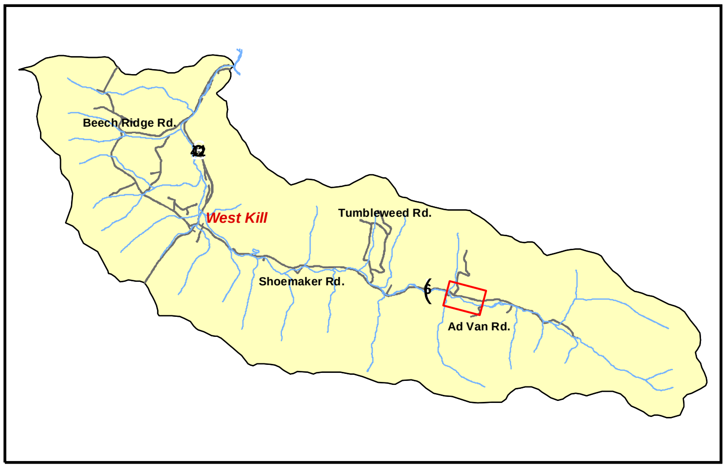


West Kill Management Unit 5

Stream Feature Statistics

11% of stream length is experiencing erosion
39% of stream length has been stabilized
26.1 acres of inadequate vegetation within the 300 ft. buffer
212 ft. of stream is within 50 ft. of the road
3 houses located within the 100-year floodplain boundary

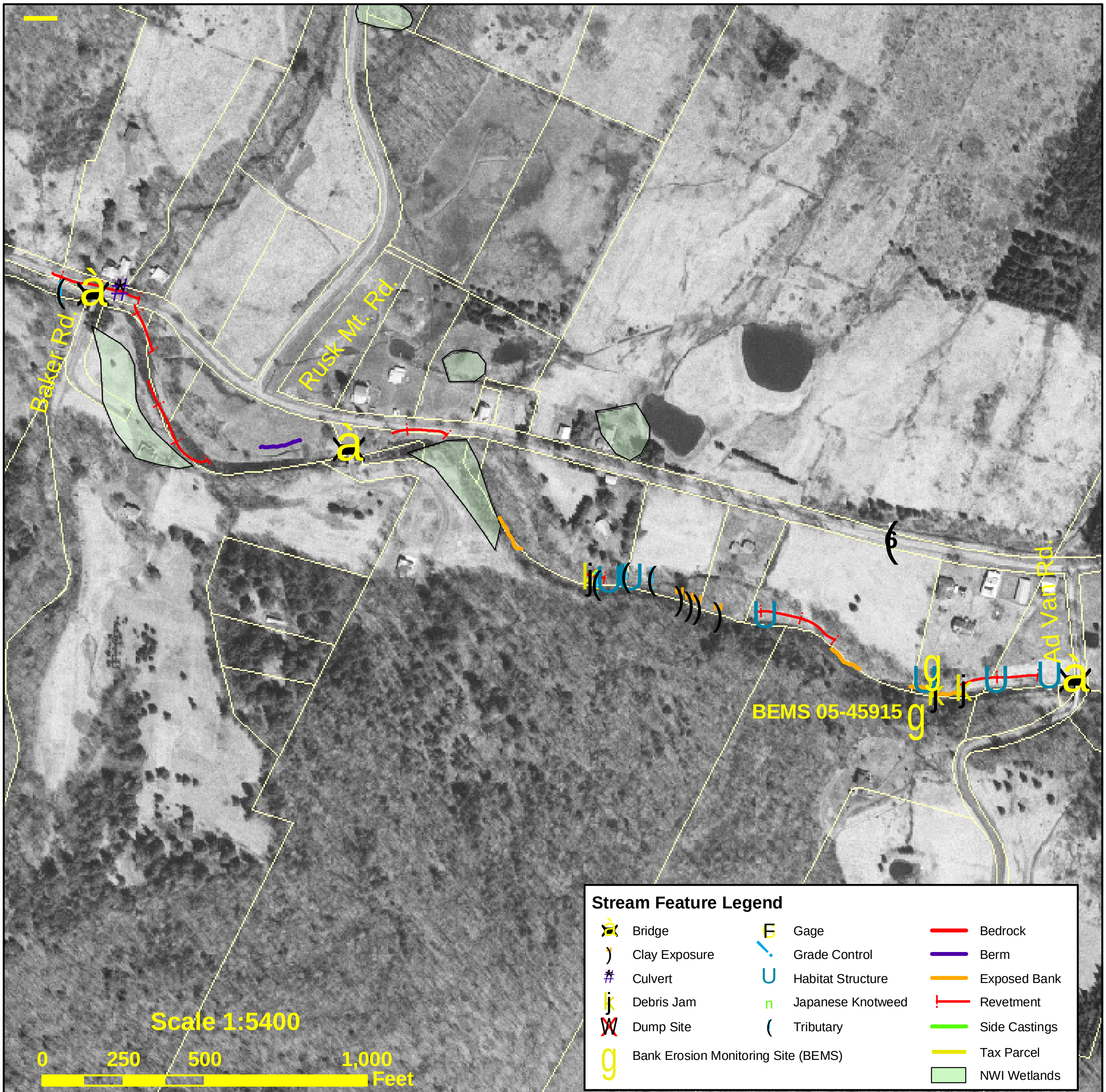


Figure 4.5.1 2004 aerial photography with stream feature inventory and tax parcels

Management Unit 5

Between Station 46365 and Station 42743

Management Unit Description

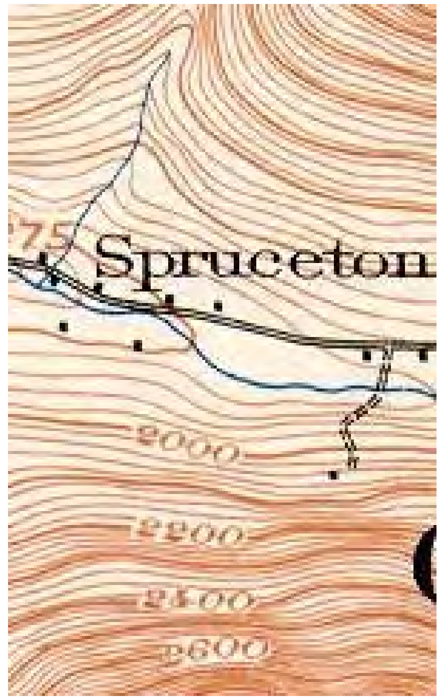
This management unit begins at the Ad Van Road bridge crossing, continuing approximately 3622 ft. to the Baker Road Bridge. The drainage area ranges from 7.4 mi^2 at the top of the management unit to 8.8 mi^2 at the bottom of the unit. The valley slope is 1.65%.

Summary of Recommendations Management Unit 5	
Intervention Level	Assisted Self-Recovery/Full Restoration BEMS #05-45915
Stream Morphology	Improve sediment transport continuity in lower reaches.
Riparian Vegetation	Buffer improvement plantings at sites throughout, interplant rip-rap installations.
Infrastructure	Improve floodplain drainage at Baker Road bridge.
Aquatic Habitat	Watershed wide study; investigate thermal barriers.
Flood Related Threats	Bank stabilization to reduce inputs of large woody debris.
Water Quality	Investigate potential sources of nutrients. Restoration of eroding banks to reduce introduction of fine sediment.
Further Assessment	Geotechnical assessment of BEMS #05-45915.

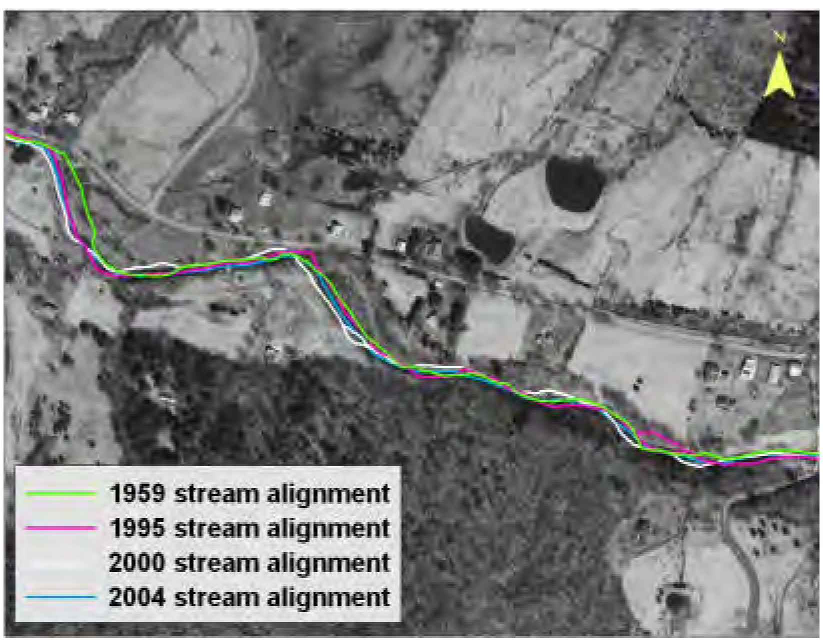
Historic Conditions

As the glaciers retreated about 12,000 years ago, they left their "tracks" in the Catskills. See Section 2.4 Geology of the West Kill Creek, for a description of these deposits.

Excerpt from Rich, 1935



Excerpt of 1903 USGS topographic map MU5



Historic Stream Channel Alignments in MU5

As seen from the historical stream alignments, the channel alignment has changed somewhat over the years.

Photos courtesy of Lenard Conklin

The images above show historic flood damage and maintenance activity on Herdman Brook culvert near the Baker Road bridge, and neighboring stream reaches in MU5. According to available NYS DEC records there were no stream disturbance permits issued in this management unit following the 1996 floods.

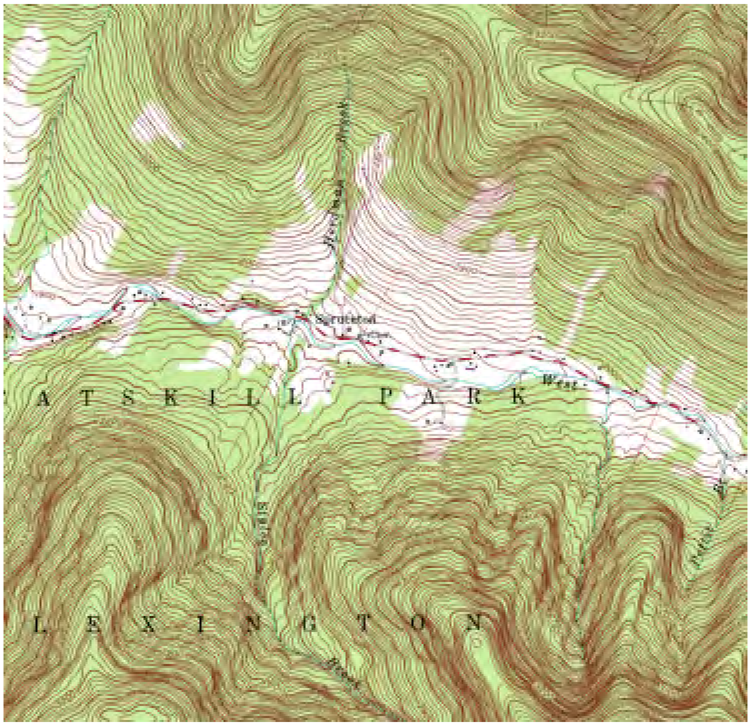
Stream Channel and Floodplain Current Conditions

Revetment, Berms and Erosion

The 2004 stream feature inventory revealed that 11% (402 ft.) of the stream exhibited signs of active erosion along 3622 ft. of total channel length . Revetment has been installed on a remarkably large 39% (1416 ft.) of the stream length. One rock wall berm was identified in this management unit at the time of the stream feature inventory.

Stream Morphology

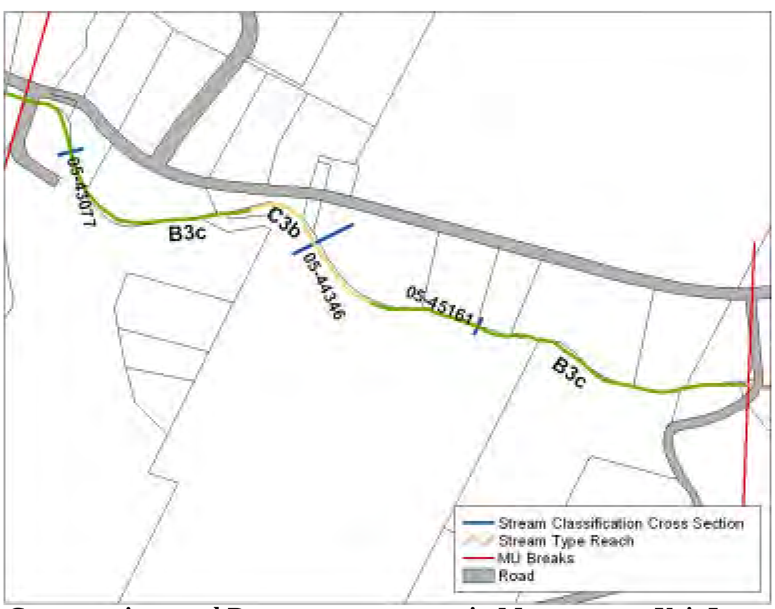
The following description of stream morphology references insets in the foldout Figure 4.5.2. “Left” and “right” references are oriented looking downstream. Stationing referencesproceed upstream, in feet, from an origin (Station 0) at the confluence with the Schoharie Creek at Lexington. Italicized terms are defined in the glossary. This characterization is the result of surveys conducted in 2004 and 2005.



The unusually high percentage of revetted streambank in MU5 is indicative of disequilibrium between the West Kill's channel and valley forms. In the upper half of MU5, the West Kill is bounded on the south by valley and terrace walls. Erosion of these hill slopes is producing significant sediment supply. There are numerous relic habitat structures in the unit, which may have promoted lateral instability. The downstream reaches are constricted by two bridges and constrained by the County Route 6 road embankment, leading to alternating reaches of aggradation and incision.

Excerpt of 1980 USGS topographic

Stream morphology, or shape (i.e., slope, width and depth) changes several times in this unit, creating small reaches with differing morphologic characteristics, which are classified as different *stream types* (See Section 3.2 for description of stream types)



Cross-sections and Rosgen stream types in Management Unit 5

Management Unit #5 begins with a 1665 ft. reach of B3c stream type. The channel is moderately *entrenched*, or confined within the stream banks during high flood events. The channel slope is a very flat 0.92 % and the bed material is dominated by cobble.

Habitat Structure

Downstream of the Ad Van Rd. Bridge, the start of this Management Unit, a log habitat structure is found (Station 46300). Habitat structures were historically installed throughout the West Kill mainstem by the New York State Department of Environmental Conservation (NYSDEC), often to create scour pools. These scour pools offer deeper holding habitat, sometimes with associated cover, and the spillways raise the level of dissolved oxygen in the water. The structures, often in the form of a log weir perpendicular to the channel, also provided grade control. Because they provide only minimal lateral control, however, higher flows frequently flank these structures. In some settings, this can promote lateral channel migration, increase width-to-depth ratios and result in bank erosion up- or downstream. In wild streams, these functions – both positive and negative – are performed to a large extent by large woody debris. The structure is in good condition, with mild aggradation upstream of the structure, and a deep scour-pool downstream. The channel constricting wings are in good condition with evidence of minor scour of the left bank. The structure has a ramp on the invert sill to promote sediment transport and to prevent the bed from collapsing into the scour hole downstream and abandoning the grade control component of the structure, as has been seen on other similar structures. The structure has been maintained by NYSDEC within the past 7 years.

Rip Rap, right

Immediately downstream of the habitat structure, a 244 ft. long installation of rip-rap begins on the right bank (Inset D, Fig. 4.5.2). The riparian buffer beyond the rip rap installation is in poor condition, with mown grass to the edge of the bank. The risk to bank stability can be minimized by maintaining mature trees along the stream margin, including a critical buffer zone extending approximately 75 ft. from the centerline of the stream (Fig. 4.5.4). The risks and benefits associated with management of streamside vegetation will depend partly on the current channel conditions, and local channel surveys are recommended at each site. Recommendations for this area include interplanting of the rip rap, and enhancement of the riparian buffer with planting of ecologically appropriate tree and shrub species in the adjacent mown field.


Habitat structure, right, looking upstream


Left

Near the mid-point of the rip rap installation, another habitat structure (Station 46150) is found. Aggradation at the structure has buried the right channel constricting wing, while the left wing appears to have been damaged be high flows. The grade control sill is intact, but may promote erosion at the right as aggradation continues.


Debris jam


Large slope failure

A debris jam, pictured above, is located at the downstream end of the rip rap installation. A large maple tree, fallen from the right bank, appears to have been jacked up and supported by a log. The log appears to have been placed to reduce the obstruction at low flow, but still presents an obstruction at the right bank, which increases with stage.

The debris jam marks the upstream extent of a 167 ft. long, 58' high, slope failure on the left bank. This bank was significant enough to warrant detailed investigation as a Bank Erosion Monitoring Site (BEMS #05-45915). In a prioritization of twenty-one BEMS sites throughout the West Kill watershed (see Section 3.3, Watershed Inventory and Assessment), this site ranked Low Priority. The *thalweg*, or deepest part of the stream channel flows up against the glacial terrace here (Inset H, Fig. 4.5.2). The hillslope is being undermined by toe erosion, leaving sections of the stream bank unvegetated. The exposed *glacial till* deposits have a high silt and clay content, contributing sediment through both *wet and dry ravel* and yielding a significant suspended sediment load during high flows. Clay inputs into a stream are a serious water quality concern because they increase *turbidity*, degrade fish habitat, and can act as a carrier for other pollutants and pathogens.

Debris jam, left

Tributary, Spring on large slope failure

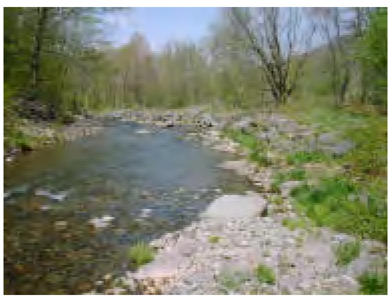
At the base of the hillslope failure, stream borne debris has collected on trees slumped from upslope, presenting an obstruction through all flows. A small unnamed tributary flows over this hillslope from the flat above, creating a debris cone and undermining the stability of the bank (Inset H, Fig. 4.5.2). A storage shed, serving a residence approximately 200 ft. back from the edge of the failure, is potentially threatened by the erosion. Groundwater is piping through the hillslope, further destabilizing the site. Without intervention, the tributary is likely to headcut at the edge of the bank, resulting in gullying. Recommendations for this site include addressing the tributary flow, either through redirection or outfall protection, and further assessment of the mechanism of failure. Full restoration at this site would likely involve establishment of a well-vegetated bench on the left, possibly with rock vanes to direct stream flows away from the bank, and revegetation of the bank face. In-depth survey and design would be required to plan a stream restoration project at this site.

Remnants of log habitat sill, right

Opposite the eroding bank remnants of a habitat structure (Station 45910) were documented on the right. The structure is in very poor condition, with minimal evidence of a sill remaining, and the left portion missing entirely. It is likely that, when it functioned as grade control, this structure encouraged lateral migration of the channel to the left. In its current condition, it increases near bank shear stress, adding to the instability problems. The stream has good access to the floodplain here, and the site is a public fishing access point.

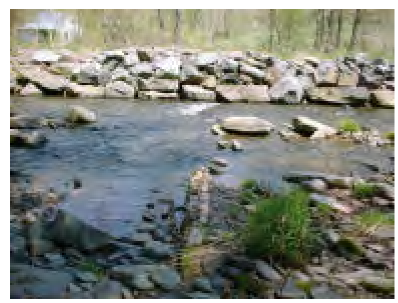
Erosion, left

As the glacial till terrace forces the channel to the right, further bank erosion, 111 ft. long, by 35 ft. high, was documented (Inset C, Fig. 4.5.2). Although it is contributing excessive sediment load to the stream, this slip is showing signs of self recovery, and was not monumented.



Rip rap, right

Continuing downstream, entrenchment increases again, and a 276 ft. installation of placed rip-rap protects the right bank. The installation is in good condition. Along this rip-rap, another relic habitat structure was documented. No channel-constricting wings were evident, and the sill was somewhat compromised. Downstream of the rip rap, a monumented cross-section (Station 45161) documents this 1665 ft. reach of B3c stream type. The slope decreases to 0.9%, but the entrenchment increases.



Habitat log sill, no wings at either bank

Clay exposure

Up- and downstream, numerous exposures of lacustrine clay were observed in the streambed (Inset G, Fig. 4.5.2). Clay inputs into a stream are a serious water quality concern because they increase *turbidity*, degrade fish habitat, and can act as a carrier for other pollutants and pathogens.

A small unnamed tributary enters, right, over a bench vegetated with sedges. The confluence is well-connected.

Tributary, right


Habitat structure


Tributary, right

Another habitat structure, observed at Station 44950, remains in fair condition with the log sill intact, but with its wing ramps mostly gone. Just downstream of the habitat structure, another small unnamed tributary enters from a well-connected, vegetated floodplain on the right.


Habitat log sill, breached on right


Stacked rock wall, right

Remnants of another habitat structure (Station 44850) are evident on the left bank. Downstream of the habitat structure, a 62 ft. length of stacked rock wall protects the right bank, and perhaps blocks a relic channel. This wall appears old, with mature trees growing through it. Some undercutting of the left bank has produced a small obstruction of woody debris.


Tributary, left

Another small, unnamed tributary enters from the left, over a low terrace. Beyond this terrace, the tributary flows over a steep sideslope, with evidence of headcutting and gullying. The tributary appears to be contributing a significant amount of silt and turbidity, and the streambed is somewhat embedded downstream of the confluence. Investigation of the source of this sediment is recommended.

As the channel bends to the right, the streamtype changes to a 700 ft. reach of C3b, with slope increasing to 2.4%, but entrenchment dropping as the channel regains connectivity with its floodplain on both sides of the channel. Riparian buffer is healthy on the right, but declines on the left, with a mown field beyond a narrow line of trees.

As the quality of the riparian buffer on the left declines, the bank becomes undercut for 124 ft., leaving large, overhanging trees that may become a debris problem. Multiple relic threads act as overflow channels on the floodplain, right, as evident from sandy deposits throughout this well-forested floodplain. Excessive access to the floodplain on the right, exacerbated by the downstream channel geometry and rip-rap, may be contributing to aggradational conditions in this reach. Recommendations include improvement of the riparian buffer on the left.

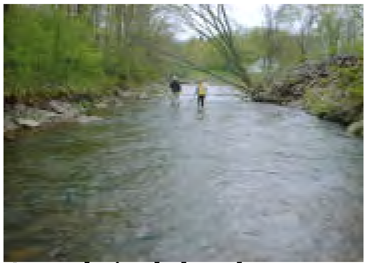

Erosion, left


Rip rap, CR6 road embankment

As the channel comes back against County Route 6, it makes a hard left bend against a 178 ft. installation of dumped rip-rap. The rip-rap is in good condition, but there is no buffer between the stream and the roadway. Recommendations for this area include interplanting of the rip rap.

Approaching the bridge at Janet Place, the channel becomes increasingly entrenched, and streamtype changes back to a 1257 ft. reach of B3c streamtype to the end of the management unit (Inset F, Fig. 4.5.2). Willows are beginning to establish at the toe of both right and left banks upstream of the bridge, and a low bench is developing on the right. Although there is only minimal abutment protection, there is only minimal scour evident at the footings of the abutments.


Approach to bridge at Janet Place, looking upstream


Aggradation below the Janet Place bridge

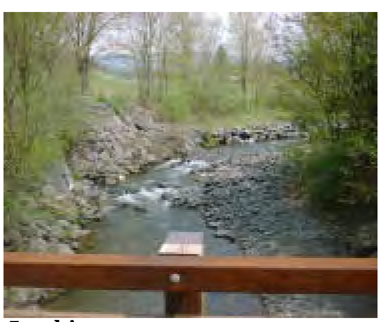
Continuing below the bridge, the streambed shows evidence of aggradation and channel grading. A stacked rock wall on the right, at the top of the bank. This has minimal impact at most flows due to some connectivity with the floodplain on the left. The riparian buffer is poor on the right bank, but better on the left. Near the tail of the aggradation, several trees are undercut on the right bank, and are likely to become dislodged if not addressed.


Stacked rock wall on right


Rip rap, right looking upstream

As the channel bends to the right, the riparian buffer on the left transitions to mown lawn around a residence (Inset E, Fig. 4.5.2). The channel appears to be aggrading, with a transverse bar directing flow toward the left bank over a small headcut. A small unnamed tributary enters on the right. The left bank is protected with 336 ft. of stacked rip-rap. A streamward bulge in the rip-rap near the home interrupts what would otherwise be a continuous bankfull bench, and is causing development of a bar on the outside of this meander upstream. This bar is vegetating with willows. Recommendations for this reach include removal of the bulge in the rip-rap to improve sediment transport continuity through the reach. Further investigation is also recommended to determine appropriate channel widths, depths, slope and entrenchment. Vegetative recommendations include interplanting of the rip rap, and enhancement of the riparian buffer with planting of ecologically appropriate tree and shrub species in the adjacent mown field.

At the downstream end of the rip-rap, a monumented cross-section (Station 43077) documents 1257 ft. of B3c stream type. The slope decreases to 1.6%, and the bed remains dominated by cobble. On the right, a low bench is protected by stacked rock rip-rap (Inset B, Fig. 4.5.2). At the head of the rip-rap, a small unnamed tributary enters from the right, draining a horse pasture along County Route 6 and a barnyard across the road. Nutrient loading from this tributary should be investigated.


Looking upstream

The channel bends back to the left as it approaches the Baker Road bridge, and Herdman Brook (0.8 mi^2), a major tributary, enters through a 60" culvert on the right. Both the culvert and its headwall and outfall protection appear somewhat compromised.


Herdman Brook confluence

Bridge at Baker Road

The Baker Road bridge (Inset A, Fig. 4.5.2) has protection at both abutments, the abutments are new and in good condition, but there is evidence of significant historic and ongoing scour and channel incision. The Herdman Brook culvert is perched high above the invert of the West Kill, and photography from 2000 shows cracked abutments that may have been compromised by abutment scour. Flows above bankfull appear to backwater at the bridge, exacerbating the upstream aggradation. An undersized bridge opening causes water to back up upstream of the bridge, reducing stream velocity, which results in sediment deposition. Additional *floodplain drainage*, using culverts set at the floodplain elevation under the south bridge approach, may help mitigate this problem.

Sediment Transport

Streams move sediment as well as water. Channel and floodplain conditions determine whether the reach aggrades, degrades, or remains in balance over time. If more sediment enters than leaves, the reach aggrades. If more leaves than enters, the stream degrades (See Section 3.1 for more details on Stream Processes).

Upstream reaches are producing excess sediment supply due to hillslope erosion, exacerbated in part by mismanaged drainage and historical grade control. More entrenched conditions in the downstream reaches of this management unit and excess sediment supply from upstream have resulted in reaches that are, alternately, under-effective and over-effective. Installation of flood plain drainage under bridge approaches would likely reduce the backwater conditions and improve sediment transport continuity.

<u>Riparian Vegetation</u>

One of the most cost-effective methods for landowners to protect streamside property is to maintain or replant a healthy buffer of trees and shrubs along the bank, especially within the first 30 to 50 ft. of the stream. A dense mat of roots under trees and shrubs bind the soil together, and makes it much less susceptible to erosion under flood flows. Mowed lawn does not provide adequate erosion protection on stream banks because it typically has a very shallow rooting system. Interplanting with native trees and shrubs can significantly increase the working life of existing rock rip-rap placed on streambanks for erosion protection. *Riparian*, or streamside, forest can buffer and filter contaminants coming from upland sources or overbank flows. Riparian plantings can include a great variety of flowering trees and shrubs, native to the Catskills, which are adapted to our regional climate and soil conditions and typically require less maintenance following planting and establishment.

Some plant species that are not native can create difficulties for stream management, particularly if they are invasive. Japanese knotweed (*Fallopia japonica*), for example, has become a widespread problem in recent years. Knotweed shades out other species with it's dense canopy structure (many large, overlapping leaves), but stands are sparse at ground level, with much bare space between narrow stems, and without adequate root structure to hold the soil of streambanks. The result can include rapid streambank erosion and increased surface runoff impacts.

An analysis of vegetation was conducted using aerial photography from 2005 and field inventories (Fig. 4.5.3). Japanese knotweed occurrences were documented as part of the stream feature inventory conducted during the summer of 2004, with additional occurrences identified in 2005.

In this management unit, the predominant vegetation type within the 300 ft. riparian buffer is Herbaceous (46 %) followed by Forest (40 %). *Impervious* area (5 %) within this unit's buffer is primarily the Greene County Route 6, along with private residences and associated roads. No occurrences of Japanese knotweed were documented in this management unit during the 2004 or 2005 inventory. However, Japanese knotweed does occur downstream, and a program for eradication of Japanese knotweed throughout the West Kill valley is recommended.

National Wetland Inventory wetlands in MU5

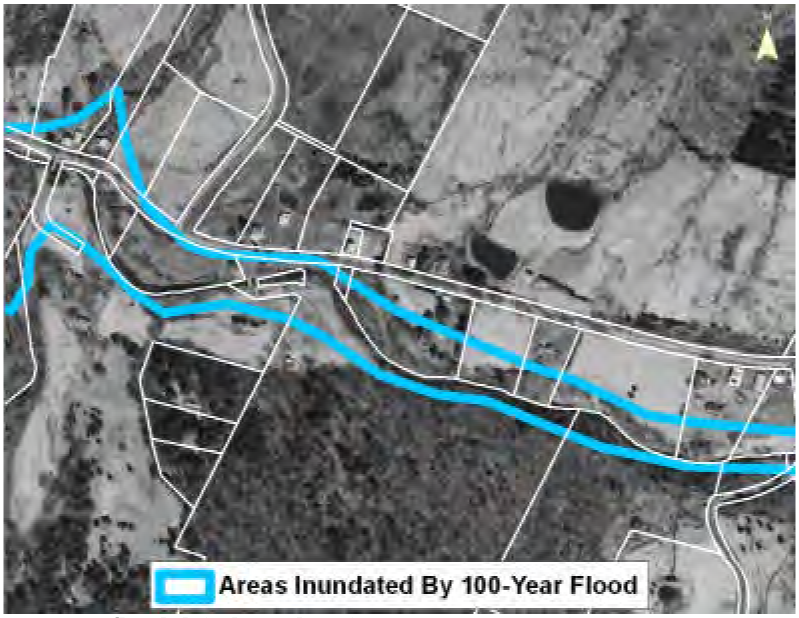
There are 4 wetlands within this management unit mapped in the National Wetland Inventory (see Section 2.5, Wetlands and Floodplains for more information on the National Wetland Inventory and wetlands in the West Kill watershed). Wetlands are important features in the landscape that provide numerous beneficial functions including protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods (See Section 2.6 for wetland type descriptions and regulations). The most upstream wetland, which is 0.5 acres in size, is classified as *palustrine, unconsolidated bottom, permanently flooded, diked/impounded* (PUBHh). Moving downstream, the next wetland is 0.8 acres in size, and is designated *palustrine, forested, broadleaf deciduous, temporarily flooded,* (PFO1A). The smallest of the wetlands in this unit is 0.2 acres, and is designated *palustrine, unconsolidated bottom, permanently flooded, diked/impounded* (PUBHh). The downstream-most wetland is 1.0 acres, designated *palustrine, scrub- shrub, broad-leaved deciduous, temporarily flooded* (PSS1A).

Areas of herbaceous (non-woody) cover present opportunities to improve the riparian buffer with tree plantings, to promote a more mature vegetation community along the streambank and in the floodplain. In November 2005, suitable riparian improvement planting sites were identified through a watershed-wide remote evaluation of current riparian buffer conditions and existing stream channel morphology. These locations indicate where plantings of trees and shrubs on and near stream banks can help reduce the threat of serious bank erosion, and can help improve aquatic habitat as well. In some cases, eligible locations include stream banks where rock rip-rap has already been placed, but where additional plantings could significantly improve long-term stream channel stability, as well as biological integrity of the stream and floodplain. Areas with serious erosion problems where the stream channel requires extensive reconstruction to restore long-term stability have been eliminated from this effort. In many cases, these sites can not be effectively treated with riparian enhancement alone, and full restoration efforts would include channel restoration components in addition to vegetative treatments.

Thirty-six potential planting sites were documented within this management unit (Fig. 4.5.4).

Recommendations for this site include planting native trees and shrubs along the edge of the stream bank and the upland area. Buffer width should be increased by the greatest amount agreeable to the landowners, but increasing the buffer width by at least 35 feet will increase the buffer functionality and improve stream bank stability while still allowing a significant lawn area.

<u>Flood Threats</u>



100-year floodplain boundary in Management Unit 5

Inundation

As part of its National Flood Insurance Program (NFIP), the Federal Emergency Management Agency (FEMA) performs hydrologic and hydraulic studies to produce

Flood Insurance Rate Maps (FIRM), which identify areas prone to flooding. The NYS DEC Bureau of Flood Protection is currently developing new floodplain maps for the West Kill on the basis of recent surveys. These maps should be completed for the West Kill watershed in 2006.

According to this existing floodplain maps, there are 3 houses located within the 100-year floodplain boundary in this management. The 100-year floodplain is that area predicted to be inundated by floods of a magnitude that is expected to occur once in any 100 year period, on the basis of a statistical analysis of the local flood record. Most communities regulate the type of development that can occur in areas subject to these flood risks. The current NFIP maps are available for review at the Greene County Soil & Water Conservation District office.

Bank Erosion

Most of the stream banks within the management unit are considered stable, but 11% (402 ft.) of the stream length is experiencing major erosion, and their average height exceeds 32 feet. The notably high percentage of stream length that has been revetted indicates a history of instability.

There is one Bank Erosion Monitoring site in MU5 (BEMS 05-45915), a relatively large failure contributing significant amounts of fine soil and clay, as well as mature trees, to the creek. This failure could constitute a flood hazard for downstream reaches due to the potential for uprooted trees to be introduced into the stream from the eroding stream bank during large floods. These trees could create debris jams at either of the two bridges downstream, or at mid-channel bars, and may shift the flow pattern of the stream, threatening roads and residential properties.

Infrastructure

Thirty-nine percent of the stream length in this management unit has been treated with some form of revetment. However, there are no immediate threats to roadways in this management unit.

Aquatic Habitat

It is recommended that a habitat study be conducted on the West Kill Creek, with particular attention paid to possible temperature barriers in aggrading sections, to the frequency of disturbance of the bed due to incision at numerous points in the system, and to embeddedness resulting from excessive entrainment of fine sediment.

Habitat was fairly good throughout this management unit, with abundant woody debris, and only one possible temperature barrier. However several reaches appear somewhat impaired, with inadequate canopy cover, low diversity of bedform and introduction of fine sediment from eroding banks.

Water Quality

Clay exposures and sediment from stream bank and channel erosion pose a potential threat to water quality in West Kill Creek. Clay and sediment inputs into a stream may increase *turbidity* and act as a carrier for other pollutants and pathogens. There were four significant clay exposures identified in the 2004 Inventory, and one additional exposure identified in 2005, primarily in reaches with poorer floodplain connectivity. Additional study is recommended to determine if unit-wide restoration practices could isolate these clay exposures from lower flows.

Stormwater runoff can also have a considerable impact on water quality. When it rains, water falls on roadways and flows untreated directly into West Kill Creek. The cumulative impact of oil, grease, sediment, salt, litter and other unseen pollutants found in road runoff can significantly degrade water quality. There is one stormwater culvert in this management unit, draining livestock enclosures in addition to roadside ditches. Additional study is recommended to determine if this drainage is contributing excessive nutrient loads to the West Kill.

Nutrient loading from failing septic systems is another potential source of water pollution. Leaking septic systems can contaminate water making it unhealthy for swimming or wading. There are numerous houses located in close proximity to the stream channel in this management unit. These homeowners should inspect their septic systems annually to make sure they are functioning properly. Each household should be on a regular septic service schedule to prevent over-accumulation of solids in their system. Servicing frequency varies per household and is determined by the following factors: household size, tank size, and presence of a garbage disposal. Pumping the septic system out every three to five years is recommended for a three-bedroom house with a 1,000-gallon tank; smaller tanks should be pumped more often.

The New York City Watershed Memorandum of Agreement (MOA) allocated 13.6 million dollars for residential septic system repair and replacement in the West-of-Hudson Watershed through 2002. Eligible systems included those that were less than 1,000-gallon capacity serving one- or two-family residences, or home and business combinations. No homeowners in this management unit made use of this program to replace or repair a septic system.

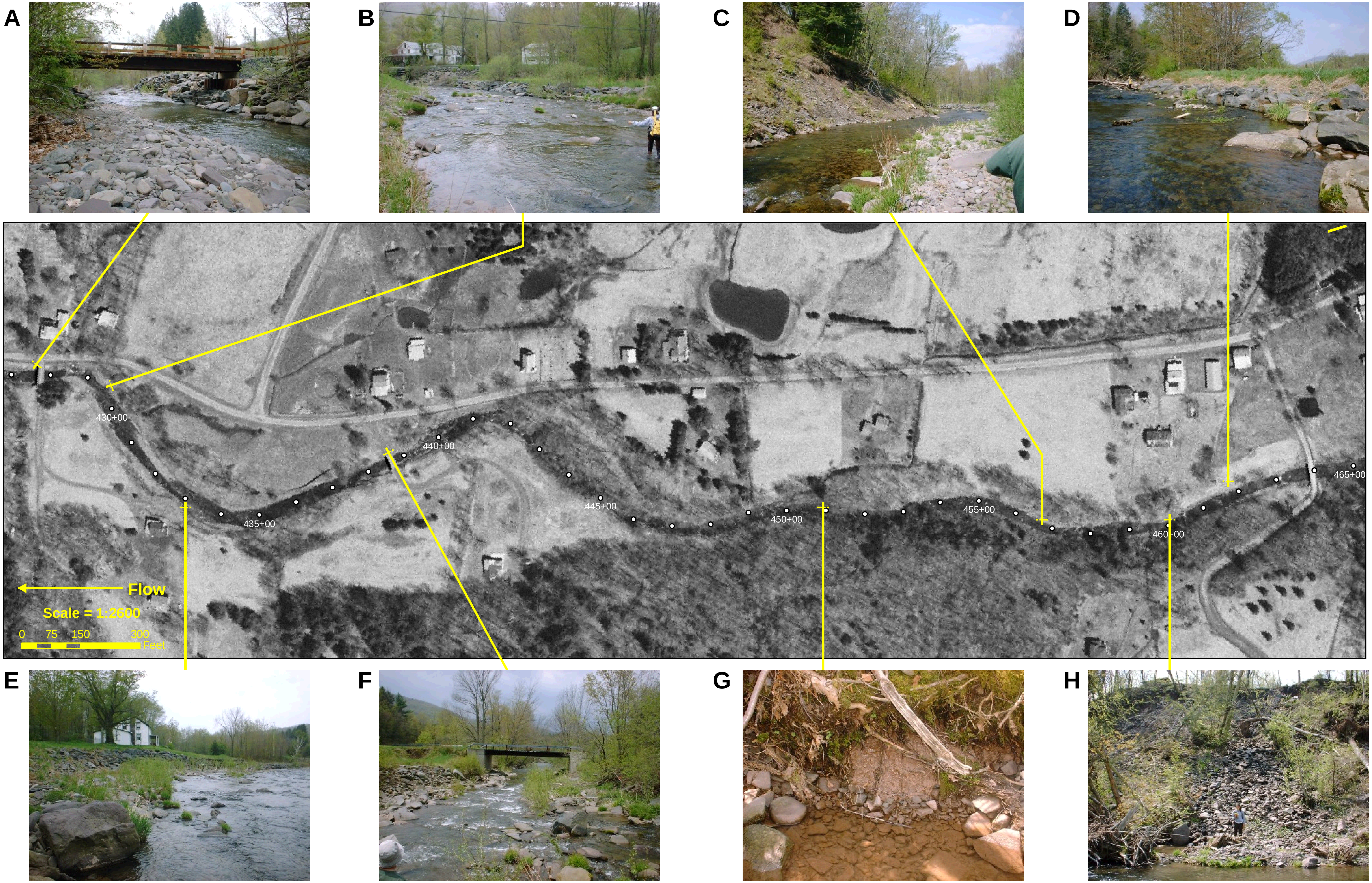


Figure 4.5.2 Management Unit 5 - 2004 aerial photography