DRAFT

WATERSHED STRATIFICATION METHODOLOGY FOR TMDL SEDIMENT AND HABITAT INVESTIGATIONS

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1.0 INTRODUCTION

1.1 PURPOSE

A water body stratification approach tailored to address sediment and habitat impairments to aquatic life and fisheries beneficial uses has been developed by MT DEQ for use in the TMDL process. One purpose of this approach is to develop sampling designs that characterize water quality and habitat conditions of 303(d) listed water bodies within the context of their individual landscape settings by describing the constituent stream reaches in terms of reach-scale reference conditions (observed versus expected values of sediment and habitat parameters). A second purpose of this approach is to establish a general framework for the achievement of data quality objectives (respresentativeness, comparability, and completeness) within sampling designs during TMDL related sediment and habitat investigations in western Montana.

Water body segments are generally delineated by a water use class designated by the State of Montana, e.g. A-1, B-3, C-3 (Administrative Rules of Montana Title 17 Chapter 30, Sub-Chapter 6). Although a water body segment is the smallest unit for which an impairment determination is made, the stratification approach described in this document initially stratifies individual water body segments into discrete assessment reaches that are delineated by distinct variability in landscape controls such as Strahler stream order, valley slope, and valley confinement. The reason for this is that the inherent differences in landscape controls between stream reaches often prevents a direct comparison from being made between the geomorphic attributes of one stream reach to another.

By initially stratifying water body segments into stream reaches having similar geomorphic landscape controls, it is feasible to make comparisons between similar reaches in regards to observed versus expected channel morphology. Likewise, when land use is used as an additional stratification (e.g. grazed vs. non-grazed sub-reaches), sediment and habitat parameters for impaired stream reaches can be more readily compared to reference reaches that meet the same geomorphic stratification criteria.

1.2 SCOPE

The specific water body stratification criteria are designed to be applied within TMDL Planning Areas of western Montana and are currently not intended for the assessment of other parameters beyond sediment and habitat and are not applicable to watersheds with origins in Plains Ecoregions as defined by Woods, Alan J. et al. 2002. **Additionally, this process is designed for the assessment of intermittent and perennial water body segments composed of 2nd through 5th Strahler stream order extents with bankfull widths less than 60 feet.** Stream segments or reaches that do not meet these stream order and bankfull width criteria will be evaluated on an individual basis.

The results of the stratification process will be used to determine appropriate field scale investigations, and subsequent extrapolation for quantifying sediment loads throughout the watershed. The methods herein have not been uniquely developed by MT DEQ but have been respectfully adapted from peer-reviewed work of research scientists from various state and federal agencies from across the United States. These methods are designed with intermittent and perennial streams in mind; ephemeral streams may necessitate modifications to the methodology, and will be addressed on an individual basis according to the objectives of the investigation.

2.0 REACH SEGMENTING METHODOLOGY

2.1 INTRODUCTION

This section details the reach segmenting approach as it applies to TMDL sediment and habitat characterization, including all aspects of target development and comparison of individual reaches to sediment target values. The process is also a major component of load quantification, specifically from bank erosion. The foundation of the approach is the concept that *state variables* of channel morphology {channel slope, sinuosity, roughness, width, depth, discharge, sediment size and sediment load} are intrinsically determined by geographic *driver variables* {e.g. time, geology, climate, topography, soils}. The framework of the approach has been modeled after watershed sampling designs developed by the Timber, Fish, and Wildlife Program in Washington State as well as from scientific research that has shown the need for considering watersheds in a form and function based context. (Montgomery, D. and Buffington, J.1997; Pleus, A. and D. Schuett-Hames, 1998; Montgomery, D. and MacDonald, L, 2002; Rosgen, D.L. 1994). In this manner, the main objective for analyzing stream reach morphology within the context of their inherent or "potential" form and function is to reduce sampling bias, increase accuracy and precision in watershed assessments and increase the ability to achieve representativeness, comparability, and completeness both within and among sediment/habitat investigations.

This approach utilizes a series of scalar stratifications in order to arrive at the geographic scale for which the combined influence of the aforementioned driver variables is essentially homogenous. The scale at which this occurs is defined as the stream reach extent. It is at the stream reach scale that the analysis of sediment and habitat parameters will occur.

Through GIS, a spatial database must be created and linked to the generated shapefiles wherein the study area, the waterbody segments, stream reaches and their associated geographic and geomorphic attributes that are involved in the investigation are documented and tracked. Geographic attributes such as ecoregion, stream order, valley confinement, valley slope, land use, riparian vegetation characteristics, etc. are to be associated with the individual stream reaches that compose the water body segments being assessed in the investigation.

Stratification of water body segments is an interdisciplinary process and will likely require the integration of work from two or more analysts, especially when a GIS-based analysis (the preferred form) is used instead of the non-GIS methods. Performing the reach breaks requires knowledge of geomorphology, hydrology, vegetation, local land use, land use impacts, and experience with topographic map and aerial imagery interpretation. Because reach segmentation requires knowledge and analysis beyond GIS software, it is not a simple step by step exercise suitable for someone whose sole expertise is in performing GIS software applications. Likewise, the GIS applications used in the stratification process (e.g. creating and editing shapefiles) need to be performed by analysts with intermediate to advanced GIS experience as the specific applications (e.g. how to edit a shapefile or route the final layer onto NHD shapefile) are not explained in this document. It will be verified that the analysts have the necessary credentials before a watershed analysis is undertaken.

The method of stratifying streams into separate reaches incorporates primary and secondary delineations which identify the physical character of the streams geomorphic processes (hard breaks) and a further stratification based on the anthropogenic influences that may distinguish one reach from another (soft breaks). The resulting product is a series of GIS shapefiles for each stratification criteria, and a final map that merges each of the shapefiles to create a final shapefile that represents each delineated reach. This final reach shapefile and associated attribute table houses all of the delineation criteria information for each delineated reach. **In order to properly delineate stream reaches, ROUTED STREAM LAYERS are the necessary base layer by which all specified shapefiles will be developed based on the stratification criteria.** The following describes the methods used to stratify a stream of interest into unique reaches for sediment and habitat analysis and the structure for the final database.

2.2 PRIMARY STRATIFICATION (HARD BREAKS): STRATIFICATION OF WATER BODY SEGMENTS INTO REACHES

Ecoregion, Stream Order, Valley Confinement, and Valley Gradient were identified as attributes whose variability accounts for significant inherent differences in the morphology of stream reaches (e.g. meandering versus non-meandering reaches) that compose a particular water body segment. These factors are generally beyond the influence of human activity, which qualifies them as important “non-study” variables that influence the measurement of sediment and habitat parameters. A non-study variable is one whose influence affects the outcome of a measurement, but whose measurement is not the focus of the analysis.

The following sub-sections describe the application of ecoregion, stream order, valley confinement, and valley gradient stratification.

2.3.1 Preliminary segmenting of non-fluvial features

- Use the most recent aerial imagery and 1:24,000 scale topographic maps to identify non-fluvial features such as lakes, reservoirs, and beaver ponds. Waterfalls are also included in the non-fluvial feature category
- Establish reaches influenced by known waterfalls by marking the contour interval that contains the waterfall. If a contour line intersects the waterfall, place breaks at the first contour line upstream of the falls and the first contour

- Establish lakes, reservoirs, and beaver pond reaches by marking the first contour line/ stream intersection both upstream and downstream of the lacustrine feature.
- The contour intervals that span non-fluvial features are reaches that are excluded from the valley gradient and valley confinement stratification steps.
- In GIS, create a layer file that delineates these non-fluvial reaches.

2.3.2 Ecoregions

Ecoregional delineation of the study area serves as the initial mechanism for stratification. The study area is stratified by Level 4 ecoregions (e.g. Bitterroot-Frenchtown Valley, Eastern Batholith). The stratification is performed through GIS by downloading the Level 4 ecoregion GIS shapefile from the US EPA website and overlaying the spatial coverage upon a base map of the study area (current link: http://www.epa.gov/wed/pages/ecoregions/mt_eco.htm).

Ecoregion delineation

Step #1: Use 1:100,000 scale map and mark the ecoregion boundaries where they cross the water body segment of interest. **This 1:100,000 scale map will serve as the base map onto which the other reach breaks will be transferred.**

Step #2: In GIS, create a layer file that delineates and segments ecoregion breaks.

Step #3: In the attribute table, create two columns to document ecoregion segmentation.

Ecoregion will be represented in the ArcGIS database by two columns; PRIMARY_ECO and SECONDARY_ECO. In the PRIMARY_ECO column, the ecoregion in which the SUBREACH exists will be identified. In the SECONDARY_ECO, all ecoregions that the stream has passed through before the current reach will be identified. If multiple ecoregions were encountered before the SUBREACH in question, then they will be named starting with the most adjacent ecoregion to the PRIMARY and follow with any subsequent ecoregions in an upstream direction. In the event that a tributary to the stream of study originates in one or more ecoregions, these ecoregions must also be accounted for in the SECONDARY_ECO fields. In the event that this occurs, consult with the project manager to determine how to account within the attribute table.

Example:

PRIMARY_ECO	SECONDARY_ECO
17ak	
15a	17ak
15a	17ak
41c	15a-17ak

2.3.3 Strahler Stream Order

In the Strahler stream order system, all streams having no tributaries are 1^{st} order streams; where two streams of order "n" come together, the resulting stream order is "n +1".

Strahler stream order classification will be performed on all specified streams within the study area. Stream order classification varies with map scale; therefore, the designated map scale to be used is 1:100,000. The National Hydrography Dataset, 1:100,000 scale shapefile is to be used to delineate stream order when using GIS. Topographic maps at other scales are not acceptable because they do not adequately distinguish between ephemeral and intermittent tributaries.

Stream order delineation

Step #1: Number the stream network throughout the study area according to the Strahler system.

Step #2: Perform the stream order breaks for the water body segment of interest by placing reach breaks at a change in order.

Step #3: Create a layer file that delineates stream order breaks.

Step #4: Further delineate the stream order breaks according the following criteria:

- Insert a break immediately upstream of a tributary confluence with the water body segment that is being assessed, when that tributary has a Strahler stream order number that is one order lower than the receiving water body segment, if the receiving stream order is $\geq$3.

  For example:

  > DO place a break where a third-order tributary confluences with a fourth order water body segment
  >
  > DO NOT place a break where a second order tributary confluences with a fourth (or higher) order water body segment
  >
  > DO NOT place a break where a first order tributary confluences with a second order water body segment.

Step #5: Create a layer file that delineates these n-1 stream order breaks.

- Reach breaks that do not result from direct stream order changes, but from the confluence of smaller tributaries (e.g. order = n-1) as described above **will be included in the Sub-reach scale delineations** and tracked in the stream reach database. In the final database there should be two columns: the first column

2.3.4 Valley Confinement

Valley confinement is designated for all reaches of every 303(d) waterbody segment within the study area as well as for all other non-303(d) stream reaches (e.g. potential reference reaches) that will be assessed during the process. Valley Confinement will be identified using GIS with a 1:24,000 scale DRG (topographic) layer **and** the most recent aerial imagery. An alternative method is to use USGS 7.5 minute (1:24,000 scale) topographic maps with 20 to 40 foot contour intervals (1:24,000 scale) **and** digital orthoquads or the most recent aerial photography. When comparing maps with aerial photos, make sure the scales are approximately the same.

Valley Confinement Delineation:

Step #1: Estimate valley bottom width

- Step A: Mark the upstream side of a contour line where it intersects the stream channel. From this intersection, extend a line perpendicular to the valley fall line to the next contour line on either side of the stream channel. The length of this line is the approximate valley width.

- Step B: Analyze the accuracy of the valley width by analyzing vegetation patterns, stream sinuosity, floodplain indicators, terrace indicators, and valley side-slope indicators.

Step #2: Evaluate Valley Confinement Use the following criteria as the primary *indicators* of valley confinement. The criteria apply to 1:24,000 scale maps with either 20 or 40 foot contour intervals.

(C) Confined Valley: Valley Width < 200 feet

(U) Unconfined Valleys: Valley Width > 200 feet

Use the following secondary indicators below to confirm the valley confinement category; positive identification of at least 50% of the indicators in any one confinement category confirms the confinement category. For exceptional situations, overruling the confinement designation for a reach is permitted when accompanied by a written justification for the altered designation and approval from TPA project manager.

Supplemental Valley Confinement Indicators

(C) Confined Valleys Indicators:

- ❖ C-1 The historic *floodplain* width in aerial photos (disregarding human impacts) appears to be < 2 stream channel widths.
- ❖ C-2 Sinuosity of the stream on the topo map is very low (e.g. <1.2); there is no apparent meandering independent of the valley curvature; all meandering appears to be forced (e.g. bedrock or debris jams).
- ❖ C-3 The contour lines intersecting the stream are strongly V-shaped.
- ❖ The channel cannot be observed from aerial photos because of tree canopy.
- ❖ C-4 The stream valley gradient is greater than 10%.
- ❖ C-5 The meander width ratio is < 2.
- ❖ C-6 The valley width is < 2 times than meander belt width.

(U) Unconfined Indicators:

- ❖ U-1The historic floodplain width in aerial photos (disregarding human impacts) is generally ≥ 2 stream channel widths.
- ❖ U-2 Sinuosity on the topo map is low to moderate (e.g. ~1.1 to 1.3); there is a low to moderate amount of meandering independent of the valley curvature; there is a moderate to high amount of unforced sinuosity.
- ❖ U-3 The general shape of successive contour lines defining the valley are often more U shaped than V shaped.
- ❖ U-4 The valley gradient is less than 10%
- ❖ U-5 The meander width ratio is ≥2.
- ❖ U-6 The valley width is ≥2 times the meander belt width.
- ❖ U-7 Floodplain vegetation consists of deciduous vegetation whose age increases with distance from the channel.

Step #3: Delineate the upper and lower boundaries of all confined valley reaches.

- Group together only the adjacent contour intervals that indicate a confined valley.
- A confined valley reach consists of two or more contour intervals.
- Do not lump individual unconfined contour intervals where they occur between confined intervals.

Step #4: Delineate the upper and lower boundaries of all unconfined reaches.

- Group together only the adjacent contour intervals that indicate an unconfined valley.
- An unconfined valley reach consists of two or more contour intervals.

- Do not lump individual confined contour intervals where they occur between unconfined intervals.

Step #5: Create a layer file that delineates confinement breaks.

2.3.5 Valley Gradient

Estimation of valley gradient is performed for all reaches of every 303(d) water body segment within the study area as well as for non-listed waterbody segments where assessment work will be performed. Valley gradient = valley length/ change in valley elevation. Important: the stream valley rather than the stream itself is used for this measurement. Valley gradients will be estimated using the 1:100,000 NHD (stream) layers when using GIS, or a 1:24,000 scale topographic map with 20 to 40 foot contour intervals. A map wheel should be used to calculate distances on a map.

The NHD layer is used for reference and not for valley gradient estimation. GIS users must not use the stream layer to automate valley gradient estimations. The method described here initially estimates gradient per contour interval, not per group of contour intervals. Although the valley gradient along a steep stream segment (>4%) on the 1:100,000 NHD layer may be approximated by the stream segment gradient, the line of the stream indiscriminately crosses contour intervals that can vary greatly in their gradient and thus may not properly delineate changes in valley gradient. Use of the 1:24,000 scale topographic layer in GIS is required to sufficiently characterize gradient variation along a water body segment and provides consistency between the two methods.

Outline for Determining Valley Gradient:

Step 1: Estimate the valley length between contour intervals
Step 2: Using the Gradient Chart, estimate the gradient for each contour interval
Step 3: Group together contour intervals that fall within the same gradient category.
Step 4: Lump "outlier" gradients with an adjacent group, based on standard criteria
Step 5: Calculate an average gradient for the contour intervals that have been grouped together and assign an overall gradient category.
Step 6: Delineate the final groups on the map

Instructions for each step are outlined in the following section.

Step #1: Estimate valley length

- Always start at the downstream end of the water body segment and move upstream for each of the following steps
- Make sure to note whether the contour interval is 20 or 40 feet; sometimes the contour interval will change where there is a change from high to lower relief.
- Mark each intersection of contour lines with the stream to create <u>nodes</u>.
- Connect each node with a single straight line segment.

- Measure the scaled distance between each node and record it on the map.
- During this step, a valley reach with a gradient that is obviously greater than 4% may be delineated by ocular estimation. This should occur only after ocular calibration has occurred whereby after measuring a considerable number of high gradient reaches it becomes obvious which reaches have gradients over 4%. In the database record these reaches as "> 4%" instead of calculating the exact valley slopes

Step #2: Estimate valley gradient for individual contour intervals

- Use the distance recorded for each contour interval to estimate the valley gradient for each contour interval from the Figure 2.3.4 below. For example, on a 40 foot contour interval map, if the map distance between contour lines was 2300 feet, then the corresponding gradient category is: <2%. Record the gradient category for each contour interval.
- More often than not, the confluence of the water body segment with its receiving water body is not intersected by a contour line. In this case, assume the gradient is equal to the adjacent upstream contour interval.

Figure 2.3.4: Gradient Chart

Valley Gradient (%) Categories	Map Scale = 1:24,000		
	40 foot contour intervals:	20 foot contour intervals:	
<2%	**>2000 feet**	**>1000 feet**	**Straight Line Valley Length Between Contour Nodes (Run)**
2% to < 4%	**Between 2000 and 1000 feet**	**Between 1000 and 500 feet**	
4-10%	**Between1000 and 400 feet**	**Between 500 and 200 feet**	
>10%	**< 400 feet**	**< 200 feet**	

Step #3: Group together contour intervals

- Group together contour intervals whose gradient falls within the same gradient category.
- A group of contour intervals is considered to be two or more intervals. Each group of intervals should be assigned a letter for future reference.

Step #4: Lump individual "anomaly" contour intervals into an adjacent group

- An "anomaly" contour interval is one whose gradient category does not match that of an adjacent contour interval or group of contour intervals.

- Lump the anomaly contour interval with an adjacent contour interval or group of contours with the next highest category without skipping a category; if not available, then…
- Lump the anomaly contour interval with an adjacent contour interval or group of contours with the next lowest category without skipping a category; if not available, then…
- Lump the anomaly contour interval with the adjacent group having the greatest number of contour intervals; if not available, then…
- Lump the anomaly contour interval with the adjacent gradient category having the longest contiguous length.

Step #5: Calculate an average gradient for the each contour intervals group and assign an overall gradient category to each group.

- For each group, divide the cumulative length between the contour nodes by the cumulative change in valley elevation.
- Assign the group to a gradient category using the same valley gradient categories from the Gradient Chart:

  Category 1: Less than 2%
  Category 2: 2% to <4%
  Category 3: 4% to 10%
  Category 4: >10%

- **Step #6:** Create a layer file that delineates gradient breaks.

2.3.5 Finalize the Primary Stratification

This procedure integrates the ecoregion, stream order, channel gradient and channel confinement breaks into individual reaches that will be identified by their unique combination of these features. Reaches that have the same stratification attributes are then grouped into sets.

Step #1: Overlay the confinement, gradient, stream order, and ecoregion layers.

- Use different segment break marks and different colors for marking each type of reach break category. Display the gradient, confinement, stream order and ecoregion layers.

Step #2. Intersect reach breaks

- Intersect the layers together to form a “primary” reach layer such that unique reaches are created wherever the breaks do not align. Each newly created reach will have only one gradient, confinement, stream order, and ecoregion designation.

- For reach breaks that fall within 250 feet of one another, merge the adjacent breaks to form one single delineated break, and thereby eliminate multiple small reaches. Due to varying levels of confidence between where the aerial assessment stratification marks a transition between attributes and where the actual transitions occur on the ground, use the hierarchy below to determine in what direction to merge breaks. If a Stream Order break is not present, than merge to Valley Gradient, etc.

Merge to: 1) Stream Order
2) Valley Gradient
3) Valley Confinement
4) Ecoregion

Step #3: Create a layer file that delineates Primary (Hard Break) reaches.

- For each break that occurs, identify the cause for change in the attribute table "Reach Break Trigger"

2.4 SECONDARY STRATIFICATION (SOFT BREAKS)

2.4.1 Delineation of reaches into sub-reaches based on land use and riparian characterization

Land use and riparian characterization is performed for all reaches of every 303(d) waterbody segment within the study area as well as for any non-listed waterbody segments where assessment work will be performed. The characterization of land use and riparian areas is most efficiently performed through GIS from an analysis of high resolution aerial imagery and land use layers.

Step #1: Identify Sub-Reach Breaks
Using aerial imagery, the GIS analyst and TMDL project manager will identify major changes in vegetation or land use that could potentially influence the character and justify further delineation into subreaches.

Land use characterization includes a summary of the major and minor types of apparent land uses, the intensity of activities, and notes upon the apparent management techniques that are being practiced. Significant irrigation withdrawals or returns justify a division into sub-reaches, as well as channelized sections of stream or alteration from road proximity. Riparian characterization may include, but is not limited to: distinctions in the type of riparian vegetation communities, changes in the apparent density or vigor of riparian community types, and changes in the width of the riparian zone.

Creation of sub-reach breaks also allows the investigator to identify discrete areas surrounding anthropogenic influences which are not optimal sampling sites when the study design goal is to sample "whole channel" characteristics. In general, their delineation indicates areas that need to be avoided during the placement of survey sites. However, identifying the affecting anthropogenic influences into discrete sub-reach breaks may also allow for sampling designs that specifically investigate these impacts in comparison to the rest of the stream or reach.

Review topographic maps and aerial photography to identify channel controls that may have effects on local channel conditions but not necessarily reach-wide conditions. Examples include:

- ❑ Local Diking (DK)
- ❑ Local Channelization (CH)
- ❑ Houses (H) within riparian zone
- ❑ Roads - (RD) dirt road sections within riparian zone
- ❑ Roads - (RP) paved road sections within the riparian zone
- ❑ Bank Hardening – rip-rap (RR)
- ❑ Culverts (C)
- ❑ Bridges (B)
- ❑ Significant irrigation withdrawals (IW) and returns (IR)
- ❑ Point sources, including mixing zones (PS)

The extent of the sub-reach should extend a minimum of 250 feet upstream and downstream from the extent of the buffered feature.

Step 3#: Add the "n-1" stream order break layer from the earlier Stream Order delineation.

Step #4: Create a layer file that delineates Secondary (Soft Break) reaches.

- For each break that occurs, identify the cause for change in the attribute table "Sub-Reach Break Trigger"

2.5 FINALIZING STRATIFICATION AND POPULATING THE DATABASE

The stratification process is complete when Primary and Secondary stratification criteria are combined to delineate a population of unique stream reaches and sub-reaches that accurately characterize the variability along the stream of interest. This variability is inherently displayed in the segmentation that occurs, and in the detail included with the associated database (attribute table).

2.5.1 Merging Hard Break and Soft Break Layers

Step #1: Combine the Hard Break and Soft Break layers to identify the final reach segmentation.

Step #2: Create a layer file that delineates the resulting unique reaches.

2.5.2 Naming Delineated Segments

Every delineated stream segment that results from this process will have its own unique alpha-numeric identifier. These identifiers are based on the combination of the hard break characteristics and the soft break segmentation that occurs within the hard break reaches. A REACH is a segment of stream that is characterized by its ecoregion, stream order, valley gradient, and valley confinement. Within each reach, there may be none or multiple SUB-REACHES. SUB-REACHES have all the attributes of the parent reach, but may have a varied character based on the anthropogenic, non-fluvial influences, or "n-1" streams that occur. In the attribute table, each segment is differentiated by a REACH # and a SUBREACH #.

- Beginning at the upper most segment and working downstream, reaches will be numbered beginning with 1.
- Subreaches are numbered within each reach, beginning at the upper most subreach segment and working downstream, beginning with 1.
- Subreach numbering begins again at 1 for each newly encountered reach.
- If a reach does not contain any subreaches within it, the subreach column in the database will be entered with a value of 1.
- The final unique identifier (Reach-ID) for each delineated segment is the result of a combination of the stream name abbreviation, the reach number, and the subreach number.

Step #1: Create columns in the attribute table and assign the appropriate Reach, Subreach, and Reach-ID.

Example:

WATERBODY	REACH_ID	REACH	SUBREACH
McClain Creek	MCL 1-1	1	1
McClain Creek	MCL 1-2	1	2
McClain Creek	MCL 2-1	2	1
McClain Creek	MCL 2-2	2	2
McClain Creek	MCL 2-3	2	3
McClain Creek	MCL 3-1	3	1
McClain Creek	MCL 4-1	4	1

2.5.3 Attribute Table Structure

The attribute table associated with the delineated segments must house all of the appropriate information that identifies the qualities of each reach and subreach. Along with the information associated with the stratification criteria described above, the following information must also be included for each delineated segment: GNIS ID, DEQ Segment ID, Segment Length, Dominant Riparian Vegetation (right bank and left bank), Adjacent Land Use (right bank and left bank), Existence of Anthropogenic Activity within 100' of the Stream (right bank and left bank), Riparian Health Assessment (right bank and left bank), Estimate of Percentage of Anthropogenic Influences that may Effect Bank Erosion, and a Comments field that provide any other useful information.

2.5.3.1 Completing Additional Data Components Once Reaches and Sub-reaches are identified

The stratification process requires a final analysis and entering of information into the database (attribute table) before it can be completed. For each delineated segment, the right bank and left bank land use and riparian quality will be assessed and the associated data input into the database. The information included in these final steps is crucial to interpreting the sediment loads derived from sediment and accounting for the differences in anthropogenic influence.

Predominant Vegetation Type
Step #1 – Create the appropriate columns in the attribute table.

Step #2 – Determine the predominant vegetation type adjacent to the stream for both right bank and left bank for each delineated segment. Choose from one of five categories: BARE, GRASS, SHRUBS, MATURE CONIFEROUS, MATURE DECIDUOUS and enter the corresponding vegetation type into the attribute table.

Adjacent Land Use
Step #1 – Create the appropriate columns in the attribute table.

Step #2 – Determine the adjacent land use for the segment for both right bank and left bank for each delineated segment. Choose one from the following categories and enter the corresponding land use into the attribute table:

Range
Wetland
Forest
Urban
Agriculture (row crops)
Road
Hay/Pasture
Harvest/Fire
Rural Res./Hobby Farm

Presence of Anthropogenic Activity
Step #1 – Create the appropriate columns in the attribute table.

Step #2 – Determine if anthropogenic activity is occurring within 100’ of the stream for both right bank and left bank for each delineated segment. Choose either YES or NO and enter into the attribute table.

Riparian Health Classification
Riparian health will be determined based on a coarse level review through the aerial assessment process. Riparian health will be classified for each side of the stream in a particular SUBREACH and derived from a combination of three parameters described above: Riparian Veg Type, Predominant Land Use, and Presence of Anthropogenic Activity within 100’ of the Stream. Riparian Health will be classified as Poor, Fair, or Good based on the combination of the three determining parameters. If Riparian Veg Type is classified as BARE, then Riparian Health will automatically be considered

POOR. If Riparian Veg Type is considered anything other than BARE, and the adjacent land use is not associated with typical anthropogenic activities, and there is no Presence of Anthropogenic Activity within 100' of the Stream, then Riparian Health will automatically be considered GOOD. Wherever there exists Presence of Anthropogenic Activity within 100' of the Stream, the Riparian Health cannot be anything better than FAIR. Generally, Land Use Types that suggest anthropogenic influence (Urban, Agriculture, Road, Hay/Pasture, Harvest/Fire, Rural Res./Hobby Farm) will automatically be designated as FAIR regardless of the presence of Anthropogenic Activity, unless on-the-ground knowledge or best professional judgment suggests otherwise. Changes to Riparian Health determinations can be made based on field visits and best professional judgment however these changes must be justified in the (Riparian) Comments field. Riparian health to be assessed and determined by the project manager and GIS analyst.

Step #1 – Create the appropriate columns in the attribute table.

Step #2 – Determine the appropriate riparian health category (POOR, FAIR, or GOOD) and enter into the attribute table.

Example Attribute Table Columns:

LB_RP_VG	LB_LAND	LB_ANTHRO	LB_RP_HLTH	LB_COMMENT
Bare	Urban	Yes	Poor	
Shrub	Forest	No	Good	
Shrub	Forest	Yes	Fair	
Mat Dec	Harvest/Fire	No	Fair	
Mat Con	Agriculture	Yes	Fair	
Bare	Range	No	Poor	
Grass	Hay/Pasture	No	Fair	
Shrub	Agriculture	No	Good	NRCS comments
Grass	Harvest/Fire	No	Good	Field visit
Shrub	Rural Res/Hobby Farm	Yes	Poor	Field visit
Shrub	Rural Res/Hobby Farm	Yes	Fair	

Bank Erosion Anthropogenic Influence

In order to correlate field measured BEHI data with the extrapolation to other delineated segments, a percent anthropogenic influence must be estimated from the aerial imagery. The percent anthropogenic influence for this exercise is **only related to the bank erosion** that may occur in a particular segment.

Step #1 – Create the appropriate columns in the attribute table.

Step #2 – Determine the appropriate percent influence on bank erosion from the following categories: TRANSPORTATION, RIPARIAN GRAZING, CROPLAND, MINING, SILVICULTURE, IRRIGATION, NATURAL, OTHER. If one category does not appear to have any influence on bank erosion for that segment, then the percent influence is entered as 0. The sum total of percent influence must equal 100 for the eight categories above. This measurement is not right bank/left bank dependent. Percents should be applied in increments of ten.

Example Attribute Table Columns:

TRANS	GRAZE	CROP	MINE	FOREST	IRRIG	NATURAL	OTHER
0	0	20	0	0	20	60	0
20	0	0	0	80	0	0	0

Segment Notes

Finally, create one column entitled segment notes that allows the GIS analyst or the planner to include any other pertinent information regarding each delineated segment.