.1	0.5	-0.2	0.3	-0.2	2.9
0.2	0.2	-0.1	0.3	0.2	0.5	0	0.2	-0.4	4
0	0.3	-0.1	0.5	0	0.6	-0.1	0.1	-0.2	3.3
-0.1	0.1	-0.1	1	-0.2	0.6	-0.1	0.3	0	0.6
0.1	0.3	0.1	0.8	-0.2	1.7	-0.2	0.2	-0.4	4
0.1	0.4	-0.1	0.7	0.5	1	0.1	0.4	-0.2	3.2
0.1	0.7	0.1	0.5	0.9	1.6	0.1	0.5	-0.6	5.1
0.6	2.2	0.2	0.2	2.8	8.6	0.1	0.7		
4.3	16.2	0.3	0.3	10	37	0.8	2.5		
9.5	39.7	0.4	1.4			3.4	11.2		
		1.1	4.4			15.8	52.6		
		2.9	9.5						
		7	2.7						

GIA4 Pebble Count conducted every 5 cm																	
cp	fp	sc	mp	cp	st	sc	mp	mp	sd	mp							
st	mp	fp	cp	cp	fp	B	sd	sd	sc	sc							
fp	B	cp	B	sc	st	fp	sd	sd	sc	sd							
sc	st	cp	sd	sc	lc	cs	lc	lc	sc	cp							
st	cp	fp	sc	lc	cp	cp	st	st	sc	fp							
cp	sd	mp	sc	cp	fp	st	sc	sc	cp	fp							
sc	fp	fp	sd	sd	cp	fp	mp	mp	cp	st							
sc	st	cp	cp	cp	st	cp	sd	sd	mp	sc							
st	mp	mp	st	lc	mp	cp	mp	mp	sc	cp							
mp	fp	cp	cp	st	mp	lc	cp	cp	sd	fp							

GIA5

GIA5a cross section shooting D-2-pts. starting river right		GIA5b cross section shooting D-2-pts. starting river right		GIA5c cross section shooting D-2-pts. starting river right		GIA5d cross section shooting D-2-pts. starting river right		GIA5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-2.7	1.7	-2.3	2.3	-1.4	1.4	-2.9	1.4	-0.6	26.3
-0.8	1.6	-0.8	2.1	-2.8	0.3	-2.1	-1	-0.3	18.1
-0.3	4	-0.2	1	-0.8	-0.8	0.2	0.6	-0.2	17.2
-0.2	0.4	0.1	0.7	0	2.3	-0.4	1.5	-0.5	23.6
-0.2	1.2	0	2.4	0.1	1.5	-0.2	2.4	-0.3	12.3
0	0.9	-0.2	1.4	0.2	0.8	0	1.1	-0.2	20.2
0.1	0.4	-0.4	2.1	0.3	0.5	0.3	1.8	-0.3	14.9
-0.1	1.5	0	1.7	0.1	4	0.2	2.6	-0.1	16.8
0.1	1.1	-0.3	0.6	-0.2	3.2	0.1	0.3		
0.2	1.3	0	2.9	0.1	0.7	0.1	0.9		
2.7	1.4	1.5	0.2	-0.2	2.3	-0.1	2	Valley/piedmont slope DTM	
		1.7	1.2	0.3	1.8	0.1	1.9	Vert (m)	Hor (m)
				-0.1	0.7	0.1	1.7	223.06	0
				0.1	1.1	0.2	1.9	220.44	102.65
				0.5	0.2	0.2	2.1	218.42	176
				0.2	0.9	0.3	0.8	214.91	287.75
				1.6	3.4	0.2	0.8		
				0.6	3.8	1.5	3.4		
				0	5.6	0.1	3.3		
				0.5	2	-0.1	6.5		
				2	5.5	2.4	4.8		

GIA5 Pebble Count conducted every 1/2m along all 4 cross sections																	
cp	cs	mp	cs	cs	fp	fp	cp	cp	fp	cp	fp	fp					
lc	fp	fp	cp	sc	cs	cp	sc	sc	cp	fp	mp						
cp	cp	lc	cp	cs	fp	cp	B	B	mp	mp	fp						
cs	cp	fp	mp	fp	cs	fp	sc	sc	cp	mp	cp						
cp	sc	mp	sc	mp	fp	cs	fp	fp	fp	cp	fp						
cs	cp	cp	cp	fp	sc	fp	fp	fp	mp	cp	mp						
mp	cp	cs	fp	cp	mp	B	fp	fp	cp	cp	cs						
mp	sc	sd	fp	mp	fp	cs	cs	cs	cp	cs	cs						
cp	mp	mp	cp	cs	cp	cp	sc	sc	fp	cs	fp						
sc	mp	fp	cs	cs	fp	fp	fp	fp	fp	fp	mp						

GIA6

GIA6a cross section shooting D-2-pts. starting river right		GIA6b cross section shooting D-2-pts. starting river right		GIA6c cross section shooting D-2-pts. starting river right		GIA6d cross section shooting D-2-pts. starting river right		GIA6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-2.9	4	-1.5	3.3	-1.5	8.5	-9.4	17.2	0.4	11.5
-0.8	1.2	-1.5	2.7	-0.9	2.4	-0.8	0.6	-0.2	1.3
-0.3	0.6	-0.2	3	-0.5	3.8	-0.4	0.2	0.4	5.2
-0.1	1.2	-0.4	0.7	-0.5	1.3	-0.4	0.1	0.4	12.1
0.1	1.1	0.1	1.8	-0.5	0.9	-0.3	0.1	0.3	7.6
-0.1	0.4	0.3	0.6	-0.3	1.7	-0.3	-0.2	0	4.6
0.3	0.7	0.1	1.3	0.1	1.6	-0.1	0.8	0.4	2.9
-0.2	0.8	0.1	1	0.1	1.6	-0.2	0.3	-0.1	3.2
0.2	1.1	-0.3	1	0.2	1.6	0.1	0.6	0.3	5
0.2	0.6	0.1	1	0.3	0.7	0.2	0.6	0.3	4.2
0.1	1.1	-0.2	1.1	0.3	0.5	-0.2	1.5	0	7.4
-0.4	1.9	0.1	0.6	-0.1	0.5	0.1	0.9	0.4	9.1
0	1.4	0.1	0.2	0.1	0.7	0.1	0.7	0.1	3.7
0.7	2.4	0.2	0.2	2.4	4.7	0.1	1.9	0	3
0.1	2.1	0.2	0.7	0.7	1.2	-0.4	0.9	0.3	4.8
1.6	9.3	1.2	1.9	1	5	0	0.8		
		2.5	3.8	7	37	0.4	0.7		
		6.8	3.3			0	1.4		
						0.2	1.8		
						0.8	2.9		
						1.5	2.1		
						2.5	16		
						6	24		

GIA6 Pebble Count conducted every 10cm																	
B	fp	lc	fp	cp	fp	fp	sc	sc	sc	sd	sd	mp	lc	sd	sd		
fp	sc	fp	sc	cp	sd	fp	B	B	st	mp	sc	sc	cp	fp	sd		
sd	lc	mp	cp	cp	st	fp	fp	fp	cp	mp	mp	mp	fp	cp	fp		
sd	cp	sc	cp	cp	cp	fp	sc	sc	sc	sc	fp	sd	sd	cp	mp		
cp	fp	sc	lc	sd	fp	fp	sc	sc	mp	cp	mp	lc	sc	lc	fp		
sd	cp	sc	sc	lc	fp	cp	st	st	sc	fp	lc	lc	fp	cp	sd		
mp	sc	cp	cp	cp	lc	fp	mp	mp	cp	sd	sc	sc	cp	sd	sd		
sd	sd	sd	sc	mp	lc	sd	lc	lc	fp	cp	cp	mp	mp	cp			
cp	fp	cp	lc	sc	lc	sc	sd	sd	cp	sd	mp	fp	mp	lc			
sd	lc	sd	cp	sc	mp	cp	cp	cp	cp	cp	fp	cp	sc	fp			

GIA7

GIA7a cross section shooting D-2-pts. starting river right		GIA7b cross section shooting D-2-pts. starting river right		GIA7c cross section shooting D-2-pts. starting river right		GIA7d cross section shooting D-2-pts. starting river right		GIA7 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-2.1	3.2	-3.1	7	-10	53	-8	48	-0.3	14.6
-5.9	9.8	-1.2	2.5	-0.5	21.6	-0.1	10.2	-0.3	8.8
-0.8	2.8	-0.3	0.7	-0.5	13.8	-0.1	5	-0.6	8.9
-0.2	0.9	-0.3	0.7	-1.2	12.7	-1.6	7	-0.3	19.6
-0.3	1.1	0.1	2.9	-1.3	5.8	-0.4	3.1	-0.2	20.6
-0.3	0.7	0.2	0.7	-0.9	5.2	-0.3	3.6	-0.4	14.2
-0.1	0.3	0.2	0.7	-0.4	2.7	-0.3	1.5		
-0.2	0.8	0.1	0.6	-0.3	0.8	-0.2	1.5		
0.2	0.8	0.1	4.3	-0.3	0.9	-0.1	1.5		
0	1	-0.5	6.7	0	0.6	-0.2	0.8		
0.1	2.9	0.3	3.8	0.1	0.9	0.1	1	Valley/piedmont slope DTM	
0.1	1	-0.2	2.5	0.4	0.8	0.1	0.6	Vert (m)	Hor (m)
0.1	1.2	0.2	2.4	0.1	0.6	0.2	0.8	270.8	270.8
-0.4	1.8	0.1	5.8	0.1	0.5	0.2	14	269.18	34.42
-0.1	2	0	10.8	-0.1	1.6	0	1.7	268.7	62.56
0.3	4.3	1.8	6	0.2	3.8	-0.1	1.7	268.4	101.52
-0.3	5			-0.2	2.1	0.1	3.4		
0.3	3.1			0	5.2	-0.2	3.4		
0	5			-0.1	14.8	0.1	1.5		
-0.3	6			-0.3	8	0.3	4.5		
0.4	2.2			5	18	4.9	10.4		
0	10.4								
0.2	8.7								
1.7	5								
3.2	17.1								
5	18								

GIA7 Pebble Count conducted every 1/2m along all 4 cross sections																	
cp	lc	cp	fp	cp	fp	cp	sd	sd	cp	cs	mp	lc					
mp	mp	fp	st	mp	st	mp	sc	sc	sc	sc	cp	cp					
fp	cp	fp	mp	sc	cp	cp	cp	cp	lc	cs	cp	mp					
fp	fp	st	mp	cp	lc	st	lc	lc	cp	cp	mp	cp					
cp	mp	cp	sc	st	cp	cp	fp	fp	cp	mp	cp	lc					
cp	sc	fp	sc	sc	cp	sd	mp	mp	fp	cp	sc						
sc	cp	cs	lc	sc	cs	cp	mp	mp	lc	mp	fp						
sd	cp	sd	cs	fp	B	mp	cs	cs	cp	cp	fp						
mp	fp	cp	cp	fp	sc	fp	sc	sc	fp	lc	cp						
cp	sd	fp	mp	cp	sc	mp	cp	cp	mp	mp	sc						

GPH1

GPH1a cross section shooting D-2-pts. starting river right		GPH1b cross section shooting D-2-pts. starting river right		GPH1c cross section shooting D-2-pts. starting river right		GPH1d cross section shooting D-2-pts. starting river right		longitudinal profile/stream gradient derived from 5m DTMs	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	197.8	0
-0.2	8.2	-0.2	6.7	-0.3	5.3	-0.2	9.4	197.57	16.4
-0.4	6.7	-0.3	4.3	-0.1	3	-0.3	8.5	197.49	30.41
-0.4	3.1	-0.3	2.9	-0.4	3.9	-0.4	3.8	197.56	48.81
-0.4	3.6	-0.5	4.8	-0.3	1.6	-0.5	3.2	197.07	62.57
-0.5	3.8	-0.5	3.4	-0.2	2.1	-0.7	4.2	196.69	71.24
-0.2	2.7	-0.2	1.6	-0.3	1.8	-0.2	1.7	197.64	82.72
0	1.2	-0.3	1.6	-0.5	2.9	-0.5	2	196.52	93.19
-0.2	0.9	-0.1	0.7	-0.2	0.8	-0.2	1.8	196.38	105.28
-0.3	0.9	-0.1	0.9	0	2.3	-0.1	1.2		
-0.1	0.7	-0.1	1.5	-0.2	1.2	0	0.7	longitudinal profile/stream D-2-pts	
0.1	0.4	0.1	1.2	-0.3	1.2	0.1	0.5	Vert (m)	Hor (m)
0.3	0.4	0.1	1.1	-0.1	1.2	0.3	0.5	0	0
0.1	0.5	0.1	1	-0.2	0.5	-0.2	0.8	-0.2	8.7
-0.2	0.9	-0.1	1.2	0.2	1	0	1.5	0.1	4.6
0	0.6	-0.2	1.2	-0.1	0.6	-0.2	0.7	0	5.7
0	0.7	-0.1	1	0.1	0.8	-0.2	0.3	-0.2	9.7
0.1	0.3	0.1	1.1	0	0.8	-0.1	0.9	-0.3	15.6
0	0.3	0.2	0.5	0.3	0.5	0	0.7	0.2	6.1
-0.2	0.7	-0.1	0.6	0.3	0.6	0.1	0.5	-0.2	8.2
-0.3	0.7	-0.3	0.5	-0.1	1.7	0.1	0.3	-0.2	12.8
-0.1	0.5	-0.1	1.7	-0.1	0.7	0.2	0.5	-0.2	3.4
0	0.9	0.1	0.6	-0.1	0.6	0.2	0.7	0.1	5.9
0.1	0.9	0.1	1	0	0.9	-0.1	0.6	-0.2	5.9
0.4	0.9	0	0.7	-0.1	0.5	-0.1	0.5		
-0.3	0.9	0.2	0.7	-0.1	0.8	-0.1	0.5		
0	0.5	0.1	0.8	0.1	0.5	-0.1	0.1		
0.1	0.9	0	3	0	0.3	0	0.4	Valley/piedmont slope DTM	
0	2.6	0.3	7.1	0.4	1.3	0.2	0.4	Vert (m)	Hor (m)
0.4	5	0	10.6	0.1	1.4	0.1	0.3	197.53	0
0	3.2			-0.1	2.1	0	1.9	197.9	29.45
				0.1	3.4	0.1	1.9	197.44	54.74
				0.3	5.7	-0.1	2.5	196.89	84.05
				0.2	6.6	0	2.5	196.74	110.97
						0.3	4.7		
						0.2	3.4		
						0.1	5.6		

GPH1 Pebble Count conducted every 10cm																	
sd	sd	st	st	fp	sd	cp	mp	mp	sd	sd	sd						
sd	fp	sd	sd	fp	sd	sc	fp	fp	st	st							
sd	cp	mp	sd	fp	sd	cp	cp	cp	sd	st							
sd	fp	sd	sd	sd	sd	sc	fp	fp	sd	sd							
st	fp	sd	st	sd	sd	fp	mp	mp	sd	sd							
sd	fp	sd	sd	st	sd	sd	mp	mp	sd	sd							
sd	fp	sd	sd	sd	fp	fp	fp	fp	sd	sd							
fp	st	sd	fp	mp	fp	sd	st	st	sd	sd							
st	fp	sd	fp	sd	mp	cp	sd	sd	sd	sd							
cp	sd	sd	sd	st	sc	cp	sd	sd	sd	sd							

GPH2

GPH2a cross section shooting D-2-pts. starting river right		GPH2b cross section shooting D-2-pts. starting river right		GPH2c cross section shooting D-2-pts. starting river right		GPH2d cross section shooting D-2-pts. starting river right		GPH2 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0	7.7	0	3.2	0.1	11.9	-0.1	2.8	0.2	16.3
-0.1	3.3	-0.1	2.4	-0.1	4.2	-0.1	2.1	0.1	14.6
-0.1	1.9	-0.1	1.8	-0.1	2.1	0	2.6	0.2	15
-0.1	1.2	-0.2	1.4	0.1	1.6	-0.1	1.5		
-0.1	1.2	-0.1	1.5	-0.1	3.2	0.2	1.7		
0.2	0.7	0.1	0.3	-0.2	1.4	-0.2	1.1		
-0.1	1.6	-0.1	0.5	-0.2	0.7	-0.1	0.4		
-0.2	1.3	-0.1	0.6	0	1.1	0	0.4		
-0.1	1	0	0.6	0	1.5	0.1	0.5		
-0.1	0.8	0	0.5	0.1	0.7	0.1	0.9		
0.1	0.5	0.1	0.5	0	1.2	0	2.7	Valley/piedmont slope D-2-pt	
0.2	0.4	0	0.6	-0.1	1.2	0	1.3	Vert (m)	Hor (m)
0.1	0.6	0.1	0.9	-0.2	0.7	-0.1	1.2	0	0
-0.2	2.3	0	1.2	0.1	0.3	0.1	0.7	-0.1	11.4
0	7.3	0.1	1	0.1	0.4	0.1	0.6	-0.4	16
0.3	6.7	0.1	1.2	0.2	0.7	-0.1	0.7		
0.1	6.5	0	2.6	0	0.4	-0.1	1.2		
		0	2	-0.1	0.7	0.2	0.8		
		0.1	4.4	0.1	0.9	0.1	1.4		
				0	1.8	0.1	1.9		
				0.1	1.4	0.1	5.4		
				0	2.1				
				0.1	4.7				

GPH2 Pebble Count conducted every 10 cm																	
st	mp	sd	st	st	sd	fp	fp	fp	fp	fp	lc	mp	sc	fp			
mp	st	sc	sd	sd	cp	fp	sd	sd	fp	st	cp	sd	mp	sd			
st	sd	fp	fp	sd	fp	sd	mp	mp	fp	sd	cp	cp	cp	sc			
sd	cp	mp	fp	fp	Org	fp	sd	sd	mp	cp	fp	sc	sd				
fp	sd	fp	fp	st	mp	mp	fp	fp	mp	sd	st	mp	cp				
st	sd	cp	sd	fp	fp	sd	sd	sd	fp	mp	cp	st	cp				
sd	sc	sd	st	fp	Org	sd	sd	sd	cp	sd	sd	fp	fp				
mp	fp	cp	fp	sd	fp	mp	sd	sd	fp	cp	sd	cp	st				
sd	sd	mp	sd	cp	mp	fp	st	st	fp	mp	lc	fp	fp				
sd	sc	mp	mp	mp	sd	fp	mp	mp	mp	mp	mp	fp	mp				

GPH3

GPH3a cross section shooting D-2-pts. starting river right		GPH3b cross section shooting D-2-pts. starting river right		GPH3c cross section shooting D-2-pts. starting river right		GPH3d cross section shooting D-2-pts. starting river right		GPH3 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.1	3.9	-0.1	7.5	-0.1	8.3	-0.2	8.7	-0.1	13.4
-0.1	1.5	-0.2	3.3	-0.1	4.5	-0.2	3	-0.1	11.6
-0.2	0.7	-0.1	1.3	-0.1	2.3	-0.1	1	-0.2	11.5
0	0.5	-0.2	1	-0.2	1.7	-0.1	1.2	-0.3	11.8
0.1	0.7	-0.2	0.7	-0.1	0.9	0	2.9	-0.1	9.2
0.1	0.7	0	1.1	0.1	1.3	-0.2	2.2		
0.2	1.1	-0.1	0.6	-0.1	1.1	0	0.7	Valley/piedmont slope D-2-pt	
0	2	0.2	0.6	0.1	1.4	0.2	0.8	Vert (m)	Hor (m)
0.1	2	0	2.3	0.1	0.8	0	1.1	0	0
0.2	4	0.1	1.1	0.2	2.2	0.4	4.4	-0.4	34.4
0.2	7.4	0.2	3	0.4	6.5	0.2	5.3	-0.8	32.4
		0.1	2.8					0.2	14.5
		0.1	4.3					-0.3	18.2
								-0.3	11.3
								-0.4	19.1

GPH3 Pebble Count conducted every 10 cm																	
fp	cp	st	mp	mp	st	sd	mp	mp	sd	st	mp	mp	cp	fp	cp		
mp	sd	st	cp	sd	sc	fp	mp	mp	sc	mp	st	st	cp	mp	cp		
fp	sd	cs	fp	st	mp	mp	st	st	cp	fp	st	fp	cp	cp	cp		
st	sd	st	cp	sd	fp	st	sd	sd	cp	cp	fp	cp	mp	cp	st		
sd	fp	mp	fp	cp	mp	fp	st	st	fp	st	sd	fp	mp	mp	cp		
sd	sc	sc	sd	mp	cp	st	mp	mp	mp	sd	sd	cp	cp	mp	st		
cp	sd	cp	mp	sd	mp	sd	sd	sd	fp	fp	cp	st	cp	fp	cp		
mp	mp	cp	mp	cp	cp	cp	mp	mp	sd	fp	cp	mp	cp	cp	mp		
fp	cp	st	st	st	st	cp	cs	cs	sd	sd	st	st	fp	mp			
cp	cp	mp	mp	mp	st	fp	st	st	cp	sd	st	sd	fp	st			

GPH4

GPH4a cross section shooting D-2-pts. starting river right		GPH4b cross section shooting D-2-pts. starting river right		GPH4c cross section shooting D-2-pts. starting river right		GPH4d cross section shooting D-2-pts. starting river right		GPH4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**
0	0	0	0	0	0	0	0	0	0
-0.2	1.8	0	7.4	-0.1	8	-0.1	6.5	0.2	3.7
-0.3	1.2	-0.2	0.8	-0.1	2.4	-0.1	2.3	0.5	7.9
-0.2	0.5	-0.2	0.7	-0.1	0.9	-0.1	0.7	0.5	7
-0.3	0.6	-0.2	0.6	-0.1	0.5	-0.1	0.2	0.6	7.4
-0.1	0.4	-0.2	0.4	-0.1	0.3	-0.1	0.4	0.1	6.5
0.1	0.2	-0.2	0.6	-0.1	0.3	0.2	0.4		
0.2	0.1	0	0.4	-0.1	0.5	0	0.8		
0.1	0.1	0.1	0.3	0	0.4	-0.1	0.8	**GPH4 Valley/piedmont slope shooting D-2-pt starting upstream**	
0.1	0.6	0.2	0.4	0.1	0.1	0	0.5	**Vert (m)**	**Hor (m)**
0.4	1.2	0.2	0.6	0.1	0.4	0.1	0.4	0	0
0.3	0.2	0.2	0.8	0.2	0.6	0.1	1.4	-0.3	13.3
0	6	0.1	2	0	1.3	0.1	3.2	-0.2	7.1
		0	4.5	0.1	2.4	0.1	5.8	-0.2	8.7
				0.1	3.2			-0.2	7.3
								-0.2	7.2

GPH4 Pebble Count conducted every 5 cm																	
st	cp	sd	mp	mp	cp	cp	sd	sd	cp	mp	cp						
st	mp	fp	sd	cp	cp	cp	cs	cs	cp	cp	mp						
sd	cp	st	mp	cp	sc	mp	cp	cp	cp	sc	mp						
fp	mp	fp	cp	fp	fp	cp	st	st	sc	cp	mp						
sc	fp	fp	fp	fp	cp	mp	st	st	cs	cp	fp						
fp	mp	mp	mp	cp	st	cp	st	st	mp	cp							
lc	fp	mp	fp	fp	cp	st	sd	sd	cp	cp							
mp	fp	cp	mp	cp	cp	fp	cp	cp	cp	st							
fp	fp	cp	cp	sc	cp	sd	mp	mp	cp	cp							
cp	cs	cp	cp	cp	mp	st	mp	mp	cp	st							

GPH5

GPH5a cross section shooting D-2-pts. starting river right		GPH5b cross section shooting D-2-pts. starting river right		GPH5c cross section shooting D-2-pts. starting river right		GPH5d cross section shooting D-2-pts. starting river right		GPH5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0	1	0	3.4	-0.2	6.9	-0.2	4.4	-0.2	9.3
-0.1	1.7	-0.2	1.5	-0.2	1.9	-0.2	2.3	0	4.3
-0.2	0.7	-0.1	1.1	-0.1	0.9	-0.1	1.1	-0.4	7.9
-0.1	0.3	-0.1	0.7	-0.1	1	-0.1	0.7	-0.2	7.4
0	0.4	-0.2	0.4	-0.1	0.2	-0.1	1.1	-0.2	8
0.1	0.5	0.1	0.8	-0.2	0.3	0	0.8	-0.2	8.9
0	2	0	0.9	0	0.4	-0.1	0.5		
0.3	2	0.1	0.5	0.1	0.2	0	0.7	Valley/piedmont slope D-2-pt	
0.4	7.7	0	1	0.2	0.8	0.1	0.5	Vert (m)	Hor (m)
-0.1	4.1	0.1	1.1	0.1	0.9	0	0.7	0	0
		0.3	1.7	0.4	4.8	0.2	0.9	-0.4	13.7
		0.1	3.5	0.2	11	0.1	1.8	-0.3	14.7
		0.2	5.2			0.2	2.4	-0.2	9.7
						0.2	5	-0.4	12.3
								-0.2	10.5

GPH5 Pebble Count conducted every 5cm																	
cp	mp	mp	sd	sc	cp	st	st	st	st	mp	mp	sd	cp	mp	fp	cs	
mp	cp	fp	cs	cp	cs	st	fp	fp	cp	fp	fp	st	fp	cp	st	fp	
mp	cp	cp	mp	fp	fp	fp	st	st	cp	cp	cp	sd	cp	cs	fp	fp	
fp	mp	fp	sd	sd	fp	fp	fp	fp	mp	mp	fp	cp	fp	mp	cs		
st	mp	sd	cp	mp	fp	st	mp	mp	fp	mp	mp	fp	sd	fp	fp		
mp	mp	fp	mp	fp	fp	cp	fp	fp	cp	fp	mp	cp	mp	sd	fp		
cp	st	cp	cp	fp	sc	fp	st	st	mp	mp	mp	cp	mp	mp	mp		
mp	fp	fp	fp	sd	fp	fp	fp	fp	mp	st	cp	st	fp	fp	sd		
cp	fp	cp	fp	cp	fp	st	sd	sd	cp	cp	fp	mp	fp	mp	cs		
fp	mp	cp	sd	st	fp	st	mp	mp	fp	fp	mp	fp	st	mp	mp		

GPH6

GPH6a cross section shooting D-2-pts. starting river right		GPH6b cross section shooting D-2-pts. starting river right		GPH6c cross section shooting D-2-pts. starting river right		GPH6d cross section shooting D-2-pts. starting river right		GPH6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.8	8.4	-0.5	8.2	-0.5	6.9	-0.6	5.6	-0.2	7.5
-0.5	3.5	-0.2	4	-0.5	3.6	-0.3	2.6	-0.3	8.4
-0.2	2.8	-0.3	1.9	-0.4	3	-0.1	0.8	-0.2	4.6
0	1.5	-0.1	0.5	-0.1	0.9	-0.1	0.4	-0.3	3.8
-0.1	0.4	-0.1	0.5	0	0.5	-0.1	0.8	-0.2	3.4
0	1	0	0.6	-0.2	0.7	0	0.6	-0.2	5.4
0.1	0.4	0.1	0.1	-0.1	0.6	0.1	0.3	-0.3	5.4
0.2	1	0	1.3	-0.1	0.7	0.1	0.5		
0.8	3.8	0.1	1.5	0.1	0.6	0.5	2.9	Valley/piedmont slope D-2-pt	
0.7	6.6	1.1	4.6	0.1	0.1	0.5	3.8	Vert (m)	Hor (m)
		0.7	6.5	0.1	0.4	0.3	4.9	0	0
				0.3	1.7			0.3	18.6
				0.8	5.6			0.5	13.1
				0.3	7			0.7	22.2

GPH6 Pebble Count conducted every 5cm																	
cp	fp	fp	fp	cp	mp	cp	fp	fp	cp	cp	cp	st					
st	cp	st	mp	cp	cp	st	cp	cp	st	cp	mp						
cp	fp	fp	cs	cp	fp	fp	cp	cp	cp	cp	cs						
cp	mp	lc	cp	mp	cp	sc	fp	fp	cp	cp	sc						
st	fp	mp	mp	mp	fp	cp	cp	cp	cp	fp	fp						
cp	mp	fp	mp	mp	cp	fp	st	st	fp	mp	fp						
cp	fp	st	cp	sd	cp	fp	fp	fp	cp	mp	mp						
st	st	mp	mp	cs	cp	sd	fp	fp	cp	lc	cp						
fp	fp	st	cp	sc	cs	sc	st	st	mp	fp	mp						
fp	st	mp	fp	sc	cp	cp	fp	fp	cp	cp	cp						

MBA1

MBA1a cross section shot with pt-2-pt method starting river left		MBA1b cross section shot with pt-2-pt method starting river left		MBA1c cross section shot with pt-2-pt method starting river left		MBA1d cross section shot with pt-2-pt method starting river right		MBA1e cross section shot with pt-2-pt method starting river right	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
-1.6	0	-1.6	0	-1.6	0	-1.6	0	-1.6	0
-1.9	1.4	-2	0	-1.8	2.2	-2	2.6	-1.7	0.9
-2.2	1.4	-2.2	2.2	-1.9	2.2	-1.8	2.1	-2.2	1.5
-2.3	1.4	-1.7	1.6	-2	0.4	-2	7.1	-2.3	1.3
-1.7	1.3	-1.7	2.9	-1.9	1.9	-1.5	1.8	-2.2	1.8
-1.5	1.4	-1.6	2.6	-1.6	1.9	-1.5	1.2	-1.9	1.2
-1.6	0.9	-1.7	2.6	-1.3	1.3	-1.8	1.2	-1.8	1
-1.7	1.3	-1.8	2	-1.4	2	-2.6	1.5	-2.2	1.7
-1.9	0.8	-1.6	2	-1.5	2.1	-2.3	1.2	-1.5	1.9
-1.5	0.7	-1.7	1.7	-1.6	0.9	-1.8	0.6	-1.4	1.6
-1.7	0.6	-1.4	1.2	-1.7	1.4	-1.3	1.2	-1.6	1.5
-1.6	1.2	-1.3	0.8	-1.7	0.3	-1.8	0.4	-1.2	2.3
-1.6	0.9	-1.2	1.6	-1.5	1	-2	1.6	-1.3	0.6
-1.4	1.1	-1.2	1.8	-1.5	1.3	-1.6	1.2	-1.5	1.6
-1.4	0.6	-1.2	2.1	-1.8	1.7	-1.7	0.7	-1.6	1.1
-1.6	0.7	MBA1 Longitudinal Profile pt-2-pt		-2.1	1.1	-1.8	1	-1.6	0.6
-1.3	0.5			-2.1	0.7	-1.6	0.8	-1.6	1.3
-1.5	1.4			-1.7	0.7	-1.4	1.1	-1.5	0.7
-1.9	2.6	Vert (m)	Hor (m)	-1.6	1.7	-1.1	0.5	-1.6	1.1
-1.4	2.1	-1.6	0	-1	1.1	-1	1	-1.5	0.8
-1.1	2.1	-1.8	7.3	-1	0.5	-1.5	0.5	-1.5	1.3
-1.4	3.7	-1.6	8.5	-1.7	0.5	-1.7	0.8	-1.2	1
		-1.7	4	-0.8	0.4	-1.4	1.3	-1.1	2.6
		-2.1	5.4	-1.3	0.7	-1.4	1		
		-2.1	5.8	-0.8	1.3	-1.5	2.1		
		-1.6	2.8			-1.7	1.7		
		-1.9	6.5			-1.7	3		
		-2.1	6.2			-1.5	1.7		
		-1.9	6.7			-1.6	2.2		
		-2.2	6.1			-2.1	2.5		
		-1.3	8.1			-1.9	3.5		
		-2.2	3.5			-1.4	2.6		
		-1.5	5.6			-1.1	1.7		
		-1.7	6.8			-1.4	1.6		
		-1.6	10.4			-1.5	1.3		
		-1.6	5						
		-2	6						
		-1.7	7.5						
		-1.7	9.9						

MBA1 Pebble Count conducted every 1/2m along all 4 cross sections																	
mp	mp	mp	sd	mp	fp	mp	cp	cp	lc	lc	fp	fp	mp	cp			
mp	mp	fp	sd	cp	sd	mp	cp	cp	B	lc	lc	lc	fp	mp			
sd	mp	fp	cp	cp	sd	mp	cp	cp	lc	B	cp	cp	cp	fp			
fp	cp	mp	cp	mp	sd	cp	fp	fp	sc	cp	mp	cp	cp	lc			
fp	mp	fp	mp	cp	sd	mp	sd	sd	lc	cp	cp	cp	fp	mp			
mp	cp	mp	cp	lc	sd	mp	cp	cp	sd	cp	sd	cp	fp	sd			
mp	fp	cp	mp	mp	sd	mp	fp	fp	B	cp	fp	lc	mp	cp			
fp	cp	fp	mp	mp	sd	cp	mp	mp	sd	lc	cp	mp	cp	cp			
fp	fp	mp	cp	B	sd	cp	mp	mp	sc	lc	mp	cp	cp				
mp	sd	mp	fp	cp	sc	fp	sd	sd	lc	mp	sd	sc	lc				

MBA2

MBA2a cross section shooting point-2-point starting river right		MBA2b cross section shooting distance between 2 points (D-2_pts) starting river right		MBA2c cross section shooting distance between 2 points (D-2_pts) starting river right		MBA2d cross section shooting distance between 2 points (D-2_pts) starting river right		MBA2 longitudinal profile shooting pt-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
-1.6	0	0	0	0	0	0	0	-1.6	0
-1.7	1.2	-0.3	0.7	-0.2	0.8	-0.2	1.5	-1.8	5.2
-1.7	1.1	-0.5	1.1	-0.4	1.3	-0.8	1.5	-1.9	6.3
-2.1	0.6	-0.3	0.6	-0.4	0.8	-0.3	0.4	-1.7	4.3
-1.9	0.3	-0.4	0.6	-0.6	1	-0.7	0.8	-1.7	3.8
-1.6	0.3	-0.4	0.8	-0.6	1.2	-0.2	0.3	-1.8	5.1
-1.7	0.2	-0.1	0.2	-0.3	0.6	-0.1	0.4	-2	4.8
-1.7	0.1	-0.2	0.1	-0.3	0.6	0	0.2	-2	3.7
-1.6	0.1	-0.1	0.4	-0.1	0.3	-0.4	0.6	-1.7	4.8
-1.6	0.1	0	0.9	-0.1	0.6	-0.2	0.4	-1.8	4.3
-1.4	0.3	0	1.1	0.1	0.4	0	1	-1.9	5.3
-1.2	0.7	0.3	0.4	-0.2	0.4	0.1	0.7	-1.7	3.5
-0.6	1.7	0.9	0.6	0	1	0	0.6	-1.6	1.6
-1	2.3	0.7	0.5	0	1.5	0.1	0.5	-1.7	3.2
-1.1	2.8	0.3	1.2	0.1	0.3	0.5	0.8	-1.9	6.1
-1.5	2.9	-0.1	1.6	0.1	0.2	0.6	1	MBA2 valley/piedmont slope 5-m DTM	
		0.7	3.2	1.3	1.6	0.7	1.5		
				0.7	1.3	0.1	0.5	Vert (m)	Hor (m)
				0.3	1.1	0.2	0.7	322.95	0
				0	0.3	0.4	3.6	322.18	40.39
				0.1	0.9			322	71.17
								321.62	93.17

MBA2 Pebble count																	
cp	cp	fp	sc	mp	mp	Bk	sc	sc	fp	cp	cp	mp	fp	fp			
cp	cs	mp	mp	fp	mp	Bk	mp	mp	cp	cp	sd	mp	fp	mp			
fp	fp	fp	cp	fp	mp	Bk	mp	mp	mp	cp	cp	mp	fp	mp			
sd	fp	fp	cp	fp	mp	Bk	cp	cp	cp	sc	cp	fp	fp	cp			
mp	fp	cp	bk	mp	mp	mp	mp	mp	mp	cp	fp	fp	mp	mp			
cp	cs	sc	bk	fp	fp	cs	mp	mp	fp	cp	Bk	fp	cs	fp			
cp	fp	fp	bk	fp	fp	cp	fp	fp	fp	fp	st	mp	fp	Bk			
cp	fp	cp	bk	fp	mp	cp	fp	fp	fp	mp	lc	cp	fp	cs			
cs	fp	fp	bk	cp	fp	lc	mp	mp	fp	fp	fp	sc	mp	Bk			
fp	fp	mp	mp	mp	cp	sc	mp	mp	fp	fp	fp	mp	fp	Bk			

MBA3

MBA3a cross section shooting D-2-pts. starting river right		MBA3b cross section shooting D-2-pts. starting river right		MBA3c cross section shooting D-2-pts. starting river right		MBA3d cross section shooting D-2-pts. starting river right		MBA3 longitudinal profile shooting pt-2-pt	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	-1.6	0
-0.2	0.9	-0.8	2	-1.8	3.3	-1.1	2.3	-1.6	6.5
-0.9	1.4	-1.4	1.6	-1.1	1.2	-1.3	2	-1.7	13.4
-1.4	1.9	-1.1	0.6	-0.3	0.2	-1	0.5	-1.6	20.9
-1.7	2.7	-0.8	0.9	-0.4	0.9	-0.8	0.9	-1.5	27.1
-0.2	1.5	-0.1	0.3	-0.5	0.2	-0.6	0.3	-1.6	33.5
0	1.5	-0.2	0.5	-0.1	0.6	-0.3	0.1	-1.4	41.1
0	0.6	0.1	1	-0.1	0.4	-0.3	-0.1	-1.6	50
-0.2	0.7	-0.1	1.4	-0.3	0.6	0.1	1.7	-1.7	55.2
0	0.9	0.1	1.1	0	1.1	0	1.8	-1.3	62.9
-0.1	0.7	0	0.3	-0.2	0.6	0	0.7	-1.6	70.6
0.3	0.2	0.1	0.4	0	0.5	0	0.4	-1.6	75.3
0.6	0.6	0.2	0.8	-0.1	0.6	0	0.7	-1	117.3
0.7	0.8	0.1	1.2	-0.1	0.4	0.2	0.7	Valley/piedmont slope shooting pt-2-pt	
0.3	0.5	0.2	1.1	0.5	-0.1	0.4	0.6		
0.7	1.5	0.2	0.5	0.3	0.2	0.7	0.6		
0.7	2.3	1.8	2.3	-0.1	1.1	0.8	0.3	Vert (m)	Hor (m)
0.6	2.1	1	1.7	1.3	0.3	1	1.3	0	0
0.6	2.4	1.6	4	1.7	0.6	1.8	0.7	0.1	80.9
0.2	0.7			2.6	3	0.8	-0.2	0	47.7
						0.5	0.8	2	133

MBA3 Pebble Count counted every 20cm																	
lc	cs	sc	sc	mp	sd	mp	sd	sd	fp	lc	Bk	WD	cp	mp			
mp	fp	cp	lc	fp	sc	fp	st	st	fp	fp	Bk	cs	sc	mp			
cp	fp	mp	cp	mp	mp	fp	Bk	Bk	cs	mp	mp	mp	WD	cp			
mp	Bk	cp	cp	mp	fp	cp	cp	cp	cp	mp	Bk	cp	fp	WD			
cp	Bk	cp	cp	sd	fp	st	fp	fp	sc	cs	mp	WD	mp	Bk			
fp	Bk	fp	mp	cp	fp	BK	fp	fp	cp	Bk	mp	fp	sd				
fp	cs	mp	cp	fp	cp	mp	cs	cs	cs	fp	WD	mp	cp				
cs	mp	cp	fp	fp	mp	cp	Bk	Bk	cs	mp	Bk	mp	mp				
fp	sc	lc	Bk	cp	sd	fp	cp	cp	cs	cs	sc	WD	cp				
mp	cp	mp	fp	cs	fp	mp	sc	sc	Bk	fp	mp	mp	WD				

MBA4

MBA4a cross section shooting D-2-pts. starting river right		MBA4b cross section shooting D-2-pts. starting river right		MBA4c cross section shooting D-2-pts. starting river right		MBA4d cross section shooting D-2-pts. starting river right		MBA4 longitudinal profile shooting D-2-pt	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	2.7	0.1	0.5	0	4.4	0.1	6.6	0.4	17.4
-0.4	1	-1.1	2.4	-0.2	1.8	-0.1	0.8	0.8	32.4
-0.7	1.6	-1.2	2.2	-0.4	2	-0.5	1.9	0.3	33.8
-0.8	1.3	-0.3	0.4	-0.9	2.4	-0.2	5.1	0.9	32.9
-0.5	0.9	-0.6	-0.1	-0.8	1.8	-0.2	0.8	0.2	23.9
-0.4	0.7	-0.2	0.4	-1.4	3.2	-0.4	0.8		
-0.3	0.7	-0.2	0.2	-0.1	0.7	-0.1	0.4		
-0.1	1.3	-0.2	0.5	0	1.4	0	0.7		
-0.2	0.8	-0.2	0.4	0.2	0.7	0.2	1.1	Valley/piedmont slope shooting D-2-pt	
0	2.3	0.1	1	0	0.9	0	2.5		
-0.1	2.2	0.2	1.5	-0.1	2.9	0	0.5		
0.1	0.5	0.1	1	-0.2	4.2	0.1	0.8	Vert (m)	Hor (m)
0.2	0.2	0.2	0.5	-0.3	1.3	-0.2	2.2	0	0
0.2	0.3	0.1	2.6	-0.1	1.4	0	1.6	-0.5	25.4
0.4	1.3	0	0.7	0.1	1.1	-0.1	0.6	-0.1	45.7
0.4	4.8	-0.1	0.8	0.3	1.8	-0.5	0.6	-0.7	16.6
1.4	3.2	0.1	0.9	-0.1	2.5	-0.2	0.4	-0.3	10.3
0.8	1.6	0.1	0.9	0.1	2.1	0.1	0.6	-0.8	31.2
0.2	1.5	-0.1	1.6	-0.1	1	0	3.1		
0	3.5	0.1	1	-0.1	0.6	-0.1	3.4		
		0.2	1.1	-0.2	0.4	0.2	1		
		0	1.8	-0.4	1.3	0.9	2.1		
		0.1	6.8	0	1.9	2.3	4.1		
		0.5	2.5	0.1	0.5	0.3	2.7		
		1.2	3.7	-0.1	0.2	0.1	5.3		
		0.8	2.7	0.2	0.3				
		0	2.5	0.2	0.3				
				0.4	-0.1				
				0.4	0.1				
				0.4	-0.1				
				0.4	0.4				
				0.5	0.9				
				0.5	0.8				
				0	1.5				

MBA4 Pebble Count conducted every 40 cm																	
fp	fp	fp	cp	sd	fp	mp	fp	fp	sd	Bk	mp	mp					
sd	mp	Bk	mp	mp	fp	mp	mp	mp	fp	Bk	mp	mp					
sd	fp	sc	cp	mp	cp	cp	mp	mp	fp	Bk	mp	cp					
fp	sd	lc	fp	fp	sc	mp	cp	cp	fp	lc	mp	cp					
cp	sd	Bk	fp	fp	fp	mp	sc	sc	fp	cp	mp	cp					
mp	mp	Bk	fp	sd	sd	cp	fp	fp	cp	fp	fp	mp					
cp	mp	fp	fp	fp	sc	cp	mp	mp	cp	fp	fp						
fp	fp	sd	mp	fp	cp	mp	mp	mp	mp	fp	fp						
fp	fp	sd	fp	mp	cp	mp	cp	cp	fp	fp	fp						
fp	sd	fp	sd	mp	cp	mp	B	B	fp	fp	fp						

MBA5

MBA5a cross section shooting D-2-pts. starting river left		MBA5b cross section shooting D-2-pts. starting river right		MBA5c cross section shooting D-2-pts. starting river right		MBA5d cross section shooting D-2-pts. starting river right		MBA5 longitudinal profile shooting D-2-pt	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.6	7.7	0.1	4.1	-0.3	2.5	-0.2	4.2	-0.3	8.8
-1	6.6	-0.1	1.3	-0.3	2.4	-0.1	1.3	-0.2	15.9
-1.5	6.1	-0.1	1.2	-0.1	1	-0.3	1.5	-0.4	15.7
-0.6	0.6	-0.4	1.1	-0.1	0.6	-0.1	0.5	-0.5	15.9
-0.2	0.5	-0.2	0.3	0.1	1.3	-0.2	0.3	-0.5	16.5
-0.1	0.5	-0.2	0.5	-0.1	1.3	-0.1	0.4		
-0.2	0.4	0	0.4	0	0.7	0	1		
0.1	0.6	0.1	0.4	-0.1	0.6	-0.1	0.3		
0.1	0.8	0	1.2	0	0.5	-0.1	0.6		
0.1	0.8	0	0.9	-0.2	1	0.1	0.3	Valley/piedmont slope shooting D-2-pt	
0.3	1	-0.1	0.8	0.1	0.7	0	0.6		
0.2	0.6	-0.2	0.8	0.1	0.4	0.2	0.4	Vert (m)	Hor (m)
0.1	0.4	0.1	0.2	0.2	0	0.3	1	294.72	0
0.3	1.3	-0.1	0.4	-0.2	0.6	0.5	1.5	293.99	36.6
0.1	1.6	0.2	0.5	0.1	0.1	0.7	1.5	292.49	92.66
		0.1	0.2	0.3	-0.2			291.7	145.52
		0.6	1	0.5	-0.2				
		0.9	1	0.7	0.4				
		0.8	1.3	0.4	0.6				
		1	3.2	0.4	1.4				

MBA5 Pebble Count conducted every 10 cm																	
cp	fp	mp	fp	fp	B	cp	fp	fp	fp	mp	fp	cp	fp	cp	cp	fp	fp
mp	fp	cp	sd	fp	cp	sc	fp	fp	fp	lc	mp	mp	cp	mp	cp	fp	fp
mp	mp	mp	sd	fp	mp	sd	fp	fp	fp	cp	mp	mp	Bk	Bk	cp	sd	fp
mp	fp	cp	Org	fp	mp	sd	fp	fp	fp	cp	lc	mp	mp	sc	cp	sd	lc
sc	cp	mp	sd	mp	cp	fp	fp	fp	fp	mp	mp	cp	lc	mp	mp	fp	sd
cp	cp	cp	fp	mp	sd	sd	fp	fp	mp	cp	cp	fp	cp	mp	fp	sd	sd
sc	cp	fp	sc	mp	cp	fp	fp	fp	fp	mp	sc	fp	Bk	lc	fp	sd	sd
mp	mp	fp	fp	mp	cp	sd	mp	mp	fp	mp	cp	sd	fp	fp	fp	fp	
cp	cp	fp	fp	cp	mp	fp	cp	cp	cp	mp	cp	fp	cp	lc	fp	fp	
cp	mp	fp	fp	fp	cp	fp	fp	fp	mp	fp	cp	mp	cp	cp	mp	fp	

MBA6

MBA6a cross section shooting D-2-pts. starting river right		MBA6b cross section shooting D-2-pts. starting river right		MBA6c cross section shooting D-2-pts. starting river right		MBA6d cross section shooting D-2-pts. starting river right		longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.6	3.6	-0.1	1.1	-0.6	5.3	-0.3	3.9	-0.8	14.3
-1.1	3.4	-0.3	0.8	-0.4	0.9	-0.3	1.5	-0.9	14
-0.2	3.4	-0.5	0.5	0.2	0.2	-0.5	0.7	-0.4	14.2
-0.1	1.5	-0.2	0.2	0	0.2	0.1	0.4		
-0.1	0.9	0	0.1	-0.3	0.3	-0.1	0.2		
-0.3	1	-0.3	0.2	-0.3	0.1	-0.6	0.2		
-0.2	1.3	0.1	1	-0.1	1.5	-0.3	0.5		
0	0.4	0	0.7	-0.1	1.4	0	0.7		
-0.2	0.3	0.3	0.4	-0.3	0.1	-0.2	0.5		
0	0.2	0.2	0.5	-0.1	0.1	0	0.2		
0.3	0.3	-0.1	0.2	0.2	0.3	0.2	-0.1		
0.2	0.2	0	0.7	0	0.4	0.4	0.6		
0.2	0.4	0.7	0.7	0.3	0.3	-0.2	0.2		
-0.2	0.4	0.7	1.8	0.3	0.7	0.2	0.1		
0	0.7	0.8	3.8	0.4	0.1	0.2	0.7		
0.6	0.3			0.2	0.6	0.5	1.2		
0.2	2.4			-0.4	0.1	0.8	3.8		
				0.2	1.5	0.2	2.6		
				0.1	2.4				
				1.1	2.5				

MBA6 Pebble Count conducted every 10 cm																	
fp	fp	lc	fp	Bk	lc	fp	mp	mp	fp	sc	lc						
mp	fp	fp	mp	BK	cp	fp	fp	fp	fp	lc	sc						
cp	sc	fp	B	B	mp	fp	mp	mp	mp	sc	fp						
mp	mp	cp	B	BK	mp	fp	mp	mp	mp	B	mp						
fp	cp	cp	cp	Bk	fp	fp	sc	sc	mp	lc	sc						
fp	mp	cp	lc	BK	fp	fp	B	B	B	fp	mp						
cp	cp	cp	sc	Bk	sc	mp	B	B	fp	mp	fp						
fp	cp	sc	Bk	BK	cp	cp	B	B	fp	fp	B						
sd	cp	fp	Bk	Bk	fp	fp	B	B	fp	mp	fp						
mp	cp	fp	BK	BK	fp	fp	fp	fp	cp	B	fp						

MBD1

MBD1a cross section D-2-pts starting river right		MBD1b cross section starting RR using D-2-pts.		MBD1b cross section continued from previous column		MBD1c cross section D-2-pts starting river right		MBD1 cross section surveyed Pt-2-pt starting river right	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	-0.1	0.6	0	0	1.6	0
-0.2	14.5	-0.1	7.9	0	3.3	-0.3	6.6	1.9	4.3
-0.6	2.8	-0.2	3.9	0.1	0.6	-0.8	1.2	1.7	3.4
-2.5	4.6	-1.4	7.1	0	2.4	-1.2	0.2	2.3	1.6
-2.6	8.4	-1.5	5.1	-0.1	0.6	-0.9	1.6	2.5	1.2
-1.1	8.5	-1.7	6.7	-0.1	0.5	-1.2	2.8	3	2
-0.2	0.7	-0.9	3.3	0.3	0.3	-1	2.1	2	1.3
-0.1	1	-0.5	3.4	-0.3	1.5	-0.8	3.6	2.4	0.4
0	3	-0.3	5.8	0.2	3.3	-0.2	6.3	1.7	0.1
0.1	2.1	-0.1	3.6	-0.1	0.8	0.3	3.7	1.9	2.2
0.3	4.4	-0.1	2.7	0.2	3.2	0	3.9	1.5	2.4
-0.1	4.6	-0.1	2.1	0.2	0.5	-0.1	1.3	1.7	4.1
-0.3	2.9	-0.3	3.6	0.2	3.8	-0.2	1.6	1.8	0.7
0	5.1	-0.1	0.2	0.2	9.6	-0.1	0.2	1.3	10.5
0.3	2.9	0	1.6	0	4.5	-0.1	0.8	1.9	16
-0.1	4.1	0.1	0.3	0.2	1	0	1.1	1.7	3.8
-0.1	6.2	0.1	0.9	0	4.1	0.1	1.4	1.6	16.5
0.1	4.4	-0.2	4.1	-0.4	2.1	0.4	3	1.6	7.2
-0.3	7	-0.1	1.8	0	1.3	-0.3	4.9	1.7	5
0.1	3.1	0.1	1.9	0.1	0.4	-0.3	3.8	1.7	4.8
-0.4	2	0	1.8	0	1.2	-0.3	1.7	1.4	11.3
0.3	1.9	0.2	0.8	0.3	0.8	-0.4	0.2	1.6	6.4
0	0.8	0.2	1.8	0.2	2.3	0.2	3.2	1.6	4.8
-0.1	0.9	-0.1	1.4	0.2	6.1	0.1	7.3	1.7	5.1
0	1.5	0	2.2	-0.1	8.7	-0.1	4.1	1.7	6.1
-0.2	4.5	-0.1	3.2	-0.3	6.4	-0.1	1.9	1.4	2.6
0	6.4	0	3.2	0.1	4.3	0.4	0.9	1.4	1
0.1	0.2	0.1	0.8	-0.2	1.2	0.1	2.2	1.5	4.5
0	2.2	0	1.3	0	10	-0.2	1.4	1.4	2
0.4	4.7	0.2	1.2	-0.2	2.5	0.1	3.6	1.6	1.2
-0.1	2.1	0	2.2	0.2	3.8	-0.3	5.3	1.4	1.4
-0.1	0.5	-0.2	3.5	0.2	7.5	0.1	4	1.5	2.4

-0.1	5.8	0	4.1	0.1	17.3	-0.3	3.8	1.7	3.2
0.1	0.9	-0.1	3.1	-0.1	9.7	0.1	1.4	1.6	1.5
0.1	7.6	0.1	1.5	-0.1	4.8	-0.3	3.7	1.5	1.8
-0.4	4	0.1	1.3	-0.2	2	0.1	1.8	1.5	2.6
0.3	3.5	0.1	2.9	-0.5	3.1	-0.2	0.3	1.8	7.3
-0.4	3.7	0	4.5	0	1.4	0	2.8	1.8	8.7
0.3	4.8	0	4.2	0.3	1.8	0.2	1	1.5	3.7
-0.3	8.2	-0.4	4.4	0.1	4.1	0	2.3	1.7	3.9
0.2	3	0.1	3.5	-0.2	4.7	-0.2	2.7	1.5	2.9
-0.1	3.7	0.3	2.4	0	8.2	0.3	3.6	1.6	3.9
-0.3	2.1	-0.2	6.5	-0.3	4.1	-0.1	1.6	1.8	6
-0.2	2.2	-0.1	0.8	-0.4	3.9	0.3	0.7	1.7	5.3
0.5	2.9	0	2.2	0.1	1.2	0.2	3	1.9	7.1
-0.3	3.3	-0.1	2.8	0.6	2.7	-0.6	3.1	1.5	3.9
0.2	2.3	0	1.1	0.6	4	0	0.9	1.9	4.8
-0.3	1.4	0.2	1.5	0.8	2.5	0	1.8	1.6	1
0	1.4	-0.3	0.7	1.5	3.5	0.3	1	1.6	4.6
-0.4	4	0	0.8	0.9	2.7	0.4	2.7	1.5	3
-0.1	1.8	0.3	0.9	0.1	1.9	-0.2	4.1	1.9	8.3
-0.1	4.4	-0.2	2.8	0	4	-0.2	6	1.7	5.5
0.1	2.5	0.1	2.9			-0.3	2.3	2	8.4
0.1	6.7	0	4			0.2	1.5	1.6	5.1
0.1	4	-0.3	1.8			-0.7	6.3	1.8	2.5
-0.1	3.1	0	1.4			0.1	7.3	1.8	1.4
-0.2	4.6	0.1	0.5			0.4	4.9	1.7	4.9
0.1	5.8	0.1	4.7			0	1.8	1.7	1.6
-0.3	2.3	-0.1	1.7			-0.2	0.8	1.6	0.5
0.2	0.3	-0.2	2.1			0.1	4.5	1.5	1.9
0.2	1.8	0.1	1.4			0.3	2.6	1.6	4.9
0	3.3	0	5.8			0.3	2.3	1.5	1.8
0	5	0.2	1.8			0.1	3.1	1.5	3.3
0.2	8.3	0	6.6			-0.1	7.1	1.7	1.1
-0.2	9.6	-0.2	5.8			-0.2	1.1	1.7	1.1
0.2	4.8	-0.1	3.6			-0.1	9.5	1.6	2.2
0.2	9.2	-0.1	5			0	5.4	1.6	2
0.1	4.3	0.1	3.7			-0.2	6.1	1.2	1.8
-0.3	1.1	-0.1	0.1			0.3	0.9	0.4	3.2
0	3.5	-0.1	5			0.3	5	0.1	3.3
0.1	1	0.1	1.9			0	4.6	-0.3	3
0	8.7	0	2.1			-0.4	5.8	0.9	1.5
-0.1	9.7	0.2	2.1			-0.4	1.8	1.6	4.9
-0.2	4.1	0	6.2			0.1	5.7	2	8.4
0.4	2.1	-0.2	3			0.1	0.7		
0.1	9.6	-0.1	0.1			0.2	3.2		
-0.5	1.8	-0.1	2			-0.2	1.4		
0.1	9.1	-0.1	2.4			0	2.5		
0.2	5.4	0.2	0.4			0.1	3.5		
-0.2	3.5	0.2	1.4			-0.1	2.1		
0	4.8	0	1.9			-0.2	8.4		
0.3	3.8	-0.1	1.5			0	6.1		
-0.2	3.1	-0.1	3.4			-0.2	4		

0.1	12.7	0	3.5			0.4	1.4		
-0.3	6	0.1	3.1			0.1	7.1		
-0.1	5.1	-0.2	1.3			-0.2	4		
0.1	7.8	-0.2	3.3			-0.2	6.3		
-0.6	9.5	0	2.1			0.2	1.1		
0.8	4.6	-0.1	2.4			0.2	2		
-0.4	4.3	0	3.4			0	4.4		
-0.6	0.9	0.2	0.6			-0.3	2.2		
0.2	2.8	-0.2	2.7			0.2	1.4		
-0.3	11	0.1	0.9			0.2	5.5		
0.2	1.7	-0.1	3.2			0	13.9		
-0.1	2.7	-0.2	1.7	MBD1 longitudinal profile 5-m DTM		-0.1	11.2		
0	5.2	-0.1	1.6			-0.2	8.6		
0.4	1.5	-0.2	0.4			-0.5	4		
-0.3	8.1	0	0.9	Vert (m)	Hor (m)	0.4	3.6		
0.5	11.9	0.2	0.7	210.2	0	-0.3	2.6		
-0.6	7.7	0	1.4	206.2	467.5	-0.1	3.8		
0.2	7.9	0.2	3.4	201.9	895.5	-0.2	0.6		
-0.3	6.2	-0.3	6.4	196.4	1310.5	0.1	5.1		
0.3	15.9	-0.3	7.2	192.5	1713.4	0.3	1.3		
-0.1	3.8	0	2.8			0.2	1.7		
-0.6	3.7	0.2	1.4			0.1	4.6		
0.4	4.5	-0.1	1.2			0	6.2		
-0.4	3.9	-0.1	3.4			0.1	10.9		
0.1	8.3	0.1	4.2	MBD1 Valley/piedmont slope GIS 5-m DTM		-0.4	3.7		
-0.3	3.3	0.1	2.4			-0.2	4.5		
0.1	9.6	0	5.7			-0.2	3.9		
-0.3	1.1	-0.1	0.7	Vert (m)	Hor (m)	0.3	5.77		
0.4	8.3	-0.3	0.3	216.8	0	0.1	4.1		
-0.4	4.8	0.1	3.5	212.8	421.7	-0.1	4.2		
0.4	6.2	-0.2	6.5	208.7	924.2	-0.1	0.5		
-0.6	4.1	0.1	3.2	202.7	1448.5	-0.3	1.3		
0	3.8	0.2	6.4	198.6	1873.5	0	5.8		
0.5	3.4	-0.1	6.7			0.3	1.2		
0	10.8	0	8			0.1	1.3		
-0.5	5.8	0.1	4.1			0.3	5.7		
0.6	6.3	-0.2	7.7			-0.2	5.2		
-0.6	14.1	-0.2	1.8			0	8.4		
0.3	2	-0.2	1			-0.1	8.2		
-0.2	22.1	0	4.2			0.2	1		
-0.5	4.4	0	1.8			0.4	2.8		
0.4	2.5	-0.1	1.1			0.9	2.6		
0.1	27.2	0.2	1.2			1.5	4.3		
-0.3	13.5	0.1	0.1			0.2	2.3		
-0.7	3.4	0.4	0.2			-0.1	3.7		
0.7	13	0	2.9						
0.1	26.6	0	3.7						
-0.1	6.7	-0.2	3.6						
-0.9	5.1	-0.2	0.9						
-0.1	6.4	0	1.2						
1	3.7	-0.1	3.3						

-0.7	12	-0.4	0.3						
0.5	3.1	0.2	2.4						
-0.1	21.7	0.1	2.3						
-0.5	3.2	0.1	0.1						
0.5	5.4	0	1.6						
-0.1	11.5	0	4.6						
9.2	27.6	-0.1	2.8						

MBD1 Pebble count, made at MBD1c along the active channel near RR every 1m																	
mp	fp	sd	fp	sd	mp	fp	sd	sd	cs	fp							
sd	fp	fp	st	cp	sd	fp	cp	cp	sd	st							
cp	fp	mp	fp	mp	sd	mp	fp	fp	st	sd							
sd	fp	fp	fp	lc	sd	fp	fp	fp	sd	sd							
mp	sd	fp	fp	sd	lc	fp	sd	sd	sd	cp							
st	st	fp	fp	cs	st	fp	sd	sd	fp	sd							
fp	sd	cs	fp	cs	st	mp	fp	fp	sd	fp							
st	st	fp	cp	cs	fp	fp	cp	cp	fp	sd							
mp	mp	sc	sd	fp	fp	fp	fp	fp	cp	sd							
st	st	sd	mp	fp	fp	fp	fp	fp	sd	mp							

MBD2

MBD2a cross section shooting D-2-pts. starting river right		MBD2b cross section shooting D-2-pts. starting river right		MBD2c cross section shooting D-2-pts. starting river right		MBD2d cross section shooting D-2-pts. starting river right		MBD2 longitudinal profile 5-m DTM	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	225.2	0
0.1	3.6	-0.1	5.5	-0.2	5.7	0.2	11.3	224.1	325.6
-0.4	2.1	-0.3	2.8	-0.3	7.3	-0.2	1.4	220.2	632.8
-1.1	3.4	-0.5	3.2	-1.1	9.3	-0.4	1.6	216.9	987.6
-0.7	2.5	-0.6	5	0	3.1	-0.2	1.6	213.7	1360.4
-0.2	0.3	0	4.3	-0.3	3.4	-0.1	2		
0.1	1.8	-0.2	2.8	-0.2	1.3	-0.2	3		
0.3	0.6	0	1.6	-0.1	1.9	-0.2	2.4		
-0.2	0.6	0	1.3	0.1	1.6	0.2	0.4		
0.2	1.6	-0.2	1.1	0.2	3.6	0.1	7.7	MBD2 Valley/piedmont slope 5-m DTM	
0	2.8	0	2.1	-0.1	4.4	-0.1	2.4		
-0.4	3.3	0	4.8	0.1	1.7	0	1.6		
-0.2	2.4	0.3	2.6	0	1.9	-0.2	1.1	Vert (m)	Hor (m)
0.3	0.8	0.2	1.9	0.2	3.2	-0.1	2.9	233.8	0
0.1	1.3	-0.1	1.8	0	3.5	0	3.8	229.1	368.3
0.1	4.7	-0.1	1	0.1	4	-0.1	5.3	224.5	673.5
-0.3	9.1	0	2.9	-0.4	0.8	-0.2	1.4	221.1	1019.3
-0.2	1.3	0.1	1.8	-0.2	3.4	-0.2	0.5	218.1	1369.7
0.1	5.4	0	5.1	0	5.7	-0.1	1.1		
0	2.2	-0.1	5.2	0.2	1.1	0.3	1.7		
-0.3	1.4	0	3.1	0.5	0.9	0.1	1.6		
-0.1	0.7	-0.1	2	-0.3	2.8	0.1	0.3		
0.2	1.2	0.1	3.3	-0.1	1.9	0.3	0.8		

0	3.3	0	6.7	0.4	1.9	0	4.2		
-0.2	6.8	0	5.4	-0.1	1.7	-0.4	3.5		
0	10.4	-0.2	2.5	-0.1	1.3	-0.3	1.9		
-0.3	4.7	0	2.8	0	1.8	-0.1	2.6		
0.1	3.2	-0.1	1.4	-0.3	0.7	0	4.4		
-0.1	2.3	-0.4	3.2	-0.1	1.4	0.2	1.6		
-0.1	1.2	0.5	2.3	0.1	1.9	0.1	1.1		
-0.2	1.5	-0.1	1.1	-0.1	7	0.5	1.7		
-0.3	1.3	0.2	0.5	0	4.7	0.2	3		
0	1.9	0	1.4	0.1	2	0.1	3.1		
0.2	1.7	0	5.5	-0.1	1.2	-0.1	9.3		
0.1	3.6	-0.1	3	-0.1	0.6	0.1	10.4		
0	3.4	0.2	1.6	-0.5	0.7	-0.2	13.1		
0.2	2.3	0	6.5	0.1	2.9	-0.2	12.1		
0.3	2.3	-0.1	0.8	0	1.9	-0.2	6.1		
1	3	-0.3	1.9	0.3	0.9	0	16.1		
-0.1	3	0	0.8	0.3	5.5	-0.2	5.2		
-0.3	4.2	-0.3	1.6	0	7.2	0.2	2.7		
-0.2	0.9	-0.1	1	0	8	-0.3	4.3		
-0.2	0.8	0.1	1.6	-0.4	2.1	0.1	2.7		
0	2.9	0	1.7	-0.1	1.1	-0.6	1.2		
0	2.7	0.1	1	0.4	2.6	0.4	6.7		
-0.3	5.2	0.1	1.4	-0.1	0.9	0	4.3		
0.7	0.8	0	3.6	-0.2	0.9	0.1	1.3		
0.1	5	0.1	2.9	-0.2	4.6	0.2	0.6		
-0.1	8	-0.1	6.3	0	3.8	0.2	1		
-0.2	7.3	0.2	5	0.1	0.9	0.1	2		
-0.1	2.8	-0.1	7	0	10	0	3.4		
-0.1	0.5	0.2	5.9	0.1	1.8	-0.3	4.7		
-0.1	0.7	-0.4	6.7	-0.1	5.8	0.2	10.3		
0	3	0.1	3.2	0	8	0	4.3		
-0.3	1	-0.3	7.8	0.1	10.1	-0.2	1.6		
1	1.9	0.1	1.5	-0.1	1.9	0	2.7		
0.1	8	-0.1	1.2	-0.2	0.8	0	4.1		
0.1	2.7	-0.2	2.6	-0.1	1.5	0.2	1.5		
0.1	2.5	0	2.8	-0.1	2.7	-0.1	5.1		
0.1	3.1	0.2	1	0.3	1.4	0.2	4.3		
0.1	2.5	0.1	10	0.2	3.8	-0.4	3.4		
0	6.9	-0.3	5.6	-0.1	6.5	0.3	2.1		
-0.2	4	0	1.8	-0.2	6.2	0	1.9		
-0.2	2.1	0.2	1.9	0	3	0.1	3.6		
0	3.3	0.1	6.5	-0.1	0.3	-0.2	3.1		
-0.4	1	-0.2	9.2	-0.1	0.3	0.1	2.4		
0	1.7	-0.1	10.3	-0.1	1.4	-0.3	2.8		
0.1	1.5	-0.1	5.6	0.2	0.7	0.1	3.2		
0.1	5.2	-0.1	5.6	0.1	0.8	0.1	9.5		
0.2	2	0.3	4.5	-0.2	2.6	-0.1	10.6		
0.1	3.8	-0.2	1.5	-0.2	3	-0.2	9.6		
0.1	3.8	0.1	4.9	0.2	7.9	-0.1	5.4		

-0.1	1	0	4.3	0	6.6	-0.3	1.2		
-0.3	1.7	-0.4	1.6	-0.1	3.4	0.4	1.8		
-0.1	1.3	0	5.6	-0.1	0.8	0	1.6		
0	3.4	0.6	3.4	-0.4	1.9	-0.1	1.1		
-0.2	1.4	-0.1	4.8	-0.1	3.4	-0.1	0.5		
-0.1	5	0	3.6	0.1	3.3	0.1	0.5		
0.5	0.8	0.1	2.5	0.2	1.2	0.2	0.6		
0.3	1.4	-0.3	2.6	-0.1	2.5	0.3	1.5		
0.1	2.8	-0.1	6.3	-0.2	1	0.4	2.6		
-0.2	4.5	-0.2	4.8	-0.1	1	0.5	7.4		
-0.1	2.9	-0.2	0.9	0.1	1.5	0.2	9.2		
0.6	2	-0.1	2.1	0.4	2.6	0.1	5.5		
0.3	1.1	0.9	0.6	0.2	2.8				
0.1	1.8	0.9	0.6	-0.2	13.3				
		0.1	4.5	-0.1	7.7				
				-0.2	5.4				
				-0.1	4.4				
				-0.1	3.3				
				0.1	1				
				0	3.9				
				-0.1	3.2				
				-0.2	2				
				-0.2	3.4				
				-0.2	4				
				-0.2	1.1				
				-0.1	2.6				
				-0.2	2.3				
				-0.1	5.4				
				0.3	1.3				
				1.9	0.8				

MBD2 Pebble Count conducted every 1/2m along all 4 cross sections																	
st	st	sd	sd	sd	fp	sd	sd	sd	mp	sd	fp	sd	sd	fp	mp	mp	sd
sd	fp	fp	cs	sd	sd	fp	st	st	sd	fp	cp	fp	sd	fp	fp	sd	sd
st	sd	fp	mp	fp	fp	fp	sd	sd	sc	sd	cp	fp	sd	st	fp	cs	fp
fp	fp	sd	sd	fp	mp	sd	st	st	fp	sd	sd	sd	fp	fp	sd	sd	mp
sd	sd	fp	cp	fp	sd	fp	sd	sd	sd	cp	cp	sd	sd	fp	sd	fp	fp
st	sd	sd	sd	sd	sd	sd	sd	sd	fp	fp	fp	fp	cp	fp	sd	fp	fp
sd	st	sd	fp	fp	fp	sd	cp	cp	fp	mp	fp	fp	cs	sd	fp	fp	sd
sd	sd	sd	sd	fp	mp	cs	fp	fp	cp	sd	cp	cp	fp	fp	fp	cp	sd
st	fp	sd	sd	sd	sd	cs	fp	fp	sd	mp	sd	fp	fp	fp	fp	fp	sd
sd	sd	cs	fp	fp	sd	sd	mp	mp	fp	sd	sd	sd	mp	sd	sd	fp	sd
fp	sc	fp	cp	sd	st	sd	sd	mp	cp	sd	cp	sd	fp	sd	fp	mp	cp
fp	sd	cp	fp	fp	sd	fp	sd	cs	st	fp	fp	cs	fp	sd			

MBD3

MBD3a cross section shooting D-2-pts. starting river right		MBD3b cross section shooting D-2-pts. starting river right		MBD3c cross section shooting D-2-pts. starting river right		MBD3d cross section shooting D-2-pts. starting river right		MBD3 longitudinal profile shooting pt-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	-1.75	0
-0.1	3	-0.7	0.5	-1.1	3.6	-2.4	7.8	-1	68.8
-0.5	5.7	-0.5	2.3	-1.1	3.3	-1.4	4.3	-1.3	35.6
-0.8	3.5	-0.2	1	-2.3	5.3	-1.4	0.3	-1.6	28.6
-1.2	2.5	-0.3	0.9	-0.2	6.3	-0.6	1	-1.2	56.5
-0.4	1.6	-0.8	1.2	-0.2	3.8	-0.9	0.5	-1.3	44.2
-0.4	2.6	-0.1	0.6	-0.1	2.4	0	0.5	-1.3	40.5
-0.1	1.3	-0.2	0.4	-0.3	2.3	0.1	0.9	-1.4	32.1
0	2.7	0.1	0.5	-0.2	1.4	-0.1	2.2	-1.5	39.3
0.1	3.8	-0.1	0.9	0	4.8	0	0.8	-1.2	28.8
0.2	3.4	0.1	2.3	-0.1	9.8	-0.1	0.5	-1.4	40.9
-0.2	1.6	-0.1	5.1	0.2	1.2	-0.1	4.2	-1.6	30
-0.2	3.7	0.1	1.4	0.2	5.5	0.1	0.5	-1.5	22.4
0	1.4	0.2	1	0.3	3.1	0.1	1.4	-1.7	23.2
-0.1	1.1	0.3	0.8	0	3.9	0.5	1.1	-1.6	23.1
-0.1	3.4	0.1	5.7	-0.1	2.6	0.5	0.3	-1.7	20.4
0	2.9	0	1.7	-0.1	1	0	6.6	-1.5	19.7
0.2	1.4	0.1	3.4	-0.1	0.4	-0.4	1.2	-1.5	22.2
0	2	-0.2	1.6	0	1.1	-0.1	1.8	-1.6	24.6
-0.2	1.8	0	1.1	0.3	1	0	2.2		
0.1	1.3	0.2	1.3	-0.1	2.3	0.1	0.8		
-0.1	2	0	5.7	-0.2	0.3	0.1	1.4	MBD3 stream gradient derived from 5-m DEM	
0	3.3	-0.1	5.2	-0.1	1.1	-0.2	0.7		
0.1	1.9	-0.2	4.6	0.2	0.8	-0.2	0.9		
0	1.5	0.1	2	-0.1	1.2	-0.2	9.5	310.3	0
-0.4	1.4	0	1.3	-0.1	1.2	0	1.8	308.7	130.7
-0.1	1.2	-0.3	2.1	0.1	1.1	0.2	1.1	306.5	334.1
-0.2	2.2	0	1.3	0.1	1.6	0.1	4.9	304.4	544.9
0.1	2.2	-0.2	1.7	-0.2	3	0	3.5	302.8	753.2
0	2.8	0	1.6	0.4	2.7	0.5	2.2		
0.1	7	0.1	2	0	2.2	0.2	5.4		
0.2	0.8	0.2	1.8	-0.2	1.4	0.1	8.4		
0.7	3.5	-0.2	1.2	0	1.7	-0.1	4.2		
0	2.8	-0.2	3.3	0	1.8	0.1	6.1		
0	3.9	-0.1	2.5	-0.1	2.8	-0.2	5.5		
-0.2	5.3	-0.1	0.8	0.2	1.6	-0.2	3.8		
-0.3	2	0	0.7	-0.2	1.5	0.1	1.5		
0.1	3.4	0.1	0.3	-0.1	0.5	-0.2	3.8		

0	1.5	0	2.6	0	0.8	-0.1	2.2		
0.3	0.7	0.1	1.8	0.4	1	0.3	1.1		
0.2	0.8	-0.1	0.9	0	0.7	0.1	4.8		
-0.1	1	0.1	1.1	-0.3	4.5	0.1	1.1		
-0.1	0.4	-0.1	1	-0.1	1.6	-0.1	1.3		
0.1	1.4	-0.1	2.6	-0.3	0.8	0	5.5		
0.1	0.6	-0.1	3	0.1	1.8	0.1	8.1		
0	5.9	0	0.6	0.2	0.8	-0.1	1.4		
0.2	3.9	0.3	0.7	0.1	1	-0.2	1.5		
-0.2	1.6	0.3	0.2	0	2.6	-0.2	2.3		
-0.3	1.1	0.4	2.7	-0.3	1.5	-0.1	7.8		
0	3.6	-0.4	2.9	-0.1	2.6	0	5.8		
0.2	0.7	0.1	1.6	0.1	3.5	0	1.9		
0	5.2	0	1.8	0	2.4	0.3	2.6		
0.1	1.2	-0.3	2	-0.2	2.7	-0.1	2.9		
0	0.8	0.1	1.9	0.1	1.2	0.1	3		
-0.3	0.1	0	1.9	-0.1	0.6	0.1	2.5		
0.4	7.4	0	0.4	-0.2	4.2	-0.3	4.1		
0.3	0.7	0.3	1.1	-0.1	4.3	-0.1	3.9		
0.1	4.1	-0.1	0.7	0.1	1.8	0.1	2.1		
-0.1	1.8	0	2.5	0.2	2.1	0.2	2.8		
-0.4	3.3	0.3	0.4	0	2.2	0.1	4.5		
-0.1	3.1	0.1	3.8	0	0.9	0	2.5		
-0.1	3.2	-0.1	1.9	-0.2	0.2	-0.2	1.5		
0.3	4.4	0.1	1.6	0	1.1	0	0.9		
0	2	-0.1	2.4	0	3.3	0.2	2.7		
-0.2	4.3	0.2	3.7	0.1	4	-0.1	2.7		
0.1	0.7	-0.1	3.6	0.3	1	0	1.8		
-0.2	4.9	-0.1	11.3	-0.4	1.2	-0.3	3.1		
-0.2	2.2	-0.3	2.2	0.1	3.3	0.1	0.9		
-0.1	3.5	0	1.2	0.2	1.6	-0.2	6		
-0.2	0.4	0.3	2	0.1	6.4	0.4	3.8		
0	4.3	0	2.9	0.1	1.6	0	1.6		
0.3	0.5	-0.3	7.1	-0.2	1.9	-0.1	1.6		
0.2	1.4	-0.3	1.1	0	6.2	0.1	4.5		
-0.2	1.1	0.1	2.5	0.1	4.1	0	1.4		
-0.3	1	0.6	3.8	-0.1	2.8	0	1.3		
0.1	0.7	0.2	8.9	0.3	3.5	-0.2	1.3		
0.4	2.1			0	7.3	0	2.9		
-0.1	3.5			-0.1	6.2	-0.1	2.7		
0.3	2.2			0.1	7.9	0	4.3		
0.5	8.4			-0.3	2.9	0.2	4.8		
0	10.6			0	2.5	0.2	4.8		
				-0.2	1.1	0	4.8		

				0	0.9	-0.2	4.8		
				0.2	1.1	-0.1	5.8		
				0	4.5	-0.1	2.3		
				0	4.5	-0.1	1		
				0	1.5	-0.2	3.6		
				-0.2	1	0.4	1.9		
				-0.1	3.1	0.1	2.2		
				0	4.4	-0.2	2.9		
				0.2	1.8	0.1	5.1		
				0.4	3.5	-0.4	0.9		
				0.9	2.9	0	4		
				0.5	7.5	0.4	0.7		
				0	4.2	0.2	6.5		
						0.5	3.1		
						1.5	9.8		

MBD3 Pebble Count conducted every 1/2m																	
sd	fp	sd	fp	fp	fp	fp	cp	cp	fp	st	st	cp	fp				
cp	fp	sd	fp	mp	sd	fp	fp	fp	fp	cs	st	fp	mp				
sd	mp	sd	fp	fp	sd	mp	sc	sc	cs	fp	cp	fp	fp				
fp	fp	fp	fp	fp	sd	cp	st	st	cs	fp	st	sc	mp				
cp	fp	sd	mp	mp	mp	fp	fp	fp	fp	st	cs	fp	st				
fp	fp	fp	mp	sd	sc	fp	cp	cp	mp	st	fp	fp	st				
fp	fp	mp	fp	fp	mp	fp	cs	cs	fp	fp	mp	fp	fp				
fp	mp	fp	cp	fp	fp	mp	cs	cs	cp	st	st	fp					
fp	cp	fp	mp	sd	fp	cp	cs	cs	mp	st	cs	fp					
cp	sd	fp	fp	sd	fp	fp	fp	fp	cs	st	cp	fp					

MBD4

MBD4a cross section shooting D-2-pts. starting river right		MBD4b cross section shooting D-2-pts. starting river right		MBD4c cross section shooting D-2-pts. starting river right		MBD4d cross section shooting D-2-pts. starting river right		MBD4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	-1.75	0
-3.4	7.5	0	1	-5.2	55.5	0.2	16	-1.5	25.5
-3.5	8.5	-0.9	1.4	-1.2	59.3	0.1	4.4	-1.7	27.2
-0.4	2.1	-2.1	5.8	-0.2	26.4	-0.5	2.9	-1.2	50.6
-0.8	7.6	-0.3	3.9	-1	23.2	-0.9	3.1	-1.7	47.8
-0.5	5.5	-0.8	5	-0.3	5.2	-0.2	3.3	-1.5	50.4
-0.3	0.8	-0.3	5.3	0.6	5.1	0.3	7.5	-1.6	28.2
-0.1	0.6	0.1	2.5	0	8.3	0	3.2	-1.4	46.1
-0.1	0.4	-0.5	12.6	-0.7	13.8	-0.2	7.6	-1.6	21.2
0	1.1	-0.5	22.7	-0.3	7.4	-0.8	1.1	-1.4	19.4

1.3	3.5	-0.4	19.5	0.1	4.2	0	0.5	-1.6	21.7
0.1	4	-0.3	0.9	0	2.3	-0.2	0.3	-1.6	22.8
-1.1	4.9	0.2	0.1	-0.3	0.7	-0.5	1.3	-1.7	31.3
0.4	16.8	-0.1	9	0.3	1	-0.1	2.8	-1.5	33.9
0.1	12.8	-0.4	2.5	0.2	2.6	0	2.3	-1.5	29.5
-0.2	10.1	0	21	1.4	4.2	0	1.5	-1.5	16
-0.3	7.4	0	10	0.3	9	0.1	2.1	-1.6	33.9
-0.5	2	0.3	10.3	-0.1	9.2	0.1	1.1	-1.4	40
-0.2	4.4	0.1	5.8	-0.4	6.8	0.6	1.3	-1.4	30.5
0.3	2.4	-0.5	4.9	0.2	7.2	0.4	0.3	-1.6	22.7
0.1	3.9	-0.1	8.5	0	8	-0.2	2.9	-1.7	23.8
-0.2	1.1	0.1	16.7	-0.3	3.1	0.3	1.2	-1.5	34.5
0	3.8	-1.1	0.2	-0.2	1.1	-0.2	1.8	-1.7	15.1
0.1	1.3	-0.7	1.1	-0.6	1.5	0.1	0.9	-1.7	28.7
-0.3	1.7	-0.8	0.9	-0.6	6.1	-0.1	1.9	-1.7	28.7
-0.1	3.3	0.2	5.5	-0.5	7.6	-0.4	2	Valley/piedmont slope D-2-pt	
0.2	1.3	0	6.1	-0.3	1.3	-0.1	2.2		
0	1.6	0.2	1.5	0	1.8	-0.1	2	Vert (m)	Hor (m)
0.1	1.8	0.1	6.7	0.2	2.3	0	1.6	0	0
0.2	2.2	0.3	5.2	-0.1	5	0.4	1.7	-0.4	36.1
0.2	1.2	0.1	2.8	-0.2	1.4	-0.3	1.4	-0.6	53.1
0.2	3.9	-0.2	3.9	-0.1	2.9	0.3	3.6	-0.5	46.5
0	3.3	-0.2	4.4	0.6	8.7	-0.1	1.9	-0.5	39.8
-0.2	4.3	-0.3	3.3	-0.1	5.2	0.3	4.3	-0.7	47.2
-0.1	6.6	-0.1	4.3	-0.4	2.6	0.1	6.5	-0.3	45.7
-0.2	5.7	0.2	7.3	0.1	2.7	-0.1	8	-0.6	49.2
-0.2	4.8	0.1	5.2	-0.4	4	-0.1	5.8	Stream gradient 5-m DTM	
0.5	3.4	-0.2	3.3	-0.1	1.3	0	3.5	Vert (m)	Hor (m)
0.6	2.5	0.2	3.7	0	2.9	-0.4	2	207	0
-0.2	5.8	-0.3	2.4	0.1	0.8	0	0.7	204	229.4
0.1	3.9	-0.1	1.4	0	2.7	0.3	0.9	203	469
0.2	5.8	0.1	0.6	-0.5	3.2	0.2	1.3	202	661
-0.3	2.6	0.2	0.4	-0.2	7.1	-0.1	3.6	Stream gradient 10-m DEM	
0	12.2	0.1	5.7	1	0.7	-0.2	7	Vert (m)	Hor (m)
0	15	0.6	3.4	-0.2	1.6	0.2	1.2	208.05	0
0.3	9.4	-0.2	17	-1.1	0.3	-0.1	2.2	208.02	20.33
0.6	4.4	-0.1	17.8	0.3	2.3	1.3	11.5	208.02	45.08
1	3	-0.1	20.8	0.1	0.9	2.6	12	207.73	79.09
1.7	4.3	0.4	16.8	-0.2	1.1	4.3	7.5	207.72	103.78
2.9	5.2	1.3	17.7	0.3	2.2	1.3	3.8	207.72	137.08
2.4	4.2	1.4	3.5	0.6	0.3	1.7	4.9	207.72	161.11
0	2.5	0.3	2	0.4	0.2	0.1	27.3	207.7	201.04
		0.1	2.7	0.8	0.3			207.62	247.12
		1.5	2.9	3.3	1.6			207.66	274.94
		3.6	5.9	3.4	3.9			207.79	305.99
		-0.3	8.6					207.36	360.24
								206.8	403.54
								206.15	449.93

								205.79	493.23
								205.63	516.08
								205.33	540.7
								205.14	559.27
								204.91	585.95
								204.62	618.1
								204.24	653.62
								204.1	684.69
								203.73	718.7
								203.21	744.4
								202.75	772.13
								201.53	834.41
								Valley/piedmont slope 10-m DEM	
								Vert (m)	Hor (m)
								214.88	0
								209.96	112.48
								209.05	235.76
								209.04	443.79
								208.82	558.21

MBD4 Pebble Count conducted every 20 cm along cross sections																	
fp	sd	sd	mp	fp	fp	Bk	sd	sd	sd	sd	sd	sc	cp	sc	mp	cp	cp
fp	sd	sd	mp	sd	sc	mp	mp	mp	sd	sd	sd	sd	sd	sd	sd	cp	cp
fp	fp	sd	sd	sd	sd	fp	fp	fp	sd	sd	sd	sd	sd	fp	cp	cp	sd
sd	sd	sd	sd	sd	sd	sd	fp	fp	sd	sd	sd	sd	sd	sd	lc	cp	sd
sd	sd	sd	sd	sd	sd	Bk	sd	sd	sd	sd	sd	lc	B	sd	sd	sd	sd
sd	sd	sc	sd	fp	Bk	cp	mp	mp	sd	sd	sd	mp	sd	cp	mp	B	cp
sd	sd	fp	fp	fp	sd	sd	fp	fp	sd	sd	sd	sd	mp	fp	fp	sd	mp
mp	sd	sd	sd	sd	sd	sd	sd	sd	sd	sd	mp	sd	sd	cp	cp	sc	cp
sd	cp	cp	sd	sd	sd	sd	sd	sd	sd	sd	sd	cp	sd	sd	sd	cp	lc
sd	sd	sd	sd	org	fp	fp	mp	mp	sd	sd	sd	sd	fp	sd	sd	sd	sd
sd	fp	sd	mp	sd	mp	mp	sd	B	sd	sd	cp	fp	sd	sc	sd	sd	sd
sd	fp	lc	sd	cp	sd	sd	cp	sd	sd	mp	cp	mp	sd	sd	sd	sd	sd
cp	sd	sd	cp	cp	sd	sd	sd	sd	cp	cp	sd	cp	sc	cp	fp	cp	mp
sd	fp	sd	sd	lc	sd	sc	sd	sd	sd	sd	sd	sd	sd	sd	sd	sd	sd
sd	sd	sd															

MBD5

MBD5a cross section shooting D-2-pts. starting river right		MBD5b cross section shooting D-2-pts. starting river right		MBD5c cross section shooting D-2-pts. starting river right		MBD5d cross section shooting D-2-pts. starting river right		MBD5 longitudinal profile 5-m DTM derived	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	211.8	0
0	6.3	0	16.6	-0.1	4.8	-0.1	7.5	211.5	169.1
-0.2	3.1	0.1	12.7	-0.2	2.3	-0.1	2.7	209	456.5
-0.3	2.4	-0.1	3.5	-0.3	2	-0.3	2.7	205.9	795.2
-0.4	3	-0.4	3.5	-0.9	3.8	-0.8	3.2	202.9	1157.3
-0.1	1.1	-0.4	1.6	-0.2	2.3	-0.6	1.6		
-0.1	0.9	-0.2	0.3	0.1	2.3	0	1.4		
-0.1	1.2	0.1	4.2	-0.2	0.8	0.2	1.3		
-0.5	0.7	0.2	6	-0.3	0.7	0.3	1.4		
-0.1	0.9	0.2	4.6	-0.4	0.9	-0.4	1.9	MBD5 Valley/piedmont slope 5-m DTM	
-0.1	0.8	0	8.5	-0.1	2.4	-0.5	3.4		
0.2	1	-0.1	6.9	0	1.1	0	1.8		
0.1	1.3	0.1	2.1	0.3	1.8	0	4.4	Vert (m)	Hor (m)
0.1	1.1	0	2.2	0.1	2.4	-0.2	1.8	214.7	0
0	1.9	-0.1	2.3	0.1	2.9	-0.2	1.8	211.1	419.1
-0.1	5.1	-0.3	1.4	0.3	2.7	0	2.8	207.4	759.2
0	5.9	-0.2	4.8	0	6.6	0.3	1.9	204.3	1085.9
-0.1	7	0.2	2.4	-0.1	4.3	0.1	5.7	200.8	1358.5
0	10.6	0.3	3.6	-0.2	2	0.1	5.7		
-0.1	10.2	-0.2	2.2	0	2.2	0	6.6		
0	4.8	-0.1	2.2	0	2.4	-0.3	2.4		
0	4	0.1	2	0.1	1.8	0	3.3		
-0.1	1.2	0.1	1.5	-0.1	2.9	-0.3	2.1		
-0.1	1.1	0.1	6.9	-0.2	3.9	0	7		
-0.2	1.6	0	7.2	0.3	1.2	-0.2	5.1		
0	0.7	0	2.9	0	1.5	-0.1	2.6		
0.1	1.2	-0.2	1.2	-0.2	1.1	-0.1	1.4		
0	5.5	-0.1	0.7	-0.1	1.5	0.1	0.8		
0	3.5	0	2.2	0.3	1.7	0.3	0.4		
0.3	0.4	0.2	1.1	0.1	1.7	0.2	1.9		
0.4	0.8	-0.1	4.5	-0.1	2.2	0.2	2.3		
0.1	4.3	0.3	6.6	0.1	1.9	0	3.7		
-0.2	12.8	-0.2	3	0.1	5.1	-0.1	2		
0	11.9	-0.1	6.8	-0.2	6.5	0	6.5		
-0.2	13.9	0.1	2.5	0.1	2.2	0	7.8		
0.3	12.3	-0.1	2.9	-0.2	3.2	-0.2	9.2		
-0.1	16.8	-0.2	2.7	-0.4	2.5	0	11.4		
-0.2	10.5	0.1	3.2	-0.3	2.5	-0.4	3.9		
-0.3	4.2	0.4	1.2	0.1	1.8	0.2	3		
-0.1	3.2	0.2	13	-0.1	3.5	0	3.8		
-0.3	1.4	0	7.2	-0.1	5	0.2	7.8		
0	2.1	-0.3	6.1	0.3	2.1	0	9.7		
0.1	1.1	-0.1	1.4	0.1	2	0.1	4.6		

0.1	1.5	-0.3	1.3	-0.1	2.1	0	2.5		
-0.1	0.8	0	1.1	0.1	2.6	-0.2	3.3		
-0.3	0.8	0.1	1.2	0.4	2.4	0	6.6		
-0.1	0.1	0	4.1	0	1.5	-0.1	8.1		
0.1	3.5	0.2	5	-0.2	1	-0.2	3.6		
-0.1	5.4	0.1	7.9	-0.1	1.2	-0.2	4.1		
0.1	1.7	-0.2	4.5	0.1	1.3	-0.3	1.2		
0.4	2.4	-0.2	7	0	0.7	0.1	3.4		
0	5.4	0	4.2	-0.2	1.5	0	2.7		
-0.1	5.5	-0.2	0.7	0	1.8	0.1	2.7		
-0.2	4	-0.2	0.9	0	2.4	0.2	2.3		
0.1	0.6	-0.1	0.8	0.3	0.6	0.1	1		
0.1	4.7	0	1.2	0.2	3	-0.5	5.9		
-0.2	7.8	0.1	0.7	0.1	4.1	-0.3	5		
0.1	2.9	0.1	1.2	0	4	0.2	2.5		
-0.2	2.6	0	2.7	0	2.8	0.3	2.9		
-0.2	1.4	0.2	8.2	-0.2	2.6	0	2.5		
-0.3	4.4	-0.2	6	-0.1	1.9	-0.1	2.3		
0.1	1.5	0	4.1	0.2	1.1	-0.3	3.7		
0.2	3.1	0.6	8.9	0	3.1	0	2.3		
0.2	6	0.7	3.1	0	1.6	0	1.4		
0.1	11.9	0.7	4.8	-0.3	1.6	0.1	6		
0	11	0.3	7.6	-0.1	2	0.1	4.7		
-0.2	1.5			0.4	1.3	-0.1	1		
0.2	2.2			-0.1	1.9	-0.2	0.9		
0.1	2			0.3	5.1	-0.2	2.6		
-0.2	1.9			-0.1	5.2	0	3.1		
0	2.9			-0.1	5.5	-0.1	7.5		
0.1	3.1			-0.2	4.7	0.2	3		
-0.2	1.6			0	8.3	0.4	0.3		
-0.4	1.1			-0.4	12.9	1.1	1.6		
-0.1	1.5			0.4	6.3	0.2	19.6		
0	2.3			0.2	3.8				
0.2	1.5			0.2	2.8				
0.1	1.7			-0.2	4.7				
0.2	1.2			0.2	2.7				
0.1	2.9			-0.1	4.9				
-0.3	5.9			-0.1	8.2				
-0.2	4.3			-0.1	5.3				
0.1	2.2			-0.3	4.3				
-0.2	2.8			0.2	3.6				
0.2	1.3			-0.2	2.9				
-0.1	1.4			0.2	3.2				
0.3	5.2			-0.2	2.2				
-0.1	2			-0.1	1.3				
-0.6	2			-0.2	1				
0.2	2.1			0	2.3				
0	0.8			0.3	1				
-0.1	1.7			0.4	1				

-0.2	0.7			0.2	2.5				
-0.1	3			0.5	4.1				
-0.1	3.1			0.6	4.9				
0.7	0.7			0.1	3.2				
0.6	0.3								
0	1.7								
1.5	8.2								
0.2	5.2								

MBD5 Pebble Count every 1/2m																	
st	cp	lc	st	fp	cs	cp	fp	fp	cs	fp	fp	cp					
fp	sd	sd	st	cp	cs	fp	mp	mp	fp	fp	cs	fp					
sd	cp	fp	sd	cp	sd	fp	fp	fp	fp	mp	mp						
fp	sd	sd	fp	fp	sd	mp	cp	cp	cs	fp	cs						
mp	sd	fp	fp	sd	sd	fp	fp	fp	fp	cp	cs						
sd	fp	mp	sd	fp	fp	sd	fp	fp	fp	lc	fp						
fp	st	fp	mp	sd	fp	sd	cp	cp	mp	sd	sd						
fp	cs	fp	fp	fp	sd	cp	B	B	mp	mp	mp						
sd	cp	mp	fp	cs	sd	fp	mp	mp	cp	cs	sd						
fp	sd	st	fp	fp	sd	fp	cs	cs	fp	fp	mp						

MBK1

MBK1a cross section shooting pt-2-pt starting river right		MBK1b cross section shooting from single point starting river right		MBK1c cross section shooting from single point method starting river right		MBK1d cross section shooting from single point starting river right		MBK1 Longitudinal profile surveyed using the pt-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
-1.6	3.3	-0.5	5.8	0	6.5	0.8	5.5	-1.6	0
-2.6	2.3	-0.1	4.8	-0.7	4.8	-0.4	4.2	-1.9	1.5
-2.1	1.8	-1.2	3.7	-1.1	3.6	-0.6	3.9	-2.3	1.7
-2.4	1	-1.5	3.5	-1.4	3	-0.8	3.4	-1.5	2
-1.4	1.2	-1.7	3	-1.5	2.88	-1.3	2.4	-1.3	1.7
-1.7	1.1	-1.9	2.3	-1.8	2.86	-1.9	2.3	-2.3	4.7
-1.8	0.9	-2.2	1.9	-2.7	2.84	-1.6	2	-2.2	5
-1.6	0.9	-2.2	1.8	-3.5	2.82	-1.4	1.2	-1.8	2.8
-2.3	0.2	-2	1.8	-3.4	2.6	-1.2	1	-1.7	2.3
-1.7	0.1	-1.6	2.1	-3.4	2.7	-1.6	1.1	-1.8	2
-0.4	1.3	-1.1	2.4	-3	2.7	-1.5	2.1	-1.9	1.3
-0.8	2.1	-1.4	3	-2.2	2.8	-1.3	3.6	-2.9	2.3
-0.5	3.2	-1.5	3.3	-0.9	3	-0.8	4.1	-2.8	0.8
		-1	4	-0.3	4	-0.1	5.4	-1.3	0.6
		-0.3	5	0	4.2	1	6.1	-0.9	2.3
						1.7	6.3	-1	2.7
								-2.2	2.4
								-2.4	0.9
								-1.4	3.3
								-1.9	5.3
								-1.9	2.4
								-1.9	2
								-2.2	2.9
								-1.6	3
								-2	3
								-1.8	2.3
								-1.8	3.4
								-1.8	4.3
								-1.7	1.3
								-2.1	1.6
								-1.5	2.6
								-2.1	1.2
								-1.7	5.9
								-2.3	5.3
								-1.7	1.1
								-1.6	1.2
								-2.3	1.4
								-4.4	1.9

MBK1 Pebble count																	
mp	cp	lc	lc	sc	cp	B	lc	B	cp	fp	sc	mp	sc	mp			
lc	B	sc	cp	mp	B	sd	cp	cp	fp	sc	mp	cs	fp	mp			
sc	fp	cp	B	sd	mp	sd	mp	mp	fp	sc	sc	lc	fp				
lc	cp	cp	fp	mp	cp	sd	cp	mp	cp	lc	cp	sc	cp				
cp	mp	B	mp	mp	sc	cp	B	fp	B	cp	cs	cp	cs				
cp	mp	mp	mp	B	fp	mp	mp	fp	cp	mp	cp	lc	fp				
cp	fp	mp	fp	cp	fp	mp	sc	sc	cp	sc	cp	fp	cp				
mp	lc	lc	sd	B	mp	sc	mp	fp	fp	sc	fp	sc	B				
fp	mp	sd	sd	B	cp	mp	fp	cp	cp	lc	cp	fp	sd				
cp	mp	sd	mp	lc	mp	sc	cp	mp	lc	cp	cp	mp	lc				

MBK2

MBK2a cross section shooting D-2-pts. starting river right		MBK2b cross section shooting D-2-pts. starting river right		MBK2c cross section shooting D-2-pts. starting river right		MBK2d cross section shooting D-2-pts. starting river right		MBK2 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.1	1	-1.3	1.9	-0.6	1.3	-0.5	1.2	-3.8	10.8
-0.3	0.2	-0.5	0.3	-0.5	1.3	-0.4	0.4	-3	2.6
-0.2	0.5	-0.1	0.5	-0.1	0.3	-0.6	0.6	-0.2	2.1
-0.4	0.3	-0.4	0.6	-0.2	0.3	-1.3	0.1	-2.5	3.3
0	0.3	-0.4	0.6	-0.1	0.9	-0.1	1	-1.4	3.4
0.3	0.1	0.2	0.4	-0.5	0.4	1	0.2	-0.4	4.2
0.4	0.1	-0.3	0.7	0.4	0.8	0	0.5	-1.3	2.2
0.3	0.1	0.4	0.2	0	0.1	0.1	0.5	-2.1	10.1
0.2	0.1	0.2	0.2	0.4	0.3	-0.5	0.4	-2.1	2.3
0.3	0.4	0.3	0.3	0.3	0.4	0.2	0.8	0.4	6.7
0.3	0.9	0.7	0.7	0.1	0.5	0.6	0.8	-1.1	9.2
		0.7	3.3	-0.4	0.5	0.5	0.2	MBK2 Longitudinal profile derived from 5-m DTM	
				0	0.3	0.8	2.5		
				0.5	0.2	0.7	1	Vert (m)	Hor (m)
				0.5	0.2			471.09	0
				0.1	0.6			468.3	10.42
				0.2	0.4			463.43	16.79
				0.1	1.1			461.82	21.21
				0.7	2.5			461.16	26.3
								459.3	31.36
								458.47	36.73
								458.47	40.84
								457.52	46.31

*NOTE: MBK2 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

MBK3

MBK3a cross section surveyed starting river right from a single point along transect		MBK3b cross section surveyed starting river right from a single point along the transect		MBK3c cross section surveyed starting river right from a single point along transect		MBK3d cross section surveyed starting river right from a single point noted along transect		MBK3 Longitudinal profile Pt-2Pt	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
-0.4	2.7	-1.6	0	-1.9	2.4	-0.4	4.4	-1.6	0
-0.5	2.1	-1.8	0.6	-2	2.16	-0.9	3.8	-1.2	2.7
-0.8	1.7	-2.1	1.3	-2.3	2.13	-1	3.1	-1.5	1.1
-0.9	1.4	-2.4	1.9	-2.5	2.1	-1.2	3	-1.7	1
-1.5	1	-2.5	2.1	-2.8	2.2	-0.9	2.9	-1.1	0.9
-1.5	0.9	-2.7	2.4	-2.9	2.3	-1.1	2.8	-0.8	0.9
-1.4	0.8	-2.9	2.9	-2.9	2.7	-1.2	2.7	-1.6	2.2
-1	0.7	-3.2	3.4	-3.1	2.8	-1.4	2.6	-1.3	1.7
-0.8	1.5	-3.1	3.7	-3	3	-1.5	2.5	-1.3	1.4
-0.2	2.8	-2.9	4	-2.5	3.1	-1.2	2.4	-1.4	1.4
		-2.4	5.3	-2.2	3.5	-0.8	2.5	-1.1	1.4
		-1.8	6.4	-2.1	4	-0.4	2.6	-0.9	0.9
				-1.7	4.3			-1.2	1.9
				-1	6			-1.4	1.8
								-1	0.9
								-1.3	1.4
								-1.3	1.6

*NOTE: MBK3 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

MBK4

MBK4a cross section shooting D-2-pts. starting river left		MBK4b cross section shooting D-2-pts. starting river right		MBA3c cross section shooting D-2-pts. starting river right		MBK4d cross section shooting D-2-pts. starting river right		MBK4 longitudinal profile shooting pt-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	-1.6	0
-0.3	1.5	-0.3	1.2	-0.7	1.6	-0.6	1.6	-0.8	2.3
-0.4	0.9	0	0.3	-0.5	0.7	-0.4	0.2	-0.6	1.9
-0.6	0.8	-0.5	0.6	0	0.4	-0.1	0.4	-0.3	3.9
-0.2	0.5	-0.1	0.3	-0.4	0.2	-0.4	0.1	0.4	4.8
-0.1	0.3	-0.1	0.2	-0.1	-0.3	0	0.4	0.6	3.8
-0.1	0.4	0.2	0	-0.1	0.5	0.4	0.3	0.9	4.8
0.2	0.2	0	0.6	0	0.4	0.1	0.7		
-0.3	0.3	-0.3	0.5	-0.1	0.2	0	0.1		
-0.2	0.2	0.1	0.2	0	0.2	0.4	0.9		
0	0.4	0.5	0.5	0.3	0.1	0.8	2.5		
0.1	0.3	0.5	0.5	-0.1	0.3				
-0.2	0.5	0.5	1.7	0.2	0.3				
0.1	0.5	0.2	0.3	0.2	0.4				
0.1	0.4	0.4	0.1	0.2	1.1				
0.1	0.7	0.3	0.3	0.7	0.8				
0.1	0.6								
0.5	1.5								

*NOTE: MBK4 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

MBK5

MBK5a cross section shooting D-2-pts. starting river right		MBK5b cross section shooting D-2-pts. starting river right		MBK5c cross section shooting D-2-pts. starting river right		MBK5d cross section shooting D-2-pts. starting river right		MBK5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.5	1.1	-1.3	2.4	-0.8	2.1	-0.6	1.5	-0.4	2.1
-0.6	1.1	-0.5	0.6	-0.7	1.3	-0.4	0.9	-1.7	4.2
-0.7	-0.1	-0.5	0.1	-0.2	0.5	-0.3	0.4	-1	4.3
0	0.2	-0.1	0.4	-0.4	0.3	-0.4	0.3	-1.2	4.9
-0.3	0.4	0	0.3	-0.7	0.4	0	0.4	Valley/piedmont slope pt-2-pt	
0	0.3	0.2	0.1	-0.2	0.2	0.4	0.3		
0.2	0.2	0.2	0.5	0.2	0.4	0.3	-0.1	Vert (m)	Hor (m)
0.3	0.1	0.1	0.1	0.2	0.1	0.6	1.3	0	0
0	0.4	0.5	1.1	0.1	-0.1			-7.2	24.6
0.2	0.2	0.5	0.5	0.5	-0.1				
0.4	1.2			0.3	0.2				
				0.2	1.1				
				0.6	0.7				

*NOTE: MBK5 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

MBK6

MBK6a cross section shooting D-2-pts. starting river right		MBK6b cross section shooting D-2-pts. starting river right		MBK6c cross section shooting D-2-pts. starting river right		MBK6d cross section shooting D-2-pts. starting river right		MBK6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0.2	0.8	-0.2	0.8	-0.5	1.2	-0.3	1.2	-0.8	2.6
-0.2	0.1	-0.1	0.3	-0.1	1.8	0.1	0.9	-1.1	3.8
-0.1	0.1	-0.1	0.4	0	0.3	-0.2	1.1	-0.8	3.5
-0.2	0.1	-0.1	0.3	-0.2	0.2	-0.1	0.3	-1.3	3.5
-0.2	0.1	-0.1	0.4	-0.1	-0.1	-0.2	0.1		
-0.1	0.5	0	0.6	0	0.4	-0.1	0.1		
0	0.1	0	0.4	0.1	0.4	-0.2	-0.1		
0.2	0.1	0.1	0.1	-0.1	0.3	0	0.7		
0.1	0.2	0.1	0.1	-0.1	0.2	0.1	0.1	Valley/piedmont slope shooting D-2-pt	
0.2	0.1	0.1	0.2	0	0.2	0	0.2		
0.1	0.5	0.1	0.7	0.2	0.2	-0.1	0		
0.5	0.3			-0.1	0.2	0	0.4	Vert (m)	Hor (m)
-0.2	0.6			0.1	0.3	0.1	0.3	0	0
				0.1	0.9	0.3	0.6	-4.9	15.4
						0.1	0.8	-2.1	6.9

*NOTE: MBK6 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

MIA1

MIA1a cross section shooting pt-2-pt, starting RR		MIA1b cross section shooting pt-2-pt, starting RR		MIA1d cross section shooting pt-2-pt, starting RR		MIA1e cross section shooting pt-2-pt, starting RR		MIA1 Long profile surveyed using pt-2-pt	
Vert (m)	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**
-1.6	0	-1.6	0	-1.6	0	-1.6	0	-1.6	0
-1.7	4.6	-2	13.1	-1.8	4.3	-1.7	2.8	-1.7	18.7
-1.6	2.1	-2	14.8	-1.5	3.7	-1.6	2.2	-2	26
-1.8	1	-1.6	1.3	-1.9	1.7	-1.5	1.7	-1.8	14.2
-1.4	1.4	-1.4	1.6	-1.7	2.1	-2	2.3	-1.9	15
-1.9	1.2	-1.3	1.2	-1.7	0.6	-1.9	3.3	-2	34
-1.3	1.5	-1.7	1.4	-1.9	2.5	-1.3	1.6	-2.1	17.6
-1.3	3.9	-1.4	10.9	-1.2	1.1	-1.6	2.4	-1.9	20.2
-1.7	3.9	-1.7	7.5	-1.5	3.2	-1.7	1.3	-1.9	31.4
-1.4	2.1	-1.8	5.3	-1.6	2.4	-1.7	3.1	-2	34
-1.6	2.3	-1.9	4	-1.5	2.7	-1.5	2.6	**-1.9**	26
-1.8	1.7	-1.4	4.3	-1.8	7.9	-1.6	2.9	**-1.9**	17.5
-1.3	1.2	-1.6	6.6	-1.6	4	-1.7	2.4	-1.9	29.2
-1.5	2.8	-1.9	3.2	-1.7	2.1	-1.2	1.8	-1.9	20.1
-1.9	8.4	-1.4	1.9	-1.4	9.1	-1.8	2.7	-2	34
-1.8	4.3	-1.9	4.2	-1.5	1.4	-1.7	5.6	-2.4	32.7
-1.4	1.7	-1.5	3.4	-1.7	6.6	-1.5	5.7	-2	22
-1.7	1.4	-1.8	8.1	-1.6	4.1	-1.7	6.3	-2	24
-1.5	1.7	-1.8	5.2	-1.5	1.1	-1.6	1.7	-1.9	30.3
-1.5	2.5	-1.6	5	-1.8	6	-1.5	1.1	-1.9	21.9
-1.6	2.5	-1.6	1.6	-1.7	4.8	-1.2	2.5	-1.9	23.4
-1.6	1.2	-1.7	2.8	-1.7	2.3	-1.5	1.6	-3	71
-1.5	0.9	-1.5	2.1	-1.8	2	-1.9	1.8		
-1.3	1	-1.4	1.5	-1.5	2	-1.7	3.9	MIA1 stream gradient 5-m DEM	
-1.8	6.5	-1.8	4.1	-2	3	-2	6.9		
-1.6	7.6	-1.7	3.7	-1.7	2	-1	0.9		
-1.7	3	-1.5	3.3	-1.6	5	-1.4	2.6	**Vert (m)**	**Hor (m)**
-1.5	4.2	-1.9	2.5	-1.6	2	-1.6	2.7	274.53	0
-1.7	2.9	-1.7	2.4	-1.5	3	-1.7	3	274.34	60
-1.6	3.2	-1.7	3.5	-1.7	8	-1.7	5.8	272.3	173.5
-1.5	2.9	-1.5	4.6	-1.5	4	-1.8	2.3	271.52	153.6
-1.7	2.3	-1.8	2.2	-1.7	2	-1.5	2.3	270.39	138.2
-1.7	2	-1.7	4.7	-1.6	1.1	-1.8	3.5	268.77	51.2
-1.7	4.3	-1.7	2.4	-1	2.3	-1.2	1.3		
-1.6	3.4	-1.7	0.7	-1.8	3.5	-1.8	1.4		
-1.5	3	-2	0.9	-1.7	3.5	-2	1.8		
-1.6	0.6	-1.9	0.3	-1.1	2.6	-2	6.3		

-1.7	0.5	-1.5	1.3	-2	5.1	-1.9	10	
-1.7	3.5	-1.1	0.5	-1.8	1.3	-1.6	2.6	
-1.6	2.4	-1.6	7.1	-1.6	6.7	-1.9	7.4	
-1.4	1.3	-1.7	4.6	-1.7	1.8	-1.4	3.5	
-1.5	7.6	-1.5	2.8	-1.5	1.6	-1.5	1.2	
-1.8	7.5	-1.4	0.6	-1.8	4.2	-1.4	0.7	
-1.9	6.9	-1.8	3.3	-1.9	2.9	-1.4	0.5	
-1.8	14	-1.4	0.7	-2	5.5	-1.1	0.2	
-1.8	1.7	-1.6	4	-1.7	1.5	-1.4	0.5	
-1.5	1.3	-1.5	3.6	-1.3	0.9	-1.6	0.6	
-1.6	2	-1.7	1.9	-1.8	3.3	-1.6	3.9	
-1.9	8.7	-1.7	5.7	-1.7	2.4	-1.4	3.1	
-1.7	1.8	-1.7	6.9	-1.6	2.5	-1.8	2.7	
-0.7	0.7	-1.7	2.2	-1.7	2.4	-1.7	2.8	
-1.7	3.2	-1.3	1.2	-1.3	1	-1.5	2.5	
-1.6	2.8	-1.2	2.2	-1.4	1.3	-1.7	1.7	
-1.6	1.5	-1.5	2.2	-1.6	2.3	-1.5	1.4	
-1.8	3.4	-1.8	1.8	-1.7	2.4	-1.3	0.6	
-1.6	4	-1.8	1.1	-1.9	0.8	-1.6	1.5	
-1.3	0.4	-2	1.4	-1.7	1.8	-1.7	1.6	
-1.1	2			-1.2	0.6	-1.4	1.1	
-1.5	2			-1.8	3.6	-1.4	1.4	
-1.5	2			-1.7	4	-1.7	2.6	
-0.7	2			-1.8	2	-1.9	4.3	
5	12			-1.6	4.5	-1.7	0.9	
				-1.8	3.9	-1.6	8.4	
				-1.4	1.3	-1.7	2.1	
				-1.3	0.3	-1.7	7.2	
				-1.1	0.8	-1.6	1.1	
				-1.5	2	-1.2	0.6	
				-1	3.5	-1.5	0.8	
				-1.1	1.3	-1.5	1.6	
				-0.9	2.2	-1.7	2.5	
				-1	2.4	-1.4	1.3	
				-1.3	3.2	-1	3	
				-1.4	3.6	-1.3	2.7	
				-1.4	3.5	-1.4	2	
				0	33	-1.4	1.3	
						-0.7	6.2	
						-1.3	0.6	
						0.7	15.4	

MIA1 pebble count conducted every 20 cm																	
fp	cs	cs	mp	cs	cp	cp	sd	fp	cp	0							
cs	cs	fp	fp	cs	st	fp	sd	fp	fp	0							
fp	cp	cs	cs	sd	sd	sd	mp	fp	fp	0							
cs	cs	sd	sd	mp	sd	cs	sd	fp	fp	0							
fp	cs	fp	cs	fp	sd	cs	cs	mp	fp	0							
mp	fp	cs	mp	cs	st	fp	sd	fp	fp	0							
fp	mp	cs	cs	fp	sd	fp	fp	mp	cp	0							
mp	sd	fp	fp	cs	cs	fp	cp	cs	fp	0							
fp	fp	fp	sc	sd	fp	cp	cs	sd	cs	0							
sd	cs	fp	fp	fp	fp	sd	fp	cs	cs	0							

MIA2

MIA2a cross section shooting D-2-pts. starting river right		MIA2b cross section shooting D-2-pts. starting river right		MIA2c cross section shooting D-2-pts. starting river right		MIA2d cross section shooting D-2-pts. starting river right		MIA2 longitudinal profile/stream gradient derived from 5-m DTMs	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	245.16	0
-0.3	7.4	0.1	6.2	-0.5	6	-0.6	8	244.14	45.54
-1.9	3.7	-0.2	3.2	-1.1	4.1	-0.1	3.6	244.71	66.42
-1.1	1.9	-1.6	4.4	-1.1	4.2	-0.2	6.8	244.74	99.86
-0.7	5	-2.8	7.8	-1	4.9	0.1	1.3	244.09	127.53
0.8	0.2	-0.9	3.3	-0.2	3.3	0	6.8	243.59	177.65
0.2	0.8	-0.8	9.7	-0.1	1.5	-0.1	13	242.38	213.83
-0.5	1.9	-0.1	0.5	0.1	1	-0.1	4.8	241.41	226.27
-0.2	2.4	0	0.6	-0.2	4.7	0.2	0.9	241.14	257.92
0	0.5	0	5	0.2	8.8	-0.2	2.2	241.78	276.7
0.3	2.5	-0.1	1.4	-0.1	3.7	-0.1	3.1	241.06	325.11
0.9	1.1	-0.2	1.3	-0.2	2.6	-0.7	2.9	MIA2 Valley/piedmont slope derived from 5-m DTMs	
0.4	1.7	0	0.4	-0.2	1.3	-0.1	3		
-0.1	6.1	0.1	2.2	-0.1	1.9	0.1	7.5		
-0.3	3.8	-0.2	2.1	-0.4	3.5	-0.6	3.3	Vert (m)	Hor (m)
-0.1	2.7	-0.4	1	-0.6	2.4	-0.3	1.6	251.12	0
-0.1	1.1	-0.1	0.5	0.1	1.3	-0.1	1	248.97	86.75
0	0.5	0	1.1	-0.1	1.4	0	4.5	249.39	191.67
0.1	1	0.2	0.6	-0.1	1.8	0.2	1.7	246.65	278.99
0.1	2.1	0.1	1.4	0.7	1.5	-0.1	1.3		
-0.1	13.1	0.2	0.7	0.2	2.4	-0.2	1.1		
0	2	0.1	3.1	0	2.6	0	1.1		
0.4	2.3	-0.2	1.9	-0.2	0.4	0.4	0.7		
0.4	3.9	-0.1	1.2	-0.4	0.3	0	1.4		
3	7	-0.2	0.7	0.1	2.2	-0.3	1.3		
0.1	2.9	0.1	1.9	0.7	2.8	0.2	1.1		
-0.1	8.1	0.1	0.6	0.3	2.1	0	1.9		
		0	0.7	0.1	6.4	-0.2	4.1		

		-0.2	0.5	-0.2	3.2	-0.3	2.7		
		0.1	1.6	-0.2	3.1	0.4	1.6		
		0.7	1.4	0.2	4.7	0.2	2.1		
		0.2	1.6	1.1	10.7	0	1.1		
		0.1	4.6	1	14.1	0.6	1.9		
		0.3	1.2	0.2	3.5	0.4	1.1		
		-0.1	4	0	14.9	0.1	1.7		
		0.1	1.5	0	11	-0.2	1.9		
		-0.2	5.8			0	3.6		
		0.1	2.3			1.1	4.3		
		-0.2	5.3			0.1	2.5		
		0.3	2.2			-0.1	2.9		
		-0.2	4.6			0.2	7.3		
		0.2	2.6			0	12		
		1	2.9						
		1.3	5.2						
		0.4	3.9						
		0	10.4						

MIA2 Pebble Count conducted every 1/2 meter																	
sd	lc	cp	sd	lc	sd	fp	sd	sd	sd	cp	sd	cp					
sd	sc	cp	sd	cp	cp	cp	sd	sd	sd	fp	sc	cp					
sd	sd	sc	sc	mp	sd	cp	sd	sd	sd	mp	sd	cp					
sd	cp	Bk	B	cp	B	sc	B	B	sd	sc	cp	sc					
sd	mp	Bk	cp	lc	fp	fp	cp	cp	sd	lc	sd	sd					
sd	cp	fp	sd	sd	fp	lc	sd	sd	sd	sd	lc	sd					
sd	sc	mp	cp	fp	sd	sd	sd	sd	cp	lc	sd	lc					
sd	cp	sc	cp	fp	sd	sd	cp	cp	fp	B	sd						
mp	fp	cp	cp	sd	B	sd	sd	sd	fp	lc	fp						
cp	sc	cp	lc	sd	fp	sd	sd	sd	sc	lc	fp						

MIA3

MIA3a cross section shooting D-2-pts. starting river right		MIA3b cross section shooting D-2-pts. starting river right		MIA3c cross section shooting D-2-pts. starting river right		MIA3d cross section shooting D-2-pts. starting river right		MIA3 longitudinal profile shooting D-2-pt	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0.1	6.8	-0.1	6.1	0	8.6	-1.3	8	-0.8	33.2
-1	1.9	-0.2	2.2	0.2	2.4	-0.3	9	-0.7	32.2
0	2.8	-0.5	1.2	-0.6	1.5	0.4	13.2	-1.8	29
-0.6	0.4	-0.9	2	-0.7	1.8	-0.4	2.6	-0.4	37.2
-0.1	1.2	-0.7	1.6	-0.5	3.7	-0.4	0.8	-1.1	21.8
0.2	0.9	-0.4	1.8	-0.1	4.2	-0.7	0.7	-0.4	37.7
0	1.4	-0.5	1.3	-0.2	1	-0.3	1.1	-0.2	21.8
-0.1	1.2	-0.1	0.3	-0.1	1.7	-0.2	0.8	-0.3	22.2
0.1	1	0.1	2.1	-0.1	2.1	-0.2	1	MIA3 Valley/piedmont slope D-2-pt	
0.4	1.5	0.6	1.1	0	1.4	-0.1	0.9		
-0.1	0.8	0	0.5	-0.2	0.5	0.1	0.8	Vert (m)	Hor (m)
0	1.8	-0.1	0.1	0	1.5	0	3.1	0	0
0.5	3.5	0	0.9	0.1	1.5	0	2.6	-0.5	32.9
1	2.2	0.5	0.7	0.2	1.2	0.6	1.4	-0.3	15.3
0.3	6.8	0	1.7	1.4	1.4	0.2	4.2	-0.9	39.4
		0.6	0.5	0.1	1.8	-0.1	2.7	-0.2	18.6
		0.1	2.5	0.5	3.5	0.4	3.7	-0.5	40.3
		0.1	4.9	-0.4	21.9	0	5.3	-1.1	45.4
		0.4	0.9	0.3	5.1	0.3	2		
		-0.3	11.3	0.3	8.6	-0.1	9.6		
		-0.7	2.1	1.4	13.6	0.4	3.9		
		-0.3	9.9			-0.2	6.6		
						2	23		

MIA3 Pebble Count conducted every 1/2m																	
fp	sd	sd	B	fp	lc	cp	sc	sc	sd	cp	B						
fp	fp	sd	B	B	lc	sc	cp	cp	sc	fp	mp						
mp	fp	sd	B	mp	sd	cp	sd	sd	sd	mp	cp						
fp	sc	cp	WD	sc	B	sc	fp	fp	fp	cp	mp						
mp	B	sc	sd	fp	fp	Org	sc	sc	B	fp	B						
fp	WD	sd	fp	fp	cp	sc	sc	sc	cp	fp							
mp	B	fp	fp	cp	B	cp	cp	cp	fp	fp							
mp	B	sd	fp	B	mp	sc	fp	fp	fp	mp							
cp	lc	lc	cp	lc	fp	sc	B	B	cp	lc							
mp	fp	sd	fp	sc	sc	mp	B	B	fp	lc							

MIA4

MIA4a cross section shooting D-2-pts. starting river right		MIA4b cross section shooting D-2-pts. starting river right		MIA4c cross section shooting D-2-pts. starting river right		MIA4d cross section shooting D-2-pts. starting river right		MIA4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	3	-0.2	3.2	0.2	10	0	2.1	-0.3	39.5
-0.1	1	-0.4	3.3	-0.2	2	-0.2	1.8	-0.7	80.4
0.6	3.5	0	1.3	-0.3	1.7	-0.6	2.2	-0.2	119.4
-0.6	3.5	0.2	0.4	0	1.9	-0.6	3.1		
0.2	2.3	-0.2	2.1	-0.1	0.4	-0.2	7.5		
-0.2	2.9	0	0.8	-0.1	0.7	-0.1	2.1		
0.2	4.2	0.4	4.2	0.3	1.1	-0.2	1		
0.3	3	-0.1	4.5	0	1	0	1.2		
0.1	2.7	0.1	5.5	-0.1	1.3	0.2	1.7	Valley/piedmont slope shooting D-2-pt	
0.1	7.7	0.2	2.7	0.1	1.4	0.1	3.4		
0.1	2.2	0.1	13.1	0	4.1	0.2	6.8		
-0.2	3.7	-0.4	7.5	-0.2	1.3	-0.1	2	Vert (m)	Hor (m)
-0.3	2.2	-0.2	2.3	0.4	5.1	0	2.7	220.55	0
-0.1	3.6	-0.4	1.4	0.2	7	-0.2	2.8	219.77	59.24
0.3	1.7	-0.3	2.1	-0.1	1.6	0	1.6	218.69	127.54
0.2	5.3	0.1	1.1	-0.1	5.2	0.4	4.4	218.35	179.33
0	4.6	0.2	0.9	-0.2	3.1	-0.1	0.7		
-0.1	1.7	0.1	1	-0.5	1.5	-0.1	0.4		
-0.7	1.6	-0.1	1.3	0	1.7	-0.1	1.7		
-0.1	1.9	-0.3	1.2	0.1	0.8	-0.2	1.4		
-0.1	1.6	-0.1	0.6	-0.1	0.4	-0.5	1.2		
-0.2	0.9	0.3	1.1	-0.1	3.5	0	2.9		
0.6	1.2	0.4	0.7	0.2	0.6	0	1.6		
0.1	0.7	0.1	0.7	0.3	1.5	0.1	1.2		
0.2	0.7	0	1.2	0.2	1.1	0	1.2		
0.1	2.3	0.8	2.1	-0.3	4	0.3	2.1		
-0.3	1.9	3.4	7.2	0	4.2	-0.2	2.4		
-0.1	0.1			0.3	1.2	0.1	2.4		
0.2	2			-0.1	1.5	0.1	3.5		
0.3	8.3			0.2	1.9	0	6.6		
-0.2	3			-0.2	2.6	0	4.2		
0	0.8			0.2	4.5	0.3	1.8		
0.1	1.1					0.7	2.6		
0.2	3.2								
0.3	5.6								
-0.1	1.1								
-0.2	0.6								
-0.2	1.6								
0.2	0.9								
0	6.7								
1	2.2								

MIA4 Pebble Count conducted every 1/2m																	
sd	cp	fp	fp	cp	cp	B	sd	sd	sd	sd	sd	fp	fp	sd	sd	fp	fp
sd	fp	mp	sd	cp	sd	fp	lc	lc	sd	sd	sd	fp	fp	sd	sd	fp	fp
sd	mp	fp	sd	fp	cp	sd	cp	cp	sd	sd	sd	fp	mp	sd	sd	mp	fp
sd	cp	mp	sd	mp	cp	fp	cp	cp	sd	sd	sd	fp	cp	sd	sd	mp	sc
sd	cp	fp	sd	sd	lc	cp	sd	sd	sd	sd	fp	fp	fp	sd	sd	fp	cp
sd	cp	mp	sd	sd	B	sc	sd	sd	sd	sd	lc	fp	fp	sd	sd	fp	fp
sd	mp	sd	sd	cp	sc	sd	sd	sd	fp	cp	fp	cp	sd	sd	sd	cp	fp
fp	sd	sd	sd	sd	sc	sc	sd	sd	cp	sd	fp	fp	lc	sd	sd	sd	sd
sd	mp	sd	sd	cp	sc	sd	sd	sd	sd	sd	cp	fp	sd	sd	sd	fp	fp
fp	fp	fp	sd	lc	cp	mp	sd	sd	sc	sc	fp	fp	sd	sd	sd	sd	sd
cp	cp	sd	cp	sd	fp	sd	sd	sd	fp	sd	sd	sd	sd	cp	sd	sd	sd
sd	sd	sd	sd	sd	sd												

MIA5

MIA5a cross section shooting D-2-pts. starting river right		MIA5b cross section shooting D-2-pts. starting river right		MIA5c cross section shooting D-2-pts. starting river right		MIA5d cross section shooting D-2-pts. starting river right		MIA5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0	4.4	0	3.6	0	3.9	0.1	5.6	-0.9	14.6
-0.1	1.5	-0.1	3	0	2.1	0	2.4	-0.3	23.9
-0.2	0.9	-0.3	0.8	0	0.8	-0.1	2.4	-0.5	34.5
-1	1.6	-0.5	0.9	-0.3	1.3	-0.5	1.4	-0.3	43.6
-0.8	1.7	-0.5	0.4	-0.4	0.7	-0.2	0.8	-0.9	61.6
-0.3	0.8	-0.7	1.6	-0.4	0.6	-0.5	0.7		
-0.3	0.9	-0.2	0.5	-0.5	0.4	-0.6	1.1	MIA5 Valley/piedmont slope shooting D-2-pt	
-0.3	0.6	-0.1	1.2	-0.2	0.2	-0.4	1.1		
-0.1	0.7	0.1	0.7	-0.4	0.2	0	1		
0	0.7	0.1	0.5	0	0.6	0.6	1.5	Vert (m)	Hor (m)
0	0.5	0.1	0.4	0.2	0.9	0.3	0.1	0	0
0.2	0.7	0.3	1	0	0.3	0.6	0.9	0.2	7.5
0.2	0.4	0.7	1.5	0.3	0.7	0.6	1	0.1	20.8
0.1	2.3	1	1.9	0.4	1.4	0.3	1.2	0.1	33.3
0.1	3.2	0.4	1.4	0.7	1.6	0.1	2.6	0.3	53.9
0	0.9	0.1	2.4	0.6	1.7	0	12	0.8	67.9
0.2	0.5	0.1	2	0.2	1.9			0.7	78.9
0.9	2.7			0.1	4.5			0.2	89.1
0.7	2.2								
0.2	2.8								
0	3.2								

MIA5 Pebble Count conducted every 1/2 meter																	
sc	cp	fp	mp	fp	sd	fp	sd	sd	fp	mp	fp	mp					
fp	cp	cs	cp	sc	cp	fp	fp	fp	fp	mp	mp	mp					
lc	fp	fp	cp	cp	lc	mp	sd	sd	fp	cp	mp	cp					
lc	mp	fp	fp	fp	sd	Org	sd	sd	fp	cp	fp						
sc	fp	fp	cp	sc	sd	mp	sd	sd	cp	fp	fp						
lc	sc	fp	sc	fp	fp	Org	sd	sd	fp	fp	cp						
sd	fp	mp	fp	cp	fp	fp	fp	fp	fp	fp	cp						
sd	fp	cp	sd	cp	fp	fp	fp	fp	fp	cp	cp						
sc	fp	fp	sd	sd	fp	fp	cp	cp	fp	fp	mp						
fp	fp	cp	cs	sd	fp	sd	fp	fp	cp	fp	cp						

MIA6

MIA6a cross section shooting D-2-pts. starting river right		MIA6b cross section shooting D-2-pts. starting river right		MIA6c cross section shooting D-2-pts. starting river right		MIA6d cross section shooting D-2-pts. starting river right		MIA6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	1.4	-0.2	0.8	-0.5	2.1	-0.1	5	0.5	31.8
-1	2.8	-1	3.5	-1	2.8	-0.2	2.9	0.1	47.4
-1.1	3.5	-0.4	2.6	-0.8	2.2	-0.3	2.1	0.6	66.4
-0.2	1.2	-0.3	3.4	-0.5	1.8	0	2.4	0.2	87.4
-0.2	0.8	-0.3	3	-0.7	4.1	-0.6	4.6		
-0.2	0.9	-0.3	1.8	-0.2	2.8	-0.6	2.6		
0.1	1.1	0.1	1.4	-0.1	0.9	-1	2.9	MIA6 Valley/piedmont slope shooting D-2-pt	
-0.1	0.5	0	1.3	-0.2	1.2	-1.4	2.8		
0	1.1	-0.1	0.9	0.1	0.6	-0.1	1		
0.2	0.9	-0.1	0.2	0	1.1	-0.1	1.8	S	Hor (m)
0.2	2.5	0	2.6	-0.1	0.9	0	3.1	0	0
0	1.8	-0.1	0.5	0	1.8	0	2.2	-0.2	33.6
0	1.8	0	0.6	0.1	2.3	0	0.9	-0.2	55.6
0.3	2.5	0.1	1	0.1	0.7	-0.2	1.3	-0.2	71.4
0.6	4.2	0.1	0.1	0	2	-0.1	0.6		
1.9	5.6	0	0.9	0.2	0.9	-0.1	0.3		
1.1	7.6	0.1	0.8	0.6	1.5	-0.1	1.1		
0.2	8.7	0.1	0.3	0.6	1.6	0	0.7		
		0.6	1.8	1.2	4.6	0.1	0.4		
		0.3	2.2	0.7	5.6	-0.1	0.7		
		0.3	3.4	0.3	2.8	0.1	0.6		
		0.9	4.9	0.2	6.6	0	0.6		
		1.4	4.1			0.4	1.6		
		0.5	4.3			0.9	3.4		
		0.2	4.6			0.3	1.7		
						0.3	3.5		
						0.6	5		

MIA6 Pebble Count conducted every 20cm along all 4 cross sections																	
cp	sc	fp	fp	mp	mp	fp	cp	cp	fp	fp	fp						
sd	cp	sd	sc	mp	fp	mp	mp	mp	fp	fp	fp						
sc	fp	cp	fp	sd	fp	fp	cp	cp	sd	mp	fp						
fp	cp	sc	cp	mp	mp	fp	fp	fp	cp	fp	mp						
cp	cp	cp	cp	sd	fp	fp	fp	fp	Org	fp	sd						
sd	sc	cp	cp	sd	cp	cp	fp	fp	Org	mp							
mp	cp	cp	fp	Org	fp	cp	fp	fp	Org	fp							
cp	sc	mp	mp	sd	fp	mp	fp	fp	sd	fp							
cp	sd	fp	fp	fp	sd	sd	mp	mp	fp	cp							
fp	sd	cs	mp	fp	sd	fp	fp	fp	fp	lc							

MPH1

MPH1a cross section shooting Pt-2-pt starting river right		MPH1b cross section shooting D-2-pts. starting river right		MPH1c cross section shooting D-2-pts. starting river right		MPH1d cross section shooting D-2-pts. starting river right		MPH1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
-1.6	2.2	-1.6	1.9	-1.6	1.9	-1.6	1.5	-1.6	0
-2	1.8	-2.2	1.3	-2	1.5	-1.7	1.4	-1.8	8.5
-1.8	1.6	-1.7	1.2	-1.9	1.2	-1.7	1.3	-1.2	2.4
-2	1.1	-1.8	0.9	-2.1	0.7	-2	0.9	-1.6	2.5
-2.2	0.4	-2	0.4	-1.8	0.5	-2.2	0.3	-1.7	3.4
-1.5	0.4	-1.6	0.4	-1.8	0.3	-1.7	0.2	-1.9	8
-1.5	0.4	-1.7	0.3	-1.6	0.2	-1.6	0.1	MPH1 stream gradient slope derived from 5m DTM	
-1.5	0.4	-1.6	0.2	-1.7	0.1	-1.6	0.1		
-1.7	0.2	-1.6	0.1	-1.4	0.2	-1.2	0.5		
-1.6	0.1	-1.3	0.3	-1.4	0.3	-1.4	0.7	Vert (m)	Hor (m)
-1.2	0.4	-1.3	0.5	-1.2	0.7	-1.3	1	214.97	0
-1	0.9	-1	1.1	-1.3	1	-1.4	1.2	214.67	7.11
-1.4	1.1	-1.3	1.4	-1.4	1.2	-1.6	1.2	215.29	16
-1.2	1.5	-1.5	1.5					214.58	25.06
-1.4	1.7							214.44	33.24
								214.65	42.16
								MPH1 valley/piedmont slope derived from 5m DTM	
								Vert (m)	Hor (m)
								215.71	0
								216.02	14.31
								215.14	24.79

MPH1 Pebble Count																	
fp	st	cs	mp	cs	cp	fp	cs	cs	WD	cp	org	cs	org				
sd	cp	cp	sc	cp	mp	sc	st	st	cp	mp	fp	mp	org				
fp	cp	fp	fp	mp	st	fp	mp	mp	WD	st	mp	cp	org				
fp	fp	cp	fp	fp	sd	mp	cp	cp	mp	cp	cs	mp	cs				
fp	mp	sc	mp	fp	st	mp	Org	Org	mp	sc	sc	mp	cs				
sc	cp	cp	cp	sc	cs	fp	mp	mp	fp	cs	mp	fp	sc				
sd	cp	cp	fp	mp	fp	cs	mp	mp	sc	WD	mp	mp					
mp	cs	cp	fp	mp	mp	cs	cp	cp	mp	cp	cs	fp					
fp	sc	fp	fp	mp	mp	fp	mp	mp	cs	sc	fp	fp					
fp	cp	sc	fp	mp	mp	cs	WD	WD	fp	cs	fp	fp					

MPH2

MPH2a cross section shooting D-2-pts. starting river right		MPH2b cross section shooting D-2-pts. starting river right		MPH2c cross section shooting D-2-pts. starting river right		MPH2d cross section shooting D-2-pts. starting river right		MPH2 longitudinal profile shooting pt-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	4.7	-0.1	2.4	-0.2	2.7	-0.2	2.1	-0.2	15.8
-0.1	0.9	-0.2	1.6	-0.1	1.2	-0.2	2.4	-0.2	31.2
-0.3	0.7	-0.3	0.5	-0.2	1.1	0	0.3	-0.1	42.7
-0.7	1.1	-0.3	0.1	-0.4	0.7	-0.1	0.1	MPH2 Valley/piedmont slope shooting pt-2-pt starting upstream	
-0.1	0.3	-0.4	0.6	-0.3	0.6	0	0.1		
-0.2	0.5	-0.2	0.5	-0.4	0.7	-0.4	1.2		
-0.1	0.2	-0.1	0.3	-0.1	0.1	-0.5	1.1	Vert (m)	Hor (m)
0	0.3	0	0.2	0	0.4	-0.4	0.9	-1.6	0
0	1	0	0.5	0.1	0.9	-0.2	0.6	-1.4	42.2
0	0.8	0	0.5	0.1	0.2	-0.1	0.5		
0.2	0.1	0.1	0.2	0.6	1.3	-0.1	0.4		
0.5	0.8	0.1	1.1	0.4	0.9	0.1	0.3		
0.4	0.7	0	1	0.4	1.3	0	0.6		
0.4	1.1	0.1	0.5	0.1	0.3	0.1	0.2		
0.2	1.6	0.2	0.5	0	0.5	0.4	0.9		
0.1	1.9	0.6	1.3	-0.1	0.2	0.4	1		
		0.2	1.3	0.1	1.1	0.3	0.7		
		0	1.6	0	1	0.1	1.5		
						0.1	2		
						0.1	2		

MPH2 Pebble Count																	
fp	st	cs	mp	cs	cp	fp	cs	cs	WD	cp	org	cs	org				
sd	cp	cp	sc	cp	mp	sc	st	st	cp	mp	fp	mp	org				
fp	cp	fp	fp	mp	st	fp	mp	mp	WD	st	mp	cp	org				
fp	fp	cp	fp	fp	sd	mp	cp	cp	mp	cp	cs	mp	cs				
fp	mp	sc	mp	fp	st	mp	Org	Org	mp	sc	sc	mp	cs				
sc	cp	cp	cp	sc	cs	fp	mp	mp	fp	cs	mp	fp	sc				
sd	cp	cp	fp	mp	fp	cs	mp	mp	sc	WD	mp	mp					
mp	cs	cp	fp	mp	mp	cs	cp	cp	mp	cp	cs	fp					
fp	sc	fp	fp	mp	mp	fp	mp	mp	cs	sc	fp	fp					
fp	cp	sc	fp	mp	mp	cs	WD	WD	fp	cs	fp	fp					

MPH3

MPH3a cross section shooting D-2-pts. starting river right		MPH3b cross section shooting D-2-pts. starting river right		MPH3c cross section shooting D-2-pts. starting river right		MPH3d cross section shooting D-2-pts. starting river right		MPH3 longitudinal profile shooting D-2-pt starting	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.3	5	-0.4	4.2	-0.3	4.2	-0.3	4.1	-0.4	27.1
-0.2	2.1	-0.1	1.2	-0.3	2.7	-0.2	1	-0.2	43.5
-0.2	1.4	-0.3	1.6	-0.6	1.3	-0.2	0.6	-0.1	60
-0.2	0.6	-0.5	1.3	-0.3	0.3	-0.5	0.8	-0.3	77.3
-0.2	0.5	-0.2	0.7	-0.2	0.6	-0.9	1.1	MPH3 Valley/piedmont slope shooting pt-2-pt	
-0.1	0.3	-0.4	1	-0.5	1.1	-0.3	0.5		
-0.3	0.7	-0.3	1	0	0.7	-0.2	0.2	Vert (m)	Hor (m)
-0.4	0.5	-0.2	1.5	0	0.5	0.2	1.2	-1.6	0
-0.1	0.1	-0.1	1.4	-0.1	1.4	0.2	1.5	-0.3	96.9
-0.1	0.2	0.3	0.3	-0.2	1	0	0.6		
-0.2	0.2	0.3	1.1	0.1	0.1	0	1.3		
0.1	1.2	0.4	0.9	0.1	0.5	0.2	1.7		
0.1	0.8	0.2	0.9	0.1	1.5	0	1.7		
0.1	0.5	0.3	1	0.1	1.2	0.1	0.6		
0.1	0.3	0.3	2	0.6	2	0.6	1.9		
0	0.7	0.1	1.4	0.5	1.4	0.3	1.6		
0.2	0.6	0.1	5.2	0	1.1	0.1	0.4		
0.2	0.6			0	0.3	0.2	1.7		
0.3	0.6			0	2.1	0.1	1.3		
0.3	1.3			0.3	4.9	0.1	5.4		
0.5	4.7			0.2	5.3				
0.1	4.9								

MPH3 Pebble Count																	
cs	mp	mp	mp	mp	cp	cp	cp	cp	cp	fp	st	cp	cp	fp	fp	sd	fp
fp	cp	cp	cs	fp	fp	cs	st	st	mp	cp	mp	mp	fp	fp	cp	cs	mp
cp	mp	mp	fp	cs	mp	cs	cp	cp	fp	st	cp	cp	fp	mp	fp	mp	fp
mp	fp	mp	fp	cs	cs	mp	st	st	cp	cp	cp	fp	fp	mp	cs	st	fp
cp	mp	mp	fp	fp	fp	cp	st	st	mp	sc	fp	cp	cp	fp	mp	cs	cp
mp	mp	fp	cs	cp	fp	sc	st	st	cs	fp	fp	sd	mp	fp	cp	fp	st
mp	cp	fp	fp	cp	fp	sc	mp	mp	cp	sd	cp	mp	mp	fp	cs	cp	sc
mp	mp	mp	fp	sc	fp	mp	st	st	mp	fp	cp	fp	cp	mp	fp	cp	mp
cp	mp	fp	sc	sc	mp	cp	sc	sc	sd	fp	mp	mp	fp	fp	cp	fp	mp
fp	mp	cs	mp	fp	fp	mp	cp	cp	cp	cp	cp	cp	cp	mp	mp	fp	cp

MPH4

MPH4a cross section shooting D-2-pts. starting river right		MPH4b cross section shooting D-2-pts. starting river right		MPH4c cross section shooting D-2-pts. starting river right		MPH4d cross section shooting D-2-pts. starting river right		MPH4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.1	1.2	-0.5	3	-0.7	5.5	-0.8	4.7	-1	10
-0.2	0.6	-0.5	2.8	-0.8	4.4	-0.7	4	-0.5	25.3
-0.4	0.9	-0.4	0.7	0	2.8	-0.2	1.2	-1	34.2
-0.2	1.2	-0.3	0.8	-0.3	1	-0.3	1.2	-1.2	36.6
-0.2	0.3	0	0.4	-0.3	0.5	-0.3	0.8	-0.2	51.8
0	0.4	0.1	0.4	-0.1	1.2	0	0.8	Valley/piedmont slope shooting D-2-pt	
0.1	0.4	0.2	0.5	-0.2	0.7	-0.1	0.7		
0.1	0.8	0.4	0.5	-0.1	0.4	0	0.7		
0.3	1.3	0.3	1.8	0.4	1.8	0.3	0.6	Vert (m)	Hor (m)
0.6	1.2	0.3	3.3	0.4	1.4	0.3	0.6	0	0
0.3	1.2			0.3	2.5	0.2	1.2	-0.2	20.4
0.3	1.3			0.1	3.3	0.2	2.9	-0.1	36
0.1	1.3					0.3	4.3	-0.5	49.2

MPH4 Pebble Count conducted every 10m																	
fp	sd	fp	fp	sd	mp	cp	sd	sd	sd	sd	fp	sd					
sd	sd	fp	fp	sd	cp	fp	sd	sd	fp	fp	fp	cp					
sd	sd	sc	mp	sd	cp	mp	sd	sd	sd	sd	fp	cp					
sd	sd	fp	cp	sd	sd	sd	sc	sc	sd	cp	mp	sc					
lc	sd	lc	lc	fp	mp	sd	fp	fp	sd	cp	cp	mp					
mp	sd	cp	sd	sd	mp	sd	fp	fp	fp	sd	mp	cp					
fp	sd	cp	sd	mp	cp	sd	fp	fp	fp	sd	sc	cp					
sd	sd	sc	sd	mp	cp	sd	lc	lc	sd	sd	sc	cp					
sd	sd	fp	sd	cp	mp	sd	sd	sd	sd	sd	fp	sc					
sc	sd	sd	sd	cp	fp	sd	sd	sd	sd	sd	mp	sc					

MPH7

MPH7a cross section shooting D-2-pts. starting river right		MPH7b cross section shooting D-2-pts. starting river right		MPH7c cross section shooting D-2-pts. starting river right		MPH7d cross section shooting D-2-pts. starting river right		MPH7 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.5	12.5	-0.5	9.3	-0.4	9.6	-0.2	6.4	-0.3	14.4
-0.1	3.8	-0.2	5.3	0	2.5	-0.2	5.5	-0.3	19.5
-0.1	2.7	0.1	1.6	0.1	2.4	0	2.4	-0.1	24.5
-0.1	1.3	0	1.1	0	0.8	0	0.7	-0.1	28.3
0.1	1.9	-0.1	0.8	-0.1	0.7	-0.1	1	Valley/piedmont slope shooting D-2-pt	
-0.1	0.7	-0.2	0.6	-0.2	0.3	0	0.3		
-0.1	1.3	0.2	0.6	0.1	0.8	0.1	0.4		
0.1	1	0.3	1	0.1	0.4	0	0.9	Vert (m)	Hor (m)
0	1.6	0.1	4.7	0	0.6	0.1	1.6	0	0
0.1	1.6			0.1	2.7	0	3.1	-0.3	38.6
				0	2.4			-0.3	66.9

MPH7 Pebble Count conducted every 5 cm																	
st	fp	fp	cs	cp	fp	st	cp	cp	fp	st	cs						
fp	st	fp	cp	st	cp	mp	mp	mp	cp	mp	cp						
cp	fp	cp	cp	mp	cp	fp	cp	cp	cp	cp	cp						
cp	fp	st	fp	sd	fp	sc	fp	fp	sd	sd	fp						
cs	fp	sd	fp	st	sd	cp	sd	sd	sd	cs	st						
fp	st	fp	st	mp	fp	fp	st	st	fp	st	mp						
cp	cp	sd	fp	cp	mp	mp	st	st	mp	mp	mp						
st	mp	fp	mp	st	sd	cp	cp	cp	mp	cp	st						
cs	st	fp	st	st	fp	fp	sd	sd	st	cp	st						
fp	st	st	cs	fp	mp	mp	st	st	fp	cs	cp						

MPH8

MPH8a cross section shooting D-2-pts. starting river right		MPH8b cross section shooting D-2-pts. starting river right		MPH8c cross section shooting D-2-pts. starting river right		MPH8d cross section shooting D-2-pts. starting river right		MPH8 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.6	13.1	-0.6	10.4	-0.5	9.4	-0.5	12.1	-0.3	3.1
-0.1	2.6	-0.2	11.9	-0.4	9	-0.3	7.3	0.5	7.9
0.1	0.9	0	2.1	0	3.1	0	1.9	-0.2	11.5
0.1	1.1	0	0.9	0	1.9	0	0.9	-0.2	14.5
-0.1	0.7	-0.1	0.6	-0.1	0.7	-0.1	0.3	-0.2	19.5
0.1	1	-0.1	0.3	-0.2	1.6	-0.1	0.2	-0.3	27.1
-0.1	1.2	0	0.5	0	0.4	0	0.6	-0.1	30.8
-0.1	0.1	0	0.4	-0.1	0.2	-0.1	0.3	-0.4	34.9
-0.3	0.2	-0.1	0.2	-0.2	0.1	0	0.4	0.1	38.2
-0.2	0.4	-0.1	0.6	-0.1	0.3	0	0.3	-0.2	41.9
0	0.6	0.2	0.2	0	0.5	0.1	0.3	Valley/piedmont slope shooting D-2-pt	
0.3	0.2	0.1	0.1	0.2	0.3	0.1	0.2		
0.1	0.1	0.1	0.3	0.1	1	0	0.4	Vert (m)	Hor (m)
0.1	0.2	0.2	0.6	0	1.5	-0.1	0.9	0	0
0.1	1	0.2	1.4	0.4	2.5	0	1	-0.3	18.8
0.5	2.5	0.4	3.4	0.5	6.4	0.1	1	-0.2	32.7
0.3	3.1	0.3	5	0.5	9.1	0.5	7.1	-0.1	41.4
0.2	8.1					0.4	9.8	-0.2	58.9

MPH8 Pebble Count																	
cp	cs	st	sd	sd	st	st	st	st	fp	st	cp	sc					
cs	sd	fp	st	fp	fp	st	sd	sd	st	fp	fp						
sd	sd	st	sd	fp	fp	sd	fp	fp	mp	cp	cp						
st	cp	fp	fp	cp	cs	cp	cp	cp	cp	fp	fp						
fp	cp	cp	st	fp	fp	cp	mp	mp	cp	cs	fp						
cp	fp	cp	cp	mp	cp	fp	mp	mp	fp	st	cs						
mp	mp	mp	fp	fp	sc	mp	cp	cp	cp	cp	st						
fp	cp	fp	cp	cp	cp	cp	st	st	cp	cs	cp						
cp	mp	fp	cp	cp	st	st	st	st	cp	cp	cp						
mp	fp	fp	sd	fp	cs	fp	fp	fp	cs	mp	mp						

MPH9

MPH9a cross section shooting D-2-pts. starting river right		MPH9b cross section shooting D-2-pts. starting river right		MPH9c cross section shooting D-2-pts. starting river right		MPH9d cross section shooting D-2-pts. starting river right		MPH9 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	1	0	0	0	0	0	0	0	0
-0.4	10.7	-0.6	9.4	-1	23	-0.8	13.2	-0.1	4.5
0	2.1	-0.5	2.2	-0.7	3.1	-0.7	6.1	0.1	11.7
-0.2	3.4	-0.3	1.7	-0.2	2.8	-0.2	4.1	-0.1	16.5
-0.1	1.6	-0.2	1.3	-0.1	0.6	-0.2	0.9	-0.3	21.8
-0.1	0.1	-0.1	0.4	-0.1	0.5	-0.2	0.5	0.1	26
-0.1	0.7	-0.2	0.3	-0.1	1	-0.2	0.4	-0.2	28.7
0	0.5	-0.1	0.5	0.1	0.5	-0.1	0.3	0.1	31.8
0.2	0.5	0.3	1.4	-0.1	0.6	0.1	0.6	-0.4	40.6
0.3	0.7	0.1	1.1	0.2	0.6	0.2	0.2	0	44.3
0.2	1	0	1.6	0.4	0.6	0.1	0.8	-0.3	48.7
0.1	6	0.1	1.2	-0.1	5.3	0	1	Valley/piedmont slope 5-m DTM	
0.9	11.6	0.2	0.9	-0.2	2.2	0.4	1.7		
		-0.1	3.1	0.6	6.1	0.2	2.9	Vert (m)	Hor (m)
		0.2	4.5	1.2	22.1	1	21	228.3	0
		2	26					226.8	131.2
								226.3	221.5
								224.4	294.1

MPH9 Pebble Count conducted every 10 cm																	
sd	fp	mp	sd	fp	fp	sd	cp	cp	cp	fp	cp	fp					
mp	fp	fp	fp	mp	cs	mp	sd	sd	sd	sd	cp	cp					
cp	cp	cp	mp	fp	cs	cs	mp	mp	fp	cp	cp	cp					
fp	mp	fp	cs	cp	cp	cp	cs	cs	cp	cp	cp	mp					
fp	cp	mp	fp	cp	mp	fp	cs	cs	cs	cs	cp	cs					
cp	fp	mp	fp	cs	fp	sc	cs	cs	fp	fp	cs	sd					
cs	cp	sd	sd	sd	sd	cs	fp	fp	fp	cs	sd	cp					
fp	cs	fp	mp	cs	mp	fp	mp	mp	cs	mp	mp						
fp	fp	cs	cs	mp	cp	fp	mp	mp	mp	cp	cp						
mp	cp	mp	sd	fp	fp	sd	sd	sd	sd	cp	fp						

PRBA1

PRBA1a cross section shooting D-2-pts. starting river right		PRBA1b cross section shooting D-2-pts. starting river right		PRBA1c cross section shooting D-2-pts. starting river right		PRBA1d cross section shooting D-2-pts. starting river right		PRBA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	2.5	-0.3	3.8	-0.4	0.7	-0.3	5.9	-0.1	7.5
-0.2	3.1	-0.4	0.6	-0.5	0.9	-0.1	1.3	-0.4	6.1
-0.7	1.6	-0.2	-0.1	-0.7	0.6	-0.1	0.9	-1.2	2.1
-0.9	0.7	-0.2	-1	-0.3	0.1	-0.9	1.8	0.7	1.7
-0.3	0.9	0	1.1	-0.2	-0.6	-0.4	0.7	-0.2	3.2
-0.3	0.6	-0.3	0.9	-0.1	0	-0.2	0.5	-0.4	3.9
-0.1	0.3	-0.5	0.7	-0.2	0.1	-0.2	0.1	-0.6	1.6
0.1	0.5	-0.3	0.9	0.1	0.7	-0.1	0.2	0.5	1.7
0.1	0.3	0	0.5	0	1.2	-0.1	0.7	0	2.6
0.2	0.3	0	0.3	-0.1	0.2	0	0.7	-0.3	2.4
0.5	0.6	-0.3	0.1	0.2	0.3	0.1	0.6	-0.3	4.9
0.4	0.5	0	0.4	0.4	0.3	0.2	0.1		
0.9	1.8	-0.1	0.2	0.3	0.3	0.4	0.4		
0.4	0.1	0.1	0.3	0.3	0.5	0.4	0.3		
0.4	0.8	0.1	0.2	0.4	1	0.3	0.8		
0	0	0.1	0.2	0.5	0.6	0.4	1.3		
		0.6	0.2	0.4	0.8	0.4	4.4		
		0.5	0.7	0	1	0.1	3.9		
		0.8	1.2						
		0.5	1.4						

PRBA1 Pebble Count conducted every 5cm																	
mp	cs	lc	cs	sd	fp	fp	mp	mp	mp	fp	cp	cp					
cp	sd	cs	fp	sc	cp	cp	cp	cp	cs	cp	fp	fp					
sc	sc	fp	sc	fp	cp	cp	fp	fp	fp	cp	cp	cp					
fp	cs	fp	mp	sd	cs	cp	fp	fp	lc	sc	cs	sc					
fp	cs	cp	cp	lc	mp	sd	mp	mp	fp	fp	cp	mp					
mp	mp	mp	cp	cp	cp	sc	cp	cp	fp	cp	cs	fp					
sc	fp	sd	fp	lc	fp	mp	fp	fp	fp	fp	cp	sd					
fp	fp	sc	cs	mp	mp	fp	fp	fp	mp	fp	cs						
cp	cp	fp	cp	cp	cp	lc	cs	cs	cp	mp	fp						
cp	fp	mp	cp	sd	lc	cp	cp	cp	fp	fp	mp						

PRBD1

PRBD1a cross section shooting D-2-pts. starting river right		PRBD1a continued from previous column		PRBD1b cross section shooting D-2-pts. starting river left		PRBD1c cross section shooting D-2-pts. starting river left		PRBD1d cross section shooting D-2-pts. starting river left	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	1.4	0	0	0	0	0	0
-0.5	9.1	-0.1	1.3	-1.1	8.4	-0.3	7	-0.7	10.3
-0.2	2.1	0.3	3	-0.4	4.3	-0.3	3.8	-0.2	4
-0.2	8.7	0.1	0.4	-0.3	2.7	0	4.1	-0.3	3.5
0.2	4.7	-0.1	5.4	-0.2	2.2	-0.1	2.8	0.2	1.8
-0.2	3.5	0.1	13.6	-0.4	1.4	-0.1	5.4	-0.2	1.9
0.2	2.9	0	4.6	-0.2	1.2	-0.3	2.5	-0.1	2.1
-0.1	4.9	-0.2	2.8	-0.3	0.6	0	1.7	-0.5	1.4
0.2	5.8	0	1.5	0.2	2	0.1	1	0.2	1.3
-0.4	1.4	0.1	1.3	-0.1	2.4	0.4	1.5	0.1	3.2
-0.3	0.5	0	4.8	0.2	0.9	-0.1	3.1	0.1	3.2
-0.2	0.4	-0.1	1.3	0	2.2	-0.3	1.3	-0.1	4.1
0.1	2	-0.2	2.2	-0.2	1.3	0	2.7	0.1	3.4
0	2.2	0.1	1.1	-0.1	1.6	-0.1	3.6	-0.1	2
0.2	0.5	0.1	3.4	0.1	0.9	0.3	0.6	0.1	2.8
0.1	0.2	-0.1	2.5	0.4	1.5	0	2.4	0	4.9
0.3	0.9	-0.4	1.4	0.3	1.3	0.2	6.7	-0.3	7.5
0.1	1	0	1.7	-0.4	0.6	0.2	2.2	-0.3	1.4
-0.1	2.8	0.2	2.5	0	0.8	-0.1	8.3	-0.3	1.6
-0.2	1	0	3.5	-0.2	0.4	0.1	11.1	0.1	1.8
-0.1	0.6	0.2	1.5	-0.1	1.1	-0.1	2.8	0.3	2.2
-0.1	0.8	-0.5	6.8	-0.1	1.2	-0.4	2.4	0.3	6.7
0	3.1	0	1.6	-0.1	1	0	4	0.1	1.5
-0.2	1.3	-0.1	1.7	0	1.7	0.4	7.1	0	7.8
-0.2	1.9	-0.1	2.3	0.2	0.6	-0.4	1.1	-0.1	0.8
0.1	0.8	0.2	0.6	0.3	0.5	-0.6	0.8	0	3
0	1.5	0.2	0.7	0.3	0.6	-0.5	1.9	0.1	4.8
0.1	1.2	0.4	1.3	0.2	3.3	-0.2	0.6	-0.5	1.6
0.1	0.6	0.1	3.2	-0.5	6.2	0	1.3	0.1	2.4
0.3	1.3	-0.3	2.2	0	2.2	0.1	1	-0.3	1.5
0.2	1.7	0.2	2	0.1	5.2	0	2.7	-0.2	0.8
-0.2	9.7	0.5	7.4	-0.2	6.9	0.6	1.7	-0.5	1.2
-0.1	2.7	1.4	15.3	-0.4	4.6	0.2	3.2	-0.1	5.1
-0.3	2.4			0.2	7.1	-0.1	1.8	0.4	1.5
0.1	1.4			0	6.1	-0.2	4.4	0.5	2.6
-0.1	2.9			0	9.2	0.2	3.9	0.9	2.3
0.1	2.6			0.1	10.2	0.3	1.9	0.4	2.4
-0.1	1.4			-0.5	10.6	0.3	3.6	0	6.2
-0.1	0.8			-0.4	2.8	-0.3	4.8	1	9.7
-0.2	0.5			-0.1	2.5	-0.4	2.7		

-0.1	2			0	2.3	-0.1	1.9		
0	0.8			0.1	1	0.4	2		
0.1	0.9			0.6	2.5	0.1	2.2		
0.1	0.9			0	4.1	-1.2	3.1		
0.2	1.4			-0.3	10.3	-0.1	2.9		
0.1	2.4			-0.2	7.2	0.5	1.3		
-0.1	0.7			-0.1	7.3	0.4	2.7		
-0.1	0.8			-0.1	4.6	1.4	14.2		
0	2.3			-0.2	1		PRBD1 longitudinal profile shooting D-2-pt starting upstream		
0.3	1.4			-0.2	2.7		Vert (m)	Hor (m)	
0	3.6			0.1	0.7		397.79	0	
-0.1	3.5			0	2.5		396.92	100.35	
0.2	3.6			0	1.9		394.29	230.42	
0	11.8			-0.1	1.3		391.79	206.55	
0	8.9			-0.2	0.3		390.29	226.08	
0.2	17.4			-0.1	0.9		388.71	148.6	
-0.3	5.8			0	3.2				
0.2	1.5			0.3	1.2				
-0.2	2.1			0.4	1.5				
0	1.6			0.1	3				
0.2	2.6			0.2	8.9				
-0.2	3.3			0.1	7.4				

PRBD1 Pebble Count conducted every 1/2m along all 4 cross sections																	
sd	cs	cp	cs	fp	sd	mp	cp	cp	mp	cs	sd	cp					
cs	mp	mp	fp	cs	cs	mp	fp	fp	fp	fp	mp	fp					
fp	cp	mp	cp	mp	cp	cs	cs	cs	st	cp	mp	lc					
cs	cp	cp	fp	cp	fp	fp	st	st	sd	sd	sd	cs					
fp	lc	lc	cp	sd	mp	st	cs	cs	cp	sd	cs						
mp	fp	B	st	fp	sd	mp	mp	mp	st	fp	fp						
cp	cs	B	cp	sd	fp	lc	cp	cp	cs	cs	fp						
sd	sd	fp	cp	fp	fp	fp	cs	cs	fp	sd	mp						
cs	mp	cs	sd	B	cs	cs	cs	cs	sd	fp	st						
fp	fp	fp	sc	sd	fp	mp	mp	mp	cs	mp	fp						

PRBK1

PRBK1a cross section shooting D-2-pts. starting river right		PRBK1b cross section shooting D-2-pts. starting river right		PRBK1c cross section shooting D-2-pts. starting river right		PRBK1d cross section shooting D-2-pts. starting river right		PRBK1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.5	2.5	-0.9	2.6	-0.1	0.6	-0.2	2.5	-1.1	2.5
-0.2	0.6	-0.4	0.5	-0.4	1.3	-0.2	1	-1.7	4.3
-0.4	1.1	0.1	0.3	-0.4	0.6	-0.2	0.4	-1.3	3.7
-0.3	0.6	-0.2	0.4	-0.2	0.2	-0.1	0.2	-1.6	4.4
-0.4	0.7	0	0.5	-0.2	0.2	-0.1	0.2	-1.2	3.5
-0.1	0.2	-0.1	0.3	-0.1	0.3	0.1	0.2		
-0.1	0.1	-0.2	0.2	-0.1	0.2	-0.2	0.1		
-0.1	0.2	-0.3	0.5	0.1	0.2	0	0.4		
0	0.3	0.1	0.5	0.1	0.1	0.2	0.3		
0.2	0.5	0.1	0.1	0.1	0.3	0	0.3		
0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1		
0.2	0.8	0.3	0.6	0.3	0.4	0.2	0.6		
0.6	1.3	0.3	0.3	0.2	0.5	0.6	1.1		
0.4	1	0.2	0.7	0.3	0.4	0.3	0.9		
0.1	0.7	0.4	1.8	0.3	1.3	0.4	1.5		
0.4	2.7			0.4	3.1				

*NOTE: PRBK1 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

PRIA1

PRIA1a cross section shooting D-2-pts. starting river right		PRIA1b cross section shooting D-2-pts. starting river right		PRIA1c cross section shooting D-2-pts. starting river right		PRIA1d cross section shooting D-2-pts. starting river right		PRIA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	1.8	0.3	4.8	-0.2	2.5	-0.3	2.1	-0.1	16.9
-0.4	1	0	1.4	-0.2	1.2	-0.3	1	-0.2	28
-0.3	0.2	-0.2	1.1	-0.2	0.6	-0.1	0.5	-0.2	28
-0.2	0.2	-0.2	0.5	-0.2	0.4	-0.1	0.3	-0.2	28
-0.1	0	-0.4	0.6	-0.2	0.7	-0.3	0.5	-0.2	12.3
0	1.3	0	1.3	-0.1	2	0	2.7	PRIA1 longitudinal profile 10m DEM	
0.2	4	-0.1	2.6	0	1.6	-0.1	1.1		
-0.1	1	-0.1	0.6	-0.2	1.5	0.1	2.4	308.79	0
0.1	1.4	0	0.9	0	0.6	0.2	1	308.52	35.68
0.1	0.1	0.2	0.2	0.3	0.5	0.1	0.6	308.39	30.71
0.2	0.3	0.1	0.4	0.1	0.4	-0.1	0.9	308.13	31.53
0.2	0.5	0.2	0.1	0	0.4	-0.3	0.7	307.82	56.59
0.4	1.8	0.2	0.8	0.1	0.3	0	1	Valley/piedmont slope shooting D-2-pt starting upstream	
0.1	1.2	0.3	0.6	1.2	2.1	1.3	4.5		
0	3.2	0.3	0.6	0.1	5.2	0.1	2.8	Vert (m)	Hor (m)
		0.4	0.3					309.37	0
		0	2.8					308.78	83.78
								308.03	119.63
								307.55	69.63

PRIA1 Pebble Count conducted every 20cm																	
fp	fp	fp	cs	cs	mp	mp	fp	fp	cs	mp	fp						
fp	cs	fp	cs	fp	fp	cs	cp	cp	cp	sd	sd						
fp	fp	sd	cs	mp	fp	fp	cp	cp	fp	fp	cp						
fp	mp	fp	mp	fp	cp	mp	mp	mp	sd	fp	fp						
fp	sd	cs	mp	mp	cp	fp	fp	fp	fp	mp	cs						
sd	fp	fp	fp	cs	cs	cp	cs	cs	sd	mp							
fp	cs	fp	mp	cs	sd	fp	fp	fp	mp	cp							
cs	mp	fp	fp	fp	fp	cs	mp	mp	fp	mp							
st	fp	fp	sd	cs	fp	mp	fp	fp	fp	cp							
fp	cs	cs	cs	fp	fp	cs	fp	fp	fp	cs							

PRPH1

PRPH1a cross section shooting D-2-pts. starting river left		PRPH1b cross section shooting D-2-pts. starting river right		PRPH1c cross section shooting D-2-pts. starting river right		PRPH1d cross section shooting D-2-pts. starting river right		PRPH1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.3	1.3	0	1.6	0	1.7	-0.1	2.3	-0.1	9.5
0.2	2	0.1	1.4	-0.4	1.1	-0.3	1.6	-0.2	9.2
-0.1	0.7	-0.3	1.1	-0.1	0.8	-0.2	0.3	-0.1	5.4
-0.4	0.6	-0.3	0.3	0.1	0.4	-0.1	0.5	Valley/piedmont slope DEM	
-0.1	0.3	-0.1	0.3	0.4	0.5	0.1	0.4	Vert (m)	Hor (m)
0.2	0.6	0.1	0.8	0.3	1.6	0.2	0.9	299.72	0
0.8	0.6	0.5	0.6	0	1	0.3	0.7	299.6	16.5
0.1	1.4	0.3	0.6			0.2	1.6	299.5	30.02
0	1.9	0	1.9			-0.3	2.5	299.41	43.89

PRPH1 Pebble Count conducted every 5 cm on a longitudinal profile																	
sd	sd	sd	sd	cs	cs	sd	fp	fp	fp	sd	cp	sd					
sd	sd	sd	sd	sd	cs	fp	sd	sd	sd	sd	sd	cp					
sd	mp	fp	mp	sd	fp	fp	mp	mp	sd	cs	cp	fp					
mp	fp	fp	mp	mp	fp	sd	sd	sd	sd	sd	fp	cs					
fp	cs	cs	sd	cs	sd	sd	cs	cs	fp	sd	sd	sd					
sd	sd	sd	sd	sd	sd	mp	cs	cs	sd	sd	sd	cs					
sd	fp	cs	cs	sd	fp	sd	sd	sd	sd	fp	sd	sd					
fp	cs	sd	sd	sd	sd	sd	sd	sd	sd	cs	sd	cs					
sd	sd	sd	sd	cs	fp	cs	sd	sd	fp	cs	cs	cs					
cs	cs	sd	sd	fp	mp	fp	sd	sd	cs	sd	sd	fp					

STBA1

STBA1a cross section shooting D-2-pts. starting river right		STBA1b cross section shooting D-2-pts. starting river right		STBA1c cross section shooting D-2-pts. starting river right		STBA1d cross section shooting D-2-pts. starting river right		STBA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.1	6.3	-0.3	2.1	-39	91	-0.8	7.9	-0.2	9.7
-0.2	1.8	-0.4	1.9	-7.8	34	-0.2	0.9	0	6.8
-0.4	1	-0.1	2.3	-1.2	13.3	-0.3	0.5	-0.1	12.7
-0.2	3.1	0.1	1.8	0	2.7	0	1	-0.2	10.2
-0.2	0.5	0.1	1.7	-0.1	1.9	-0.1	0.3	-0.2	13.7
-0.3	0.9	-0.1	0.7	0.1	1.2	-0.2	0.7	-0.4	6.2
0.2	1.1	-0.2	0.6	-0.2	0.5	0	1.3	-0.1	3.3
-0.1	1	-0.1	1.5	-0.3	0.6	0.1	0.5	-0.4	6
0.1	0.7	0.1	0.4	-0.1	1.8	-0.1	1.2	0	15.4
-0.1	0.9	0	1.1	0.1	0.5	0.1	0.9	-0.5	9.7
0.1	2	-0.4	1.4	-0.1	0.5	0.1	0.4		
0.2	0.9	0.2	0.6	0.1	0.7	0.1	0.6		
0.5	2.3	0.2	1.3	-0.2	0.9	0.1	4		
0.3	0.1	0.6	1.2	0.2	0.5	1.7	4.3		
1.3	3	1.8	2.5	0.1	0.4	1	3.9		
1	0.5	4.9	7.2	0.1	0.8				
2.8	6.6			0.3	2.1				
				5.2	9.5				

STBA1 Pebble Count conducted every 10 cm																	
sc	cp	mp	fp	mp	fp	st	fp	fp	mp	mp	cp	mp	mp	sc	cs		
lc	cp	mp	fp	mp	sc	cp	B	B	mp	sc	fp	cp	cp	sc	fp		
cp	mp	fp	fp	fp	fp	fp	mp	mp	cp	mp	cp	cp	cp	cp	cp		
mp	cs	fp	mp	fp	mp	mp	mp	mp	cp	fp	cp	mp	cp	mp	B		
cp	cp	fp	cs	fp	mp	mp	mp	mp	fp	fp	cp	fp	cp	cp	sc		
fp	cs	fp	mp	cs	st	mp	sc	sc	mp	lc	lc	lc	sc	sc	cp		
mp	mp	fp	cp	mp	cp	mp	fp	fp	fp	cs	cs	sc	mp	sd	cp		
fp	st	fp	cs	mp	mp	sc	cp	cp	sc	fp	fp	fp	cp	sc	mp		
st	B	cs	mp	sd	cp	fp	fp	fp	fp	cp	mp	mp	sc	cp	lc		
sc	mp	fp	mp	mp	mp	cp	B	B	mp	fp	fp	cp	cp	ls			

STBD1

STBD1a cross section shooting D-2-pts. starting river left		STBD1b cross section shooting D-2-pts. starting river left		STBD1c cross section shooting D-2-pts. starting river left		STBD1d cross section shooting D-2-pts. starting river left		STBD1 longitudinal profile derived from 10-m DEM	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	500	0
-10	37	-6.1	25.2	-0.2	10.5	-71	128	497.11	161.93
-2.3	8.7	-0.9	2.6	-0.5	7.7	-3	56	486.47	649.03
-0.3	2.7	-0.5	4.5	-0.1	5.4	0.6	13.6	475.45	604.37
0.1	5.5	-0.3	3.5	-0.1	0.8	-0.3	14.6	465.93	654.45
-0.4	3.1	0.1	0.9	-0.2	0.6	-1.6	6.7	457.58	451.86
-0.2	2.5	0.1	10.5	-0.2	0.6	1.3	4.6		
-0.1	3.2	0	2.3	-0.2	0.9	0.1	5		
0.5	1.6	-0.2	2.1	0.1	3.3	-0.1	10.7		
-0.4	2.2	0.1	1	0	2.1	-0.7	2.3		
0.1	5	0	3.8	0.1	0.8	1.6	18.6		
0.3	0.9	0	4.3	0.1	0.8	-0.1	19.4		
0	4.4	-0.1	0.4	0.1	1.9	0.3	17.1		
-0.5	5.4	-0.2	1	0.9	4.8	-1.5	6		
0.2	1.1	-0.2	1.6	0.2	5.9	0	3.9		
-0.3	1	-0.1	3.8	-0.2	6.9	1.5	17.4		
0	4.9	-0.1	4.7	-0.3	4.9	0.3	15		
0.4	4.6	0.2	0.9	0	5.4	0.2	14.9		
-0.2	2.6	0.1	6.4	-0.3	4.1	-0.2	20.3		
0.1	2.2	-0.2	6.1	-0.3	5.1	-0.1	17.3		
0.1	3.6	0.5	3.9	-0.1	1.3	0.2	27.5		
-0.3	1.2	0	0.8	0.7	4.7	0.1	21.9		
0.1	1.7	-0.2	0.8	0	8.2	-0.5	13.5		
0	2.6	0	2	0.3	3.8	0.5	9.9		
0.1	1.6	0.1	2.7	0.1	13	0.1	12.8		
-0.1	3.5	-0.3	3.3	0	5.6	-0.4	3.3		
-0.2	2.9	-0.3	0.6	-0.3	3.8	0.1	1.6		
0.2	3.8	0	5.9	0.2	2.4	0.1	1.9		
-0.3	2.6	0.4	2	-0.2	5	0.1	3.2		
0	5.2	-0.3	1.4	0	1.3	-0.2	1.5		
-0.1	2.2	0	1.8	-0.3	1.9	-0.2	4.2		
0	5.4	0.3	2.7	0	3	0	1.8		
0.2	2.1	0.1	2.1	0.2	1.6	-0.4	4		
0.2	9.5	0	11.4	0.1	5.2	0.1	6.2		
0	11.1	0.1	16.2	0.3	5	0.1	3.1		
-0.1	13.5	-0.1	16.8	0	2.3	0.3	2.1		
-0.4	6.5	-0.1	1.1	-0.3	7.5	0.1	4.5		

-0.3	0.6	-0.3	1.8	0.5	8.5	0	4.5		
-0.3	0.8	0	0.9	-0.1	18.7	-0.1	2.4		
0	2.3	0.2	0.9	-0.2	5	-0.3	1.2		
0.1	0.6	-0.1	9	0	6.2	0.1	5.2		
0	1.5	-0.1	1.1	0	7.6	0.1	1.4		
0.2	2.1	-0.1	0.3	-0.5	9.9	0.1	5		
0.3	2.1	-0.1	0.9	-0.1	2.7	0	10.7		
0.3	8.7	0.1	0.7	0.3	4.7	0.2	4		
0	13.4	0.1	1.1	0.5	8.7	0.1	9.1		
-0.3	2.2	0.6	5.2	0.1	12.3	0.1	7		
0	1.7	0.3	3.7	-0.2	3.7	0	8.8		
0.1	3.1	0.1	12.9	0.3	3.2	0.1	4.7		
0	5.1	-0.3	0.6	0	4.2	-0.3	1.6		
0	4.4	-0.1	4.6	-0.1	4.2	0.1	3.2		
-0.1	2.8	-0.4	9.8	0.4	2.5	-0.3	0.8		
0	2.3	-0.5	6.9	0.3	11.2	0.2	3.2		
-0.1	1.7	-0.3	7.5	0.3	7.9	0.2	0.7		
-0.1	4.5	-0.3	1.5	0	8.5	-0.2	2.2		
0	4.1	0.2	2.6	-0.1	5.1	-0.2	3.5		
0.3	0.9	0.2	5.8	-0.1	1.8	0.4	1.3		
0.2	7.5	-0.1	7	0.2	4	-0.1	2		
-0.3	2.4	-0.1	9.1	0.2	3.7	0	2.6		
-0.1	1.6	-0.2	12.2	0.2	10.2	-0.4	1.3		
0.1	3.4	-0.1	4.9	-0.1	7	0	4.4		
-0.3	2.1	-0.2	1.6	-0.2	0.8	0.4	1.3		
0	4.4	-0.1	0.8	0.1	1.4	0	3.5		
0.6	3.2	-0.1	0.6	-0.1	2.9	-0.2	3		
-0.2	1.9	-0.1	1.3	0.1	5	0	3.6		
0	5.1	0	1.6	-0.3	2	-0.3	1.2		
0.2	3.2	0.1	1.6	-0.1	1.9	0	3.5		
-0.3	8.1	0.2	2.9	0.1	1.6	0.2	1.1		
-0.3	1.6	-0.1	1.5	0.2	0.3	0.1	2.5		
-0.1	2.4	-0.2	6	-0.1	7.2	-0.1	5.8		
0.3	3.4	0.1	1.6	-0.3	6.8	0	6.2		
-0.1	6.3	-0.2	6	0.1	1.4	-0.2	0.8		
-0.2	3	0.1	5.2	0.1	10.3	-0.1	5.4		
0.2	1.7	-0.1	1.8	-0.2	3.3	-0.1	5.4		
0.2	5.7	0	3.6	0.2	4.2	0.2	0.8		
-0.1	4.3	0.2	1.3	-0.2	8.9	-0.1	2		
-0.3	3.3	0	3.3	0.2	8.8	-0.2	1.4		
0.2	2.2	0	3.4	-0.2	8.4	-0.1	5		
0	4.8	0	0.9	0.2	6.3	0.3	0.6		
-0.2	2	0	1.6	-0.2	1.1	0.2	2.6		

0.2	1.2	-0.1	1.7	-0.3	0.7	-0.2	5.2		
0.2	9.7	-0.1	4.8	0.3	1	-0.1	3.1		
-0.2	5.6	0.1	0.7	0.1	8.7	0	1.3		
0.2	9.9	0.3	2.1	-0.2	1.7	-0.5	0.1		
-0.2	4.1	-0.1	2.2	0	0.7	0	2.9		
-0.2	2.2	-0.1	1.3	0.2	1.3	0.2	1		
-0.1	3.2	0.1	4.2	0.1	10.2	-0.1	4.9		
0.1	1.8	0	2.5	-0.1	4.5	0.3	2.1		
0.2	1	0.2	2.4	0.3	7.5	-0.1	2.9		
0.1	4.2	-0.1	8.9	0.1	8.8	-0.5	3		
0.7	6.4	0.1	6.3	-0.3	6.3	0.1	1.6		
1.6	6	-0.2	1	-0.2	2.6	-0.2	4		
		0.1	3.7	-0.2	1.1	-0.1	3.3		
		-0.2	2.2	0.1	4.4	0.1	0.8		
		-0.2	5.3	-0.3	1.6	0.2	0.5		
		-0.1	4	0	1	0.3	2.5		
		0.1	1.9	0.3	1.6	0.9	8		
		0.1	2.6	-0.2	8.3	1.2	10.7		
		1.5	10.4	-0.1	4	0.8	8.6		
		1.1	11.1	-0.4	1.1				
				0	5.1				
				0.3	6.4				
				-0.4	3.5				
				0.1	4.4				
				0.1	7				
				0	5.4				
				-0.1	1.6				
				0.2	1.4				
				-0.4	0.7				
				0.1	5.3				
				0	8.4				
				0.3	2.1				
				0	4.2				
				-0.1	4.2				
				1.5	5.1				
				3.1	12.7				

STBD1 Pebble Count conducted every 1/2m along all 4 cross sections																	
cs	fp	sd	fp	mp	fp	fp	cs	cs	fp	fp	cs	mp	fp	fp	cs		
fp	sd	cs	cs	fp	fp	cs	fp	fp	cs	cs	cs	fp	cs	cs	fp		
fp	fp	cs	cs	fp	cs	fp	fp	fp	fp	fp	cs	sd	cs	sd	cs		
mp	fp	cs	fp	cs	cs	cs	fp	fp	sd	cs	fp	sd	fp	mp	cs		
mp	sd	cs	fp	cs	sd	fp	cs	cs	fp	fp	cs	fp	fp	sd	fp		
sd	mp	fp	sd	fp	fp	fp	cs	cs	cp	fp	fp	cs	cs	fp	sd		
sd	cs	sd	fp	cs	cs	fp	cs	cs	cs	cs	sd	sd	fp	cs	fp		
fp	fp	fp	cs	cs	cs	cs	cs	cs	cs	sd	fp	fp	sd	fp	mp		
cs	fp	fp	fp	fp	cs	sd	fp	fp	cs	cs	fp	sd	sd	fp	sd		
fp	cs	sd	cs	fp	cs	fp	fp	fp	sd	fp	cs	cs	cs	cs	cp		

STBK1

STBK1a cross section shooting D-2-pts. starting river right		STBK1b cross section shooting D-2-pts. starting river right		STBK1c cross section shooting D-2-pts. starting river right		STBK1d cross section shooting D-2-pts. starting river right		STBK1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.4	3.4	-1.2	4.8	-0.7	1.2	-8.5	14.9	-0.8	1.5
-0.2	1.7	-0.4	0.9	-0.8	1	-1.4	3.5	0.3	1
-0.2	0.1	-0.2	0.1	-0.4	0.7	-0.6	1	-0.8	1.8
-0.2	0.2	-0.2	0.5	-0.2	0.2	-0.1	0.7	-0.5	0.7
0	0.8	-0.1	0.3	-0.1	0.3	-0.2	0.2	0.2	1.2
0.2	0.2	-0.1	0.2	0.2	0.5	0	0.3	-0.4	0.1
0	0.2	-0.1	0.4	-0.1	0.3	-0.3	1.6	-0.4	2.2
-0.3	0.8	0.1	0.1	0.1	0	0.1	0.2	-0.7	4.1
-0.1	1.2	0	0.4	0	0.3	-0.1	0.2	-0.8	4.1
0.3	0.6	0	0.7	0.1	0.1	0	0.3	-0.6	1.7
0	0.8	0.3	0	0.1	0.3	0.2	0.6	-1.3	2
0.3	1.6	0.1	0.5	0.3	0.4	-0.2	0.2		
		-0.3	1.2	-0.2	0.7	0	0.4		
		0.1	1.6	-0.3	1.9	0.2	0.2		
						0	0.3		
						0.3	0.6		
						0.1	1.7		
						-0.3	1.3		

*NOTE: STBK1 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

STIA1

STIA1a cross section shooting D-2-pts. starting river right		STIA1b cross section shooting D-2-pts. starting river right		STIA1c cross section shooting D-2-pts. starting river right		STIA1d cross section shooting D-2-pts. starting river left		STIA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	0.6	0	4.5	0.2	5.3	0.7	9.2	0.2	13
-0.6	1	-0.9	1	-0.3	1.3	-0.5	3	0.4	22.4
-0.5	0.7	-0.3	0.4	-0.5	1.4	-0.5	2.8	0.4	22.2
-0.2	0.5	-0.1	0.5	-0.5	2.5	-0.3	0.8	0.3	21.5
-0.1	0.2	0	1.2	-0.4	1	-0.2	1.1	0.3	21.1
-0.2	0.3	0	2.8	-0.2	0.3	-0.2	1		
0	3.1	0.1	1.4	0	2.2	0	1.8	Valley/piedmont slope 10-m DEM	
0.1	1.7	0.1	0.4	-0.1	2.2	-0.1	2.3		
0.2	1.6	0.4	0.9	0.1	1	0.2	0.2		
0.3	1.2	0.3	2.9	0.1	0.5	0.2	0.1	Vert (m)	Hor (m)
0.3	2.3	0.4	4.3	0.4	0.6	0.2	0.2	552.38	0
0.4	3			0.3	1.1	0.4	0.8	551.2	53.4
				0.2	2.4	0.5	1.5	550.69	24.6
				0.6	4.6	0.3	1.7	550.2	21.5
						0	2.8		

STIA1 Pebble Count conducted every 5 cm																	
sd	sd	cp	fp	cs	mp	cs	mp	mp	sd	fp	cs	sd	cs				
cs	sd	sc	mp	fp	fp	cs	sd	sd	fp	cs	fp	cs	sd				
fp	fp	cs	cp	cp	mp	cs	cs	cs	cs	sd	cs	cs	fp				
sd	fp	fp	cs	cp	cp	cp	cp	cp	sc	mp	cs	cs	cp				
fp	sd	cs	fp	fp	sd	cs	cp	cp	fp	fp	cs	mp	sc				
fp	cs	sd	cs	fp	cs	sd	cp	cp	mp	cp	cs	cs	cs				
mp	fp	fp	sd	cs	fp	fp	sc	sc	cp	fp	cp	sd	cp				
sd	fp	cp	cp	sd	cs	fp	fp	fp	sd	cp	sc	cs	sd				
fp	cs	fp	mp	fp	fp	cs	fp	fp	fp	cs	cs	fp					
sd	fp	cp	mp	fp	mp	fp	cs	cs	cs	cs	cs	fp					

STPH1

STPH1a cross section shooting D-2-pts. starting river left		STPH1b cross section shooting D-2-pts. starting river left		STPH1c cross section shooting D-2-pts. starting river left		STPH1d cross section shooting D-2-pts. starting river left		STPH1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0	8.3	-0.1	20.2	-0.1	7.5	0	18	-0.1	9.8
0.2	1.1	0.1	2.5	0.3	2.7	-0.4	4.5	-0.3	10
-0.3	0.6	-0.3	1.6	-0.1	1.1	0	2.2	-0.2	10
-0.1	0.8	-0.1	0.8	0	1.3	0.2	1.4	-0.1	10.3
-0.2	0.6	-0.2	0.3	-0.1	0.6	-0.2	0.5	-0.2	5.8
-0.1	0.2	-0.2	0.6	-0.2	0.6	-0.1	0.2	0	5.5
0	0.8	0	0.8	-0.1	0.2	-0.1	0.3		
0.1	0.5	0.2	0.5	-0.1	0.1	0	0.9		
0.2	1.1	0.3	0.7	0	0.7	-0.1	0.7		
0.1	0.6	0.1	2.2	0	0.7	0.1	0.3	Valley/piedmont slope 10-m DEM	
0.2	2.3	0.1	5.3	0.1	0.2	0.2	0.8		
-0.1	3.4			0.1	0.5	0.1	2.1	Vert (m)	Hor (m)
				0.1	0.1	0.1	5.8	361.06	0
				0.3	1.7			360.41	34.46
				0.2	3.2			360.08	62.68
				0.1	6.3			359.58	87.56

STPH1 Pebble Count conducted every 5-10cm																	
fp	cs	fp	cs	fp	sd	st	mp	mp	sc	cp	sd	fp					
fp	st	fp	st	cs	fp	cp	mp	mp	fp	cs	fp	cs					
fp	fp	fp	fp	fp	st	cp	sd	sd	cp	cp	fp	cs					
fp	fp	fp	sd	cs	fp	cs	cs	cs	cp	cp	cs						
st	cs	fp	cs	fp	fp	cp	sc	sc	cp	cs	cs						
fp	cp	fp	cs	mp	sd	sc	sc	sc	fp	mp	mp						
sd	fp	st	sd	cs	fp	cp	sc	sc	mp	fp	fp						
fp	cs	mp	cp	cp	fp	sd	fp	fp	cs	cp	cs						
fp	mp	st	sd	cs	cs	cp	mp	mp	sd	cs	sd						
sd	mp	fp	cs	cs	fp	cp	cs	cs	cp	cs	cs						

UMBA1

UMBA1a cross section shooting D-2-pts. starting river right		UMBA1b cross section shooting D-2-pts. starting river right		UMBA1c cross section shooting D-2-pts. starting river right		UMBA1d cross section shooting D-2-pts. starting river right		UMBA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.4	6.6	-0.2	8.2	-0.3	7.6	-0.2	17.6	0	9.7
-0.1	2.2	-0.1	4.4	-0.4	3.7	-0.3	3.1	0.2	5.6
-0.2	0.5	-0.2	1.3	-0.1	0.8	-0.5	1.9	-0.1	5.7
-0.2	0.3	-0.2	0.8	-0.1	0.2	-0.2	0.3	0	12.1
-0.2	0.3	-0.3	0.5	-0.4	0.3	-0.2	1.5	0.1	5.2
0.1	0.4	-0.1	0.6	0	1.3	0	0.4	0.1	5.7
0	1	-0.1	0.6	0.2	0.9	0.2	0.7	-0.2	2.3
0	1.2	0	1.3	0.2	1	0.7	3	0.1	5.3
0.1	0.2	0.2	0.6	0.4	1.9	0.4	1.9	0.2	7.8
0.1	0.4	0.2	0.5	0.3	0.9	1	2.2	Valley/piedmont slope10-m DEM	
0.2	0.7	0.2	1.6	1	2.7				
0.2	1.4	0.8	2.1	3.1	7.9			Vert (m)	Hor (m)
0.9	3.2	1.4	3.3					439.39	0
1.8	4.4							436.55	43.98
								434.9	130.29
								434.26	186.21

UMBA1 Pebble Count conducted every 5cm																	
sd	fp	fp	cs	fp	mp	cp	fp	fp	mp	cs	cp	fp	sd				
st	sd	fp	cs	fp	cp	mp	mp	mp	fp	fp	cs	cp					
fp	cp	cp	cs	cp	mp	fp	fp	fp	mp	cp	fp	sc					
sd	sd	fp	fp	cp	cs	mp	fp	fp	fp	cs	fp	lc					
fp	sd	mp	mp	fp	mp	mp	mp	mp	fp	fp	mp	sd					
sd	cp	mp	fp	cp	fp	fp	cs	cs	cs	fp	fp	fp					
fp	fp	cp	cs	mp	cp	fp	mp	mp	fp	cp	cs	cp					
fp	fp	cp	mp	mp	mp	fp	fp	fp	cs	mp	fp	sc					
sd	fp	cp	cs	fp	fp	fp	mp	mp	cp	mp	fp	cp					
fp	fp	cp	sd	fp	lc	fp	fp	fp	fp	sc	sd	sd					

UMBD1

UMBD1a cross section shooting D-2-pts. starting river right		UMBD1a survey continued from previous column		UMBD1b cross section shooting D-2-pts. starting river right		UMBD1c cross section shooting D-2-pts. starting river right		UMBD1d cross section shooting D-2-pts. starting river right	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	-0.2	2	0	0	0	0	0	0
-10.4	126.3	-0.4	1.2	0.4	15	-0.1	9.2	-2.8	89.9
-1.3	25.9	-0.2	0.6	-0.3	7.4	-0.5	10.5	0.2	15.7
-1.4	30.7	0	0.7	-1.9	6.4	-0.8	7.8	-0.3	4.3
-1	23.6	0.3	1.3	0.1	8.2	-0.4	5.3	-0.5	2
-0.8	19.2	-0.3	1.4	-0.2	9.3	-0.1	5.4	-0.6	1.3
-0.7	5.3	-0.1	1.6	-0.2	2.6	-0.2	1.8	0	2.3
0.1	4.1	0.1	2.6	-0.3	0.9	-0.3	1.2	0.1	2.1
0.5	2.6	0	2.5	-0.2	4.9	-0.1	1.6	-0.4	2.1
-0.1	13.1	0.1	0.6	0.4	1.3	0.3	3	-0.2	0.4
-0.4	16.7	0.2	2.2	0.4	1.5	-0.6	0.4	-0.1	0.6
-0.4	13.5	-0.1	1.7	0.1	7.9	0	2.4	0.2	0.7
-0.3	5.7	0.2	1.2	-0.4	4.1	0.2	1.6	-0.1	1.2
-1	10	0.3	2.5	-0.5	3.4	0.2	0.8	-0.2	0.6
-0.4	1.3	-0.2	2.2	0.4	2	0	2.5	-0.2	2.7
0.2	2.8	0.1	3	-0.1	2.3	-0.3	3.2	0.5	0.8
-0.7	1	0.2	0.5	0.1	2.7	0.3	0.9	0.2	1.9
0.2	1.3	-0.4	2.5	-0.1	5.4	-0.2	4.7	-0.3	2.4
0.1	4.4	-0.2	1.7	-0.3	0.9	0.3	0.9	0.3	5.7
0.2	2.1	-0.3	2.2	0	2.8	-0.2	4.2	0.1	6.3
0.4	1.1	-0.1	0.9	0.1	3.7	0	4.3	-0.3	3.5
0.3	2.4	0.4	1.2	-0.3	2	0.3	1.7	-0.2	2.6
-0.3	4.4	0.3	1.8	-0.1	3	0.1	3.1	0.1	1.5
0.2	4.7	-0.2	7.3	0.2	1.3	0	1.6	0.3	2.2
-0.1	3.2	-0.7	1.5	-0.2	2.1	0.4	1.3	0.1	1.9
-0.2	4.7	0.7	1.5	0.3	0.3	-0.2	11.8	0	1.5
0	3.2	0.2	4	0	1	-0.2	17.5	0.2	4.9
0	4.1	1.6	12	0.3	1.1	0	6.2	0	5.4
-0.3	2.1	4.1	15	0.2	3.9	-0.5	7.2	-0.1	4.2
-0.3	2.1	2	7	-0.3	2.8	0.1	9.8	-0.4	2.7
0	1.9			0.1	3.5	0.5	3.5	0.2	3.9
0	2.5			0.2	0.5	-0.1	7.4	0	4
-0.2	2.4			-0.1	8.9	-0.3	6.1	-0.3	3.8
0.3	3.2			0.3	6.3	0.1	13.8	0.3	2.3
0	1.3			0.1	6.9	0.2	10.3	-0.1	4.3
1.3	0.4			-0.3	7.4	-0.4	15.6	0.2	9.8
-0.3	9.5			-0.1	3.5	0.1	16	-0.2	5.2
-0.1	3.1	UMBD1 longitudinal profile 10-m DEM		0.2	6.2	0.1	12.8	-0.1	3.6
-0.1	10.6			0.3	2.7	-0.2	2	0.3	4.6
0	9.9			0.4	8.5	0.2	2	0	13.9
0	16.6	Vert (m)	Hor (m)	-0.1	8.5	0.1	11.6	-0.5	4.2
-0.3	4.4	552.62	0	0.2	2	-0.4	7.2	-0.7	1.6
0.3	2.2	549.61	271.54	-0.4	11.5	-0.3	14.7	1	1.5
0	10.3	545.32	600.84	-0.5	1.9	-0.4	6.3	-0.1	3.2
-0.4	2.8	540.51	959.9	0.4	1.1	0.3	5.3	0.5	2
0.3	12.7	535.19	1302.85	-0.5	4.9	-0.6	2.1	-0.3	1.1
-0.3	4.9	533.1	1468	0.6	5.6	0.2	4	0.3	4.3
0.5	11.9			-0.1	12.7	0.2	1.1	-0.3	3.9
-0.1	6			-0.1	4.4	0.1	3.7	0.4	4.3
-0.3	4.2			0.2	8.3	-0.2	3.6	0	9.3

-0.4	2.4			-0.2	9.7	-0.3	2.7	-0.2	15.7
-0.2	3.9			-0.1	10.5	0	3.3	0.1	8.6
-0.6	1.9			-0.2	5.8	-0.1	2.7	-0.1	6.7
0.1	1.7			0.4	3	0.5	1.5	-0.1	13.4
0.3	1.2			0.1	12.7	0.1	3.5	-0.2	7.1
-0.4	1.9			-0.1	9	-0.1	6.3	-0.2	5.8
-0.3	1.3			-0.5	1.6	0	7.2	-0.5	1.3
0	2.4			0.2	2.1	0.6	4.7	-0.1	1.9
0.5	3.2			-0.3	3.9	-0.2	7	0.3	4.7
0.3	4.9			-0.5	2.4	-0.4	4.1	-0.1	2.9
0	5.8			0	3.3	-0.6	3.1	0.5	6.4
0.2	8.2			0.4	1.2	-0.2	2.9	-0.1	6.5
-0.4	8.5			0.2	0.7	0.6	0.8	-0.5	1.2
0.1	2.7			0.2	3.8	0.3	1.8	0.4	3.5
-0.1	3.6			-0.3	5.1	0.4	6.1	0.2	3
-0.2	2.8			-0.1	7.5	0.5	10	0.1	3.5
0.1	1.4			0.2	3.9			-0.1	3
-0.1	2			-0.3	3.6			-0.3	0.6
-0.1	1.3			0	1.7			0	1.8
0	2.2			0.4	1.5			0	1.6
0.3	2.6			0	4.6			0.4	2.2
-0.2	4			0.4	9			0.1	2.5
0.1	3.6			0.1	1			-0.1	7
0.2	1.2			-0.1	1.4			-0.1	3.3
-0.2	15.1			-0.5	1.3			1.4	4
-0.2	6.5			0	2			0.7	11
-0.1	9.8			-0.2	1.5			2	67.9
0.5	2.6			0	2.2				
0.1	8.8			-0.1	3.1				
-0.3	17.8			0.5	0.6				
-0.2	12.1			0	1.4				
-0.2	1.9			0.2	0.5				
0	1.1			0	3.3				
0.3	1.5			0.6	1.7				
0	3.4			-0.1	6.4				
0.1	2.5			0.1	14.9				

UMBD1 Pebble Count conducted every 0.5 m																	
st	fp	org	st	sd	cs	fp	cp	cp	sd	mp	sd	mp	fp	fp			
st	fp	wd	sd	wd	fp	fp	cs	cs	fp	sd	st	cp	cp	fp			
fp	mp	fp	st	cs	sd	mp	cs	cs	mp	cp	cp	mp	mp	cp			
mp	st	cp	fp	fp	st	mp	cs	cs	mp	fp	fp	mp	sd	mp			
cp	mp	fp	fp	fp	st	cp	fp	fp	cs	mp	cp	mp	dp	st			
cp	cs	sd	cs	cp	st	sd	st	st	mp	mp	mp	mp	lc	st			
cp	st	sd	cs	mp	mp	st	sc	sc	sd	fp	fp	fp	mp	fs			
mp	st	sd	fp	sc	sd	st	cp	cp	mp	sc	mp	cp	sd	st			
fp	st	st	fp	mp	cp	cp	cp	cp	mp	st	cp	fp	sd				
sd	st	st	fp	cp	sd	fp	fp	fp	fp	st	st	cs	fp				

UMBK1

UMBK1a cross section shooting D-2-pts. starting river left		UMBK1b cross section shooting D-2-pts. starting river right		UMBK1c cross section shooting D-2-pts. starting river right		UMBK1d cross section shooting D-2-pts. starting river left		UMBK1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1.8	3.4	-1.6	6.1	-0.9	2.9	-6.2	6.5	0.6	1.5
-1.1	0.2	-1.5	2.1	-1.3	3.1	-3.1	8.1	0.8	1.6
-0.1	0.3	-0.7	1.5	-1.3	3.2	-0.8	1.9	0.4	3.2
-0.1	0.9	-0.3	0.2	-0.3	1	-0.3	0.4	0.4	1.4
-0.2	0.7	-0.3	0.6	-0.4	0.9	-0.3	1.5	-0.1	3.2
0	0.7	-0.3	0.9	0.4	0.7	-0.3	1.5	0	2.4
-0.1	0.8	-0.1	1.2	0.3	0.3	0	1.5	0.1	0.6
0.3	1.2	0.2	1	0.8	1.4	0.3	1.3	0.3	1.2
-0.1	0.4	0.2	1	1.1	3.3	0.3	0.7	0	2.3
0.2	0.3	0.7	1.2	1.5	3.2	0.3	1	0.8	3.3
0.1	0.3	0.9	2.2	8.7	2.1	0.4	1.4	0.6	3.5
0.4	1	2.2	5.1			1.6	3.1	1.2	4.5
0	0.9	2.2	5.3			1.7	2.9	0.6	2.6
0	0.7					7.5	0.9	0.9	3.4
0.1	0.6							0.6	3.5
0.2	0.5							0.1	2.5
1	1.9							0.7	4
0.9	3								
1.8	5.7								
17	33								
19.4	21.9								

UMBK1 Pebble Count conducted every 5 cm																	
fp	fp	sd	cp	fp	cs	cp	cp	cp	fp	st	cp						
fp	fp	fp	fp	st	fp	cp	cp	cp	fp	mp	cs						
fp	st	cs	cs	fp	cp	mp	mp	mp	st	fp	cp						
cs	fp	cp	fp	fp	cp	fp	fp	fp	fp	cp							
mp	mp	mp	mp	cp	fp	mp	cp	cp	cs	cs							
cs	mp	fp	fp	fp	fp	fp	mp	mp	sd	mp							
st	fp	fp	sd	mp	fp	fp	mp	mp	cp	mp							
fp	mp	mp	fp	cp	cp	mp	cp	cp	fp	fp							
fp	mp	sd	mp	mp	cs	mp	cp	cp	fp	fp							
fp	fp	cs	cp	fp	mp	cp	mp	mp	mp	fp							

UMIA1

UMIA1a cross section shooting D-2-pts. starting river left		UMIA1b cross section shooting D-2-pts. starting river right		UMIA1c cross section shooting D-2-pts. starting river right		UMIA1d cross section shooting D-2-pts. starting river right		UMIA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.3	0.8	-0.5	1.3	-1.1	3	-0.6	4.4	-0.2	6.2
-0.9	0.3	-0.5	1.1	-0.9	2.5	-1.1	5.1	0.1	7.8
-0.6	1.2	-0.8	1.7	-0.1	1.6	-0.2	4.4	-0.2	8
-0.2	0.3	-0.5	1.1	-0.1	0.4	-0.2	1.3	0	8
-0.2	0.4	-0.2	0.7	-0.1	1.1	-0.2	1.4	-0.3	3.6
-0.2	0.8	-0.3	1.1	-0.2	0.5	-0.1	0.4	0	4.4
0	1.7	0.1	1	0	1.1	-0.2	1.3	0	6
0.1	0.5	0.2	1.2	0.1	0.5	-0.1	0.5	0	9.9
0.2	0.6	0.2	0.5	0.2	0.9	0	0.4	-0.3	8
0.1	0.9	0.3	1.4	0.1	1.8	0	0.3	Valley/piedmont slope 10-m DEM	
0	3.4	-0.1	2.2	0.9	3.5	0.3	0.7		
0.3	4.3	0.3	2.5	0.5	2.7	0.2	0.7	Vert (m)	Hor (m)
0.8	2.2	1.6	9.9	0.4	5	0.7	1.5	496.51	0
0.5	3.4					1.1	1.5	496.11	26.71
0.4	3.6							496.01	44.52
0.1	7.5							495.72	63.1
								495.42	82.33

UMIA1 Pebble Count conducted every 20 cm																	
mp	fp	fp	cp	sc	cp	fp	sc	sc	cp	mp	sc						
mp	cp	lc	sd	cs	cp	fp	fp	fp	fp	mp							
sc	cp	fp	fp	cs	fp	cp	cp	cp	sc	sc							
cp	mp	cs	sc	cp	mp	mp	mp	mp	fp	fp							
sd	cp	cp	lc	sc	sc	cp	mp	mp	cp	mp							
lc	sd	cp	fp	cp	mp	sd	cp	cp	cp	mp							
fp	mp	cp	fp	mp	cp	cp	fp	fp	cs	fp							
fp	fp	B	cp	cp	fp	cp	sc	sc	cs	cp							
sc	mp	cs	mp	st	cs	mp	mp	mp	cp	sd							
cp	B	fp	fp	sc	cp	fp	sc	sc	fp	fp							

UMPH1

UMPH1a cross section shooting D-2-pts. starting river right		UMPH1b cross section shooting D-2-pts. starting river right		UMPH1c cross section shooting D-2-pts. starting river right		UMPH1d cross section shooting D-2-pts. starting river right		UMPH1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0	6.1	0	5.2	-0.3	6.8	-0.1	4.2	-0.1	5.1
-0.3	4.9	-0.3	6.4	-0.2	4.8	-0.1	3.4	0.1	1.9
-0.1	1	-0.2	3.4	-0.1	2.2	-0.2	3.6	-0.1	2.8
-0.1	1.2	-0.2	1.4	-0.1	1.7	-0.2	1.5	0	2.1
-0.2	0.6	0	0.6	-0.3	2.1	0	1.2	0.1	4.3
0.2	0.7	-0.2	0.4	0.1	1.8	-0.2	1.2	-0.2	8
0.1	1.1	-0.1	0.6	0	1.6	0.1	0.7	-0.3	7.5
-0.1	1.6	0.1	1	-0.1	1.4	0.1	1.4	-0.1	5.2
0.1	0.8	0.1	0.4	-0.2	0.7	0	0.8		
-0.1	0.9	0	2.2	0.2	0.7	-0.1	0.5	Valley/piedmont slope 10-m DEM	
0.1	1.8	0	0.8	0.1	1	0	0.5		
0.2	6.4	-0.1	0.7	-0.1	1	0.1	0.4	Vert (m)	Hor (m)
0.4	12	0.1	0.4	0.1	0.9	-0.1	0.8	481.57	0
		0.2	1	-0.1	0.9	0.1	0.7	480.76	21.27
		0	1.4	0	0.9	-0.1	1.5	480.54	39.4
		0.4	9.5	0.1	0.5	0.1	0.6	479.87	55.66
		0.2	5.1	0.2	2.4	0.1	1.9		
				0.2	6.1	0.3	7.4		
						0.2	9.4		

UMPH1 Pebble Count conducted every 5 cm																	
st	cs	st	cp	fp	mp	sd	st	st	st	sd	cs	st					
cs	sp	st	sd	sd	cs	cs	fp	fp	st	sd	fp	st					
sd	fp	st	sd	cs	cp	dp	st	st	fp	mp	cs	st					
sd	sd	mp	cp	fp	cp	dp	mp	mp	sd	fp	cs	st					
st	sd	fp	sd	fp	cp	dp	fp	fp	st	fp	cs	st					
st	cs	fp	st	mp	fp	cs	fp	fp	fp	fp	fp						
cs	fp	fp	cs	mp	cs	fp	st	st	sd	mp	fp						
sd	sd	sd	cs	fp	cs	cs	sd	sd	fp	fp	cs						
cs	sd	fp	sd	sd	cs	st	st	st	sd	fp	st						
st	sd	sd	sd	cs	mp	cs	st	st	sd	mp	st						

YBA1

YBA1a cross section shooting D-2-pts. starting river right		YBA1b cross section shooting D-2-pts. starting river right		YBA1c cross section shooting D-2-pts. starting river right		YBA1d cross section shooting D-2-pts. starting river right		YBA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-6.5	10.5	-2.7	10.5	-4	19.2	-3.2	12	-0.3	15.3
-1.5	2.5	-2	5	-0.9	2.9	-0.6	5.4	-0.8	35
-0.1	0.7	-1.3	2.5	-0.6	0.7	-0.4	1.5	-0.4	15.9
-0.1	0.1	-1.2	0.7	-0.5	1.2	-0.5	0.6	-0.3	10.3
-0.1	0.3	-0.4	-0.1	-0.2	1.1	-0.2	1	-0.2	8.6
-0.1	0.3	-0.5	-0.1	-0.2	0.7	-0.4	0.3	-0.5	19.5
-0.1	0.6	0	2.9	0	0.4	-0.2	0.8	-0.4	14.9
-0.1	2.5	0	1.5	-0.1	0.2	0.1	0.7	-0.2	10.7
-0.1	0.2	0.7	0.8	-0.1	1.6	0	2.3		
-0.1	3.9	2.3	2.4	-0.1	0.3	0	3.2		
-0.1	1.5	0.4	2.6	0.1	0.5	0.4	0.5		
0.2	1.9			-0.1	0.4	0.1	0.3		
-0.1	2.3			-0.2	1.9	0.9	0.9		
0	2			0.1	0.8	1.3	1.4		
-0.2	1.3			-0.2	1.2	1.3	2		
1.2	0.9			0.2	3				
2.2	4.3			0.4	0.5				
4.3	7.7			0.1	1				
				3	5.6				

YBA1 Pebble Count conducted every 20 cm											
cp	cp	mp	cp	fp	cp	mp	cp	cp	sd	fp	mp
cp	fp	fp	cp	cp	fp	mp	cp	cp	fp	fp	fp
fp	fp	cp	mp	mp	fp	fp	fp	fp	cs	fp	fp
cs	cs	fp	cs	fp	fp	cs	mp	mp	fp	mp	
cs	fp	fp	fp	cs	sc	lc	cp	cp	fp	fp	
fp	sc	fp	cp	fp	sc	cp	fp	fp	mp	fp	
fp	fp	fp	fp	cp	fp	sc	fp	fp	fp	fp	
fp	cp	fp	mp	fp	mp	fp	cs	cs	mp	fp	
fp	fp	fp	fp	mp	cs	mp	cp	cp	fp	cs	
mp	mp	fp	fp	fp	cp	cs	fp	fp	mp	fp	

YBA2

YBA2 a cross section shooting D-2-pts. starting river right		YBA2b cross section shooting D-2-pts. starting river right		YBA2c cross section shooting D-2-pts. starting river right		YBA2d cross section shooting D-2-pts. starting river right		YBA2 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-5.5	1.2	-2.8	2.8	-4.7	13	-5.2	3.2	1	38.6
-5.9	11.3	-1.7	0.2	-1.2	0.9	-0.4	0.9	0.5	27.7
-2.4	3.6	-0.4	1.8	-0.6	1.1	-1	0.4	0.3	13.8
-2.1	1.6	-0.1	0.1	-1	0.5	0	0.9	0.3	21.4
-2	0.2	-0.1	0.1	0	2.5	-0.2	0.4	0.2	17.7
-0.5	1.5	-0.2	2.3	0	2.1	-0.1	0.8	0.2	14.4
-0.3	1.5	0.2	0.6	0.3	1.4	0	1.1	0.6	25.8
0	0.4	0.1	0.6	0.2	0.2	-0.2	0.6	0.3	20.7
0.3	0.9	-0.5	1.3	-0.3	0.5	-0.1	1.3	Valley/piedmont slope 5-m DTM	
-0.2	0.5	0.1	2.4	-0.2	0.9	-0.1	1.9		
0.2	1.8	-0.1	2.6	0.5	0.7	0	2.7		
-0.3	0.5	0.8	-0.4	-0.1	0.4	0.2	1.3	Vert (m)	Hor (m)
-0.2	0.8	-0.1	1.8	0.2	0.7	0.1	0.8	218.28	0
0	1.9	-0.1	0	0.5	1.2	1.2	1.1	217.14	13.14
0.2	2.1	-0.1	0.1	2	3.5	1.1	1.5	217.65	36.03
0.2	1.7	0.4	0.9	3.3	0.6	4.1	4.1	216.82	52.26
0.3	0.7	0.4	1.4	2.4	2.9				
0.2	2.7	5.7	2.4						
-0.1	2.9								
0.2	2.6								
0.1	2								
2.5	4.9								
5	2.7								

YBA2 Pebble Count																	
cp	sc	cp	sd	fp	fp	sd	fp	fp	cp	fp	cp	fp					
fp	sc	mp	cp	fp	fp	fp	cs	cs	mp	cs	mp	fp					
cs	fp	sc	mp	cp	fp	fp	cs	cs	sd	cp	cs	cp					
mp	cp	cp	cp	fp	mp	cp	cp	cp	B	cp	cp	cp					
mp	cs	mp	sc	fp	cp	cp	mp	mp	cp	fp	cp						
fp	mp	cp	fp	mp	cs	cp	cp	cp	cp	mp	fp						
cp	mp	fp	fp	cs	fp	st	cp	cp	fp	cp	mp						
cp	fp	fp	mp	mp	cs	cp	mp	mp	sd	mp	sc						
fp	mp	sc	mp	cp	cp	fp	fp	fp	fp	sd	sd						
mp	fp	cp	sd	mp	fp	sd	sd	sd	fp	cs	cp						

YBA3

YBA3a cross section shooting D-2-pts. starting river right		YBA3b cross section shooting D-2-pts. starting river right		YBA3c cross section shooting D-2-pts. starting river right		YBA3d cross section shooting D-2-pts. starting river right		YBA3 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-3.4	4.2	-2.2	2.8	-1.1	2.3	-3.2	7.5	-0.4	3.9
-1.1	0.8	-1.8	1.5	-0.9	1.5	-0.9	0.1	-0.2	3.9
-0.4	0.2	-1.4	2.4	-0.7	0.7	-0.1	0.2	-0.2	2.6
-0.4	0.1	-0.2	0.3	-0.2	0.1	-0.3	0.1	-0.1	1.2
0	1.6	-0.2	0.4	0	0.1	0	0.1	-0.2	3
0.4	0.2	0	0.5	-0.6	-0.1	0.2	0.9	-0.4	6.3
0.2	0.4	0.1	0.2	0	0.2	0.9	1.4	-0.1	2.9
0.3	0.2	-0.1	0.3	-0.2	0.1	0.6	0.5	-0.2	5.3
0.8	1.8	0	0.4	0.1	0.5	2.4	5.7	0	3
3.8	6.3	0.1	0.3	0.1	0.6			-0.5	2.2
2.8	7.2	0.2	0.4	0.7	0			-0.1	4.3
		0.8	1.9	0.3	0.6				
		0.8	1.6	0.6	0.1				
		5.7	11	0.2	0.4				

YBA3 Pebble Count conducted every 5 cm																	
cp	fp	fp	cs	fp	cp	cp	mp	mp	mp	mp	mp	mp					
fp	fp	cs	fp	lc	lc	mp	cs	cs	fp	cp	mp	cp					
fp	fp	fp	mp	cs	fp	mp	cp	cp	cp	fp	mp	fp					
cp	fp	fp	fp	st	cp	lc	mp	mp	sc	sc	cs	cs					
fp	mp	fp	cp	cp	fp	fp	mp	mp	fp	fp	cp	fp					
sd	fp	fp	cp	fp	lc	fp	sd	sd	mp	cp	cs	sc					
sc	fp	mp	cp	cp	cs	cp	fp	fp	cp	mp	cs	fp					
fp	fp	fp	mp	cp	cp	sc	sc	sc	mp	cp	cp						
fp	cs	mp	mp	mp	mp	fp	cs	cs	cp	mp	sc						
st	cp	cp	cp	fp	sc	cp	cp	cp	cp	cp	fp						

YBA4

YBA4a cross section shooting D-2-pts. starting river right		YBA4b cross section shooting D-2-pts. starting river right		YBA4c cross section shooting D-2-pts. starting river right		YBA4d cross section shooting D-2-pts. starting river right		YBA4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-6.5	11.8	-10.8	27.9	-7.3	8.7	-6.9	2.5	-0.2	6.8
-1.3	0.2	-3.7	7.6	-4.3	1.2	-1	0.3	-0.3	6.4
-0.9	1.5	-0.8	0.8	-0.3	0.2	-0.1	1.1	-0.4	12.3
-0.3	0.1	-0.2	0.2	-0.2	1.6	-0.4	0.7	-0.1	6.5
-0.4	0.2	-0.4	0.1	0.2	1.4	-0.4	1	-0.2	1.8
-0.2	0.3	-0.2	0.2	0.5	0.8	0	0.8	-1.7	4.7
-0.3	0.1	0	1	1	0.9	-0.3	0.5	0.4	4.5
0.2	0.5	0.7	0.3	0.1	1.4	-0.6	0.4	-0.4	4.5
0	0.5	1.1	0.4	-1.1	0.8	0.3	0.5	-1.6	2.1
-0.4	0.9	-0.5	1.5	-0.7	0.1	-0.3	0.5	0.6	1.4
0	0.9	-1.1	0.8	-0.3	0.1	0.1	0.6	0.7	2.4
0.2	1.1	-0.3	0.7	-0.6	0.1	-0.1	0.8	0	10.7
-0.2	1	-0.6	0.3	0	0.6	0.4	0.3	-0.6	7.3
0	1.1	-1.1	0.6	-0.1	0.4	-0.1	0.3	-0.1	14.2
0.2	0.1	-0.1	1.9	0	0.5	0	0.5		
0.3	1.9	0.1	1.9	0.2	0.4	0.5	0.3		
0.1	1.3	0.5	1	0.3	0.3	3.5	0.6		
0.6	1.2	0.1	0.8	-0.2	0.3	2.5	3.1		
0.1	1.6	0.3	0.4	0.7	0.3				
1.9	3.9	0.2	0.1	0.2	0.7				
2.4	3.6	1.4	4	1.7	0.5				
9.3	17.2	8.1	12.7	1.4	1.3				
		3.1	2.7						

YBA4 Pebble Count conducted every 10 cm																	
cp	fp	sc	sc	fp	sc	cp	mp	mp	lc	mp	cp						
cp	mp	cs	lc	mp	cp	cp	sc	sc	cp	lc							
cp	cp	lc	lc	st	cp	cs	cp	cp	B	sc							
cp	cp	cp	B	Bk	B	cp	sc	sc	cp	sc							
cp	cp	cp	cp	BK	lc	fp	cp	cp	sc	cp							
sc	cp	sc	lc	st	lc	sc	sc	sc	cp	cp							
cp	cp	cp	cp	fp	lc	lc	lc	lc	lc	cp							
cp	fp	cp	cp	fp	lc	sc	mp	mp	cp	cp							
mp	cp	mp	mp	mp	cp	cp	lc	lc	lc	cp							
mp	cs	cp	fp	fp	cp	sc	B	B	cp	sc							

YBA5

YBA5a cross section shooting D-2-pts. starting river right		YBA5b cross section shooting D-2-pts. starting river right		YBA5c cross section shooting D-2-pts. starting river right		YBA5d cross section shooting D-2-pts. starting river right		YBA5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-11.2	11.8	-12.9	7.3	-12.6	7.7	-8.7	12.3	-0.5	14.9
-2.3	3	-14.2	17.1	-7.5	10.7	-6.3	4.9	-0.2	21.3
-0.3	1.5	-4.3	4.3	-3.1	2.1	-0.9	3.3	0	10.2
-0.3	1	-2.2	2.5	-0.3	0.4	-0.4	0.4	-0.3	17.9
-0.2	0.5	-0.7	1.8	-0.3	0.2	-0.2	1.1	-0.2	13.4
0.1	0.9	-0.3	1.1	-0.1	0.5	-0.8	0.6	-0.1	18.8
0	1.1	-0.2	0.5	-0.2	0.3	0.3	1.1	-0.3	12.3
0.2	0.7	-0.2	0.6	-0.1	0.7	0.5	1	-0.2	20.9
-0.1	0.5	-0.1	1.1	0.1	0.2	0.3	2		
0.1	0.7	0.2	0.3	-0.2	0.2	0	0.8		
0.3	1	-0.1	0.4	-0.2	1.2	-0.2	0.6		
-0.3	1	-0.1	0.1	0.5	0.3	0	0.5		
0.2	0.9	-0.1	1.2	0	1.4	0.2	0.9		
0.2	0.3	0.2	0.4	-0.4	0.3	0.3	0.3		
0.3	0.6	-0.1	1.2	0.1	1	0.3	0.5		
0.2	0.9	0.2	0.7	0.4	0.7	0	0.8		
1.9	1.2	0	0.6	0.1	0.6	3.7	6.9		
5.5	11.4	0.1	0.2	0.1	1	1	6.1		
		0.2	0.8	0.1	1.2	3.9	9		
		1.9	2.1	0	1.1	7.1	19.1		
		3.1	2.8	-0.1	0.3				
		2.3	1.7	0.3	1				
				0	0.5				
				0.3	0.6				
				1.6	3.3				
				6.4	6.6				
				38	70				

YBA5 Pebble Count																	
B	mp	mp	fp	fp	fp	fp	sc	sc	cp	fp	sc	sd					
B	fp	cp	sd	Bk	cp	sc	cs	cs	fp	cp	sd	mp					
B	sd	sc	fp	cp	sc	sc	lc	lc	mp	sc	fp	lc					
B	sd	mp	sc	fp	cp	B	lc	lc	mp	st	fp	fp					
cp	fp	sd	B	B	cs	sc	lc	lc	lc	fp	fp	mp					
mp	lc	lc	sd	sc	lc	fp	cp	cp	cs	fp	mp	sc					
B	sd	sd	Bk	lc	sc	cp	fp	fp	mp	sc	cs	cs					
fp	cp	fp	cp	st	cp	mp	mp	mp	mp	st	mp	cs					
fp	lc	sd	mp	lc	fp	cp	cp	cp	lc	fp	Bk						
fp	cp	sd	st	fp	cp	cp	mp	mp	fp	fp	sc						

YBA6

YBA6a cross section shooting D-2-pts. starting river right		YBA6b cross section shooting D-2-pts. starting river right		YBA6c cross section shooting D-2-pts. starting river right		YBA6d cross section shooting D-2-pts. starting river right		longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1.3	3	-0.8	1.3	-0.6	1	-1.4	2.1	-0.1	5.6
-1.2	2.4	-2.3	2.8	-1.1	1.5	-0.7	0.4	-0.2	4
-0.7	1.1	-0.9	1	-0.9	0.8	-0.5	0.8	-1	2
-0.5	0.8	-0.4	0.7	-0.8	1.9	-0.9	1	0.4	2.5
-0.2	0.3	-0.2	0.2	-0.3	0.6	-0.8	0.5	-0.3	3
-0.3	0.2	-0.5	0.6	-0.6	0.3	-0.5	0.9	-0.9	11.8
-0.1	0.7	-0.1	0.7	-0.5	0.5	-0.1	0.2	-0.3	11.4
0.1	0.3	-0.2	0.3	-0.4	0.7	-0.1	0.1	-0.3	4
0	0.4	0	0.5	0	0.2	0	0.2		
0.1	0.1	-0.2	0.5	-0.2	0.2	-0.2	0.1		
0.1	0.4	0.2	1	0	0.3	0.1	0.9		
0	0.5	0.2	0.4	-0.1	0.3	0	1		
0.3	0.7	0.5	0.8	-0.2	0.7	0.1	0.2		
0.4	0.2	0.5	0.5	0.1	0.3	0.1	0.5		
1.4	2.4	1.1	1.2	0.2	0	0.1	0.4		
		2	1.2	0	0.2	0.3	0.7		
		2.2	2.8	0.9	0.2	0.8	1.4		
				0.3	-0.3	2.2	3.3		
				1.7	1.6	7.7	11.4		
				3.6	1.7				

YBA6 Pebble Count conducted every 1/2m along all 4 cross sections																	
cp	cp	mp	fp	cp	cp	fp	cp	cp	mp	mp	fp						
fp	mp	fp	fp	cp	fp	fp	mp	mp	sc	fp	fp						
mp	mp	mp	cp	fp	sc	mp	fp	fp	cp	fp	cp						
cp	cs	sd	fp	fp	cp	cp	mp	mp	fp	cp							
sc	fp	mp	mp	cs	mp	cp	fp	fp	fp	fp							
cp	cp	cp	mp	mp	mp	cp	cp	cp	fp	fp							
fp	mp	fp	cp	sc	fp	cp	cp	cp	mp	cp							
mp	sc	cp	fp	cs	fp	fp	mp	mp	mp	cp							
cs	cp	mp	mp	cp	mp	mp	cs	cs	cp	fp							
sc	cp	fp	cp	cp	cp	cp	cp	cp	fp	cp							

YBD1

YBD1a starting river right		YBD1b starting river right		YBD1c starting river right		YBD1d cross section starting river right,		YBD1 stream gradient derived from 10-m DEMs	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	95.2	0
-1.5	3.3	-1.1	3.8	-5.5	18.7	-0.8	18.6	101.6	523
-0.8	1.4	-1.4	2.8	-6.7	24	0	8	107.8	539
-0.4	0.3	-0.5	1.4	0.3	19.4	-0.1	5.4	114.6	538
-0.6	1.1	-0.4	2	-0.1	2.3	-0.3	5.8	120.1	371
0	1.1	-0.3	1.7	-0.4	2.3	0.2	3.7	126.9	323
-0.2	5.2	-0.3	0.2	-0.2	0.3	-0.3	4.1		
0.2	0.7	-0.3	0.6	-0.1	0.9	0.2	0.4		
0.2	3.8	-0.1	2.9	0.1	2.3	0.1	3.9	Stream gradient derived from 5-m DTM	
-0.1	1	-0.1	4.1	0	8.3	0	9.9		
0.2	4.3	0.2	0.7	0.2	4.1	-0.2	10.4	Vert (m)	Hor (m)
-0.2	3.1	0.2	10.6	0	7.7	0	12	119.68	0
0.4	6.2	-0.2	3.2	-0.1	3.1	0	16.3	116.39	250.99
-0.1	3.3	0.2	3.1	-0.1	5.2	-0.1	2.6	112.82	483.05
-0.2	1.7	-0.3	2.3	0	2.9	0	3.6	111.53	687.89
-0.1	2.9	0.2	2.1	0.1	3	-0.3	2.1	106.98	1030.12
0.2	2.8	-0.2	1	-0.2	2.9	0.2	3.9	105.05	1332.42
-0.1	2.2	-0.1	2.7	0	4.3	-0.3	6.6	101.33	1616.29
-0.2	1.8	-0.2	0.7	0	6.3	-0.2	2.5	100.83	1812.24
0.1	2.4	0	5.3	-0.1	4.9	0.3	1.9	97.84	2003.8
0.2	0.8	0.2	3.3	0	4	-0.1	3.2	95.37	2158.78
0	1.7	0	2.7	0.1	7.4	-0.3	2.8	93.89	2322.55
0.1	3.9	-0.3	2.1	-0.2	6.5	-0.2	3.6	YBD1 Valley/piedmont slope derived from 5-m DTMs	
-0.2	3.5	0	2.8	0.2	6.8	0.1	11.8		
-0.2	2.2	0.1	1.8	-0.2	7.8	0.1	5.8		
0	1.5	-0.2	2.2	-0.4	8.6	-0.3	2.9	Vert (m)	Hor (m)
0.2	1.1	0.2	2.3	0.2	3.3	-0.4	1.6	126.82	0
0	3.3	0	3.3	-0.2	2	0.2	7.1	126.04	220.83

-0.2	4.2	-0.1	3.8	0.1	3.2	0.1	3.6	123.34	358.95
0.1	0.9	0.2	5.5	0.1	2	-0.3	4	122.15	564.62
-0.2	1	0.3	1.9	-0.2	2.4	0.3	1.2		
-0.1	3.6	0.2	2.5	0.1	2.8	0.1	4		
0.1	2.6	0.1	2.9	-0.1	1.9	0	3.5		
-0.5	0.8	-0.2	4.8	0.1	2.4	-0.3	4.4		
0	1.3	-0.3	2	-0.2	1	0.8	7.3		
0.1	0.8	0	5.5	0.1	1.6	-0.2	5.8		
-0.1	0.9	-0.2	2.4	-0.1	1.2	0.2	10.8		
-0.1	0.2	0.1	0.6	0	2.5	-0.3	2.1		
-0.1	3.2	-0.2	4.5	0.1	0.6	-0.3	8.5		
0.3	1.9	-0.1	0.4	0	1.6	0.2	7.5		
0	3.5	-0.1	3.3	0.1	3.1	-0.2	2.3		
0.1	1.4	0.3	2.7	-0.1	4.3	0	7.6		
0	1.8	-0.2	3.5	0.1	3.4	0.3	2.6		
-0.2	2.1	0.3	3.9	-0.4	3.3	0	11.9		
-0.1	0.5	-0.1	1.9	0	1.2	-0.2	4.6		
0.2	2.2	0.1	1.6	0.1	0.6	-0.5	1		
-0.2	0.8	-0.2	2.7	-0.2	4	0	2.4		
0.1	1.6	-0.1	3.1	-0.1	0.6	0.2	3.3		
-0.1	1.1	-0.2	1.3	0.1	0.6	-0.2	2.3		
0.1	1	0	3.4	0	0.9	0.1	3.1		
-0.1	3.5	-0.1	7	-0.3	2.9	0.1	4		
-0.1	1.4	0.1	4.3	0.2	1.5	-0.3	1.8		
-0.2	0.4	-0.4	1.9	-0.4	4.8	0.2	5.9		
0	1.8	0.1	2.4	0.2	6.2	0	2.8		
-0.1	0.4	-0.1	1.1	0.1	10.5	-0.4	0.8		
0.1	1.8	-0.1	2.3	0.7	1.6	0.1	1.8		
-0.2	0.7	0.2	1.8	0	4.2	0	12.5		
0	1.2	-0.1	1.1	-0.3	2.3	0.2	3.1		
-0.2	1	0.3	2.3	0.1	3.9	0.1	6.5		
0	0.9	-0.3	4.6	0.2	3.8	-0.5	3		
0.1	0.9	0.2	3.9	-0.5	7.5	0.1	1.1		
0	1.9	-0.4	3	0.1	6.4	0.1	6.4		
0.1	1.6	0.1	2.1	-0.2	8.6	0.1	3.8		
0.2	1.4	0	5.8	0	12	-0.2	5.3		
0.1	1.2	-0.3	1.6	-0.3	5.4	-0.2	1.7		
-0.1	1.5	0.2	2.4	0.3	4.3	-0.1	5.6		
-0.1	1.4	-0.3	2.7	0.6	2	0.2	3.5		
-0.1	0.4	0.1	3.5	0.7	1.1	0.4	2.3		
-0.1	0.3	-0.6	3.9	4.9	11	-0.1	2.5		
-0.1	3.3	0.3	3.2	10	26	-0.3	0.9		
0.2	0.4	-0.3	1.3			-0.1	4		
0	2.5	0	1.9			-0.1	5.1		
-0.2	2.2	0.2	0.6			0.1	4.7		
0	1.2	0.1	1.9			-0.2	2.8		
0.1	1.5	0	3.1			0.2	3.6		
-0.1	2.9	-0.3	2.4			0	2.5		
-0.1	1.4	0	4.8			0.3	3.1		

0.1	0.5	-0.1	0.1			-0.1	10.6		
0.1	0.5	0	6			-0.2	11.2		
-0.5	2.1	0.1	1.9			0.1	3.2		
0	6.3	-0.2	3.4			0	6.8		
0.2	0.8	0.4	2.3			-0.1	7.4		
0.6	1.7	0.1	2.8			-0.5	4.1		
0	2.6	-0.2	2.9			-0.1	2.5		
-0.1	2.1	0.1	2.3			0.1	1.8		
-0.1	2.5	0.2	6.5			0.1	2.5		
0.1	1.6	-0.2	6.3			0	3.7		
0	2.5	0.1	4.3			-0.1	7.1		
0.1	1.2	-0.3	4.4			2.5	7.3		
-0.1	2.6	0.1	2						
0	2.7	-0.1	3.6						
-0.2	2.7	0.2	4						
0.1	0.8	0	3.2						
-0.1	1.6	-0.2	1.1						
-0.1	3.3	-0.3	2.2						
0.6	1.3	0	1.6						
0.2	2.8	0.2	0.7						
0.1	3.1	0	2						
5.6	9	0.4	2						
12	34	-0.1	2.9						
		-0.1	1.8						
		0.5	4.4						
		1.5	8.7						
		1	7.3						
		7.3	14.9						
		8.7	29						

YBD1 Pebble Count conducted every 1/2m along YBD1a																	
st	cs	cs	sd	cp	st	fp	st	st	fp	st	cs	fp	sd	sd	mp	fp	st
mp	cp	mp	cs	sc	st	cs	sd	sd	fp	st	mp	cp	cp	st	cs	sd	fp
cp	fp	fp	cs	sd	mp	cp	st	st	sc	fp	fp	sd	cp	fp	sd	st	fp
mp	cs	fp	sd	st	sd	sd	st	st	st	sd	fp	sd	fp	cp	fp	mp	mp
fp	cs	fp	sd	sd	mp	sd	lc	lc	sd	sd	sd	fp	st	sd	sd	fp	fp
sc	fp	fp	sd	st	fp	cp	sd	sd	fp	cp	cs	fp	sd	cs	sd	sc	cs
sd	fp	mp	st	st	sd	fp	fp	fp	sd	mp	mp	mp	mp	cs	st	fp	sd
sd	cs	fp	mp	sd	fp	sd	cp	cp	cs	fp	cp	sc	fp	fp	st	sd	cs
fp	mp	fp	mp	st	mp	sd	st	st	cp	cs	st	fp	fp	fp	sd	st	fp
fp	fp	fp	sd	st	fp	sd	mp	mp	st	mp	st	sd	cp	fp	st	st	sc

YBD2

YBD2a cross section shooting D-2-pts. starting river left		YBD2b cross section shooting D-2-pts. starting river left		YBD2c cross section shooting D-2-pts. starting river left		YBD2d cross section shooting D-2-pts. starting river left		YBD2 longitudinal profile derived from 5m DTMs	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	162.83	0
-9.1	13.6	-11	30	-6	31	-14.3	69.4	160.45	141.48
-3.7	7	-3.4	14.4	-3.9	19.8	-0.5	3.1	158.3	282.55
-1	2.7	-0.6	11.5	-1.4	5	-0.6	2.7	156.37	360.86
0.1	2.9	-0.2	0.9	-2.3	5	-1	2.4	154.53	464.91
0	4.3	-1.1	1	-1.7	3.7	-1.6	3.4	151.3	566.13
-0.1	1.6	-1	0.7	-1.3	3.5	-2.2	4.4	150.46	647.83
0.1	7.6	-0.1	0.9	-1.1	1.7	-0.9	2.2	145.46	863.4
-0.1	4.3	0	1.7	-0.6	0.7	-0.3	1.1	142.6	979.16
0.1	2.2	0.2	4.6	-0.2	0.9	0	3.3		
-0.2	6.9	-0.1	0.7	0	1.7	-0.2	6.4		
-0.1	5.8	0	0.9	0	1.8	-0.1	4		
0.1	1.9	0	2.4	-0.1	0.6	-0.3	2.5		
-0.1	1.9	0.2	1.1	0.3	2.6	0	2.1	Valley/piedmont slope derived from 5m DTMs	
0.1	4.3	-0.1	4.2	-0.3	2	-0.1	1.8		
-0.1	0.6	0.2	0.9	0	0.9	-0.1	3.2		
0	2.5	-0.1	2.1	0.3	2.3	0.3	0.7	Vert (m)	Hor (m)
0.2	1.4	0	4.2	0	4.4	0.1	3	165.29	0
-0.3	3.7	0.2	2.2	-0.2	3.9	-0.2	3.5	160.35	309.07
-0.1	2.3	-0.2	3.4	0	2.2	-0.2	0.6	154.27	546.24
0.3	2	0	5	-0.2	0.5	0	1.3	153.9	705.13
-0.1	2.7	-0.1	3	0.1	2.1	0.1	1.5	151.23	902.88
-0.3	3.6	0.3	3.9	-0.1	1.2	-0.1	2	147.71	1155.68
0	5.3	-0.2	1.4	-0.1	2	0.1	2.5		
0.2	2	-0.1	7.2	0.2	2.3	0.1	5		
-0.2	2.5	0.1	1.4	0	1.5	-0.2	4.7		
0.2	2.5	0.2	3.6	0.2	2.1	-0.1	3.5		
-0.3	3.2	-0.2	3.5	-0.3	3.9	0.1	6		
0.1	2.6	0	2.9	0.1	4.5	-0.3	4.3		
-0.2	7.4	-0.2	1	0	4.8	-0.2	0.7		
-0.4	3.8	0.1	1.9	-0.2	1.8	0.2	1.3		
0	4.4	-0.2	4.5	-0.3	1.6	-0.2	1.9		
0.2	2.4	-0.1	3.1	0	2.7	0.2	4.4		
-0.5	2.4	0.2	1.9	0	2.3	-0.2	4.6		
-0.2	5.7	-0.1	4.8	-0.2	1.7	0.1	1.8		
0.1	9.6	-0.3	2.5	0	2.3	-0.3	2.8		
-0.2	5.2	-0.1	1.1	-0.1	2.5	0.1	2.4		
0.1	6	-0.4	6.3	-0.2	1	-0.1	1.5		
0.2	3	-0.3	2	0	3.1	-0.1	4.7		
-0.1	3	0	5.5	0	3.2	0.1	2.5		
0	0.7	0.2	0.6	-0.1	3.1	-0.2	1.9		
0.7	0.2	-0.1	2.2	0	1.9	0.1	1.4		

1.1	1.2	-0.2	0.5	0.1	0.3	-0.1	4.1		
-1	8	-0.1	3.2	0	2	0.2	2.8		
0.8	5.8	0.4	1.7	0.4	0.9	-0.1	2.8		
3.2	12.9	0.4	1.2	0.2	1	0.2	3.1		
0	15	0.1	6.8	0.6	1.3	-0.2	3.9		
		0.1	7.1	0.4	3.9	-0.1	2.9		
		-0.6	35.5	0.7	9.4	0	2.9		
		3	9.6	1.5	31.7	0.1	1.1		
						-0.4	3.4		
						0.2	0.7		
						-0.4	4		
						-0.1	3.7		
						0.2	2		
						0.3	4.1		
						0.1	2		
						-0.1	2.4		
						0.1	4		
						0	2.9		
						0.2	1.5		
						1.7	3.1		
						1	0.5		
						0.3	14.3		

YBD2 Pebble Count conducted every 1/2m																	
fp	fp	cp	fp	sd	fp	fp	fp	fp	sd	fp							
fp	fp	fp	fp	fp	cp	sd	mp	mp	mp	cp							
sd	fp	sd	fp	fp	mp	fp	fp	fp	fp	fp							
mp	cp	cs	fp	fp	cp	sd	fp	fp	mp	sc							
fp	cp	mp	mp	fp	fp	sd	cs	cs	fp	fp							
mp	mp	fp	fp	mp	fp	lc	sc	sc	sd	sd							
fp	cs	fp	sd	cp	sd	fp	fp	fp	sd	fp							
sd	cs	fp	fp	sd	mp	fp	cp	cp	cp	fp							
fp	cs	fp	fp	fp	sd	fp	mp	mp	cs	fp							
mp	fp	fp	mp	fp	sd	fp	mp	mp	mp	fp							

YBD3

YBD3a cross section shooting D-2-pts. starting river right		YBD3b cross section shooting D-2-pts. starting river right		YBD3c cross section shooting D-2-pts. starting river right		YBD3d cross section shooting D-2-pts. starting river right		YBD3 longitudinal profile derived fron 5m DTM	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	164.46	0
0	10.8	-3.7	6.3	-0.2	10.1	-0.5	12.8	162.48	140.31
-0.3	4.7	-1.9	2.6	-0.7	0.9	-5.5	8.3	160.11	367.95
-4	18.8	-0.2	0.4	-0.6	1.2	-2.8	7	159.62	518.81
-3.2	17.7	-0.4	1.1	-0.3	1.5	0.2	4.1	156.11	705.56
-2.5	21.9	-0.3	1	0.2	2.5	-0.5	2.2	153.92	1051.77

-1.6	3.5	0	2.6	-0.3	2.4	0.3	1.2	149.99	1267.88
-0.1	2.1	-0.2	2.1	0.1	3.3	0.1	7.1	148.25	1386.67
0.4	1.1	-0.1	5.6	0.1	3.3	-0.2	6.1	146.56	1493.18
0	7.4	-0.1	0.2	-0.3	2.6	0.2	3.9	144.33	1731.11
-0.4	6.8	-0.2	1.8	-0.1	2	-0.2	5.7		
0.1	2.3	0.4	0.9	0.1	0.1	-0.4	1.1		
-0.2	1.6	-0.1	7.6	0.1	1.8	0.8	1.1		
0.2	2.3	0.4	7.2	0	3.3	0.2	2.8		
0.1	3.4	-0.2	6.5	-0.3	4.1	-0.7	1.9	YBD3 Valley/piedmont slope derived fron 5m DTM	
0	7	-0.4	7.5	0.3	1.3	0	9.4		
-0.3	7.3	0.3	6.3	0.3	1.4	0.1	10.2		
0	3.6	-0.6	4.3	-0.3	4.2	0	7.1	Vert (m)	Hor (m)
-0.2	3.7	0.2	4.6	0.4	5.3	-0.3	7.6	176.08	0
0.1	3.4	-0.1	6	0.1	4.1	0.1	3.6	172.05	317.68
0.2	9.7	0	4.7	-0.4	6.2	-0.2	3.2	167.88	605.56
0	6.1	0	3.8	0.1	4.3	0	4.6	165.05	1003.03
0	3.3	-0.1	1.8	-0.1	7.3	0.6	4.5	160.8	1308.75
-0.1	0.9	-0.1	0.5	-0.4	1.1	0	4.4		
-0.2	0.8	-0.2	0.4	-0.1	4.3	0.1	3.5		
-0.2	1	-0.1	2.6	0.1	1.6	0.3	0		
0	3.8	0.2	4.8	0.1	2.9	0.4	17.8		
-0.1	0.2	-0.2	1	0	4.3	-0.1	3.2		
0	4.2	0.1	4	0.1	2.9	-0.4	4.8		
0	4.6	0.4	10.1	0.3	1.7	0.3	2.5		
-0.3	7.7	-0.1	4.1	0.1	8.2	-0.1	6.8		
0.1	0.9	-0.2	0.5	-0.2	10.2	-0.1	2.3		
-0.2	3.2	0.1	7.3	-0.3	2.2	0.2	5		
0.1	0.5	0.1	0.9	0.1	2.6	0.4	3.3		
0.1	2.7	-0.1	2.9	-0.2	1.3	0	3.7		
-0.4	2.4	0.5	4.9	0.2	3	-0.1	4.5		
-0.1	1.3	-0.1	8.4	0	3	-0.2	1.6		
-0.2	0.9	-0.4	0.9	-0.2	1.1	-0.5	0.8		
0	6	-0.1	5.5	0	2.7	0.2	4.8		
0.1	3	0.3	0.6	-0.1	9.8	0.1	3.1		
-0.1	0.7	-0.2	2.6	0.2	0.7	-0.4	10.2		
0.2	0.8	0.4	5.2	0.1	2.9	-0.3	1.6		
0.1	3.6	-0.2	5.8	-0.2	2	0.2	0.7		
-0.2	0.5	0.1	11.7	0.2	7.3	0	3.9		
-0.2	5.7	-0.4	4.2	-0.3	3.5	-0.3	0.9		
0.2	1	0.3	2.2	0	3.8	-0.1	9.1		
-0.3	1.7	-0.1	9.4	0.1	0.8	0.2	1.5		
0	1.4	-0.1	4.9	0	8.9	0.1	7.8		
0.1	0.8	-0.2	0.8	-0.2	2.7	-0.4	6.8		
-0.2	0.8	-0.1	9	0.2	2.1	0.2	1.1		
0	5.6	0.1	5.4	-0.1	3.2	0.1	3.2		

0.2	1.2	-0.2	2.6	-0.3	1.5	-0.1	2.3		
0	0.4	0	3.5	0.1	2	-0.2	0.3		
0.2	0.3	0.4	1.3	0.3	0.7	0	4.7		
0	0.6	2.8	0.9	-0.2	9.4	0	4.1		
2.3	0.1	1.5	7.2	-0.3	2.6	0.4	1		
2.3	4.4			0	5.6	0	7.7		
3.3	13.5			0.2	5.5	-0.2	9.7		
				-0.1	4	0.1	9.2		
				0.1	9.6	-0.3	2.8		
				0.1	0.6	-0.3	7		
				-0.2	4.3	0.3	1.3		
				-0.1	0.6	0.1	1.9		
				-0.1	3.1	-0.1	3.2		
				0.1	3.5	-0.3	0.6		
				0.3	1.2	0	3.4		
				0.1	6.3	0.3	1.7		
				0	9.9	0.5	2		
				-0.1	8.7	6.3	8		
				0.1	2.1				
				-0.2	2.5				
				-0.2	1				
				0	5				
				0	1.7				
				0.2	0.9				
				0.3	1.2				
				0.2	9.5				
				0.4	15.6				
				2.9	10.3				

YBD3 Pebble Count conducted every meter																	
mp	mp	cs	cs	cs	cs	fp	sd	sd	st	sd	mp						
st	fp	sd	st	st	fp	st	fp	fp	mp	sd	mp						
st	mp	st	lc	st	fp	fp	cp	cp	sd	fp	sc						
cs	sc	st	sd	st	sd	cp	fp	fp	fp	mp	fp						
fp	sd	fp	sd	sd	st	fp	mp	mp	mp	sd	fp						
sd	mp	mp	sc	mp	sd	st	st	st	st	st	st						
sc	cp	fp	sd	mp	cp	st	st	st	sd	sd	fp						
st	fp	st	st	fp	fp	fp	cs	cs	cs	sd	cs						
st	mp	mp	sd	cs	fp	sd	sc	sc	cp	cp	mp						
fp	fp	mp	cs	cs	cp	mp	st	st	fp	cp	st						

YBD4

YBD4a cross section shooting D-2-pts. starting river right		YBD4b cross section shooting D-2-pts. starting river right		YBD4c cross section shooting D-2-pts. starting river right		YBD4d cross section shooting D-2-pts. starting river right		YBD4 longitudinal profile derived from 5m DTM	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	229.7	0
-16.9	35.2	-5.6	56.8	-1.6	10.2	-4.2	27.8	227.32	206.92
-5.4	18.7	0	9.5	-1.1	5.5	-0.1	3.3	225.54	368.26
-1.3	5.6	-0.3	2.8	-1.9	7.5	-0.9	1.1	224.01	478.44
-1.4	2.9	-0.4	1.3	-0.8	2.1	0	1.9	223.32	681.04
-0.4	0.8	0.2	4.5	-0.6	2.4	0.3	4.8	221.88	738.42
-0.6	1.6	-0.4	6.1	-0.1	1.4	0.3	9.9	219.62	992.66
-0.5	5.6	-0.1	6	-0.3	1	-0.2	2.7	218.09	1120.23
-0.3	4.4	-0.2	1.9	0	4.1	-0.4	1.3	217.2	1241.4
-0.4	3.4	0.4	3.1	0.1	1.5	-0.2	3.5	YBD4 Valley/piedmont slope derived from 5m DTM	
0	1.7	0.9	8.2	0.1	7.7	-0.6	3.2		
0.1	2	0	11.9	0	3.9	-0.1	2.4		
0.2	1.2	-0.5	2.6	-0.3	2.9	0.7	2.3	Vert (m)	Hor (m)
-0.1	2.5	-0.1	1.2	0.3	1	0.1	5.1	234.54	0
0.2	4.6	-0.2	1	0	8.1	-0.5	5.2	232.44	119.32
0.2	4.2	0.1	4.3	-0.2	6.4	0.5	3.2	231.02	343.01
-0.1	8.9	-0.2	6.2	0.2	1.6	-0.4	9.1	228.05	548.54
-0.3	2.9	0	2.9	0	6.9	-0.3	2.8		
-0.2	2.2	0.3	4.7	0	12.7	-0.2	8.1		
-0.2	3.4	-0.1	2.5	-0.2	2.3	0.6	6.6		
-0.1	2.6	-0.4	1.8	0.2	3.1	-0.5	5.4		
-0.2	5.4	0.1	3.5	-0.1	2.1	-0.1	9.8		
-0.1	2.7	0	5.9	0.2	4.1	0.1	10.1		
-0.2	0.8	-0.6	1	-0.4	4.2	-0.1	6.3		
-0.3	5.7	-0.2	3.1	0.2	3.2	-0.2	4.4		
0.1	1.2	0.1	4.2	-0.1	10.2	-0.3	1.1		
0.3	0.6	-0.3	3.4	0.2	5.2	-0.4	0.4		
-0.2	4.5	0.2	1.5	0	3.9	0.3	4.5		
-0.4	2.2	0.5	2.1	-0.5	3.6	-0.4	2.2		
0.3	2.1	-0.1	4	0.3	2.3	0.2	6.1		
-0.2	6.3	-0.4	1.5	-0.2	15.1	-0.1	2.1		
-0.2	7.8	-0.3	2.2	-0.3	9.8	0	3.6		
0.7	2	0.2	5.9	0.1	3.8	0.2	4.9		
-0.1	8.4	0.2	0.8	-0.3	4.6	-0.3	5.1		
-0.1	9.9	0	4.2	0.2	2.9	0.2	0.9		
-0.1	2.8	-0.2	0.7	-0.2	3.2	0.1	1.9		
-0.2	7.1	-0.1	1.5	2.5	5.9	0.1	3.9		

-0.2	10.4	0.2	1.8	4.8	8.9	-0.4	4.1		
-0.3	2	0	7.7			0.2	1.9		
0.3	1.1	0.3	4.5			-0.1	3.3		
-0.3	3.1	0.4	11.9			0.5	3.6		
-0.3	1.7	0.1	6.7			-0.3	11.2		
0.5	2.6	-0.5	2.8			0.2	4.5		
-0.3	1.3	0.1	4.3			-0.1	8.1		
-0.3	8.4	0.1	4.9			-0.5	5.5		
0.2	1	-0.2	2.4			0.3	3.1		
0	1.4	0.3	1.8			-0.6	3.1		
0.7	3.2	0.2	11.3			0.3	13.8		
1.6	5	-0.6	6.4			0.3	14.8		
3.1	4.1	0.1	1.5			0.2	17.2		
1.8	3.9	0	3.2			-0.4	3.4		
		2.4	3.1			-0.4	1.5		
		3.8	10.3			-0.1	2.7		
						-0.6	1.9		
						0	7		
						-0.3	10.5		
						0.2	12.8		
						-0.2	4.1		
						0.1	6.6		
						0.3	3.6		
						0	6.9		
						1.3	9.3		
						6.1	7.3		
						2.6	5.9		

YBD4 Pebble Count conducted every 20cm																	
fp	mp	cp	mp	fp	fp	cs	sd	sd	cs	sc	fp	fp	mp	mp	fp	sd	
cp	cp	cs	fp	mp	cp	fp	mp	mp	cs	cs	fp	cp	st	cs	fp	st	
cp	mp	cp	fp	sc	lc	cp	mp	mp	mp	cp	fp	mp	fp	st	st		
cs	sc	lc	cs	cs	sd	fp	cs	cs	fp	fp	fp	sd	sd	cs	sd		
fp	sc	fp	mp	fp	cp	fp	cp	cp	mp	sd	cs	sd	st	fp	fp		
fp	fp	cs	cs	cs	fp	sd	mp	mp	cp	fp	cp	cp	sd	fp	cp		
mp	fp	sc	cp	lc	cp	cp	fp	fp	cs	sd	fp	cp	cp	cs	cs		
cs	cs	fp	cs	mp	cp	cp	cs	cs	mp	cp	cs	sd	sd	mp	cs		
cs	cp	lc	fp	sd	cp	fp	sd	sd	fp	fp	cs	sd	cp	fp	fp		
fp	cp	fp	mp	cs	mp	fp	fp	fp	cs	cs	fp	st	cp	fp	B		

YBK1

YBK1a cross section shooting D-2-pts. starting river right		YBK1b cross section shooting D-2-pts. starting river right		YBK1c cross section shooting D-2-pts. starting river right		YBK1d cross section shooting D-2-pts. starting river right		YBK1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-3.5	5.6	-5.7	10.8	-6.4	11.3	-17	48	-0.1	6.1
-0.7	0.5	-1	1.2	-0.5	0.1	-13	47	-0.6	1.4
-0.7	0.4	-1.2	0.6	-0.6	0.3	-3.5	9.1	-0.7	3.4
-0.4	0.1	-0.3	0.1	-0.3	0.1	-3.2	6.8	0.5	4.7
-0.4	0.1	-0.4	-0.1	-0.2	0.1	-0.8	1.6	-0.3	2.4
-0.3	0.2	-0.2	0.3	-0.5	0.2	-0.3	0.6	-0.2	2.3
0	0.3	0.2	1.3	-0.3	0.3	-0.3	0.9	-0.6	1.3
0.1	0.3	0	0.6	-0.2	0.4	-0.2	0.5	-0.9	1
0.4	-0.1	0.4	0.4	0	1.2	0	0.3	-0.3	1.1
0	0.3	0.5	0.2	0	0.9	0.1	0.1	0.9	2.4
0.3	0.5	0.5	0.1	0.5	0.2	0.1	0.4	-1.1	1.6
0.8	0.4	0.7	0.7	0	0.3	0.6	0.9	0.1	0.6
0.5	0.9	1	1.4	0.7	0.3	0.1	0.9	0.5	4.8
0.6	0.9	0.6	1.5	0.4	0.9	0.5	0.6	-0.5	2.1
0.4	1.2	1.2	0.2	0.6	0.2	0.6	1.8	-0.6	1.8
1.1	0.6			0.7	1.2	1	0.2	0.2	0.9
				0.4	1.8	0.6	1.7	0.5	4.2
				1.7	1.3	1.2	2.4	-0.2	2.7
								-0.8	3.2
								-0.4	2.7
								0.9	3.9
								-0.3	25.1

YBK1 Pebble Count conducted every 5 cm																	
lc	sc	fp	fp	mp	mp	cp	cp	cp	cp	mp	mp						
mp	cp	mp	mp	cp	cp	mp	sc	sc	cp	cp	cp						
cp	fp	fp	mp	fp	mp	cs	cp	cp	mp	cp	fp						
fp	mp	fp	fp	mp	cs	cp	fp	fp	cp	cp	sc						
mp	mp	cs	mp	mp	sc	cp	fp	fp	cp	mp	cp						
mp	fp	cp	cp	fp	fp	mp	sc	sc	sc	cp	sc						
cp	mp	cp	mp	fp	fp	mp	cp	cp	fp	sc	fp						
fp	fp	fp	fp	fp	fp	mp	mp	mp	cp	mp							
cp	fp	fp	mp	fp	cp	sc	mp	mp	mp	fp							
cp	cp	mp	mp	fp	cp	fp	sc	sc	cp	sc							

YBK2

YBK2a cross section shooting D-2-pts. starting river right		YBK2b cross section shooting D-2-pts. starting river right		YBK2c cross section shooting D-2-pts. starting river right		YBK2d cross section shooting D-2-pts. starting river right		YBK2a cross section shooting D-2-pts. starting river right	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1.3	1.4	-0.5	0.6	-3.3	7.5	-0.9	2.1	0.1	3.3
-0.7	2	-1.2	0.1	-0.8	0.9	-1.7	3.5	-0.1	1
-0.5	0.6	-0.5	0.5	-0.7	0.7	-0.2	0.7	0	3.6
-0.1	0	-0.2	0.4	0	0.6	-0.2	0.4	-0.2	1.5
-0.1	0.3	-0.1	0.1	-0.4	0.6	-0.2	0.4	-1.7	2.3
-0.2	0	-0.2	0.3	0	0.3	-0.1	0.3	-0.2	4.8
0.1	0.4	0	0.4	0.2	0.1	0.1	0.2	-0.4	1.1
0	0.6	0.1	0.2	0	0.2	0.1	0.3	0	2.4
0.5	0.8	-0.1	0.1	0.1	0.1	-0.1	0.3	0	1.8
0.4	0.5	0	0.4	0	0.3	-0.2	0.3	-0.9	1.2
0.5	0.3	0.1	0.4	0.1	0.3	-0.2	0.4	0	0.8
0.4	0.7	0.3	0.2	0.4	0.5	-0.2	0.3	-0.2	2.9
-0.1	0.5	0.4	0.2	1.3	0.5	-0.1	0.4	-0.3	3.6
		0.1	0.4	1.7	0.9	0.4	0.3	-0.1	0.1
		2.8	4.1	1	1.5	-0.1	0.2	-1.1	1.3
		1.6	0.2			0.1	0.3	0.5	1.1
						0.2	0.2	0	1.8
						-0.1	0.3		
						0.5	0.8		
						0.6	1.6		
						4.1	7.8		

*NOTE: YBK2 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

YBK3

YBK3a cross section shooting D-2-pts. starting river right		YBK3b cross section shooting D-2-pts. starting river right		YBK3c cross section shooting D-2-pts. starting river right		YBK3d cross section shooting D-2-pts. starting river right		YBK3 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1	1.2	-0.7	1.5	-1.9	5.3	-2.2	4.6	-0.3	8.2
-1	1.7	-1.3	2.4	-0.3	2	-1.1	1.8	-0.1	2.1
-0.8	1.2	-0.5	0.2	-0.4	0.5	-0.8	0.6	-0.3	3.7
-0.2	0.2	-0.3	0.1	-0.4	0.2	-0.1	0.4	-0.6	3.9
-0.2	0.1	-0.5	0	-0.7	1.2	-0.3	0.2	-0.5	1.3
-0.3	0.2	-0.5	0.1	-0.4	0.2	-0.2	0.2	-0.2	1.9
-0.1	0.5	0	0.2	-0.1	0.1	-0.2	0.2	-0.1	4
0	0.7	0.3	0.3	-0.1	0.4	0	0.5	-0.3	3.9
0.1	0.7	0.1	0.2	0.1	0.3	0.2	0.4	YBK3 Valley/piedmont slope shooting D-2-pt	
0.2	0.1	0.5	0.2	0.1	0.2	0.1	0.2		
0.1	0.1	0.7	0.3	0.4	0.4	0.4	0.5		
0.5	0.7	1.1	2.4	2.1	3.1	0.4	0.9	Vert (m)	Hor (m)
0.5	0.4	1	1.1	0.9	1.1	0.7	0.3	0	0
0.8	0.2	2.3	3.8	2.4	5.4	1	1.7	-0.7	23.4
3	5.2					0.5	2	-0.9	21.5
						3.8	8.5	-0.3	11.8
								-0.6	15
								-0.9	15.5

*NOTE: YBK3 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

YBK4

YBK4a cross section shooting D-2-pts. starting river right		YBK4b cross section shooting D-2-pts. starting river right		YBK4c cross section shooting D-2-pts. starting river right		YBK4d cross section shooting D-2-pts. starting river right		YBK4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-2.5	3.5	-62	123	-3.7	11.3	-2.5	5.2	-0.5	16.5
-2.1	9.7	-4.7	27.4	-2	5.9	-4	6	-0.9	19.7
-1.6	6.8	-3.9	21.1	-3	0.4	-0.5	1.1	-0.3	20.1
-0.9	3.7	-1.2	2.7	-0.1	1.5	-0.5	0.6	-0.3	18.6
-0.2	0.2	-0.1	0.8	-0.2	0.4	-0.1	1.5	-0.2	8.8
0	0.9	-0.5	1.4	-0.3	0.4	-0.1	0.7		
0.2	0.4	-0.3	1.3	-0.1	0.8	-0.2	0.6		
0	0.3	-0.2	1	0.1	0.6	-0.1	0.6		
-0.2	0.1	0.1	1	0.3	0.3	0.1	0.4		
0.1	0.5	-0.3	0	-0.1	0.3	-0.1	0.4		
-0.1	0	0	1.2	-0.1	0.1	0.1	0.3		
0	0.2	0.3	0.8	0.1	1	-0.2	0.8		
0.2	0.3	0.2	1	0.2	0.5	0.2	0.9		
-0.1	0.2	0.3	1.1	0.2	1.1	0.3	0.1		
-0.2	0.1	1.1	2.2	0.2	0.8	0	0.1		
-0.2	0.6	4	9.5	0.9	1.5	-0.2	0.2		
0.1	1	12.4	33.8	1.6	2.6	0.2	0.7		
0.2	1.2	37	76	7	16	0.2	0.5		
0.2	1.6			43	87	4.3	7.3		
0.1	1					18	31.4		
5	13.6								
10.3	31.4								
40	73								

YBK4 Pebble Count conducted every 1/2 m																	
sc	cp	Bk	mp	lc	Bk	cp	fp	fp	fp	cp	Bk	cs	cp	sd	fp	sd	
Bk	fp	cs	fp	Bk	sd	mp	fp	fp	cp	Bk	mp	sd	sc	st	bk	mp	
fp	cs	mp	Bk	fp	st	fp	mp	mp	fp	fp	fp	fp	fp	Bk	bk	fp	
sd	Bk	lc	fp	cp	cp	sc	sc	sc	cp	fp	sc	sc	cp	mp	bk	cp	
lc	mp	Bk	lc	fp	fp	cp	mp	mp	fp	fp	sc	cp	sc	fp	fp	bk	
Bk	Bk	fp	Bk	cp	Bk	mp	fp	fp	cp	sc	fp	B	cp	Bk	fp		
mp	sd	sc	fp	cp	st	Bk	sd	sd	fp	cp	mp	sc	mp	cp	bk		
fp	Bk	Bk	sc	cs	cp	cp	sc	sc	mp	sc	fp	cs	sc	bk	fp		
sd	fp	sc	Bk	mp	mp	mp	mp	mp	Bk	cp	cs	fp	fp	mp	fp		
Bk	sc	Bk	fp	lc	sc	fp	cp	cp	lc	fp	fp	Bk	mp	bk	bk		

YBK5

YBK5a cross section shooting D-2-pts. starting river right		YBK5b cross section shooting D-2-pts. starting river right		YBK5c cross section shooting D-2-pts. starting river right		YBK5d cross section shooting D-2-pts. starting river right		YBK5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-1	0.3	-3.4	1.6	-3	1.6	-6.1	6.1	-2.1	1.3
-0.4	0.2	-0.3	0.7	-1.6	3	-2.8	5.3	-0.1	3.7
-0.5	0.1	-0.9	0.2	-0.6	1	-0.5	0.8	-0.2	3.2
0	0.2	-0.6	-0.2	-0.2	0.4	-0.3	0.4	-0.1	1.4
-0.1	0.2	-0.2	0.1	-0.2	0.1	-0.1	0.2	-0.3	0.3
0	0.3	-0.1	0.5	-0.1	0.5	0	0.4	-0.1	4
0.5	0.4	0.1	0.3	0.1	0.4	-0.1	0.2	0	1.6
0.4	0.1	0.8	0.2	0	0.4	0	0.5	-1.1	0.9
1.9	1	0.6	0.3	0.2	0.6	0.2	0.2	0.3	1.3
1.7	1.5	0.3	0.6	0.4	0.9	0.3	0.3	-1.1	0.6
2.8	2.3	0.5	0.4	0.4	1.2	0.9	0.6	0.1	1.4
		1.5	2.9	0.8	1.9	2.2	2.6	-0.6	0.9
		4	2.9	4	3.6	1.4	0.2	-0.1	1
								-0.6	0.6
								-0.7	3.7
								0	0.7
								-0.9	0.5
								0.3	1.1
								-0.1	2

*NOTE: YBK5 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

YBK6

YBK6a cross section shooting D-2-pts. starting river right		YBK6b cross section shooting D-2-pts. starting river right		YBK6c cross section shooting D-2-pts. starting river right		YBK6d cross section shooting D-2-pts. starting river right		YBK6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-3	6.3	-0.9	0.5	-1.4	1.4	-0.6	1.2	1.2	4.1
-0.6	2.6	-0.3	1.1	-0.3	0.3	-0.5	0.1	-1.4	3.9
-0.1	1.7	-0.1	0.2	-0.3	0.3	-0.6	1.4	-0.6	1.5
-0.2	0.3	-0.1	0.3	-0.3	0.6	-0.3	0.1	-0.7	2.4
-0.2	0.9	-0.1	0	-0.2	0.1	-0.3	0.9	-1.1	4.1
-0.2	0.1	-0.1	0.3	-0.3	0.1	-0.1	0.1		
-0.1	0.8	0	0.1	-0.1	0.4	-0.1	0.3		
0	0.3	0.1	0.3	0.1	0.2	-0.1	0.1		
0.3	0.6	0	0.2	0	0.5	0	0.4		
0.1	0.3	0.1	0.1	0.1	0.2	0.2	0.2		
		0.1	0.2	0.1	0.2	0	0.5		
		0.4	1.1	0.1	1	-0.1	0.3		
		0.7	0.5	0.5	1.5	0.1	0.4		
		0.7	2	1.3	3.4	0.1	0.2		
				2.6	2.5	0.5	1.2		
						0.6	1.5		
						2.1	3.6		
						2.7	2.2		

*NOTE: YBK6 pebble counts not applicable because limited clasts in channel appear to be colluvium fallen from adjacent hillslopes.

YIA1

YIA1a cross section shooting D-2-pts. starting river right		YIA1b cross section shooting D-2-pts. starting river right		YIA1c cross section shooting D-2-pts. starting river right		YIA1d cross section shooting D-2-pts. starting river right		YIA1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
0	10.5	0.2	6.7	0	5.7	-0.9	6.5	0.8	30.5
0	0	-0.4	3.6	0.1	2.9	0.1	1.8	0.6	42
0	7.2	0	3.2	-0.1	2.2	-0.3	3.3	0.4	25.4
-0.3	1.5	-0.4	2.8	-0.1	1.8	0.1	2.8	0.5	33
0.2	9.4	-0.3	0.2	-0.9	1.4	-0.7	1.8	0.6	35.8
-0.3	1.7	-0.6	0.8	-0.2	0.8	-0.5	2	0.8	35.5
-0.4	4.3	-0.3	0.1	-0.4	2	0.3	1.4	0.5	30.4
-0.5	4.3	-0.2	0.5	0	1.3	-0.3	1.7	0.1	5.5
-0.5	1.1	-0.4	0.7	0.1	2.3	-0.7	1.8	0.5	33.6
-0.3	0.7	-0.1	1	-0.1	3.1	-0.2	0.6	Valley/piedmont slope 5-m DEM	
-0.5	3.2	0.2	3.4	0.1	2.2	-0.2	0.6		
-0.1	3	-0.2	3	-0.2	1.7	-0.1	0.3	Vert (m)	Hor (m)
-0.2	0.3	0.2	1.6	-0.1	1.8	-0.1	0.7	180.6	0
0	2.8	0	3	0.1	3.3	0	1.5	178.27	107.5
0.2	2.9	-0.2	1.1	-0.1	0.2	-0.1	5.1	174.5	263.5
0	5.1	-0.1	3.1	-0.1	2.1	-0.1	3.2	173.7	340.2
-0.1	3.9	0	3.7	0.3	1.5	-0.1	3.6		
0.2	1.9	0.5	0.6	1	0.6	0.2	0.7		
0.5	0.1	0.6	-0.2	0.7	0.8	-0.1	0.3		
1	0.3	1.2	0.5	0.9	0.1	0.7	5.6		
1	1.4	1	1.5	1	1.2	2.6	5.6		
0	3	0	3	0	1	2.7	6.4		

YIA1 Pebble Count conducted every 20 cm																	
st	sd	cp	sd	mp	fp	cp	mp	mp	cs	mp	mp	mp					
st	cs	sc	sc	fp	fp	mp	fp	fp	fp	fp	fp	mp					
st	cp	fp	fp	cp	mp	fp	fp	fp	fp	fp	cs	fp					
sd	mp	fp	mp	cp	fp	fp	cs	cs	fp	fp	fp						
sd	fp	cs	mp	cp	sd	fp	cp	cp	fp	mp	fp						
st	cs	fp	mp	mp	st	fp	cp	cp	fp	fp	cs						
st	mp	fp	sd	mp	mp	fp	mp	mp	fp	fp	st						
st	fp	fp	cp	fp	mp	fp	fp	fp	mp	cs	mp						
sd	cs	sc	fp	fp	fp	fp	fp	fp	fp	mp	mp						
sd	cp	cs	fp	fp	fp	fp	cp	cp	mp	fp	cp						

YIA2

YIA2a cross section shooting D-2-pts. starting river right		YIA2b cross section shooting D-2-pts. starting river right		YIA2c cross section shooting D-2-pts. starting river right		YIA2d cross section shooting D-2-pts. starting river right		YIA2 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-6	33	-4.7	25.5	-4.2	32	-2	16	-0.2	9
-0.1	2.7	0.1	3.6	0	2.5	-1.8	4.9	-0.3	6.2
-0.4	1	0.3	1.7	-0.2	1.4	-0.1	2.6	0	5.5
0.1	0.9	-0.1	3.2	-0.1	0.5	-0.2	3	-0.6	4.4
0.4	1.5	-0.4	1	-0.1	0.8	-0.2	0.4	0.1	8.9
-0.1	1.2	-0.5	0.6	-0.3	0.4	-0.5	0.4	-0.2	6.8
-0.8	1.1	-0.3	0.3	-0.1	0.4	-0.3	0.4	-0.5	16.6
-0.2	0.3	-0.4	0.4	-0.2	0.1	0	0.5	-0.1	7.5
-0.3	0.3	0.1	0.8	-0.1	0.6	0.2	0.3		
0	1.2	0	0.5	0.2	-0.1	-0.1	0.2		
-0.1	0.4	-0.1	1.1	0	0.3	-0.3	0.1		
-0.1	0.8	0.2	0.2	0.1	0.3	-0.1	0.2		
0.3	0.5	0	0.8	0	0.3	0.2	0.2		
0.2	0.3	-0.2	0.5	0.3	0.2	0	0.9		
0.2	0.6	0.5	0.2	0	0.6	0.1	0.4		
0	1.6	0.2	0.5	0.2	0.1	0.2	0.3		
0.5	0.8	0.6	0.4	0.4	0.6	0.4	1.7		
0.7	3.3	1	2.4	0.7	3.7	0.3	2		
1.6	4.8	2.4	5.4	1.6	11.2	0.2	7		
0.6	3.4	3	9.3	3.9	16.5	2	19.1		
				10.4	61.1	6	34		

YIA2 Pebble Count conducted every 10 cm																	
lc	cp	cp	sc	fp	cp	lc	lc	lc	cs	mp	fp						
cp	B	cp	lc	sc	fp	fp	cp	cp	cp	fp	mp						
mp	cp	fp	sc	cp	B	lc	B	B	st	mp	B						
cp	cp	fp	cp	mp	mp	mp	B	B	fp	cp	sd						
cp	fp	cp	B	cp	sc	cs	cp	cp	lc	mp	mp						
mp	sc	fp	fp	fp	sd	cp	sc	sc	fp	fp	lc						
fp	mp	fp	cs	lc	mp	lc	lc	lc	fp	cp	cp						
cp	cp	mp	sc	fp	lc	B	fp	fp	fp	cp	B						
cs	mp	cp	cp	sc	fp	lc	sd	sd	mp	mp	cp						
lc	sc	sc	mp	fp	mp	cp	B	B	fp	mp	cp						

YIA3

YIA3a cross section shooting D-2-pts. starting river right		YIA3b cross section shooting D-2-pts. starting river right		YIA3c cross section shooting D-2-pts. starting river right		YIA3d cross section shooting D-2-pts. starting river right		YIA3 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-2.4	7.3	-2.4	3.3	-3.1	1.8	-2.8	0.9	-0.4	22.1
-0.6	7	-2.4	1.9	-2.2	1.2	-4.8	4.2	-0.7	32.8
0.3	5.2	-0.6	0.6	-1.2	0.1	-2.4	0.2	-0.4	25.3
-0.6	3.8	-0.5	1.1	-0.4	1.5	-0.2	1.8	-0.5	33
-0.4	4.7	0	2.8	0	4.2	-0.1	0.1	-0.5	22.2
-0.6	3.4	0	4.2	0	6.1	0	3	-0.5	26.8
-0.7	2.3	0.1	1	0.2	0.9	0.1	0.4	-0.6	28.4
-0.3	2.7	0	2.3	0.1	3.5	-0.1	2.9	-0.7	28.3
-0.8	2	-0.1	3.6	-0.1	1.8	0.3	0.8		
0.2	2.1	0.1	0.5	0.1	0.7	0.1	2.4	YIA3 Valley/piedmont slope 5-m DTM	
0.3	3	0	1.4	0	2.8	0.1	6.9		
-0.2	0.4	0.2	1.7	0.6	3	-0.1	2.3	Vert (m)	Hor (m)
-0.1	1	0.1	0.9	0.1	5.1	-0.1	2.8	137.19	5.85
-0.2	0.2	0.1	1.6	0.1	3.8	0	1.5	134.77	69.39
0	3.5	0.5	3.6	3	9.4	0.2	3.5	133.71	136.73
-0.1	4.3	2	5.3			0.4	1.3	132.14	225.68
0.2	0.4	1	5.1			0.3	8		
0	2.5					2	5.9		
3.3	1.6								
-0.3	6.9								
-0.4	2.3								
0.4	3.9								
1.2	5								
-0.1	12.7								
0.9	6.5								
0	5.8								
0.1	29.2								
2.6	6.6								

YIA3 Pebble Count conducted every 20 cm																	
cp	cp	mp	fp	cp	mp	cs	fp	fp	sd	cs	cs	cp					
cs	mp	mp	sd	fp	fp	cs	mp	mp	sd	sd	mp	fp					
sd	fp	fp	fp	cs	mp	fp	mp	mp	fp	fp	fp	fp					
cs	cs	fp	fp	mp	sd	cs	fp	fp	cs	fp	sd	sc					
fp	cs	cs	fp	cp	sd	cp	mp	mp	fp	sd	cp						
fp	fp	fp	cs	mp	sd	cs	sd	sd	fp	cs	mp						
fp	fp	fp	fp	mp	mp	mp	fp	fp	sd	cp	sd						
fp	cs	fp	cp	mp	mp	fp	cs	cs	cs	cs	cp						
fp	cs	mp	mp	mp	sd	mp	cp	cp	fp	sc	cs						
cp	fp	fp	cs	fp	cp	cp	sd	sd	fp	sd	mp						

YIA4

YIA4a cross section shooting D-2-pts. starting river right		YIA4b cross section shooting D-2-pts. starting river right		YIA4c cross section shooting D-2-pts. starting river right		YIA4d cross section shooting D-2-pts. starting river right		YIA4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-4.9	10.8	-7.6	16.3	-0.1	0.3	-3	4.2	0	18.2
-0.1	3.7	-0.1	4.7	-0.7	7.6	-3.8	5.8	-0.6	23.8
-0.3	0.9	0.2	1.7	-0.2	1.8	-0.2	0.3	-0.5	16.7
0.2	1.3	-0.1	1.5	0	0.7	-0.3	0.6	-0.1	7.2
0	1.5	0	5.5	0.1	0.3	-0.1	0.5	0.2	6.4
-0.2	0.7	0.1	2.4	-0.2	0.2	0.1	1.2	-0.2	7.3
0.1	2.4	-0.4	2.4	-0.2	0.9	0	1	-0.2	10.2
-0.3	2.8	0.1	2.3	-0.1	1.1	0.1	1.9	-0.2	12.9
0	3.2	0	1.9	0.2	0.3	0.1	1.1	YIA4 Valley/piedmont slope 5-m DTM	
0.1	2.5	-0.3	0.8	-0.1	0.5	0.1	0.9		
-0.2	2.8	-0.2	1.8	0.2	0.2	0.2	0.7		
-0.1	0.4	0.1	1.3	0.2	0.5	0.2	0.4	Vert (m)	Hor (m)
0	1.6	0.3	0.7	0.1	0.6	-0.1	1.3	155.6	3.35
0.1	2.2	1.2	3	0	2.6	0	5.1	153.58	26.77
1.9	0.5	6.8	8.5	0	1.7	4.8	11.3	154.49	54.17
1.7	2	2	3.4	0.1	1.4	7.4	14.2	153.05	73.29
1.5	3.1			3.9	9.8				
2.7	2.8			8	16				

YIA4 Pebble Count																	
sd	fp	mp	sd	mp	mp	sd	fp	fp	mp	sd	mp	sd	sd	st			
mp	fp	sd	fp	sd	cp	fp	sd	sd	sd	sc	fp	fp	fp	mp			
sd	fp	mp	mp	sd	mp	cs	sd	sd	mp	mp	B	fp	mp	mp			
cs	fp	sd	fp	fp	cp	cp	fp	fp	fp	cp	lc	sc	fp	fp			
fp	cp	fp	fp	fp	sd	fp	fp	fp	fp	fp	fp	lc	fp	cp			
fp	fp	mp	fp	mp	fp	sd	sd	sd	st	st	sd	sd	sd				
cp	fp	cp	sd	sd	fp	sd	lc	lc	cp	sd	cs	fp	mp				
fp	sc	sd	mp	cs	cp	fp	cp	cp	cp	fp	fp	fp	mp				
fp	fp	sd	fp	sd	mp	fp	sd	sd	fp	cp	fp	sc	sc				
fp	fp	mp	cp	fp	cp	lc	fp	fp	lc	cp	cp	cp	fp				

YIA5

YIA5a cross section shooting D-2-pts. starting river right		YIA5b cross section shooting D-2-pts. starting river right		YIA5c cross section shooting D-2-pts. starting river right		YIA5d cross section shooting D-2-pts. starting river right		YIA5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**	**Vert (m)**	**Hor (m)**
0	0	0	0	0	0	0	0	0	0
-2.4	3.3	-4.5	10.2	-4	11	-1.5	6.4	0.6	37.4
-3.5	0.8	-3.8	3.7	-3.5	4.1	-2.8	9.8	0.6	42.4
-4	1.2	-5.8	13.8	-5.1	10.2	-2.4	7.2	0.5	37.3
-0.3	1	-1.1	8.1	-1.5	10.6	-2.2	4.6	0.7	50.5
-0.4	3.8	-1	10.5	-0.3	11.4	-1.4	1.5	0.4	26.5
0	3.3	0.4	5.4	-0.5	5.3	-1.5	3.2	0.4	41.1
0	1	-0.3	8.6	-0.1	4.8	-0.8	2.8	0.5	35.2
0	6.4	0	4.8	-0.4	8.6	-0.8	5.5	0.5	40.5
0.1	7.9	-0.4	2.9	-0.2	2.7	-0.5	5.8	**YIA5 Valley/piedmont slope derived from 5m DTM**	
-0.1	3.1	-0.3	1.4	-1.1	2.1	0	3		
0.5	1.4	-0.3	2.6	0.1	2.5	0.1	3.6		
0.6	0.2	-0.2	1.1	0.4	1.9	-0.4	2.4	**Vert (m)**	**Hor (m)**
1.5	1.5	-0.3	1.3	-0.2	1.2	-1.6	5.5	166.52	0
1.1	1.9	-0.2	0.8	-0.1	2	-0.2	3.2	165.22	111.51
		0.1	1.7	-0.1	2	-0.1	1.5	162.55	231.38
		-0.1	5.4	0.1	1.6	-0.2	0.6	161.43	292.37
		0.1	1.4	-0.2	1.7	-0.2	1.1	160.71	324.34
		0	4.1	-0.3	0.8	-0.4	0.9		
		-0.2	4.5	0	6	-0.1	2.1		
		0.3	3.1	-0.2	8.4	0	4.8		
		0.2	2.8	0.8	0.3	0.2	3.6		
		0.4	1.2	2.2	0.5	-0.1	4.6		
		1.1	0.7	1.5	0.9	-0.1	0.3		
		1.7	1.3	1.2	1.4	-0.1	5.4		
		1	1			0.3	0.5		
						0.2	0.5		
						0.2	0.8		
						0.1	1.4		
						0.1	1.9		
						0.5	1.9		
						2.8	6.1		
						1.1	4.9		
						0.3	8.6		

YIA5 Pebble Count conducted every 20cm																	
st	st	mp	fp	fp	fp	fp	sd	sd	mp	cp	cs	sc	fp				
mp	fp	fp	cs	fp	fp	fp	fp	fp	cs	fp	mp	lc					
cs	cp	fp	fp	fp	fp	fp	fp	fp	cs	cp	mp	sc					
mp	fp	fp	fp	mp	lc	fp	mp	mp	cs	sc	lc	fp					
mp	fp	fp	cs	fp	mp	cs	cp	cp	sd	fp	mp	mp					
mp	fp	fp	fp	mp	fp	cs	st	st	fp	fp	fp	cp					
fp	mp	fp	mp	fp	fp	st	st	st	mp	cs	fp	fp					
fp	mp	lc	sd	cp	sd	cp	mp	mp	fp	fp	fp	cs					
cp	st	cp	cp	lc	st	fp	mp	mp	cs	mp	cp	cs					
cp	fp	st	sd	cs	fp	mp	cs	cs	fp	fp	cs	cp					

YIA6

YIA6a cross section shooting D-2-pts. starting river right		YIA6b cross section shooting D-2-pts. starting river right		YIA6c cross section shooting D-2-pts. starting river right		YIA6d cross section shooting D-2-pts. starting river right		YIA6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-7	14.4	-1.7	3.3	-0.9	2.7	-1.3	6.1	-0.1	6.6
-0.1	1.6	-0.6	3.4	-1	3	-0.6	5.3	-0.2	11.5
-0.3	1.4	0	4	-0.4	3.2	-0.7	3.2	-0.3	12
-0.3	3.4	-0.2	2.5	-0.2	0.8	-0.4	1.4	-0.1	11.6
-0.3	7.3	-0.3	0.6	-0.4	0.7	-0.1	1.6	-0.2	9
-0.1	1	0	1.1	0	1.8	0	1.2		
-0.1	1	0.3	1.4	0.1	0.3	-0.1	0.2		
0	1.7	-0.1	6.7	0	0.7	0	0.9		
0.1	0.7	-0.3	3	0.2	0.6	-0.2	0.2	YIA6 Valley/piedmont slope shooting D-2-pt starting upstream	
0.2	0.7	0.2	4.1	-0.1	5	-0.1	1.3		
-0.2	5.2	2.5	5.3	-0.3	2.7	0.2	1.3		
-0.1	6.1			0	1.4	0.1	1.7	Vert (m)	Hor (m)
0.2	1.4			5.9	11	-0.1	1.1	0	0
1	2.2					0.4	3.8	-0.3	21.1
0.7	0.9					0.5	0.4	-0.2	14.2
						1.1	3.9	-0.5	21.2

YPH1

YPH1a cross section shooting D-2-pts. starting river right		YPH1b cross section shooting D-2-pts. starting river right		YPH1c cross section shooting D-2-pts. starting river right		YPH1d cross section shooting D-2-pts. starting river right		YPH1 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.1	6.6	-0.3	5.2	-0.2	3.7	-0.1	3.4	0.5	5.7
-0.2	1	-0.2	1.2	-0.4	4.6	-0.2	2.6	0.1	6.3
-0.8	2.5	-0.3	1.8	-0.2	2	-0.1	0.7	0.1	1.2
0	0.5	-0.2	2	-0.2	1.2	-0.2	0.6	0.3	4.7
-0.2	0.3	-0.2	1.1	-0.1	0.6	-0.4	0.7	0.1	3.6
0	0.4	-0.1	0.2	-0.1	0.9	-0.1	0.3	0.1	6
-0.1	0.4	0	0.2	-0.1	0.5	-0.2	0.3	0.2	2.6
0.1	0.4	-0.1	0.1	-0.1	0.4	-0.2	0.5	0.1	5.2
-0.2	0.4	-0.1	0.3	0.2	0.4	0.1	0.4	Valley/piedmont slope shooting D-2-pt	
0.1	0.3	0.1	0.4	0.5	0.8	0.1	0.7		
0.1	0.1	0.1	0.4	0.4	1.1	0.2	0.9		
0.3	0.7	0	0.7	0.5	2	0.4	1.5	Vert (m)	Hor (m)
0.3	0.8	0.1	0.5	0.3	2.1	0.7	2.4	0	0
0.3	1	0.9	1.5			0.4	2.7	-3.6	20.4
0.1	1	0.1	0.9					-1.7	14.7
0.2	3.5	0.2	3					-0.7	9.7
								-0.6	11.6
								-0.6	9.8

YPH1 Pebble Count conducted every 1/2m along all 4 cross sections																	
lc	cp	fp	cp	fp	cp	cp	fp	fp	cs	sd	fp	cp	cp	fp			
fp	fp	cs	fp	sd	cp	mp	fp	fp	sd	cp	st	mp	st	st			
fp	cp	cs	cp	mp	cp	fp	fp	fp	cp	fp	mp	st	cp	fp			
cp	mp	mp	cp	fp	cp	mp	cp	cp	sd	cp	st	st	sc	fp			
sd	cp	fp	fp	mp	cp	cp	mp	mp	mp	mp	fp	mp	mp	sd			
sc	mp	cp	cp	mp	mp	cp	mp	mp	cp	cp	mp	cp	st	fp			
cp	sc	cp	fp	fp	sc	mp	fp	fp	cp	mp	cp	mp	sd	cp			
fp	fp	sd	fp	fp	mp	fp	fp	fp	cp	mp	fp	st	cp	sd			
mp	cs	mp	sd	lc	sc	mp	cp	cp	cp	mp	sc	sd	sd	fp			
fp	fp	fp	cp	mp	sc	mp	sc	sc	fp	fp	fp	fp	cp	fp			

YPH2

YPH2a cross section shooting D-2-pts. starting river right		YPH2b cross section shooting D-2-pts. starting river right		YPH2c cross section shooting D-2-pts. starting river right		YPH2d cross section shooting D-2-pts. starting river right	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0
-0.2	7.1	-0.1	13.2	-0.2	4.5	-0.1	8.2
-0.4	4.9	-0.3	6.1	-0.3	4.2	-0.4	5.8
-1.1	4.4	-1	4	-0.5	3.8	-0.7	7.2
-0.4	1.4	-0.4	1.6	-0.2	2.8	-0.3	1.4
-0.1	0.2	-0.1	1.2	-0.3	1	0.1	1.5
0	0.5	-0.1	0.1	0	1.4	-0.1	0.4
0	0.6	-0.1	0.7	-0.1	0.1	-0.1	0.4
0.1	0.2	0.1	0.7	-0.1	0.4	0.1	0.4
0.1	0.7	0.1	0.4	0	0.4	0.2	0.6
0.1	0.7	0.1	0.6	0.1	0.5	0.3	1.9
0	4.1	0	1.3	0.3	0.9	0.5	5.5
1.5	11.4	0.1	2.2	0.2	1.2	0.2	5.3
0.2	4.4	1	8.3	0.3	3.8		
		0.1	5	0.4	6.6		
				0.1	4.5		

YPH2 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)
0	0
-0.3	3.4
-0.4	4.3
-3	4.2
-0.4	4.5
-0.3	4.3

YPH2 Valley/piedmont slope 5-m DTM	
Vert (m)	Hor (m)
232.01	1.75
231.81	13.57
231.41	25.48
231.06	44.76

YPH2 Pebble Count conducted every 1/2m along all 4 cross sections																
fp	cp	mp	mp	mp	sd	sc	lc	lc	mp	fp						
cp	fp	cp	fp	st	sc	sc	sc	sc	cp	cp						
cp	cp	fp	mp	lc	mp	fp	cp	cp	cp	lc						
mp	mp	fp	cp	cp	mp	fp	cp	cp	mp	fp						
mp	mp	sc	cp	st	lc	fp	cp	cp	fp	fp						
fp	cs	fp	fp	cp	cs	cp	cp	cp	st	cp						
mp	cp	cp	sc	mp	cs	lc	sc	sc	cp							
cs	st	cp	mp	fp	fp	cp	fp	fp	cp							
mp	fp	mp	mp	mp	st	mp	mp	mp	cp							
fp	fp	mp	cs	sd	fp	fp	sc	sc	st							

YPH3

YPH3a cross section shooting D-2-pts. starting river right		YPH3b cross section shooting D-2-pts. starting river right		YPH3c cross section shooting D-2-pts. starting river right		YPH3d cross section shooting D-2-pts. starting river right		YPH3 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.5	1.1	-0.4	1	-0.5	1.3	-0.5	2.3	-0.3	1.9
-1.6	3.3	-1.2	2.1	-0.4	1	-0.4	1.3	-0.1	4.5
-0.6	1.1	-0.8	1.4	-0.5	1	-0.6	1.7	-0.1	1.1
-0.1	0.1	-0.3	0.5	-0.2	0.1	-0.1	0.5	0	0.7
0	0.4	-0.1	0.1	-0.7	1.3	-0.1	0.1	-0.3	1.9
0.1	0.2	-0.1	0.1	-0.2	0.4	-0.2	0.3	-0.1	2.5
0.1	0.1	0	0.1	-0.1	0.1	0.1	0.4	-0.3	4.1
0.2	0.3	-0.1	0	-0.1	0.1	0.1	0.4	-0.4	4.3
0.1	0.3	-0.1	0.3	-0.1	0.3	0.1	0.2	-0.3	2.2
0.1	1.1	0.1	0.4	0.1	0.3	0.1	0.2	Valley/piedmont slope shooting D-2-pt	
		0.1	0.5	0.1	0.5	0	0.4		
		0.3	1.4	0.2	0.7			Vert (m)	Hor (m)
		0.8	2.4	0.5	1.6			0	0
		0.7	1.8	0.9	2.1			-0.3	18.5
		0.4	1.3	0.4	1			-0.1	6.4
				0.4	1.2			-0.3	5.8
								-0.2	5.8
								-0.3	7.1

YPH3 Pebble Count conducted every 20 cm																	
fp	fp	fp	sc	fp	mp	fp	fp	fp	mp	fp	sd						
cs	cp	sc	cp	cp	fp	fp	mp	mp	mp	mp	sc						
fp	sc	fp	cs	cp	sd	cp	sc	sc	fp	fp	cp						
mp	fp	cp	fp	mp	mp	mp	cp	cp	cp	sc							
fp	fp	cs	cs	fp	mp	fp	mp	mp	cp	cp							
cs	cp	mp	fp	mp	mp	cp	sc	sc	fp	cp							
mp	cp	fp	fp	mp	fp	cp	fp	fp	cp	cp							
mp	cp	cp	fp	fp	cp	sd	fp	fp	lc	fp							
mp	mp	fp	fp	mp	fp	mp	fp	fp	cp	fp							
fp	fp	fp	cp	cp	cp	cp	fp	fp	cp	mp							

YPH4

YPH4 a cross section shooting D-2-pts. starting river right		YPH4 b cross section shooting D-2-pts. starting river right		YPH4 c cross section shooting D-2-pts. starting river right		YPH4 d cross section shooting D-2-pts. starting river right		YPH4 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.4	4.1	-0.6	3.3	-0.6	5.1	0.1	5.4	-0.1	7.3
-0.7	1.9	-0.6	1.8	-0.9	2.9	0	0.8	-0.3	8.1
-0.4	0.9	-0.3	1.7	-0.2	1.2	-0.1	4.5	-0.3	7.3
-0.1	0.3	-0.2	0.9	-0.1	0.3	-0.2	1.5	-0.3	7.9
-0.2	0.2	0	0.4	-0.2	0.5	-0.1	0.9	-0.3	7.6
-0.1	0.7	-0.2	0.4	0	0.5	-0.2	0.6		
0.1	0.5	0	0.3	0.1	0.3	-0.2	0.2		
0.2	0.3	-0.3	0.1	-0.1	0.2	-0.2	0.2		
0.1	0.3	0.1	0.6	0	0.5	-0.2	0.3	Valley/piedmont slope shooting D-2-pt	
0.3	0.5	-0.1	0.4	0.2	0.1	0	0.8		
0.6	1.7	0.3	0.3	0.4	0.5	0.2	1.4		
0.9	2.5	0.4	0.6	0.9	2.3	0.3	1.1	Vert (m)	Hor (m)
0.1	1	0.4	0.7	0.3	1.4	0.8	2.3	0	0
		0.5	1.2			0.3	2.4	0.2	9.9
		0.5	1.9			-0.1	5.6	0.2	10.3
		0.1	0.7					0.2	17.6

YPH4 Pebble Count conducted every 5 cm												
st	sc	cp	fp	mp	fp	cs	cp	cp	fp	cp	fp	
mp	fp	st	mp	cp	fp	sc	cp	cp	fp	mp	fp	
fp	cp	fp	cp	sc	cp	mp	sc	sc	mp	cs	sc	
sd	st	cs	fp	cp	cp	mp	cp	cp	sc	cp	cp	
cp	mp	mp	fp	cp	fp	cp	st	st	fp	cp		
sd	fp	fp	cp	fp	mp	st	sc	sc	fp	cs		
cp	cp	cp	sc	fp	mp	mp	cp	cp	fp	fp		
fp	st	cp	cp	mp	fp	cs	sd	sd	mp	sd		
mp	mp	cs	fp	cp	fp	cp	fp	fp	mp	cp		
sc	fp	sd	fp	cp	fp	mp	mp	mp	fp	sc		

YPH5

YPH5a cross section shooting D-2-pts. starting river right		YPH5b cross section shooting D-2-pts. starting river right		YPH5c cross section shooting D-2-pts. starting river right		YPH5d cross section shooting D-2-pts. starting river right		YPH5 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.2	3.9	-0.2	2.9	-0.2	4	0	12.1	0.3	6.3
-0.3	1.6	-0.3	3.6	-0.2	3.3	-0.2	2.7	0.2	6.4
-0.3	1.4	-0.2	1.6	0	1.8	-0.3	2.7	0.1	6
-0.3	1.5	-0.1	0.6	-0.1	0.9	-0.2	2.3	0.2	6
-0.1	0.3	-0.1	0.3	-0.1	0.4	-0.1	0.7	0.3	7.4
-0.1	0.5	-0.1	0.1	-0.1	0.1	-0.1	0.3		
0	0.4	0	0.5	-0.2	0.3	-0.1	0.4		
0.2	0.3	-0.1	0.1	0	0.2	0	0.8	Valley/piedmont slope shooting D-2-pt	
0.5	0.9	0	0.6	0	0.3	0.2	0.4		
0.4	2.3	0.1	0.3	0.2	0.4	0.1	0.2		
0.1	2.8	0.1	0.1	0.3	0.7	0.1	0.5		
		0.1	0.5	0.1	1.6	0.4	1.2	Vert (m)	Hor (m)
		0.2	0.7	0.3	2.3	0.1	0.9	0	0
		0.2	1.5	0.2	2.8	0	5.8	-0.1	17.2
		0.2	2	0	15.1	0	11.9	-0.2	19.4
		0.1	7.8					-0.1	13
		0.1	9.3					-0.2	24.7

YPH5 Pebble Count conducted every 1/2m along all 4 cross sections																
cp	fp	cp	fp	st	st	cp	mp	mp	fp	fp	cp					
cp	cp	mp	mp	st	cs	mp	cp	cp	cp	mp	fp					
fp	sd	mp	fp	cs	st	fp	cp	cp	mp	cs	sd					
mp	cp	mp	fp	st	cp	cp	cp	cp	cp	mp	mp					
fp	cp	cp	mp	st	sc	cp	sc	sc	fp	sc	sc					
mp	mp	cp	sd	fp	sd	sd	cp	cp	fp	cp	fp					
cp	fp	cp	fp	st	st	sc	cs	cs	fp	fp	fp					
mp	fp	fp	cp	st	cp	mp	sc	sc	cs	cs	fp					
sc	fp	fp	st	sc	fp	fp	fp	fp	fp	sc	fp					
mp	mp	fp	fp	fp	fp	fp	cp	cp	mp	cp						

YPH6

YPH6a cross section shooting D-2-pts. starting river right		YPH6b cross section shooting D-2-pts. starting river right		YPH6c cross section shooting D-2-pts. starting river right		YPH6d cross section shooting D-2-pts. starting river right		YPH6 longitudinal profile shooting D-2-pt starting upstream	
Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)	Vert (m)	Hor (m)
0	0	0	0	0	0	0	0	0	0
-0.1	0.6	-0.1	3.1	0.1	2.8	0	1.4	-0.2	6.4
-0.4	1.2	-0.4	0.9	-0.1	1.1	-0.1	1.4	-0.3	7.6
-0.4	1.1	-0.2	0.3	-0.1	0.6	-0.1	0.4	-0.1	4
-0.2	0.4	-0.1	0.2	-0.2	0.5	-0.1	0.3	-0.6	3.5
-0.2	0.3	-0.1	0.2	-0.1	0.2	-0.1	0.1	-0.5	5.8
-0.1	0.3	-0.1	0.4	0	0.9	0	0.6	-0.3	2.9
-0.1	0.4	0.2	0.2	0.1	0.1	0.1	0.3	-0.1	2.2
0.1	0.2	0	0.5	0	0.5	0.1	0.7	Valley/piedmont slope shooting D-2-pt	
0.2	0.4	0.1	0.8	0	1.2	0.1	1.4		
0.1	0.5	0.2	0.9	0.1	1.2	0.4	2.3	Vert (m)	Hor (m)
0.2	0.6	0.4	2.1	0.2	4.4	0	2.2	0	0
0.2	0.7	0.1	1.2	0	3.4			0.4	11.3
								0.1	9.5
								0.2	8.7
								0.3	10.5
								0.3	11

YPH6 Pebble Count conducted every 1/2 m																	
CP	cp	fp	st	cp	mp	cp	cp	cp	cp	cp	sc	cp					
fp	cp	fp	mp	sd	cp	cp	fp	fp	sd	fp	cp	mp					
cp	cs	mp	cp	cp	cp	cp	cp	cp	mp	cp	cp						
fp	fp	sd	mp	fp	cp	st	mp	mp	mp	mp	fp						
fp	sc	sd	sc	mp	cs	mp	sc	sc	cp	cp	mp						
mp	sc	mp	cp	mp	cp	cp	sd	sd	cp	fp	sc						
sd	sc	fp	cp	cp	st	sc	mp	mp	sd	st	sc						
fp	st	sc	sc	fp	cp	fp	st	st	cp	cp	fp						
mp	cp	mp	fp	cp	sd	fp	fp	fp	cp	cp	cp						
cp	cp	mp	fp	sd	cp	st	mp	mp	fp	mp	sc						

Table 12. Coordinates of the downstream extent of each study reach in NAD 83 UTM Zone 12N

Coordinates (NAD 83 UTM Zone 12N) for the downstream extent of each study reach						
Reach	Latitude	Longitude		Reach	Latitude	Longitude
GBA1	3700660.403	172777.0357		MIA6	3705139.72	176936.4992
GBA2	3700522.144	173150.5511		MPH1	3707081.629	176365.7592
GBA3	3692053.111	169513.8746		MPH2	3707086.817	178133.3496
GBA4	3692265.044	169487.2613		MPH3	3707068.6	177627.6499
GBA5	3698563.523	174310.5895		MPH4	3702979.2	176300.7
GBA6	3692608.754	168841.0353		MPH7	3707330.889	176312.4846
GBD1	3697430.291	174471.0531		MPH8	3705473.662	176208.6597
GBD2	3703603.19	171552.286		MPH9	3705434.574	176206.846
GBD3	3695629.855	168136.2348		PRBA1	3629550.227	328117.8512
GBD4	3695237.085	169090.5529		PRBD1	3621041.856	337875.0174
GBK1	3698916.138	173303.7231		PRBK1	3629811.444	327709.0997
GBK2	3700517.015	173026.27		PRIA1	3629733.77	333708.1993
GBK3	3698970.138	174116.8398		PRPH1	3628774.809	330966.6577
GBK4	3693279.131	169128.5771		STBA1	3631216.955	363290.8988
GBK5	3692251.385	169406.3894		STBD1	3627515.255	353774.8604
GBK6	3692839.037	169297.7331		STBK1	3626672.602	356227.1139
GIA1	3700583.887	173318.6722		STIA1	3630811.032	362951.0592
GIA3	3697084.973	175485.11		STPH1	3631565.808	348679.7479
GIA4	3700046.064	173851.6523		UMBA1	3613010.011	333225.148
GIA5	3693511.424	167305.7993		UMBD1	3606633.832	339745.3441
GIA6	3703190.942	171935.9438		UMBK1	3613853.351	333766.3583
GIA7	3697744.15	174780.9502		UMIA1	3607128.297	337038.0335
GPH1	3704004.094	173018.9006		UMPH1	3606527.576	336062.917
GPH2	3703803.688	172783.1187		YBA1	3665510.726	166607.1191
GPH3	3704052.626	168382.2258		YBA2	3669992.505	167014.8239
GPH4	3697398.736	174659.2079		YBA3	3663035.832	169949.7471
GPH5	3695311.34	175443.6361		YBA4	3663195.889	170141.5925
GPH6	3693898.53	167061.6052		YBA5	3668259.044	166722.4947
MBA1	3700868.369	179864.2706		YBA6	3665591.026	166560.2847
MBA2	3702299.721	184048.6418		YBD1	3663874.618	170419.4985
MBA3	3702520.561	184356.5157		YBD2	3666061.376	169368.8793
MBA4	3702267.187	183159.3153		YBD3	3668100.296	171733.9472
MBA5	3700353.87	179781.0479		YBD4	3673486.871	172168.8438
MBA6	3701507.597	177733.5709		YBK1	3667515.156	171089.7653
MBD1	3707373.295	175130.1874		YBK2	3665519.213	166481.4603
MBD2	3707295.881	176637.0975		YBK3	3668398.52	172678.9238
MBD3	3701857.436	183085.2646		YBK4	3667060.618	172167.1788
MBD4	3704555.973	174559.2631		YBK5	3663002.726	170332.9214
MBD5	3707955.297	175553.85		YBK6	3663160.854	170276.2137
MBK1	3700025.682	179073.3646		YIA1	3666505.103	168128.5447
MBK2	3700050.952	178721.6825		YIA2	3675203.55	172400.0012

MBK3	3702979.793	184615.4356		YIA3	3665516.125	169901.3619
MBK4	3703742.264	184743.9756		YIA4	3667107.321	171692.06
MBK5	3703692.794	184942.8643		YIA5	3667597.802	168853.3146
MBK6	3701257.952	177842.2587		YIA6	3668316.063	172467.8865
MIA1	3701540.548	179818.167		YPH1	3675705.195	172852.4553
MIA2	3702772.982	176932.3273		YPH2	3673818.597	172297.5659
MIA3	3702784.75	176296.2355		YPH3	3665496.342	166465.0007
MIA4	3702782.011	175037.5191		YPH4	3665957.664	168847.4065
MIA5	3705670.016	176358.4638		YPH5	3668111.7	169850.2559
				YPH6	3670075.864	167609.1894

11.2 Appendix B. MATLAB code for univariate analysis

```
function [r]=stats1d(D)
%%calculates basic statistics
%NAS 09/02/09
%INPUT: D= vector of data
%OUTPUT: r= statistical results

%% calculating basic statistics
r.mean=mean(D);
r.mode=mode(D);
r.median=median(D);
r.variance=var(D);
r.standard_dev=std(D);
r.min=min(D);
r.max=max(D);
r.range=max(D)-min(D);
r.skewness=skewness(D);
r.kurtosis=kurtosis(D);
r.residual=D-mean(D);


%% NAS 07/13/12
% INPUT: M= vector of data
% and make sure it is in same directory as this file
% THis code provided basic analysis of summary univariate
statistics

M=load('Total101_MATLAB_103012.txt');

%% Assign variables to data matrix

HUB=M(:,1); % 10 Digit HUB watershed (1=Mohave, 2=Gould, 3=Yuma)
st=M(:,2); % Stream type (1=BK, 2=BA, 3=IA, 4=BD, 5=PH)
No=M(:,3); % Number identification of a specific streamm type
```

```
within a particular HUB
A=M(:,4); % drainage area (km²)
SG=M(:,5); % stream gradient, a.k.a. slope (m/m)
d50=M(:,6); % median grain size (mm)
WD=M(:,7); % width-to-depth ratio (m/m)
ER=M(:,8); % entrenchment ration, Wv/Wc (m/m)
SS=M(:,9); % shear stress (Pa)
DSS=M(:,10); % dimensionless shear stress
SP05=M(:,11); % stream power for n=0.05 (0.06 for BK) (W/m)
USP05=M(:,12); % unit stream power for n=0.05(0.06 for BK) (W/m²)

%% Test each variables for normality at 95% confidence level

[hA,pA]=lillietest(A,0.05)
[hSG,pSG]=lillietest(SG,0.05)
[hd50,pd50]=lillietest(d50,0.05)
[hWD,pWD]=lillietest(WD,0.05)
[hER,pER]=lillietest(ER,0.05)
[hSS,pSS]=lillietest(SS,0.05)
[hDSS,pDSS]=lillietest(DSS,0.05)
[hSP05,pSP05]=lillietest(SP05,0.05)
[hUSP05,pUSP05]=lillietest(USP05,0.05)

%% calculate basic statistics
% plot, histogram, boxplot, emperical cdf, calculate basic stats

SG_stats=stats1d(SG)
title('stream gradient')

WD_stats=stats1d(WD)
title('width/depth')

ER_stats=stats1d(ER)
title('entrenchment ratio')

SS_stats=stats1D(SS)
title('shear stress')

d50_stats=stats1D(d50)
title('median grain size')

DSS_stats=stats1D(DSS)
title('dimensionless shear stress')

SP05_stats=stats1D(SP05)
title('stream power')

USP05_stats=stats1D(USP05)
```

```
title('unit stream power (n=0.05)')

%% calculate 1-demensional statistics of all variables within
each stream type class

% calculate 1-demensional statistics of all variables (except
grain size) for bedrock channels

BK_SG=stats1d(SG(st==1))
BK_WD=stats1d(WD(st==1))
BK_ER=stats1d(ER(st==1))
BK_SS=stats1d(SS(st==1))
BK_d50=stats1d(d50(st==1))
BK_DSS=stats1d(DSS(st==1))
BK_SP05=stats1d(SP05(st==1))
BK_USP05=stats1d(USP05(st==1))

% calculate 1-demensional statistics of all variables for
bedrock with alluvium channels

BA_SG=stats1d(SG(st==2))
BA_WD=stats1d(WD(st==2))
BA_ER=stats1d(ER(st==2))
BA_SS=stats1d(SS(st==2))
BA_d50=stats1d(d50(st==2))
BA_DSS=stats1d(DSS(st==2))
BA_SP05=stats1d(SP05(st==2))
BA_USP05=stats1d(USP05(st==2))

% calculate 1-demensional statistics of all variables for
incised alluvium channels

IA_SG=stats1d(SG(st==3))
IA_WD=stats1d(WD(st==3))
IA_ER=stats1d(ER(st==3))
IA_SS=stats1d(SS(st==3))
IA_d50=stats1d(d50(st==3))
IA_DSS=stats1d(DSS(st==3))
IA_SP05=stats1d(SP05(st==3))
IA_USP05=stats1d(USP05(st==3))

% calculate 1-demensional statistics of all variables for
braided channels

BD_SG=stats1d(SG(st==4))
BD_WD=stats1d(WD(st==4))
BD_ER=stats1d(ER(st==4))
BD_SS=stats1d(SS(st==4))
```

```
BD_d50=stats1d(d50(st==4))
BD_DSS=stats1d(DSS(st==4))
BD_SP05=stats1d(SP05(st==4))
BD_USP05=stats1d(USP05(st==4))

% calculate 1-demensional statistics of all variables for
piedmont headwater channels

PH_SG=stats1d(SG(st==5))
PH_WD=stats1d(WD(st==5))
PH_ER=stats1d(ER(st==5))
PH_SS=stats1d(SS(st==5))
PH_d50=stats1d(d50(st==5))
PH_DSS=stats1d(DSS(st==5))
PH_SP05=stats1d(SP05(st==5))
PH_USP05=stats1d(USP05(st==5))

%% Create boxplots to examine relationship between variables and
stream type

figure(10);  clf;
set(gca,'FontSize', 50,'LineWidth',10);

subplot(2,2,1)
boxplot(SG,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title ('Stream gradient');

subplot(2,2,2)
boxplot(USP05,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title ('Unit stream power (n=0.05, n=0.06 for BK)');

subplot(2,2,3)
boxplot(WD,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title('Width/depth');

subplot(2,2,4)
boxplot(SS,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title ('Shear stress');

figure(11);  clf;
```

```
set(gca,'FontSize', 50,'LineWidth',10);

subplot(2,2,1)
boxplot(ER,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title ('Wv/Wc');

subplot(2,2,2)
boxplot(SP05,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title ('Stream power');

subplot(2,2,3)
boxplot(DSS,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title ('Dimensionless shear stress');

subplot(2,2,4)
boxplot(d50,st,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('stream type');
title ('Median grain size');


%% Create box plots to view variables among HUB

figure(12);  clf;
set(gca,'FontSize', 50,'LineWidth',10);

subplot(2,2,1)
boxplot(SG,HUB,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
title ('Stream gradient');

subplot(2,2,2)
boxplot(USP05,HUB,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
title ('Unit stream power');

subplot(2,2,3)
boxplot(WD,HUB,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
```

```
title ('Width/depth');

subplot(2,2,4)
boxplot(SS,HUB,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
title ('Shear stress');

figure(13);  clf;
set(gca,'FontSize', 50,'LineWidth',10);

subplot(2,2,1)
boxplot(ER,HUB,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
title ('Wv/Wc');

subplot(2,2,2)
boxplot(SP05,HUB,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
title ('Stream power');

subplot(2,2,3)
boxplot(DSS,HUB,'boxstyle','filled')
set(gca,'YScale','log','FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
title ('Dimensionless shear stress');

subplot(2,2,4)
boxplot(d50,HUB,'boxstyle','filled')
set(gca,'FontSize', 20,'LineWidth',3)
%xlabel ('HUB');
title ('Median grain size');

%% create a plot matrix of correlation between all variables in
matrix [V]

U=[SG,WD,ER,SS,d50,DSS,SP05,USP05];
[rho,Pval]=corr(U)
figure(14); clf;
plotmatrix(U)
set(gca,'YScale','log','FontSize', 20,'LineWidth',5)
title('      S             WD          Wv/Wc          SS
d50           DSS            SP           USP    ')


%% create qqplots of all variables for all stream types to check
```

```
for normality

figure(24); clf;

subplot(3,3,1)
qqplot(SS) % qqplot of shear stress for normality
xlabel('shear stress')

subplot(3,3,2)
qqplot(SG) % qqplot of stream gradient for normality
xlabel('stream gradient')

subplot(3,3,3)
qqplot(SP05) % qqplot of stream power for normality
xlabel('stream power (n=0.05)')

subplot(3,3,4)
qqplot(WD) % qqplot of width/depth ratio for normality
xlabel('Width-to-depth ratio')

subplot(3,3,5)
qqplot(ER) % qqplot of entrenchment ratio for normality
xlabel('Wv/Wc (entrenchment ratio')

subplot(3,3,6)
qqplot(USP05) % qqplot of unit stream power for normality
xlabel('Unit stream power (n=0.05)')

subplot(3,3,7)
qqplot(DSS) % qqplot of dimensionless shear stress for normality
xlabel('Dimensionless shear stress')

subplot(3,3,8)
qqplot(d50) % qqplot of median grain size for normality
xlabel('Median grain size')

%% Residual Plots to examine equality of variance in
entrenchment ratio

figure(25); clf;

BKER=ER(st==1); % create separate variable for bedrock channel
entrenchment ratio
L1=length(BKER); % determine # of BK reaches with entrenchment
ratio calculations
F1=BK_ER.mean*ones(L1,1); % create a column of means (mean
entrenchment ratio of bedrock reaches)
BKER_res=BKER-BK_ER.mean; % calculate residuals for entrenchment
```

```
ratio of bedrock reaches
scatter(F1,BKER_res); % plot residuals of bedrock entrenchment
ratio

hold on; % holds current figure for plotting
BAER=ER(st==2); % create separate variable for bedrock with
alluvium channel entrenchment ratio L2=length(BAER);
% determine # of BA reaches with entrenchment ratio calculations
F2=BA_ER.mean*ones(L2,1); % create a column of means (mean
entrenchment ratio of BA reaches)
BAER_res=BAER-BA_ER.mean; % calculate residuals for entrenchment
ratio of BA reaches
scatter(F2,BAER_res); % plot residuals of BA entrenchment ratio

hold on; % holds current figure for plotting
IAER=ER(st==3); % determine # of IA reaches with entrenchment
ratio calculations
L3=length(IAER); % create a column of means (mean entrenchment
ratio of IA reaches)
F3=IA_ER.mean*ones(L3,1); % create a column of means (mean
entrenchment ratio of IA reaches)
IAER_res=IAER-IA_ER.mean; % calculate residuals for entrenchment
ratio of IA reaches
scatter(F3,IAER_res); % plot residuals of IA entrenchment ratio

hold on; % holds current figure for plotting
BDER=ER(st==4); % determine # of BD reaches with entrenchment
ratio calculations
L4=length(BDER); % create a column of means (mean entrenchment
ratio of BD reaches)
F4=BD_ER.mean*ones(L4,1); % create a column of means (mean
entrenchment ratio of BD reaches)
BDER_res=BDER-BD_ER.mean; % calculate residuals for entrenchment
ratio of BD reaches
scatter(F4,BDER_res); % plot residuals of BD drainage areas

hold on; % holds current figure for plotting
PHER=ER(st==5); % determine # of PH reaches with entrenchment
ratio calculations
L5=length(PHER); % create a column of means (mean entrenchment
ratio of PH reaches)
F5=PH_ER.mean*ones(L5,1); % create a column of means (mean
entrenchment ratio of PH reaches)
PHER_res=PHER-PH_ER.mean; % calculate residuals for entrenchment
ratio of PH reaches
scatter(F5,PHER_res); % plot residuals of PH drainage areas

title('entrenchment ratio residuals')
```

```
%% Residual Plots to examine equality of variance in stream
gradient (SG)

figure(26); clf;

BKSG=SG(st==1); % create separate variable for bedrock channel
SG
L1=length(BKSG); % determine # of BK reaches with SG
calculations
F1=BK_SG.mean*ones(L1,1); % create a column of means (mean SG of
bedrock reaches)
BKSG_res=BKSG-BK_SG.mean; % calculate residuals for SG of
bedrock reaches
scatter(F1,BKSG_res); % plot residuals of bedrock SG

hold on; % holds current figure for plotting
BASG=SG(st==2); % create separate variable for bedrock with
alluvium SG
L2=length(BASG); % determine # of BA reaches with SG
calculations
F2=BA_SG.mean*ones(L2,1); % create a column of means (mean SG of
BA reaches)
BASG_res=BASG-BA_SG.mean; % calculate residuals for SG of BA
reaches
scatter(F2,BASG_res); % plot residuals of BA SG

hold on; % holds current figure for plotting
IASG=SG(st==3); % determine # of IA reaches with SG calculations
L3=length(IASG); % create a column of means (mean SG of IA
reaches)
F3=IA_SG.mean*ones(L3,1); % create a column of means (mean SG of
IA reaches)
IASG_res=IASG-IA_SG.mean; % calculate residuals for SG of IA
reaches
scatter(F3,IASG_res); % plot residuals of IA SG

hold on; % holds current figure for plotting
BDSG=SG(st==4); % determine # of BD reaches with SG calculations
L4=length(BDSG); % create a column of means (mean SG of BD
reaches)
F4=BD_SG.mean*ones(L4,1); % create a column of means (mean SG of
BD reaches)
BDSG_res=BDSG-BD_SG.mean; % calculate residuals for SG of BD
reaches
scatter(F4,BDSG_res); % plot residuals of BD SG

hold on; % holds current figure for plotting
```

```
PHSG=SG(st==5); % determine # of PH reaches with SG calculations
L5=length(PHSG); % create a column of means (mean SG of PH
reaches)
F5=PH_SG.mean*ones(L5,1); % create a column of means (mean SG of
PH reaches)
PHSG_res=PHSG-PH_SG.mean; % calculate residuals for SG of PH
reaches
scatter(F5,PHSG_res); % plot residuals of PH SG

title('NON-transformed residuals stream gradient')

%% Residual Plots to examine equality of variance in shear
stress
figure(27); clf;

BKSS=SS(st==2); % create separate variable for bedrock with
shear stress
L2=length(BKSS); % determine # of BK reaches with shear stress
calculations
F2=BK_SS.mean*ones(L2,1); % create a column of means (mean shear
stress of BK reaches)
BKSS_res=BKSS-BK_SS.mean; % calculate residuals for shear stress
of BK reaches
scatter(F2,BKSS_res); % plot residuals of BK shear stress

BASS=SS(st==2); % create separate variable for bedrock with
alluvium shear stress
L2=length(BASS); % determine # of BA reaches with shear stress
calculations
F2=BA_SS.mean*ones(L2,1); % create a column of means (mean shear
stress of BA reaches)
BASS_res=BASS-BA_SS.mean; % calculate residuals for shear stress
of BA reaches
scatter(F2,BASS_res); % plot residuals of BA shear stress

hold on; % holds current figure for plotting
IASS=SS(st==3); % determine # of IA reaches with shear stress
calculations
L3=length(IASS); % create a column of means (mean shear stress
of IA reaches)
F3=IA_SS.mean*ones(L3,1); % create a column of means (mean shear
stress of IA reaches)
IASS_res=IASS-IA_SS.mean; % calculate residuals for shear stress
of IA reaches
scatter(F3,IASS_res); % plot residuals of IA shear stress

hold on; % holds current figure for plotting
BDSS=SS(st==4); % determine # of BD reaches with shear stress
```

```
calculations
L4=length(BDSS); % create a column of means (mean shear stress
of BD reaches)
F4=BD_SS.mean*ones(L4,1); % create a column of means (mean shear
stress of BD reaches)
BDSS_res=BDSS-BD_SS.mean; % calculate residuals for shear stress
of BD reaches
scatter(F4,BDSS_res); % plot residuals of BD shear stress

hold on; % holds current figure for plotting
PHSS=SS(st==5); % determine # of PH reaches with shear stress
calculations
L5=length(PHSS); % create a column of means (mean shear stress
of PH reaches)
F5=PH_SS.mean*ones(L5,1); % create a column of means (mean shear
stress of PH reaches)
PHSS_res=PHSS-PH_SS.mean; % calculate residuals for shear stress
of PH reaches
scatter(F5,PHSS_res); % plot residuals of PH shear stress

title('Non-transformed residuals median grain size')

%% Residual Plots to examine equality of variance in median
width/depth ratio (WD)

figure(28); clf;

BKWD=WD(st==1); % create separate variable for bedrock channel
WD
L1=length(BKWD); % determine # of BK reaches with WD
calculations
F1=BK_WD.mean*ones(L1,1); % create a column of means (mean WD of
bedrock reaches)
BKWD_res=BKWD-BK_WD.mean; % calculate residuals for WD of
bedrock reaches
scatter(F1,BKWD_res); % plot residuals of bedrock WD

hold on; % holds current figure for plotting
BAWD=WD(st==2); % create separate variable for bedrock with
alluvium WD
L2=length(BAWD); % determine # of BA reaches with WD
calculations
F2=BA_WD.mean*ones(L2,1); % create a column of means (mean WD of
BA reaches)
BAWD_res=BAWD-BA_WD.mean; % calculate residuals for WD of BA
reaches
scatter(F2,BAWD_res); % plot residuals of BA WD
```

```
hold on; % holds current figure for plotting
IAWD=WD(st==3); % determine # of IA reaches with WD calculations
L3=length(IAWD); % create a column of means (mean WD of IA
reaches)
F3=IA_WD.mean*ones(L3,1); % create a column of means (mean WD of
IA reaches)
IAWD_res=IAWD-IA_WD.mean; % calculate residuals for WD of IA
reaches
scatter(F3,IAWD_res); % plot residuals of WD d50

hold on; % holds current figure for plotting
BDWD=WD(st==4); % determine # of BD reaches with WD calculations
L4=length(BDWD); % create a column of means (mean WD of BD
reaches)
F4=BD_WD.mean*ones(L4,1); % create a column of means (mean WD of
BD reaches)
BDWD_res=BDWD-BD_WD.mean; % calculate residuals for WD of BD
reaches
scatter(F4,BDWD_res); % plot residuals of BD WD

hold on; % holds current figure for plotting
PHWD=WD(st==5); % determine # of PH reaches with WD calculations
L5=length(PHWD); % create a column of means (mean WD of PH
reaches)
F5=PH_WD.mean*ones(L5,1); % create a column of means (mean WD of
PH reaches)
PHWD_res=PHWD-PH_WD.mean; % calculate residuals for WD of PH
reaches
scatter(F5,PHWD_res); % plot residuals of PH WD

title('NON-transformed residuals width/depth ration')

%% Residual Plots to examine equality of variance in unit stream
power at
% (n=0.005)

figure(29); clf;

BKUSP05=USP05(st==1); % create separate variable for bedrock
channel USP
L1=length(BKUSP05); % determine # of BK reaches with USP
calculations
F1=BK_USP05.mean*ones(L1,1); % create a column of means (mean
USP of bedrock reaches)
BKUSP05_res=BKUSP05-BK_USP05.mean; % calculate residuals for USP
of bedrock reaches
scatter(F1,BKUSP05_res); % plot residuals of bedrock USP
```

```
hold on; % holds current figure for plotting
BAUSP05=USP05(st==2); %  create separate variable for bedrock
with alluvium USP
L2=length(BAUSP05); % determine # of BA reaches with USP
calculations
F2=BA_USP05.mean*ones(L2,1); % create a column of means (mean
USP of BA reaches)
BAUSP05_res=BAUSP05-BA_USP05.mean; % calculate residuals for USP
of BA reaches
scatter(F2,BAUSP05_res); % plot residuals of BA USP

hold on; % holds current figure for plotting
IAUSP05=USP05(st==3); % determine # of IA reaches with USP
calculations
L3=length(IAUSP05); % create a column of means (mean USP of IA
reaches)
F3=IA_USP05.mean*ones(L3,1); % create a column of means (mean
USP of IA reaches)
IAUSP05_res=IAUSP05-IA_USP05.mean; % calculate residuals for USP
of IA reaches
scatter(F3,IAUSP05_res); % plot residuals of USP for IA

hold on; % holds current figure for plotting
BDUSP05=USP05(st==4); % determine # of BD reaches with USP
calculations
L4=length(BDUSP05); % create a column of means (mean USP of BD
reaches)
F4=BD_USP05.mean*ones(L4,1); % create a column of means (mean
USP of BD reaches)
BDUSP05_res=BDUSP05-BD_USP05.mean; % calculate residuals for USP
of BD reaches
scatter(F4,BDUSP05_res); % plot residuals of BD USP

hold on; % holds current figure for plotting
PHUSP05=USP05(st==5); % determine # of PH reaches with USP
calculations
L5=length(PHUSP05); % create a column of means (mean USP of PH
reaches)
F5=PH_USP05.mean*ones(L5,1); % create a column of means (mean
USP of PH reaches)
PHUSP05_res=PHUSP05-PH_USP05.mean; % calculate residuals for USP
of PH reaches
scatter(F5,PHUSP05_res); % plot residuals of PH USP

title('NON-transformed residuals width/depth ratio')


%% creates a 3-d scatter plot of stream gradient vs. width/depth
```

ratio vs. entrenchment ratio sized according to shear stress using colors to indicate stream type

```
figure(31); clf; % open and clears figure
set(gca,'FontSize', 20)
scatter3(USP05(st==1),WD(st==1),SG(st==1),'ro','filled','SizeDat
a',4*SS(st==1)) %bedrock - red
hold on
scatter3(USP05(st==2),WD(st==2),SG(st==2),'bo','filled','SizeDat
a',4*SS(st==2)) %bedrock with alluvium - blue
hold on
scatter3(USP05(st==3),WD(st==3),SG(st==3),'go','filled','SizeDat
a',4*SS(st==3)) %incised alluvium - green
hold on
scatter3(USP05(st==4),WD(st==4),SG(st==4),'ko','filled','SizeDat
a',4*SS(st==4)) %braided - black
hold on
scatter3(USP05(st==5),WD(st==5),SG(st==5),'mo','filled','SizeDat
a',4*SS(st==5)) %piedmont headwater - yellow
set(gca,'ZScale','log','Xscale','log','Yscale','log')
xlabel('unit stream power (W/m^2)')
ylabel('width/depth ratio (m/m)')
zlabel('stream gradient (m/m)')
title('3-dimensional plot of predictor varaibles for 101 study
reaches')

%% Perform log transformation

A=log10(A);
SG=log10(SG);
WD=log10(WD-0.1); % this does not acheive normality but is the
best transformation toward a normal distribution
ER=log10(ER+0.01);
d50=log(d50);
SS=log10(SS);
DSS=log10(DSS);
SP05=log10(SP05);
USP05=log10(USP05);

%% Run one-way ANOVA to examine multiple comparisons between
stream types

[pSG,tbl,SGstats] = anova1(SG,st)
[c,m,h,gnames] = multcompare(SGstats);
title('stream gradient')

[pWD,tbl,stats] = anova1(WD,st)
[c,m,h,gnames] = multcompare(stats);
```

```
title('width/depth')

[pER,tbl,stats] = anova1(ER,st)
[c,m,h,gnames] = multcompare(stats)
title('entrenchment ratio')

[pSS,tbl,stats] = anova1(SS,st)
[c,m,h,gnames] = multcompare(stats);
title('shear stress')

[pUSP,tbl,stats] = anova1(USP05,st)
[c,m,h,gnames] = multcompare(stats);
title('unit stream power (n=0.05)')

[pDSS,tbl,stats] = anova1(DSS,st)
[c,m,h,gnames] = multcompare(stats);
title('dimensionless shear stress')

[pSP,tbl,stats] = anova1(SP05,st)
[c,m,h,gnames] = multcompare(stats);
title('stream power (n=0.05)')

[pd50,tbl,stats] = anova1(d50,st)
[c,m,h,gnames] = multcompare(stats);
title('median grain size')

%% HUB: Run one-way ANOVA to examine multiple comparisons
between HUBs

[pSG,tbl,SGstats] = anova1(SG,HUB)
[c,m,h,gnames] = multcompare(SGstats);
title('stream gradient')

[pWD,tbl,stats] = anova1(WD,HUB)
[c,m,h,gnames] = multcompare(stats);
title('width/depth')

[pER,tbl,stats] = anova1(ER,HUB)
[c,m,h,gnames] = multcompare(stats)
title('entrenchment ratio')

[pSS,tbl,stats] = anova1(SS,HUB)
[c,m,h,gnames] = multcompare(stats);
title('shear stress')

[pUSP,tbl,stats] = anova1(USP05,HUB)
[c,m,h,gnames] = multcompare(stats);
title('unit stream power (n=0.05)')
```

```
[pDSS,tbl,stats] = anova1(DSS,HUB)
[c,m,h,gnames] = multcompare(stats);
title('dimensionless shear stress')

[pSP,tbl,stats] = anova1(SP05,HUB)
[c,m,h,gnames] = multcompare(stats);
title('stream power (n=0.05)')

[pd50,tbl,stats] = anova1(d50,HUB)
[c,m,h,gnames] = multcompare(stats);
title('median grain size')

%% Create new matrix of variables of interest

P=[SG,WD,SS,USP05]; %create a vector including slope,
width/depth, entrenchment ratio, shear stress, and unit stream
power w/ (n=0.05 & 0.006 for BK channels)

%% Conduct Royston's test for multivariate normality

Roystest(P,0.01);

%% Create new matrix of variables of interest with stream type
column

X =[st,SG,WD,SS,USP05]; %create a vector including slope,
width/depth, entrenchment ratio, shear stress, and unit stream
poer w/ (n=0.05 & 0.006 for BK channels)

%% Test for homoscedasticity, multivariate equality of
covariance/variance matrices

MBoxtest(X,0.01) % perform Box’s M-test
mbbtest(X,1000,0.01) % perform non-parametric bootstrap version
of Box’s M-test
```

11.3 Appendix C. Variable means by stream type for all 101 study reaches

Bedrock					
	Minimum	Maximum	Mean	Median	Standard deviation
Width/depth ratio, W/D (m/m)	3.1	27.8	11.15	8.22	6.8976
Ratio of valley to channel width, W_v/W_c (m/m)	1.48	3.17	2.0229	1.84	0.4812
Stream gradient, S (m/m)	0.0259	0.578	0.2289	0.1969	0.1456
Shear stress, τ (Pa)	56.27	1051.8	471.0562	358.29	278.432
dimensionless shear stress, τ*	0.26	5.1	2.9413	3.58	1.9046
median grain size, d50 (mm)	5	40	12	8.5	11.8322
Stream power, Ω (W/m)	312.6809	22397	4995.3	1933	6169.9
Unit stream power (n=0.06), ω (W/m^2)	57.3726	7332.2	1952.4	1047.5	1847.8

Bedrock with alluvium					
	Minimum	Maximum	Mean	Median	Standard deviation
Width/depth ratio (W/D)	7.09	36.21	18.6381	17.6	7.7396
Ratio of valley to channel width, W_v/W_c	1.23	3.63	1.9752	1.82	0.5871
Stream gradient, S (m/m)	0.0049	0.0716	0.0375	0.0349	0.0201
Shear stress, τ (Pa)	8.81	267.93	98.6557	99.96	58.768
dimensionless shear stress, τ*	0.04	1.24	5102.3	4384.8	0.2977
median grain size, d50 (mm)	5	40	14	12	8.8938
Stream power, Ω (W/m)	17.1383	5235.4	974.4023	797.225	1104.5
Unit stream power (n=0.05), ω (W/m^2)	4.8967	887.3502	191.391	167.5997	192.6988

Incised alluvium					
	Minimum	Maximum	Mean	Median	Standard deviation
Width/depth ratio (W/D)	11.61	113.81	34.3686	26.8	23.2006
Ratio of valley to channel width, W_v/W_c	1.1	6.69	2.6067	2.22	1.4948
Stream gradient, S (m/m)	0.0077	0.0798	0.0231	0.0174	0.0157
Shear stress, τ (Pa)	18.99	111.96	59.6386	54.48	30.26
dimensionless shear stress, τ*	0.08	1.75	0.4786	0.32	0.4254
median grain size, d50 (mm)	1.25	40	15.1548	5	15.1023
Stream power, Ω (W/m)	51.7699	4397.2	960.4606	517.8781	1130.3
Unit stream power (n=0.05), ω (W/m^2)	13.3649	216.152	89.0211	69.9453	62.9427

Braided					
	Minimum	Maximum	Mean	Median	Standard deviation
Width/depth ratio (W/D)	62.91	471.81	243.66	207.78	122.5836
Ratio of valley to channel width, W_v/W_c	2.03	6.94	4.0591	4.155	1.4123
Stream gradient, S (m/m)	0.0069	0.0395	0.013	0.0103	0.0079
Shear stress, τ (Pa)	25.28	79.54	38.8525	35.8	14.86
dimensionless shear stress, τ*	0.123	1.93	0.557	0.3975	0.5003
median grain size, d50 (mm)	1.25	40	7.1562	5	9.047
Stream power, Ω (W/m)	840.6636	6076.5	3058.6	2708.4	1650.8
Unit stream power (n=0.05), ω (W/m^2)	21.2682	116.1821	44.4563	36.3598	27.6835

Piedmont headwater					
	Minimum	Maximum	Mean	Median	Standard deviation
Width/depth ratio (W/D)	9.5	70.41	23.7941	18.735	16.2041
Ratio of valley to channel width, W_v/W_c	1.35	7.65	2.8982	1.7515	1.7515
Stream gradient, S (m/m)	0.0039	0.2486	0.0418	0.0285	0.0512
Shear stress, τ (Pa)	4.2	150.02	43.4305	29.59	39.4594
dimensionless shear stress, τ*	0.02	1.7	0.3895	0.28	0.3629
median grain size, d50 (mm)	1.25	12	8.5227	12	4.1497
Stream power, Ω (W/m)	2.5684	797.8235	122.1212	49.3738	179.3239
Unit stream power (n=0.05), ω (W/m^2)	1.2348	270.4486	54.829	24.9103	74.4068

All stream types					
	Minimum	Maximum	Mean	Median	Standard deviation
Width/depth ratio (W/D)	3.1	471.81	57.1222	20.42	95.4653
Ratio of valley to channel width, W_v/W_c	1.1	7.65	2.6474	2.19	1.4195
Stream gradient, S (m/m)	0.0039	0.578	0.0714	0.0279	0.1077
Shear stress, τ (Pa)	4.2	1051.8	146.47	57.87	212.4051
dimensionless shear stress, τ*	0.02	5.1	0.6931	0.4	0.9711
median grain size, d50 (mm)	1.25	40	11.4801	12	10.5174
Stream power, Ω (W/m)	2.5684	22397	1952.1	828.3038	3437
Unit stream power (n=0.05 or 0.06), ω (W/m^2)	1.2348	7332.2	483.2431	76.7006	1125.8

11.4 Appendix D. R-studio code and results for PERMANOVA and linear PDA

```
> ALL_PERMdata <- read.delim("~/Desktop/Stats/Total101_LOGreaches_103012.txt")
> View(ALL_PERMdata)

> adonis(ALL_PERMdata ~ ST*HUB, data = YPG_PERMdata, permutations = 9999, method = "euclidian", strata = "HUB")

        Call:
        adonis(formula = ALL_PERMdata ~ ST * HUB, data = ALL_PERMdata,      permutations = 9999, method = "euclidian", strata =
        "HUB")

        Terms added sequentially (first to last)

                  Df SumsOfSqs MeanSqs F.Model      R2 Pr(>F)
        ST         1    266.13 266.126  362.47 0.65330 0.0001 ***
        HUB        1     68.45  68.453   93.23 0.16804 0.0001 ***
        ST:HUB     1      1.56   1.558    2.12 0.00382 0.1130
        Residuals  97    71.22   0.734         0.17483
        Total     100   407.35                 1.00000
        ---
        Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

> YPG_Data <- read.delim("~/Desktop/Stats/YPG_LOGreaches_103012.txt")
> View(YPG_Data)
> BMGR_Data <- read.delim("~/Desktop/Stats/BMGR_LOGreaches_103012.txt")
> View(BMGR_Data)

> lda(ST ~ SG + WD + SS + USP05, data = YPG_Data, method = "moment")


Coefficients of linear discriminants:
             LD1        LD2       LD3          LD4
SG    -0.1510687 -4.0598311  6.269437   1.61470589
WD     3.9631519  1.0974438  2.512471  -0.06091826
SS    -4.3506290  7.3419823 -7.210438 -18.04815490
USP05  2.6061506 -0.3943355  2.439092  11.00381401

> r <- lda(ST ~ SG + WD + SS + USP05, data = YPG_Data, method = "moment")
> predict(r,YPG_Data)

$class
 [1] 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 2 1 1 2 2 2 3 2 2 3 5 5 2 5 2 2 3 2 2 3 2 2
[38] 3 5 2 2 3 4 3 2 3 2 5 3 2 3 3 3 3 4 4 4 3 4 4 4 4 4 4 4 4 4 3 5 5 5 5 5 5
[75] 5 5 2 5 5 5 5 5 5 5 5 5
Levels: 1 2 3 4

$posterior
              1            2            3            4            5
1  9.955743e-01 3.338779e-03 1.071756e-03 8.746193e-07 1.429490e-05
2  6.763740e-01 3.058786e-01 1.753948e-02 5.471795e-10 2.079438e-04
3  9.598447e-01 3.100905e-02 9.136229e-03 9.356521e-06 6.816415e-07
4  9.135116e-01 8.146285e-02 4.689122e-03 3.936823e-10 3.363884e-04
5  4.456098e-01 4.535803e-01 5.907186e-02 2.274854e-08 4.173806e-02
6  9.987194e-01 1.201853e-03 6.825687e-05 4.218888e-11 1.046348e-05
7  7.759154e-01 1.846823e-01 3.934915e-02 3.347667e-07 5.288925e-05
8  9.965973e-01 3.249877e-03 1.525812e-04 1.534687e-11 2.456364e-07
9  9.773981e-01 2.076404e-02 1.073825e-03 6.320532e-11 7.640593e-04
10 9.959987e-01 3.505310e-03 3.853633e-04 1.272130e-09 1.105908e-04
11 9.952396e-01 4.660877e-03 9.601279e-05 8.910945e-14 3.475559e-06
12 9.693058e-01 2.220580e-02 3.712445e-03 2.805081e-08 4.775958e-03
13 6.021182e-01 3.797275e-01 1.811217e-02 1.020786e-10 4.207259e-05
14 9.126452e-01 8.001425e-02 6.317438e-03 1.127412e-09 1.023147e-03
15 8.121375e-01 1.821808e-01 5.483376e-03 7.952222e-12 1.983263e-04
16 6.482129e-03 4.704080e-01 4.368712e-01 3.319210e-05 8.620547e-02
17 9.810898e-01 1.748138e-02 1.321373e-03 1.521176e-10 1.074651e-04
18 9.251670e-01 5.944040e-02 4.814296e-03 7.800650e-10 1.057834e-02
19 2.783682e-01 7.168971e-01 4.424661e-03 7.816393e-11 3.100748e-04
20 5.732621e-02 6.704466e-01 2.658108e-01 6.670454e-07 6.415749e-03
21 3.171589e-02 6.143579e-01 3.512485e-01 4.755811e-06 2.672980e-03
```

```
22 1.711004e-02 3.985174e-01 5.805112e-01 3.734601e-04 3.487808e-03
23 8.394234e-02 4.531716e-01 2.468421e-01 1.566292e-06 2.160423e-01
24 2.439191e-01 6.114628e-01 1.386917e-01 8.164379e-08 5.926250e-03
25 3.796116e-02 4.462222e-01 5.142727e-01 1.495328e-04 1.394396e-03
26 1.936393e-02 2.371320e-01 2.384534e-01 2.019728e-05 5.050304e-01
27 2.649293e-05 9.120277e-02 1.620549e-01 1.740389e-06 7.467141e-01
28 7.072234e-03 5.752447e-01 4.159510e-01 4.545366e-06 1.727505e-03
29 1.624542e-03 1.648182e-01 1.747703e-01 3.596424e-06 6.587834e-01
30 2.249959e-01 6.331375e-01 1.377587e-01 5.758166e-08 4.107821e-03
31 1.420197e-02 5.088092e-01 4.764258e-01 6.588131e-05 4.970896e-04
32 2.408344e-03 3.452626e-01 6.464143e-01 2.104150e-04 5.704290e-03
33 2.863854e-01 5.763591e-01 1.051326e-01 7.834456e-09 3.212293e-02
34 4.416021e-01 4.707532e-01 8.761520e-02 1.183593e-07 2.936200e-05
35 6.801199e-04 3.371357e-01 6.426830e-01 7.075821e-05 1.943046e-02
36 2.230386e-01 5.619548e-01 1.634538e-01 2.845776e-07 5.155255e-02
37 5.372622e-03 5.439711e-01 4.152984e-01 3.702021e-06 3.535422e-02
38 1.661623e-02 4.647566e-01 4.919767e-01 3.393792e-05 2.661651e-02
39 7.459668e-02 1.758082e-01 1.950381e-01 3.680062e-05 5.545202e-01
40 4.138478e-03 4.970223e-01 4.949171e-01 7.332169e-06 3.914792e-03
41 3.533516e-02 4.890495e-01 4.724220e-01 8.782818e-05 3.105528e-03
42 4.127161e-03 3.750266e-01 5.243523e-01 8.184029e-05 9.641215e-02
43 7.793800e-07 2.699882e-04 1.976990e-02 9.799511e-01 8.233830e-06
44 2.961929e-04 1.031845e-01 8.101501e-01 8.587274e-02 4.964598e-04
45 2.259031e-02 5.717955e-01 4.052960e-01 1.856444e-05 2.995754e-04
46 3.250425e-04 2.655499e-01 7.214233e-01 1.685824e-04 1.253313e-02
47 7.155299e-02 5.846607e-01 2.445921e-01 7.968348e-07 9.919339e-02
48 9.208050e-05 5.566798e-02 2.745021e-01 8.383883e-04 6.688994e-01
49 2.561011e-03 2.732262e-01 7.192868e-01 4.857334e-03 6.861964e-05
50 2.990880e-02 7.175957e-01 2.378248e-01 1.560598e-07 1.467053e-02
51 4.900629e-04 1.173208e-01 8.142081e-01 3.010628e-02 3.787479e-02
52 1.196054e-03 3.391683e-01 5.618177e-01 6.525872e-05 9.775270e-02
53 3.436252e-04 1.386931e-01 8.324076e-01 2.787600e-02 6.796601e-04
54 6.320756e-04 2.068547e-01 4.371363e-01 1.070340e-04 3.552698e-01
55 5.840013e-11 1.814959e-07 5.583627e-05 9.999440e-01 4.728835e-09
56 2.364081e-10 5.747140e-07 1.097839e-04 9.998896e-01 1.299148e-08
57 4.011646e-08 3.373091e-05 2.812296e-03 9.971530e-01 9.443426e-07
58 3.029527e-03 7.663671e-02 6.807381e-01 1.970645e-01 4.253111e-02
59 1.271509e-12 5.232189e-09 3.321857e-06 9.999967e-01 9.040738e-09
60 2.953925e-09 1.245969e-05 1.709351e-03 9.982734e-01 4.797262e-06
61 6.578041e-09 1.790115e-05 1.851960e-03 9.981294e-01 7.246285e-07
62 6.722824e-07 3.079421e-03 1.169116e-01 8.799830e-01 2.527840e-05
63 1.101004e-09 6.634778e-06 9.816438e-04 9.990097e-01 1.973895e-06
64 2.371359e-12 8.635800e-09 4.555417e-06 9.999954e-01 7.247792e-09
65 2.055191e-07 3.730490e-05 2.850448e-03 9.971094e-01 2.645165e-06
66 1.521640e-10 2.436924e-07 5.384689e-05 9.999459e-01 1.100879e-08
67 4.724537e-08 1.284453e-04 1.088089e-02 9.889358e-01 5.485577e-05
68 4.284247e-05 5.852930e-02 7.723349e-01 1.076445e-01 6.144854e-02
69 6.648960e-07 2.960095e-03 3.312647e-02 2.925892e-04 9.636202e-01
70 6.614832e-07 1.179695e-03 1.033590e-02 8.163071e-05 9.884021e-01
71 4.255223e-02 2.041524e-01 1.045087e-01 8.149812e-07 6.487859e-01
72 2.271831e-05 3.196864e-03 4.331295e-03 7.943455e-08 9.924490e-01
73 4.275915e-05 1.467718e-03 1.786886e-03 6.324709e-08 9.967026e-01
74 3.597680e-09 4.106089e-04 8.107481e-04 9.659887e-10 9.987786e-01
75 2.564792e-06 4.958274e-03 6.181637e-03 1.499083e-08 9.888575e-01
76 1.484851e-04 1.278624e-01 2.885122e-01 2.608551e-05 5.834509e-01
77 2.553976e-01 4.029664e-01 2.210214e-01 4.702386e-06 1.206100e-01
78 2.236269e-06 4.246895e-04 8.696279e-04 7.738007e-08 9.987034e-01
79 1.207034e-02 3.499060e-01 1.381810e-01 1.057846e-07 4.998426e-01
80 5.014470e-04 8.952786e-02 5.348288e-02 7.804611e-08 8.564877e-01
81 7.302103e-05 3.000562e-03 2.098722e-03 7.958333e-09 9.948277e-01
82 1.215566e-02 1.677490e-03 1.474965e-03 3.993742e-07 9.846915e-01
83 3.750120e-02 8.724632e-02 2.162703e-02 7.252327e-09 8.536254e-01
84 1.112205e-02 2.870729e-01 9.749815e-02 5.048075e-08 6.043069e-01
85 4.710850e-04 2.538004e-02 1.036254e-02 3.806131e-09 9.637863e-01
86 2.381629e-04 1.562255e-03 7.438774e-04 7.989029e-10 9.974557e-01

> r <- lda(ST ~ SG + WD + SS + USP05, data = YPG_Data, method = "moment")
> predict(r,BMGR_Data)
$class
 [1] 1 1 1 5 2 5 5 3 5 4 4 4 5 5 5
```

Levels: 1 2 3 4 5

$posterior

	1	2	3	4	5
1	8.844278e-01	8.006970e-02	3.350592e-02	2.998897e-06	1.993613e-03
2	9.881760e-01	8.252794e-03	8.789997e-04	6.663361e-10	2.692176e-03
3	9.022548e-01	4.106911e-02	1.526881e-02	5.489992e-07	4.140673e-02
4	1.651501e-06	3.656449e-02	5.463177e-02	4.342851e-08	9.088020e-01
5	2.291830e-01	5.424431e-01	1.387214e-01	1.384263e-07	8.965234e-02
6	6.551567e-04	1.237347e-01	4.265814e-01	7.170747e-04	4.483117e-01
7	7.430322e-05	7.406258e-02	1.006516e-01	1.242991e-06	8.252103e-01
8	5.449181e-05	2.306225e-01	6.117199e-01	7.850849e-05	1.575246e-01
9	6.662575e-06	4.608226e-03	4.338015e-02	8.531312e-05	9.519196e-01
10	3.061462e-08	3.453291e-05	3.061293e-03	9.968892e-01	1.489594e-05
11	1.828160e-06	4.469168e-03	1.632024e-01	8.305686e-01	1.757973e-03
12	1.961568e-11	1.766195e-08	7.329584e-06	9.999926e-01	3.217987e-08
13	3.801828e-07	5.670347e-04	7.085506e-03	1.380934e-04	9.922090e-01
14	1.650245e-08	2.433858e-05	4.106896e-05	2.098924e-10	9.999346e-01
15	2.154154e-06	1.249446e-03	1.939032e-03	1.933772e-08	9.968093e-01

11.5 Appendix E. Salford Systems CART analysis parameters and variable strength

```
===================
VARIABLE IMPORTANCE
===================

                                         Relative    Number Of
                                       Importance   Categories      Penalty
-----------------------------------------------------------------------------
WD                                      100.00000
S                                        96.09880
SS                                       65.10194
USP05                                    64.30212

===============
OPTION SETTINGS
===============

Construction Rule           Gini (priors altered by costs)
Estimation Method           15-fold cross-validation
Misclassification Costs     Unit
Tree Selection              1.00000 se rule
Linear Combinations         No

Initial value of the complexity parameter            = 0.00000
Minimum size below which node will not be split      = 10
Minimum size for a child node                        = 1
Node size above which sub-sampling will be used      = 101
Maximum number of surrogates used for missing values  = 3
Number of surrogate splits printed                   = 3
Number of competing splits printed                   = 3
Maximum number of trees printed in the tree sequence  = 10
Max. number of cases allowed in the learning sample   = 101
Maximum number of cases allowed in the test sample    = 0
Max # of nonterminal nodes in the largest tree grown  = 100
 (Actual # of nonterminal nodes in largest tree grown = 18)
Max. no. of categorical splits including surrogates   = 1
Max. number of linear combination splits in a tree    = 0
     (Actual number cat. + linear combination splits  = 0)
Maximum depth of largest tree grown                  = 9
     (Actual depth of largest tree grown             = 9)
Exponent for center weighting in split criterion      = 0.00000
```