

## APPENDIX A – STREAM SEDIMENTS

The following notes describe in greater detail some technical elements of the stream evaluation methodology used in Chapter 5.

### **Stream Classification System Used**

To best realize the analytical objectives for the Auburn Ravine and Coon Creek watershed evaluation, an area-wide channel processes-based classification system is adopted which was originally designed to evaluate the channel segments of a watershed in the context of channel network system interaction, sediment routing, short-term and long-term channel segment adjustments to changes watershed conditions, and the role and response patterns of various bedforms in channel processes and sediment routing. The system applied here is a modification of a classification approach proposed by Montgomery and Buffington (1993, 1997, 1998). This system organizes bedforms in channel segments based fundamentally on their role in sediment routing and storage processes which provides a basis for categorizing stream segments. This system allows characteristics of channel segments to be related to hill slope and landscape evolutionary processes of the watershed, to be related by position in the watershed channel network with respect to sediment production, transport, storage, and disposition, and to be related to potential future channel conditions with changing future watershed conditions which drive channel forming stream flow and sediment regimes of channel segments.

### General Stream Systems

The highest and most generalized hierarchical level reflects the commonalities and differences among the stream segment of the AR/CC watershed at the most generalized and regional or watershed scale. Stream system categories characterize general stream processes with respect to channel dynamics and channel/floodplain relationships for all stream orders in relatively large areas of the watershed and the channel network.

### Channel Confinement

The second hierarchical level applies at a stream segment scale, as opposed to a regional scale of channel types, and refers to the susceptibility of stream banks to modification under the pressures of ongoing channel dynamics or due to changing channel forming stream flow and/or sediment regimes. Conditions and variability of channel confinement is both related to a range of possible bedform types (third level), and to general channel change response patterns (first level). Therefore it provides a process-based link between bedform level and the general stream system level.

### Channel Bedform Type

The third hierarchical level applies at the stream reach scale, as opposed to the segment and regional scales, and addresses the in-channel and channel bed shapes and features typically observed in streams such as bedrock drops, rapids, riffles, and pools. The predominant bedform types present in various channel reaches and segments are related to basic sediment routing and channel form relationships and provide insight as to

possible types of changing channel conditions that may occur when watershed conditions lead to changes in stream flow and/or sediment regimes. Bedforms are related to channel processes and channel response patterns with respect to channel confinement and therefore provide important information on sediment routing processes and the basic structure of aquatic habitat of various channel reaches.

### Predominant Bed Material

The fourth hierarchical level characterizes the channel bed sediment found in the bedforms in various channel reaches and segments. This level defines the sediment sizes found in various bedforms and provides greater detail on the character of the sediment involved in routing and storage through the channel network, and additional information on the aquatic habitat conditions of the various bedforms of channel reaches and segments.

### **General Stream System Used**

General Stream Systems refers to areas of the AR/CC watershed in which basic and fundamental elements of stream processes are similar. The elements of stream system similarity may include; the form and dynamics of the channel beds, the manner in which channels change in shape and size to accommodate changes in stream flow patterns, relative resistance to changing patterns, the manner in which channel segments store and govern the incoming sediment, and the way in which channels interact with adjacent floodplain areas.

The stream system is the highest and most generalized hierarchy for stream classification used in this ERP. Therefore it needs to reflect the commonalities and differences among the stream segments of the watershed at the most generalized level. Stream system categories need to characterize general stream processes of relatively large areas of the watershed and need to accommodate the variability inherent between stream orders.

Stream order is a generalized system of ordering reaches of channels in a channel network by the pattern of tributary confluences upstream from particular channel reaches. For the purposes of the AR/CC ERP, stream order will only be applied to mapped streams between confluence junctions as depicted on the USGS on 7.5' quadrangles. The following are the definitions of stream orders (Strahler, 1957):

#### Order 0

Areas of concentrated flow too infrequent to have regular winter season flows but may have flow during or immediately after storms; these flow areas have no blue line stream designation on the USGS quad maps. Order 0 streams extend upstream from blue line streams regardless of apparent channel network complexity of the Order 0 system.

#### Order 1

Stream reaches shown on the USGS quads as blue line streams upstream of any confluence with other blue line stream reaches; the streams can be shown as either

perennial (flow throughout most of the year in most years) or intermittent (flows are seasonally present in most years).

### Order 2

Stream reaches shown on the USGS quads as blue line streams extending downstream of any confluence of two Order 1 stream reaches to a confluence with another Order 2 stream reach.

### Order 3

Stream reaches shown on the USGS quads as blue line streams extending downstream of any confluence of two Order 2 stream reaches to a confluence with another Order 3 stream reach.

### Order 4

Stream reaches shown on the USGS quads as blue line streams extending downstream of any confluence of two Order 3 stream reaches to a confluence with another Order 4 stream reach. The highest stream order in the AR/CC Study area is lower Coon Creek from the Cross Channel to its confluence with Doty Ravine. In larger regions or areas with different geology and precipitation, higher stream orders may occur and would be numbered following the same rules.

Stream ordering can provide an organizational framework within which to categorize general potential stream processes and channel - floodplain interactions. General watershed scale observations have shown that there can be a downstream progressive change in channel forming and process characteristics from the small headwater streams (lower stream orders) to the downstream mainstem stream channels (higher stream orders). These progressive changes in channel and floodplain processes relate to long-term landscape evolution with respect to watershed erosional and geomorphologic processes, and the routing of sediment through the channel network.

## **Classification System For Bank Confinement**

### Highly Confined

This portion of the watershed is located primarily within the landscape formed from the moderate-grade metamorphic volcanic geologic unit. Metamorphosis to a greenschist phase, relatively recent exposure, and its position adjacent to softer geologic units combine to make the stream system area one in which channels are largely controlled by bedrock and hill slope processes.

Channels tend to have relatively steep gradients, bedrock as a prominent element in channel beds and banks, hillsides often adjacent to or close to channel margins, and discontinuous stable coarse material low terraces and narrow overbank floodplain areas. Coarse material (cobble and boulders) are derived from hillside processes and are

transported through the channel network at very slow, long-term rates mostly during episodic major stream flow events. Finer sediment sand through small cobble), derived either locally or upstream in other stream system areas, is either transported through the channel network of this stream system during each moderate and major stream flow event or is deposited in short-term storage in pool areas and in out-of-channel locations (small floodplains or in hillside backwater areas).

The channels in the stream system tend to have very stable beds and banks, and relatively large bed material. The mainstem, higher stream order, channels are composed of a complex of channel bedforms including bedrock, cascades, and pool-riffles. Lower order channel segments are more strongly controlled by hillside processes with few floodplain areas. The 0 order channels tend to be relatively stable with shallow clay rich soils and intermittent bedrock controls.

### Moderately Confined

This portion of the watershed is located in areas where topography is more muted and hill slopes have less control on channel processes. This stream system occurs in areas of low-grade metamorphic volcanics, lower relief portions of the moderate-grade metamorphic volcanics, and areas underlain by weathered granitics. Lowered topographic relief allows for a greater degree of channel margin separation from hill slopes and more room for channel forming processes along channel segments.

This stream system is limited to moderate relief but bedrock influenced areas of the watershed which are portions of the channel network predominated by small headwater, low stream order channels. Because of moderate relief, channels tend to have low to moderate gradients, and because of moderate gradients and greater hill slope separation, channels have coarse sized materials but generally smaller than the bed materials of the channels of the Highly Confined stream system. Channels of this stream system tend to be intermittently controlled by isolated exposures of bedrock, have generally wider channels, have bed materials of cobbles and small boulders, small pockets of gravel, occasional constructed floodplains, and banks of coarse fluvial material and bedrock. Some 0 order channel segments, those with a low channel gradient, have little confinement with broad overbank floodplain areas with small stable banks while others, with steeper gradients, are directly influenced by hillside processes, are confined by these hill slopes and can have incising channels with steep unstable banks. Many low gradient 0 order streams are broad, shallow grassy swales which during major rainfall events, have with a wide, shallow, and very slow surface flow pattern. This stream system area is one of general sediment production and export to downstream reaches. Banks generally are stable and resilient but some can be somewhat less confined and there can be limited areas of sporadic channel adjustment and short-term increases in sediment storage.

With respect to 0 order streams, the lower foothill granitic terrain should be considered as a distinct sub-area of this stream system (refer to High Gully Erosion Potential map). Unchanneled 0 order stream segments in this terrain respond much differently to changes

in land use and surface runoff management than do similar order stream in the other portion of the Moderately Confined stream system area.

Increases in overland flow, concentrated flow in swale settings, and localized changes in channel gradient due to grading or other changes to the land surface all can interrelate to induce serious channel downcutting, gully development, and high rates of coarse sand sediment production. With the conversion of broad swales with high surface roughness and low gradients, to steep gradient, highly confined gullies, the speed at which runoff is delivered to the channel network can be accelerated. This is due to a reduction in the channel storage function of these converted stream segments from swales to incised channels.

### Dynamic Confinement

This stream system includes the mainstem stream corridor areas of the AR/CC watershed with relatively low gradients and bounded by relatively young alluvial terraces and elevated floodplain surfaces constructed by overbank flows. These terraces and elevated floodplain surfaces, ranging from 5 to 10+ ft. high above the channel bed, are composed of loose, coarse material, highly susceptible to bank erosion and channel pattern changes, and the channels are fundamentally unconfined. The bed of these channel is composed of highly mobile materials including sand through to small cobble. Occasionally local bedrock is exposed on banks and in the bed. Although the channels are technically unconfined and are essentially self-formed by the hydraulic response to stream flow and sediment regimes, the stream system is referred to as dynamic confinement because the channels can appear stable and confined on a short-term scale but can interact with banks to result in substantial changes on a long-term scale. These changed mechanisms have the potential for large-scale bank adjustments with highly dynamic sediment routing and storage adjustments.

Due to local geologic history this stream system occupies the central portion of the AR/CC study bounded on the east by gradients too steep and bed material too coarse to have induced the deposition of high terraces, and on the west by areas in which channel banks are controlled by the harder materials of the Riverbank Formation and channel adjustment opportunities are restricted. Based on the position of this stream system in the watershed and the dynamics of the channel and terrace interaction, this stream system both translates sediment from upstream sources to downstream sinks, but more predominantly is a primary area of channel adjustments and short and long-term sediment storage processes. The sediment storage component of this stream system is through the process of bank and terrace erosion and subsequent deposition to accommodate changes in balances of channel forming stream flow and sediment input regimes. The channel segments of this stream system are highly dynamic in form and in response to changes in input channel forming stream flow and sediment regimes. This dynamic channel response characteristic of this stream system allows channel segments to act as governing elements in metering of both flows and sediment to downstream channel segments.

The channel bedforms in this stream system are a complex of plane-bed, pool-riffle, and dune-ripple types. Generally these bedforms range in occurrence from the upstream steeper gradient where plane-bed features and riffle-pool systems are more common to the downstream lower gradient portion where dune-ripple types are more common. Bed material also grades from coarser in the upstream portion with a mix of cobbles, gravel, and sand, to a bed composed only of sand in the downstream portion. This implies that over a long-term time scale this stream system is a long-term sediment sink for small cobble, gravel, and pebble sized materials.

### Translational

This stream system is one in which downstream translation of sediment from upstream to downstream occurs without appreciable changes in short or long-term channel storage of sediment. Channel banks are composed of, and the bed underlain by, the relatively hard Riverbank Formation which is highly resistive to bank erosion and channel adjustment and strongly confines the channel. This is an area of substantial overbank flooding or flood potential due to generally low relief and poor topographic confinement. However due to hydraulic properties of the channel and floodplain areas overbank sediment deposition appears to be limited in magnitude and extent. The mobile bed material is limited to sand and the bedforms are typically dune-ripple, mostly planed to a flat bed during the summer low flow period.

### Basin

This is an area in which overbank flooding and backwater hydraulics are prominent characteristics. Historically overbank deposition of fine sediments was frequent resulting from the quite, standing water, and relatively long-duration inundation pattern. Over a geologic scale time frame, this was a region of sediment deposition and net aggradation. The development of the canal and drainage/levee system has influenced this backwater effect. Most of the channels in this stream system have been straightened and are now confined by local levees and channel processes are basically confined by these levees.

### Overbank

This is a stream system noted by well confined channels inset within extensive floodplain areas. In this stream system the overbank flood prone areas are relatively large in proportion to the watershed area and size of the channel that course through them. Channel and floodplain conditions indicate that sediment routing is dominated by translation with little interim storage and that sediment rates are presently, and have been in the geologic time frame, relatively low. On the other hand overbank floodplains indicate that the channels of this stream system provides a substantial flood flow channel storage function in routing and muting flood flows to downstream channel segments.

## **Classification Used For Channel Bedform Types**

Bedforms are the in-channel and channel bed shapes typical observed by visitors and users of streams and rivers include such features as bedrock drops, rapids, riffles, and

pools. These and other in-channel bed features come in many sizes and shapes, come in intergrading conditions, and come with many complicating attributes. There have been many methods and systems proposed by field researchers for use in organizing the nearly continuous array of intergrade among these in-channel bed features. Under field applications, most of these systems have been found to be insufficient to fully address the characteristics of the forms and the process-forming relations of stream flow and sediment regimes.

For the AR/CC ERP the primary concern is about general sediment routing through the channel network and the kinds and magnitudes of channel segment responses that may result from changes to the channel forming stream flow and sediment regimes. These changes are the driving factors that determine how channels are now, and have been, responding to present watershed conditions and how they may respond in the future to future watershed conditions. The nature of the changes in channel conditions are the types that may impact riparian lands and landowners by serious bank erosion and overbank flooding, expose social/cultural infrastructure features and facilities located near channels to risk, and impact aquatic and riparian resource habitat conditions.

The basic bedforms of channel segments are related to the channel forming stream flow and sediment input regimes and related to the degree of confinement. As a result, the bedform character of channel segments should reflect those features that relate to the balancing forces of the channel forming stream flow and sediment regimes. Also, since changes in stream flow and sediment input regimes are a function of watershed conditions and upstream channel segment conditions, the present bedform characteristics offer insight to possible future bedform conditions. Changes in bedform conditions can be related to changes in bank conditions, landowner values, and aquatic and riparian habitat conditions

The relationship between the nature of bedforms and the balancing of stream flow and sediment input regimes are reflected by local bedform and sediment routing and storage characteristics. Based on the dependence of bedforms on sediment routing and storage characteristics of channel segments, and the importance of sediment routing on channel conditions of the AR/CC the channel bedform classification system of Montgomery and Buffington (1998) was adopted. This system organizes bedforms in channel segments based fundamentally on sediment routing and storage processes. This system allows characteristics of channel segments to be related to hill slope and landscape evolutionary processes of the watershed, to be related by position in the watershed channel network with respect to sediment production, transport, storage, and disposition, and related to potential future channel conditions with changing future watershed conditions driving channel forming stream flow and sediment regimes. Following are brief summaries of the characteristics of the bedforms found in channel segments of the AR/CC study area.

#### CO - Colluvium

This channel bedform is usually located in the upstream limits of channel network systems. As a result of limited watershed contributing areas, rainfall event runoff is

limited to infrequent and relatively high magnitude storms. Runoff from these events usually have frequencies and magnitudes too small to impart sufficient stream power to the land surface to initiate erosion and channelized flows. The hill slope sediment delivery processes are more active than surface flow energies and absent (or found in discontinuous patches) are defined channels with channel bank slope inflections, or evidence of transported sediment material. The headwater extent of continuous channels may progressively grow upstream into the colluvium channel bedforms if increased runoff energies result from land use changes, changes in surface water management, or changes in climate related precipitation.

### BR - Bedrock

Bedrock channel forms are reaches dominated by bedrock exposures where the bed and/or banks are controlled by these restive elements. Channels controlled by bedrock also have in-channel and bank deposits of more mobile material which can have significant aquatics habitat resource values. These channel are generally very stable and resilient to most changes in stream flow and sediment input regimes. They tend to have very close spatial and process relationships to hill slopes and can be reaches of channel with high rates of sediment delivery from landscape evolutionary processes. Sediment delivery to these channel segments, depending of the particle sizes, are either transported out of the segments during high stream flow events, or only progress short distances. Larger materials, transported only short distances are progressively reduced in size through particle impact and are progressively transported greater distances. The dominance of bedrock features imply that in these reaches there are greater sediment transport energies than sediment available for transport.

### CA - Cascade

Cascade channel forms are reaches dominated by primarily detached transportable materials, but material too large to be transported by typical flood events; generally they are only mobilized by extreme events. The distribution of the larger, often the pool forming boulders, are more related to incidental bed and bank morphology rather than fluid hydraulic patterns even when considering hydraulics at very high flows. This sediment size and stream flow energy relationship results in unstructured channels. Water flow patterns at almost any stream flow magnitude are highly unorganized and the flow paths chaotic. The steep gradients and very coarse in-channel sediments imply that there are greater stream flow energies available to transport sediments than in-channel sediment available for transport.

These channel forms are relatively stable and unresponsive to changes in stream flow and/or sediment input regime changes. They may however be subject to changes at very large stream flow events in which large sized particle may be transported very short distances and rearranged but the resulting rearrangement does not conform to fluid hydraulic patterns. Bank trend to be resistant to changes under most flow magnitudes however, in some circumstances individual banks can contribute to the large material in

the channel and occasionally extreme stream flows events may result in bank erosion and lateral bank migration.

### PB - Plane-bed

Plane-bed channels generally are wider and shallower, and relatively flat bedded compared to the foregoing bedform types. The bed material tends to be coarse sized, often gravel, cobble, and sometimes small boulders; mostly laying across the bed without significant particle size sorting and notable in-channel organized structure. The organized structures missing include attached bars, riffles, and pools that would be due to channel hydraulic variability both across the channel and along the channel and an abundant sediment supply in transport available for differential sorting and deposition. The coarse bed material can armor finer subsurface material which implies that general bed mobility occurs during bankfull discharges.

These channels tend to have intermediate gradients, particle sizes, and locations between steeper upstream rapid and cascade reaches and lower gradient downstream pool-riffle reaches. These reaches are considered to be a transitional forms between upstream reaches where, during channel forming events, the available flow energies during channel forming events have greater transport capacity than the in-channel sediments available for transport, and the downstream reaches where the in-channel sediments available for transport are greater than the available flow energies. Due to relatively steep gradients and coarse bed materials, channel banks often are composed of coarser materials deposited during extreme stream flow events. The bed material and bed slopes result from a balance between input sediment regimes from upstream reaches, and the stream flow energies resulting from stream flows and local channel width. As a result they can function as sediment storage reaches for coarse gained sediment by absorbing unusually large sediment loads associated with major, very infrequent, stream flow events, and metering these sediment out more slowly during more frequent, less extreme flood flows.

Because these channel forms are typically composed of relatively coarse bed material and the banks are composed of material more resistance to mobilization the bedforms are relatively stable under stream flow and sediment regimes to which they are adjusted. Operating as short-term sediment storage reaches following extreme event stream flows, these channel types can adjust through variations in aggradation and degradation, channel slope, and bed sediment sizes. Generally these event related and short-term variabilities do not lead to bank instability, but might depending on the volume of sediment imported and the capacity of the channel to store and meter that volume.

Longer-term shifts in stream flow and sediment regimes which may result from watershed process changes or changes in upstream channel segment can induce changes and instability in these plane-bed channels. Actual changes would be highly site and circumstance specific but could include, channel widening or narrowing, induced general bank erosion and land losses, increased channel gradient with lower channel flow capacity in upstream reaches, decreases in gradient with incision and deepening in upstream reaches, or a transition to either pool-riffle or cascade bedforms.

## PR - Pool-Riffle

Pool-riffle channels are characterized by a complex of bedforms associated with low gradient, sediment rich streams such as riffles and pools of varying sizes, shapes, and configurations. These channels generally have abundant sediment of sizes subject to transport and sufficient stream flow energies during flood flow events to transport sediment at typical flood flows. The banks are composed of erodible material allowing the channel widths to adjust and conform to and balance the channel forming stream flow and sediment regimes. The adjustable widths of these channel types allow for the development of fluid hydraulic complexity leading to the differential development and distribution of bedforms and sorted sediment size classes. These in-channel hydraulic variabilities provide for the development of scour pools and depositional bars and riffles. The in-channel bedforms constructed during major stream flow events are not substantially modified at lower flows because the bed materials are typically too coarse for low flow transport.

The bed surface materials can be coarser than the underlying sediment indicating that generalized bed material mobilization occurs at or near bankfull discharges. The sediment abundance, bed material mobility, and the lack of confining channel banks leads this channel type not only to complex in-channel features, but also to a highly dynamic channel morphology that may change year to year. The changes expected include channel alignment and the locations of pools and riffles. These changes may not be dramatic but long-term observation may well detect substantial position changes of in-channel features. In this channel type, these changes can be considered as an element of its stability - dynamic equilibrium - constantly changing specific conditions within an envelope or specific range of variability.

Within this range of variability and channel dynamism, the basic hydraulic configuration of these channels are largely controlled by bankfull flow relationships. In fully alluvial channels, such as pool/riffle types, bankfull flows are those that are great enough to apply enough stress and energy to the channel bed to initiate general bed material mobilization and sediment transport. Surprisingly these flows are relatively frequent, usually 1 to 3 year flood flow events. These are flows that occur on average once every year or two.

The hydraulic elements that control bankfull relationships include the stream flow regime that impart energies to the channel sediment, the size of the bed-surface sediment which, depending on size, can be mobilized at different bed-surface stress forces, and the bed shape that can vary the amount of bed stress imparted for a given stream flow magnitude. Therefore while these channel types can be very dynamic within a range of basic stability, small changes in channel forming stream flow and/or sediment regimes in channel segments can induce channel instability and changed channel conditions.

Since these channel types are located in unconfined circumstances, channel changes induced by small changes in the channel forming stream flow and/or sediment regimes can lead to dramatic and rapid changes in bank conditions leading in turn to rapid channel derangement followed by long-term channel reconstruction. Because sediment loads are

an important element in bankfull relationships, channel derangement in one portion of a channel segment can introduce substantially greater sediment loads to downstream reaches which can then induce cycles of derangement in other locations of the segment.

The pool/riffle channels located in unconfined conditions are highly susceptible to significant instability, are highly subject to channel pattern derangement and slow reconstruction, and are prone to developing positive feedback cycles of inducing channel pattern derangement in other portions of channel segments. Within a relatively narrow range of variability, these channels they can provide significant in-channel short-term sediment storage due to the generally wide bed and low gradient. In-channel changes induced by short-term sediment storage can be changes in bed elevation, local channel slope, sizes, types and distribution of bars and riffles, channel sinuosity, and the width of the active channel. Under these circumstances these channel types can both translate sediment to downstream segment and can store and meter out short-term pulses of sediment from upstream sources. However if changes to the stream flow and/or sediment regimes are sufficient to modify the basic bankfull relationships, these channels can undergo dramatic and large scale channel pattern changes and release large amounts of sediment to downstream reaches because of the unconfined nature of the banks associated with the bedform.

#### DR - Dune-Ripple

These channel forms are characterized by beds loaded with fine sediment that is non-cohesive materials transported, to some degree, at nearly all flows - even at very low flow velocities sand grains can roll individually along the bed forming low amplitude ripples and low, wide dunes or sand wedges progressing as a bedform body downstream through the movement of individual particles. The bed surfaces are not armored by larger material so the amount of sediment in transport and the depth of bed sediment scour are both related to stream flow magnitudes and stream flow energies. The dune-ripple channels are located in the confined channel bank portion of the AR/CC study area. As a result these channels are not subject to instability induced by this sediment regime, however this channel type is a result of the sand sediment loading due to upstream channel and watershed circumstances. It is possible that a significant reduction in sand loading would lead to a different channel type.

#### BF - Bedrock-Forced

These channel forms are controlled laterally by bedrock exposures on banks and often bed elevations are controlled by bedrock surfaces in the channel buried by in-channel sediment. This bedform type often has hard hydraulic forcing structures in the bed or on the banks of the active low flow channel. The hydraulic forcing structures include bedrock exposures and rooted riparian tree root masses. In the AR/CC study area, this bedform type may have a channel bed composed of any mix of transportable sediment from coarse sand through to gravel and small cobble. The segments with this bedform tend to have much lower gradients than the bedrock forms presented above.

The primary character of these bedforms is erosion resistant banks and very mobile bed material. The low gradient provides the opportunity for the deposition of mobile bed materials and, due to the confining nature of the banks, during flood flow events, general bed material mobility can occur. During sediment transporting flows hydraulic forcing structures create variable hydraulic energies resulting in scour pools within the bed sediment. When the bed materials are pebbles, gravel, or cobble, these scour pools remain structured between stream flow events. When the channel is loaded with coarse sand, these in-channel features can become infilled between channel forming stream flow events. Active channel widths may vary due to the particular patterns of bedrock controls and these varying widths provide for variations in bedrock-forced bedform features from short straight run reaches that are bedrock pools infilled completely with coarse sand or other small material, to highly compressed and contorted pool-riffle reaches, to short plane-bed reaches.

The role of these bedforms in the channel network is the translation of sediment. Sediment storage is limited mostly to only short-term, over season, in-channel deposits of material which are in general transport from upstream segments. In small sections where contorted pool-riffle sequences occur there can be some sediment storage over a longer time line. Bedrock banks are not responsive to changes in stream flow and/or sediment regimes, however bedrock banks are not consistent in these reaches of bedrock-forcing bedforms. There are often portions of channel margins controlled by hill slopes and isolated small bodies of elevated terraces. These non-bedrock channel margin areas are susceptible to bank erosion with changes in stream flow and/or sediment regimes, or changes in bed elevation that may result of changes in sediment regimes.

### **Classification of Predominant Bed Material**

For this analysis, the following classification of bed material was used.

- (Si) - Silt (less than 0.0002 inches [ $< 0.0625$  mm])
- (Sa-f) - Sand - fine (0.002 - 0.08 inches [0.0625-2.0 mm]- finer size portion)
- (Sa-c) - Sand - coarse (0.002 - 0.08 inches [0.0625-2.0 mm] - coarser size portion)
- (Pb) - Pebble (0.08 - 2.5 inches [2.0-64.0 mm] - finer size portion)
- (Gr) - Gravel (0.08 - 2.5 inches [2.0-64.0 mm] - coarser size portion)
- (Co) - Cobble (2.5 - 10 inches [64.0-256.0 mm])
- (Bl) - Boulder (greater than 10 inches [ $> 256.0$  mm])
- (Br) - Bedrock