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, mapped using photointerpretation methods, and 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. Most of the data presented in the Management Unit Descriptions in Section 4 was derived from an inventory walkover conducted during the Spring and Summer of 2004. Following the flood of April 3-4, 2005, a second walkover was conducted to track changes in occurrences of bank erosion and clay exposures that may have resulted from the high flows.

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.

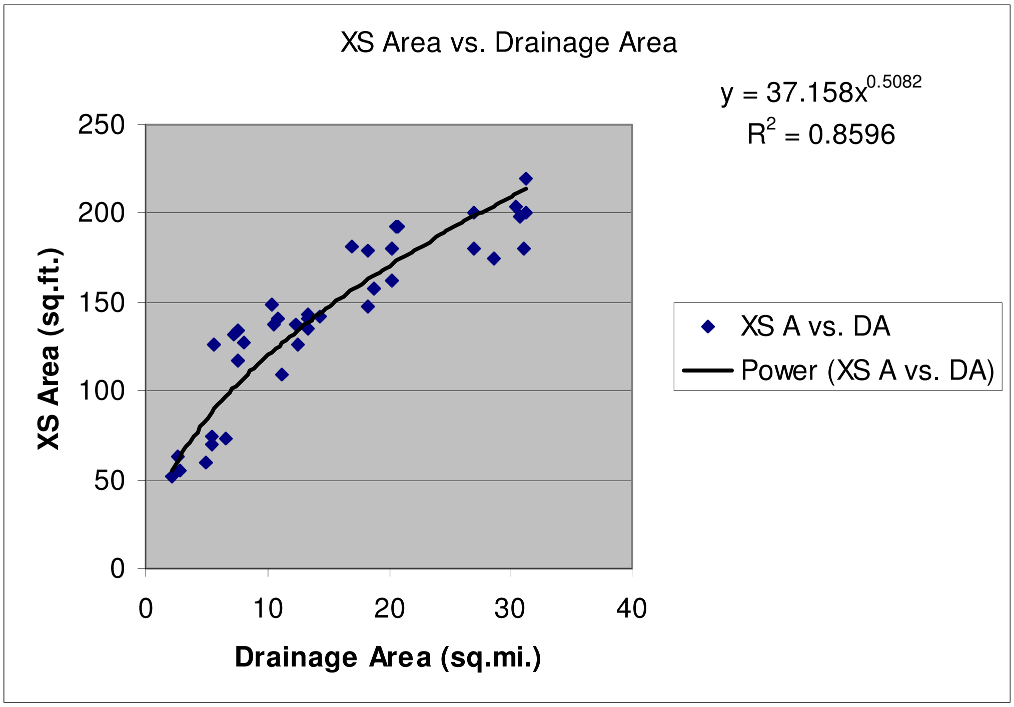
The first step in this watershed assessment was production of a set of stream corridor maps which featured:

- Digital Orthographic Photography (2004)
- 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 gages on the West Kill Creek at Spruceton and Lexington.
- USGS blue line streams
- Contour lines
- Property boundaries and owners names
- Historical channel alignments, from 1959 and 1980 aerial photography
- Floodplain boundaries

[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.

Fieldwork proceeded in several 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. As part of this analysis, occurrences of Japanese knotweed (*Polygonum cuspidatum*) along the streambank were identified.

The first page of each of the Management Unit Descriptions in Section 4 presents the results of this inventory, along with summary statistics.



The second pass involved survey of the reference hydraulic geometry stations, including longitudinal profile of current water surface and thalweg, elevation survey of the cross-sections, and pebble counts at each. 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.

The third pass through the stream involved elevation survey of the remaining classification cross-sections, producing a total of fifty-seven sections for the West Kill mainstem, and of the twenty-one Bank Erosion Monitoring sites (BEMs). Reaches were then classified to Rosgen Level II, and adjacent reaches of the same stream type conjoined on the maps. The results of this effort are provided in a table in Appendix C. 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 fourth pass through the system was made during 2005, as described above, to document changes that may have occurred as a result of heavy Spring flooding.

To describe the current conditions and recommendations for the stream corridor, the 10.7 miles of West Kill 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.

2) Valley Confinement - The width of the 100-year floodplain was measured perpendicular to the valley fall line, and this was compared to bankfull channel width as predicted from regional hydraulic geometry curves (Miller and Davis, 2002), and the ratio of these was determined at regular intervals along the valley alignment. 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 2001 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 a 2001 GPS walkover. Frequency of occurrence of these controls influenced management segment breaks.

5) Clay Exposures and Bank Erosion - A major water quality concern is clay eroding from stream banks. Clay exposures were documented in the 2001. GPS walkover, and again in 2005. 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.

Analysis of changes in channel morphology, riparian vegetation and bank erosion were used to characterize conditions in each unit and make appropriate management recommendations. Bank erosion sites were prioritized using a matrix involving many variables.

West Kill

Bank Erosion Monitoring Site Prioritization

BEHI #	MU #	Stream Station	Bank Height / Bankfull Height	Root Depth / Bank Height	Root Density (%)	Bank Angle (Degrees)	Surface Protection (%)	Bank Materials	Strat	NBS/ Shear Stress Category	Entrainment Stability Indicator	Erosion Area	Infrastructure Threat	Presence / absence of clay	BEMS Prioritization Rating
5	6	41388	3	0.224	5%	41	10.00%	cobble	no	High	Good	720.00	No	No	Low Priority
15	17	14571	2	0.070	5%	44	5.00%	cobble	no	Moderate	Excellent	1440.00	No	No	Low Priority
14	16	15177	5	0.238	8%	63	15.00%	cobble	no	Very High	Excellent	2100.00	No	No	Low Priority
16	17	9386	4	0.093	10%	32	15.00%	gravel	no	Very High	Excellent	1080.00	No	No	Low Priority
7	7	38013	3	0.366	6%	76	10.00%	cobble	no	Extreme	Excellent	1380.00	No	No	Low Priority
1	2	53926	11	0.375	19%	43	20.00%	cobble	no	Extreme	Fair	920.00	No	No	Low Priority
19	21	767	2	0.205	15%	25	35.00%	cobble	no	Extreme	Fair	1200.00	No	No	Low Priority
3	3	50144	6	0.172	7%	39	40.00%	gravel	no	Extreme	Excellent	1800.00	No	No	Low Priority
4	5	45915	12	0.034	1%	32	40.00%	cobble	no	Very High	Fair	4550.00	Yes	No	Low Priority
sup.	7	38945	8	0.081	2%	36	5.00%	silt	no	Extreme	good	1020.00	No	Yes	Medium Priority
10	12	26669	2	0.507	10%	54	10.00%	gravel	no	Extreme	Excellent	1400.00	Yes	Yes	Medium Priority
11	12	25688	10	0.024	0%	28	15.00%	clay	no	Very Low	Poor	1500.00	No	Yes	Medium Priority
2	2	51510	8	0.100	6%	35	70.00%	gravel	no	Extreme	Fair	1620.00	No	Yes	Medium Priority
sup.	4	47032	12	0.024	1%	36	5.00%	clay	no	Extreme	Excellent	3000.00	No	Yes	Medium Priority
12	13	22596	3	0.113	2%	37	10.00%	clay	no	Extreme	good	3740.00	No	Yes	Medium Priority
9	11	30028	10	0.115	3%	31	40.00%	clay	no	Extreme	Good	5250.00	Yes	Yes	Medium Priority
6	6	40777	25	0.050	3%	35	40.00%	clay	no	Very High	Good	16000.00	Yes	Yes	Medium Priority
13	13	21106	12	0.015	2%	36	5.00%	sand	no	Extreme	Good	11200.00	No	Yes	High Priority
18	20	3358	7	0.008	0%	39	0.00%	sand	no	Very High	Good	24420.00	No	No	High Priority
8	10	31201	2	0.102	1%	36	10.00%	gravel	no	Extreme	Fair	1530.00	Yes	Yes	High Priority
17	19	6005	10	0.014	2%	29	10.00%	clay	no	Extreme	Excellent	51830.00	Yes	Yes	High Priority