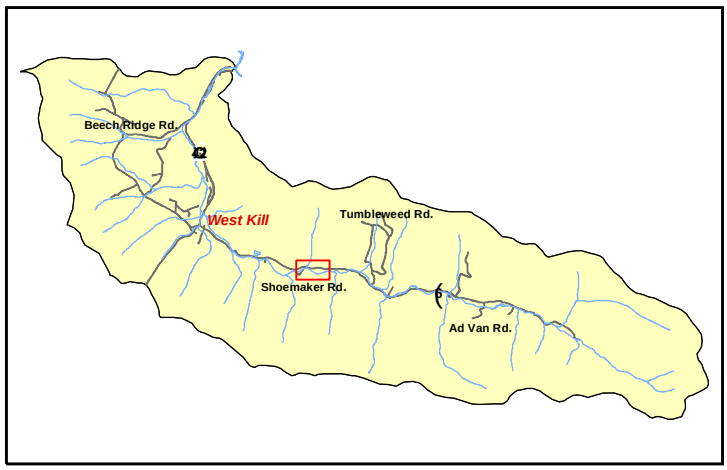


West Kill Management Unit 11

Stream Feature Statistics

13% of stream length is experiencing erosion
3% of stream length has been stabilized
19.6 acres of inadequate vegetation within the 300 ft. buffer
89 ft. of stream is within 50 ft. of the road
7 houses located within the 100-year floodplain boundary

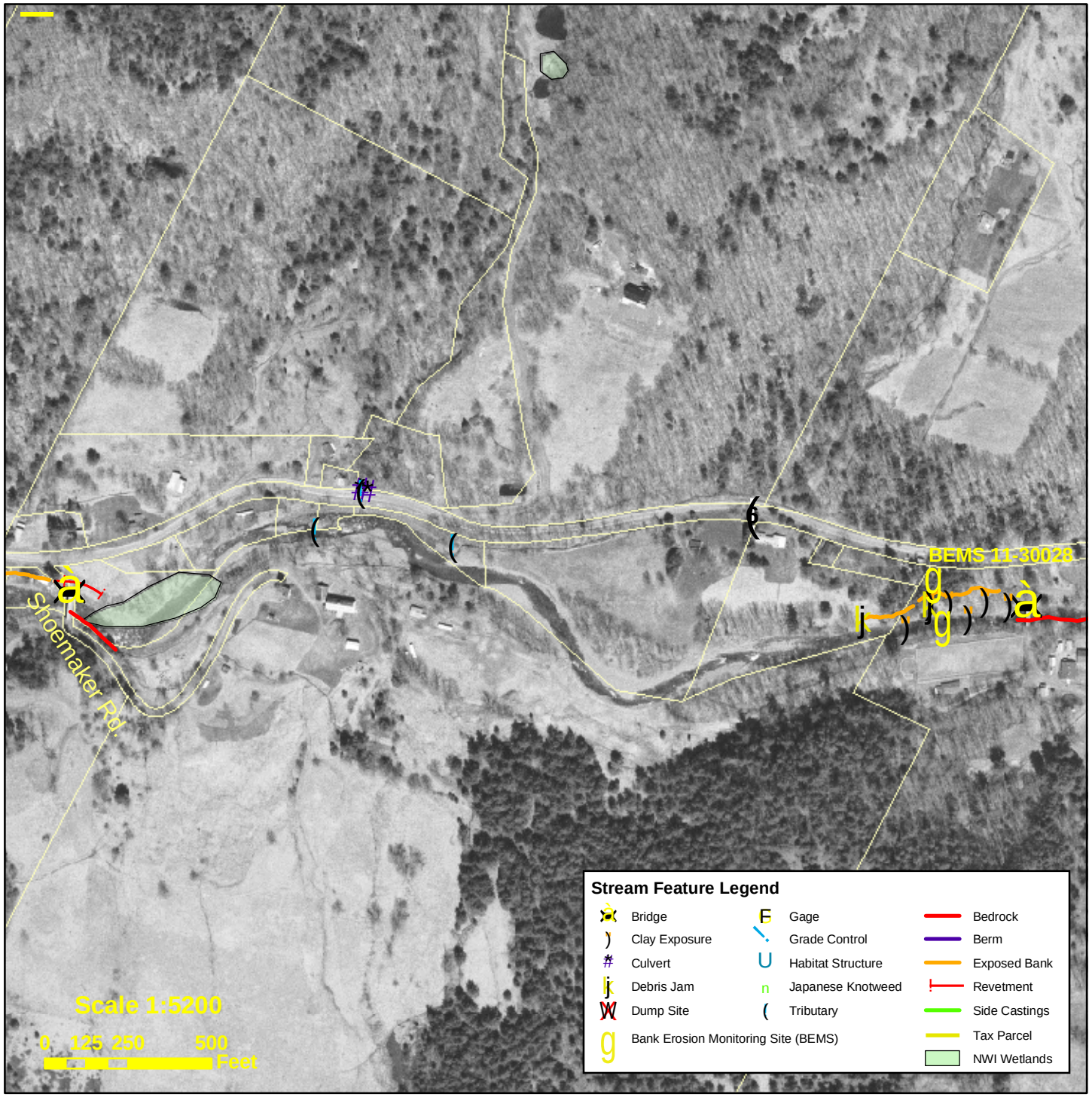


Figure 4.11.1 2004 aerial photography with stream feature inventory and tax parcels

Management Unit 11

Between Station 30263 and Station 26957

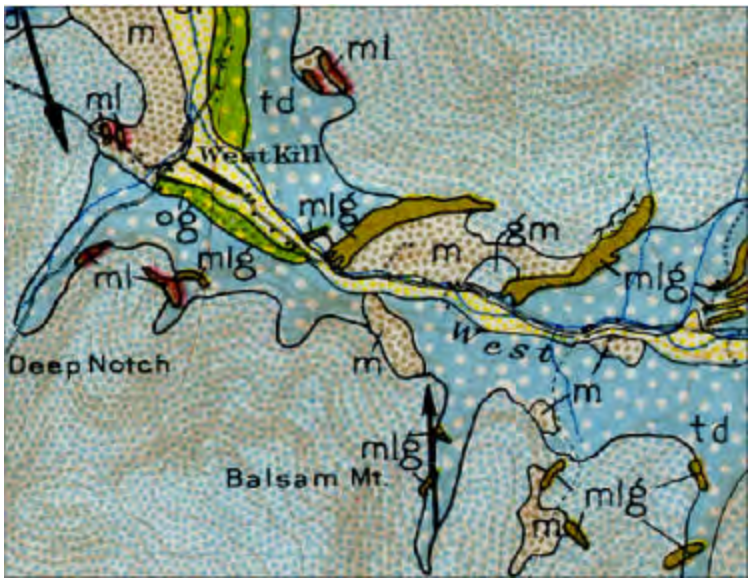
Management Unit Description

This management unit begins at the private bridge crossing that serves RCH Stables, continuing approximately 3306 ft. to the Shoemaker Road Bridge. The drainage area ranges from 15.6 mi^2 at the top of the management unit to 16.9 mi^2 at the bottom of the unit. The valley slope is 1.65%.

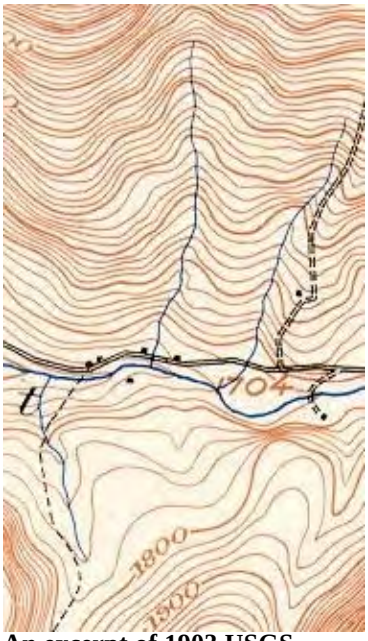
Summary of Recommendations Management Unit 11	
Intervention Level	Full Restoration (See Section 5- Shoemaker Road Demonstration Project).
Stream Morphology	(See Section 5- Shoemaker Road Demonstration Project)
Riparian Vegetation	Riparian plantings on the right terrace near Station 29750.
Infrastructure	Geotechnical assessment and stabilization of mass failure threatening CR6.
Aquatic Habitat	Watershed wide study. Continue monitoring of habitat response.
Flood Related Threats	(See Section 5- Shoemaker Road Demonstration Project)
Water Quality	Isolate sources of fine sediment.
Further Assessment	Geotechnical assessment of bank failure threatening CR6, Investigation of sources of turbidity in tributary (Station 27860).

Historic Conditions

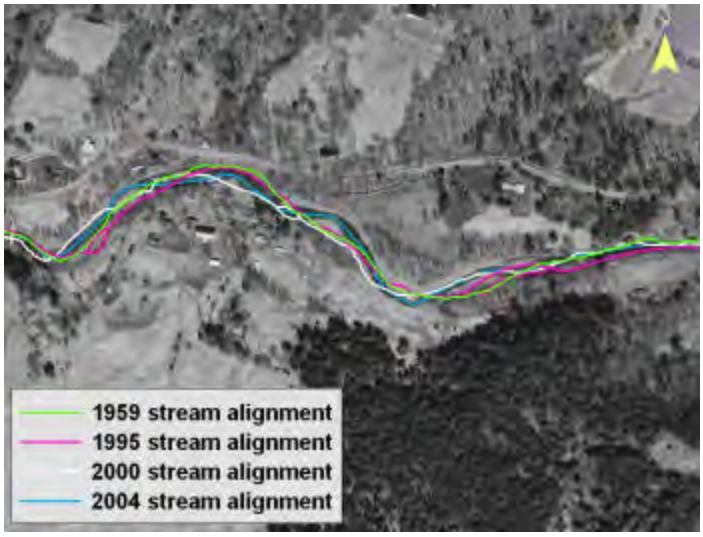
As the glaciers retreated about 12,000 years ago, they left their "tracks" in the Catskills. See Section 2.4 Geology of the West Kill Creek, for a description of these deposits.



Excerpt from Rich, 1935



An excerpt of 1903 USGS Topographic map MU11



Historic Stream Channel Alignments in MU11

As seen from the historical stream alignments, the channel alignment has changed somewhat over the years. Channel alignment changes evident in the 2004 stream alignment are the result of channel modifications made as a component of the West Kill Demonstration Project #1. Changes evident in previous years, however, indicate a history of lateral extension, trending toward increased sinuosity and belt width.

Stream Channel and Floodplain Current Conditions

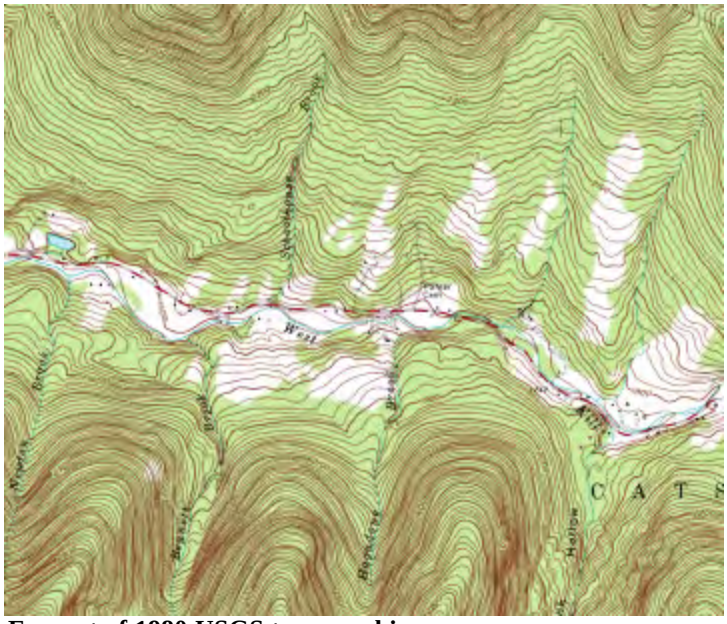
Revetment, Berms and Erosion

The 2004 stream feature inventory revealed that 13% (423 ft.) of the stream exhibited signs of active erosion along 3306 ft. of total channel length (Fig. 4.11.1). Revetment has been installed on 3% (96 ft.) of the stream. This figure, however, does not include a

significant rip-rap installation within the limits of the West Kill Demonstration Project #1. No 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 4.11.2. "Left" and "right" references are oriented looking downstream. Stationing references 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. Italicized terms are defined in the glossary. This characterization is the result of surveys conducted in 2004 and 2005.



Excerpt of 1980 USGS topographic map

Cross-sections and Rosgen s tream types in Management Unit 11

This management unit is bounded by pinch points and bedrock grade controls at the RCH Stable bridge, and the bridge at Shoemaker Road. Though the alluvial terrace to the north broadens, the channel remains confined, with little access to the floodplain. This management unit contains West Kill Stream Restoration Demonstration Project #1.

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, Introduction to Stream Processes, for a description of stream types)

Management Unit #11 is characterized by a 3306 ft. reach of B3c stream type. The channel is moderately *entrenched*, or somewhat confined within the stream

banks during flood events. The channel slope is relatively flat for "B" stream types at 1.7%, indicated by the "c" suffix on the stream type. The bed material here is dominated by cobble.

The bridge at RCH Stables marks the upstream limit of Management Unit #11. The channel invert through the bridge is controlled by bedrock spanning the entire bed from abutment to abutment.

Bridge at RCH Stable

Clay exposure, right

Six significant clay exposures (Inset G, Fig. 4.11.2) were identified during the 2004 walkover in the reach between Station 30250 and Station 29900. The exposed lacusterine clay deposits were discovered on both the left and right banks and in the bed throughout the reach. The *exposed lacustrine* 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.

Clay exposure, right

Bank Failure, right

A deep rotational failure is active on the right bank immediately downstream of the bridge. Lacustrine clay deposits are exposed at the toe along the entire 260 ft. length of the failure. Although Greene County Route 6 lies approximately 150 ft. from the toe of the failure, stress cracks are evident in the pavement, the result of mass wasting of the hillside. This failure poses an immanent threat to the stability of the sole egress from the upper valley. Failure of the bank and roadway would prevent emergency services from accessing a significant number of homes in the upper valley. This erosion has been monumented as a Bank Erosion Monitoring Site (BEMS Station 11-30028). In a prioritization of twenty-one BEMS sites throughout the West Kill watershed (see Section 3.3, Watershed Inventory and Assessment), this site ranked Medium Priority. Geotechnical evaluation of this failure is recommended before any treatments are attempted in this area.

Bank Failure, right

Bank Failure, right

Bank erosion, right

Bank erosion continues on the right for another 164 ft. However, the erosion becomes far less rotational and more surficial.

Debris jam, right

Debris introduction is a problem along both of these eroded banks. Mature trees are slumping from the bank, and several have become entangled in debris jams (Inset F, Fig. 4.11.2) located on the right bank, at the downstream end of the both the first and second erosion locations. The debris is aligned parallel to the bank, providing some measure of toe protection and creating only a minimal flow obstruction.

West Kill Stream Restoration Demonstration Project #1 begins near Station 29500, and extends to the Shoemaker Road Bridge at the end of Management Unit 11. Detailed walkover data was not collected in the project reach, as construction was in progress at the time the walkover was conducted. The project report is presented in Section 5. Please see the report for a detailed discussion of the pre-existing conditions as well as the project goals and objectives.

Tributary, right

Two tributaries join the West Kill from the right in the project reach. The first is an unnamed tributary (Station 28300) that is well connected, but is sparcely vegetated at its mouth. The second is Schoolhouse Brook (Station 28000), delivering flow from a 0.8 mi^2 drainage area.

Schoolhouse Brook, right

The brook flows under Greene County Route 6 through a concrete twin-elliptical culvert structure before outfalling onto the heavily armored road embankment. A smaller culvert (Inset B, Fig. 4.11.2) just upstream of the concrete culvert conveys roadside drainage to the West Kill under Greene County Route 6.

A third tributary (Station 27860) joins the West Kill, in the project reach, from the left. The mouth of the tributary is perched but well vegetated. Flow from the tributary is notably turbid even at low flow. Investigation of the source of turbidity is recommended here.

Tributary, left

Bedrock, left

Bedrock controls 55 ft. of the left bank and portions of the bed near Station 27100. The left abutment of the Shoemaker Road Bridge is poured on this bedrock.

Shoemaker Road bridge, looking downstream

Shoemaker Road bridge, looking upstream

Shoemaker Road bridge (Insets A and E, Fig. 4.11.2), replaced following the 1996 flood, marks the downstream limit of Management Unit #11 (MU11). The left abutment is poured on bedrock, and the right is armored with heavy rip-rap. No scour is evident at either of the abutments.

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 3.2 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. Sediment transport issues through much of this unit have been addressed as a component of West Kill Stream Restoration Demonstration Project #1 Installation of flood plain drainage under the RCH Stable bridge approach would likely reduce the backwater conditions and improve sediment transport continuity.

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. 4.12.3). 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 (42 %) followed by Herbaceous (35 %). *Impervious* area (5%) within this unit's buffer is primarily the Greene County Route 6, along with private residences and associated roads. There were no occurrences of Japanese knotweed documented in this management unit during the 2004 and 2005 stream inventories. 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 MU11

There is one wetland 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 wetland is

0.8 acres in size, and is designated *palustrine, forested, broadleaf deciduous, temporarily flooded*, (PFO1A).

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 potential planting sites were documented within this management unit (Fig. 4.11.4). Much of the unit was planted as a component of West Kill Stream Restoration Demonstration Project #1.

Recommendations for this unit 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

100-year floodplain boundary in Management Unit 11

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 seven 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 13% (423 ft.) of the stream length outside the limits of the restoration project is experiencing major erosion.

There is one Bank Erosion Monitoring sites in MU11 (BEMS 11-30028). A geotechnical assessment of this site is recommended to evaluate the extent and magnitude of the failure.

Infrastructure

Thirty-nine percent of the stream length in this management unit has been treated with some form of revetment, indicating a history of instability.

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 documented in the restoration project area in a detailed fisheries study conducted by United States Geological Survey both pre- and post-construction. In addition to the USGS study, Greene County Soil & Water Conservation District documented the pre-construction habitat using MesoHabSim methodology developed by Cornell University.

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 six significant clay exposures identified in the 2004 Inventory, and only one clay exposure identified in 2005.

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 2 stormwater culverts in this management unit.

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.

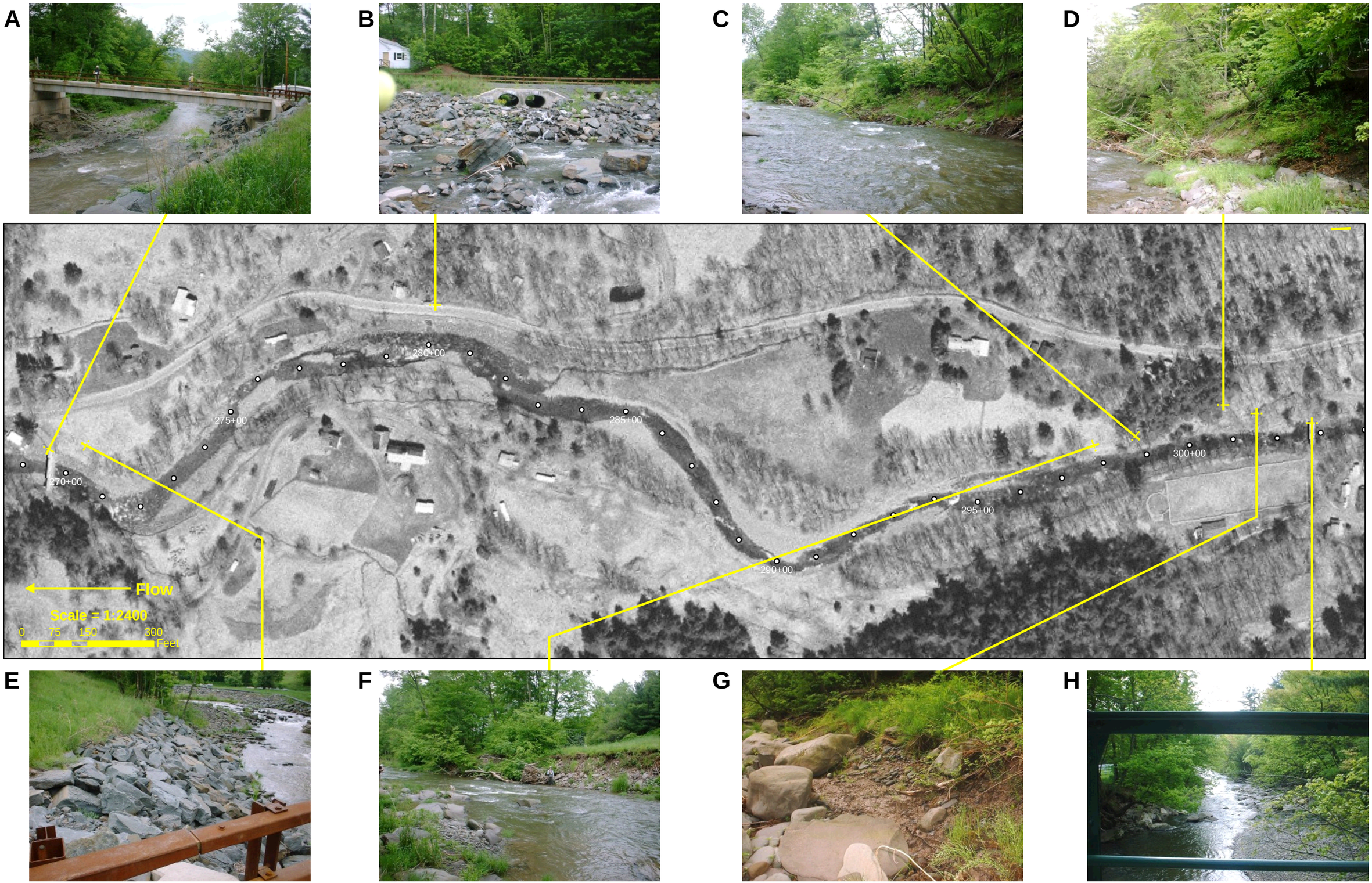


Figure 4.11.2 Management Unit 11 - 2004 aerial photography