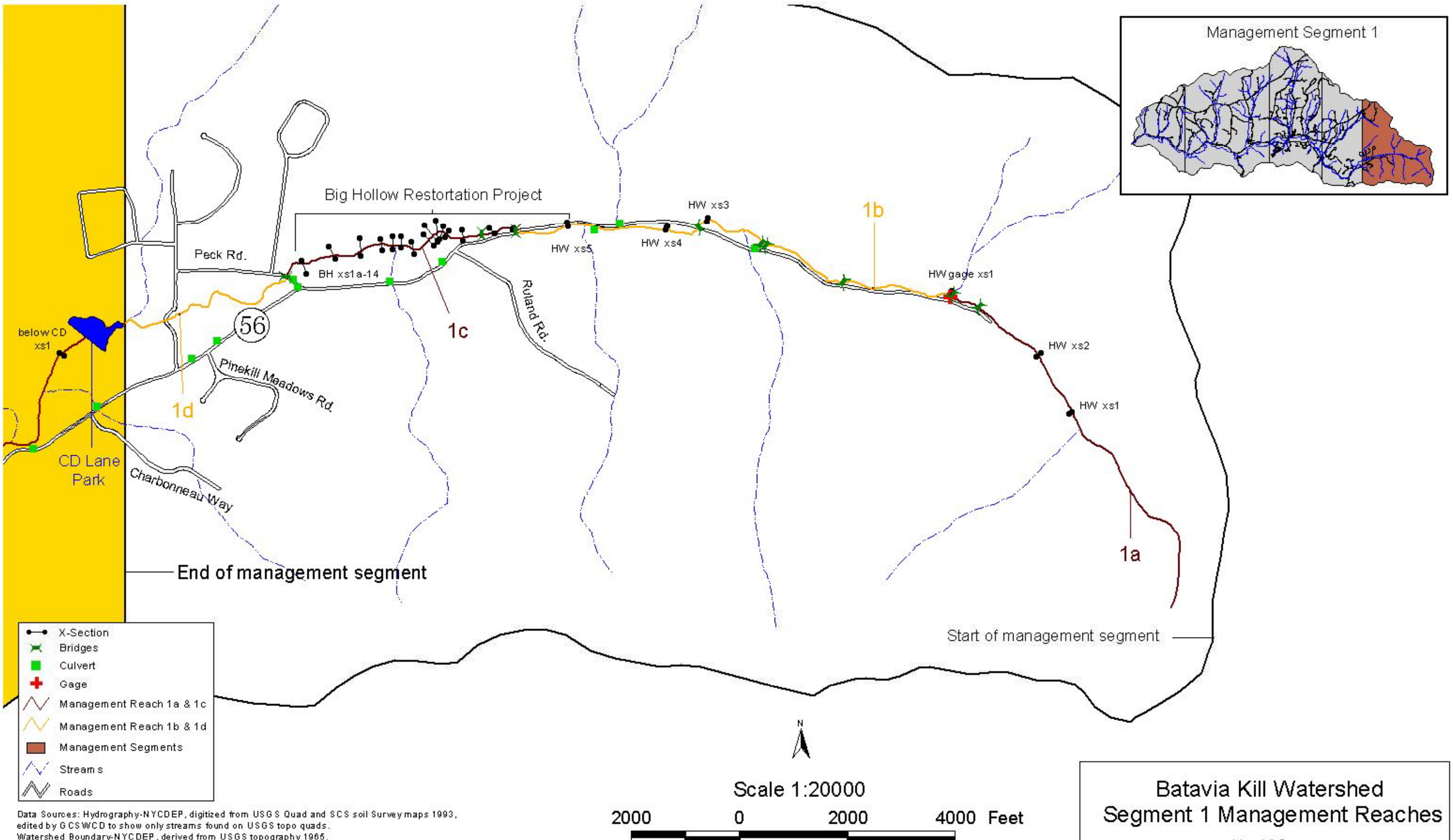
Management Segment 1

Source to C.D. Lane Park

Management Segment 1 encompasses the upper most reaches of the Batavia Kill headwaters and is approximately 5 miles in length. From the streams origins on the western slopes of Blackhead and Black Dome Mountains, to its entrance into the CD Lane Park flood control structure, this segment is the only portion of the stream corridor that is not influenced by the Batavia Kill Watershed District flood control structures. The *valley morphology* transitions from a narrower, V shaped form into a broader U shaped valley with multiple river terraces. The segment is located within Valley Zones 7, 6, 5 and a portion of 4, **(Figure V-12)** and has valley slopes ranging from greater than 6.8% in the headwaters, to slopes near 1.3% as the valley floor becomes flatter.

The stream channel alignment is characterized by low sinuosity which is influenced by the natural topography of a narrow valley width, combined with steep valley slopes. In much of this segment, the Batavia Kill has a narrow *belt width* and is partially constricted by a town road as well as county route 56. Review of historical aerial photography suggests that portions of this segment have been modified numerous times. The main channel passes under 9 bridges and through 1 culvert in just 2.5 miles of stream channel along CR 56. These alignment modifications have caused further constriction of the segments available belt width and ability to adjust laterally.

The Phase I Inventory & Assessment conducted in 1997 revealed that while the upper headwaters segments were highly stable, sections of the Batavia Kill located within the lower three miles of the management segment exhibited signs of extreme instability. To evaluate the management segment in closer detail, the GCSWCD used general valley morphology and physical stream characteristics to further subdivide the management reach into shorter stream reaches **(Map VI-2)**. The management segment was broken into 4 stream reaches which are discussed in detail in the following sections



Batavia Kill Watershed
Segment 1 Management Reaches

Map VI-2
Greene County Soil & Water Conservation District
Batavia Kill Stream Corridor Management Plan

Data Sources: Hydrography-NYCDEP, digitized from USGS Quad and SCS soil Survey maps 1993, edited by GCSWCD to show only streams found on USGS topo quads.
Watershed Boundary-NYCDEP, derived from USGS topography 1965.
Bridges-GCSWCD, data collected using GPS unit.
Roads-Greene County Real Property Tax.
Gages-GCSWCD, derived from latitide/longitude of USGS gages.
Village/Hamlet-GCSWCD, derived from USGS topographic map .tif file.
Management Segments & Reaches-GCSWCD, based on management segments and reaches detailed in Batavia Kill Stream Corridor Management Plan.
Map produced by Greene County Soil & Water Conservation District, January 2002.
Note: GIS data are approximate according to their scale and resolution. They may be subject to error and are not a substitute for on-site inspection or survey.

Reach 1a (Source to Maplecrest Gage Station)

Reach 1a begins at the first section of perennial stream located along the main stem of the Batavia Kill, and continues downstream to the USGS stream gage station near the NYSDEC trail. There is approximately 1.5 miles (7783 feet) of stream length located in this reach **(Map VI-3)**. This reach is located primarily within the confines of NYS Forest Preserve, which has resulted in minimal anthropogenic impacts to the stream corridor. The drainage area at the bottom of the reach is 2.03 square miles, with several small intermittent tributaries contributing to the reach. Reach 1a encompasses valley zone 7 and 6 **(Figure V-12)**, and is characterized by valley slopes ranging from 13.4% in the headwaters to 6.8% at the lower reach. Land use in reach 1a is overwhelmingly forest, with low density development along the immediate stream corridor consisting of older farmsteads, seasonal cabins and small scale agriculture

Stream Morphology/Stability

During the 1997 Phase I Inventory and Assessment process, the GCSWCD noted that reach 1a was characterized as being very stable, with no measurable erosion noted. Interpretation of historic and recent aerial photographs for current stream conditions and changes over time was generally inconclusive due to the small stream size and dense forest canopy which obscures the stream location on older aerials photographs. Assessment of this reach was limited to field inventories, and observations of both current stream process and evidence of past instability.

Figure VI-1: Headwater segments in 1a are characterized by a healthy riparian forest and a course streambed of boulders and cobble.

Phankuch stability indices completed in reach 1a scored the reach as being in general good physical health in the upper section of the reach, with stream health slightly declining in the lowest section of the reach. The GCSWCD has observed several isolated sections of instability, but these were considered to be localized disturbances and not representative of a larger instability problem. The GCSWCD continues to observe the condition of these areas, and has not noted any continued degradation of the streams health as of the summer of 2002.

The GCSWCD established three (3) monumented cross sections within reach 1a. These sections were used to determine Level II stream classification (Rosgen 1996). Cross section #3, located at the USGS gage station, was established in 1998 to monitor stream behavior in this highly stable reach and to verify bankfull estimates at the stream gage. The other two cross sections are located upstream of the gage station and were installed in 1999 to classify the reach for management purposes. In reach 1a, the Batavia Kill is an A3 stream type in the upper portion, transitioning to a B3 stream type through the second cross section and continuing down the reach to the gage station. A profiles of stream slope through the sections was surveyed in the summer of 2000 to calculate *stream discharge* and channel *shear stress*.

Figure VI-2: Heavy moss growth and imbrication of boulders and cobbles are characteristic of a stable stream profile

Cross section #1 classifies as an A3 stream type, which are generally very steep, highly entrenched, confined channels. These channels are typically sensitive to disturbance, and have poor recovery potential (Rosgen 1996). Sediment supply is also high, with bed and bank erosion typically occurring. The catchment's steep *hydrography* and poor drainage classification results in runoff events characterized by rapid increases in stream stage and a pulse of water and sediment which the channel must convey during storm events. Assessment of cross section #1 between 1999 - 2000 indicated only minor erosion, with no evidence of either channel aggradation or degradation. The erosion is considered to be minor, and localized.

The stream channel approaching cross section #2 transitions from an entrenched A stream type into a moderately entrenched channel with the introduction of a narrow, defined *floodplain*. Stream type changes to B3, with channel material remaining fairly constant from cross section #1 . *Cobble* is the predominant particle size, although bedrock and medium boulders are also frequent seen throughout entire reach. Cross section #2 has exhibited a consistent and stable channel *morphology* throughout the monitoring period, with no appreciable lateral erosion observed. Measurements of *width/depth ratio*, *entrenchment ratio* and cross sectional area have remained essentially unchanged **(Figure VI-3)**.

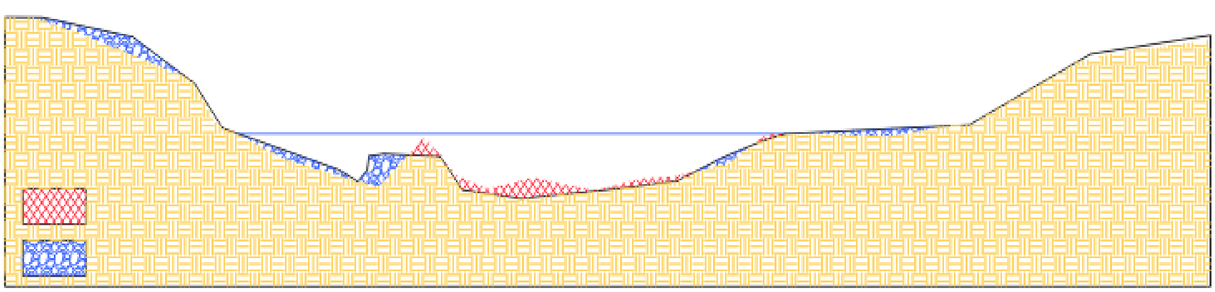


Figure VI-3: Overlay of 1999 and 2000 monitoring surveys for Headwaters #2 cross section, depicting minimal erosion or aggradation

Cross section #3 is located at the USGS Maplecrest stream gage station, and was established to verify *bankfull discharge* at the gage station. The cross section indicates a

B3 stream type, and the channel's *morphology* exhibits a high state of stability. Based on visual observations and monitoring of the cross sections, there has been no evidence of lateral migration, aggradation, or degradation and the steam banks are well vegetated in the area represented by the cross section.

Riparian Vegetation

The riparian vegetation community in reach 1a is primarily second growth, mixed deciduous forest, with intermittent stands of conifer. Historically, the upper watershed was dominated by hemlock forest, harvested to support the tanning industry over 100 years ago. Reintroduction of conifer species on the high slopes of the watershed, near Black Dome Mountain, is apparent in aerial photography, and it is unknown if these plantings were done before, or after ownership by New York State. The forest canopy in reach 1a nearly completely covers the stream in summer, keeping the water cool, and providing good fisheries habitat. The GCSWCD has not noted the presence of any invasive species such as Knotweed.

Water Quality

The GCSWCD has not inventoried any significant water quality impacts in reach 1a. Only one part-time residence is located in the reach, and the structure is located well above and over 300 feet from the stream. On-site waste water treatment is not considered an issue. Minimal impacts may be attributed to runoff from Big Hollow Road, which is narrow and unpaved through reach 1a. The road does run close to the stream, and maintenance of the road surface and drainage systems should be conducted in a manor which would reduce erosion, as well as any entrenchment of the stream channel.

Infrastructure

Infrastructure in reach 1a is limited to two small bridges spanning the Batavia Kill, including a private driveway which accesses the Gundersen property, and a small footbridge which provides access to the NYSDEC trail system. Neither structure appears to have an impact on either the stream's stability, or its ability to transport sediment from the steep slopes above. Neither structure impedes access to the adjoining floodplain and both structures are in good condition. The Gundersen's have requested the assistance of the GCSWCD to advise them on maintenance of their bridge. A short section of town is also present in the reach. The road provided access to the NYSDEC trail head and appears to be adequately protected from erosion by the woody riparian buffer. The GCSWCD and Town of Windham highway department work cooperatively on stream related maintenance issues.

Flooding Issues

The GCSWCD is not aware of any flooding issues in reach 1a

Reach 1a Summary

The stream morphology in reach 1a can be characterized as being very stable. Stability is strongly influenced by both the lack of human activity, as well as the numerous bedrock sills, boulders, and woody debris formations which provide effective grade control structures. A well imbricated bedform is resistant to degradation, and woody debris . The reach is strongly confined by valley topography as reflected in an inventoried sinuosity of 1.14, as such future management activities must take caution to prevent further entrenchment of the stream channel. The GCSWCD has not observed any significant stream processes which would indicate broader instability problems.

Table VI-1: Management Recommendations Reach 1a

Reach 1a: Headwaters to USGS Maplecrest Gage Station.	
Intervention Level	Preservation
Stream Morphology	No action recommended at this time, stream morphology is stable, and exhibits an appropriate form. Continue to monitor minor instabilities.
Riparian Zone	Good condition, See General Recommendations.
Water Quality	Good condition, See General Recommendations.
Infrastructure	1. Avoid widening of trail head access road to prevent entrenchment and loss of riparian zone. 2. Use appropriate BMPs to provide stormwater protection along trail head access road to mnimize NPS impacts. 3. Avoid stream disturbances associated with future maintenance or repair to existing bridges. Prevent further entrenchment with abutments or rip-rap and avoid disturbance of channel bed protective cover.
Habitat	Good Condition, See General Recommendations.
Further Assessment	1. Continue to monitor USGS gage for refinements of stream flow calculations. 2. Inventory/Investigate role of large woody debris in relation to stability and habitat in Batavia Kill headwaters. Manage woody debris as appropriate to maximize stability.

Reach 1b: Maplecrest Gage to County Bridge #3-30287-0

Reach 1b begins at the USGS gage station in Maplecrest, and flows parallel with Big Hollow Road for approximately 8744 feet (1.7 miles) to the county bridge below the L. MacGlashen farm **(Map VI-3)**. The stream reach is located within valley zone 5 **(Figure V-**

12), with an average valley slope of 2.7%. Valley *morphology* is characterized by steep side slopes, with a narrow, confined valley floor. The drainage area contributing to the reach ranges from 2.03 mi^2 at the top of the reach, to 5.5 mi^2 at the county bridge. Land cover through the reach is dominated by forest, while other land use in the reach includes limited residential development and some small scale agriculture.

STREAM MORPHOLOGY/STABILITY

The Phase I Inventory and Assessment in 1997 identified erosion along 1520 feet of streambank within the reach, which represents 17% of the total streambank length. The reach averages 1.91 ft^2 of exposed streambank per linear foot of streambank. The stream channel transitions from a steeper, step-pool complex in the upper reach, to a riffle-pool sequence as both valley slope and confinement decrease. *Remotely sensed data* was used to classify B, C, F and D stream types within the reach.

Figure VI-4: Section of segment 1b as it runs along access road to NYSDEC trail head.

To facilitate discussion of stream condition, reach 1b is further subdivided into an upper **(Figure VI-5a)** and lower **(Figure VI-5b)** reach. The upper portion of reach 1b is characterized as being relatively stable. The assessment noted evidence of abandoned channels, most likely avulsions associated with larger flood events, as well as small sections of multiple, braided channels and minor bank erosion. Aerial photography has not been useful in documenting channel migration due to heavy forest cover obscuring the stream in the older aerial photographs. Observed instabilities were considered to be local in nature, with no reach wide instability. This section of the reach has been modified in response to stream impacts on the town road, as well as the private bridges. Numerous attempts to stabilize streambanks with rock rip-rap, as well as the presence of rip-rap protection at bridge openings, was noted.

While the upper portion of the reach is characterized as being relatively stable, the lower portion of reach 1b was noted as having significant areas of channel erosion **(Figure VI-5b, photos A,B,D,E,F)**. The erosion inventoried in 1997 was almost exclusively located ti this sub-reach. Instabilities were noted in several areas, with channel aggradation and degradation observed, as well as lateral channel erosion. In August of 1999, three monitoring sections were installed in this section to determine stream type, and to determine the current state of instability.

The first monitored cross section in the reach (Headwaters #3) is located just upstream of the county bridge **(Figure VI-5b)**. This bridge was substantially damaged in the April 1987 flood event, and replaced in 1989. In 1990, the GCSWCD sponsored a stabilization project which included stacked rock rip-rap on the right bank above the bridge, and sloped rip-rap on the left bank below the bridge. The project also included extensive channelization, extending approximately 100 to 150 feet upstream and downstream of the bridge. Flood events in 1996 and 1999 resulted in repetitive damage to the stacked rock rip-rap above the bridge **(Figure VI-5b, photo D)**. Subsequently, the GCSWCD has observed active erosion just above the bridge. The lateral can likely be attributed to the rip-rap bank protection, floodplain fill and channelization of the stream.

While the bridge opening appears to be adequately sized for its location in the watershed, further evaluation of the stream/road alignment, as well as channel entrenchment, could identify an effective strategy to addressing the instability. *Mitigation* of the instability problem at the bridge would have a direct benefit by reducing the frequency and cost of repairs, as well as protecting the structure from future floods. Immediately below the bridge (150'), the stream channel has responded favorably to past disturbances **(Figure VI-5b, photo H)**. A well vegetated *bankfull* channel has formed within the over widened channel, and a young, but healthy, riparian buffer is becoming established. The response of this short section to past channelization is an excellent example of a streams ability to re-establish a stable form.

Continuing downstream through the reach, the Batavia Kill rapidly becomes entrenched, and begins to exhibit signs of a larger instability problem which continue to the bottom of the reach. In this section of reach 1b, the Batavia Kill exhibits classic signs of *stream evolution* process. Work undertaken by the GCSWCD in 1987 and 1990 addressed erosion problems in this reach, and it is now evident that these sites were part of a larger instability problem in the reach. The work completed by the GCSWCD in 1987 and 1990 is likely to have contributed to the continued instability by reinitiating the degradation processes. To monitor the problems noted in the lower part of reach 1b, the GCSWCD installed two monitoring cross sections in 1999. By 2002, the problems had continued to worsen, and the GCSWCD installed an additional 12 cross sections, and over 3500 feet of stream profile was surveyed.

Approximately 600 feet downstream of the county bridge, the GCSWCD installed a second cross section (headwaters #4) to monitor possible entrenchment of the stream channel which was noted during the 1997 inventory, as well as during continued observations by the GCSWCD. The cross section measurements resulted in an F3 Stream type classification, which is characterized as being an entrenched stream morphology. The channel has been modified in the recent past, with a section of newer **rip-rap** located on the right bank just below the cross section. While surveys of the cross section indicated only minimal stream bank erosion, recent observations have noted signs (i.e increased bank failures) of continued degradation **(Figure VI-5b, photo A)**. The GCSWCD feels that a *head cut* moving up the reach will continue to degrade the reach, but currently there is insufficient monitoring data to confirm this assessment. The streambed above the cross section is heavily armored with large, well *imbricated* boulders which are most likely reducing the speed at which the head cut is moving upstream.

Continuing down the reach, the Batavia Kill has been characterized by adjustments in the streams planform. The stream channel upstream of the new bridge at the L. MacGlashan farm has migrated toward the south over 150' since 1959, with the largest movement of nearly 50' occurring between 1995 and 2000 **(Figure VI-6)**. The largest shifts have occurred during years of large storm events in 1996 and 1999, with an average erosion rate of approximately 1' per year **(Figure VI-5b, photo B)**.

Figure IV-6: Aerial overlay of channel migration between 1959 (light blue) and 2000 (dark blue) at L. MacGlashen farmstead.

At the bottom portion of reach 1b, monitoring between 1999 and 2001 has indicated localized channel aggradation leading to flooding problems along CR 56 and the county bridge at the bottom of the reach. A single monitoring cross section (headwaters #5) was classified as an C4 stream type, and throughout the monitoring period the cross sectional area of the *bankfull* channel has remained constant, while the width/depth ratio has significantly increased due to over-widening and aggradation of the channel **(Figure VI-7)**. In one year of monitoring, the channel has aggraded almost two feet and has eroded laterally approximately six feet along the highway **(Figure VI-8)**. The aggradation significant reduced channel capacity resulting in frequent flooding of CR56, while the lateral migration of the channel was threatening CR56. In 2002, the GCSWCD used FEMA funds to implement temporary measures in this area. The channel was excavated to provide more capacity, and large rock was buried in the right streambank along CR 56.

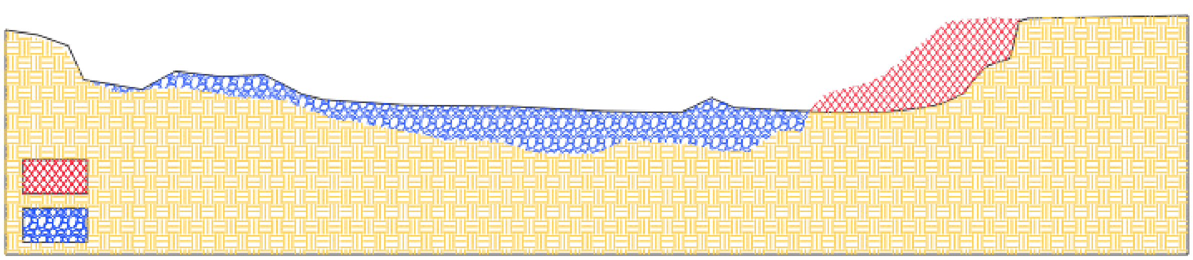


Figure VI- 7: Headwaters cross section #5 overlay from 1999-2000 depicting channel aggradation and lateral migration. Red = erosion, Blue = deposition

The aggradation in the lower reach is most likely attributed to several factors. First, the GCSWCD had inventoried a large beaver dam located which was causing a decrease in sediment transport capacity and promoting local aggradation of the channel. A second factor contributing to the aggradation is an increase in overall sediment supply from the areas of degradation and lateral erosion above. The most significant change was noted after the September 1999 flood event in which the stream discharge in this area exceeded 790 cfs, and completely buried the beaver dam with gravel. The result was significant localized flooding and nearly 6 feet of lateral erosion.

While the upper portion of reach 1b has only minor, localized instability problems, the lower extent of the reach is felt to be heading towards extreme instability. The GCSWCD has observed aggradation, degradation and lateral meander migrations in this section of the reach, and there is a very low probability that the stream channel will achieve an acceptable state of stability on its own. There is currently a seasonal structure threatened, and several homes are likely to be impacted in the future.

Figure VI-8: Aerial view of lateral migration along CRT in lower section of management segment 1b.

RIPARIAN VEGETATION

The riparian condition in reach 1b can be characterized as fairly good in the upper reach, and poor to non-existent in the lower sub-reach. The upper reach contains dense forest cover, with small areas of shrub and/or grass cover in the immediate stream corridor. The riparian buffer appears to provide adequate cover for habitat, as well as stability, but in several areas is not wide enough to provide effective water quality benefits. In the lower portion of the reach, much of the stream corridor does not contain adequate woody vegetation in the riparian buffer. While trees are present on the top, as well as bottom, of the sub-reach, the active degradation process is quickly causing slope failures and the buffer is being lost.

WATER QUALITY

At the present time, the most significant water quality concern in the reach would appear to be *turbidity*, and *TSS*, generated by the unstable stream segments. The GCSWCD has noted the presence of lodgement tills within the actively degrading channel, and assumes that glacial clays are most likely very close to the surface. Continued degradation of the channel will increase water quality impacts if the stream channel becomes entrenched in the clay deposits. Other water quality issues which require further evaluation include;

- A small horse paddock, located in the lower-sub-reach, is located immediately on the stream with a very narrow riparian buffer. While the paddock contains only a single horse, its position allows for essentially no buffering of runoff. The site may qualify for the NYC *WAP* Small Farms Program, which would provide technical assistance and funding to address any potential impacts.

- While the GCSWCD has not observed any evidence of impact from septic systems, in several instances the available land for infiltration of waste water is limited, and water quality protection will require a properly functioning system. The GCSWCD will continue to monitor the availability of funding under the *CWC* Septic Rehabilitation and Replacement Program, and work with landowners to seek system testing and rehabilitation as necessary.

INFRASTRUCTURE

In regards to infrastructure, the GCSWCD inventoried four (4) bridges and one (1) culvert within reach 1b. In the upper sub-reach, infrastructure includes two small private bridges and a large culverts, as well as sections of Big Hollow Road which run immediately adjacent to the stream. While no broad scale instability was noted near the bridge structures, it does appear that the alignment, and the size of the hydraulic openings, on the smaller bridges may be contributing to localized instabilities. Big Hollow Road does contribute to channel entrenchment, but at this time does not appear to be causing any problems. Caution must be taken in road maintenance activates to avoid any further entrenchment of the channel by widening the road or placing rip-rap. The reach also includes a county bridge and a town bridge in the lower sub-reach.

In September1999, the town bridge at the L. Milton MacGlashan farm failed during the Tropical Storm Floyd flood event **(Figure VI-5b, photo F)**. The cause of the failure was documented as scour of the left bridge abutment, most likely the result of inadequate capacity to pass the storm flow, as well as degradation of the streambed and lateral erosion. The placement bridge was relocated approximately 150 feet down stream, to a location where the stream planform was straight. The new bridge was built at 60 feet in length, in an area where the GCSWCD has determined the bankfull width to be approximately 35 feet. The combination of the new alignment, and the lengthening of the bridge, are both highly favorable to reestablishing a stable stream morphology in this reach.

In lower reach 1b,it must also be noted that the GCSWCD has also been watching an area of severe streambank failure associated with a large culvert on a small unnamed tributary to the Batavia Kill. The culvert has been substantially damaged in the 1987, 1996 and 1999 flood events **(Figure VI-5b, photo C)**. While the culvert has been replaced after each storm event, this drainage feature continues to contribute to the instability in this section of the reach. In 1990, the GCSWCD had undertaken a rip rap project in this area to address erosion at the point where the small tributary meets the main stream, and to protect a small cabin in that area. Rip rap was placed on the right bank of the tributary between the culverts and the Batavia Kill, and continued downstream on the right bank of the Batavia Kill. In the 1999 flood event, this rip rap completely failed, with massive erosion occurring near the cabin **(Figure VI-5b, photo G)**. It is unknown to what extent the culverts have contributed to overall instability, but the GCSWCD strongly recommends additional assessment, and appropriate mitigation of this problem.

HABITAT

Fisheries habitat within the reach can be characterized as being in good condition at the top of the reach, with poorer conditions in the lower reach corresponding with the instability problems discussed above. The reach is the location of the control and reference reach being used by the USGS to monitor effectiveness of the Big Hollow restoration project. The reference reach, is located in the upper sub-reach, and represents natural conditions with good habitat. The control reach, is a site with unstable conditions similar to the Big Hollow site before the restoration project. The control for the fisheries monitoring project is a degraded reach located just above the new bridge at the L. MacGlashen farm. Future restoration activities in this area would provide enhanced habitat value.

REACH 1b SUMMARY

While the upper section of segment 1b is currently stable, management actovities should focus on preservation of the natural stability. Management activities related to road and bridge maintenance, logging and development should be done carefully, and in a manner that will not result in increased entrenchment. Improvements to the riparian buffer may also be beneficial in some areas in the upper reach. In the lower portion of the reach, the section between the upper most county bridge in the valley, and the recently replaced county bridge below the L. MacGlashen farm, the stream is highly unstable. The channel exhibits signs of multiple *head cuts* working their way up the channel, and at the present time, all stages of *channel evolution* can be observed in this short section of the valley.

Based on the current level of instability, and the fact that the reach frequently experiences damaging floods, the GCSWCD feels that reach will continue to destabilize, and that natural recover can be reasonably expected. As the reach degrades, individual efforts to address “local” instability will result in uncoordinated management activities which may further impact the reach. The GCSWCD has implemented a full Phase III/IV monitoring strategy, and will continue to assess the site for potential restoration in the future. Presently, the instability is not an immediate threat to the bridges within the reach, and the threat to CRT 56 due to lateral migration has been temporarily mitigated by the placement of large rock on the right bank.

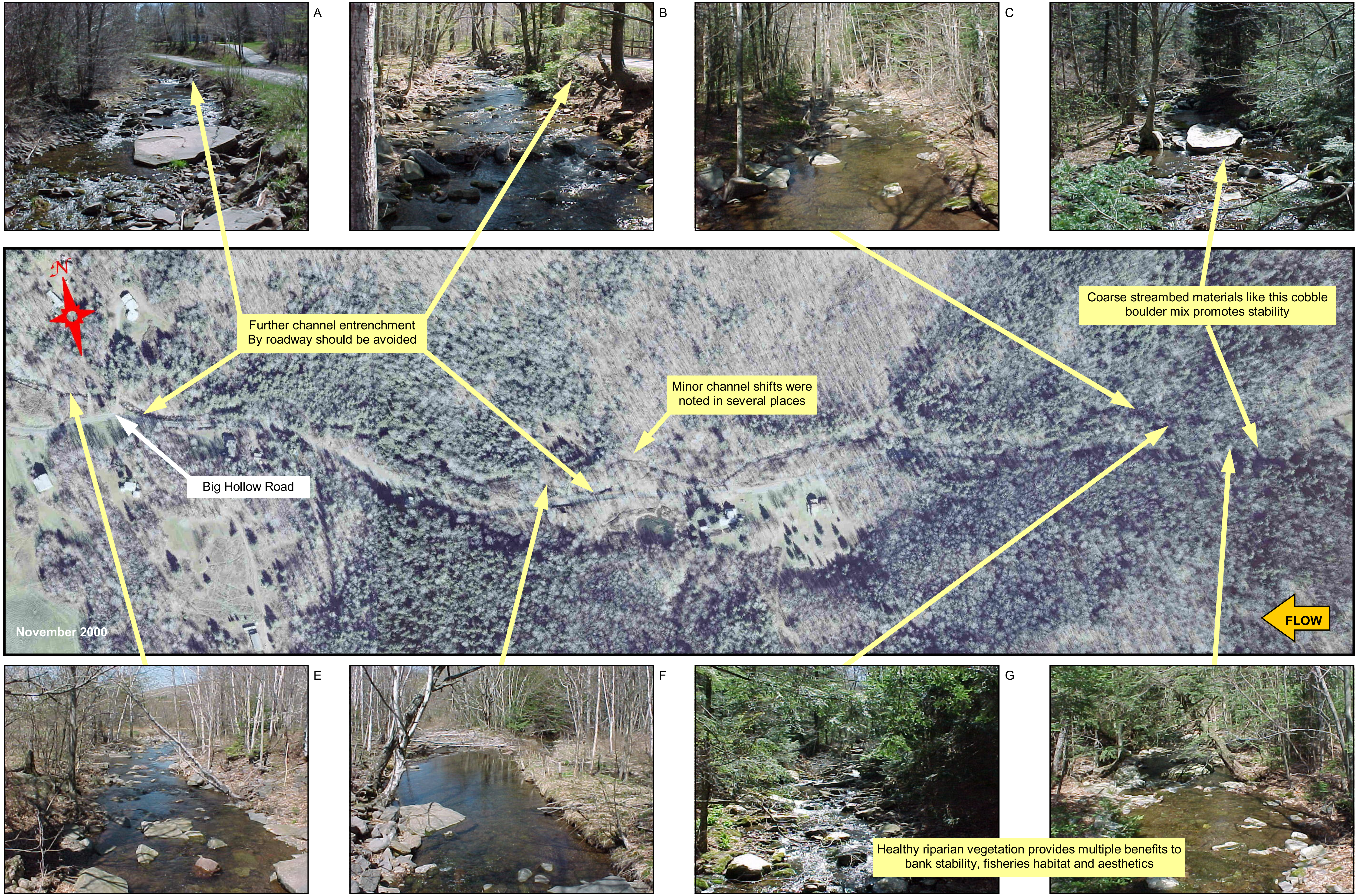


Figure: VI-5a: Reach 1b-Upper

Figure VI-5b: Reach 1b - Lower

TABLE VI-2 Reach No. 1b - Maplecrest Gage to County Bridge #3-30287-0	
Intervention Level	Upper Reach - Protection, maintain natural stability Lower Reach - Full Restoration
Stream Morphology	Upper sections of the reach exhibit stable conditions, and future management activities must carried out such that entrenchment is not increased. Modification of the streambed must also be avoided to prevent channel degradation. Lower section of the reach will require a full restoration to establish the appropriate stable stream type and form for the watershed setting. A C/B stream type complex appears to be the appropriate stream type for this reach. Continued instability is highly likely to threaten property and infrastructure.
Riparian Conditions	1. Lower reach requires extensive riparian buffer establishment. Stable morphology must be addressed first. 2. See General Recommendations.
Water Quality	1. Inform landowners of *WAP* Small Farms Program, seek technical assistance and funding to address small horse paddock adjacent to the stream. 2. Monitor *CWC* septic program, when eligibility opens for areas outside the current priority areas. Seek landowner participation in *CWC* program to test, and rehabilitate as appropriate, on-site septic systems.
Infrastructure	1. Observe function of new bridges. All bridges in the reach have been replaced between 1989 and 2001 and are of adequate size to support a stable stream reach. Monitor channel morphology for any possible adjustments associated with the bridges. 2. Upper county bridge should be further evaluated to address repetitive failure of **rip-rap** upstream of the bridge. Adjust channel alignment, reduce entrenchment by providing additional floodplain access, install rock vanes for bank stability and re-establish riparian buffer. 3. Work with Greene County Highway Department to investigate drainage structures associated with the larger tributary upstream of L. MacGlashen bridge. Develop strategy to upgrade structures and develop stable transition from the tributary to the Batavia Kill. 4. Avoid further entrenchment of stream channel by CRT 56 or the town section of the roadway. Plan drainage infrastructure to avoid stream stability impacts.
Habitat	Fisheries habitat will greatly benefit from restoration of the lower sub-reach. See General Recommendations.
Further Assessment	1. Continue to assess data from newly established cross sections to monitor instability in the lower and middle sections of the reach.

REACH 1c (CR 56 Bridge below L.MacGlashen to Peck Road Bridge)

Reach 1c consists of approximately 4,700 feet of stream, and runs between the new county bridge just down stream of the L.MacGlashen farm, to the county bridge at Peck Road. The site is located in valley zone 4 **(Figure V-12)** and has an average valley slope of 1.3%. The valley morphology is characterized by a broad valley floor, containing alluvial terraces and a well developed floodplain. The contributing drainage area ranges from 5.5mi^2 on the upper end of the segment, to 7.2 mi^2 on the lower end. The entire reach was subject to full restoration in 2001-02. Land use in the reach is open space, with limited residential development.

Figure VI-9: View of restoration work undertaken in segment 1c during 2001.

STREAM MORPHOLOGY/STABILITY

The Phase I Inventory and Assessment in 1997 identified segment 1c as exhibiting signs of extreme erosion. The inventory noted 2580' of streambank, or 55% percent of the reach, was experiencing active erosion. Measurements of the impacted streambanks revealed 11.92 ft^2 of exposed streambank per linear foot, the highest rate of any reach on the Batavia Kill. Reach 1c contains B4 and C4 stream types, with changes in stream type related to the influence valley morphology on channel entrenchment. Active mass wasting was present along a high terrace that runs through most of the reach, with unstable banks exceeding 50 feet in height **(Figure VI-10, photo B,C)**. Erosion was also occurring along the low terraces in several areas in the reach **(Figure VI-10, photo A,E,F)**. Detailed assessment of reach 1c was initiated in the summer of 1998, and continued through 2001 when construction was initiated on the demonstration restoration project.

The GCSWCD completed a Phase I through Phase IV assessment including 15 monumented cross sections, a survey of the longitudinal profile, and assessment of channel and point bar sediment characteristics. Monitoring was conducted annually in 1998, 1999, 2000 and in 2001 prior to construction. A topographic survey covering an area of approximately 32.5 acres was completed for the entire reach in 1998, and repeated in 1999 due to dramatic changes which occurred during the September 1999 flood event. The monitoring activities confirmed the highly unstable nature of the reach, and indicated that the channel was experiencing aggradation, degradation and lateral erosion at various locations through the reach.

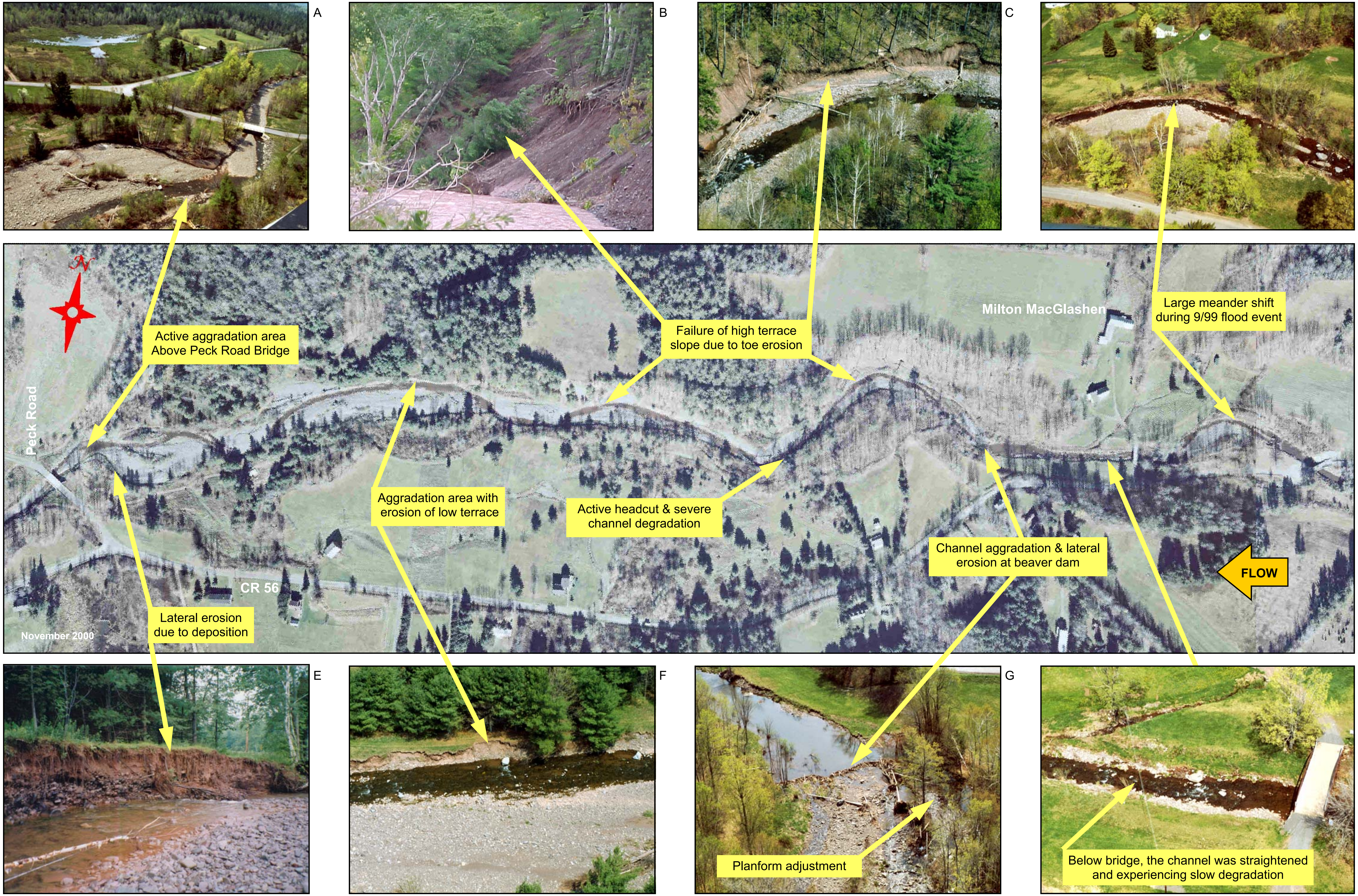


Figure VI-10: Reach 1c

Assessment of long term planform adjustments was conducted utilizing aerial photographs from 1959 to 2000, which were adjusted to match the topographic survey completed by the GCSWCD. This allowed comparisons of the Batavia Kill's meander pattern over a period of 41 years, as well as evaluation of abandoned channels. **Figure VI-11** depicts the water surface from 1995 (blue) overlaid on a 2000 photograph. As shown, significant channel shifts had occurred throughout most of the reach, with major changes in channel planform observed after the 1999 flood event. During the flood, some sections of the stream channel moved in excess of 100 feet. As seen in Figure VI-11, planform adjustment has ben active along almost the entire reach. The segments where planform does not appear to have changed are characterized as being moderately to highly entrenched.

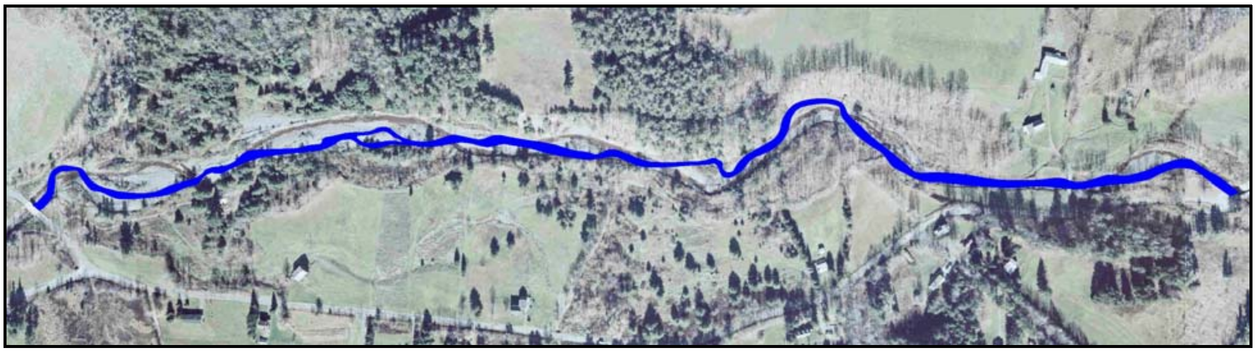


Figure VI-11: Aerial view of channel planform changes between 1995 (blue) and 2000 (photo).

At the top of the reach, only minor planform changes were noted between 1959 and 1995, and a healthy riparian buffer was present during the1997 inventory. Between May 1995 and 1998 when the detailed assessment was initiated, the channel started to experience planform changes. The flood of September 1999, resulted in a substantial channel shift on the right bank, with the channel migrating over 75' . The channel avulsion occurred in spite of a dense riparian buffer.

Moving down the reach, a beaver dam 300 feet below the town bridge was observed to be impacting sediment transport through the reach **(Figure VI-11, photo G)**, with the channel filled with gravel and other sediments. The stream channel was responding to the channel aggradation with lateral erosion as the stream attempted to cut a channel around the beaver dam. Monitoring cross sections showed the development of a divided channel below the dam **(Figure VI-12)**, with the main (left) channel incising over one foot, and the right channel almost half a foo, during the monitoring period. Further below the beaver dam, the channel was experiencing lateral erosion and over widening, as well as having degraded nearly 2 ½ feet.

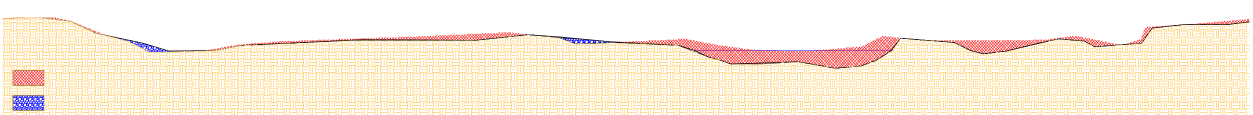


Figure VI-12: Monitoring cross section below beaver dam, note erosion of multiple channels on left side.
Red = erosion, Blue = Deposition

Moving down the reach, the alignment of the channel had migrated to a position against a high terrace on the right streambank **(Figure VI-11, photo B,C)**. The terrace averages approximately 55 feet in height, and runs approximately 220o along the center pf reach 1c. Prior to restoration, approximately 1,075 feet of stream channel was directly against the high terrace, with large slope failures present. Mast wasting of the high terrace was facilitated by erosion at the toe of the bank **(Figure VI-13)**. The low terrace, running along the opposite bank also showed equal signs of instability **(Figure VI-11, photo E)**.

Figure VI-13: Eroded high terrace at middle of management segment.

The middle section of reach 1c has been extremely dynamic. Aerial photo interpretation revealed lateral migration of nearly 150 feet occurring between 1959 and 1995. Between 1995 and 1999, the stream migrated back toward the south over 100 feet, and was continuing to actively erode **(Figure VI-14)**. Minor erosion was noted during the first year of monitoring with approximately 1 foot of stream bank erosion. Between 1999 and 2000 the channel incised 2.6 feet and eroded 15 feet of the left stream bank.

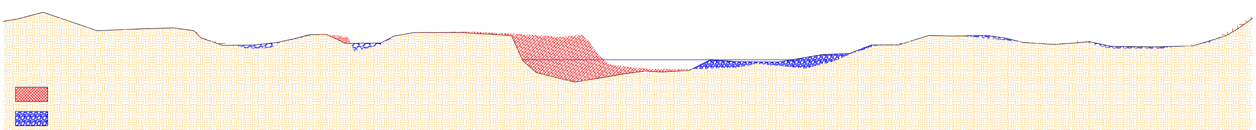


Figure VI-14: Lateral erosion of low terrace and channel degradation at cross section #8 located in the middle of reach 1b. Red = erosion, Blue = deposition

During the period between 1998 and 2001, a section of the reach just above cross section #8 was observed to be experiencing extreme degradation. While not captured by the monitoring cross section, the reach incised approximately 8 feet in two years. Streambanks that were approximately 4.5 feet n height at the onset of monitoring, had increased to over 12 feet in height in some places. The severe degradation was caused by an active head-cut which was moving through the reach.

The lower half of reach 1c was primarily characterized as an aggradation area, with excessive sediment deposition, multiple channels and poor riparian conditions. Typical of aggradation areas, channel planform was highly variable, with even small storm events significantly changing the stream pattern. Between 1995 and 2000, some sections of the stream laterally migrated over 100 feet. Additionally, aggradation was transferring erosional forces against the outer banks, with active erosion on both the left and right banks was noted during the assessment process **(Figure VI-15) (Figure VI-10, photo E)**.

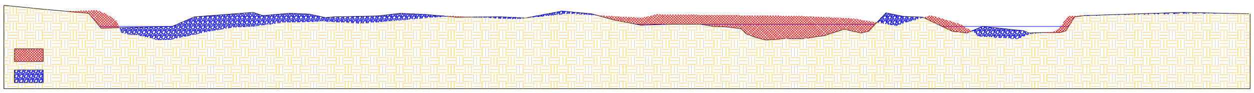


Figure VI-15: Monitoring cross section (#14) at the lower end of reach 1c indicated etensive deposition, and erosion associated with rapid planform changes. Note erosion at both far edges of the channel, as well as the poor width to depth ratio and channel over widening. Red = erosion, Blue = deposition

The exact cause of the aggradation in this section of the reach is difficult to determine with any degree of certainty, and is likely a combination of multiple factors. The most significant influence on aggradation at the lower end of the reach can be attributed to both the Peck Road bridge and the C.D.Lane flood control structure. In both cases, a back water effect appears to be influencing sediment transport, with sediment deposition upstream of the bridge **(Figure VI-10, photo A)** causing the stream channel to braid into three separate channels. As the stream responds to aggradation by increased lateral erosion, the continued over widening of the channel further reduces sediment transport capacity.

Historical photographs dating back to 1959 appear to indicate that this has been a depositional area for at least 41 years. In 1990, the Peck Road bridge was replaced after being damaged in a flood. While the new bridge appears to have adequate width to accommodate the *bankfull* channel, it lacks sufficient flood plain drainage. *Aggradatio*n in the lower end of reach 1c is also influenced by the instability problems upstream. Reach 1c has evidence of multiple head-cuts, which typically results in aggradation downstream where the channel slope is flatter. Aggradation is facilitated by the extra sediment produced by the head-cut.

Riparian Vegetation

The condition of the riparian area in the segment was highly variable. At the head of the segment, much of the riparian area was characterized by open fields, with narrow strips of wooded riparian vegetation **(Figure VI-10, photo A,D,H)**. In the lower extent of the reach, the stream was bordered by denser, woody vegetation, however extreme boundary shear stress from channel aggradation and over-widening has resulted in the trees being undercut and lost. While the high terraces in the segment support vegetation at the top of the terrace, and once were stabilized by forest cover, the unstable faces of the terrace are too steep to support bank stabilizing vegetation. The portion of the streambank which is exposed to the erosional forces of the stream is predominantly unprotected by vegetation.

Establishment of an effective riparian buffer is a primary emphasis of the restoration design. The GCSWCD has replanted over 13 acres of floodplain with bare root trees and shrubs including hybrid poplar, white pine, river birch, streamco willow, red osier dogwood, american cranberry, button bush and other species. Additionally, extensive plantings of willows using bioengineering methods have also been completed. The GCSWCD will replant sections as necessary, and is using irrigation to help insure successful establishment.

Water Quality

Issues related to water quality in reach 1c were limited to turbidity. In 1998, the Town of Windham reported to the GCSWCD that the swimming beach at C.D.Lane Park was experiencing problems with sedimentation. Investigations of potential upstream sources revealed extensive clay and lodgement till exposures in reach 1c. While no water quality monitoring was completed, visual observations of the reach during higher flows clearly indicated that the reach was a significant contributor to *turbidity* and *TSS* . The primary goal of the demonstration restoration demonstration project was mitigation of this impact.

Infrastructure

Infrastructure in the reach includes three bridges. As noted earlier, the Peck Road bridge was replaced in 1990, with the other two bridges in the reach replaced in 2001 and 2002. , including county bridges at the top and bottom of the reach and a town bridgeA town owned bridge in the reach at the M. MacGlashen Farm had remained stable through the monitoring period, but was damaged beyond repair in September 2001 by an oil delivery truck. The old bridge had adequate width to prevent impacts on channel morphology, and the bridge was not impacting stream stability **(Figure VI-11, photo H).** Downstream of the town bridge, the channel was characterized by incised conditions, but the reach had remained fairly due to the presence of some coarser bed materials and thick willow vegetation.

Habitat

Prior to construction of the restoration project, habitat was of very poor quality. Lack of cover, poor riffle-pool structure and loss of summer base flow were some of the problems noted. The restoration project is being monitored closely by the USGS to determine if the project was successful in improving fisheries habitat.

Summary Segment 1c Conditions

The entire length of reach 1c was determined to be a priority for restoration due water quality impacts, and in 2001 and 2002 was restored using natural channel design methods **(See Section VII: Demonstration Projects)**. During the period of the stream restoration construction, both the county bridge at the top of the management segment, and the bridge to the M. MacGlashen farm were also replaced. The will continue to work to establish effective riparian vegetation, and the project is being monitored for physical stability, as well as function.

TABLE VI-3 Reach No. 1c - County Bridge #3-30287-0 to Peck Road	
Intervention Level	Protection - full segment was restored in 2001-02
Stream Morphology	Stream restored to C4/B4 stream type, extensive floodplain reconstruction was also a primary goal of the design. Project will be monitored to evaluate success in meeting water quality and stability goals.

Riparian Conditions	1. GCSWCD will continue to undertake planting of tree/shrub stock to reach vegetation cover goals. Re-planting and irrigation will be done as appropriate. 2. See General Recommendations.
Water Quality	No recommendations, pre-existing water quality impact addressed in restoration design. No current known impacts on water quality within the segment.
Infrastructure	1. Observe function of new bridges at top and middle of the management segment t insure no impact on restoration work. Adjust restoration project as necessary to address any observed problems. 2. Continue to assess impact of Peck Road bridge and C.D.Lane flood structure on sediment transport through the lower section of the reach. If sediment management is required, work with GC Highway to insure work is done to prevent degradation of restoration work. 3. Monitor new bridge at M. MacGlashen farm for impacts on stream form and function. Review impact of floodplain drains under approach fill to reduce potential backwater effect..
Habitat	See General Recommendations. Habitat will greatly benefit from restoration of the reach.
Further Assessment	1. Continue to monitor project to determine if stability goals have been met. 2. Complete additional hydraulic analysis of bridges within the management segment and the C.D.Lane flood control structure. 3. Continue to assist USGS with fisheries assessment on project reach.

REACH 1d (Peck Road Bridge to C.D. Lane Park)

Reach 1d is located between Peck Road and the C.D. Lane flood control structure. The reach is approximately 3,700 feet long, and is 75% bounded by properties owned by the Batavia Kill Watershed District. The drainage area to the reach ranges from 7.2mi^2 at the Peck Road bridge to 9.4mi^2 at the entrance to the lake. The reach is located in valley zone 4 **(Figure V-12)**, having an average valley slope of 1.3%. A high bank runs along the south side of the stream for approximately 1400 feet, with an accessible floodplain along the north bank. At the lower end of the reach, the high and low terraces switch sides.

Stream Morphology/Stability

Reach 1c is characterized as a moderately entrenched, single thread, channel in the upper section, transitioning to an over-widened and abraided channel on the lower end. During the Phase I inventory and Assessment, the reach was shown to have significant erosion along 34% of the streambanks, with an average of 3 ft^2 of exposed bank for every foot of stream length. The majority of the erosion was present in the upper half of the reach **(Figure VI-16, photo C,D,G,H)**. A topographic survey of the lower half of the reach was completed in October 1997, and a Phase II analysis included one monumented cross section just above the flood impoundment.

Analysis performed on the 1995 and 2000 aerials **(Figure VI-17)** revealed only minimal planform change through the majority of the reach, with the exception of two isolated areas. The first area is located along one meander, half way down the reach which has migrated north nearly 50 feet in the 5 year period. The second area is at the bottom of the reach where the stream confluences with the flood retention pool. Historic aerial photograph interpretation of stream channel shifts through this reach is limited by the available photographs after construction of the flood control structure.

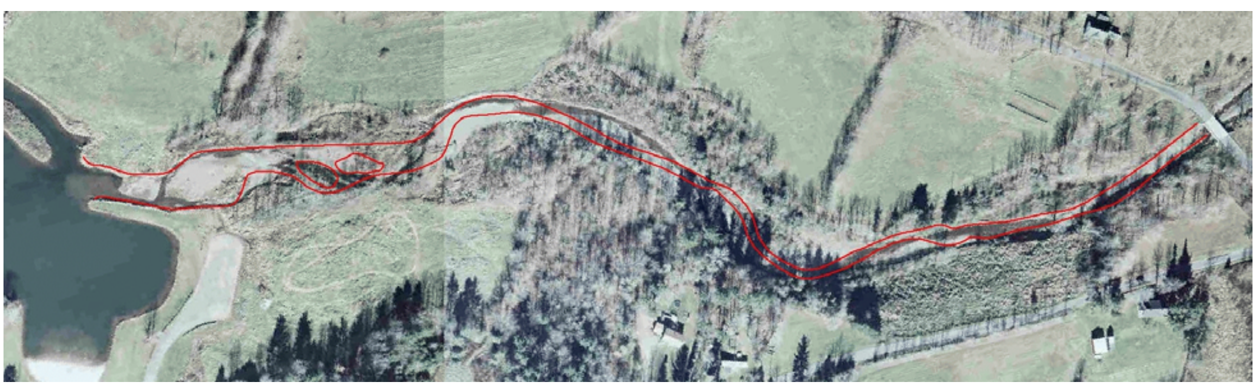


Figure VI-17: Comparison of 1995 (red) and 2000 (photo) stream Planform in management segment 1d.

While the GCSWCD did not complete a detailed Phase III/IV assessment of this reach, the instability problems represent classic responses to modification of a streams natural form and/or function. First, the aggradation and frequent planform adjustments just above the permanent lake is typical of those situations where an impoundment interrupts a streams hydraulic regime, and subsequently its sediment transport capabilities. During larger storm events, the flood impoundment quickly increases its water surface elevation, with the flood pool backing up the stream channel. The backwater results in a dramatic reduction in stream velocity, with the sediment laden stream flow quickly dropping its sediment when it reaches the flood pool.

A second stability problem noted in the reach involves a moderate head-cut which has been observed in the center of the reach. Between 1995 and 2002, the stream channel has migrated against the high terrace on the south, and active *degradation* of the channel continues to destabilize the high slopes. In the area behind the Starr residence, many large trees have been lost, and the slope has exposed clay materials. The GCSWCD feels that the head-cut, and subsequently the slope failure, is most likely a result of past management activities related to gravel management at the flood structure.

Since the construction of the flood control structure, active gravel management in the area where the stream meets the permanent lake has been undertaken on several occasions. Large scale excavation of gravel last occurred under the supervision of the GCSWCD in the early 1990's. At that time, tens of thousands of yards of gravel was removed, leaving an over-widened channel with a very flat slope. At the upstream extent of the gravel removal, the final condition was a greatly steepened riffle, which most likely promoted the head-cut observed in the reach. Stream channel response to modification of local streambed slope during gravel management has been poorly understood, partly due to the fact that these changes take time to evolve. Modifications during gravel removal can result in instability problems both upstream and downstream from the disturbance.

Recognizing the fact that the flood control structure is a permanent feature, the GCSWCD strongly recommends development of a formal sediment management strategy. While maintenance of flood structure capacity by reducing sedimentation may be desirable, a formal management plan would assess alterative methods, and any impacts on the upstream reach. A management plan should address sedimentation of the flood pool, habitat, localized stability and broader impacts upstream from the management zone. Development of the management plan should be done in cooperation with the Batavia Kill Watershed District, Town of Windham, USDA-NRCS , NYSDEC and NYCDEP.

Riparian Buffer

The riparian buffer in reach 1d is variable. The majority of the reach is in relatively good condition, but several sections require attention. Comparison of aerial photographs from 1959 to 2000 **(Figure VI-18)** indicate that there has been relatively minimal change in the riparian zone over the past 41 years. Prior to the construction of the flood control dam, the reach had several active farms along its length, with pen fields bordered by thin woody buffers. At this time, the right bank has a good buffer condition with the exception of a short section at the bottom of the reach. The left bank has a good buffer at the top and bottom of the reach, but the middle fo the reach exhibits poor conditions. Active erosion in this area has removed critical deep rooted vegetation. It is interesting to note the changes in **Figure**

VI-18 as the C.D.Lane flood control structure is constructed.

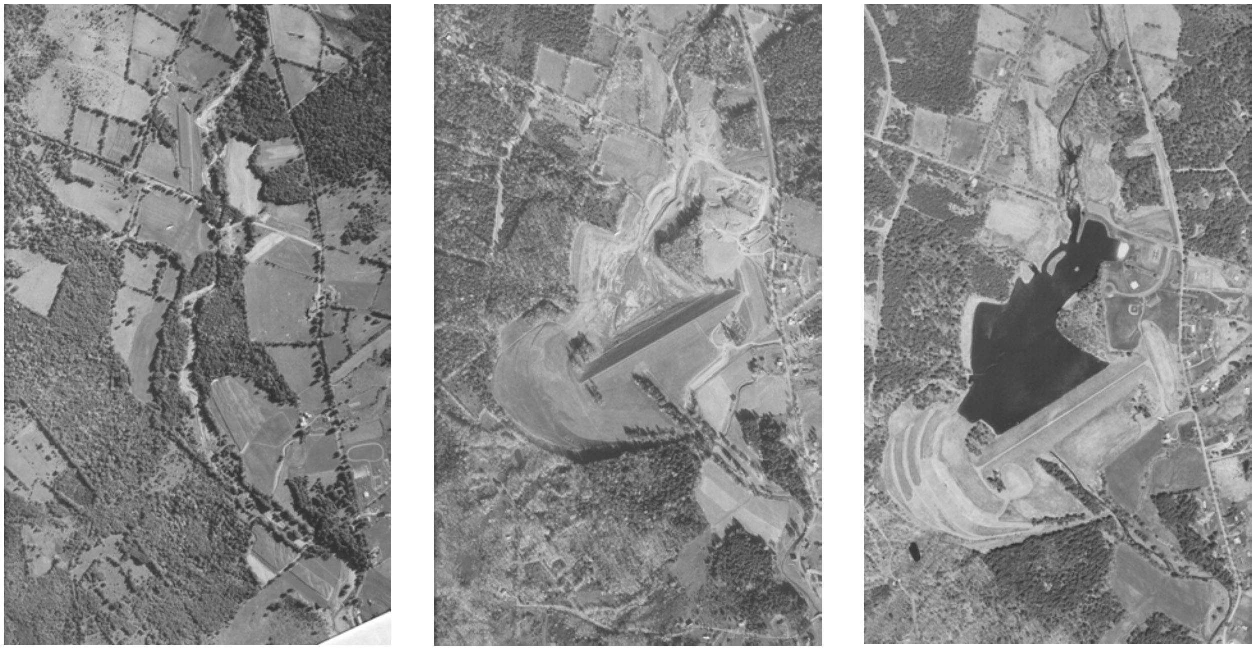


Figure VI-18: Aerial progression from 1959, 1980 and 1995 indicates reach 1d has exhibited poor riparian conditions for over 40 years. Note that the C.D.Lane lake is empty in the center photo.

Water Quality

The GCSWCD did not note any specific water quality issues in reach 1d. Much of the reach is bounded by lands owned by the Batavia Kill Watershed District and as such development has been minimal. There is one drainageway that enters on the right bank just above the lake, that may be impacted by stormwater discharges. The GCSWCD has noted erosion as well as sedimentation of the small stream channel which receives the flow from a piped stormwater system on the road above. Water quality benefits may achived by developing sediment basins along the channel.

Infrastructure

The only infrastructure within the reach is the flood control structure. As noted earlier, the GCSWCD recommends the development of a long term management plan for the site. The management plan would not only address issues such as gravel management, but also cold water releases, maintenance of the structure and its attendant facilities, as well as day to day operational procedures. These recommendations are provided n greater detail in Section VIII General Recommendations.

Habitat

Habitat conditions in reach 1d are generally poor. The aggradation within the channel causes summer flows to become sub-surface, cutting off migration to upstream reaches. The channel has lost most of its riffle-pool structure, and inadequate riparian buffer areas does not provide adequate overhead cover in many places.

Flooding Issues

After the flood of September 1999, the GCSWCD discovered that a residence just above the C.D.Lane facility had been flooded, and that this was a repetitive problem with the home being flooded in 1987 and 1999. The flooding is a direct result of the flood pool behind the C.D.Lane dam backing up into the residence. When the flood event is of a great enough magnitude to cause the emergency spillways to flow, the home is flooded. At this time, the GCSWCD is aware of the problem, and has given it high priority under the Districts flood mitigation program. The situation is discussed in greater detail in Section VIII General Recommendations.

Reach 1d Summary

Reach 1d presents a challenge to management of a stable stream system. The C.D.Lane Flood Control structure exerts significant influence on both stream form and function through the entire reach, and has strong potential to extend these influences much further upstream. The reach exhibits characteristics which are not unexpected given the influence of the dam and past management practices. Aggradation at the lake confluence due to loss of sediment transport capacity, lateral erosion in response to channel aggradation, and upstream migration of a head-cut due to management activities, have all been observed in the reach.

The GCSWCD strongly suggests that this reach be considered for further analysis and treatment. Since the 1996 flood event, the GCSWCD has noted that the center of the reach is showing increasing signs of incisement, and the stream is migrating laterally against the south high terrace behind the Starr residence. Slope failures of the high banks is ongoing, and noted along the majority of the left bank, as well as the right bank. . There is evidence of a small head-cut in this area which appears to be working slowly upstream.

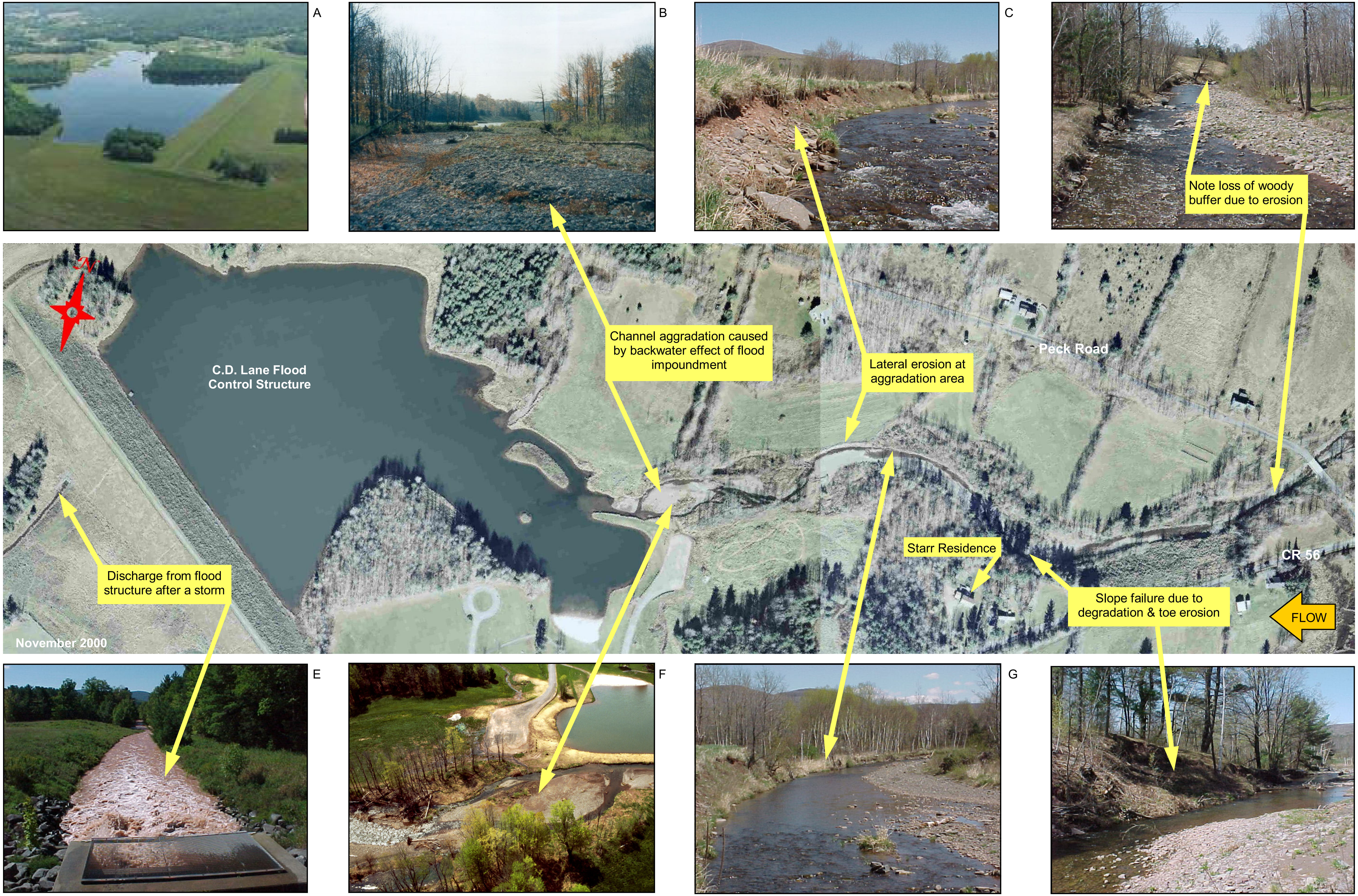


Figure VI-16: Reach 1d

TABLE VI-4 Reach No. 1d Peck Road Bridge to C.D.Lane Park	
Intervention Level	Assisted Self Recovery/Preservation
Stream Morphology	Stream morphology is strongly influenced by the flood control structure. Channel aggradation in the lower reach will always be an issues, and will continue to impact local stability. Improper management of the gravel deposition will continue to degrade upstream conditions.
Riparian Conditions	The GCSWCD will continue to improve the riparian buffer on the right bank, in the area being used for the Plant Materials Center. Riparian buffer conditions on the left bank should be improved in the enter of the reach, but only after the active degradation is addressed.
Water Quality	See General Recommendations
Infrastructure	1. Observe function of Peck Road bridge at the top of the reach. Monitor bridges impact on sediment transport, as well as local slope. 2.Develop comprehensive long range management plan for flood control structure (see details in General Recommendations)
Habitat	Investigate possible benefits of managing aggradation area such that fisheries migration can be reestablished.
Flooding	Address structural flooding at Starr residence (See general recommendations for more detail)
Further Assessment	1.Complete additional hydraulic analysis of flood control structure, to better understand impact on sediment transport.