## Section 3.3 Watershed Assessment and Inventory

A watershed assessment protocol was prepared to support the development of this plan. This protocol had four objectives. First, it was meant to provide for the project team a general, baseline inventory of conditions throughout the stream corridor, by defining the focus of observation during the assessment. This baseline Stream Feature Inventory included:

1) conditions that affect hydraulic function, particularly sediment transport function such as bedrock sills and banks, cultural and natural grade controls, berms, and riprap or other revetment;
2) potential sources of water quality impairment in the corridor, especially eroding banks, clay exposures, and exposed septic leach fields or other hazards);
3) riparian vegetation, including locations of functional reference riparian communities, locations where a change in riparian vegetation management is warranted to improve ecosystem function, and occurrences of invasive exotic vegetation of significant consequence to stream stability and ecosystem function);
4) locations of cross-sections to be surveyed for characterization of channel morphology, and flagged bankfull stage locations, including locations of "reference cross-sections" at which the channel-forming, or "bankfull" stage could be determined with confidence; and
5) infrastructure, including road crossings, bridge abutments, culverts and outfalls, and utility lines or poles, and other features such as tributary confluences, springs, wells or diversions.
This inventory was used to help define and prioritize further assessment and scope the issues to be addressed in the management plan.

Second, the field protocol was meant to support the characterization of channel form, or *morphology*, throughout the mainstem. Because sediment transport function and the stability of stream beds and banks is highly influenced by channel morphology, characterization of this morphology was key to the identification of reaches that were likely to present erosion, water quality or habitat problems, either in themselves or in the context of adjoining reaches and the system as a whole. The methods chosen for this characterization employed Rosgen's natural channels classification system (Rosgen 1996), described in Section 3.2. This classification supports (but does not provide) general management interpretations regarding channel morphology on a watershed-wide basis. The morphological variables measured to classify reaches in the Rosgen approach (i.e., entrenchment ratio, width/depth ratio, slope, sinuosity and median particle size of bed material) can inform the interpretation of process, beyond classification of Rosgen stream types.

Third, this protocol was meant to provide field verification of the characterization of the vegetative community (physiognomic) structure of riparian areas from remotely-sensed data. Characterizing riparian vegetation supported assessment of the capacity of the riparian "buffer" to mitigate potentially deleterious water quality impacts from upland land uses. In addition, riparian classification will define the role of vegetation in the cohesiveness of stream bank soils and the integrity of the stream and riparian ecosystems. This analysis should lead to recommendations for where improvement of buffer functionality might be most critical or effective, and locations of reference riparian vegetative communities within the watershed.
The fourth purpose of this protocol was to support analysis that would determine, for certain reaches and conditions identified during the stream feature inventory, the extent to which

channel geometry and stream bank stability departs from a potential stable form[1]. This allowed determination of locations for which restoration of stable channel geometry was required, or alternatively where bioengineered bank stabilization would be sufficient to reasonably assure future stability. In this regard, the protocol represented a "first cut" to identify where further assessment is warranted, both of potential stable reference reaches and reaches where instability is indicated. Reference reaches will subsequently be surveyed in greater detail and over time to verify their stability and to provide data on the range of values they exhibit in variables such as facet dimensions, Bank Erodibility Hazard Index (BEHI) scores (Rosgen 1996), measures of bed aggradation and degradation, bank erosion rates, and substrate size distribution. Stable channel geometry derived from these reaches can be used in the design of channel stability restoration projects. Unstable reaches will be subsequently surveyed in greater detail to allow comparison to the stable ranges of these same variables exhibited by reference reaches, and among themselves to characterize their relative severity and support the prioritization of their remediation.

The first step in this watershed assessment was production of a set of stream corridor maps which featured:

- Digital Orthographic Photography (2000)
- Identification of drainage area above and below each tributary confluence, and anticipated cross-sectional area at bankfull discharge at those points, using regional hydraulic geometry curves developed for the Catskills, and validated at the USGS gage on the Stony Clove Creek at Phoenicia
- USGS blue line streams, classified by slope (<2%, 2-4%, 4-10%, >10%)
- Contour lines
- Property boundaries and owners names
- Historical channel alignments, from 1959 and 1980 aerial photography

Fieldwork proceeded in six passes. The first pass used a Global Positioning System (GPS) to map locations of features identified in the Stream Feature Inventory (described above). Photographs were taken of each feature, and upstream and downstream at cross-section locations. Bank erosion sites were evaluated using Rosgen's Bank Erodibility Hazard Index. These banks were later monumented and surveyed for the purpose of long-term monitoring. The first page of each of the Management Unit Descriptions in Section 4 presents the results of this inventory, along with summary statistics.

[1] This approach assumes that for any valley setting, a variety of channel morphologies might be found, and that some of these forms, in that setting, convey the range of water and sediment discharges supplied by the landscape in a manner which allows them to maintain their morphology with relatively little change from year to year (stable forms), while others are less effective and are likely to evolve relatively rapidly through a sequence of channel forms due to vertical and/or lateral adjustments (unstable forms). For any valley setting, there is a discrete range of potentially stable forms.

The second pass involved elevation survey of the longitudinal profile of current water surface and field identified bankfull stage, and the third involved elevation survey of the (92) reference cross-sections described above. Following this survey, a stream-specific hydraulic geometry curve was developed for these cross-sections to support determination of bankfull stage at the remaining cross-section locations established during the stream feature inventory (Fig. 1). (Discharge was added later, back-calculated at each cross section using slope and pebble count data, and two different equations). Bankfull stage was rechecked in the field at high and low outliers.

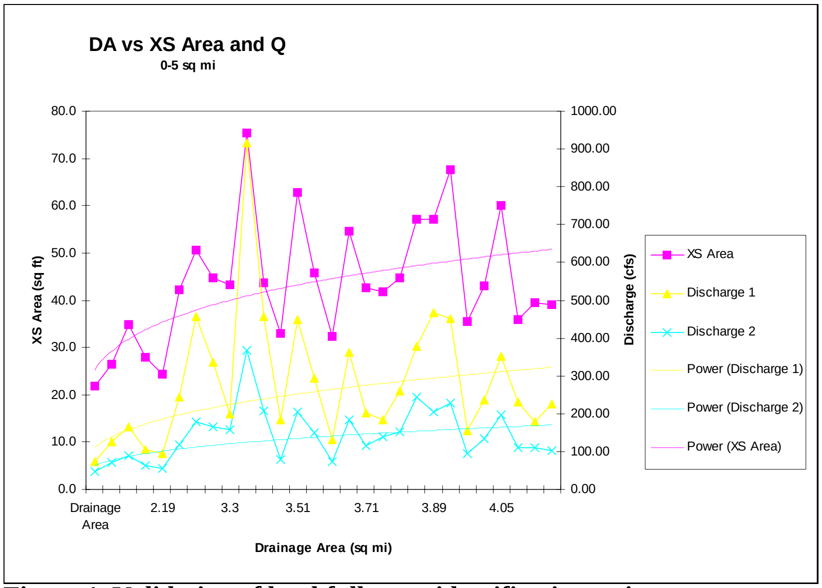

**Figure 1 Validation of bankfull stage identification, using comparison of cross-sectional areas**

The fourth pass through the stream involved elevation survey of the remaining classification cross-sections, producing a total of 99 sections for the Stony Clove mainstem. Reaches were then classified to Rosgen Level I, and adjacent reaches of the same stream type conjoined on the maps. During the fifth pass through the system, modified Wolman pebble counts were conducted for each of these conjoined reaches. The results of this effort are provided in a table in Appendix C. These data were then used to classify the stream reaches to Rosgen Level II. In each of the Management Unit Descriptions that follow, the sub-sections on <u>Current Stream and Floodplain Conditions</u> contains a map presenting the reach classification.

A fifth pass through the system was made during the mapping of fish habitat for the MesoHABSIM analysis (see Section 2.7 for a general description of this analysis, and Appendix B for a description of the methods employed). As part of this analysis, occurrences of Japanese knotweed (*Polygonum cuspidatum*) along the streambank were identified. This species has become a widespread problem in recent years, shading out other species but not providing adequate root structure to stabilize the soil in streambanks. The result can be rapid streambank erosion. In 2002, riparian vegetation in a 300 ft. corridor was characterization of using 2001 aerial photography. A more detailed description of the methods used for this characterization are provided in Appendix A. A final pass through the creek was made to ground-truth a selected sub-set of this characterization. The results of these vegetation analyses are presented in each Management Unit Description in Section 4, under the sub-sections on <u>Riparian Vegetation</u>.

To describe the current conditions and recommendations for the stream corridor, the 9.3 miles of Stony Clove Creek inventoried, was divided into twenty-one management units (Fig. 6) based on the following criteria:

1) Valley Slope - A profile of the valley slope was created using United States Geologic Survey contour data (Fig. 2). This profile was divided into segments based on common slope characteristics.

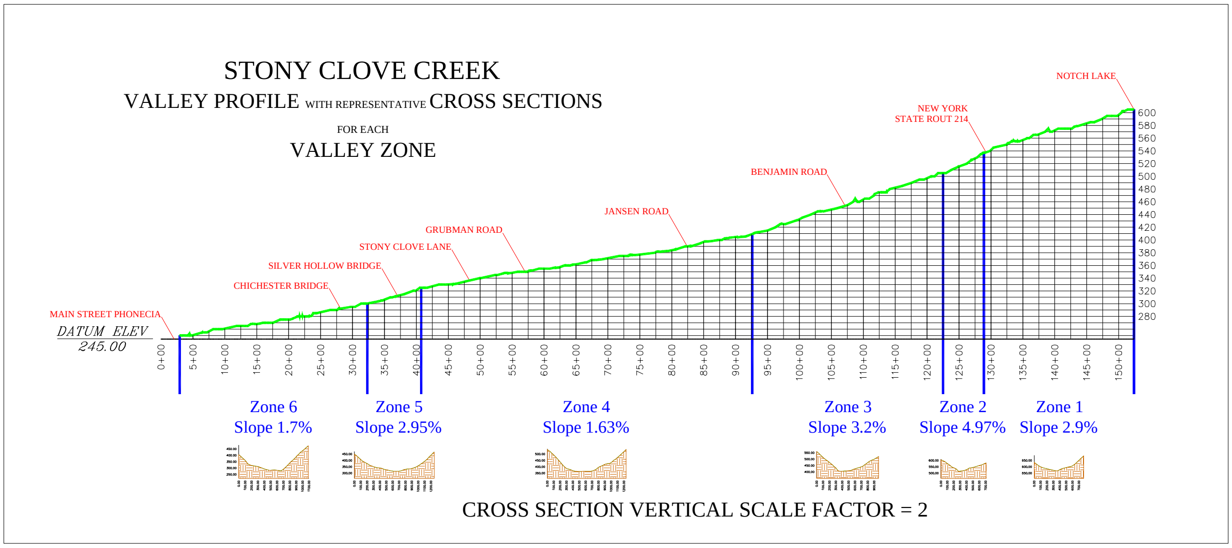


**Figure 2 Stony Clove Creek Valley Profile**

2) Valley Confinement - The width of the 100-year floodplain was measured perpendicular to the valley fall line at each of the 199 cross sections along the mainstream, and the ratio of this width to bankfull and floodprone width at each was determined. A graph of these ratios was generated and analyzed to identify segments exhibiting common valley confinement characteristics.

3) Historical Channel Alignment - Stream alignments were created from 1959, 1980 and 2000 aerial photographs (as described above). These alignments were overlaid to determine segments of historical stream instability.

4) Vertical and Lateral Controls - Bedrock channels inverts, revetments, bridges and berm locations were documented in the 2001 GPS walkover. Frequency of occurrence of these controls influenced management segment breaks.

5) Clay Exposures - A major water quality concern is clay eroding from stream banks. Clay exposures were documented in the 2001 GPS walkover. Frequency and extent of these exposures influenced management segment breaks.

The resulting 21 management units are reflected in the 21 units described in Section 4. The data were then compiled by management unit to facilitate interpretation of conditions, trends and to make recommendations. Figures 3-5 illustrate the format used for data analysis. These data are available for review at Greene County Soil and Water Conservation District.

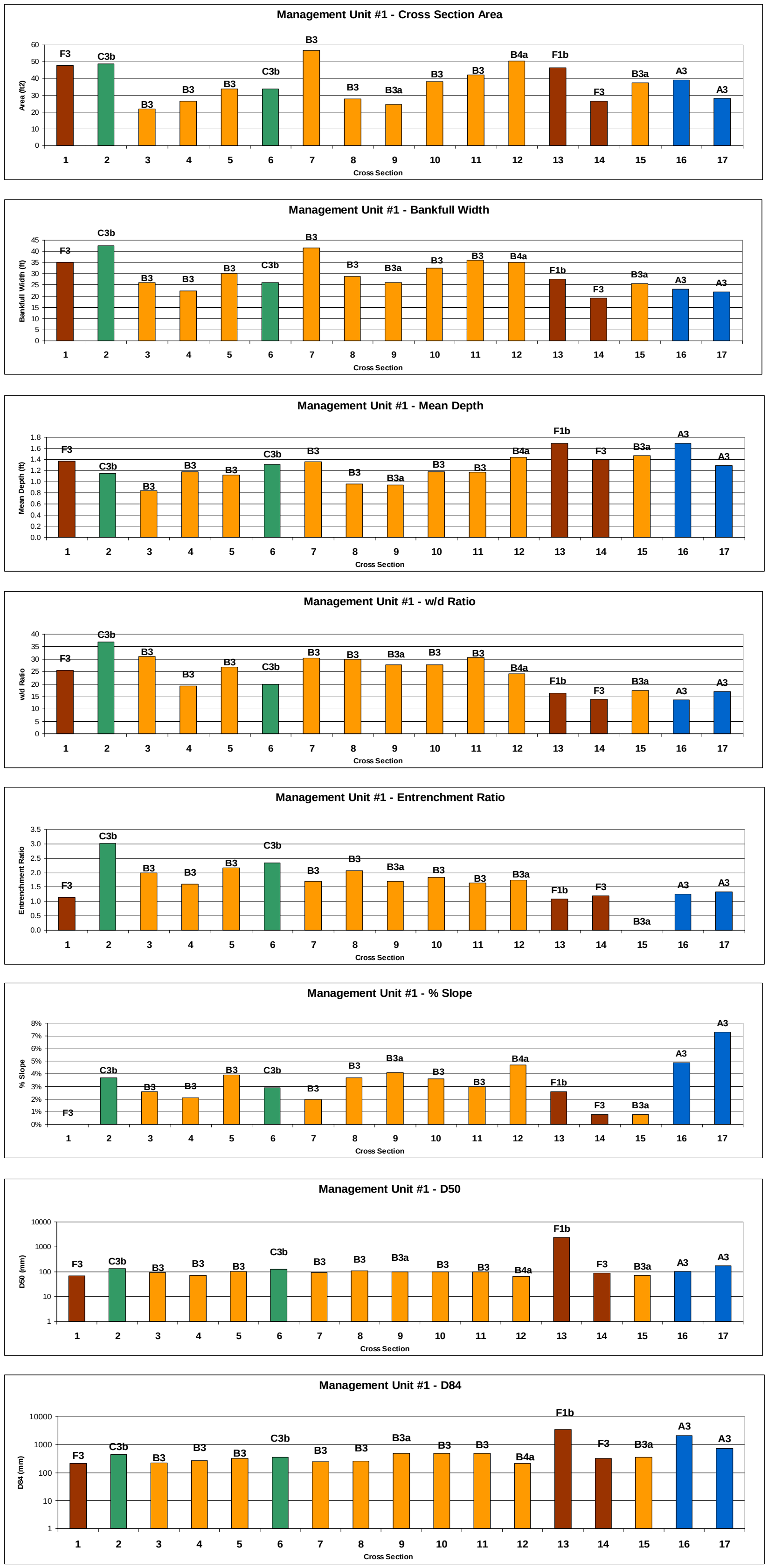


**Figure 3 Channel morphology characteristics for Management Unit 1**

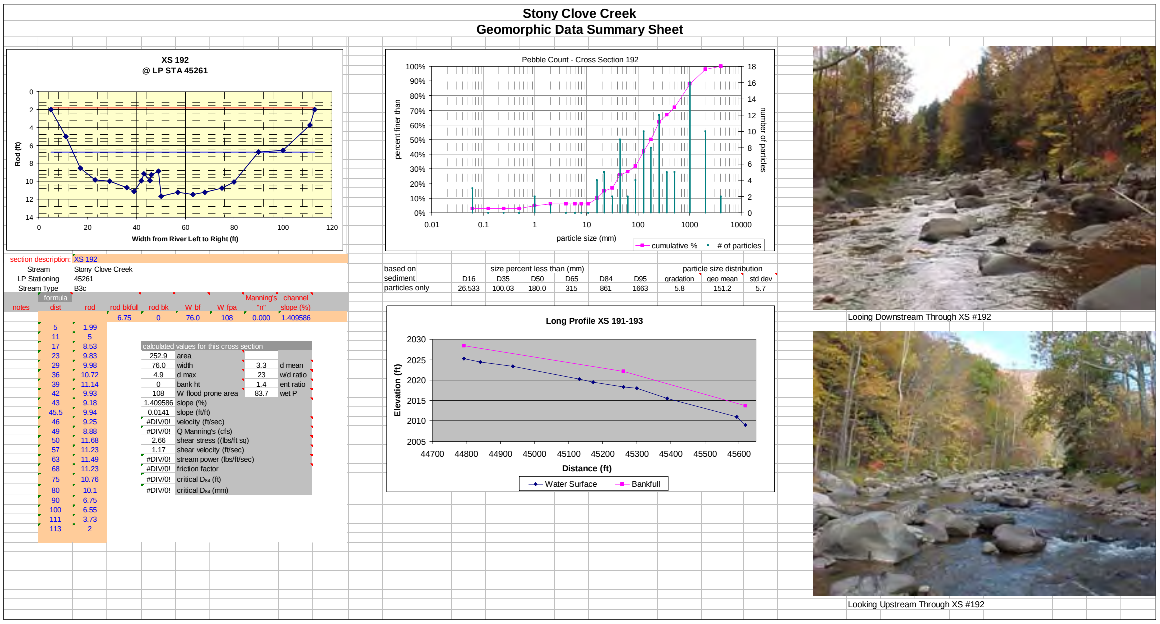


**Figure 4 Reach morphology summary page**

## BANK EROSION HAZARD INDEX

SITE: Stony Clove BEHI#24 — DATE: 8-16-01, Survey 9-13-01

DATA COLLECTED BY: JD, AD, AB, MV — BANK EROSION SEGMENT LENGTH: 1128.3 ft.

LOCATION: STA 3+74+40 between XS171 and XS172, Left bank

NOTES: Clay exposures on bank

| CRITERIA | | VERY LOW | | LOW | | MODERATE | | HIGH | | VERY HIGH | | EXTREME | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VALUE | INDEX | VALUE | INDEX | VALUE | INDEX | VALUE | INDEX | VALUE | INDEX | VALUE | INDEX |
| BANK HT/ BKF HT | | 1.0 - 1.1 | 1.0 - 1.9 | 1.1 - 1.19 | 2.0 - 3.9 | 1.2 - 1.5 | 4.0 - 5.9 | 1.6 - 2.0 | 6.0 - 7.9 | 2.1 - 2.8 | 8.0 - 9.0 | > 2.8 | 10 |
| ROOT DEPTH / BANK HEIGHT | | 1.0 - 0.9 | 1.0 - 1.9 | 0.89 - 0.50 | 2.0 - 3.9 | 0.49 - 0.30 | 4.0 - 5.9 | 0.29 - 0.15 | 6.0 - 7.9 | 0.14 - 0.05 | 8.0 - 9.0 | < 0.05 | 10 |
| ROOT DENSITY (%) | | 100 - 80 | 1.0 - 1.9 | 79 - 55 | 2.0 - 3.9 | 54 - 30 | 4.0 - 5.9 | 29 - 15 | 6.0 - 7.9 | 14 - 5 | 8.0 - 9.0 | < 5 | 10 |
| BANK ANGLE (DEGREES) | | 0 - 20 | 1.0 - 1.9 | 21 - 60 | 2.0 - 3.9 | 61 - 80 | 4.0 - 5.9 | 81 - 90 | 6.0 - 7.9 | 91 - 119 | 8.0 - 9.0 | > 119 | 10 |
| SURFACE PROTECTION (%) | | 100 - 80 | 1.0 - 1.9 | 79 - 55 | 2.0 - 3.9 | 54 - 30 | 4.0 - 5.9 | 29 - 15 | 6.0 - 7.9 | 15 - 10 | 8.0 - 9.0 | < 10 | 10 |
| TOTALS | | | | | 2.9 | | | | | | 8.9 | | 30 |
| NUMERICAL ADJUSTMENTS | None | | | | | | | | | | | | |
| **TOTAL ADJUSTED SCORE** | | | | | | | | | | | | | 41.8 |

BANK MATERIALS:

BEDROCK: BANK EROSION POTENTIAL ALWAYS VERY LOW
BOULDERS: BANK EROSION POTENTIAL ALWAYS LOW
COBBLE: DECREASE BY ONE CATEGORY UNLESS MIXTURE OF GRAVEL/SAND IS OVER 50%
GRAVEL: ADJUST VALUES UP BY 5 - 10 POINTS DEPENDING ON COMPOSITION OF SAND
SAND: ADJUST VALUES UP BY 10 POINTS
SILT/CLAY: NO ADJUSTMENT

STRATIFICATION: 5 - 10 POINTS (UPWARD) DEPENDING ON POSITION OF UNSTABLE LAYERS IN RELATION TO BANKFULL STAGE

**BANK EROSION POTENTIAL**

| | |
|---|---|
| Very Low | 5-9.25 |
| Low | 10-19.5 |
| Moderate | 20-29.5 |
| High | 30-39.5 |
| Very High | 40-45 |
| Extreme | 46-50 |

## NEAR BANK STRESS RATING

| Near Bank Stress Rating | NBS Rating | NBS/Shear Stress |
|---|---|---|
| Very Low | Less than 0.8 | |
| Low | 0.8 - 1.05 | |
| Moderate | 1.06 - 1.14 | |
| High | 1.15 - 1.19 | |
| Very High | 1.20 - 1.60 | 1.5 |
| Extreme | greater than 1.60 | |

Near-bank stress (NBS) = shear stress for 1/3 of the bankfull channel width
Shear Stress = (mean depth) (slope) (specific weight of water)
NBS rating from Rosgen, Wildland Hydrology (table 6-9) revised 2001

## COMBINATION BANK ERODIBILITY RATING

| Near Bank Stress Rating | BEHI Rating | NBSR * BEHI |
|---|---|---|
| 1.5 | 41.8 | 62.70 |

## ENTRAINMENT

| $J_{bkf}$ | $J_c$ | $J_e = (J_{bkf}/J_c)$ |
|---|---|---|
| 1.41 | 0.49 | 2.88 |
| Stability Indicator | | Poor |

**Figure 5 Bank erosion site summary sheet**

Additional data analysis was used for specific interpretations. Figure 6 depicts width/depth ratios and slope for the 199 cross-sections. In the absence of some other mitigating characteristic, reaches falling in the upper left are likely to have excess transport capacity, and those in the lower right, insufficient transport capacity.

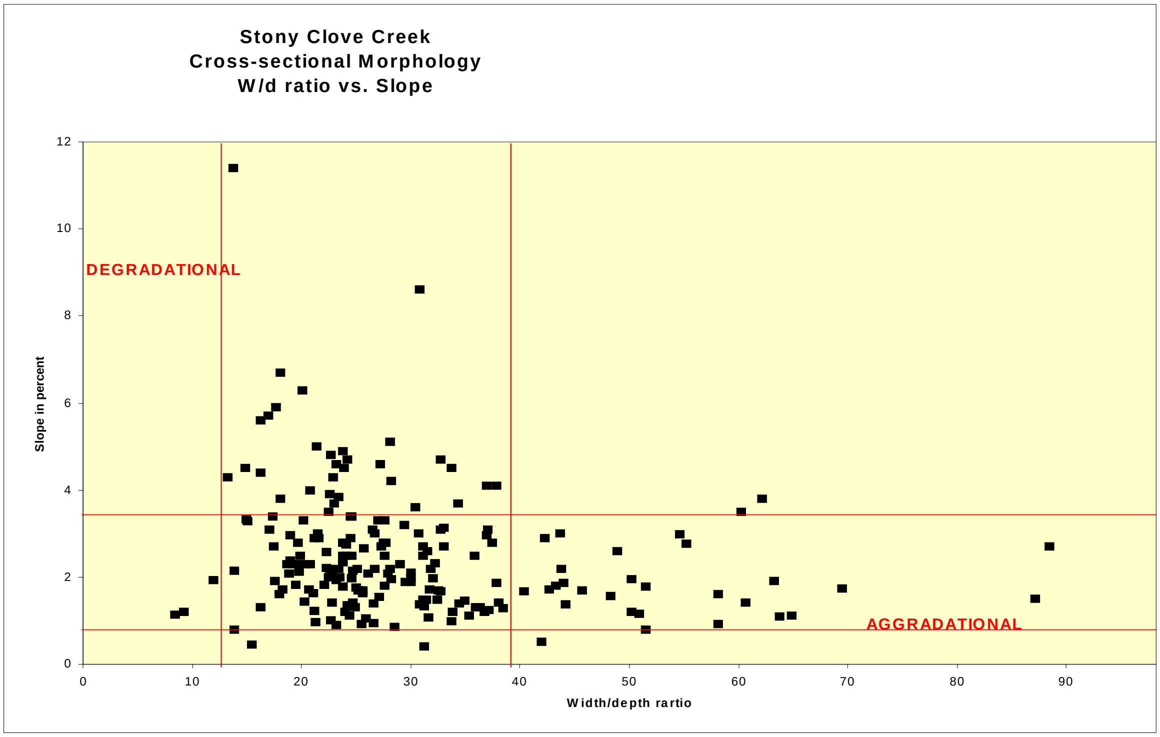


**Figure 6 Width to depth ratios vs. slopes for 199 cross-sections, suggesting sediment transport effectiveness**