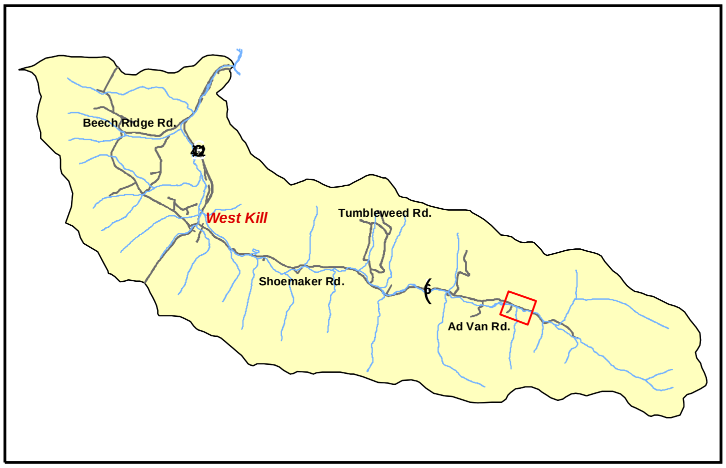


West Kill Management Unit 3

Stream Feature Statistics

19% of stream length is experiencing erosion
20% of stream length has been stabilized
12.4 acres of inadequate vegetation within the 300 ft. buffer
763 ft. of stream is within 50 ft. of the road
0 houses located within the 100-year floodplain boundary

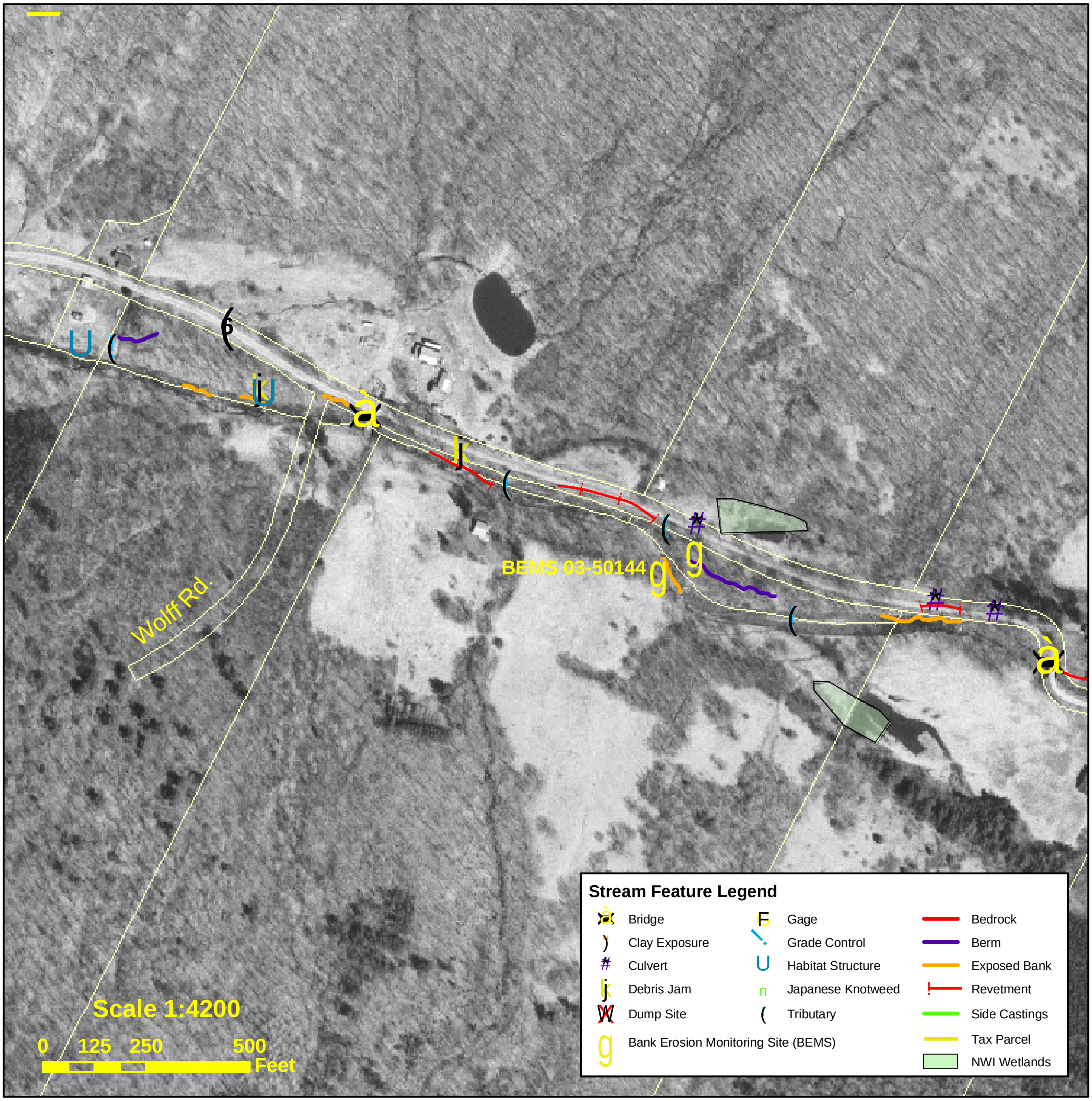


Figure 4.3.1 2004 aerial photography with stream feature inventory and tax parcels

Management Unit 3

Between 51153 and 48476

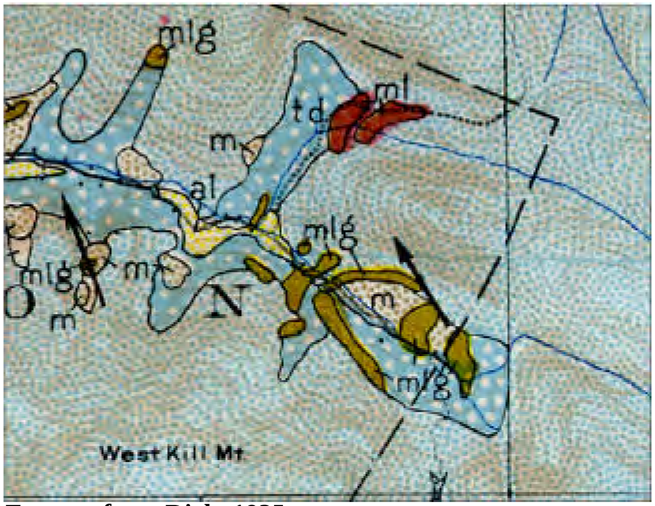
Management Unit Description

This management unit begins at the Spruceton Road bridge crossing (Station 51153), continuing approximately 2677 ft. to just downstream of the relic DEC habitat structure at Station 48600. The drainage area ranges from 5.49 mi^2 at the top of the management unit to 6.6 mi^2 at the bottom of the unit. The valley slope is 2.19%.

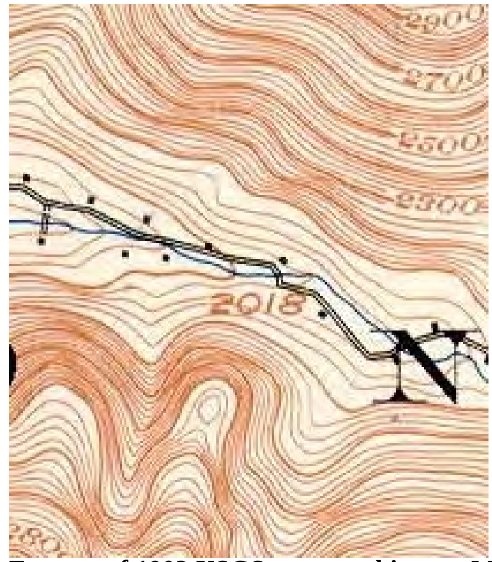
Summary of Recommendations Management Unit 3	
Intervention Level	Predominantly Passive Restoration; one potential Assisted Self-Recovery site.
Stream Morphology	Berm evaluation.
Riparian Vegetation	Evaluate identified sites for potential improvement in riparian vegetation.
Infrastructure	Interplanting of revetment.
Aquatic Habitat	Watershed study.
Flood Related Threats	None
Water Quality	Investigate source of nutrient enrichment at small tributary.
Further Assessment	Additional classification cross-section (~ Station 49175).

Historic Conditions

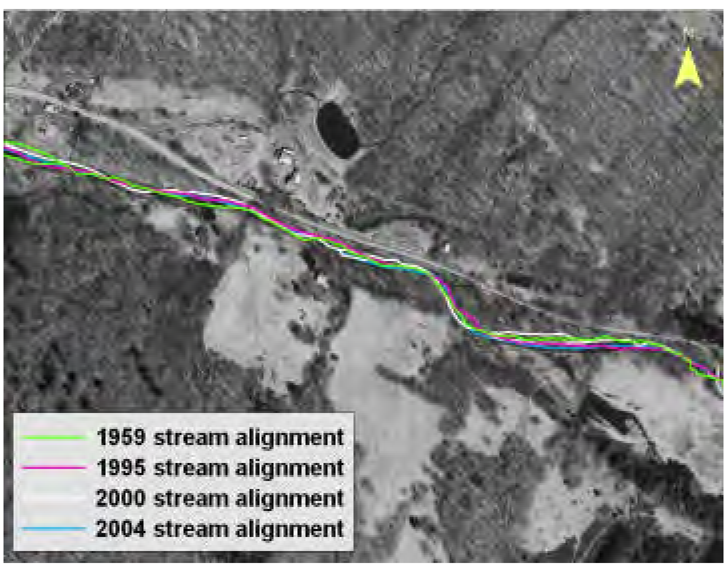
As the glaciers retreated about 12,000 years ago, they left their "tracks" in the Catskills. See Section 2.4 Geology of the West Kill Creek, for a description of these deposits.



Excerpt from Rich, 1935



Excerpt of 1903 USGS topographic map MU3



Historic Stream Channel Alginments in MU3

As seen from the historical stream alignments, the channel alignment has not changed significantly over the years.

According to available NYS DEC records there have been no stream disturbance permits issued for work in this management unit.

Stream Channel and Floodplain Current Conditions

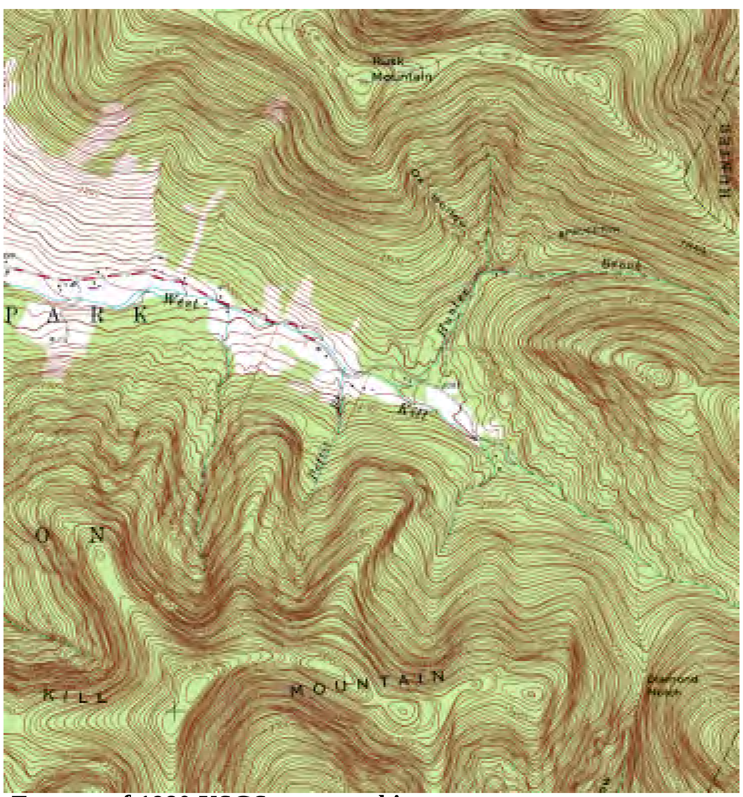
Revetment, Berms and Erosion

The 2004 stream feature inventory revealed that 19% (512 ft.) of the stream exhibited signs of active erosion along 2677 ft. of total channel length (Fig. 4.3.1). Revetment has been installed on 20% (525 ft.) of total stream length. Two berms were identified in this management unit at the time of the stream feature inventory.

Stream Morphology

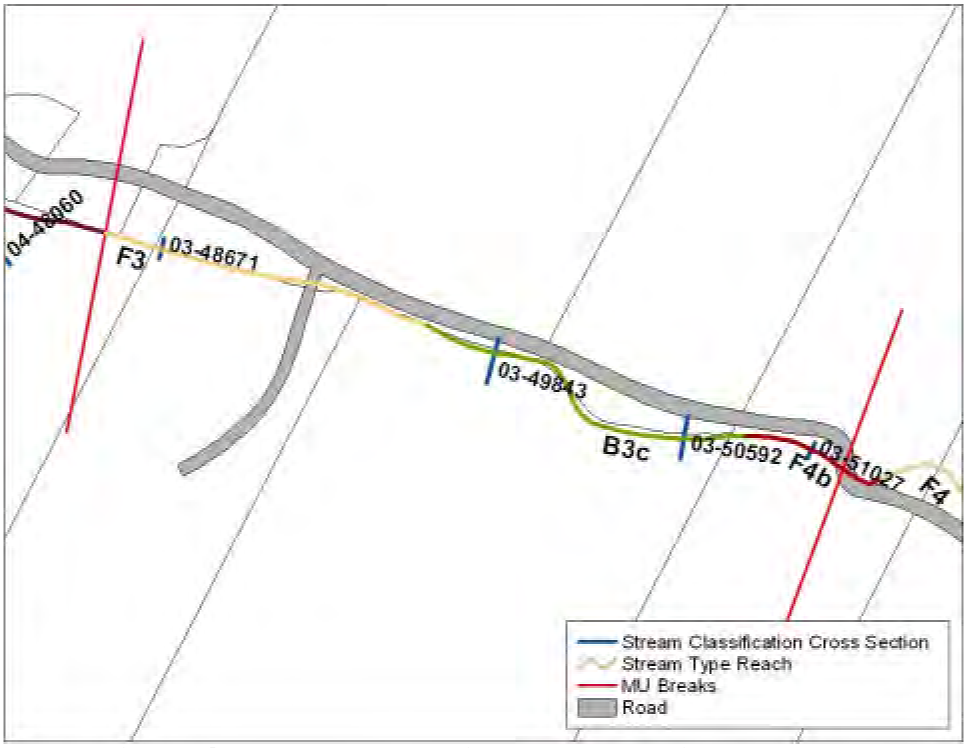
The following description of stream morphology references insets in the foldout Figure 4.3.2. "Left" and "right" references are oriented looking downstream. Stationing references, however, proceed upstream, in feet, from an origin (Station 0) at the confluence with the Schoharie Creek at Lexington. Italicized terms are defined in the glossary. This characterization is the result of surveys conducted in 2004 and 2005.

In Management Unit 3, the channel morphology of the West Kill is significantly impacted by the encroachment of Spruceton Road. In several locations, the stream has abandoned its former floodplain through incision, likely the result of historic berming, armoring and channelization. The low sinuosity and beltwidth is uncharacteristic of this valley slope, and provides minimal opportunity for sediment storage and dissipation of stream power at high flows.



Excerpt of 1980 USGS topographic map

Stream morphology, or shape (i.e., slope, width and depth) changes several times in this unit (Fig. 5), 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 3

Looking downstream from top of MU 3

Management Unit 3 begins with a 353 ft. reach of F4b stream type, entrenched, or confined within the stream banks, with a gravel bed and a slope of 2.33%, as determined from a monumented survey cross-section (Station 51027). This unstable stream type is often the result of historic incision, followed by channel widening as the oversteep streambanks are eroded back through toe scour. F4 stream types exhibit extreme sensitivity to disturbance, poor recovery potential, very high streambank erosion potential and typically produce a very high sediment supply. All of these characteristics are exacerbated by the steep (b-category) stream slope documented at this reach.

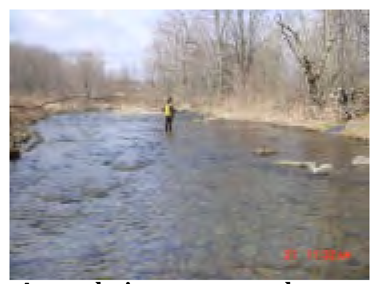
Sidecast materials form a bench at the base of both banks, evidence of previous maintenance activity intended to control aggradation.

Rip-rap, dumped and stacked at road embankment

Bank Erosion - some debris introduction, scoured toe and over-hanging vegetation, headcut near up stream end of erosion

These processes are evident in the head-cut, rip rap and minor bank erosion documented just downstream of the monumented cross-section. Large rocks appear to have stabilized the head cut, but several types and ages of rip-rap indicate repeated treatment of embankment failure. This armoring has directed erosive forces to the opposite bank, resulting in bank erosion (Inset H, Fig. 4.3.2). Undercutting of the adjacent flood terrace has led to overhanging and leaning trees, and introduction of sediment. Two culverts drain a local residence and driveway from the right (both 18" dia.). Both are stabilized with rock outfall protection, although one of them is perched.

Continuing downstream, *aggradation* has raised the base elevation of the channel, reconnecting it with its floodplain and moderating the entrenchment. Two monumented cross-sections (Stations 50592, 49843) document 1200 ft. of B3c stream type. The slope decreases to 1.8%, and the bed becomes dominated by cobble.



Aggradation - near road embankment, could threaten road in the future

Tributary, and series of beaver ponds along drainage way

Evidence of beaver activity, observed in an unnamed tributary that enters from the left bank, suggests that this aggradation could be the result of temporary impoundment of the stream.

Berm, right

On the right, side-cast materials form a berm, perhaps intended to protect the road, but which cuts off significant flood plain. Berms such as this, while created with the best of intentions, tend to raise flood elevations and increase the erosive power of the stream. It is recommended that the berms should be evaluated for their influence on floodplain connectivity and stream entrenchment, and that removal should be considered where there is significant deleterious impact.


Erosion

Such erosion is observed just downstream, as the channel bends to the right at a high terrace on the left, and heads into a fairly steep riffle. This erosion has been monumented as a Bank Erosion Monitoring Site (BEMS, Station 03-50144). 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 till terrace here, with substantial boulders—that appear to be placed—providing some toe protection. The unvegetated banks are contributing sediment through both *wet and dry ravel*, and yielding a significant suspended sediment load during high flow events. 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.

As the channel is turned back to the left by the embankment of Spruceton Road, a small unnamed tributary enters from the right through a culvert under the road (see station 050). The tributary flows on a broad flood plain, and there is a 2' head cut at the bottom of the riffle, this marks the beginning of a more entrenched reach downstream. Slope increases modestly.


Culvert, right


Rip-rap, right, several types and ages

Headcuts are a typical response to bank hardening, as erosive power is deflected to the bed of the channel, leading to incision. The rip-rap installation just downstream may be responsible for incision here. The channel is confined by the road on the right and the terrace on the left here, producing a markedly straight section for 800 ft. The rip-rap on the right (252 ft.) is of several types and ages, alternating between side castings at the upstream end, dumped rip-rap in the middle, and stacked stone at the downstream end. This indicates repeated treatment of embankment failure. There is no vegetative buffer here between stream and road.

Tributary, left

Stacked rock wall

An unnamed tributary (0.46 mi^2) enters from the left off the terrace, with a stable connection at the confluence. Beyond a low bench on the left, a stacked rock wall angles toward the stream. As the wall encroaches on the floodplain, entrenchment increases, and stream type changes to F3 for 1124 ft., or the remainder of Management Unit 3.

Debris Jam

Wolff Road Bridge (TH 147)

Downstream of the rip-rap on the right, a low bench emerges at the base of the road embankment, vegetated with willow. A small headcut and scour pool appears to be associated with a fallen tree on the bench near the approach to the Wolff Road (TH147) bridge downstream. While woody debris is valued as a feature of good fish habitat, it can present a threat to infrastructure, potentially obstructing conveyance through bridges. Stream managers, highway departments and homeowners must strike a balance between these competing objectives. Removal of the tree is recommended here to reduce potential threat to the bridge and continued scour of the bench at higher flows.

Downstream of the fallen tree on the right, the vegetative buffer on the bench and road embankment improves. The tree line on the left narrows as the stacked rock wall impinges on the channel. A poured concrete scour wall protects the left abutment of the Wolff Road bridge (Station 49325) (Inset C, Fig. 4.3.2), and may be an indication of previous channel degradation. The right abutment is stacked rock. The bridge appears to pass bankfull flows without significant backwater; higher flows are confined throughout the reach by the generally entrenched conditions.

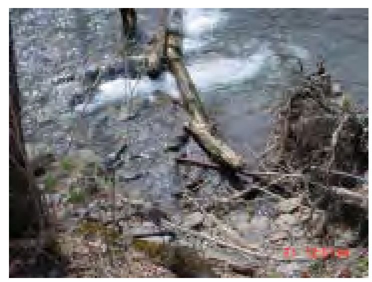
Downstream of the bridge, the right bank is experiencing minor erosion as Spruceton Road diverges from the West Kill (Inset B, Fig. 4.3.2). This erosion site, which may be associated with accelerated flows downstream of the bridge, is a good candidate for remediation using vegetative toe and bank protection. Stream slope is decreasing here, and a stable bench protects the left bank. Vegetative buffer improves on both sides.

Bank Erosion

Small debris jam at habitat structure

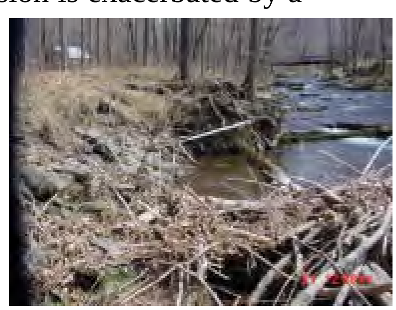
Approximately 250 ft. downstream of the bridge a habitat structure (Station 49060) was installed. Habitat structures were historically installed throughout the West Kill mainstem by the New York State Department of Environmental Conservation (NYSDEC), often to create scour pools. These scour pools offer deeper holding habitat, sometimes with associated cover, and the spillways raise the level of dissolved oxygen in the water. These 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, as is seen here. In wild streams, these functions – both positive and negative -- are performed to a large extent by large woody debris. The structure is being flanked on both channel banks, and while still providing grade control upstream, is beginning to be compromised, with throughflow and underflow near right bank.

Habitat Structure



Bank Erosion, left (Inset F, Fig. 4.3.2)

Minor toe scour erosion associated with this structure is evident on both the left (60 ft.) and right (20 ft.) banks. On the right, the erosion is exacerbated by a collection of large woody debris. As the structure continues to deteriorate, these banks are likely to revegetate and stabilize over time. Downstream, previous erosion of the left bank has left a short lateral bar with abundant



Bank Erosion, right

Bank Erosion, left

boulders and some willows, stabilizing the toe for a short distance, but erosion (73 ft.) again occurs as the bar recedes and the channel narrows.

On the right, a berm of side cast, large cobble material -- set back at upstream end, approaching the channel downstream -- progressively narrows the available floodplain.

Berm

Tributary, right

Moving downstream, Spruceton Road has diverged from the West Kill sufficiently to allow for a residence and horse paddock on the right. A small, unnamed tributary borders the edge of the paddock, well-connected coming off the low floodplain, which appears stable, but highly channelized. There is some evidence at the confluence of nutrient enrichment; possible sources should be investigated.

A monumented cross-section (Station 48671) documents this 1124 ft. reach of F3 stream type. The slope decreases to 1.7%, and the bed is still dominated by cobble. Entrenchment here is already moderating as the high terrace pulls away to the left, and just downstream of this cross-section, the stream regains good connection with its floodplain. As a result, this cross-section classifies the stream only marginally as an "F-type", indicating the transition to a less-confined "C-type" stream. The next monumented cross-section downstream, however, classifies as a "D-type" stream. Therefore, it is recommended that an additional cross-section be established, (˜ Station 49175), to specify these reaches and their transitions, from "F" to "C" to "D".

Another NYSDEC habitat structure (Station 48610) (Inset A, Fig. 4.3.2) just downstream of the monumented cross-section exhibits similar conditions to the one just upstream: the structure is compromised at both ends, causing minor bank scour at both left and right banks. Management Unit 3 ends approximately 134 ft. downstream of this structure.

Habitat structure, left bank scour

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).

Varying entrenchment conditions in this management unit have resulted in moderate channel aggradation and degradation, as the channel bed elevation adjusts to over- or under-effective sediment conveyance, depending on the reach. In some places, this discontinuity of sediment transport appears to be the result of historic channel management: channel dredging and clearing, road embankment hardening, habitat structures, berming and channelization. In other places, it may be the result of beaver activity. These problems do not appear severe however, and *passive restoration*, or letting the stream reestablish its own equilibrium, is recommended for most of the management unit.

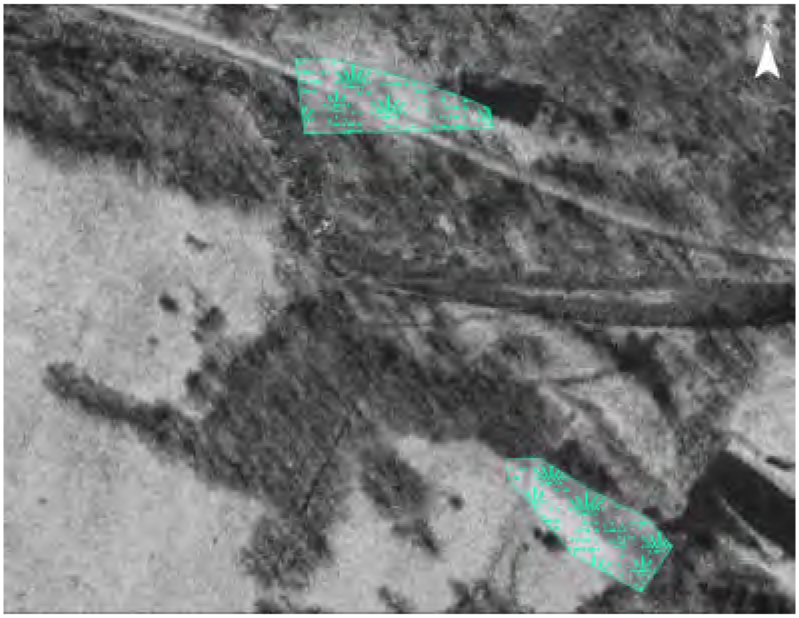
Riparian Vegetation

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. 4.3.3). 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 Forest (48 %) followed by Herbaceous (30 %). *Impervious* area (3 %) within this unit's buffer is primarily 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 MU3

There are 2 wetlands within this management unit (Fig. 4.3.1) 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). Both wetlands are 0.3 acres in size. The one on the north side of Spruceton Road is classified as *palustrine, unconsolidated bottom, permanently- flooded, diked/ impounded* (PUBHh), and the other is designated *palustrine, unconsolidated bottom, permanently- flooded, excavated* (PUBHx).

Areas of herbaceous (non-woody) cover may present opportunities to improve the riparian buffer with tree plantings, to promote a more mature vegetative community along the streambank and in the floodplain. In November 2005, potential riparian improvement planting sites were identified through a watershed-wide remote evaluation of current riparian vegetation conditions. These are sites where plantings of trees and shrubs on and near stream banks would likely reduce the threat of serious bank erosion, and can improve aquatic habitat as well. In some cases, these sites 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.

In many cases, these sites can not be effectively treated with riparian enhancement alone, and full restoration efforts would include bank and/or channel restoration components in addition to vegetative buffer plantings. This analysis identified potential planting sites within a 300 ft buffer; in many locations this will include areas that landowners will want to continue managing as fields or lawns. 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 4.3.4). 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.

Seventeen potential planting sites were documented within this management unit (Fig. 4.3.4).

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.

Flood Threats

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. There are currently no FIRMs for this management unit. 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.

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.

Bank Erosion

Most of the stream banks within the management unit are considered stable, and 19 % (297 ft.) of the stream length is experiencing significant erosion. There are no Bank Erosion Monitoring Sites in this management unit.

Infrastructure

Twenty percent (525 ft.) of the stream length in this management unit have been treated with some form of revetment. However, there are no immediate threats to roadways in this management unit. Those embankments at greatest risk are maintained with revetment.

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, and to the frequency of disturbance of the bed due to aggradation and degradation at numerous points in the system.

Habitat was fairly good throughout this management unit, with some woody debris, and no apparent physical or temperature barriers. However several reaches appear somewhat impaired, with inadequate canopy cover, low diversity of bedform and introduction of fine sediment at one eroding bank.

The continued deterioration of the NYSDEC habitat structures will reduce erosion threats in their vicinity, and is unlikely to meaningfully reduce the quality of the habitat in the unit.

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 are no significant clay exposures that need to be addressed in this management unit.

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 are 3 stormwater culverts in this management unit, and 29% of the stream lies within 50 ft. of a road.

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.

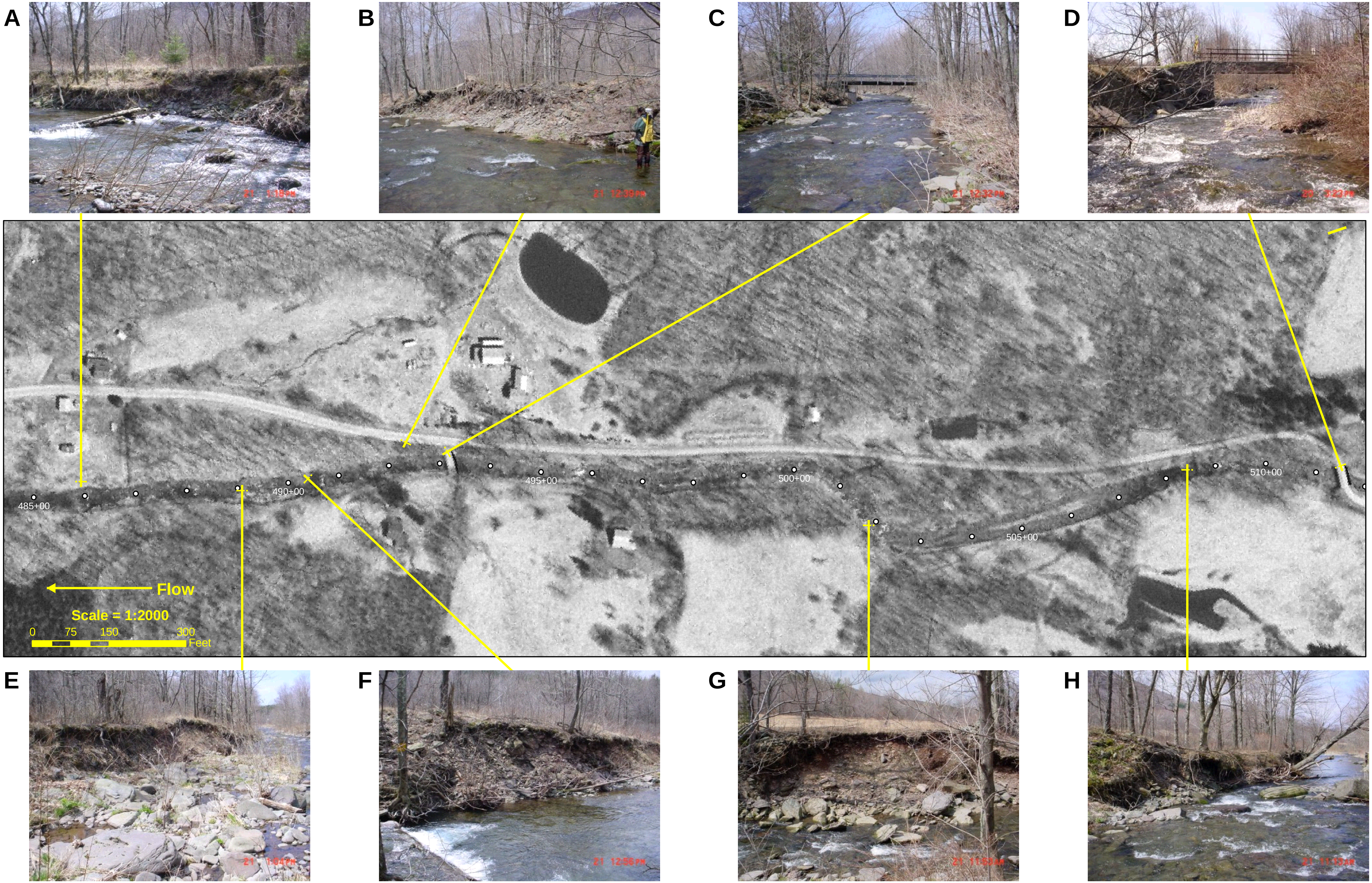


Figure 4.3.2 Management Unit 3 - 2004 aerial photography