Open Space Institute

STORM KING ART CENTER

June 19, 2015

BY EMAIL AND OVERNIGHT MAIL

Village of Kiryas Joel Board of Trustees
% Tim Miller Associates, Inc.
10 North Street
Cold Spring, New York 10516

Re: Joint Comments on the Village of Kiryas Joel's Annexation DGEIS

Dear Board of Trustees:

The Black Rock Forest Consortium, the Open Space Institute, Inc., the Orange County Land Trust, the Palisades Interstate Park Commission, and the Storm King Art Center wrote to the New York State Department of Environmental Conservation (NYSDEC) on March 20, 2013 and on April 28, 2014, regarding our concerns over the use of a proposed water supply well in Mountainville (the Mountainville Well) by the Village of Kiryas Joel (the Village). Our consulting hydrogeologists and biologists with The Chazen Companies also prepared a report dated April 29, 2014 identifying significant and substantive concerns with the proposed use of the Mountainville Well. We enclose copies of our March 20, 2013 and April 28, 2014 letters, and Chazen's April 29, 2014 report. For the reasons set forth below, the environmental impacts resulting from the Village's use of the Mountainville Well require further environmental review, including analyses of alternatives in order to minimize the impacts on the Moodna Creek and Ramapo River watersheds and their ecology.

As part of the Village's application to the NYSDEC, and in the Village's negative declaration under the State Environmental Quality Review Act (SEQRA) for the expansion of its water supply (the Water Supply Expansion Neg Dec), the Village stated, repeatedly, that the use of Mountainville Well would be as a secondary water supply source, which was a necessary prerequisite to the Village making a connection to the New York City Catskill Aqueduct (the NYC Aqueduct). The Village's Water Supply Expansion Neg Dec specifically stated that the Mountainville Well "will assure an adequate backup supply as required for the Village's Catskill Aqueduct connection." See the Water Supply Expansion Neg Dec at 1; see also the Village's Supplement W-1 for the Public Water Supply Permit dated November 15, 2011.

Now, in its Draft Generic Environmental Impact (DGEIS) the Village has changed its water supply project, stating that the Mountainville Well would be used as a primary source of water supply for some unspecified period of time, and possibly as a permanent water supply. See DGEIS at 3.5-1, 6. The Village's only apparent obligation would be to merely identify a redundant source of water one year after placing the Mountainville Well into service as a primary water source. The Village makes no commitment to use a redundant water supply within any timeframe, or to reserve the use of the

Mountainville Well as a backup supply as it previously claimed. This is a substantial change to the Village's proposed water supply expansion.

The Village's indefinite use of the Mountainville Well as a primary water source heightens our concerns over the environmental threats to the Moodna Creek and Ramapo River watersheds and their surrounding ecology.

Unfortunately the Village unilaterally suspended the NYSDEC's review of its water supply application. As a result, the Village has yet to address any of the significant and substantive comments raised during the NYSDEC's legislative hearing, including our prior comments. Nonetheless, construction of the pipeline to the Mountainville Well continues, without either NYSDEC or NYC approval to actually fill it with water. Furthermore, the Village is installing a pipe that is 24 inches in diameter; the Village's prior SEQRA review only evaluated the impacts associated with the use of an 18 inch diameter pipe. A 24 inch pipe has double the carrying capacity of an 18 inch pipe. This is one more example of the outstanding issues that the Village did not review under SEQRA, or inadequately reviewed.

SEQRA requires that a lead agency rescind a negative declaration whenever substantive (1) changes are proposed for the project, (2) new information is discovered, or (3) changes in circumstances related to the project arise; that were not previously considered and the lead agency determines that a significant adverse environmental impact may result. 6 NYCRR § 617.7(f).

Accordingly, we request that the Village rescind its Water Supply Expansion Neg Dec and undertake a full SEQRA analysis of the potential environmental impacts resulting from the Village's proposed permanent use of the Mountainville Well. Once again, our concerns are set forth in detail in the attached March 20, 2013 and April 28, 2014 letters, and Chazen's April 29, 2014 report.

Should the Village determine not to rescind its Water Supply Expansion Neg Dec, then the Village must address our concerns raised in this letter, our prior letters and the Chazen report as part of the Village's current Generic Environmental Impact Statement on the proposed annexation. We submit these documents as comments to the DGEIS, and because they are substantive, the Village must address them in any Final Generic Environmental Impact Statement. 6 NYCRR § 617.9(b)(8).

By reviewing separately the water supply issues from the annexation, the Village improperly segmented the review of water supply issues. Indeed, in its Water Supply Expansion Neg Dec the Village claimed that the expanded water supply would not induce growth. See Water Supply Expansion Neg Dec at 8. But now, in the Village's DGEIS, the Village states that "the primary benefit of annexation as it relates to water supply is the ability of landowners to connect to the Village of Kiryas Joel public water system." See DGEIS at 3.5-16. Thus, the Village has separated the environmental review of the water supply expansion from the annexation. **The Village should make every effort to cure this improper segmentation by undertaking a comprehensive environmental review now.**

The landscape in Orange County affected by the proposed water supply expansion has been the epicenter of conservation efforts for more than a century. Starting in 1909, the State of New York and the Palisades Interstate Park Commission protected over 71,000 acres of land in the western Hudson Highlands, including Harriman State Park (New York State's second largest state park), Bear Mountain State Park, Sterling Forest State Park and Storm King State Park. Collectively we have protected an additional 9,000 acres in this area at an aggregate cost of over $72 million. The proposed water supply project may have a significant impact on the public's use and enjoyment of these scenic, historic and ecologically sensitive lands. As noted by Chazen, the Village's existing water supply analysis "fails to describe and evaluate inevitable environmental impacts of a 425 gpm inter-basin transfer removing water from the Woodbury Creek tributary watershed and its downstream Moodna Creek watershed." Based on actual field data and analyses, Chazen found that,

> [the] continuous removal of 425 gpm will deplete the Woodbury Creek of more than half its flow during at least one month per year on average, **and is likely to fully dry the creekbed during drought periods**. These depletion impacts raise concerns also for downstream Moodna Creek flows since our data demonstrate that the Woodbury Creek supports half the flow of the Moodna Creek during dry periods.

See Chazen report at 1 (emphasis supplied). The Village has not addressed these concerns.

All agencies subject to SEQRA must "conduct their affairs with an awareness that they are stewards of the air, water, land, and living resources, and that they have an obligation to protect the environment for the use and enjoyment of this and all future generations." 6 NYCRR § 617.1(b). We ask that the Village carefully consider our significant and substantive concerns for the Moodna Creek and Ramapo River watersheds and their ecology.

Respectfully Submitted,

Open Space Institute, Inc.

By: ______________________
Kim Elliman
President & CEO

Palisades Interstate Park Commission

By: ______________________
James F. Hall
Executive Director

Storm King Art Center

By: ______________________
John P. Stern
President

Orange County Land Trust

By: ______________________
James Delaune
Executive Director

Black Rock Forest Consortium

By: ______________________
William Schuster
Executive Director

Enclosures

Open Space Institute

ORANGE COUNTY LAND TRUST

STORM KING ART CENTER

BLACK ROCK FOREST CONSORTIUM

April 28, 2014

BY HAND DELIVERY

R. Scott Ballard
Environmental Analyst
New York State Department of Environmental Conservation
Region 3
21 South Putt Corners Road
New Paltz, New York 12561

Re: Joint Comments on the Water Supply Application of the Village of Kiryas Joel
NYSDEC Application No. 3-3399-00065/00001

Dear Mr. Ballard:

The Black Rock Forest Consortium (BRFC), the Open Space Institute, Inc. (OSI), the Orange County Land Trust (OCLT), the Palisades Interstate Park Commission (PIPC), and Storm King Art Center (SKAC) wrote to you last year requesting that the Department hold an adjudicatory hearing on the water supply application submitted by the Village of Kiryas Joel. There are significant and substantive issues that must be addressed before the Department can make a final determination on this application, and a hearing would provide a full and fair opportunity for those issues to be adjudicated.

The Department determined to hold a legislative hearing, and we appreciate the opportunity that such a hearing provides to elicit further information about the Village of Kiryas Joel's proposed water taking and inter basin transfer. During the past year when this project was on hold at the request of the applicant, we engaged the services of The Chazen Companies, and in particular, Russell Urban-Mead, a hydrogeologist with great familiarity with the Moodna basin, and Barbara Beall, a professional wetland scientist.

Our professionals conducted an extensive review of the Village's proposal in order to evaluate the potential impacts on the availability of water in the Moodna basin, and the potential impacts to ecology. Chazen prepared an extensive report, criticizing the Village's application for shortcomings in its analysis. Chazen found significant concern should the Village utilize its proposed public water well on anything but a short term, infrequent basis. A copy of Chazen's report is attached.

We seek to protect the water resources of the Moodna Creek Watershed and the ecology it supports. The NYSDEC's own 2006 Hudson River biodiversity report and 2008 Moodna Creek Watershed biodiversity reports specifically discuss the significant role the Woodbury Creek and its associated wetlands play in maintaining a habitat corridor, ecological biodiversity and connectivity between the Hudson Highlands and the mouth of the Moodna Creek, an irreplaceable aquatic system. The withdrawal of 59% and more of the flow from Woodbury Creek and significant flow from Moodna Creek during low flow conditions by the Mountainville Well has the potential for significant adverse impacts on aquatic connectivity, water quality, rare wetland plants, wood turtles, stream salamanders, trout species, damsel and dragonflies, among other resources. The NYSDEC 2006 and

2008 reports state that hydrological changes in streams and wetlands cause significant direct and indirect impacts to these resources and the biodiversity they support.

Given these concerns, which are substantiated by expert analysis, we recommend the following key considerations to the Department:

1. The Department should require the Village to submit additional information to address the deficiencies in their application and hydrogeological study as outlined in Chazen's report. Should the Village fail or refuse to do so, we recommend that the Department deny the application.

2. Should the Department ultimately determine to issue an Article 15 Water Supply Permit to the Village, we recommend that the Department impose adequate safeguards to ensure that the wells are used solely when water from the City of New York aqueduct is not available. Such safeguards should include, at a minimum, gauging and monthly monitoring reports submitted to the DEC to ensure that the water is not being taken in nonemergency situations. Copies of those reports should be provided simultaneously to all interested organizations that have a vested interest in preserving the resources throughout the Moodna basin.

3. As we previously wrote to you on March 20, 2013 (copy of letter attached), our concerns constitute significant and substantive issues. If these concerns are not addressed by the applicant, we request that the Department hold an adjudicatory hearing pursuant to 6 NYCRR Part 624 so that our concerns can be heard in a more formal forum and adjudicated.

Thank you for the opportunity to submit these comments.

Respectfully Submitted,

Open Space Institute, Inc.

By: ______________________
Kim Elliman
President & CEO

Palisades Interstate Park Commission

By: ______________________
James F. Hall
Executive Director

Storm King Art Center

By: ______________________
John P. Stern
President

Orange County Land Trust

By: ______________________
James Delaune
Executive Director

Black Rock Forest Consortium

By: ______________________
William Schuster
Executive Director

Palisades Interstate Park Commission

BLACK ROCK FOREST CONSORTIUM

Open Space Institute

ORANGE COUNTY LAND TRUST

STORM KING ART CENTER

March 20, 2013

BY EMAIL AND OVERNIGHT DELIVERY

R. Scott Ballard
Environmental Analyst
New York State Department of Environmental Conservation
Region 3
21 South Putt Corners Road
New Paltz, New York 12561

Re: Joint Comments on the Water Supply Application of the Village of Kiryas Joel NYSDEC Application No. 3-3399-00065/00001

Dear Mr. Ballard:

The Black Rock Forest Consortium (BRFC), the Open Space Institute, Inc. (OSI), the Orange County Land Trust (OCLT), the Palisades Interstate Park Commission (PIPC), and the Storm King Art Center (SKAC) request that the Department hold an adjudicatory hearing on the water supply application submitted by the Village of Kiryas Joel. There are significant and substantive issues that must be addressed before the Department can make a final determination on this application, and a hearing would provide a full and fair opportunity for those issues to be adjudicated.

The Village of Kiryas Joel (the Village) proposes to connect a new well to a 13.5 mile pipeline to be constructed across three towns that would also allow the Village to connect to New York City's Catskill Aqueduct. This new well and aqueduct connection would enable the Village to increase its water supply by more than 600,000 gallons per day, for a total Village water supply of about 2,540,000 gallons per day.

At the outset, we wish to note that our organizations do not critique the Village's vision for its future growth. Rather, our collective concern is how the Village's proposal relates to regional issues of water conservation and future needs, wastewater treatment and capacity, and regional patterns of growth. These are the issues that concern us for they intersect directly with our mutual efforts to conserve the environment and natural setting of the Hudson Valley.

Although all of our organizations operate independently, we share the joint purpose of protecting scenic, natural and historic landscapes to provide public enjoyment, conserve resources, and sustain communities. The landscape in Orange County affected by the proposed water supply project has been the epicenter of conservation efforts for more than a century. Starting in 1909, the State of New York and the PIPC protected over 50,000 acres of land in the western Hudson Highlands, including Harriman State Park (New York State's second largest state park), Bear Mountain State Park, and Storm King State Park. BRFC, OSI, OCLT and the SKAC (and their conservation partners) have protected an additional 22,000 acres in this area, including Sterling Forest State Park, at an aggregate cost of over $72 million. The proposed water supply project will likely have a significant impact on the public's use and enjoyment of these scenic, historic and ecologically sensitive lands. A more complete description of our organizations and their conservation efforts is set forth in the enclosed addendum. We are all deeply committed to protecting the natural beauty and integrity of this great landscape so close to the nation's largest metropolitan area.

Which brings us to our concerns regarding the Village's proposal to transport water across 13.5 miles, from one water basin to another, and across three towns solely to spur its own future development. For the sake of context, Orange County and its communities have a long history of efforts to identify and protect their water sources. The Village's increased withdrawals must be evaluated in the context of those efforts and of the limited volume of the resource.

It is apparent to us that little or no consideration has been given to the regional impacts of water conservation and future needs, wastewater treatment and capacity, and regional patterns of growth that would result from the Village's proposal. At first glance these would appear to be issues supposedly addressed as part of the State Environmental Quality Review (SEQR). We note that the Village served as SEQR Lead Agency for its own proposal. It appears to us that the Village gave little or no consideration to the various environmental impacts during its SEQR review. For instance, regarding the growth inducing aspects of this proposal and its effects on groundwater resources for neighboring communities, the Village merely noted that "there are no other public or private groundwater wells in the direct vicinity of the project or within the zone of influence of the proposed new wells." See Village's Negative Declaration at 7 (Second, dated December 4, 2012).

First, the Village's information is incorrect: there are several public and private groundwater wells in the direct vicinity of the Village's proposed well. Second, and equally important, there has been no apparent consideration given to the right of adjoining communities to access their water resources and indeed, their ability to conserve it. By taking water from such a long distance from its own boundary, the Village will likely be taking water at the expense of their neighboring municipalities' future needs and their efforts -- and our efforts -- towards conservation. The Village's proposal would remove a significant amount of water from the Moodna basin and deposit it ultimately as wastewater into the Ramapo River. Additionally, we are concerned about the stream flow impacts on the Woodbury Creek. There appears to be no evaluation of these issues whatsoever. However, before the Department grants any permit for this project, it must address these issues.

We recognize that the Department does not provide oversight over the SEQR reviews of other agencies. But here, our concerns are not merely SEQR concerns; rather, they go to the heart of the Department's permit jurisdiction.

The Department's guidance makes it clear that its "authority relates more to the taking and distribution of water than to the physical construction or alteration of facilities." See Technical Operational Guidance Series (TOGS) 3.2.1. at 9 (December 13, 1990) (emphasis in original). By contrast, the information provided by the Village relates almost exclusively to the construction of the well and pipe facilities, and virtually ignores the actual taking of water and its long-term impacts. By doing so the Village effectively segmented the SEQR review of this proposal from its true impacts. But no matter: the Department must consider these impacts as part of its review and decision-making.

The Environmental Conservation Law requires the Department to affirmatively find that the water supply proposal will be "just and equitable to all affected municipalities and their inhabitants with regard to their present and future needs for sources of potable water supply" before it issues a permit. ECL § 15-1503(2)(c) (emphasis added). This provision has been part of the water supply permit requirements since enacted in 1905, and it is central to the decision making required here. Indeed, in order to issue the permit to the Village, the Department must make an affirmative finding for all of the statutory determinations, including that the Village's proposal is just and equitable to all affected municipalities:

> For a permit to be issued, an affirmative finding must be made for each and every [statutory determination set forth in ECL § 15-1503]. Any single negative determination must result in denial of the permit.

See TOGS 3.2.1. at 2 (emphasis in original).

No analysis has been provided on the issue of impacts to the affected municipalities, which is of paramount importance to current and future conservation efforts, water demand and patterns of growth. We believe that this must be addressed in an adjudicatory hearing. Only at a hearing will the Department be able to hear from hydrogeologists and planners from the surrounding communities to detail their conservation efforts and future water needs. None of this information exists in the current record.

The Department's regulations also demand further analysis. 6 NYCRR Part 601 requires the Department to determine that the proposal is "environmentally sound", and also requires the Department to "consider the particular facilities and processes involved, taking into account the environmental impact, age of equipment and facilities involved, the processes employed, energy impacts and other appropriate factors." 6 NYCRR § 601.2(g) (emphasis added). We question how the Department can make such determinations on the basis of the meagre record before it and the Village's Negative Declaration which provided such short shift (or no shrift) to any possible impact to community character, aesthetics, air quality, public health, induced growth, community plans and cumulative impacts. For each of these areas of inquiry, the Village merely concluded that there would be no impact. The Department's regulations require it to delve deeper.

We are also deeply concerned regarding the resulting wastewater impacts. The Village claims the increased wastewater flows "will not have an adverse impact on wastewater treatment capacity or the Ramapo River." See Village's Negative Declaration at 9. It is entirely unclear how the Village arrived at this conclusion, which is not supported by the record before us. The integrity of the Ramapo River and its ecosystem is one of our primary concerns. We question whether the additional wastewater impacts on the Ramapo River and decreases in water levels in the Woodbury Creek -- and the ancillary habitat impacts associated with decreased stream flows -- will result in those protected waterbodies' degradation, which would violate the Department's antidegradation policy. See Water Quality Antidegradation Policy TOGS 1.3.9 (September 9, 1985); see also In the Matter of Athens

Generating Company, LP, 2000 WL 33341186 at 31 (N.Y. Dep't Env. Cons. April 26, 2000) (citing PUD No. 1 v. Washington Dept. of Ecology, 511 U.S. 700, 717-723 (1994)). Further proof needs to be adduced in order for the Department to conclude that the Village's proposal is environmentally sound.

Given the significant and substantial issues raised above, we respectfully request that the Department hold an adjudicatory hearing. 6 NYCRR Part 621.8 requires that:

> [W]here any comments received from members of the public or other interested parties raise substantive and significant issues relating to the application, and resolution of any such issue may result in denial of the permit application, or the imposition of significant conditions thereon, the department shall hold an adjudicatory public hearing on the application.

An adjudicatory hearing would provide the only opportunity for all interested parties, communities and stakeholders to address the significant and substantial regional impacts of the Village's proposal.

Respectfully Submitted,

Open Space Institute, Inc.

By: ______________________
Kim Elliman
President & CEO

Palisades Interstate Park Commission

By: ______________________
James F. Hall
Executive Director

Storm King Art Center

By: ______________________
John P. Stern
President

Orange County Land Trust

By: ______________________
James Delaune
Executive Director

Black Rock Forest Consortium

By: ______________________
William Schuster
Executive Director

Addendum

Palisades Interstate Park Commission | BLACK ROCK FOREST CONSORTIUM | Open Space Institute | ORANGE COUNTY LAND TRUST | STORM KING ART CENTER

Addendum to our Joint Comments on the Water Supply Application of the Village of Kiryas Joel
NYSDEC Application No. 3-3399-00065/00001

The signatories to this letter have a common purpose of protecting lands and water resources in the vicinity of the proposed water supply project, and have collectively protected (with their conservation partners) over 22,000 acres of land in the Moodna, Woodbury and Ramapo watersheds. As more fully set forth below, each of the signatories to this letter owns a significant amount of land and interests in land (such as conservation easements) which will be directly affected by the proposed water supply project. The signatories are as follows:

<u>Black Rock Forest Consortium</u>

The Black Rock Forest Consortium ("BRFC") owns the nearly 4,000-acre Black Rock Forest in the Hudson Highlands immediately east of the proposed water supply project. The lands have been managed as an experimental and research forest for over 80 years, and include numerous lakes and streams. In 1989 the forest and its extensive water resources, including the Canterbury, Black Rock and Mineral Brook streams, were permanently protected and made available to the general public through the Black Rock Forest Consortium, a non-profit consortium of universities and research institutes.

<u>Open Space Institute, Inc.</u>

Open Space Institute ("OSI") has a long-standing interest in the protection of the Hudson Highlands on the west side of the Hudson River in Orange County, and has permanently protected for the benefit of the public a substantial amount of land in the Moodna, Woodbury Creek and Ramapo River watersheds. Over the last 17 years OSI has directly invested over $8.5 million protecting over 3,680 acres of land in the Towns of Cornwall, Woodbury, Blooming Grove, Tuxedo and Monroe.

Most recently OSI purchased the Houghton Farm, a 151-acre property which surrounds the site of the proposed pumping station (and through which the Woodbury Creek runs) because of its historic and scenic importance (Winslow Homer lived and painted on the Houghton Farm). In 2012 OSI transferred the Houghton Farm to the Storm King Art Center ("SKAC") subject to easements that strictly limit future development.

OSI has been collaborating with SKAC and BRFC on further land and easement purchases in order to create a major "wildlife" corridor in the vicinity of the proposed water supply project. This wildlife corridor will among other things enable flora and fauna to adapt to climate change and allow the movement of species between the Black Rock Forest Preserve and the nearly 3,000-acre Schunnemunk Mountain State Park. As part of this effort, on March 19th of this year OSI spent more than $2.25 million to acquire and protect a 702-acre tract in the immediate vicinity of the proposed water supply project.

Orange County Land Trust

The Orange County Land Trust ("OCLT") is a tax-exempt charity which protects fields, forests, wetlands, ridgelines and river corridors in and around Orange County, including the area surrounding the proposed water supply project. In the Towns of Cornwall, New Windsor, Woodbury, Blooming Grove and Monroe in Orange County OCLT has protected over 525 acres of ecologically important and scenic land.

Palisades Interstate Park Commission

In 1900 governors Theodore Roosevelt of New York and Foster M. Voorhees of New Jersey formed the Palisades Interstate Park Commission to oversee the preservation of the Palisades and lands along the Hudson River. The lands preserved by the Commission grew by the addition of the 10,000 acre Bear Mountain State Park to the more than 40,000 acre Harriman State Park and the 18,000 acre Sterling Forest State Park. The Palisades Interstate Park system has been expanded over the years: it now includes 24 parks and eight historic sites, covering over 100,000 acres along more than 20 miles of Hudson River shoreline and beyond.

Storm King Art Center

Storm King Art Center (SKAC), founded in 1960, is one of the world's leading sculpture parks. It owns and protects more than 700 acres of land in the Town of Cornwall, New York, in the immediate area of the proposed water supply project. More than 80,000 people visited SKAC in 2012. Since 1985 SKAC has worked with OSI and other organizations to preserve more than 2,500 acres of land in the immediate region, 2,300 acres of which now form part of Schunnemunk Mountain State Park. In 2012 SKAC purchased the 150 acre Houghton Farm property, subject to a conservation easement, from OSI. This property surrounds the proposed well field, part of the proposed water supply project that is the subject of the above-referenced application.

THE Chazen COMPANIES®
Proud to be Employee Owned
Engineers
Land Surveyors
Planners
Environmental & Safety Professionals
Landscape Architects

Hudson Valley Office
21 Fox St., Poughkeepsie, NY 12601
P: (845) 454-3980 F: (845) 454-4026
www.chazencompanies.com

Capital District Office (518) 273-0055
North Country Office (518) 812-0513

April 29, 2014

Mr. Scott Ballard, Deputy Regional Permit Administrator
NYSDEC, Region 3
21 South Putt Corners Road
New Paltz, NY 12561

Re: April 29, 2014 Legislative Public Hearing Written Comment Submission
Village of Kiryas Joel Proposed Mountainville Well. No 1
DEC Application No: 3-3399-00065/00001 Water Withdrawal
Chazen Job # 41317.00

Dear Mr. Ballard:

The following comments are offered by The Chazen Companies (Chazen) on behalf of the Black Rock Forest Consortium, the Open Space Institute, the Orange County Land Trust, the Palisades Interstate Park Commission and the Storm King Arts Center.

SUMMARY OF CONCERNS, WITH RECOMMENDATIONS

Based on our analysis, the NYSDEC does not have enough technical information with which to make a decision about this permit application. The Applicant's 72-hour well pumping test may satisfy NYSDOH yield and quality criteria, but fails to describe and evaluate inevitable environmental impacts of a 425 gpm inter-basin transfer removing water from the Woodbury Creek tributary watershed and its downstream Moodna Creek watershed. We have described below our concerns about riparian, wetland, and habitat corridors and numerous species contained within the specific Woodbury Creek corridor as well as Moodna Creek Hudson River estuary environment. Given these significant ecological service data gaps, the NYSDEC cannot make an informed decision on this project with the information at hand.

Before this proposed full-time inter-basin transfer can be permitted, the NYSDEC should request that the Applicant perform a full evaluation of the inevitable water loss impacts on aquatic and ecological resources, and conduct a better-instrumented and much longer pumping test to secure improved understandings of both the stabilized radius-of-impact around the well(s), and better define the proportional shares of intercepted groundwater no longer reaching the stream versus directly induced stream flow that would support this proposed wellfield. Once those data are collected, a second opportunity for the public to review and comment should be provided. Data we present show that continuous removal of 425 gpm will deplete the Woodbury Creek of more than half its flow during at least one month per year on average, and is likely to fully dry the creekbed during drought periods. These depletion impacts raise concerns also for downstream Moodna Creek flows since our data demonstrate that the Woodbury Creek supports half the flow of the Moodna Creek during dry periods.

In the event that the NYSDEC choses to not ask the Applicant to complete the necessary full evaluations of the aquatic and ecological resources and new pumping tests, then the NYSDEC should only issue a permit allowing occasional use of this well site, uniquely as a back-up source for the current water source, with verifiable permit conditions for extremely episodic use, limited to not more than 72 hours, with monitoring and reporting to demonstrate that the well is being used only in accordance with these conditions. Clarification is also required whether more than 425 gpm would ever be sought from this location. We have grave concerns about the ecological carrying capacity of both the Woodbury Creek and Moodna Creek should the NYSDEC permit any additional inter basin transfers, aside from perhaps short-term, emergency period (e.g. back-up) withdrawals.

If the NYSDEC is not willing to undertake any of the steps outlined above, we have recommended to our clients that they respectfully request an adjudicatory hearing on this matter.

Potential Impacts to Wetlands within the Test Well Radius of Influence

Based on map interpretation of Figure 3 of the Applicant's 2011 pumping test report, at least 5 acres of federally-regulated wetland lies in areas between 100 and 700 feet from the test well. As discussed later in this letter, the wetland immediately adjacent to the well can be characterized as a groundwater slope wetland, meaning that it receives at least a portion of its hydrological inputs from groundwater seepage. The Applicant's pumping test suggests that drawdown impacts were unlikely to have reached 100 feet from the test well after 72-hours of pumping.

Again, depending on the frequency and duration of pumping and its timing relative to background hydrological conditions, the range of impacts (and severity) occurring after withdrawal periods longer than 72 hours could include changes in species composition, and changes in wetland covertypes, significant reductions in wetland coverage, increased colonization by invasive species, and loss of wetland hydrology necessary to support aquatic organisms.

Potential Impacts to Ecological Resources

Chazen has conducted a literature review, mapping review and preliminary on-site ecological review of habitats in the vicinity of the Mountainville Well including the Woodbury Creek riparian corridor and other wetlands, as well as a review of Woodbury Creek from upstream near the Route 32/I-87 crossing downstream to the outlet of Moodna Creek at the Hudson River. It is noted that the NYSDEC's own 2006 Hudson River Biodiversity Report and 2008 Moodna Creek Watershed Biodiversity Report recognizes the importance of Woodbury Creek, Moodna Creek and its location in the Highlands as being significant areas for contributing to and maintaining biodiversity, and that Woodbury and Moodna Creeks serve as a riparian corridor connecting the Highlands to the Hudson River.

These reports specifically discuss adverse impacts that result from changes in aquatic hydrology to streams and wetlands. Hydrological changes to the stream and wetlands have the potential to change stream and terrestrial biodiversity and the overall connectivity of the riparian corridor. The 2006 NYSDEC Report states: "minimizing the hydrological alteration of stream systems….will help to protect stream biodiversity…"[1] "Wetland conservation strategies should include, where possible, the restoration and protection of wetland hydrology and wetland plant communities, [and] control of invasive species."[2]

---

[1] Penhollow, M.E. P.G. Jensen and L.A. Zucker. 2006. Page viii.
[2] Ibid. Page viii.

One can "preserve the species that depend on unfragmented forests and habitat corridors by conserving mature lowland forests, forest fragments in riparian areas, and controlling invasive species."[3]

Again, the severity of the impacts to ecological resources is dependent upon the frequency, duration and volume of pumping, and the background hydrological conditions when the pumping occurs. Along with the overall reductions in the ability of the Woodbury Creek riparian corridor to provide a biodiversity linkage from the Highlands to the mouth of the Moodna Creek, the following aquatic dependent species are specifically identified as potentially being significantly impacted should the Mountainville Well be placed in continuous service:

- Rare plants.
- Macroinvertebrates.
- Rainbow, brown and brook trout.
- Other fish species.
- Wood turtle.
- Mink.
- Dragonflies and damselflies.
- Bats and birds.

As discussed later in this letter, a 2012 Biomonitoring Report[4] indicates a steady decline in water quality at the downstream Woodbury Creek monitoring location. Our stream gauging data suggest that the Mountainville Well, if placed in continuous service, would reduce flows in Woodbury Creek by 59% during Q90 conditions (and by greater percentages under yet drier conditions). This has the potential to increase temperatures, reduce levels of dissolved oxygen and reduce the stream's capacity to assimilate discharges. This combination of factors is likely to further reduce the water quality in the stream both in the Woodbury and Moodna Creeks.

The mixing of freshwater and salt water at the Moodna Creek mouth is key to the "irreplaceable" aquatic plant communities found at this location. Woodbury Creek inputs to Moodna Creek are a significant portion of the overall water budget to Moodna Creek. Under continuous pumping, during the Q90 conditions, the freshwater flow in Moodna Creek would be reduced by 27% and by greater fractions during yet drier conditions, assuming the addition of no further Inter Basin transfers. The aquatic ecosystem at the mouth of the Moodna Creek has developed in response to the regular volumes of freshwater and tidal pulses moving through the mouth. Changing the percentage of freshwater to salt water pulses in this area has the potential to change the equilibrium of the unique aquatic habitats found in this area. Moodna Creek is already experiencing adverse impacts to fisherie populations, theorized to be the result of increased sewage plant discharges upstream.[5] Reducing freshwater inputs from Woodbury Creek due to withdrawals from the Mountainville Well has the potential to exacerbate downstream pollution impacts due to reduced freshwater flow volumes and increased temperatures. This will further reduce the assimilative capacity of the Woodbury and Moodna Creeks, further stressing fisheries and aquatic flora and fauna at the mouth of the Moodna.

---

[3] Ibid. Page viii.
[4] Orange County Water Authority. 2013.

[5] Heady, Laura. 2008. Page 7.

Additive and Cumulative Impacts

The Mountainville Well pumping test report also includes calculations suggesting that up that 1,212 gpm could be pumped from the same location. Should such withdrawal levels be advanced, there is a strong likelihood that there will be **no** freshwater flow from the Woodbury Creek or Moodna Creek reaching the Hudson River in the Q90 condition (up to one month per year).

Summary Conclusions

1. An inter-basin transfer of 425 gpm from the Mountainville Well warrants a serious review by the NYSDEC of the riparian, wetland, and ecological issues due to flow depletion in both the Woodbury Creek tributary and the Moodna Creek, and of the impacts to wetlands within the dewatered radius of influence around the proposed well.

2. The Mountainville Well pumping test data suggest to us that occasional use of the Mountainville Well as a back-up water supply (i.e., infrequent episodes less than 72 hour in duration) could be authorized since direct radial drawdown impacts did not appear to reach either wetlands or the Woodbury Creek in 72 hours. While short-term Inter-Basin Transfers would still be occurring, the impacts to aquatic and ecological resources would be muted if withdrawals were kept to short durations and low frequencies.

3. It is our professional opinion therefore that adequate environmental data may be available to support issuance of a Back-Up 425 gpm well use permit, provided it contains enforceable conditions that can be monitored, for example: stipulating use **only** when the Applicant's stated Primary Source (the NYCDEP Aqueduct) is documented to be off-line. However, no permit, even for intermittent use, for withdrawals up to 1,212 gpm should be authorized, and no permit for greater than 72 hours should be authorized on the basis of the currently-available ecological, wetland, and/or pumping test data. If Well 1 is proposed to be used for periods longer than occasional 72-hour, even as a back-up well, the potential adverse impacts to aquatic, wetland, and ecological resources identified and discussed in this letter should be independently examined by the NYSDEC before a permit is issued.

QUALIFICATIONS

This review was completed by Russell Urban-Mead, CPG, PG, Senior Hydrogeologist at Chazen, Barbara B. Beall, PWS, LEED®AP, Director of Wetlands and Ecological Services at Chazen, and Mallory Gilbert, PWS, CPSS, CPESC, of Chazen and of M.N. Gilbert Environmental. Resumes of these three professional are available upon request. All three have been active in their professional fields for 25+ years, and are qualified as expert witnesses.

EXPANDED ANALYSIS

HYDROGEOLOGIC RESOURCES

Existing Conditions

In order to become familiar with the watershed and hydrogeologic setting of the proposed Kiryas Joel Mountainville Well and its environments, Mr. Urban-Mead reviewed prior stream gauging data, USGS gauging station data for the nearby Wappinger Creek, the Ayer and Pausek USGS publication[6], as well as groundwater supply reports for the Mountainville and recently-activated Village of Cornwall wellfield.

Watershed Flow Characteristics: Attachment A, Stream Gauging Summary, provides the results of stream flow measurements collected by Chazen in August of 2010 in the Moodna watershed, including on the Woodbury Creek. The Woodbury Creek flows past the Mountainville Well (Mountainville Well) before entering the Moodna Creek.

For seasonal reference purposes, and because there is no USGS gauging station on the Moodna Creek, Chazen compared its August 2010 Moodna Creek and tributary flow data to flow data recorded continuously by USGS in the nearest and somewhat equally-sized watershed, which is Wappinger Creek in Dutchess County. Both watersheds lie in similar climate zones with similar annual precipitation expectations.

On August 12, 2010, flow at the USGS gauging station on Wappinger Creek was 25 cubic feet per second (cfs). According to Ayer and Pausek, flows of 21 cfs in the Wappinger Creek are equaled or exceeded 90% of the time (Q90), meaning that similar or lower flows would be expected up to 10% of the time. These references suggest similar or lower flows than those recorded by Chazen in the nearby Moodna and Woodbury Creeks on August 13 of 2010 would also be expected up to slightly more than 10% of the time, or approximately 37 or more days per year on average.

On August 13, 2010, Chazen recorded a flow of 4.04 cfs (1,813 gallons per minute) on the Moodna Creek near its outlet into the Hudson River at Route 32 near Quaker Avenue, and on August 12, 2010, flow of the Woodbury Creek near its outlet into the Moodna Creek was 2.14 cfs (960 gpm), measured where the creek passes under Creamery Road in the Town of Cornwall. Notably, this datum indicates that the Woodbury Creek was providing essentially half the total flow of the Moodna Creek (4.04 cfs) where it entered the Hudson River.

As another observational calculation, each creek's flow was divided into their respective contributing watershed areas to identify a flow-per-square-mile value:

- August 12, 2010 flow in Wappinger Creek equaled 0.138 cfs/sq.mi;
- August 13, 2010 flow in Moodna Creek equaled 0.022 cfs/sq. mi.; and
- August 12, 2010 flow in Woodbury Creek equaled 0.096 cfs/sq. mi.

In summary, the stream gauging work Chazen completed in 2010 suggests the Moodna Creek is prone to very dry flow conditions, more so than other regional streams during low-precipitation periods, and that

[6] Ayer, G.R. and F.H. Pausek. 1968.

the Woodbury Creek is a significant dry-season contributor to the Moodna Creek tributary. Woodbury Creek is however itself a small creek, sustaining only moderate flows during dry seasons.

Well Withdrawals and Inter-Basin Transfers: Groundwater withdrawal impacts from the Mountainville Well, at 425 gpm, must be evaluated as and recognized as an Inter-Basin Transfer. All water withdrawn from the Mountainville Well will be pumped to another watershed, where most will be returned to another watershed.[7] The Mountainville Well withdrawals will accordingly reduce the overall hydrologic budget in the Woodbury Creek tributary and Moodna Creek on a gallon-for-gallon basis by 425 gpm.

The Village of Cornwall also recently placed new wells on line which Chazen believes are permitted for a withdrawal rate of 0.9 million gallons per day (mgd), equal on average to 364 gallons per minute (gpm). Based on communications with the water district, approximately two thirds of this water is similarly used outside the Woodbury Creek watershed boundary, so approximately 243 gpm of this withdrawal is also an Inter-Basin Transfer. The Village of Cornwall wells had not yet been placed on line during Chazen's 2010 stream gauging effort. As a result, we should adjust downward Chazen's 2010 measurements by approximately 243 gpm to estimate current 10% flow condition. Thus, in 2014, low or lower flow expected up to 10% of each year ("Q90 flow) would become 717 gpm or less for the Woodbury Creek, and 1,570 gpm or less for the Moodna, for at least one month per year on average.

Against these adjusted low-flow condition stream values, the proposed Mountainville Well 425 gpm well Inter-Basin Transfer represents 59% or more of the Woodbury Creek flow and 27% or more of the Moodna Creek flow into the Hudson River during dry and extremely dry Q90 conditions typically occurring up to 37 days per year.

Mountainville Well Pumping Test: The 2011 well pumping test included installation of a test well followed by a 72-hour flow test as documented in a 2011 report prepared by the Applicant's consultant.[8] The flow rate at the end of the test was 425 gpm. The report estimates that two more wells could be installed, for a theoretical safe site yield value of 1,212 gpm. Chazen's comments on the pumping test, provided below, focus solely on potential dewatering impacts the well may have within the radius of impact of the test well and on likely hydrogeologic interconnections between the well and the Woodbury Creek. We have reviewed comments submitted by Maser Consulting (dated on or around April 16, 2014) on behalf of the Village of Cornwall on Hudson and the Town of Cornwall, and endorse and agree with the various test deficiencies identified.

The data in the Applicant's 2011 Pumping Test Report show that the radial drawdown area around the test well was still expanding at the end of the 72-hour test. See Attachment B (Monitoring Well 1 drawdown) which illustrates graphically, for example, that drawdown was continuing through to the end of the test period. This demonstrates that groundwater levels around the test well were continuing to adjust downward and outward when the test was ended. Thus the Applicant's development of a Distance-Drawdown plot in the test report (see their Appendix VI) was premature, should not be used to suggest the test resulted in a 100 foot radius of impact, and should not have been used as the basis for any calculations suggesting the final yield potential for this site. As noted by Maser Consulting, the

---

[7] The Inter-Basin Transfer may be to septic systems or to a separate wastewater treatment plant; this is irrelevant as the discharge will not be to the Woodbury or Moodna Creek Watershed.
[8] Leggette, Brashears & Graham, Inc. 2011.

monitoring wells were also partially penetrating (installed at less than half the depth of the pumping well) so only delayed drainage, rather than immediate drawdown, is recorded by either MW-1 or MW-2.

The two shallow monitoring wells do, however, demonstrate that active well pumping at depth dewatered sediments extending far up toward the ground surface. Approximately 9.7 feet of drawdown had developed in MW-1 and 0.42 feet had developed in well MW-2 by the end of 72 hour observation period. This is helpful information because some references have suggested the Woodbury Creek flows over a clay or silt horizon, disconnected from the underlying sand and gravel valley aquifer.[9] The test response of wells MW-1 and MW-2 suggest this is not true in this location. Furthermore, only the geologic log for MW-1 identifies any clay seams, and mini-well 3 (PZ-3) installed by the Applicant in the Woodbury Creek demonstrated continuous stream flow loss (downward migration) throughout the test period. So, taken all together, no present evidence suggests the Woodbury Creek is isolated from the deeper geologic sediments tapped by the test well. Thus direct drawdown radius-of-impact influences and induced stream flow depletion can reasonably be expected and should be evaluated at this site.

Where proposed wells are situated near streams (in this case 500 to 700 feet from a bend in the stream), well yield is normally supported by intercepted groundwater otherwise migrating toward the stream, and by some measure of induced stream flow from the stream bed. Wells further from streams often are supported solely by intercepted groundwater flow. Distinguishing relative shares is not critical because the sum of intercepted baseflow and any induced streamflow equals the pumping withdrawal rate regardless of stream setback distances or any diverting clay horizons.

However, in this instance, we do recognize that the 72-hour test has provided moderately-secure data suggesting that the test radius of influence had not yet reached or yet sharply depleted the Woodbury Creek of flow. By terminating the test at 72-hours, the impacts of removing nearly 2 million gallons of water in 3 days could be distributed over also the pre- and post-test periods, resulting in muted stream and wetland dewatering impacts. Infrequent and short (72 hours or less) well withdrawals at a rate not exceeding 425 gpm from the site would likely not adversely impact Woodbury Creek, the Moodna Creek, or wetlands near the test well.

AQUATIC AND ECOLOGICAL RESOURCES

Methodology

In order to become familiar with the physical and biological setting of the proposed well field and its environments, Ms. Beall and Mr. Gilbert reviewed a number of data sources and references. They are listed at the end of this letter. Attachment C contains excerpts from two important NYSDEC reports: 2006 Hudson River Estuary Wildlife and Habitat Conservation Framework: An Approach for Conserving Biodiversity in the Hudson River Estuary Corridor,[10] and 2008 Biodiversity of the Moodna Creek Watershed: Important Resources and Conservation Recommendations.[11]

Ms. Beall and Mr. Gilbert collected data from the Natural Resources Conservation Service (NRCS) on-line Web Soil Survey data, the NYSDEC Environmental Resource Mapper, and the NWI Wetland Mapper.

---

[9] Frimpter, Michael H. 1985.
[10] Penhollow, M.E., P.G. Jensen and L.A. Zucker. 2006.
[11] Heady, Laura. 2008.

Figures are included within the main body of this letter. Attachment D, NRCS Soil Maps and Report, provides information on the soils in the vicinity of the proposed well location.

Ms. Beall and Mr. Gilbert reviewed Google Earth and Bing Maps Birds Eye View Aerial Photographs of the Woodbury and Moodna Creeks. Attachment E provides aerial photographs illustrating these areas.

Ms. Beall and Mr. Gilbert made a telephone call to Mr. William Schuster, PhD, Executive Director of the Black Rock Forest Consortium to discuss the ecology of the adjacent Black Rock Forest and its relationship to the Woodbury and Moodna Creek watershed. In addition, a telephone call was made to Ms. Sheila Tuttle, a leading biologist for wood turtles in New York State to discuss the life cycle and habitat requirements for that species.

On April 9, 2014, Mr. Mal Gilbert made a site inspection of Woodbury Creek and adjacent wetlands on the Houghton Farm property. He also reviewed the condition of Woodbury Creek upstream and downstream of the Houghton Farm property, and finally reviewed conditions in the Moodna Creek along Route 32 to its confluence with the Hudson River. Photographs from that site visit are provided in Attachment F, Photographs.

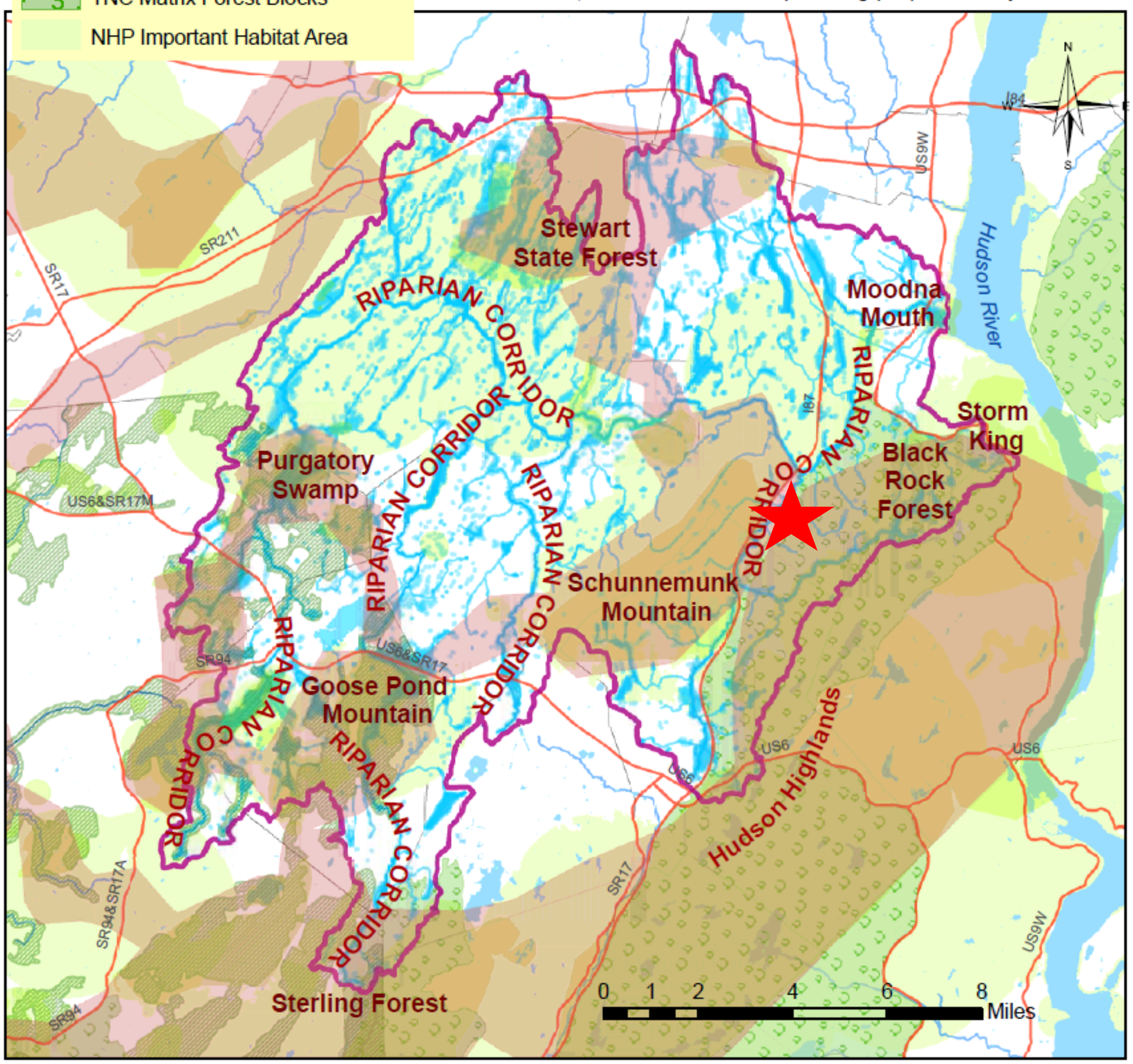
Existing Conditions - Background Mapping Data and Literature Review

The Mountainville Well is located in the Woodbury Creek/Moodna Creek/Hudson River Estuary. The figure titled Figure 5. Conservation Network of Biodiversity Cores and Connections in the Moodna Creek Watershed,[12] illustrates the approximate location of the Mountainville Well relative to the various biodiversity lands and habitats in the Moodna Creek watershed. The proposed well site (along with the Woodbury Creek drainage) is located within the Highlands, a Significant Biodiversity Area of the Hudson River Estuary according to the NYSDEC's 2006 Hudson River Estuary Wildlife and Habitat Conservation Framework.[13] As will be discussed further below, the Highlands are recognized as a significant biodiversity area of the Hudson River Estuary Corridor notable for unfragmented forests and other wildlife corridors. The Mountainville Well is located on the noted Woodbury Creek riparian corridor that provides connectivity between these various Highland habitats as well as connectivity to Moodna Creek and the Hudson River estuary. Maintaining this connectivity via Woodbury Creek and its associated wetlands is important to maintaining ecological functioning and biodiversity not only to the Highlands but also to downstream Moodna Creek.

[12] Heady, Laura. 2008.
[13] Penhollow, M.E., P.G. Jensen and L.A. Zucker. 2006. See Figure 3.

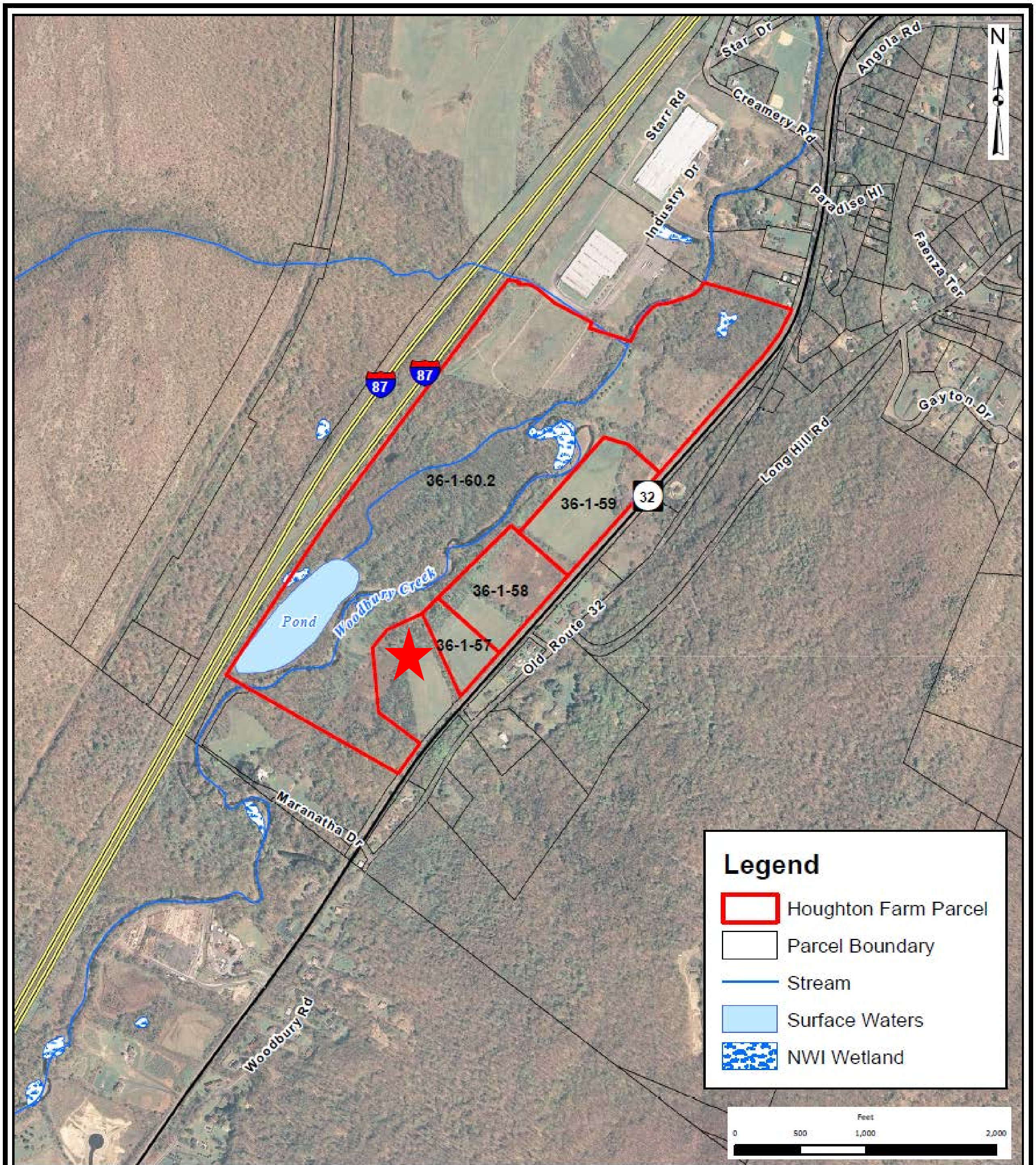
Figure 5. Conservation Network of Biodiversity Cores and Connections in the Moodna Creek Watershed *Orange County, NY*

This map includes the biodiversity hotspots and wildlife corridors identified in the Orange County Open Space Plan, overlaid onto the documented biodiversity resources shown in Figure 4. Also identified are riparian corridors not included in the county's 'Cores & Corridors' network, but which may serve as important landscape linkages. Further analysis is needed on a finer scale, to identify additional cores and connections, and appropriate land-use strategies that will conserve important biodiversity areas, with generous buffers and connectivity to other hotspots. This map can be considered a "first step" toward developing a comprehensive biodiversity conservation strategy for the watershed, and is intended for planning purposes only.



Map created 18 June 2008 by:
Laura Heady, Hudson River Estuary Program,
NYS Department of Environmental Conservation
in partnership with Cornell University

Data Sources:
NY Natural Heritage Program
NYS Department of Environmental Conservation
National Wetland Inventory
The Nature Conservancy
Orange County Planning Department



THE Chazen COMPANIES
ENGINEERS/SURVEYORS
PLANNERS
ENVIRONMENTAL SCIENTISTS
LANDSCAPE ARCHITECTS

Dutchess County Office:
21 Fox Street, Poughkeepsie, NY 12601
Phone: (845) 454-3980
Capital District Office:
547 River Street, Troy, NY 12180
Phone: (518) 273-0055
North Country Office:
375 Bay Road, Queensbury, NY 12804
Phone: (518) 812-0513

Water Resource Joint Comments on KJ Water

Houghton Farm

Town of Cornwall, Orange County, New York

Drawn:	JLN
Date:	04/08/2014
Scale:	1:12,000
Project:	41317.00
Figure:	1

Significant portions of the Highland area and associated riparian corridors are owned or were acquired and given to the State of New York by the interests we represent including the Black Rock Forest Consortium and the Storm King Art Center, whose lands are in close proximity to the red star shown on "Figure 5." Further, the Houghton Farm property, which contains 6,100 linear feet (straight line) of Woodbury Creek and associated wetlands is owned by the Storm King Art Center (see Figure titled "Houghton Farm," where the Mountainville Well is identified with a red star).

These not-for-profit organizations have acquired these tracts to protect undeveloped and unspoiled open space characteristics, viewsheds, and the aquatic and ecological resources contained therein. These include the biodiversity and habitat corridors that these resources provide. The value of these areas for biodiversity is illustrated on Figure 4 of the NYSDEC's 2006 Hudson River Estuary Report, which shows a significant number of NYS Natural Heritage occurrences within the Highlands significant habitat area, including in the vicinity of the Mountainville Well.

Of specific concern for the Mountainville Well are impacts to the wetland, tributary and riparian areas and wildlife corridors found on the Houghton Farm property. The NYSDEC's 2006 Report generically described the importance, ecological functions and values, and conservation strategies of tributaries and riparian areas, wetlands, and unfragmented forest and habitat corridors and how they relate to the biodiversity of the Hudson River Estuary Corridor. Relevant excerpts are provided below to summarize the NYSDEC's findings:

> "Tributaries and Riparian Areas High quality tributaries, riparian areas, and floodplain forests are important habitat for many species including trout and black bass, salamanders, river otter, beaver, cerulean warbler, and wood turtles. Aquatic animals are highly dependent on riparian areas for shade, leaves (as a source of food), edge-of-channel habitat structure (such as undercut banks), soil stabilization, and woody debris. Removal of riparian areas, modification to stream channels, and increasing impervious surfaces cause some of the changes to watershed hydrology that are putting the water and habitat quality of tributary streams in the Hudson River Valley at risk. Minimizing development in riparian corridors, **minimizing the hydrologic alteration of stream systems, protecting native floodplain meadows and forests,** and restoring natural stream channels **will help to protect stream biodiversity."**[14] [Emphasis added].

More detailed discussions of tributaries and riparian areas are found on pages 42 through 46 of the 2006 NYSDEC Report, and are provided as Attachment C to this letter. Specifically, "[r]iparian habitats represent only a small portion of the landscape, but are a critical source of biodiversity." The report goes on to discuss that these areas provide a variety of important ecological functions including maintaining physical and chemical characteristics of the stream such as temperature moderation. Further, the streams provide habitat for a variety of fish and wildlife species. Aquatic invertebrates are food for predatory fish, use riparian vegetation as habitat, and depend upon leaves as a source of food. It discusses features of streams, such as undercut banks, depth of water and other features that are key components to support a number of plant and animal species. The report describes why tributaries and riparian corridors have high levels of biodiversity due to the numerous niches they contain for both aquatic and terrestrial animals. "Streams support fish and aquatic macro-invertebrate communities,

[14] Ibid. Page viii.

stream salamanders, green frog, snapping turtle, eastern painted turtle, and northern water snake. A number of invertebrates use these habitats, including damselflies, butterflies and dragonflies."[15]

The 2006 NYSDEC Report then discusses degradation of these resources. "Other significant causes of water quality impairment include…thermal modification, flow alteration, and other habitat modifications,"[16] and recommends that "[m]inimizing hydraulic alteration of the stream system within the watershed (including intermittent tributaries and wetlands) will help protect stream biodiversity…. Stream managers should consider that alterations of floodplain, channel, and riparian habitats in one section of the stream can cause unwanted changes in downstream habitats."[17]

> "Wetlands The Hudson River Estuary region contains a rich diversity of wetland types, from freshwater tidal swamps and brackish tidal marshes to fens, bogs, and forested wetlands. These wetlands are home to a variety of species including the federally-listed black duck, wood frog, the threatened Blanding's turtle, marbled and Jefferson salamanders, muskrat and beaver. Unfortunately, more than 50% of the wetlands in the region have been lost since European settlement. Wetland conservation strategies should include, where possible, the restoration and **protection of wetland hydrology and wetland plant communities**, control of invasive species, and management of certain types of wetlands through mowing and grazing. Inland intermittent vernal pools, a common but threatened wetland habitat type, should be identified and conserved along with surrounding critical woodland habitat, and best forest management practices can be used to protect them from pollution and disturbance."[18] [Emphasis added].

More detailed discussions of Wetlands are found on pages 50 through 82 of the NYSDEC report, and these pages are also provided as Attachment C to this letter. Relevant to this project, page 57 of the 2006 NYSDEC report states "Non-tidal wetlands, like tidal wetlands, are sensitive to hydrological changes… Upstream changes in water quantity (changes in hydrology) or quality also impact wetlands."[19] The text then repeats the recommendations summarized in the Executive Summary discussed above; protection of hydrological inputs to wetlands is important to protecting biodiversity in wetlands.

> "Unfragmented Forest and Habitat Corridors Intact forests are summer breeding habitat for migratory songbirds, bobcat, **black bear**, wood thrush, barred owl and red-shouldered hawks. Although few examples of "old-growth" lowland forests remain, forests of moderate-sized and moderate-aged trees continue to provide valuable habitat and have the potential to provide mature forest habitat in the future. Many of the biological communities that characterize unfragmented forests are at risk in areas of the Hudson Valley. We can preserve the species that depend on unfragmented forests **and habitat corridors by conserving mature lowland forests**, concentrating disturbance on

[15] Ibid. Page 43.
[16] Ibid. Page 43.
[17] Ibid. Pages 44-45.
[18] Ibid. Page viii.
[19] Ibid. Page 57.

> the edges of forest blocks, **restoring forest fragments in riparian areas**, restoring gaps between disconnected forest tracts, and **controlling invasive species** while managing for well-developed growth on the forest floor."[20] [Emphasis added].

More detailed discussions of unfragmented forest and habitat corridors are found on pages 47 through 49 of the 2006 NYSDEC Report, and these pages are provided within Attachment C of this letter. As shown on Figure 11 of this report, the Mountainville Well is located in the Highlands, which is identified on Figure 11 as being a "significant biodiversity area of the Hudson River Estuary corridor notable for unfragmented forests and habitat corridors."[21] As noted on the Moodna Creek Figure 5 included above, the Woodbury Creek also represents a riparian habitat corridor, including the 6,100 feet of riparian corridor on the Houghton Farm property. It provides habitat connectivity eastward into upstream into additional riparian areas and the Black Rock Forest and westward, under I-87 into the additional upland forested habitats.

> "Upland areas are linked with the estuary through smaller waterways such as creeks, rivers and ditches that drain the land and empty into the Hudson River. As water flows from the uplands to the estuary, its chemical, physical and biological nature is modified. As a result, the conditions of these tributaries and the lands they drain directly affect the estuarine environment."[22] "While some species flourish in the Hudson River Estuary Corridor, others are threatened by habitat loss and fragmentation, pollution, and competition with invasive or overabundant species."[23] "Six turtle species found in the Hudson River Estuary corridor (other than sea turtles) are state-listed as endangered, threatened and special concern species including the box turtle, Blanding's turtle, eastern mud turtle, spotted turtle, **wood turtle,** and eastern box turtle. **Numerous areas throughout the Hudson River Estuary Area of Biological Concern have been documented as containing crucial habitat for salamanders** and frogs, including northern cricket frog, blue spotted salamander, marbled salamander, four-toed salamander, spotted salamander, Jefferson salamander, and longtail salamander."[24] {Emphasis added]

> "Hudson River tributaries and their area of confluence with the main stem provide important habitat for migratory fishes, including striped bass, American shad, rainbow smelt, alewife, and blueback herring, as well as resident species, such as white sucker, yellow perch, spottail shiner, white perch, and smallmouth bass. Tributaries with largely intact natural processes have food webs that support diverse plant and animal life. These systems convert carbon and nutrients into biodiversity rather than excessive algae or nutrient exports, which in turn protects the estuary. In addition, streams with intact floodplains soak up and store flood waters **while replenishing ground water**, filtering nutrients and

[20] Ibid. Page viii.
[21] Ibid. Figure 11.
[22] Ibid. Page 16.
[23] Ibid. Page 17.
[24] Ibid. Page 24.

> chemicals, depositing sediments onto floodplains, and limiting erosion."[25] [Emphasis added].

The 2006 NYSDEC Report identifies a series of conservation issues and recommendations to public and private land managers. Presumably these recommendations would be relevant to NYSDEC staff making decisions about this water supply application. These recommendations can be summarized as "whenever possible, do no harm, and if possible, make things better." For the riparian and wetland corridor on the Houghton Farm property adjacent to the Mountainville Well, the main concern would be dewatering of the Woodbury Creek and adjacent wetlands, resulting in habitat losses, potential fragmentation of the stream corridor and incresaed potential for invasive species growth, resulting in habitat losses to Woodbury Creek and adjacent wetlands. A secondary concern would be potential impacts on habitats downstream and upstream resulting from dewatering, hydrological modifications, and habitat/connectivty losses.

> "Habitat loss and fragmentation on public and private lands is probably the most signficiant threat to biodiversity in the Hudson River Estuary Corridor. Fragmentation of large habitat areas into smaller sections can lead to local extirpation of area-dependent species. Fragmentation might also interrupt species migration…. Many types of disturbances can lead to the loss or degradation of habitats… These activities provide entry points for invasive, exotic species. Alterations to and manipulation of existing hydrological regimes and water levels can adversely effect wetland communities and species requiring wetland habitat. Hydrologic disturbances include…irrigation pumping."[26]

NYSDEC's recommendations to prevent such impacts include:

- "Protect large, contiguous, unaltered tracts whenever possible.
- **Preserve links between natural habitats** on adjacent properties.
- **Preserve natural disturbance processes** such as fires, floods, tidal flushing, **seasonal drawdowns**, and wind exposure, whenever possible.
- Restore and maintain broad buffer zones of natural vegetation along streams, along shores of other waterbodies and wetlands, and at the perimeter of other sensitive habitats.
- …[m]aximize on-site runoff retention and infiltration to help **protect groundwater recharge, and surface water quality and flows**…"[27]

Following the NYSDEC's 2006 Estuary-wide biodiversity study, in 2008 Laura Heady of the NYSDEC's Hudson River Estuary Program drafted a report titled Biodiversity of the Moodna Creek Watershed: Important Resources and Conservation Recommendations.[28] The 2008 Moodna Creek Biodiversity Report details the habitats, ecological areas and wildlife found within Moodna Creek and Woodbury Creek. It then provides recommendations similar to those discussed in the 2006 Hudson River Estuary Corridor Report but specifically tailored to the Moodna Creek watershed. The following is relevant to the Mountainville Well.

---

[25] Ibid. Page 24.
[26] Ibid. Page 122.
[27] Ibid. Page 25.
[28] Heady, Laura. 2008.

The 2008 Report confirms that a southern portion of the Moodna watershed is included in the Highlands Significant Biodiversity Area which includes the Schunnemuck Mountain, the Black Rock Forest, the Stormking Forest and Woodbury Creek. The 2008 Report also discusses in greater detail the Moodna Creek mouth and tidal wetlands, which are designated as an "irreplaceable" Significant Coastal Fish and Wildlife Habitat by the NYS Coastal Zone Management Program, and highlighted as one of four Selected Priority Watershed by the Orange County Open Space Plan (June 2004).[29]

The 2008 Report notes that coldwater fishes of the Moodna Creek watershed include "native brook trout, and the stocked rainbow and brown trout. Stream reaches supporting coldwater fishes, invertebrates, and salamanders are usually fed by cool-cold groundwater. Brook trout and slimy sculpin are the dominant fish of small coldwater streams of high quality. These streams have shallow margins, woody debris, canopy shading, and boulders. Blacknose dance, creek chub, and white sucker may also occur at coldwater sites. Both brook and brown trout are found in the…Woodbury Creek tributaries. The DEC annually stocks the Moodna Creek mainstream with brown and rainbow trout and the Woodbury Creek with brown trout."[30]

The 2008 Report notes that several turtle, frog and salamander species rely heavily on stream corridor habitats, and states that wood turtle populations are found within Woodbury Creek[31]. Stream salamanders are found in "moist areas of streambanks, seepages, and both intermittent and perennial streams" and that "the most abundant headwater stream salamander in the Hudson Valley is the two-lined salamander followed by the northern dusky salamander. The long-tailed salamander is rare is Orange County."[32] Other species noted in this report within the Moodna Creek watershed that may be relevant to the Mountainville Well include:

- Dragonflies and damselflies. "Orange County has the second highest number of dragonflies and damselfly species in the United States… Aquatic dragonflies and damselflies use a variety of wetland habitats and can be impacted by...hydrologic alteration."[33]
- Bats, including big brown bat, little brown bat, Eastern small-footed bat (NYS Special Concern), and Indiana Bat (federal and New York State Endangered) are known to occur in the Moodna Creek watershed. Stream corridors are very important habitats for this species, especially combined with forested areas. Streams are prime foraging habitat due to the abundance of insects and forest openings needed for maternity colonies and summer roosting.[34] The northern long-eared bat has also recently been identified as a candidate species for listing as endangered by the USFWS, which would automatically place it on the NYS list.
- Birds, including yellow-throated warbler, warbling vireo, and Louisana waterthrush prefer to nest near streams. The cerulean warbler and least flycatcher are stream corridor birds that are declining in their range. Other water dependent birds include wood duck, great blue heron, green heron, and belted kingfisher. Birds are found more abundantly in stream corridors than in other parts of the landscape.[35]

[29] Ibid. Page 3.
[30] Ibid. Page 9.
[31] Ibid. Page 9.
[32] Ibid. Page 9.
[33] Ibid. Page 18.
[34] Ibid. page 9.
[35] Ibid. Pages 8 and 9.

Pages 4 through 7 of the 2008 NYSDEC Moodna Biodiversity Report describe the "irreplaceable" and highly significant wetland/tributary complex at the mouth of the Moodna River. These pages of the report have been excerpted and placed in Attachment C of this letter. To summarize:

- "The confluence of the Moodna Creek and Hudson River is especially rich in biodiversity, and marks the average northern extent of the salt front in the estuary. The inputs of nutrients from the Moodna watershed; the mixing of the Moodna's fresh water with the brackish water from the Hudson; and the tidal influence of the estuary together create conditions and habitats that are uncommon in New York. Habitats of the Moodna mouth system include 3.5 miles of freshwater tributary, with the lower mile in tidal range of the Hudson River. Where it reaches the river, the creek flows into an approximately 75 acre…embayment, with extensive emergent marsh, swamp, mudflats, submerged aquatic vegetation (SAV), and wooded islands. East of the railroad trestle, there are additional mudflats and a large area of SAV that continues northward along the shoreline."[36]

- Fish habitat in the lower portion of the Moodna Creek extends 3.5 mile upstream to the dam upstream of Orrs Mill Bridge on NYS Route 32. Anadromous fish enter the creek in the spring for spawning and the larval fish develop in the flats at the mouth. Depending on the fluctuation of the salt front, bluefish, bay anchovy, weakfish, Atlantic silversides, hogchoker, and blue crab may enter the tributary to feed.[37]

- The confluence of the Moodna and the Hudson provide habitat for the Bald Eagle (NY Threatened) and Osprey (NY Special Concern). It is considered an important breeding area for the Bald Eagle.[38]

- The tidal freshwater marsh at 59 acres is a Class 1 NYSDEC wetland, and the largest in Orange County. This is a mix of freshwater wetland/brackish tidal marsh/brackish intertidal mudflats. "Statewide there are few occurrences of these rare ecological communities, which hosts suites of species especially adapted to the changing conditions caused by tides. Due to their changing salinity values, brackish tidal marshes provide habitats for a combination of species that are characteristic of both salt and freshwater tidal marshes. Brackish intertidal mudflats support populations of mobile invertebrates like clams, snails, worms and crustaceans that are adapted to the unstable surface of the mudflat. During high tide, these invertebrates are fed upon by shad, bass, and other fish; low tide brings foraging opportunities for shore birds. Rare plants associated with the mudflats at the Moodna mouth include spongy arrowhead, and historical records of estuary beggarticks. The wetland complex at the Moodna mouth provides breeding habitat for a number of birds… and has been identified as important habitat area for least bittern (NYS Threatened)…." The submerged aquatic vegetation (SAV) beds also contribute to the overall habitat value of the Moodna mouth system. They occur in the lower reach of the creek, in the embayment, and east of the train trestle along the Hudson shoreline. Unlike other tidal covers and bays in the Hudson where the invasive water chestnut often dominants… the SAV beds at the Moodna mouth are comprised of water celery, a native plant. The SAV beds

[36] Ibid. Page 4.
[37] Ibid Page 4.
[38] Ibid. Page 4.

trap fine sediments and organic matter, maintain dissolved oxygen levels, and provide habitat for a rich diversity of fish and invertebrates."[39]

- The Report discusses threats and conservation opportunities, and states that there is the potential that sewage problems in the Moodna have been impacting water quality and may be the cause of the loss of herring runs on the Moodna. There is a concern that continued or worsening water quality in the Moodna may have other adverse impacts on the rich biodiversity of this area. The marsh and mudflats may also be vulnerable to pollution, and changes may encourage invasion by exotic species such as water chestnut and purple loosestrife.[40]

Woodbury Creek: The following discussion is more specific to Woodbury Creek, located to the west of the Mountainville Well. This stream flows south to north, and discharges into the Moodna Creek just east of the NYS Thruway Corridor. According to the NYSDEC Resource Mapper, Woodbury Creek is a NYSDEC Class C(TS) waterbody from the Woodbury/Cornwell boundary north to its outlet into Moodna Creek.[41] The Class C(TS) designation indicates that Woodbury Creek has the capacity to support trout species and serve as spawning habitat. Aerial photographs indicate that Woodbury Creek is a meandering stream within a braided stream channel[42] in numerous locations on the Houghton Farms parcel near the location of the Mountainville Well.

Woodbury Creek is regularly monitored by Orange County using benthic macroinvertebrate[43] sampling as part of an overall water quality monitoring program in Orange County. The closest sampling point to the Mountainville Well is located approximately 1.3 miles downstream (near Taylor Road) of the proposed well field and is ID 2489-008 located at Latitude 41.40765; Longitude -74.0751.

The 2012 monitoring data (as well as previous annual monitoring data) is provided in the Orange County 2012 Stream Biomonitoring Report.[44] Sampling has occurred in this location four times, in years 2005, 2006, 2010 and 2012. The 2013 Report states that this sampling location has Slightly Impaired water quality.

The 2013 Report states that the -0.42 BAP score decline between the 2010 and 2012 sampling at the Woodbury Creek Sample Location 2489_008 was not remarkable because the change was less than 0.5 points. However the Report did not compare the 2012 BAP score to the 2005 and 2006 BAP scores at this location. If one compares all the BAP data, there has been a steady and significant (-1.56 point) decline in BAP scores at this location since sampling began in 2005. In 2005, the BAP value was 8.2, which placed this stream in the Non-Impaired Category. In 2006, the BAP value was 7.3, which placed

[39] Ibid. Page 7.
[40] Ibid. Page 7.
[41] Upstream, in Town of Woodbury, the Woodbury Creek becomes Class C.
[42] Braided, meaning that there is more than one stream channel conveying flow.
[43] Benthic macroinvertebrates are small animals (typically insects) living among the sediments and stones on the bottoms of streams, rivers and lakes. Different species have different tolerances for water quality degradation, so reviewing the relative make-up of the aquatic organisms provides a snapshot of the average water quality at a particular location, and with long term monitoring can illustrate changes in water quality over time. Biological Assessment Monitoring has a formal scientific protocol and scoring. A Biological Assessment Profile of 10 to 7.5 is considered Non-impaired. A score from 7.5 to 5.00 is considered Slightly Impaired. A score of 5.00 to 2.5 is considered Moderately Impaired and a score of 2.5 to 0.00 is considered Severely Impaired.
[44] Orange County Water Authority. 2013.

the stream in the Slightly Impaired Category. In 2010 and 2012, the BAP values were 7.06 and 6.64 respectively, which is still within the Slightly Impaired category , but with even poorer water quality. This change is illustrated in the chart below, with a BAP value of 7.5 being the change between Non-Impaired and Slightly Impaired.

Wetlands: The NYSDEC Environmental Resource Mapper does not show any wetlands mapped in this area of Woodbury Creek in the vicinity of the Town of Cornwall, and based on an email from the NYSDEC, there are no state-regulated wetlands that are currently mapped, or proposed for inclusion in mapping in that location based on the recent NYSDEC remapping in Orange County.[45]

The NWI Wetland Mapping indicates a small area of wetlands north of the Mountainville Well on the Houghton Farm property, on parcel 36-1-60.2. This may be associated with an area of mapped hydric Canandaigua soils discussed below. There is also a large pond located directly west of the well on the west side of Woodbury Creek. The pond is currently breached and drained.

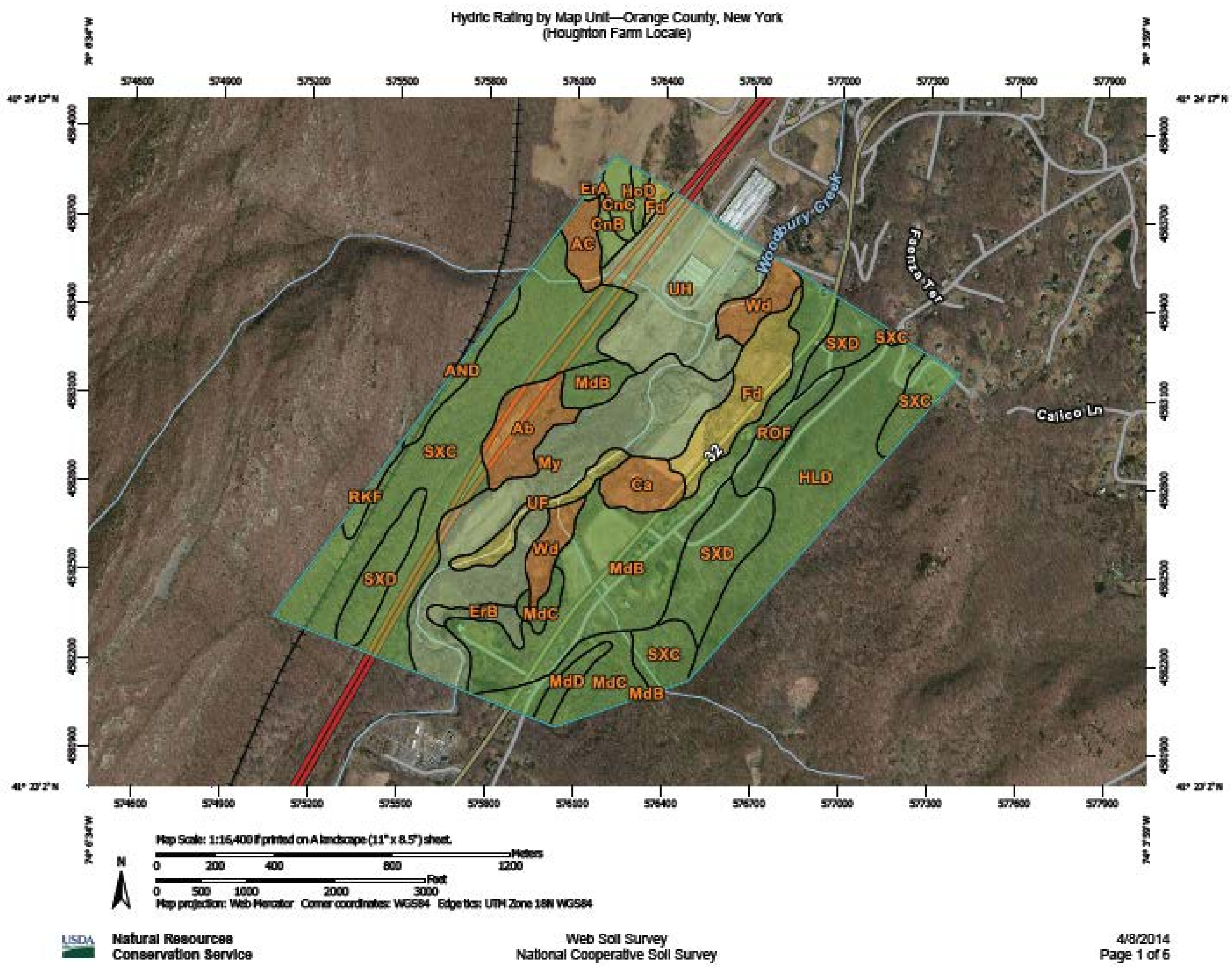
In contrast, according to the Natural Resources Conservation Service on-line soil survey mapping, (see Attachment D, NRCS Soils Map and Report) and the figure below, there are significant areas of contiguous hydric (wetland) or partially hydric soils in the vicinity of the proposed well on the adjoining Houghton Farm property:

- Two areas totaling 17.4 acres are Wayland (Wd) (hydric) soils. One area is located immediately west and curving around the Mountainville Well. The second area is located immediately east of Woodbury Creek south of Industry Drive.
- A 10 acre area of Canandaigua silt loam (Ca) (hydric) located approximately 735 feet to the north.
- An 8.5 acre area of Udifluvaquent/Fluvaquent (UF), located along the main channel of Woodbury Creek that connects the Wayland Soil and the Canandaigua Soil. The

[45] Doug Gaugler. Email with Chazen Companies April 14, 2014.

Udifluvaquent/Fluvaquent soils are identified as having approximately 55% coverage of soils with hydric soil characteristics.

- A 25 acre area of Fredon Soil (Fd) is connected further north to the Canandaigua soil. This is a soil where approximately 55% of the area will have hydric soil characteristics.



This data indicates the potential for up to 44 acres of interconnected hydric soils within a wetland complex on the east side of and linked by Woodbury Creek on the Houghton Farm property. While the actual area may be less, the soil survey data clearly indicates the potential for more than 12.4 acres of interconnected stream/wetland in the vicinity of the Mountainville Well. A review of aerial photographs, especially the BING Birds Eye View aerial photographs supports the assessment that there is a high potential for wetlands in these hydric soil areas.

Moodna Creek: Aerial photographs of the mouth of Moodna Creek, and representative locations along Moodna Creek are provided in Attachment F to this letter.

Ecological Resources:

- In preparing this letter, we discussed the resources found on the Houghton Farm property and on the adjacent Black Rock Forest with Dr. Schuster. It is Dr. Schuster's assessment that there are a number of white oaks on the Houghton Farm property that are older than 100 years, and that the wooded areas on this tract could be identified as a "legacy forest." There are also known areas of rare wetland plants in the nearby Quassaick Creek, which could also be located here, specifically narrow-leaved sedge (*Carex amphibola*) and beaked agrimony (*Agrimonia rostetella*). The Woodbury Creek supports brook trout that breed in this area and connect to Mineral Spring Brook/Trout Brook Road upstream and south of Houghton Farm property. Dr. Schuster also stated that there were some pools along the Woodbury Creek that could sustain trout during dry periods. In addition, he identified the Houghton Farm property as supporting wood turtle, a species that is also found periodically on the Black Rock Forest property. He believes that the wood turtles migrate up and down this aquatic corridor including on to the Black Rock Forest property. Dr. Schuster stated that mink and river otter have been caught on camera traps in the Black Rock Forest, and, given their habitat requirements are also potentially found on the Houghton Farm property. While neither mink nor otter are rare or threatened in New York, impacts to trout fisheries in this corridor would adversely impact these two species, and negatively impact biodiversity. Dr. Schuster also identified productive vernal pools on the Houghton Farm property; the species composition is known to include peepers and wood frogs, but a biological study has not yet been made for salamander species such as marbled, spotted, Jefferson salamander.

Existing Conditions - Field Review

An assessment level field review was conducted on the Houghton Farm property, and the Mountainville Well was reviewed from off-site adjacent properties associated with the Houghton Farm property. In addition, Woodbury Creek was reviewed from locations upstream and downstream. Moodna Creek was also reviewed from its confluence with Woodbury Creek downstream to the Hudson River.

Woodbury Creek: During the April 9, 2013 site inspection, Woodbury Creek was observed to be an approximately 40 to 50-foot wide corridor with strong flow. The stream had a sandy/gravel substrate (bottom), with deeper flows (approximately 2 to 4 feet deep in places) along undercuts at the base of the stream banks. Gravel bars with shallower flow (6 to 12 inches deep) are intermittently found within the center portion of the stream and in "point bars" deposited where stream flow energy facilitates deposition. The flow was clear, with visibility of at least 3 feet in depth. The stream appeared to have good water quality in this location.

In and along the wooded riparian corridor at Houghton Farm property, trees that were present included Red and Black Oak, White Oak, Eastern Cottonwood, American sycamore, Red Maple, Sugar Maple, Green/White Ash, occasional Black Walnut, Black Cherry, Pin-oaks, and Elm, also a few larger-diameter (one ± 40" DBH) Norway Spruce. The understory fringes along the open field interfaces were dominated by raspberry, blackberry, various goldenrods, remnant aster(s), Chinese bittersweet, dewberry and occasional patches of Japanese knotweed. The wooded corridor was fairly open in places with variable herbaceous and woody components. A species of agrimony plant (*Agrimonia* sp.) was observed, but due to the seasonality of the site inspection, the species of the plant could not be keyed out at this time of year.

Wetlands: Based on the site inspection, the soils mapped as Canandiagua and Wayland described in the bullet item list above definitively contain significant wetland areas. The soils in these two locations are generally a silty clay loam or silt loam with variable percentages of smaller gravels and occasional cobbles intermixed. Both soils were confirmed to have hydric soil indicators present.

The area mapped as Wayland (hydric) soils immediately west of the Mountainville Well is dominated by an emergent wetland with shrub and early successional forest on the eastern and western edges. This wetland was generally in the shape of a crescent, wrapping around the west side of the Mountainville Well, and generally follows the NRCS hydric soil mapping. The wetland was observed to be dominated by skunk cabbage, sensitive fern, reed canary grass, purple loosestrife, green bulrush, other rush and sedge species, including potentially lake sedge (*Carex lacustris*). The eastern edge of the wetland is dominated by a shrub fringe area, including silky dogwood, pussy willow, multi-flora rose, green ash and red maple. Where the wetland transitions towards Woodbury Creek, it became more forested, with cottonwood, and larger sycamores on higher areas. The Wayland wetland consistently had standing water three to four inches deep at the time of the site visit. The wetland also appears to be gently sloping downhill (with an approximate 4 to 6 foot drop) over the approximately 400 feet from its eastern upland boundary to the location where it abuts Woodbury Creek.

The general hydrologic classification of the Wayland wetland area would be as a ground water/surface water slope wetland.[46] This assessment is based on visual observation of somewhat channelized flow from southeast to northwest parallel to and along the stream gradient in the center of the wetlands, yet with additional hydrological inputs observed entering the wetland laterally from seeps along the eastward slope. These seeps, flowing into the wetland more or less perpendicular from the somewhat channelized flow path indicate a groundwater interface along that wetland/upland boundary to the west and southwest of the Kiryas Joel parcel where the well is located. While wells and piezometers are needed to definitively define this as a groundwater slope wetland, the field characteristics are strongly suggestive of this Hydrogeomorphic (HGM) class of wetland. As will be discussed in greater detail in the "Impacts" section, these field observations also strongly suggest that hydrological inputs into this wetland would be impacted by more than infrequent water withdrawals (i.e., of a frequency or duration that would reduce or eliminate the groundwater inputs into this wetland system).

The well field itself is proposed at the western edge of an upland open meadow that appeared to be dominated by old-field grasses, milkweed, various goldenrod and asters, as well as reed canary grass. There are scattered hardwood tree and shrub species on the field boundaries. The upland field actually appears to slope approximately 8 to 10 feet from Route 32 in a downward gradient towards the west, and, as stated above, there appears to be lateral hydrological inputs along the toe of the upland fringe transition down to the Wayland wetland.

Linear wetland drainage channels are regularly located between the active and abandoned agricultural fields, including north of the upland field containing the Mountainville Well. These drainages generally flow east to west perpendicular to and starting from Route 32 and end in wetlands or at a junction with Woodbury Creek. The wetland drainage north of the field containing the Mountainville Well was shrubby to wooded dominated by red maples, cottonwoods, gray-stem dogwood, multiflora rose and skunk cabbage, with apples, blackberry and raspberry further upslope along the well-defined wetland drainage channel that emanates from a culvert under Route 32. At this location, the understory vegetation includes a mix of sedges and rushes (*Carex* and *Scirpus*) with purple loosestrife. A similar linear wetland drainage is located adjacent to the next open upland field on the Houghton Farm property to the north.

[46] Turner, Marjut H. and Gannon, Richard. 2013.

Woodbury Creek is located within an 8.5 acre area mapped as Udifluvaquents/Fluvaquents. This soil mapping group, which is typically 55% hydric, connects the Wayland soils immediately west of the proposed well field with the Canandaigua soil to the north, described below. Since fluvaquent soils form along streams (i.e., "fluvial") it makes sense that this soil was found along the Woodbury Creek. Consistent with its soil mapping, the area contained uplands, where relic stream bank alluvial deposits are higher and do not receive inundation or saturation from the stream or surrounding wetlands at a frequency and duration sufficient to support wetland vegetation; lower tiered fluvial deposition areas have adequate hydrology to support wetland plants.

Further north is a 10.5 acre area mapped as Canandaigua (hydric) soils, which was observed to support wooded and shrub wetlands along with some emergent depressions. The Canandaigua soil wetland area is shown in Attachment 7, Photo 7 and has a small patch of common reed (*Phalaris arundinacea*) approximately 50 feet in diameter. The area also contains some purple loosestrife mingled with various shrubby species (dogwoods/multiflora, etc.) and green ash *(Fraxinus pennsylvanica*). A linear wetland drainage channel is also located north of and meandering through this field. A 25 acre area of Fredon soil then extends adjacent and parallel to the eastern limit of Woodbury Creek and northward to Industry Drive. At Industry Drive, the Fredon soils connect with another area of Wayland soils. There are a group of vernal pools dominated by larger diameter green ash trees in this area. A photograph of these vernal pools is provided.

Based on our review of the wetlands on the Houghton Farm property, it appears that a wetland delineation of this property would result in an interconnected wetlands and stream complex larger than 12.4 acres in size. The mapped Wayland soils, which would be part of this wetland complex, are immediately west of the Mountainville Well. Based on the Applicant's delineation and siting map, portions of this wetland complex are within 200 feet of the proposed well, and may actually be within 100 feet of the well.

The Soil Survey report for the Houghton Farm property indicates the presence of a potential aquitard at approximately 30 inches below the soil surface. The interface of this aquitard layer with the slope along the east side of the Wayland soils is likely the reason for groundwater slope seepage and hydrological inputs from the east. This aquitard would tend to perch hydrology allowing wetlands to form but then would allow for slow recharge to the local and regional groundwater. Hydrologic inputs into these wetlands are a mix of direct precipitation, surface water runoff, and groundwater inputs from side slope seeps.

Ecological Resources:

- Agrimony, a plant, was observed on the site, although it could not be keyed to species.
- Trout were observed in Woodbury Creek during the April 9, 2014 site visit. The stream had good riffle/pool/run characteristics that in turn provide good trout habitat along the corridor. Habitat features observed included low turbidity and apparent good water quality, gravel bottom, good trout refugia including deep pools, woody debris coverage and root wads in various locations, including upstream and downstream in Woodbury Creek from the Mountainville Well.
- The stream had excellent wood turtle habitat. The stream contained deep clear water with a gravelly bottom and moderate flow. In several places the banks were undercut with overhanging tree roots and larger boulders. This is important because wood turtles over-winter in the bottoms of the streams in these undercut areas. These turtles typically travel up and down stream corridors to reach other turtle populations and to access other necessary habitats,

including riparian forests, wetlands, hayfields and early successional upland fields. These habitats were all observed within the Woodbury Creek corridor.
- Evidence of beaver was observed within the stream corridor.
- Bear tracks, recent, were observed along the stream corridor. This is indicative of the riparian area serving as a travel corridor for a large land mammal.
- Mink tracks were observed along the Woodbury Creek corridor. This is also indicative of the riparian area serving as a food source (trout) and a travel corridor for a higher order carnivore in the food chain. In addition, it is noted that mink have also been identified in the Black Rock Forest, and as stated above, the Woodbury Creek likely serves as an important linkage between these habitats.

Moodna Creek: Moodna Creek was reviewed from adjacent roadsides all the way to its confluence with the Hudson River. The freshwater and tidal interactions at the Moodna Creek are profound. The creek appears to pulse in and out of the mouth of the creek, constrained by the existing railroad bridge abutment. During low tide, one can observe the lens of clear freshwater flowing into the Hudson's more turbid water and the mixing that was observed within the Hudson River. Upstream, the Moodna Creek had good flow during the spring site visit.

Potential Impacts

Woodbury Creek: According to the Applicant, the nearest point on the Woodbury Creek is located approximately 450 feet to the west of the Mountainville Well. The average local distance to the creek ranges up to 700 feet, given a curve in Woodbury Creek at this location. Although flows in Woodbury were quite strong during the time of the site visit, pumping from the well field could result in a cone-of-depression that would extend to the creek substrate interface. The potential severity of the impacts increases with A) increased duration and frequency of pumping and/or volume of water withdrawals (i.e., 24/7 withdrawals) during normal flow conditions; and B) low-flow conditions, where withdrawals would exacerbate stresses to the aquatic ecosystem.

During Q90 conditions, the discussion above has indicated that removal of 425 gpm of water withdrawal is approximately 59% of the total flow in the stream. It is noted that this portion of the stream is upgradient of the gauging location at Creamery Road where data was taken, and so hydraulic inputs may be lower farther upstream at this location. During those times, when the stream's hydrology and associated ecosystem would already be stressed by drought conditions, the stream substrate could become a losing-stream gradient possibly resulting in a significant reach of the stream bottom lacking any surface flow during the time of the drought and pumping, and continuing for some time after the drought ended until groundwater and surface water balances were reestablished. The drawdown impacts would exacerbate stresses to aquatic organisms that would already be experienced in the stream during a drought condition.

The severity of the impacts is related to the frequency, duration, and volume of pumping and the existing background hydrological conditions (i.e., high flow versus drought conditions) during pumping. Given the duration and instrumentation of the well pumping test, there is inadequate data to quantify impacts of continuous well usage, so such impacts must be discussed quantitatively. Continuous 24/7 pumping would have the greatest impact, while use of the wells as a back-up water supply would likely have minimal to no discernable impact, provided this use did not exceed the 72-hour duration evaluated by the 2011 pumping tests, and the use occurred infrequently. These impacts would be least during periods of normal to high flow.

The range of impacts could include dewatering of the riparian corridor within the cone of depression, changes to the riparian corridor plant composition, and reduced riparian corridor aquatic habitat continuity. Depending on the frequency and duration of pumping and its timing relative to background hydrological conditions, the range of impacts (and severity) could include:

- Reductions to the depths, sizes and numbers of pools suitable to serve as refugia or hibernacula for species (discussed below).
- Reduced flow volumes in the stream. Under severe conditions, this could result in complete dewatering of a portion of the stream, and desiccation of the stream substrate.
- Increased temperatures in the stream due to reduced groundwater inputs and increased thermal warming of the substrate.
- Inability for the stream to move nutrients and sediments from upland areas to downstream aquatic habitats such as the mouth of Moodna Creek.
- Fragmentation of the riparian corridor to upstream and downstream locations with a dewatered length/reach at this location.
- Changes in water quality due to volume and temperature of flow. Combined with continued downstream discharges, the percentage of discharge to flow will change. Increased temperatures and reduced flow volumes will reduce the assimilative capacity of the stream to accept permitted SPDES discharges. As discussed previously, the 2012 Stream Biomonitoring Data is already showing a steady decrease in water quality downstream in Woodbury Creek. Increased water withdrawals will not improve water quality or the Biomonitoring results.

Wetlands: In order to understand potential impacts on wetlands, one must also understand the hydrology of wetlands. Wetlands result from “inundation or saturation by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soils.” The fluctuation of the water table (the hydroperiod) is unique for each wetland type, and is dependent upon the water budget. Wetlands typically take in water from precipitation, groundwater and surface water, and release it by evapotranspiration, groundwater outflow and surface water outflow. The type and area of wetland that develops over time is dependent upon the frequency and duration (and volume/area) of inundation and saturation, which is, in turn, dependent upon the three hydrological inputs. In other words, the depth, duration and timing of the cyclical hydrology patterns in a wetland are directly responsible for how a wetland presents in the landscape. The Diagram of a Waterbalance for a wetland[47] illustrates these concepts.

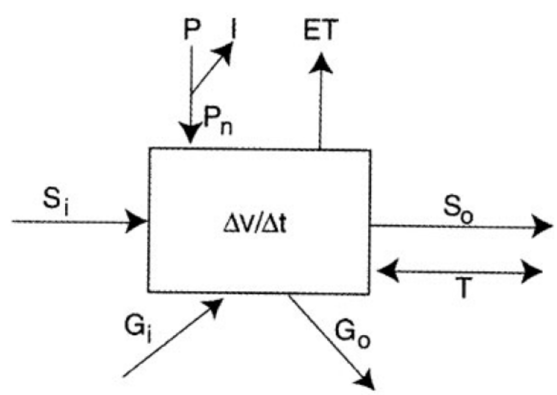
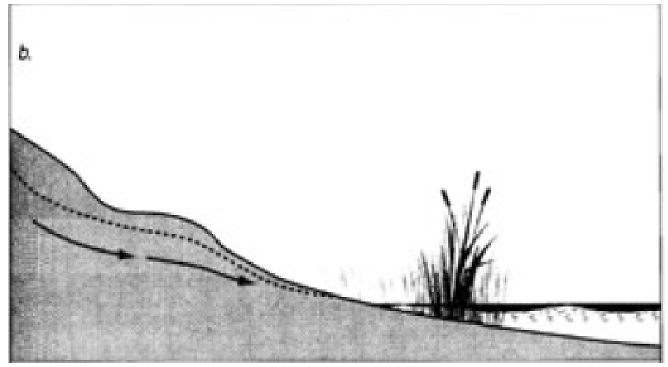


Diagram of a waterbalance, where P=precipitation, Pn= net precipitation, ET=evapotranspiration, I=Interception, Si=surface water inflow, So=surface water outflow, Gi= groundwater inflow, Go=groundwater outflow, T= Tide, V=change in storage, and t=time (Mitsch and Gosselink, 2000).

[47] Turner, Marjut H. and Gannon, Richard. 2013.



As mentioned in the existing conditions discussion above, the Wayland soils on the site, which were observed to support wetlands immediately adjacent to the Mountainville Well appear to be groundwater slope wetlands. See the diagram to the right.[48] The Soil Survey report for the Houghton Farm property indicates the presence of a potential aquitard at approximately 30 inches below the top of grade. The interface of this aquitard layer with the slope along the east side of the Wayland soils is likely the reason for groundwater slope seepage and hydrological inputs from the east. This aquitard would tend to perch hydrology allowing wetlands to form but then would allow for slow recharge to the local and regional groundwater. This means that a significant portion of the hydrologic input to that wetland is likely from groundwater inputs. In addition, the adjacent linear drainage wetlands to the north and south of the Mountainville Well appear to direct water into these wetlands.

The Wayland soils currently support emergent wetlands with a wetland scrub-shrub/ forested fringe. The severity of impacts to these wetlands from the Mountainville Well is directly related to the frequency and duration of withdrawal of groundwater and surface water inputs to the wetlands. Impacts to hydrological inputs into wetlands would range from immediate and direct to delayed responses from sustained drawdown. However the soils are not homogeneous along the stream corridor, and because there are also soils with greater sands and gravels (i.e., Marden gravelly silt loam, Erie gravelly silt loam), and since the pumping test length was not extended to stabilization, one cannot fully definitely predict the extent of impacts to the wetland.

The pumping test did demonstrate some draw down in this location, so clearly there will be impacts to the hydrology of the wetland. The severity of impacts would be greatest with a constant 24/7 pumping and associated drawdown. Intermittent pumping would have less of a significant impact. Use of the well for a back-up water supply would have the least amount of impacts to the wetland.

The following range of impacts (and their severity) are dependent on the frequency and duration of pumping and its timing relative to background hydrological conditions:

- Steady drawdown could impact species composition and distribution in the wetland. It could change the covertype from an emergent wetland to a shrub or forested covertype.
- There could be significant modifications of wetlands resulting in transition to uplands due to the loss of seasonal hydrology that currently sustains them.
- Loss of wetland hydrology could result in the loss of rare plants.
- Loss of wetland hydrology could encourage additional colonization by invasive species.
- Loss or reductions in wetland hydrology would result in the loss of functions and values to the animals that live in or utilize the wetlands for portions of their life cycle. This includes wood turtles, reptiles and amphibians.
- Should pumping occur during a drought in the late summer, and should the drought extend into the fall, there could be impacts on late-season hydrology, which would have a large impact and

[48] Ibid.

potential to change vegetative communities, due to an inability to catch up to the hydrological inputs necessary to support wetland development.

- Impacts would be greatest in the Wayland soil wetland and adjacent drainage ditches. Impacts would decrease in wetlands as one moves away from the Mountainville Well.

As identified above, both the NYSDEC 2006 Hudson River Estuary Report and the 2008 Moodna Creek Report discussed adverse impacts to tributaries and riparian areas and wetlands from changes in hydrology. The Mountainville Well has the potential for significant adverse impacts on the tributary and riparian area of Woodbury Creek, and on the wetlands in the vicinity of the well.

Ecological Resources:

Depending upon the frequency, duration and volume of pumping, and the existing background flows in the stream and the existing wetland hydrology conditions at the time of pumping, adverse impacts on aquatic organisms or other organisms that rely upon these habitats could include:

- Reduction in the numbers of rare plants.
- Increased mortality of macroinvertebrates due to periodic desiccation of the substrate.
- Increased warming of the stream flow due to reduced 55°F groundwater inputs and increased thermal warming of stream substrate.
- Increased mortality of trout and other fishes due to lack of water, reduced food sources, increased water temperatures and decreased dissolved oxygen.
- Reduced mobility of trout and other fisheries to move upstream or downstream.
- Artificial isolation of water dependent species such as the trout into smaller pools.
- Increased predation of trout in those pools.
- Impacts on fall fish migration and spawning especially for brook trout due to inability to traverse sections of the streambed that could become dry.
- For long-duration/high frequency pumping especially during extended drought conditions, potential for adverse impacts on spring rainbow trout spawning.
- For long-duration/high frequency pumping, potential for adverse impacts on wood turtles' use of deep pools in the riparian stream corridor for winter hibernation.
- For long-duration/high frequency pumping, adverse impacts on wood turtle populations' ability to use the riparian stream corridor for movement to other habitats and migration to find mates and maintain genetic diversity.
- Impacts on long-term fish viability and species composition.
- Adverse impacts on predators such as mink and otter due to a loss of prey species.
- Impacts on other species such as dragonflies and damselflies due to substrate desiccation.
- Impacts on bats and birds that forage on macroinvertebrates, where populations could potentially be reduced due to changes in hydrology including possible substrate desiccation.
- Reductions in the ability of the Woodbury Creek riparian corridor to provide a biodiversity linkage through the Highlands.

Hydrological changes to the stream and wetlands have the potential to changes stream and terrestrial biodiversity and the overall connectivity of the riparian corridor. The 2006 NYSDEC Report, quoted previously state: "minimizing development in riparian corridors, minimizing the **hydrological alteration of stream systems**….will help to protect stream biodiversity…"[49] "Wetland conservation strategies

[49] Penhollow, M.E., P.G. Jensen and L.A. Zucker. 2006.

should include, where possible, the restoration and **protection of wetland hydrology and wetland plant communities**, [and] **control of invasive species**." [50] "[P]reserve the species that depend on **unfragmented** forests **and habitat corridors by conserving mature lowland forests…restoring forest fragments in riparian areas**, restoring gaps between disconnected forest tracts, and **controlling invasive species."**[51]

Moodna Creek: As discussed previously, the mixing of freshwater and salt water at the Moodna Creek mouth is key to the "irreplaceable" aquatic plant communities found at this location. The Moodna Creek appears to pulse in and out of the mouth of the creek, constrained by the existing railroad bridge abutment. During low tide, one can observe the lens of clear freshwater flowing into the Hudson's more turbid water. Previously, this letter has documented that the Woodbury Creek inputs to Moodna Creek are a significant portion of the overall water budget of Moodna Creek. The aquatic ecosystem at the mouth of the Moodna Creek has developed in response to the freshwater and tidal pulses moving through the mouth. Changing the percentage of freshwater to salt water pulses in this area has the potential to change the equilibrium of the unique aquatic habitats found in this area. The Mountainville Well at 425 gpm withdrawal is projected to result in a 29% reduction in flows in Moodna Creek under the Q90 conditions.

As discussed above, Moodna Creek is already experiencing a loss of the herring runs in the Moodna, theorized to be the result of increased sewage plant discharges upstream. A reduction in freshwater inputs from Woodbury Creek due to withdrawals from the Mountainville Well has the potential to exacerbate downstream pollution impacts due a reduced dilution effect of freshwater flow volumes and increased temperatures in Moodna Creek. These conditions reduce the assimilative capacity of streams. This, in turn has the potential to cause further impacts to fisheries at the mouth of the Moodna, adversely impacting the fish species more sensitive to pollution and oxygen levels.

Similar to the situation at the Woodbury Creek, the severity of the impacts is related to the frequency and duration of water withdrawals and the background hydrological conditions when they occur. Continuous water withdrawals will be more impacting than episodic withdrawals, with the least impacts occurring when the new well is used as a back-up water supply during non-drought conditions.

Mitigation

The criteria that the NYSDEC must apply in deciding whether to issue or deny a water supply permit application includes the following:

In making its decision to grant or deny a permit or to grant a permit with conditions, the department shall determine whether:

a. the proposed water withdrawal takes proper consideration of other sources of supply that are or may become available;
b. the quantity of supply will be adequate for the proposed use;
c. the project is just and equitable to all affected municipalities and their inhabitants with regard to their present and future needs for sources of potable water supply;
d. the need for all or part of the proposed water withdrawal cannot be reasonably avoided through the efficient use and conservation of existing water supplies;

[50] Ibid. Page viii.
[51] Ibid. Page viii.

e. the proposed water withdrawal is limited to quantities that are considered reasonable for the purposes for which the water use is proposed;
f. the proposed water withdrawal will be implemented in a manner to ensure it will result in no significant individual or cumulative adverse impacts on the quantity or quality of the water source and water dependent natural resources;
g. the proposed water withdrawal will be implemented in a manner that incorporates environmentally sound and economically feasible water conservation measures; and
h. the proposed water withdrawal will be implemented in a manner that is consistent with applicable municipal, state and federal laws as well as regional interstate and international agreements.

Focusing only Items f and g above, our review of the record to date indicates that inadequate ecological study has been completed to conclude that there will not be significant adverse environmental impacts from the project on:

- Hydrology in Woodbury Creek.
- Hydrology in the large (potentially NYSDEC eligible) wetland complex within the Houghton Farm property, especially to the Wayland wetlands immediately to the west of the Mountainville Well.
- Rare plants that may occur in this area.
- Aquatic organisms that rely directly on these aquatic resources including trout, other fish species, wood turtle, damselflies, dragonflies.
- Species that consume aquatic organisms such as Indiana Bat (foraging), Northern Long-Eared Bat, other bat species, otter, and mink.
- Downstream water quality in Woodbury Creek and Moodna Creek.
- Riparian corridor connectivity for use by the species listed above.
- Biodiversity as discussed in the NYSDEC's own 2006 and 2008 Reports on Biodiversity of the Hudson River Estuary and the Moodna Creek watershed.

It is our opinion that the severity and significance of the impacts will be directly related to the frequency and duration of pumping, and the volume of groundwater removed, along with the background hydrologic conditions when that pumping occurs. It is our opinion that continuous pumping of the 425 gpm well has the potential for significant adverse impacts on the aquatic resources of Woodbury Creek, surrounding wetlands, the aquatic organisms that rely on those resources, and potentially the irreplaceable wetlands at the mouth of Moodna Creek. It is further our opinion, however, based on an interpretation of the available pumping test data, that very limited and episodic pumping might be tolerable, with more limited impacts to the Woodbury Creek, Moodna Creek and the wetlands abutting the site wells.

The NYSDEC itself, in its 2006 and 2008 Hudson River and Moodna Creek biodiversity reports have already identified Woodbury Creek, the Highlands and the mouth of the Moodna Creek as critical, "significant", and "irreplaceable" ecological resources for maintaining biodiversity. For this project, the NYSDEC's record does not contain an appropriately designed well pumping test protocol. On this project the NYSDEC's record also does not contain a thorough review of impacts on trout, wood turtles, wetlands, stream hydrology and the other important aquatic and ecological resources identified in this letter. The ecological resources identified in this letter are well-founded, based first on literature review, specifically the NYSDEC's 2006 and 2008 Reports, other mapping review, and a field inspection.

Finally, it should be noted that the Storm King Art Center purchased the Houghton Farm property in part to protect the aquatic and ecological resources on this site for the benefit of biodiversity in the Hudson River Estuary. This goal is aligned with the NYSDEC's goals and conservation strategies stated in their 2006 and 2008 reports. It would therefore be a travesty (and contrary to the recommendations in their own Reports) for the NYSDEC to issue a water withdrawal permit for this location that did not ensure that significant adverse impacts would be minimized to the maximum extent practicable.

The NYSDEC has available to it, a simple solution. Use of the new Kiryas Joel 425 gpm water well solely as a back-up water supply for those times when the NYCDEP primary water supply is not available, for periods not to exceed 72-hours, is unlikely to have an adverse impact on aquatic resources. We do not believe that such short-term and infrequent withdrawals of this volume, especially during normal hydrologic flow conditions, would change existing background hydrology. Therefore, the NYSDEC could strongly condition the water withdrawal permit to meet this requirement, and require notification and monitoring measures to ensure that there would be compliance with the permit conditions.

If this is not acceptable or feasible, then we believe the NYSDEC is mandated by their own regulations, by the NYSDEC's 2006 and 2008 Biodiversity Reports, and by the lack of documentation in the record regarding well pumping data and identified potential impacts on tributaries and riparian corridors, wetlands, habitat corridors and the diverse assemblage of flora and fauna that rely upon these resources, to conduct additional studies and reviews of these issues.

Sincerely,

Barbara B. Beall, PWS, LEED© AP
Director, Wetlands and Ecological Services

for Mal Gilbert, PWS, CPSS, CPESC

Russell Urban-Mead, CPG
Senior Hydrogeologist/VP, Environmental Services

cc: Dominic Cordisco, Esq.

Attachment A: Stream Gauging Summary For Moodna Watershed
Attachment B: Monitoring Well 1 Showing Continuous Decline
Attachment C: Excerpts from NYSDEC Reports
Attachment D: NRCS Soils Maps and Reports
Attachment E: Aerial Photos
Attachment F: Photographs

REFERENCES

Ayer, G. R. and F. H. Pausek. 1968. “Streams in Dutchess County, New York. United States Geological Bulletin.

Black Rock Forest. 2013. Amphibians of the Black Rock Forest List, Cornwall NY. http://www.blackrockforest.org/pdf-files/ReptilesAmphibiansSpeciesList.pdf. Reviewed April 9, 2013.

Black Rock Forest. 2013. Birds of the Black Rock Forest List, Cornwall NY. http://www.blackrockforest.org/pdf-files/BirdSpeciesList.pdf. Reviewed April 9, 2013.

Black Rock Forest. 2013. Mammals of the Black Rock Forest List, Cornwall NY. http://www.blackrockforest.org/pdf-files/MammalsSpeciesList.pdf . Reviewed April 9, 2013.

Frimpter, Michael H. 1985. Ground-Water Resources of Orange and Ulster Counties, New York. US Geological Survey Water-Supply Paper 1985. Prepared in cooperation with the New York State Conservation Department. USDOI, Washington, D.C. See http://pubs.usgs.gov/wsp/1985/report.pdf.

Heady, Laura. 2008. Biodiversity of the Moodna Creek Watershed: Important Resources and Conservation Recommendations. NYSDEC Hudson River Estuary Program, Cornell University Department of Natural Resources. June 19, 2008.

Hines, Kevin W. 2013. Comment Letter of Kevin W. Hines, Legislator of the Orange County Legislature to the NYSDEC on the Mountainville Pump Station. Application ID: 3-3399-00065/00001. Letter dated March 7, 2013.

Holloran, Neal and Dobbins, Kelly. 2013. Comment Letter of the Moodna Creek Watershed Intermunicipal Council to the NYSDEC on the Village of Kiryas Joel Water Supply Permit Application for Mountainville Pump Station. Application ID: 3-3399-00065/00001. Letter dated March 22, 2013.

Leggette, Brashears & Graham, Inc. 2011. 72-Hour Pumping Test Report for Well 1 Mountainville Pump Station Parcel, Route 32, Cornwall, NY. Prepared for Village of Kiryas Joel. August 2011.

NYSDEC. 1990. Division of Water Technical Operation Guidance Series (3.2.1) Public Water Supply Permit Program Application Processing. Albany NY [Provide website link].

NYSDEC. 2012. Letter to Gedalye Szegedin, Village Administrator Village of Kiryas Joel regarding SEQRA Lead Agency Circulation Response for Village of Kiryas Joel Water Supply Permit Application for Mountainville Pump Station. Application ID: 3-3340-00284/00001; WSA# 11,609. Letter dated November 21, 2013.

Orange County Water Authority. 2013. Orange County, NY Water Quality Biomonitoring Project Water Quality Biomonitoring Report for year 2012. Report Date January 2013. Goshen, NY.

Penhollow, M.E., P.G. Jensen, and L. A. Zucker. 2006. Wildlife and Habitat Conservation Framework: An Approach for Conserving Biodiversity in the Hudson River Estuary Corridor. New York Cooperative Fish and Wildlife Research Unit, Cornell University and New Y0rk State Department of Environmental

Conservation. Hudson River Estuary Program. Ithaca, NY. http://www.dec.ny.gov/docs/remediation_hudson_pf/hrebcf.pdf.

Schuster, William; Chmar, Andrew; DeLaune, James; and McGee, James. 2013. Comment Letter of the Black Rock Forest Consortium, Orange County Land Trust, Hudson highlands Land Trust, Black Rock Fish and Game Club, and Simon Gruber to the NYSDEC on the Village of Kiryas Joel Water Supply Permit Application for Mountainville Pump Station. Application ID: 3-3399-00065/00001. Letter dated March 25, 2013.

Turner, Marjut H. and Gannon, Richard. 2013. Watershedss: Functions of Wetlands (Processes): Hydrologic Flux and Storage. North Carolina State University Water Quality Group (NCSU). http://www.water.ncsu.edu/watershedss/info/wetlands/function.html.

Village of Kiryas Joel Board of Trustees. 2012. State Environmental Quality Review Negative Declaration Notice of Determination of Non-Significance. December 4, 2012.

Attachment A:
Stream Gauging Summary For Moodna Watershed

Exhibit B - Field Data and Notes
Orange County Stream Gauging 2010

Stream Gauging Results, Chazen Companies, August 2010

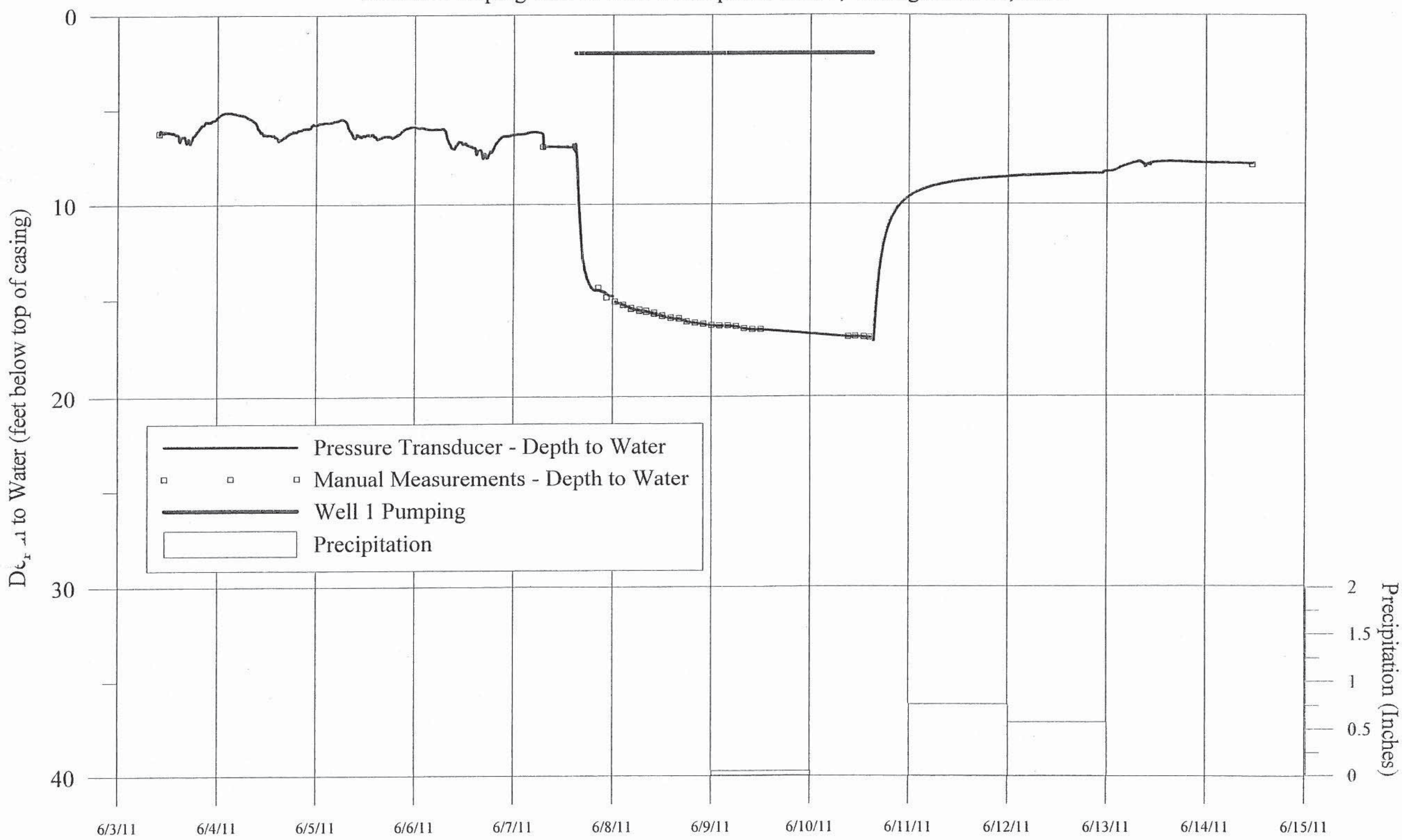
	Location	Date	End Time	Flow (cfs)	Flow (gpm)	Approx. Watershed (mi2)**	Normalized Flow, cfs/mi2	Comments
Moodna	Woodbury Creek @ Creamery Hill Road, Cornwall	13-Aug-10	13:05	2.14	960	22.2	0.096	
	Moodna Crk @ Otterkill Road, Cornwall	13-Aug-10	13:45	2.13	956	137	0.015	
	Satterly Creek @ Hudson Rd, near Washingtonville	13-Aug-10	14:15	0.25	112	12.2	0.02	visual flow estimate only
	Cromline Crk @ Tuthill Rd, Blooming Grove	13-Aug-10	14:35	0.16	72	30.9	0.005	
	Otter Kill @ Rte 207 near Maybrook Rd, Hamptonburgh	13-Aug-10	15:30	0.28	126	30.7	0.009	
	Moodna Crk @ Rte 32 rest stop near Quaker Ave	13-Aug-10	16:45	4.04	1813	177	0.022	difficult gauging, boulders
Reference	Quassaic Creek @ Walsh Ave, Newburgh, Orange Co.	13-Aug-10	10:10	2.67	1198	50.2	0.053	
	Rutgers Crk @ Rte 284, Minisink, Orange County	16-Aug-10	11:00	1.98	889	31	0.064	
	Indigot Creek @ Rte. 284, Wawayanda, Orange County	16-Aug-10	11:26	1.08	484	18.5	0.058	
	Wawayanda Crk @ Ryerson Road, Warwick, Orange Co	16-Aug-10	14:00	4.42	1983	80	0.05	
	Wappinger Creek Dutchess County*	12-Aug-10	from USGS	25	11221	181	0.138	flow from USGS website
	Ten Mile River, Dutchess County*	12-Aug-10	from USGS	12	5386	203	0.059	flow from USGS website

** watershed sizes estimated either from the Moodna watershed plan, OCWA mapping, plamineter or USGS website
* Wappinger Creek flow is approximately equal to Q90 flow conditions (10% driest condition)

Attachment B:
Monitoring Well 1 Showing Continuous Decline

VILLAGE OF KIRYAS JOEL
MOUNTAINVILLE ESTATES PARCEL
CORNWALL, NEW YORK

Hydrograph of Water-Level Measurements Collected from Monitoring Well MW-1 During the 72-Hour Pumping Test of Well 1 Completed June 7, Through June 10, 2011



K:\Jobs\Village of Kiryas Joel\Mountainville Estates Parce\Hydrographs\KJM-MW-1.grf

LEGGETTE, BRASHEARS & GRAHAM, INC.

Attachment C:
Excerpts from NYSDEC Reports

HUDSON RIVER ESTUARY

WILDLIFE AND HABITAT CONSERVATION FRAMEWORK

An Approach for Conserving Biodiversity
in the Hudson River Estuary Corridor

New York State Department of Environmental Conservation

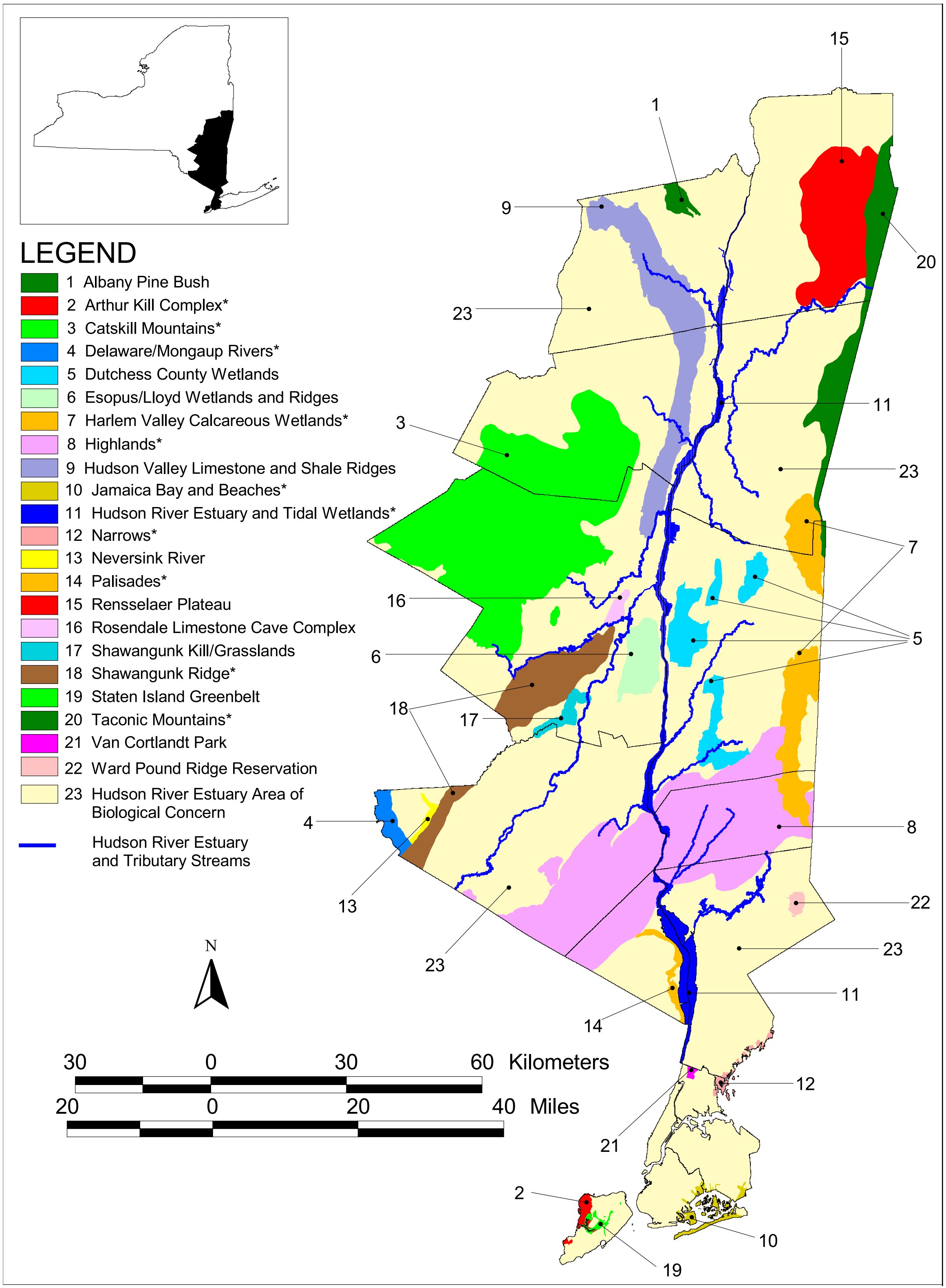


Figure 3. Significant biodiversity areas of the Hudson River Estuary corridor.

* Areas marked with an asterisk extend beyond the political boundaries of the study area.

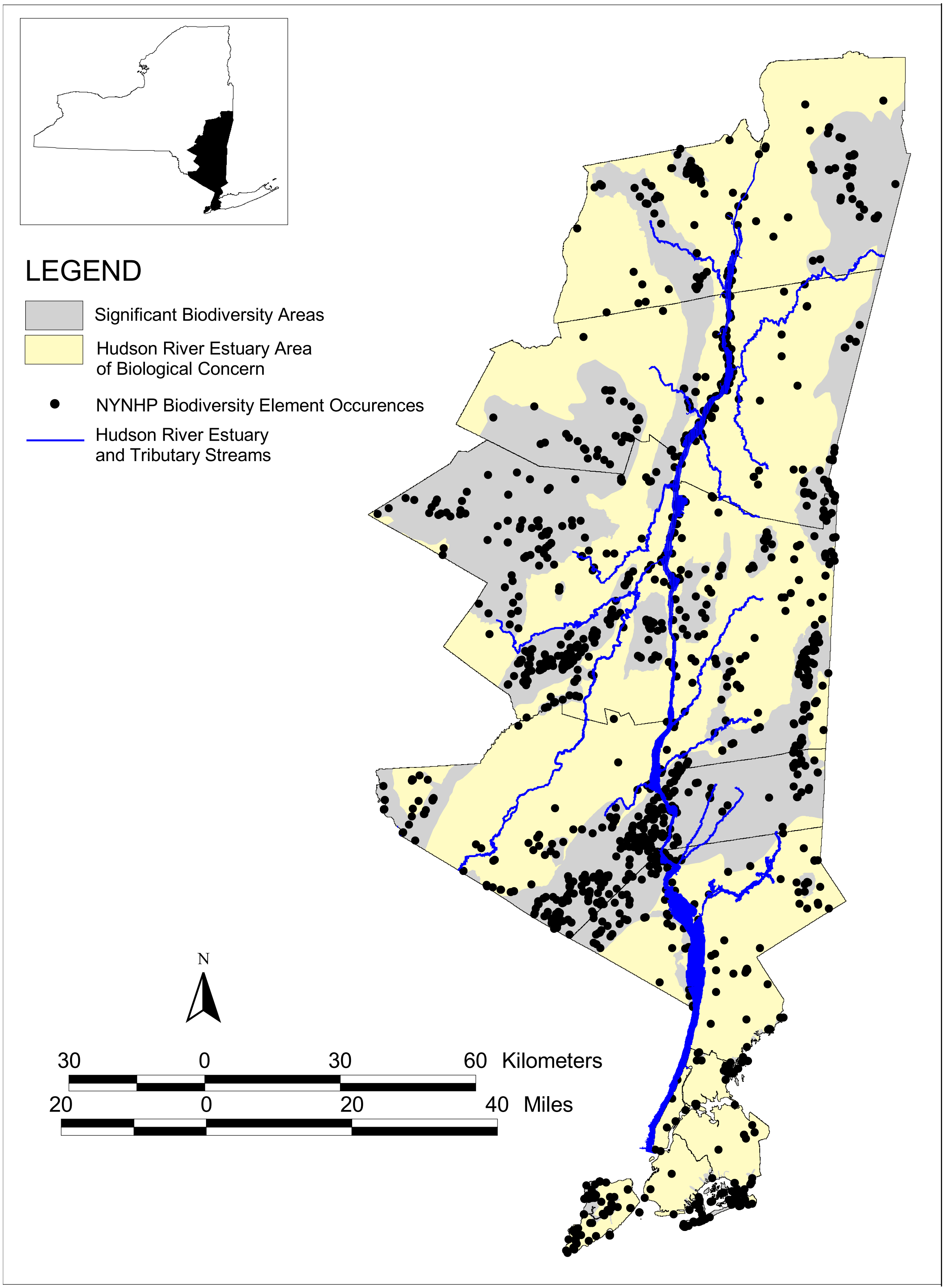


Figure 4. Biodiversity element occurrences tracked by the NY Natural Heritage Program within the Hudson River Estuary corridor. The dots may represent one individual plant or animal occurrence, or a community of organisms.

Tributaries & Riparian Habitat

Description:

The health of the Hudson River Estuary is closely linked to the health of its tributaries and their watersheds. There are roughly 65 major tributaries to the Hudson River Estuary with over 3,600 miles of streams in the estuary watershed. These tributaries and adjacent riparian areas provide important habitat for fish and wildlife. Migratory fish, like herring and eel, and resident species, such as black bass, rely on tributary habitats to complete their life cycles. Blue crabs use the tributaries for nursing and overwintering. In the Hudson River Estuary, the mouths of tributary streams and rivers are influenced by daily tides, and are thus unique communities.


Intertidal swale. Photo courtesy of Kathryn Schneider.

Streams include channel habitat and riparian areas on the tops of the banks, the floodplain, and non-floodplain areas adjoining the stream. A typical stream channel exhibits a sequence of microhabitats in the form of pools, riffles, and runs. Pools and slow runs might support submerged vegetation while channel bars and portions of low banks can support plants such as willows, alder, silky dogwood, spotted jewelweed, stinging nettle, and whitegrass. Streambanks and floodplains are often dominated by plants tolerant of flooding and ice damage. The floodplain is the low-lying area that is flooded by a stream at statistical intervals. The 100-year floodplain for example, is predicted to be flooded once per century. Floodplains contain a variety of habitats, including but not limited to upland meadow, wet meadows, swamps, marshes, and lowland forests. Although once common, floodplain forest is now rare in the Hudson River Estuary corridor.

Riparian habitats represent only a small portion of the landscape, but are a critical source of biodiversity. A riparian zone is an interface between aquatic and terrestrial systems. Riparian ecosystems cover the land bordering a stream, wetland, lake, tidewater, or other body of water. The suitability of these zones for supporting aquatic and terrestrial plants and animals can be altered by agricultural and timber harvesting activities, the creation of physical structures such as buildings, roads, and dams and other human disturbances such as recreation.

Ecological Importance:

Riparian zones serve a variety of functions, including those related to physical and chemical characteristics of streams (e.g., moderating water temperature, controlling stream erosion and sedimentation, controlling non-point source pollution) and they provide habitat for a variety of fish and wildlife species. Many aquatic invertebrates, which are food for predatory fish, use riparian vegetation as habitat and depend upon leaves as a source of food. Leaves fallen from streamside trees are the carbon source that fuels the entire aquatic food chain in small to medium-sized tributary streams. Riparian trees also help to create critical habitat features, such as cover, undercut banks, and piles of woody debris that trap nutrients. Even a narrow band of woody vegetation contributes to edge of channel habitat structure (such as undercut banks) and temporary bank stabilization. Riparian vegetation is a source of woody debris that helps to create microhabitat within the stream channel. In addition to supporting the aquatic environment, riparian areas are unique ecosystems in themselves, and present optimal conditions for a number of plant and animal species. The soils and microclimate within riparian areas often contain the right conditions for ferns, orchids, and other plants that prefer rich, moist soils and environs.

Riparian zones tend to be biodiverse, because they provide a close juxtaposition of wildlife habitat requirements, an increased number of niches due to increased plant diversity and structural heterogeneity, and high edge-to-area ratios resulting from their linear shape. Riparian corridors are networks that provide potential routes for animal movement, seed dispersal, and gene flow across landscapes, and may serve as a source area for recolonization of nearby disturbed areas. Loss of mature, riparian forest remains an issue of concern in the Hudson River Estuary corridor. Wildlife species that depend upon wide bands of mature riparian forest, riparian wetlands, and silt-free channel beds are the most imperiled.


Belted kingfisher. Photo by Isidor Jeklin.

Terrestrial animals utilize riparian areas for foraging, breeding, migration, hibernation, and refuge. Semi-aquatic mammals that use tributary habitats include mink, muskrat, and river otter. Bats and birds forage on insects above the water. A variety of birds use tributaries and riparian habitat, including waterfowl, woodcock, belted kingfishers, osprey, eagles, herons, and many songbirds. Streams support fish and aquatic macroinvertebrate communities, stream salamanders, green frog, snapping turtle, eastern painted turtle, wood turtle, and northern water snake. A number of invertebrates use these habitats, including damselflies, butterflies, and dragonflies.

Pollutants released in the watershed find their way to the estuary through tributaries. In the Hudson River Estuary corridor, pollutants of concern include excessive sediment and nutrients, toxic chemicals, heavy metals, and pathogens. Other significant causes of water quality impairment in tributary streams include noxious aquatic plants (particularly at tributary mouths), thermal modification, flow alteration and other habitat modifications. Many pollutants readily attach to sediment, which in excess, is also considered a pollutant. Potential pollutants such as pathogens, phosphorus, and some pesticides readily attach to sediments and are resuspended in the water column during disturbances, or transported downstream to drinking water reservoirs or the Hudson River Estuary. All stream systems naturally erode and redeposit sediments. However, sediment erosion or deposition beyond natural rates can create conditions that aquatic organisms are unable to tolerate. Common sources of sediment include eroding banks (although some bank erosion is natural), construction sites, agricultural fields, and urban runoff.

The obstruction of fish migration by dams and other structures, and habitat alteration related to activities such as gravel mining or reservoir water releases, can also degrade tributary habitats. Dams alter river continuum and connectivity, disrupt sediment transport, and alter natural fluctuation in water supply. Increasingly, increased impervious surfaces are causing changes to watershed hydrology, particularly in the rapidly urbanizing portions of the Hudson River Estuary corridor. Impervious surfaces such as roads, rooftops, and parking lots direct stormwater to streams as runoff, rather than allowing it to infiltrate the soil and reach the stream as groundwater. Because water is not stored in the soil and released to the stream at slower rates, the result is that low flows are more severe and last longer during summer months, while storm flows may peak at higher and more destructive levels. Both the increased flow rate and amount of water reaching the stream can cause devastating changes in channel and riparian habitats.

Headwater mountain stream. Photo courtesy of Mark Vian.

Conservation Strategies:

The cumulative effects of channelization, point and nonpoint source pollution, gravel mining, dam construction, floodplain filling, and riparian vegetation removal throughout a stream system can lead to dramatic declines in biodiversity. Best Management Practices designed to reduce these disturbances should be developed based on an understanding of how disturbances affect certain species, at what intensities, and during which times during the species' annual life-cycle. Management of stream and riparian habitats may involve the establishment of buffers, limiting livestock and human access during critical time periods, and limiting certain types of activities. Conservation easements, local zoning ordinances, and set-aside of riparian areas, can create a space for natural stream processes to operate.

Minimizing development in the riparian corridor, and minimizing hydrologic alteration of the stream system within the watershed (including intermittent tributaries and wetlands) will help to protect stream biodiversity. Restoration of native riparian meadows and forests, as well as natural channel morphology is essential for the protection of water quality. Stream managers should consider that alterations of floodplain, channel, and riparian habitats in one section of the stream can cause unwanted changes in downstream habitats.

Longtail weasel.
Photo courtesy of Cornell University.

Management approaches to conserving riparian zones must address both the loss and degradation of these habitats and the effects of human disturbance. The USDA Forest Service (Welsch 1991) provides specific guidelines for the conservation and maintenance of riparian zones, including recommendations for the size of forest buffer widths. In general, riparian buffer widths should be at least 300 feet to support wildlife habitat. However, conservation buffers of this size are not always possible. Buffers of at least 50 feet protect some streamside functions, although their long-term effectiveness should be examined for the particular stream and the probability of channel adjustments. Recommended buffer sizes can also be based on particular stream processes and species-specific habitat requirements (Wenger 1999). Riparian buffer recommendations should be incorporated into forestry and agricultural Best Management Practices and communicated to interested landowners.

Biodiversity areas notable for tributaries & riparian habitat (Figure 10):

- Delaware/Mongaup Rivers
- Hudson River Estuary Area of Biological Concern
- Shawangunk Kill/Shawangunk Grasslands
- Neversink River

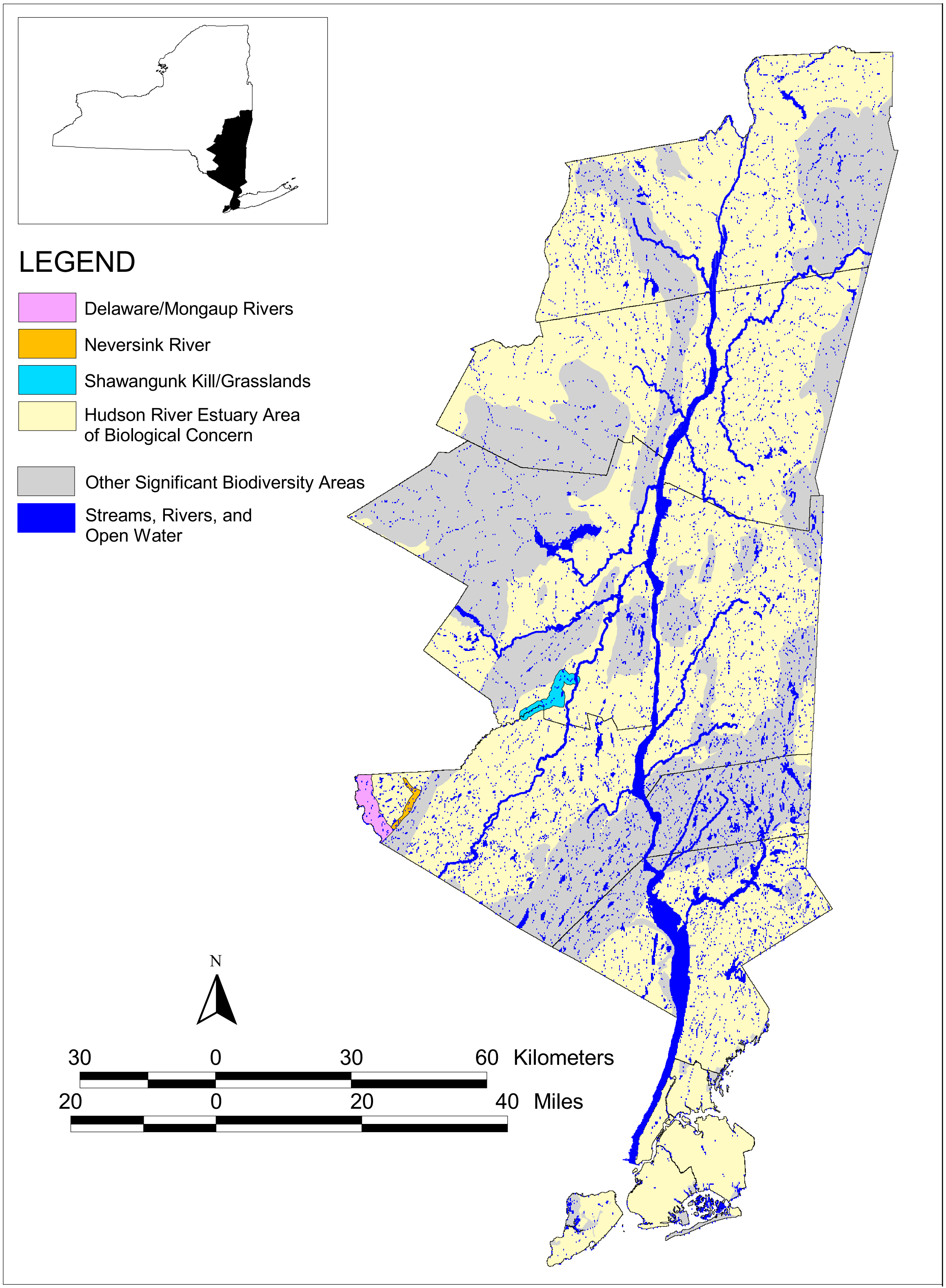


Figure 10. Significant biodiversity areas of the Hudson River Estuary corridor notable for tributaries and riparian habitat.

Unfragmented Forest & Habitat Corridors

Description:

Unfragmented forests are relatively large forest or woodland tracts that are unbroken by major roads or other developments. Some of the forest types found in the Hudson River Estuary corridor include pitch pine-oak forest, Appalachian oak-hickory, chestnut oak forest, beech-maple mesic forest, hemlock-northern hardwood forest, spruce-northern hardwood forest, mountain spruce-fir forest, and mountain fir forest. Some examples of large forested blocks in the Hudson Valley include the Rensselaer Plateau, the Highlands, and the Catskill, Taconic, and Shawangunk mountains. Lowland forest floors that have deep leaf litter and uncompacted soils are rare remnants of features that may once have covered large areas in the Hudson River Valley.

Ecological Importance:

Unfragmented forest blocks are important for a number of species sensitive to disturbance and dependent on large areas to meet their habitat requirements. These species are typically defined as interior or area-sensitive species and include several large mammals (e.g., bobcat, black bear, fisher), raptors (e.g., red-shouldered hawk, Cooper's hawk), and songbirds (e.g, woodland warblers, forest thrushes). Furthermore, some species depend on the clean, cold water provided in headwater streams in forested regions. These streams are critical habitat for trout as well as several species of amphibians.

Sharp-shinned hawk.
Photo by Johann Schumacher.

Habitat corridors that link intact forest blocks are extremely important features in the landscape. Corridors are habitat for dispersing animals, and most importantly connect species populations. In many cases these corridors represent riparian habitat as well.

Although few examples of "old-growth" lowland forest remain, forests of moderate-sized and moderate-aged trees continue to provide valuable habitat and might provide valuable mature forest habitat in the future. Typical trees in a lowland forest include sugar maple, oaks (black, red, chestnut, white), American beech, and hemlock. Other trees that may be present include shagbark hickory, white ash, basswood, tulip tree, and black birch. Characteristic animals of unfragmented forests are red-shouldered hawk, barred owl, pileated woodpecker, ovenbird, wood thrush, cerulean warbler, and Acadian flycatcher. A diverse small mammal community and invertebrate community are usually also present. Rare fungi, lichens and bryophytes (mosses and liverworts) are associated with remaining lowland old-growth forests. The red-shouldered hawk may be rare in part due to fragmentation of this habitat.

Conservation Strategies:

Habitat change and fragmentation are substantial pressures negatively affecting biological diversity in the Hudson River Estuary corridor. Floodplain forest and mesic lowlands are especially at risk of fragmentation, and are under-represented on public lands (A. Finton, NY Natural Heritage Program, pers. comm.). Therefore, it should be stressed that intact, forested habitats should be conserved regardless of size. Within fragmented landscapes, the conservation of habitat corridors that link intact forest blocks is of particular importance. On a local level, this will involve the identification of forest blocks and corridors. Once identified, conservation tools aimed at protecting these areas (e.g., conservation easements, acquisition on a willing seller basis) should be implemented. Forestry plans for these areas should emphasize selective and low-impact harvesting, particularly of mature lowland forest. Forest management practices that reduce the impact of roads and compaction and disturbance by vehicles should be encouraged.

Chestnut oak forest.
Photo by Andrew Finton.

On a regional level, strategies to address habitat change and fragmentation should focus initially on identifying those lands most at risk, assessing the juxtaposition of protected forest blocks and corridors with unprotected land, and identifying critical areas for maintaining or establishing habitat connectivity. Spatial analyses of these features could be conducted using remote-sensing products. Other studies that examine the effects of human demographics on habitat fragmentation could be extremely important for identifying priority areas for conservation efforts and directing development to less sensitive areas.

Biodiversity areas notable for unfragmented forest & habitat corridors (Figure 11):

- Catskill Mountains
- Highlands
- Rensselaer Plateau
- Shawangunk Ridge
- Taconic Ridge

Other biodiversity areas that contain unfragmented forest:

- Palisades

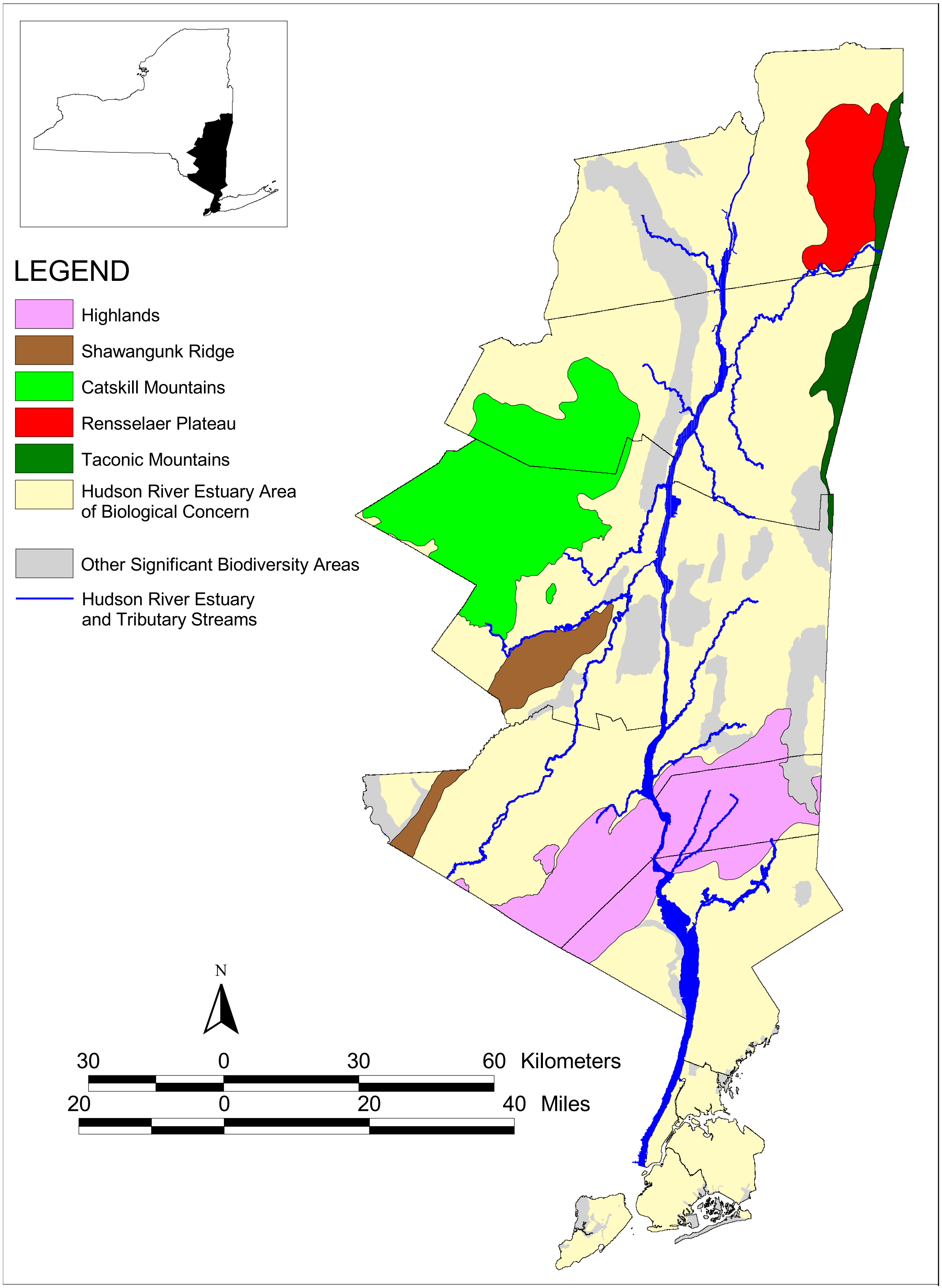


Figure 11. Significant biodiversity areas of the Hudson River Estuary corridor notable for unfragmented forest and habitat corridors.

Wetlands

Description:

Much of the information on wetlands provided below was adapted from Kiviat and Stevens (2001).

- Tidal and Non-Tidal Wetlands

  The Hudson River Estuary corridor contains a rich diversity of wetland types, which in turn supports a variety of plant, wildlife, and fish species. About 29 of the 57 wetland community types occurring in New York have been documented in the Hudson River Estuary corridor (Howard et al. 2002, Edinger et al. 2002). Wetlands represent a transition between aquatic and terrestrial systems and as such, generally support high species diversity. Some wetlands (e.g., bogs) support low species diversity but represent an important component of biodiversity at the landscape scale.

  Tidal wetlands occur along the 152-mile Hudson River estuary and include brackish tidal marsh, brackish intertidal mudflats, freshwater tidal swamp, freshwater tidal marsh, and freshwater intertidal mudflats. The species composition of Hudson River Estuary wetlands change as the water characteristics change from brackish to fresh. Examples of non-tidal wetlands include fens, bogs, scrub-shrub swamp, and forested, floodplain, and headwater wetlands.

  Tidal wetlands of the Hudson River Estuary corridor include (Kiviat and Stevens 2001):

  Fresh and Brackish Subtidal Shallows: The subtidal shallows is the zone between the mean low water elevation and approximately 6.5 ft below mean low water. This zone supports beds of submerged vegetation, which are well-known for their importance to fish and waterfowl. In some areas, the subtidal shallows extend into portions of tidal tributary mouths. This habitat is found throughout the tidal Hudson, but is more extensive in shallower reaches of the river, including the Haverstraw Bay-Tappan Zee and areas north of Saugerties.

  Fresh and Brackish Intertidal and Supratidal Marsh: The intertidal marsh is the herbaceous wetland (i.e., dominated by non-woody plants) and mudflat zone between mean low water and mean high water. A supratidal marsh is a predominately herbaceous wetland occurring at elevations between mean high water and approximately 3.3 ft above mean high water. Possibly the best-studied Hudson River habitat, the marshes attract attention because of their documented importance to fish and birds. These habitats also support many rare plant species, are important for recreation, and appear to play a beneficial role in Hudson River water quality. The combined intertidal and supratidal zones cover approximately 26% of the 58,000 acre high-tide surface area of the tidal Hudson River between the Rip Van Winkle Bridge and the New York-New Jersey state line. The intertidal marhes probably comprise somewhat less than half of the 26%.

Intertidal and Supratidal Swamp: The intertidal swamp is a wooded wetland, dominated by trees or shrubs, occurring in the upper intertidal zone, but below mean high water. A supratidal swamp is a wooded wetland lying between mean high water and approximately 3.3 ft above mean high water. It thus receives tidewater only during spring tides and storm tides. Tidal swamps have been studied little in the Hudson or elsewhere on the Atlantic coast. Hudson River intertidal and supratidal swamps are known to support rich biological communities, including numerous rare plants and a few rare animals. Most tidal swamp is in highly sheltered areas where tidal wetlands predated the Hudson River railroads, on dredge spoil deposits between the railroad and mainland, or at stream mouths, between islands and the mainland, and in protected coves. The largest examples are at Mill Creek, Stockport Flats, Rogers Island, Rams Horn Creek, and Tivoli Bays.

Tidal Tributary Mouth: The mouths of tributaries where nontidal and tidal waters mix, differ in substrate and chemistry from the adjoining aquatic habitats of the tributary and Hudson River. Tidal tributary mouths often have relatively scoured, rocky bottoms, fluctuating turbidity, and a shorter ice season than the adjoining bays or coves. These areas are important foraging habitats for fishes and water birds, and important spawning habitats for ocean and Hudson River fishes. Tidal stream mouths are found throughout the estuary, although in urban areas some streams have been diverted into culverts or artifical channels.

Non-tidal wetlands of the Hudson River Estuary corridor include (Kiviat and Stevens 2001):

Wet Clay Meadow: Wet clay meadows are wet meadow or wet oldfield habitats on clayey soil; most were formerly agricultural fields. Post-agricultural wet meadows may seem unexceptional on first inspection, but some are significant habitats for rare plants. This habitat should be expected wherever level, non-forested expanses of clayey soils occur in the Hudson River Estuary corridor, generally at 100-200 ft elevation.


The threatened spreading globeflower. Photo by Troy Weldy.

Fen and Calcareous Wet Meadow: These are open (i.e., unshaded by trees), herb-dominated (usually sedge-dominated), calcerous, shallow wetlands. Fens are distinguished by groundwater seepage, and a “fen plant community”, typically including shrubby cinquefoil. Calcareous wet meadows may have a variety of water sources, and a less specialized plant community. Fens and calcareous wet meadows occur where bedrock is limestone or other carbonate rock, or where the soils contain glacier-transported materials from carbonate rocks. These habitats support many rare plants and animals, and are sensitive to hydrological changes and pollution. Most fens and calcareous wet meadows are at low elevations.

Blue flag iris. Photo by Paul Jensen.

Non-Calcareous Wet Meadow: These are wetlands with non-calcareous soils and groundwater where the soil is saturated for part or all of the growing season, but only shallowly and briefly inundated, if at all, and which support predominantly herbaceous (non-woody) vegetation. Non-calcareous wet meadows are common in the Hudson River Estuary corridor. They occur where there is seepage, or accumulation of rainwater or runoff, on soils that are moderately to highly acidic. Wet meadows usually occur where there is or was livestock grazing, mowing, hay cutting, recent abandonment of crops, or where woody vegetation has recently been cleared. Wet meadows also occur in beaver meadows (abandoned beaver ponds) and some partially drained marshes. Wet meadows are often associated with the margins of marshes or swamps. Biodiversity values of non-calcareous wet meadows are poorly studied.

Hardwood Swamp: In prevalent usage the term "swamp" refers to a wetland dominated by trees or shrubs. Non-tidal hardwood swamps are fairly common in the study area; conifer swamps are very rare, very different ecologically, and very important for biodiversity. Swamps may be inundated throughout, may contain only small streams or pools, or may border larger streams, ponds, or lakes. Springs or seeps (groundwater discharge) may be present within or at the edges of swamps. Hardwood swamps are more extensive in areas of lower human population and are more common and extensive at lower elevations. Kettle shrub pools are an important type of swamp habitat, particularly to the threatened Blanding's turtle. Kettle shrub pools are deep-flooding, seasonal, shrub-dominated wetlands on glacial outwash, originally formed by the melting of stranded blocks of glacial ice.

Beaver Pond: Beaver ponds are created by beavers building dams across small to medium-sized perennial streams. Beaver ponds flood portions of the riparian area for a few years or sometimes longer. The pond accumulates silt, organic matter, and nutrients. Eventually the beavers die or leave the pond, the dam deteriorates, and the water level of the pond draws down, leaving a beaver meadow — a silty marsh or wet meadow. Beaver ponds and beaver meadows are different from surrounding habitats and are used by many other animals and plants. Beaver ponds are widespread in the Hudson River Estuary corridor, except in areas of high human population density where beaver ponds are usually drained to prevent damage to roads, yards, and ornamental trees.

Circumneutral Pond Lake: These are calcareous spring-fed water bodies with deep, organic substrates, and supporting vegetation of both acidic bogs and calcareous marshes. Floating peat mats and rafts are often present. Circumneutral bog lakes contain a variety of habitats for rare and uncommon species. Bog lakes are probably widespread near the Hudson River Estuary although many (and the best known) examples occur farther inland.

Acidic Bog: Acidic bogs are perennially wet, very low-nutrient wetlands dominated by low shrubs and peat mosses, with acidic, organic soils. Bogs are rare in the Hudson River Estuary corridor, are strikingly different from other wetlands, and support many uncommon and rare plants.

Marsh: Marshes are wetlands dominated by herbaceous (non-woody) plants, and with standing water through all or much of the growing season. Marshes are very important habtitats for many species of birds. A marsh may be isolated from other surface waters, may adjoin a pond or stream, or may have a stream flowing through it. Nontidal marshes are widespread throughout the Hudson River Estuary corridor, but are mostly at low elevations where more water and nutrients collect.

- Vernal Pools

Vernal pools are seasonal or ephemeral wetlands that form in shallow depressions and alternate on an annual basis between a stage of standing water and extreme drying conditions. They are found in a variety of settings, including depressions in upland forests, in floodplains, in wet meadows, and as part of large wetland complexes. By definition, vernal pools are free of fish and thus can support a rich community of amphibians and invertebrates that would be difficult to sustain if fish were present. Vernal pools are a common, but threatened habitat type that look unassuming, but are critical breeding areas for several species (see below).


Vernal pool at Ward Pound Ridge Reservation. Photo by Dennis DeMello.

Overall, characteristics of vernal pools vary greatly in terms of recharge, discharge, source of water, and geology. Largely fed by precipitation, these small pools may be most readily identified in the spring. Often occurring in small depressions, many dry up in late summer. However, a few have water year round.

Ecological Importance:

- Tidal and Non-Tidal Wetlands

Wetlands are unparalleled in their importance to many fish and wildlife species, providing a variety of habitat components such as breeding grounds, nesting sites, foraging areas, and other critical habitat. Because of historical losses in wetlands across North America, including New York State, these habitats often support endangered, threatened, and special concern plant and animal species. For example, the Hudson River Valley contains critical wetland habitat for the federally listed bog turtle, Blanding's turtle, and northern cricket frog. Additionally, wetlands along the Hudson River Estuary are especially important for migratory waterfowl in the Atlantic Flyway. Tidal wetlands of the estuary represent some of the state's rarest ecological communities and are important as nursery areas for a number of marine and anadromous fish. Furthermore, wetlands perform a variety of unique physical, chemical, and biological functions that are essential to the health of the environment. Wetlands regulate water flow, protect lake and river shore areas from erosion, and improve water quality.

Quality tidal habitats have low densities of introduced plants such as water-chestnut and Eurasian watermilfoil, and smaller fractions of artificial materials (cinder, demolition debris, railroad ties) in the sediments. Many state-listed rare plants (e.g., Long's bittercress, spongy arrowhead, estuary beggar-ticks, smooth bur-marigold, goldenclub, Fernald's sedge) and other species in the Hudson Estuary corridor that are almost or completely restricted to the Hudson depend upon tidal marsh habitats. Extensive cattail stands, and to some extent mixed cattail stands, support breeding birds that depend to a variable degree on grass-like marsh plants. The mouths of tributaries, where nontidal and tidal waters mix, are important foraging habitats for fishes and water birds, and important spawning habitats for ocean and Hudson River fishes.

Northern cricket frog. Photo by John White.

Common animals of nontidal wetlands include white-footed mouse, raccoon, red-winged blackbird, swamp sparrow, and green frog. Wetlands are used by muskrat, mink, beaver, tree swallow, waterfowl, herons, shorebirds, northern water snake, turtles, frogs, and many invertebrates. Larger live or dead trees often contain cavities used by bats, owls, woodpeckers, eastern bluebird, gray treefrog, and other cavity-using animals. In addition, many species use the buffer areas surrounding wetlands, which may not be protected.

In general, higher quality nontidal wetlands have a large extent, absence or rarity of invasive plants (e.g., purple loosestrife, common reed, reed canary grass), an intact buffer zone with minimal impingement by intensive land uses, absence of landfills or dumps upstream or upgradient, and light or no livestock grazing. Large mats of floating filamentous algae that cover pools for long periods each year indicate overfertilization from external sources. High quality fen and calcareous wet meadows have minimal cover of tall herbs, tall shrubs, or trees. Higher quality wet clay meadows have a greater abundance of sedges (other than tussock sedge). Hardwood swamps of high quality have larger trees and more large downed wood in the swamp.

- Vernal Pools

Vernal pools are a common, but threatened habitat type in the Hudson River Estuary corridor. They are often damaged because they are overlooked or not appreciated by landowners, or in environmental reviews for development. Vernal pools and their surrounding terrestrial areas provide critical habitat for a number of amphibians and invertebrates, some of which breed only in vernal pools. Vernal pools are the only significant breeding areas for Jefferson salamander, spotted salamander, marbled salamander, and wood frog. Other typical users include spring peeper, spadefoot toad, gray treefrog, American toad, and other amphibians that depend on pond habitats for reproduction.

Spotted salamander.
Photo courtesy of Cornell University.

Frogs move from the forest to vernal pools where they mate and lay eggs and then return to the woods after breeding. The deposited eggs hatch into tadpoles, which transform into adults sometime within 6 to 15 weeks. Salamanders spend much of the year underground in tunnels made by small woodland mammals. They emerge from the ground in early spring and migrate up to half a mile on warm, rainy nights to vernal pools. Once they have deposited their eggs, the adult salamanders typically wait for the next rainy night, when they return to the forest. The developing amphibians prey on fairy shrimp, copepods, daphnia, phantom midge larvae, and mosquito larvae. Young adults leave the vernal pools once they have lost all traces of gills and return to breed about two to four years later.

Because these species are largely dependent on vernal pools for breeding success (the risk of predation is high in permanent wetlands), the loss of vernal pools in upland areas will lead to the loss of amphibian species that depend on them, and thus loss of biodiversity. Amphibians in general are declining worldwide, as are many vernal pool dependent amphibians in the Northeast. Jefferson salamander, marbled salamander, and blue-spotted salamander are listed as special concern in New York State. The four-toed salamander, spotted salamander, and wood frog are vernal pool-using species threatened in the Northeast.

Vernal pools are also important habitat for other species, such as wetland dependent turtles (including the state-listed Blanding's turtle and spotted turtle), birds (including the federally listed American black duck), and small mammals. In Dutchess County, kettle shrub pools (a type of vernal pool formed by the melting of stranded blocks of glacial ice) support populations of the threatened Blanding's turtle. Neotropical migrant birds such as the worm-eating warbler, veery, and wood thrush also use vernal pools.

Conservation Strategies:

- Tidal and Non-Tidal Wetlands

  Freshwater tidal and non-tidal wetlands in New York State are protected under the Freshwater Wetlands Act, Article 24 and salt-water tidal wetlands in the lower estuary are regulated under theTidal Wetlands Act, Article 25 of the Environmental Conservation Law. However, most small freshwater wetlands less than 12.4 acres are not covered under this legislation. Exceptions are certain smaller wetlands of unusual local importance and wetlands above one acre in size that are regulated within the Adirondack Park. Efforts to identify and protect smaller wetlands should be encouraged. Adequate protection of the uplands buffering wetlands is essential to preserving the integrity of wetland ecosystems and habitat quality for wildlife.

  Physical disturbances to tidal wetlands should be avoided or minimized, and tidal flushing should be fully maintained. Dredge spoil disposal in the last century has eliminated large areas of tidal wetlands, especially between Saugerties and Albany. Large areas have also been filled for construction of the railroads and for urban-industrial development, especially in the Westchester and Albany areas. Pervasive chemical pollutants, such as PCB and metals, have contaminated the water and substrates of the Hudson River tidal habitats. Power boating and jet skiing in the shallows can have numerous effects, including pollution and toxic effects on organisms. Motorized craft should be excluded from shallows as much as possible to prevent pollution, and disturbance of animals and plants there. Abandoned and derelict duck blinds should be removed from tidal wetland habitats and duck hunters encouraged to use temporary blinds that are removed each season. The U.S. Army Corps of Engineers and NYSDEC are studying the potential for "restoring" some of the subtidal and intertidal habitat altered by spoil disposal.

Wetland stream. Photo by Paul Jensen.

  The mouths of tributaries are degraded by stream channel alteration and water pollution, particularly near urban-industrial areas. Removal of obsolete dams and other structures, and restoration of stream bank plant communities would benefit tributary mouths. In some cases, fish ladders may be needed to provide access for spawning above dams that cannot be removed. Boat traffic in some areas constitutes intense disturbance of tributary mouth and tidal habitats. Finally, restoration of tidal flow should be emphasized and may require the installation of structures that allow flows to bypass obstructions.

  Without mowing, burning or grazing, wet meadows are likely to be overgrown by purple loosestrife, shrubs and trees. Common reed is also a potential problem. Invasive species monitoring and control efforts will be particularly effective on sites that currently have minimal invasive species problems. Recent advances in reducing purple loosestrife are encouraging and may present opportunities for local community involvement in the future.

Non-tidal wetlands, like tidal wetlands, are sensitive to hydrological changes and pollution. Filling, dumping, damming, excavation (to create ponds), siltation, pollution (from road or agricultural runoff), alteration of vegetation, and drainage are destructive to wetlands. Upstream changes in water quantity (changes in hydrology) or quality also impact wetlands. The woody vegetation in communities such as red maple-hardwood swamps and dwarf shrub bogs is often killed by higher water levels caused by downstream dams or road-bed impoundments. Low-intensity grazing or hay cutting may be compatible with biodiversity in some types of wetlands, depending on the kinds of rare or uncommon biota present. Restoration or protection of wetland hydrology, restoration of wetland plant communities, maintenance of buffer zones, control of invasive species, identification and protection of smaller wetlands, and management of certain types of wetlands through mowing, grazing or burning are conservation management actions needed for wetlands. Best Management Practices (BMP's) for timber harvesting (Welsch et al. 1995) and agricultural operations to promote wetland conservation should be encouraged and implemented in the Hudson River Valley.

Great horned owl.
Photo courtesy of Cornell University.

- <u>Vernal Pools</u>

Identification and mapping of vernal pools is a necessary first step in their conservation. Learning how to recognize these pools, even in the dry season, is of critical importance. Vernal pools can be identified through a variety of signs and plant species that may indicate their presence. Some of these identifiers include blackened and compressed leaf litter, buttressed tree trunks, water marked tree trunks, and vegetation such as red maple, highbush blueberry, and buttonbush. Pools should be identified in late winter or early spring when they are most readily recognized. Calhoun and Klemens (2002) recommend Best Development Practices and planning tools for conserving vernal pool wildlife and Welsch et al. (1995) provides Best Management Practices for timber harvesters. Management plans for foresters and local governments (master planning or open space planning) should call for identifying the location of any vernal pools, and the establishment of protective buffer zones around these areas. Reschke (1990) points out that more data on characteristic plants and invertebrates are needed.

Biodiversity areas notable for wetlands (Figure 12):

- Dutchess County Wetlands
- Esopus/Lloyd Wetlands and Ridges
- Harlem Valley Calcareous Wetlands
- Hudson River Estuary and Tidal Wetlands
- Hudson River Estuary Area of Biological Concern

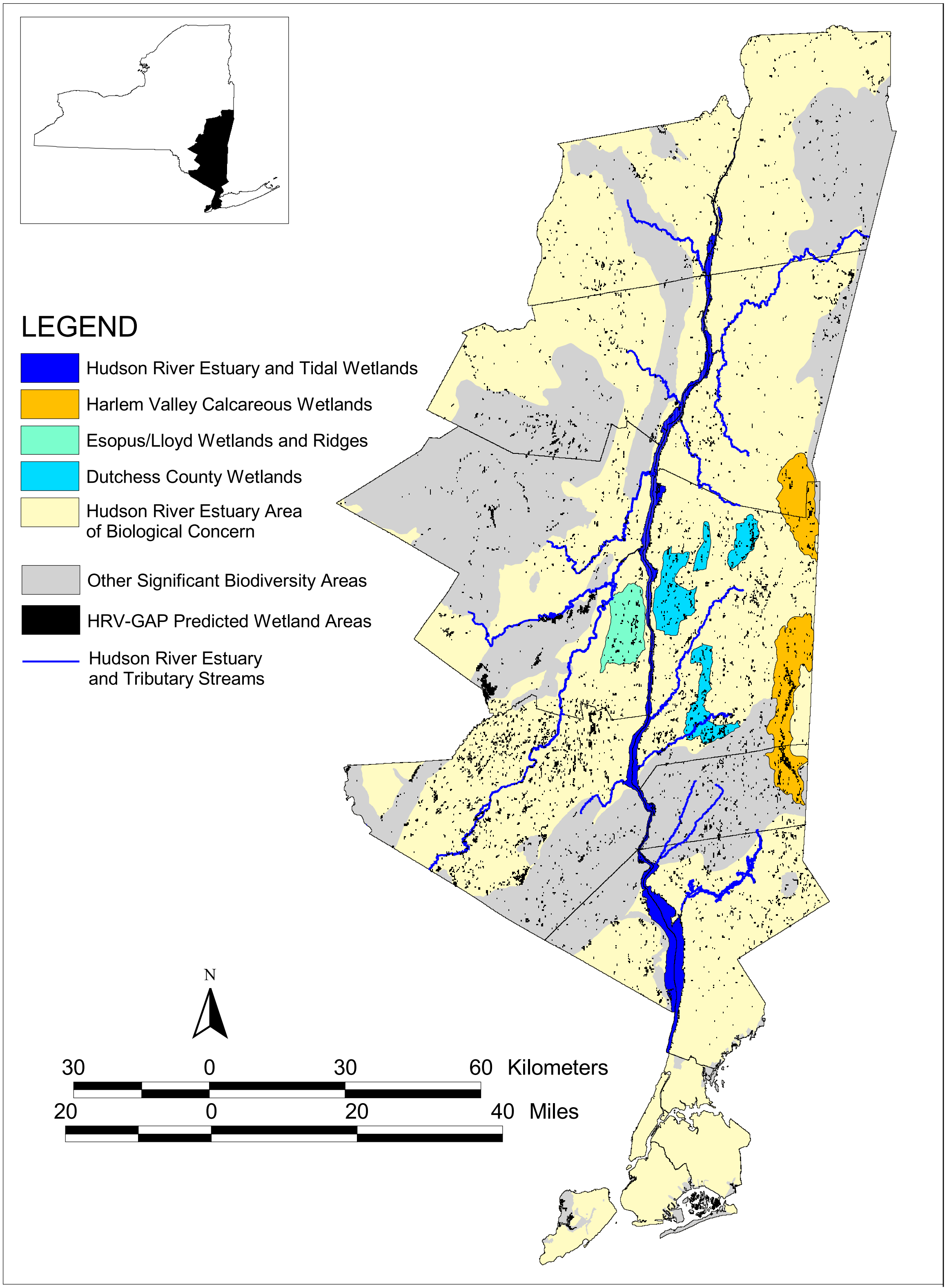


Figure 12. Significant biodiversity areas of the Hudson River Estuary corridor notable for wetlands. The map shows wetland occurrences predicted by the Hudson River Valley Gap Analysis (Smith et al. 2001) as black polygons. This is not a regulatory map.

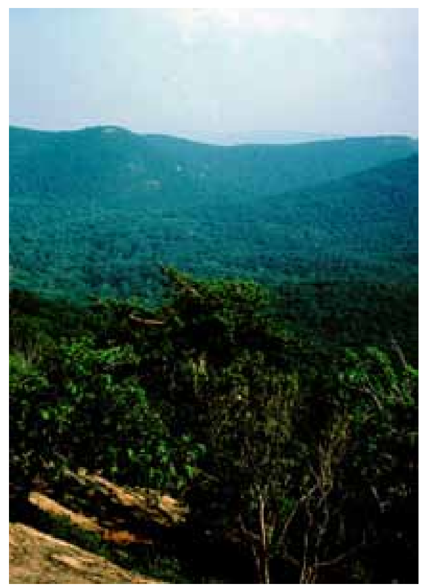
Significant Biodiversity Area Descriptions:

The Northeast Ancram fen complex follows the ridgetop of the Taconic Mountain range (Washburn, Alander, Brace, and Thorpe Mountains) from Copake, New York, southward to State Line, Connecticut. Included is the wetland complex at State Line and the ridges just west of Indian Lake south to Sharon Station Road. This site includes the wetlands and immediate watershed of the Drowned Lands Swamp, Punch Brook, and Bashbish Brook on the western half of this complex, and the chain of wetlands along the Noster Kill and Webatuck Creek on the eastern half of this complex; it includes the Panhandle or Oblong of the northeastern corner of Dutchess County southward towards Millerton, and the western escarpment of the Taconic Mountains. The southern portion of the Panhandle wetlands and the wetlands south of Millerton drain southeastward to the Housatonic Watershed. The northern portion of the Panhandle wetlands and the Drowned Lands area drain into the Roeliff Jansen Kill, which is part of the Hudson River Watershed.

Highlands

Site Description:

The Highlands are noteworthy as a relatively undeveloped corridor of forests, wetlands, and grasslands of regional importance to breeding and migratory birds, resident amphibians and reptiles, and rare plants and communities close to the New York City metropolitan area. It is significant for its high concentration of species and communities of special regional emphasis dependent on large, unfragmented forest and wetland habitats.


The Highlands. Photo by Paul Jensen.

The portion of the Highlands west of the Hudson River includes 190,243 acres within the State of New York and continues west to cross the entire State of New Jersey. The portion of the Highlands east of the Hudson River totals 215,137 acres in Dutchess, Putnam, and Westchester counties extending from the Hudson River to the Connecticut border. Ridgelines and valleys, including stream courses and wetlands and lakes are generally in a northeast to southwest alignment. Streams run directly into the Hudson River Estuary, otherwise they generally run into the Ramapo River, which flows south through the center of the Highlands west of the Hudson River. Major streams east of the Hudson River include Canopus Creek, Peekskill Hollow Creek, and the Croton River. The Delaware Aqueduct, a major water source for New York City, begins at the West Branch Reservoir within the Highlands.

There is a large diversity of bedrock types in the Highlands. These rocks are the oldest in the Hudson River Estuary corridor at 1.3 billion years old; they were formed during the same process that formed the Adirondack Mountains in northern New York. The high complexity indicates that these layers have been compressed, bent, twisted, and otherwise metamorphosed into erosion-resistant bedrock that form the mountains of southeastern

New York. The folds and faults in the bedrock are generally parallel to each other and generally determine the positions of the ridges and valleys. A large fault, the Ramapo Fault, coincides with the path of the Hudson River and separates the Highlands East from the Highlands West. The complexity of the Highlands bedrock acts to increase the diversity of the communities and taxa (animal and plant species and subspecies) present by increasing the types and range of minerals and nutrients available. Areas on the surface that are not bedrock outcrops usually consist of glacial till or more recent riverine or lake deposits.


Acidic talus slope woodland.

The matrix communities of the Highlands include Appalachian oak-hickory forest, chestnut oak forest, and oak-tulip tree forest. Recently, a 5,681-acre chestnut oak forest was documented, along with a 2,071-acre Appalachian oak-hickory forest. A large matrix chestnut oak forest of 45,000 acres links the West Point Military Academy with the occurrence of this community in Black Rock Forest and Harriman and Bear Mountain State Parks. Hemlock-northern hardwood forest acts as a large patch community here, in comparison to the more northern Catskill Mountains where it may be matrix forest as well. Dispersed among the matrix forests are patch communities such as pitch pine-oak-heath rocky summit, rocky summit grassland, and acidic talus slope woodland, which may be either large patch or small patch, and red cedar rocky summit, inland white cedar swamp, rich graminoid fen, dwarf shrub bog, highbush blueberry bog thicket, and cliff community, which tend to be small patch communities.

Site Location:

In southeastern New York State, within the Highlands physiographic region.

Towns:	Beacon, Beekman, Blooming Grove, Carmel, Chester, Cornwall, Cortlandt, East Fishkill, Fishkill, Haverstraw, Highlands, Kent, Monroe, North Salem, Patterson, Pawling, Peekskill, Philipstown, Putnam Valley, Ramapo, Somers, Southeast, Stony Point, Tuxedo, Warwick, Woodbury, Yorktown		
Counties:	Dutchess, Orange, Putnam, Rockland, Westchester		
Approximate Size:	619.14 mi^2		
Land Stewardship:	<u>Name or Classification</u>	<u>Manager</u>	<u>Area</u>
	Clarence Fahnestock State Park	NYSOPRHP	16.86 mi^2
	Franklin D. Roosevelt State Park	NYSOPRHP	0.47 mi^2
	Hudson Highlands State Park	NYSOPRHP	5.95 mi^2

Wonder Lake State Park	NYSOPRHP	1.49 mi^2
Donald Trump State Park	NYSOPRHP	0.44 mi^2
Bear Mountain State Park	NYSOPRHP	7.16 mi^2
Goose Pond Mountain State Park	NYSOPRHP	7.16 mi^2
Harriman State Park	NYSOPRHP	74.09 mi^2
Sterling Forest State Park	NYSOPRHP	22.44 mi^2
Storm King State Park	NYSOPRHP	2.84 mi^2
Big Buck MUA	NYSDEC	0.23 mi^2
California Hill MUA	NYSDEC	0.47 mi^2
Depot Hill MUA	NYSDEC	0.42 mi^2
Ninham Mountain MUA	NYSDEC	2.56 mi^2
Pudding Street MUA	NYSDEC	0.11 mi^2
White Pond MUA	NYSDEC	0.45 mi^2
Castle Rock Unique Area	NYSDEC	0.24 mi^2
Black Rock Forest Preserve		6.0 mi^2
Camp Smith State Military Reservation	Division of Military and Naval Affairs	3.0 mi^2
West Point Military Academy	U.S. Department of Defense	25.22 mi^2
NYC Watershed Protection	NYCDEP	8.55 mi^2
Municipal/County Parks		5.02 mi^2
Publicly Owned Water Bodies		7.37 mi^2
Private Conservation Land		20.31 mi^2

Ecological Significance:

This significant area represents one of the largest unfragmented landscape blocks in New York State that creates an important landscape corridor that links the mid-Atlantic states (New Jersey and Pennsylvania) with New England. Along with the continuous and relatively unfragmented forests, the area contains higher elevation ridges and several networks of relatively undisturbed wetlands in the valleys. The ecological significance of this area relates to its large, contiguous forest and wetland habitats and the disturbance sensitive species dependent on these habitats, as well as the diversity of plants, communities, and animals unique to this region.

Species populations in the Highlands are indicative of large contiguous areas of undisturbed forest and wetland habitats and include wood turtle, timber rattlesnake, red shouldered hawk, barred owl, warblers and thrushes, black bear, and bobcat. The rare cerulean warbler, a forest-interior specialist, has a thriving population in the deciduous forests of the Highlands, one of the few concentrations of this species in the state.

Timber rattlesnake.

There are numerous abandoned mines in the Highlands, many of which are currently being used as winter bat hibernacula. The federally listed endangered Indiana bat and the state special concern eastern small-footed bat are known to occur in the Highlands. Regionally rare ridge top communities include rocky summit grasslands and pitch pine-oak-heath rocky summit community. The great species diversity that is supported throughout the region is an indication of the high ecological value of the area's habitat.

Conservation Issues and Recommendations:

The most significant threat to the Highlands is the continued conversion and fragmentation of the area's forests and wetlands. Conservation efforts should focus on maintaining the unfragmented forest core from the glacial moraine north to the Hudson and across the Hudson to the Connecticut border with linkages on forested ridges to the Delaware River to the south. Additional inventory work is needed.

Location Description:

This area is similar to the USFWS New York-New Jersey Highlands Significant Habitat Complex. The physiographic region of the Highlands follows the boundary between the Highlands and Piedmont physiographic provinces on the southeast, and between the Highlands and the Appalachian Ridge and Valley provinces on the northwest. Though the physiographic region proper extends from the Delaware River in New Jersey northeast across the Hudson River to Candlewood Lake in southwestern Connecticut, the extent of the Highlands biodiversity area described in this document is confined to the study area. The Highlands province is distinguishable from the adjoining provinces by differences in geology, topography, and geomorphology (landforms).

Hudson River Estuary and Tidal Wetlands

Site Description:

The Hudson River Estuary contains significant freshwater and brackish tidal wetlands, as well as other riverine and estuarine habitats, islands, riparian zones, and important tributaries. These habitats support a high diversity of fish, birds, and mammals. Tidal wetlands exist along the entire reach of the estuary and include some of the rarest ecological communities in the state. Some of the islands contain significant upland communities, including pitch pine-oak-heath rocky summit and hemlock-northern hardwood forest.

The Hudson River extends 152 miles from the mouth of the river to the Federal Dam near Troy, New York. The width of the river ranges from 1/6 mile to 2.5 miles and the surface area at high tide is 82,000 acres. Intertidal wetlands and subtidal shallows consist of 26% or 21,200 acres of this surface area.

The Hudson River Estuary has a four-foot tidal pulse that extends all the way to Troy. In years with average amounts of precipitation falling in typical seasonal patterns, the leading edge of salt water is held downriver between the Tappan Zee and Yonkers during spring runoff. As runoff slackens during the summer, the salt front pushes northward to Newburgh Bay, and during droughts to Poughkeepsie and beyond. Because of the changing levels of salinity and tidal nature of the Hudson River, species assemblages vary by locality and overall diversity is high. In addition to the tidal riverine community, brackish intertidal mud-flats, brackish tidal marsh, freshwater intertidal mudlflats, freshwater intertidal shore, freshwater tidal marsh, and freshwater tidal swamp all together form a matrix down the shoreline of the river. Brackish, or lower salinity, tidal wetlands are regularly flooded by ocean water that has been diluted by freshwater from upstream. These wetlands are found south of the Highlands down to Manhattan. Freshwater tidal swamps found along the Hudson are globally rare. Saltwater marshes are now rare in New York Harbor, although they once extended for thousands of acres around Manhattan. Patch communities within the tidal portion of the Hudson River include calcareous shoreline outcrop, cliff community, and tidal creek.

Osprey. Photo by O.S. Pettingill.

The Hudson River Valley is broad and gently rolling with a bedrock of shale, siltstone, sandstone, limestone, and dolostone. Most of these are relatively soft sedimentary rocks and easily eroded. These bedrock formations have been eroded away to low plains with the Hudson River flowing through them. Most of the surficial deposits near and within the river are modern river channel deposits. River margins are made nutrient rich as the river carries fresh sediment from the uplands and deposits them along the river's banks.

Site Location:

The Hudson River Estuary is the portion of the Hudson River extending from the Battery at the southern tip of Manhattan north to the Federal Dam in Troy, New York.

Towns:	Albany, Athens, Bethlehem, Bronx, Brunswick, Catskill, Clarkstown, Clermont, Coeymans, Colonie, Cornwall, Cortlandt, Coxsackie, Esopus, Fishkill, Greenburgh, Greenbush, Greenport, Haverstraw, Highland, Hyde Park, Livingston, Lloyd, Marlborough, Mount Pleasant, New Baltimore, New Windsor, Newburgh, North Greenbush, Nyack, Orangetown, Ossining, Peekskill, Philipstown, Poughkeepsie, Red Hook, Rhinebeck, Saugerties, Schodack, Stockport, Stony Point, Stuyvesant, Ulster, Wappinger, Yonkers
Counties:	Albany, Bronx, Columbia, Dutchess, Greene, New York, Orange, Putnam, Rensselaer, Rockland, Ulster, Westchester
Approximate Size:	110.66 mi^2

Land Stewardship:

Name or Classification	Manager	Area
Storm King State Park	NYSOPRHP	2.97 mi^2
Bear Mountain State Park	NYSOPRHP	7.48 mi^2
Hook Mountain State Park	NYSOPRHP	1.31 mi^2
Nyack Beach State Park	NYSOPRHP	0.17 mi^2
Tallman Mountain State Park	NYSOPRHP	1.06 mi^2
Palisades State Park	NYSOPRHP	0.004 mi^2
Hudson Highlands State Park	NYSOPRHP	9.38 mi^2
Rockefeller State Park	NYSOPRHP	0.07 mi^2
Bristol Beach State Park	NYSOPRHP	0.004 mi^2
Hudson River Islands State Park	NYSOPRHP	0.36 mi^2
Schodack Island Sate Park	NYSOPRHP	1.83 mi^2
Mills-Norrie State Park	NYSOPRHP	1.54 mi^2
Quiet Cove State Park	NYSOPRHP	0.05 mi^2
Riverbank State Park	NYSOPRHP	0.04 mi^2
Hudson River State Park	NYSOPRHP	0.53 mi^2
Moodna Creek Unique Area	NYSDEC	0.09 mi^2
Kowawese Unique Area	NYSDEC	0.16 mi^2
Rogers Island WMA	NYSDEC	0.49 mi^2
Turkey Point State Forest	NYSDEC	
Montrose Point State Forest	NYSDEC	
Tivoli Bays WMA[1]	NYSDEC	2.69 mi^2
Nutten Hook Unique Area	NYSDEC	0.05 mi^2
Piermont Marsh[1]	NYSDEC	0.1 mi^2
Stockport Flats[1]	See Below	2.41 mi^2
Iona Island[1]	See Below	0.87 mi^2
Public Easements	NYSDEC	0.24 mi^2
Municipal/County Parks		3.26 mi^2
Private Conservation Land		6.16 mi^2

[1]One of four tidal wetlands that make up the Hudson River National Estuarine Research Reserve, a collaborative effort involving the National Oceanic and Atmospheric Administration (NOAA), the Palisades Interstate Park Commission, NYSDEC, NYS Office of General Services, and NYSOPRHP (NYSDEC & NOAA 1993). An additional 1.5 mi^2 is included in Piermont Marsh and includes part of Tallman Mountain State Park.

Ecological Significance:

The Hudson River is one of the most extensive freshwater tidal river systems in the northeastern United States. The tidal communities found here are regionally and globally rare. Wetland habitats are the cornerstone of the Hudson River Estuary ecosystem because they play a critical role as nursery grounds for fish and shellfish species, nesting sites and migration stops for birds, and sources of nutrients to the food chain. The marshes and tidal flats of the Hudson River Estuary contribute essential nutrients to aquatic and terrestrial food webs that extend throughout the river system and far into the Atlantic Ocean. Besides serving as important habitats, the wetlands that border the Hudson River Estuary perform other valuable services. Pollutants are filtered from water that flows through fresh and saltwater marshes, and these same wetlands buffer valuable real estate from floodwaters and storm surges. Estuarine plants also help to prevent erosion and stabilize the shoreline.

Estuaries are transition zones from inland freshwater ecosystems to saltwater ecosystems found in coastal environments. Estuarine environments are among the most productive on Earth, creating more organic matter each year than comparably sized areas of forest, grassland or agricultural land. Several measures of the importance of estuaries are that more than half of the commercial fish species caught globally and more than 75% of America's commercial fish catch spend part of their lives in an estuary. Key commercial and recreational species such as striped bass, bluefish, and blue crab depend on nursery habitat in the Hudson River Estuary.

During recent field surveys, populations of the state-endangered plant Hudson River water nymph were rediscovered in a freshwater intertidal mudflats community. The entire global range of this plant is limited to the Hudson River Valley; therefore, it is considered endemic. This is the only endemic plant to all of New York State. Other globally rare plants still found in the Hudson Rive Estuary include estuary begger-ticks, Long's bittercress, and salt-meadow grass. Rare animals of the Estuary include shortnose sturgeon, Atlantic sturgeon and Atlantic needlefish. Harbor seal are periodically reported and the Northern diamondback terrapin is present in some of the lower Hudson River Estuary tidal marshes.

The Hudson River Estuary ecosystem has been stressed by multiple activities such as the discharge of raw sewage that leads to high bacterial counts and low dissolved oxygen levels, landfilling that has destroyed valuable wetlands, cooling water intakes that kill millions of fish, and food webs contaminated by toxic chemicals. Among fish of commercial, recreational and ecological importance, the American shad, Atlantic sturgeon, river herring (blueback herring and alewife), American eel, and largemouth bass are in decline. Little is known of the status of blue crab, smallmouth bass, and other species. Striped bass have increased over the last few decades, but fishing pressure in the Estuary and along the Atlantic coast must be carefully managed or it could lower current population levels. Although tidal wetlands have been protected by state and federal law since the 1970s, erosion, sea level rise, changes in salinity, introductions of nonnative species and other factors have caused changes in wetland plant and animal communities over time.

Further description of the Hudson River Estuary is divided below into general salinity habitat zones based on average annual salinities.

- <u>Lower Hudson River Estuary</u>

  The lower Hudson River Estuary zone from Manhattan to Stony Point is an area that approaches marine habitat characteristics, having very strong semi diurnal (twice daily) tidal currents and moderate salinities. This section of the Hudson is generally the zone of greatest mixing of river water and ocean water. The lower Hudson is rich in benthic resources and provides a significant nursery for fish populations. It is an important source of food resources for populations of wintering and migratory birds. This stretch of the river has significant concentrations of wintering waterfowl, especially canvasback. Other important animal species living in this area include osprey, fiddler crabs, blue crab, and diamondback terrapin. There are several regionally significant plants that occur in the Lower Hudson including the state endangered cylindrical headed bulrush. Piermont Marsh is a sizeable intertidal brackish marsh community and one of the largest undeveloped wetland complexes on the Hudson. It includes the northernmost occurrence of salt marsh species on the Hudson. Because it represents an exemplary ecological community type, Piermont Marsh has been designated as one of four sites that make up the Hudson River National Estuarine Research Reserve.

- Mid-Hudson River Estuary

  The productive and regionally significant Mid-Hudson River estuary is generally fresh water in winter and has low salinity in summer. This section encompasses regionally significant spawning migratory and nursery habitat for anadromous, estuarine, and freshwater fish, important winter feeding and roosting areas for the federally listed threatened bald eagle, and globally and regionally rare brackish and freshwater tidal communities and plants. The open water and tidal wetlands in this reach are spawning and nursery habitats and a migratory pathway between the upper and lower estuary for anadromous and resident fish.

  The habitat contains many unusual features, including deep tidal river habitat that is a rare ecosystem type in the eastern United States, and an important winter foraging area for the bald eagle. The numerous creeks and tidal brackish and freshwater marshes in this stretch serve as breeding, nursery, and migration corridors for fish and wildlife. Iona Island supports important winter roost sites for bald eagles that feed in the adjacent deepwater segment of the river. Iona island also has several rare plants including Bush's sedge, slender knotweed, and pinweed. Con Hook Marsh is a small, brackish tidal marsh with several rare plants, including cylindrical headed bulrush, spongy arrowhead, necklace sedge, and pinweed. Con Hook Marsh is also an important wintering area for waterfowl, especially mergansers. Constitution Marsh is a freshwater to brackish tidal marsh and is the largest undeveloped brackish tidal wetland on the Hudson River. It is a prime breeding and feeding area for marsh nesting birds.

Muskrat. Photo by John Kanter.

- Upper Hudson River Estuary

  The open water, tidal wetlands, and tributaries in the upper reach of the Hudson are regionally important fish spawning habitats for anadromous fish, especially American shad, striped bass, Atlantic sturgeon and shortnose sturgeon, and provide habitat for all life stages of resident freshwater species. The numerous creeks and tidal freshwater marshes in this stretch serve as breeding, nursery, and migration corridors supporting waterfowl, shorebirds, herons, raptors, and passerine birds. Regionally and globally rare tidal communities include freshwater tidal swamp, freshwater tidal marsh, freshwater intertidal mudflats, and freshwater intertidal shore. The Hudson River water nymph, a state-endangered endemic plant, was recently rediscovered in a freshwater intertidal mudflats community from the Upper Hudson River (Howard et al. 2002).

Conservation Issues and Recommendations:

All activities that degrade water quality in the Hudson River Estuary adversely affect the fish and wildlife that use this habitat for various life functions. Water pollution by chemical or oil spills; excessive turbidity; sedimentation; and other point and nonpoint source pollution degrade the quality and function of the estuarine habitat. Toxic contamination has long term effects on the safety of food and the health of consumers due to bioaccumulation and biomagnification. Water quality improvement efforts are needed throughout the estuary. Upgrades to sewage treatment facilities, control of point and nonpoint source pollution, and contaminant trackdown and clean-up should continue to be major goals throughout the watershed. Full restoration of the hydrologic continuum (wetlands and the river), especially hydrologic connections under the existing railroad beds, and restoration of riparian corridors along the tributaries to the Hudson, will increase available upland habitat, improve the quality of aquatic habitat in the tributaries, and reduce sediment and nutrient input into the Hudson. Improvement of habitat complexes for animals requiring both wetlands and uplands should be encouraged. Additionally, measures to conserve and educate the public about submerged aquatic vegetation (SAV) beds located throughout the estuary should be continued and expanded.

Location Description:

- Lower Hudson River Estuary

  This area is also identified by the USFWS as the Lower Hudson River Estuary Significant Habitat Complex. The area for the lower Hudson River follows the shores of the Hudson River from the tip of Battery Park, Manhattan, generally referred to as river mile 0, north to the Stony Point area river mile 41. The area includes all riverine and estuarine habitats, including open water and tidal wetlands in this stretch of the river.

- Mid-Hudson River Estuary

  This area is identified by the USFWS as the Mid-Hudson River Estuary Significant Habitat Complex. The mid Hudson River estuary follows the shores of the Hudson River from Stony Point, river mile 41, to Poughkeepsie, river mile 75. The significant area includes all riverine and estuarine, open water and tidal wetland habitat in this stretch of the Hudson.

- Upper Hudson River Estuary

  This area is identified by the USFWS as the Upper Hudson River Estuary Significant Habitat Complex. The upper Hudson River estuary follows the shores of the Hudson River from Poughkeepsie at river mile 75 to the northern inland extent of the tidal Hudson River at Troy Lock and Dam, river mile 152. The significant area includes the tidal freshwater portion of the Hudson River, including all riverine, open water, and tidal wetlands in this stretch of the river as well as supratidal wetlands and some adjoining uplands and nontidal wetlands. The significant area also includes the lower portion of major and minor tributaries feeding into this part of the Hudson, up to the first impediment to fish passage in each tributary.

Hudson Valley Limestone and Shale Ridges

Site Description:

The Hudson Valley Limestone and Shale Ridges consist of the limestone areas that parallel the New York State Thruway, mainly to the east of the Thruway, and the parallel shale ridge west of the Thruway. This area is a regionally significant geologic feature that contains habitats that support several rare mammal, amphibian, reptile, bird, and plant species. The area covers about 127,000 acres in a curved line about 54 miles long and 5.6 miles wide at its widest point. The northern section consists of the band of cliffs known as the Helderberg Escarpment and the southern section extends along the Potic Mountain ridge.

Hudson Valley shale ridges. Photo by Elizabeth Hill.

Significant natural communities in this area include red maple-blackgum swamp, vernal pool, chestnut oak forest, Appalachian oak hickory forest, and pitch pine-oak-heath -rocky summit. In addition, small patch communities in the Potic range to the south include shale cliff and talus community and shale talus slope woodland. In other areas, calcareous cliff community, calcareous talus slope woodland, red cedar rocky summit, and rocky summit grassland communities have been documented in the upland and bedrock outcrop localities. In the lowlands, floodplain forest, limestone woodland, maple-basswood rich mesic forest, red maple-hardwood swamp, and silver maple-ash swamp have been documented.

The bedrock of the Hudson Valley Limestone and Shale Ridges mainly consists of limestone from the early to mid Devonian Period (approximately 400 million years ago). These rocks were produced when the area was covered by shallow seas and fossils are not uncommon. The limestone acts as a buffer to neutralize the increased acid precipita-

Biodiversity of the Moodna Creek Watershed:
Important Resources and Conservation Recommendations

19 June 2008
DRAFT

Photos by L. Heady

Laura Heady, NYS DEC Hudson River Estuary Program
in partnership with Cornell University Department of Natural Resources

Hudson River Shoreline: The Moodna Mouth

The confluence of the Moodna Creek and Hudson River is especially rich in biodiversity, and marks the average northern extent of the salt front in the estuary (although the front moves farther upstream under low flow conditions). The input of nutrients from the Moodna watershed; the mixing of the Moodna's fresh water with brackish water from the Hudson; and the tidal influence of the estuary together create conditions and habitats that are uncommon in New York. Habitats of the Moodna mouth system include 3.5 miles of freshwater tributary, with the lower mile in tidal range of the Hudson River. Where it reaches the river, the creek flows into an approximately 75 acre (30 ha) embayment, with extensive emergent marsh, swamp, mudflats, submerged aquatic vegetation (SAV), and wooded islands. (See Figure 1.) East of the railroad trestle, there are additional mudflats and a large area of SAV that continues northward along the shoreline. The various habitats and wildlife assembled at the Moodna mouth offer excellent opportunities for recreational fishing, birdwatching, paddling, environmental education, and overall outdoor enjoyment.

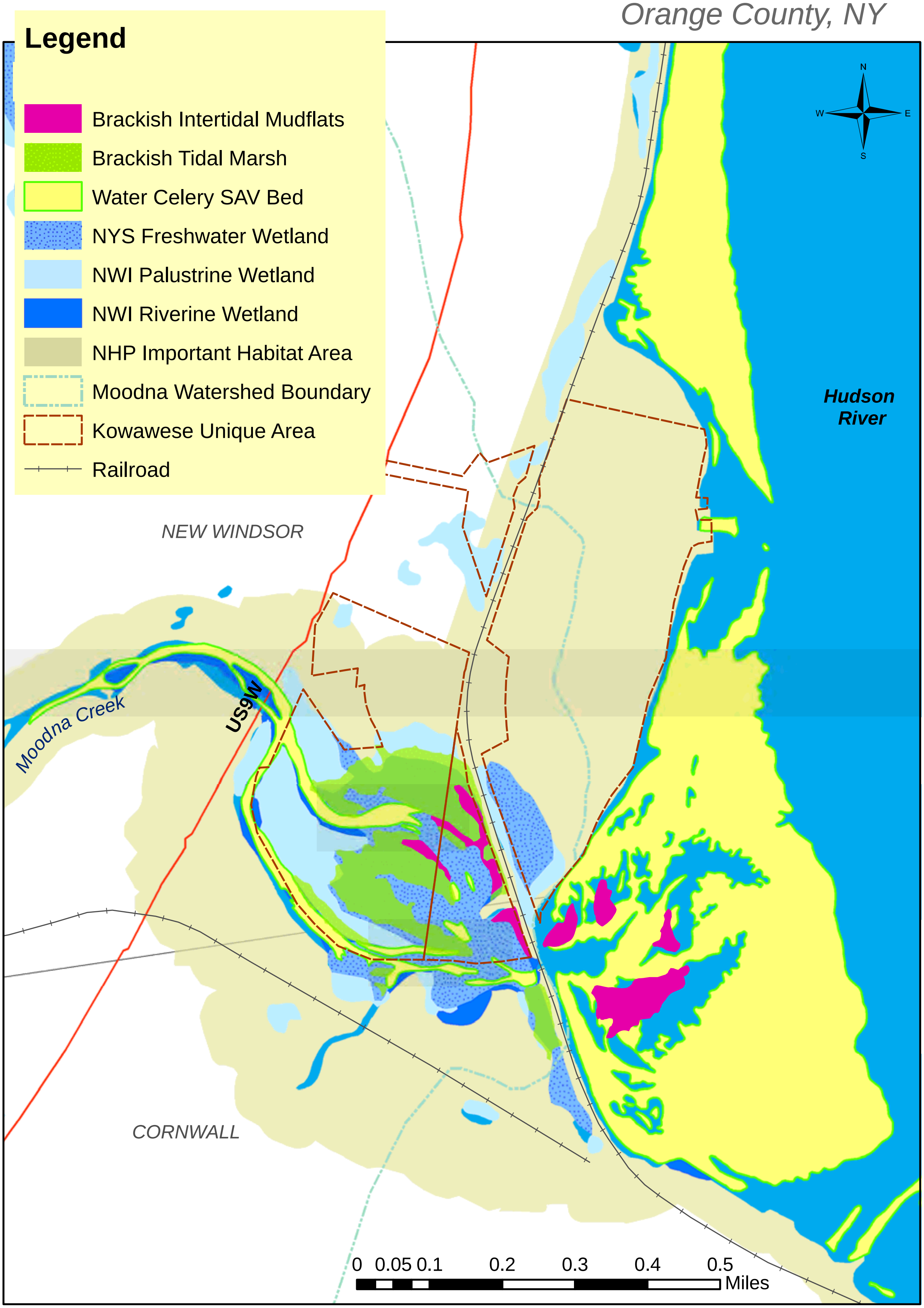
Lower Reach of Moodna Creek. Fish habitat in the lower portion of Moodna Creek extends from the mouth and upstream for 3.5 miles to the dam located just upstream of the Orrs Mill bridge on NYS Route 32. (See Figure 2.) Anadromous fish, including alewife and blueback herring, enter the creek in the spring for spawning, and the resulting larval fish develop in the flats at the creek mouth. The lower portion of the Moodna also supports a warmwater fish community throughout the year; resident species include American eel, largemouth bass, smallmouth bass, bluegill, pumpkinseed, white perch, yellow perch, white catfish, and brown bullhead. As the salt front moves up the Hudson, bluefish, bay anchovy, weakfish, Atlantic silversides, hogchoker, and blue crab may enter the tributary to feed.

Confluence. The confluence of the Moodna and Hudson provides important habitat for bald eagle (NYS Threatened) and osprey (NYS Special Concern). Both feed on spawning fish and waterfowl, and use the tall trees along the shoreline and on wooded islands for perching and roosting. The Moodna mouth is one of the few areas in the Hudson where eagles are consistently observed in the summer, and the area is considered important breeding habitat for bald eagle by the NY Natural Heritage Program. In addition, it supports a wintering population of bald eagles from December through March. (See Appendix A for conservation recommendations for bald eagle.)

Marsh and Mudflats. The tidal freshwater marsh at the mouth of the Moodna is the largest in Orange County. This 59 acre (24 ha), Class 1 NYS Regulatory Freshwater wetland includes areas of brackish tidal marsh and brackish intertidal mudflats. Statewide, there are few occurrences of these rare ecological communities, which host suites of species especially adapted to the changing conditions caused by tides. Due to their changing salinity values, brackish tidal marshes provide habitat for a combination of species that are characteristic of both salt and freshwater tidal marshes. Brackish intertidal mudflats support populations of mobile invertebrates like clams, snails, worms, and crustaceans that are adapted to the unstable surface of the mudflat. During high tide, these invertebrates are fed upon by shad, bass, and other fish; low tide brings foraging opportunities for shore birds. Rare plants associated with mudflats at the Moodna mouth include spongy arrowhead, and historical records of estuary beggarticks.

Figure 1. Ecological Communities of the Moodna Creek Mouth

Orange County, NY

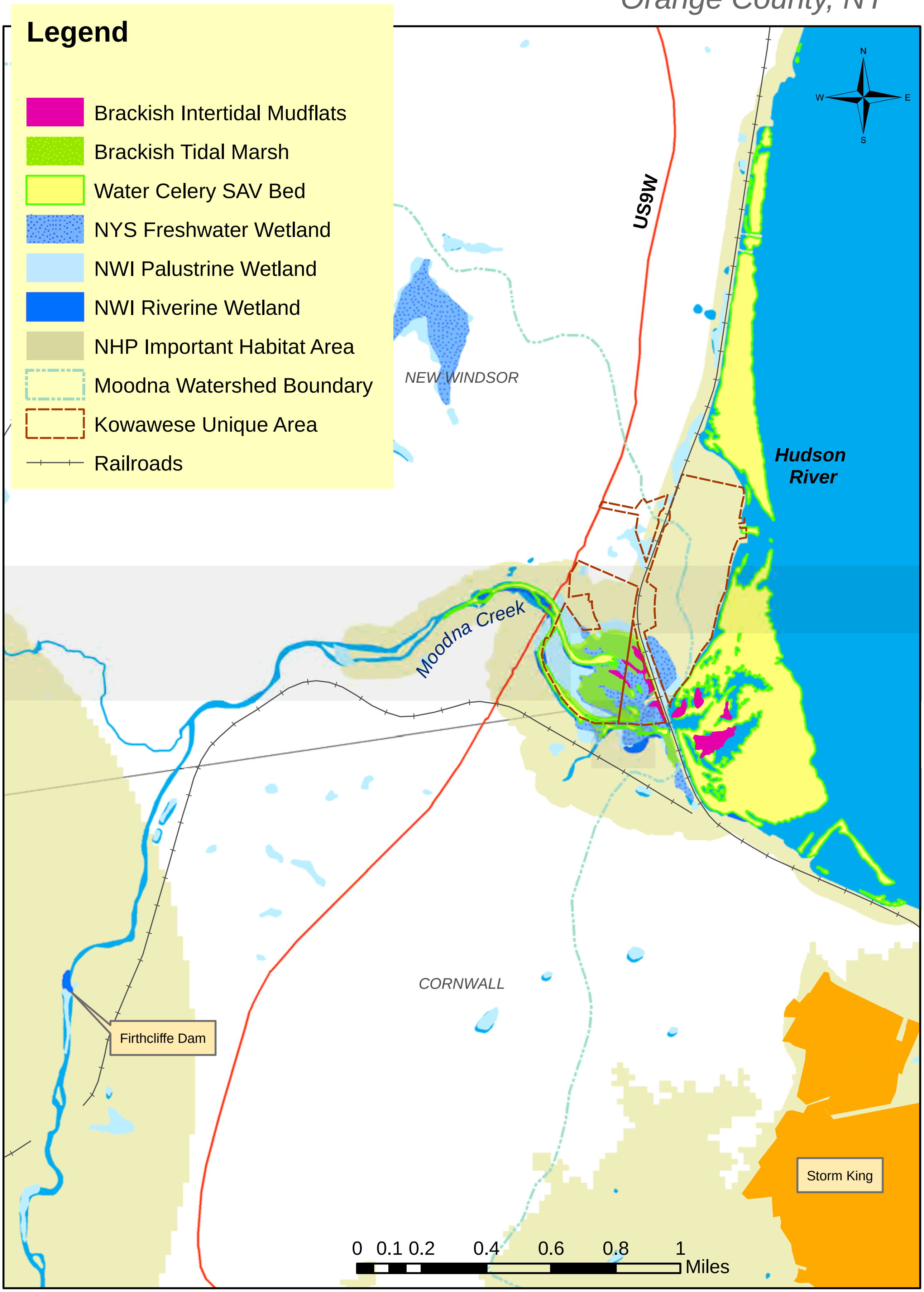


Map created 14 June 2008 by:
Laura Heady, Hudson River Estuary Program,
NYS Department of Environmental Conservation
in partnership with Cornell University

Data Sources:
NY Natural Heritage Program
NYS Department of Environmental Conservation
National Wetland Inventory

Figure 2. Ecological Communities of the Moodna Creek Mouth and Lower Reach to Firthcliffe Dam

Orange County, NY



Map created 14 June 2008 by:
Laura Heady, Hudson River Estuary Program,
NYS Department of Environmental Conservation
in partnership with Cornell University

Data Sources:
NY Natural Heritage Program
NYS Department of Environmental Conservation
National Wetland Inventory

The wetland complex at the Moodna mouth provides breeding habitat for a number of birds, including green-backed heron, black duck, wood duck, Virginia rail, spotted sandpiper, fish crow, and marsh wren, and has been identified as important habitat area for least bittern (NYS Threatened). (See Appendix A for conservation recommendations for least bittern.) Herons, waterfowl, and shorebirds concentrate in the area during spring and fall migrations, and the creek is thought to be a major crossing point for raptors migrating along the northern slope of the Hudson Highlands. In addition, the NY Natural Heritage Program considers the Moodna mouth an important "Waterfowl Winter Concentration Area."

Submerged Aquatic Vegetation. The submerged aquatic vegetation (SAV) beds also contribute to the overall habitat value of the Moodna mouth system. They occur in the lower reach of the creek, in the embayment, and east of the train trestle along the Hudson shoreline. (See Figure 2.) Unlike other tidal coves and bays in the Hudson where the invasive water chestnut often dominates and poses management challenges, the SAV beds at the Moodna mouth are comprised of water celery, a native plant. SAV beds trap fine sediment and organic matter, maintain dissolved oxygen levels, and provide habitat for a rich diversity of fish and invertebrates (Findlay et al. 2006).

Threats and Conservation Opportunities

- **Water quality.** Habitat value for fish and wildlife in the lower reach of the creek, and associated recreation opportunities, is dependent on good water quality. Herring may already be an indicator of declining conditions in the Moodna. In 1996, Hudsonia reported a moderately large herring run on the Moodna (Schmidt and Cooper 1996). Local fishermen have observed declines in this run in the last six years, and speculate that this decrease coincides with sewage problems in the Moodna (L. Abuza, pers. comm.). The NYS DEC Hudson River Fisheries Unit selected the Moodna for the 2008 Volunteer River Herring Monitoring Survey due to its historically large herring run. Over 35 monitoring sessions in April and May found no evidence of river herring in the Moodna, while the same protocols were used successfully to document herring in other monitored streams in the estuary watershed. To address water quality concerns, the two sewage treatment plants in the vicinity of the Moodna mouth should be assessed to understand and avoid impacts to the rich biodiversity of the area. Riparian buffers should be maintained and restored as necessary, and pollution from stormwater runoff should be prevented.
- **Marsh and mudflats.** The large marsh and mudflat habitat complex may also be vulnerable to pollution from the nearby sewage treatment plants, and to dumping, channeling, and disturbing remaining upland buffers. An additional threat is invasion of exotic species such as purple loosestrife and water chestnut. Recreational boat traffic that scrapes mudflats at high tides degrades their important habitat value and should be prevented. Hardened shorelines should be minimized or avoided and instead, low-sloped shorelines should be maintained within the tidal zone. This will be especially important as climate change causes sea level rise, and tidal habitats need to migrate inland.
- **SAV beds.** SAV beds are especially vulnerable to motorized boating activity and shoreline access; recreational activity should be limited in areas of SAV. Maintaining natural shorelines is strongly encouraged.
- **Breeding marsh birds.** Disturbance of breeding birds can result in failed nesting efforts or abandonment of nests completely. Marsh bird communities have shown significant

decline when urban/suburban development within 1600 ft (500 m) and 3200 ft (1000 m) of the marsh exceeds 14% and 25%, respectively (DeLuca et al., as cited in McElfish et al. 2008). Such impacts can be reduced by maintaining and restoring effective buffers, and by educating visitors and landowners about marsh bird ecology. (See Appendix A.)

- **Citizen science.** Pursuit of opportunities to engage local residents in citizen science and conservation of the Moodna mouth system is encouraged. Partnerships with the Hudson River Estuary Program can be formed to engage high school students in eel monitoring, provide continuing volunteer opportunities for herring monitoring in the tidal creek, and plan riparian buffer restoration through Trees for Tribs.
- **Public outreach.** Exploration of the Hudson shoreline and tidal creek through public canoe and kayak programs is recommended to help connect watershed residents to their rich local resources.

Streams and Riparian Corridors

Written by Leslie Zucker, NYS DEC Hudson River Estuary Program and Cornell University

Streams and the vegetated corridors around them (called "riparian areas") make a critical contribution to the health and overall biodiversity of the Moodna Creek Watershed. Plants and animals create the environmental conditions necessary for many of the water quality and hydrologic functions of streams. Plants allow groundwater to infiltrate the soil and recharge aquifers, streams, and reservoirs. Plants hold soils in place and contribute to processes that filter contaminants and excess nutrients from runoff. Vegetated, low-lying areas near streams absorb storm waters and lessen flooding and erosion downstream. Ultimately, these benefits save local governments money and protect private property.

Riparian areas are also unique habitats that support a high abundance and diversity of plants and animals. Because they are transition zones between the wet, aquatic environment of the stream channel, and the drier and higher terrestrial uplands, they are highly biodiverse. Some aquatic and semi-aquatic animals that must be near water, are found only in riparian corridors, while other wildlife are found in greater abundance in riparian corridors. Stream corridors contain other unique habitat features. When flooded during high flows, riparian corridors become stream channel habitat and are used as refuges for larval fish. Riparian areas often contain wetlands that provide habitat for the Hudson Valley's globally important amphibian and reptile diversity. And, streams corridors are used by wildlife as transportation routes if suitable habitats remain connected across the landscape.

Some of the unique fish and wildlife of the Moodna Creek and its tributaries are described below.

Birds

A variety of songbirds can be found nesting and rearing their young in wide, forested bottomlands of the Moodna Creek, including a few that prefer to nest near streams such as the yellow-throated vireo, warbling vireo, and Louisiana waterthrush. The cerulean warbler and least flycatcher are likely stream corridor birds that have declined throughout their ranges in recent decades, but are still found in the Moodna Creek Watershed. Other birds that might be seen in stream corridors of the watershed include the wood duck, great blue heron, green heron, belted kingfisher, and in the deeper forests, the red-shouldered hawk. Birds are found more abundantly in stream corridors than in other portions of the landscape and bird diversity increases as the width of stream corridors increase.

Bats

An abundance of insects and forest openings make stream corridors prime foraging habitat for bats. Large trees with peeling bark, such as shagbark hickories and dead standing snags are used as maternity colonies or summer roosting sites for bats. In addition to foraging and roosting, bats use stream corridors as travel routes. Bats that might be seen in stream corridors of the Moodna Creek and tributaries include the big brown bat, little brown bat, and the rare Eastern small-footed bat (NYS Special Concern). The Eastern small-footed bat has been observed in the Mineral Spring Brook and Trout Brook stream corridors. The watershed and its stream corridors are also home to the federally endangered Indiana bat (NYS Endangered).

Amphibians and Reptiles

Several turtle, frog, and salamander species rely heavily on stream corridor habitats. The wood turtle is particularly interesting, not just because its angular shell looks like a wood carving, but also because the wood turtle spends its entire life in stream corridors. Wood turtle populations are found in stream corridors of the Otter Kill, Seely Brook and Woodbury Creek.

Stream salamanders are lungless and must obtain oxygen through their skin. As a result, they can be found in the moist areas of streambanks, seepages, and both intermittent and perennial streams. The most abundant headwater stream salamander in the Hudson Valley region is the northern two-lined salamander followed by the northern dusky salamander. The longtail salamander is rare in Orange County and declining within New York State.

Fish

Fish communities of the Moodna Creek range from anadramous fishes that use the tidal creek and mouth for spawning, to inland warmwater and coldwater fish communities. Little comprehensive monitoring of the Moodna Creek fish community has been conducted. The historical warmwater fish community includes the following species: white sucker, creek chubsucker, rock bass, redbreast sunfish, pumpkinseed, black crappie, blueback shad, American shad, cutlips minnow, Eastern silvery minnow, golden shiner, bridle shiner, common shiner, spotfin shiner, spottail shiner, fallfish, longnose dace, blacknose dace, creek chub, redfin pickerel, chain pickerel, brown bullhead, fourspine stickleback, and tessellated darter (NYS Museum 1936). Of these, the creek chubsucker, Eastern silvery minnow, bridle shiner, spottail shiner, spotfin shiner, fallfish, and fourspine stickleback have not been observed in recent times (NYSDEC Bureau of Fisheries 2007). However, additional surveys would be needed to confirm the presence or absence of these species.

Coldwater fishes of the Moodna Creek Watershed include the native brook trout, and the stocked rainbow trout and brown trout. Stream reaches supporting coldwater fishes, invertebrates, and salamanders are usually fed by cold-cool groundwater. Brook trout and slimy sculpin are the dominate fish of small coldwater streams of high quality. These streams have shallow margins, woody debris, canopy shading, and boulders. Blacknose dace, creek chub, and white sucker might also occur at coldwater sites. Both brook and brown trout are found in the Trout Brook and Woodbury Creek tributaries. The DEC annually stocks the Moodna Creek mainstem with brown and rainbow trout and the Woodbury Creek with brown trout.

Little is known about changes in the abundance of fish within the watershed. Parts of the watershed could still retain near historical levels of fish diversity, if not abundance. However, other major tributaries of the Hudson River have experienced declines in fish diversity and shifts in abundance between the 1930s and the 1990s related to changing land uses and pollution, and it's likely parts of the Moodna Creek system have as well (Stainbrook et al. 2006, Daniels 1999).

Threats and Conservation Opportunities

- **Stream fragmentation.** One of greatest threats to stream corridor biodiversity is the modification and fragmentation of stream corridors. Fragmentation occurs through direct modification of the stream channel and clearing for incompatible land uses within the stream corridor. A first step to the conservation of existing riparian corridors is to map riparian cover from the edge of the bankfull channel, to as far inland as natural vegetation extends. These areas can then be reviewed for their biological significance and level of connectivity, given the surrounding land uses. (See Figure 3 for an example of how buffer width analysis can be used to identify conservation and restoration opportunities.) Approaches that have been used to protect existing buffers include: fee simple acquisition, conservation easements, municipal planning tools, riparian buffer ordinances, and development tools (Alliance for the Chesapeake Bay 2004).
- **Riparian buffers.** Riparian buffer plantings are recommended for stream reaches with breaks in continuous natural cover. To enhance connectivity, stream corridor conservation programs should seek to maintain existing natural cover along both banks of the stream and extending as far into adjacent areas as needed to maintain stream integrity (see Table 1 for width recommendations). It is important to protect riparian areas along both stream banks for both habitat and channel stability. Most streams in settled areas have variable-width buffers that can accommodate both land uses and conservation goals. Generally, headwater streams (first to third order) require smaller buffer widths to maintain stream integrity, while mid-order reaches require the widest buffers. Mid-reaches are usually highest in biological diversity (although headwater streams are key to overall stream health) and most prone to channel erosion.
- **Comprehensive conservation and management.** It is possible, and recommended to combine conservation of stream corridor habitats with other stream management priorities. For example, the mapped 500-year floodplain viewed along with mapped stream corridor habitats could be used to identify conservation zones that meet both habitat and floodplain management objectives.
- **Climate change adaptation.** As precipitation patterns change due to global climate change, more high flow events are likely to occur, putting infrastructure near streams at risk (NECIA 2006). Shifts in streamflow have the ability to create new patterns of erosion and deposition in channels (see Rosgen 1994). Conserving wide, connected stream corridors is an important climate change adaptation strategy that will help to maintain biodiversity and protect vulnerable infrastructure, water supplies and water quality.
- **Stream microhabitats.** High quality in-stream habitat usually requires a patchwork of riffles and pools, and the input of woody debris to maximize habitat structure and create sufficient oxygen levels for aquatic life. Where possible, woody vegetation (shrubland and forests) should be allowed to mature, or restored through forest buffer plantings.

- **Watershed land use.** Another significant threat to stream integrity is watershed land use that alters the flow patterns of water. A number of studies have observed a "threshold effect" where urban land cover over 10% of the watershed area coincides with degradation in stream fish and macroinvertebrate communities (Schuler 1994. This threshold has been observed in the Moodna Creek for both anadromous and resident fishes (Limburg and Schmidt 2001). The impacts of urbanization can be reduced by limiting sprawl, implementing stormwater control practices, and situating development outside of stream corridors. Urban development and land modification within the stream corridor is particularly harmful. These actions create local stress for a system that may already be impaired by overall watershed development. The alternative is for landowners and municipalities to engage in programs that protect or restore natural conditions near the stream.
- **Further study.** Little is known about the status of fish and other aquatic communities in the Moodna Creek and its tributaries. Partnerships to complete biological surveys and develop monitoring protocols should be explored with a range of actors such as the NYSDEC, county and local agencies, and area research and conservation organizations. At the same time, an assessment of stream habitat and physical condition should be conducted to determine if habitat alteration is a significant threat to stream integrity in the Moodna watershed.

Table 1. Recommendations for minimum widths and connectivity of natural cover within the stream corridor to conserve biodiversity. *Table created by L. Zucker.*

Wildlife Species or Group	**Minimum Buffer Width**	**Minimum Stream Length**	**Sources**
Wood Turtle	300-1,000'	1 mile	NYSDEC Endangered Species Program; NY Natural Heritage Program; Compton et al. 2002
Stream Salamanders	150'	Continuous	Simlitsch and Bodie 2003
Bats	300'-500'	Continuous	NY Natural Heritage Program; Menzel et al. 2005
Birds	Minimum 100' for edge and resident birds Minimum 300-500' for migratory and forest interior birds	Continuous	Spackman and Hughes 1995; Stauffer and Best 1980
Warmwater fishes	150'	Limit breaks in cover and reduce the direct hydraulic connection of surface water and storm sewers to the stream	Wang et al. 2001
Coldwater fishes	35'-100'	80% of banks with at least 35' forest cover	Wenger et al. 1999

Forests

While much of the forested land in the Moodna Creek watershed is fragmented, there remain significant forest resources, ranging from large, matrix forests of global importance to smaller, stepping stone forests which provide important links to core habitat areas. These forest ecosystems, located primarily in the eastern and southern portions of the watershed, are extremely important to biodiversity, but also offer essential services to the human community. Forests, particularly large stands, contribute to water quality and quantity, mitigate effects of climate change, produce timber, and provide recreational opportunities such as hiking, hunting, and birdwatching.

The Orange County Open Space Plan (2004) provides a good overview of forest resources for the entire county; the following discussion of the Moodna watershed reflects the size classes described in the Open Space Plan.

Globally Important Forests (greater than 15,000 acres). The Nature Conservancy's "ecoregional planning" efforts identified "matrix" community types that extend over very large areas of 1,000 to many millions of acres, often covering 80% or more of the undeveloped landscape. The size and natural condition of the identified "matrix forests" allow for the maintenance of dynamic ecological processes and meet the breeding requirements of species associated with forest interior conditions. The Moodna watershed contains two such globally-important, matrix forests. The east side of the watershed contains a large portion of the West Point/Black Rock matrix forest, which in total includes over 20,000 acres (8,100 ha) of core habitat, and connects southward to the even larger Harriman matrix forest. Protected lands in this forest include Storm King State Park, Black Rock Forest, and West Point Military Academy (although the latter is not permanently protected). The watershed's southern tip in Monroe enters the Ringwood matrix forest, which in total includes an expanse of over 50,000 core acres (20,000 ha) and includes protected lands in Sterling State Forest. Forests of this size are large enough so over time they will express a range of forest successional stages including areas that have been subjected to recent large-scale disturbance such as blowdowns and fire, areas under recovery, and mature areas. These forests also provide sufficient area to support enough individuals of most species to maintain genetic diversity over several generations. (Orange County Open Space Plan 2004)

The large forests of the Hudson Highlands are primarily Appalachian oak-hickory forest, chestnut oak forest, and oak-tulip forest, and are interspersed with smaller but ecologically significant patch communities, such as pitch pine-oak-heath rocky summit, rocky summit grassland, and woodland pools. These large, relatively undeveloped blocks of forests, wetlands, grasslands, and ridges are noteworthy for the links they provide between the mid-Atlantic states and New England, and for the wildlife species they support, which are wide-ranging and area-sensitive, and thrive in large, unfragmented landscapes. Examples of wildlife using large forest habitat in the Moodna watershed include black bear and bobcat; Indiana bat; timber rattlesnake and wood turtle; and many birds, including warblers and thrushes.

Regionally Important Forests (14,999 down to 6, 000 acres). The Orange County Open Space Plan highlights forest patches greater than 6,000 acres (2,400 ha) as important for habitat to more area-sensitive species, and because they can accommodate the large-scale disturbances that maintain forest health over time. The plan identifies a regionally important forest on and around

Schunnemunk Mountain. This forest is primarily chestnut oak forest, but at higher elevations, includes one of the best statewide examples of pitch pine-oak-heath rocky summit community. In the stream drainages, the chestnut oak forest is replaced by hemlock-northern hardwood forest, most of which has been killed off by wooly adelgid.

Locally Important Forests (5,999 down to 2,000 acres). These small but locally important forests often represent the lower limit of intact, viable forest size for forest-dependent birds, which often require 2,500 to 7,500 acres (1,000 to 3,000 ha) of intact interior habitat. These forests, like the larger regionally important forests, also provide important corridors and connectivity among forest ecosystems within Orange County. The Open Space Plan indicates that in the Moodna watershed, there are a only a few locally important forests remaining. These are found in Goose Pond Mountain State Park in Chester, near the headwaters of Trout Brook, and straddling the borders of Hamptonburgh and Goshen along the Otter Kill.

Stepping Stone Forests (1,999 down to 200 acres). These smaller forests provide valuable, relatively broad corridors and links to larger patches of habitat such as the local, regional, and global forests found in the watershed. Such broad connections are more effective than narrow, linear corridors, and enable species to move from one habitat to another across an otherwise hostile and fragmented landscape. There are a number of stepping stone forests in the Moodna watershed, including patches to the west of Schunnemunk; to the west and south of Goose Pond; and to the south of Stewart State Forest.

Threats and Conservation Opportunities

- **Setting priorities for forest conservation.** Smaller blocks of forests are less likely to support the rich diversity of species of the Moodna Creek watershed. The Orange County Open Space Plan suggests that priorities for protection therefore should range from high to low as forest blocks range from globally important (high priority) to stepping stone (lowest priority).
- **Protection of large forests.** Globally-important forests are increasingly rare in the Hudson Valley, where development patterns have fragmented most forested lands into smaller and smaller patches. Communities in the Moodna watershed have an important stewardship role to play in the conservation of large, contiguous forests, and where possible, expanding on them by protecting adjacent forested lands through acquisition, conservation easement, sustainable forestry agreements, and effective conservation subdivision design. The forest blocks identified in the Orange County Open Space Plan should serve as a framework for establishing priorities and opportunities to maintain habitat connectivity between large core areas such as Schunnemunk Mountain and Storm King, or Goose Pond and Sterling Forest. (See “Cores, Connections, and Landscape Perspective” section.)
- **Forest fragmentation.** Further fragmentation of forest patches should be prevented. Placement of future roads, driveways, utility lines, and other fragmenting features should be designed to avoid intact, contiguous forested areas. Such fragmentation leads to decreased habitat availability, introduction of invasive species like Japanese barberry, increased songbird nest predation and parasitism, and increased mortality of wildlife attempting to cross roads and developed areas. There are human health implications as well. Research conducted in Dutchess County suggested a link between increased risk of Lyme disease and reduced forest size, due to an associated reduction in small mammal

diversity. The prevalence of white-footed mice in small, isolated forest patches led to higher incidence of Lyme, since this mouse is the most effective carrier of the bacterium that causes the disease. The risk of Lyme disease is much lower in intact forest ecosystems where the infection rate is diluted by a diverse small mammal fauna (Allan et al. 2003).

- **Forest habitat for pool-breeding amphibians.** Planning for future development and timber harvesting should include practices to conserve adequate forested habitat around woodland pools to support forest amphibians (see "Wetlands" section). Pool-breeding species such as marbled salamander, Jefferson salamander, and wood frog require substantial forested areas for all non-breeding parts of their life cycle. Recommendations in Calhoun and Klemens (2002) and Calhoun and deMaynadier (2004) should be followed.
- **Natural disturbance.** Forest systems benefit from cycles of natural disturbance. A history of fire suppression in the larger forests of the watershed has contributed to changes in forest community structure, and build-up of fuel material. The expansive wildfire at Minnewaska State Park Preserve in Ulster County in spring 2008 illustrates how fire suppression can ultimately lead to more intense and difficult to manage wildfires. Prescribed burning may provide a favorable alternative for the large forests in the Moodna watershed, and warrants investigation.

Wetlands

The Moodna Creek watershed contains a diversity of wetland habitats…from the freshwater tidal marsh at the creek mouth to the small woodland pools in Black Rock Forest, to the large hardwood swamps in the Otter Kill basins, and the fens and freshwater marshes in the Black Meadow Creek drainage. Each of these wetland types is shaped by different hydrology, chemistry, and position on the landscape; in turn, they support different species that are adapted to the particular conditions of the habitat. These wetland systems also provide a number of services to Moodna watershed residents, including floodwater retention, water purification, and in some cases, groundwater recharge.

Rare Wetland Wildlife. In addition to the countless common plants and animals supported by wetland communities in the Moodna watershed, there is an especially rich diversity of rare wildlife, including:

- southern leopard frog (NYS Special Concern) in the Otter Kill and Seely Brook basins (primary habitat is wet meadow, also permanent and seasonal wetlands and some upland areas);
- northern cricket frog (NYS Endangered) in the Black Meadow Creek basin (primary habitat complex includes permanent wetlands and upland forest);
- marbled salamander (NYS Special Concern – Watch List) in Black Meadow Creek basin and other pool-breeding amphibians in Seely Brook and Otter Kill basins (breeding habitat is woodland pools and non-breeding habitat is upland forest);
- bog turtle (NYS Endangered) in the Black Meadow Creek basin (primary habitats are fens and wet meadows);

- spotted turtle (NYS Special Concern – Watch List) in Black Meadow Creek, Seely Brook, and Otter Kill North basins (habitat complex includes woodland pools, upland forest, and wet meadows or swamps);
- great blue heron rookeries in Purgatory Swamp in the Otter Kill South basin and Hamptonburgh Preserve in Otter Kill North;
- nesting bald eagle (NYS Threatened) at Tomahawk Lake in Cromline Creek basin, and at the Moodna Creek mouth;
- gray petaltail (NYS Special Concern) in the Highlands (habitat is seepage slopes), New England bluet in Black Rock Forest (habitat is ponds or lakes with boggy edges), and many more dragonflies and damselflies.

Note that the above records are based on documented occurrences in the NY Natural Heritage Database; observations from the NYS Herpetological Atlas; and Orange County biodiversity data. There are likely occurrences of these and other species elsewhere in the watershed that are yet unrecorded. Refer to the appendices for additional information on wetland wildlife of conservation concern.

Wetland Habitat Types. A thorough survey of the different wetland types in the Moodna watershed has not been conducted, so available *habitat* information is limited to wetland classifications on the National Wetland Inventory (NWI) maps, or inferences from reported species presence. Wetland habitats that appear to occur in the watershed include lakes and ponds, hardwood swamps, floodplain forest, emergent marsh, wet meadows, fens, woodland pools, springs and seeps, beaver ponds, and possibly bog lakes and kettle pools. (Detailed profiles of different wetland habitats are included in Edinger et al. 2002 and Kiviat and Stevens 2001.)

Two small but important wetland habitats that are known to occur in the watershed are fens and woodland pools. Due to their small size, they are more frequently omitted from regulatory wetland maps than swamps, marshes, and other large wetlands. While these larger wetlands are no less important, fens and woodland pools are often missed completely during the land use and conservation planning process and therefore warrant special conservation consideration, as they support species that rarely occur in other habitat types.

> ***Fens*** are shallow, open-canopy wetlands, fed by groundwater seepage and dominated by herbaceous vegetation. Fens are an uncommon type of wet meadow, and are often quite small. Their calcareous conditions result from underlying limestone or carbonate rock. Fens often support rare plants, as well as rare animals like bog turtle, spotted turtle, ribbon snake, and several butterflies like Dion skipper. Because the presence of fens is so strongly linked to the bedrock properties and groundwater of the area, they are particularly vulnerable to alterations in hydrology and chemistry. Fens in the Moodna Creek watershed are known to occur in the southwestern subbasins, including Black Meadow Creek basin, but their full distribution in the watershed is not known.
>
> ***Woodland pools*** are small, isolated wetlands that typically dry out annually. This subset of "vernal" pools occurs in depressions in forested landscapes, and usually has no inlet or outlet, and therefore does not support a fish community. As a result, woodland pools are excellent "nurseries" for developing amphibian eggs and larvae. In the Hudson Valley, they provide important breeding habitat for marbled salamander, Jefferson salamander, blue-spotted salamander, spotted salamander, wood frog, and fairy shrimp, and also are

used as foraging habitat by turtles, snakes, frogs, wood ducks, bats, and other wildlife. Because of their small size and isolation, woodland pools lack Federal or State protection, and consequently are often overlooked, filled, or drained. In instances where pools receive local protection, the protected adjacent area or "buffer" is typically inadequate. In order to sustain populations of pool-breeding amphibians, substantial forested habitat in the surrounding area must be protected. Calhoun and Klemens (2002) recommend maintaining forested buffers of 750 feet around pools, with less than 25% development or disturbance in the forested zone. While Black Rock Forest is known to have many woodland pools, and pool locations were documented in MCA's Southern Wallkill Biodiversity Plan (Miller et al. 2005), distribution of this habitat on private lands is relatively unknown or undocumented for the watershed and requires further study.

Threats and Conservation Opportunities

- **Wetland habitat mapping.** Watershed communities will be better equipped to make land-use decisions if higher-quality wetland maps are available. One method to obtain such information is to create town-scale wetland maps; although this process can be costly, volunteers can be engaged to assist with appropriate components (see below). These maps can be part of a comprehensive natural resource inventory (NRI), and can represent different wetland habitat types (e.g., hardwood swamp, emergent marsh, etc.); include wetlands of all sizes, with no minimum area; and designate zones with varying degrees of conservation need. In these zones, regulated buffer sizes could be adjusted to meet specific goals; for example, maintaining water quality in an urbanized area versus protecting important habitat for a rare species. In the absence of a town-scale map, at a minimum, NYS Freshwater Wetland (including 2008 amendments for Orange County), NWI, and hydric soil data can be compiled into a GIS project as a baseline that can eventually be enhanced by detailed remote sensing and field investigations. Wetland buffers of at least 150 ft (50 m) can be added as important adjacent area. When setting conservation priorities, special attention can be given to large wetland complexes, and clusters of small or medium size wetlands. Larger buffer sizes can be added if local conditions or conservation needs are known (e.g., forested buffers of 750 ft [250 m] are recommended for woodland pools.)
- **Citizen science.** Citizen scientists and volunteers can be engaged in mapping of locally-important wetlands. For example, a partnership with the Hudson River Estuary Program can be pursued to develop a map of woodland pools in the watershed. In addition, biodiversity assessment training is available to municipalities from Hudsonia Ltd. on identification and mapping of ecologically-significant habitats; this habitat approach can be part of an NRI process.
- **Local ordinances.** Municipalities can pursue creation of local wetland ordinances, to ensure that wetlands and buffer areas that are inadequately protected by existing state and federal regulations no longer fall through regulatory cracks. Such ordinances can ensure protection of important community resources, while assisting decision-making boards and landowners in identifying conservation priorities early in the planning process.
- **Amphibian and reptile habitat complexes.** The Moodna watershed has an extremely rich diversity of amphibians and reptiles, many of which are increasingly rare. These species often require habitat complexes for survival, so maintaining landscape connectivity is extremely important. (Mitchell et al. 2006) For example, within New York, the imperiled northern cricket frog is known to migrate at least 750 ft (250 m) from

its summer wetland habitats. Similarly, spotted turtle needs to make overland movements to access different seasonal habitats. Local planning boards, decision makers, landowners, and conservation leaders should be educated on the habitat needs of these protected and declining species, to ensure their ability to persist in the watershed.

- **Dragonflies and damselflies.** Orange County has the second highest number of dragonfly and damselfly species in the United States. In North America, about 15% of dragonfly species are at risk of extinction in the foreseeable future. (Dunkle 2000) Aquatic dragonflies and damselflies use a variety of wetland habitats, and can be impacted by fish stocking, mosquito control, pesticides, hydrologic alteration, removal of aquatic vegetation, and other changes to habitat quality. Outreach and education to landowners and local leaders on conservation-oriented practices may help generate a sense of stewardship responsibility around this local natural legacy.

Grasslands, Shrublands, and Farmland

The history of agricultural practices in the watershed, along with current farming activity, has maintained important early-successional habitats like meadows and shrubby old fields. A number of wildlife species are dependent on these grassland habitats for breeding and foraging. In addition, agricultural lands can provide a ‘permeable’ landscape that is important for connecting core habitats across the landscape. While some farms and farming practices (e.g., large-scale industrial operations) cause damage to habitats and ecosystems, other farms (e.g., small-scale family farms) support species that are disappearing as rural countryside converts to suburban neighborhoods. (Miller et al. 2005) Finally, old and active farms create the pastoral landscape that adds to local scenery and a community’s “sense of place,” as well as sustain a region’s ability to provide locally-grown food and contribute to groundwater infiltration.

Grasslands. Grassland-breeding birds are especially dependent on open, grass-dominated fields for nesting. Studies have found that patches greater than 100 acres (40 ha) are necessary to support a diversity of breeding grassland birds; considerably larger patches, however, have greater potential for high species diversity and breeding success (Helzer and Jelinski 1999, Herkert 1991). Some of the smaller patches of grassland in the Moodna watershed are suitable for species that require less area for breeding, such as bobolink. (See Appendix A.) Grassland species that were reported as ‘confirmed breeders’ in the watershed during the 2000-2005 NYS Breeding Bird Atlas include bobolink, eastern meadowlark, and savannah sparrow; several additional grassland species were observed during the Atlas but breeding was not confirmed. (See Appendix B.)

The open, grassy areas at Stewart International Airport have historically supported grassland breeding birds, including upland sandpiper (NYS Threatened) in the 1980s. Given the recent expansion of the airport, it is uncertain whether grassland habitat remains available; however, small local airports and other facilities with large ‘lawns’ may provide suitable breeding or overwintering habitat if managed appropriately. Northern harrier (NYS Threatened) and short-eared owl (NYS Endangered) have been observed using grasslands near Purgatory Swamp as overwintering habitat.

For information on the values of *wet* meadow habitat, see the “Wetlands” section.

the next step is to collect existing information, and recognize that gaps will need to be filled by further study.

Figure 4 includes recommended conservation areas from MCA's Southern Wallkill Biodiversity Plan, which studied Chester, Warwick, and Goshen; Orange County data on rare species; Important Areas identified by the NY Natural Heritage Program; and matrix forests mapped by The Nature Conservancy. (The map also shows water resources in the watershed with buffers of 325 ft (100 m) on large streams; 215 ft (65 m) on wetlands and waterbodies; and 165 ft (50 m) on smaller tributaries.) These collective areas do not represent the only important biological resources in the watershed, as there is much yet to learn; they also aren't "hands-off" areas where development or disturbance is prohibited. Rather, they provide a framework that can be used to think about the big picture, and employ different approaches to avoid the known threats to local biodiversity, and to pursue the various conservation opportunities at hand.

Another existing source of information on Moodna resources is the Orange County Open Space Plan (2004), which identified a number of resources as "Core Biological Diversity Areas" that are located in the Moodna watershed (Figure 5):

- Hudson Highlands (including Sterling Forest, Storm King, and Black Rock Forest)
- Schunnemunk Mountain
- Goosepond Mountain (including Goosepond Mountain State Park)
- Purgatory Swamp
- Stewart State Forest.

These large areas, many of which are protected, are known biodiversity hotspots with primarily undeveloped lands. Studies at more local scales will help to determine what additional, smaller hotspots may be important components of this conservation network. For example, the Southern Wallkill Biodiversity Plan emphasized the biological importance of the Black Meadow Creek corridor and its relationship to Glenmere Lake, which is outside of the Moodna watershed but supports a northern cricket frog (NYS Endangered) population that crosses the boundary (Miller et al. 2005). Recent research suggests that habitat restoration efforts should focus on enlarging core areas, particularly by widening narrow sections of large fragments, to provide more interior habitat for core-dwelling species and to reduce invasive species, which flourish at the edge of habitat fragments (Ewers and Didham 2007).

Connections

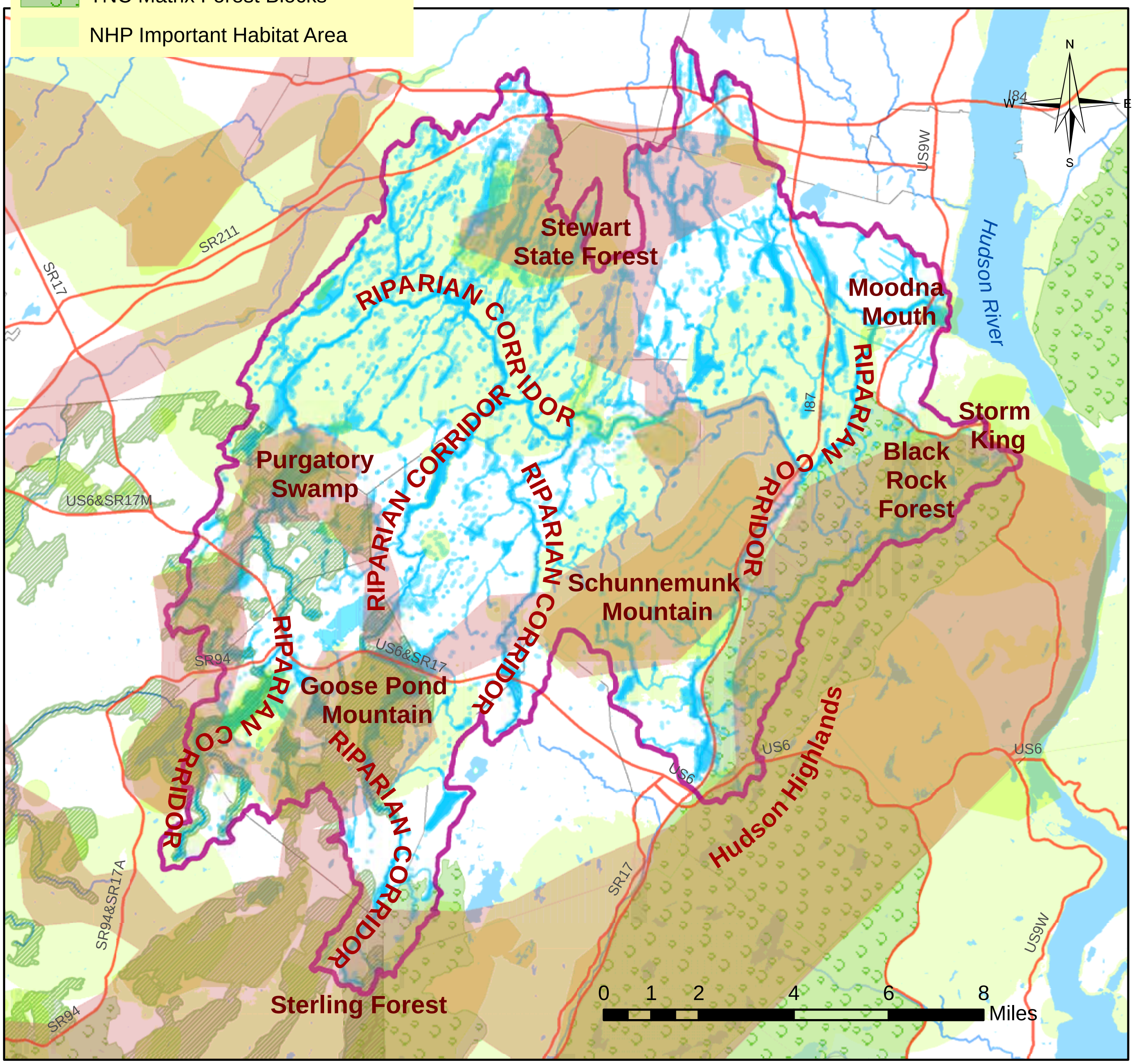
Identifying and conserving links between biodiversity cores is necessary to allow wildlife to overcome fragmentation and still move between habitats. These wildlife 'corridors' are not the narrow, straight passageways we're familiar with in our built environment; rather, they need to be broad, natural areas without roads, housing developments, and other fragmenting features. These connections enable wildlife to move safely between breeding and foraging habitats; to shift habitats when conditions become unsuitable; and to maintain genetic exchange between populations. Well-connected landscapes will also enable future migrations northward and to higher elevations, as species respond to increasing temperatures from climate change. This may be particularly important in Orange County where a number of species, like marbled salamander and box turtle, are already close to the northern limit of their range.

Figure 5. Conservation Network of Biodiversity Cores and Connections in the Moodna Creek Watershed *Orange County, NY*

Legend

- Moodna Watershed Boundary
- Major Road
- Orange County Cores & Corridors
- Orange County Rare Species
- MCA S. Wallkill Biodiversity Plan
- TNC Matrix Forest Blocks
- NHP Important Habitat Area

This map includes the biodiversity hotspots and wildlife corridors identified in the Orange County Open Space Plan, overlaid onto the documented biodiversity resources shown in Figure 4. Also identified are riparian corridors not included in the county's 'Cores & Corridors' network, but which may serve as important landscape linkages. Further analysis is needed on a finer scale, to identify additional cores and connections, and appropriate land-use strategies that will conserve important biodiversity areas, with generous buffers and connectivity to other hotspots. This map can be considered a "first step" toward developing a comprehensive biodiversity conservation strategy for the watershed, and is intended for planning purposes only.



Map created 18 June 2008 by:
Laura Heady, Hudson River Estuary Program,
NYS Department of Environmental Conservation
in partnership with Cornell University

Data Sources:
NY Natural Heritage Program
NYS Department of Environmental Conservation
National Wetland Inventory
The Nature Conservancy
Orange County Planning Department
Metropolitan Conservation Alliance

The following recommendations for landscape connections incorporate suggestions included in the Orange County Open Space Plan (Figure 5):

- Goosepond Mountain to Sterling Forest
- Goosepond Mountain to Schunnemunk Mountain
- Schunnemunk Mountain to Stewart State Forest
- Schunnemunk Mountain to Storm King
- Black Meadow Reservoir to Purgatory Swamp
- Otter Kill/Moodna Creek corridor (linear along river)
- Stream corridors throughout the watershed.

Land cover and fragmenting features in these potential connections will need to be assessed to determine feasibility for establishing functional biodiversity corridors. In addition to maintaining existing connections, there may be opportunities to restore linkages severed by major roadways, dams, and other barriers. Academic institutions, graduate students, conservation organizations, and the Hudson River Estuary Program may serve as good partners for conducting such analyses. Subsequent steps may require intermunicipal partnerships, outreach to landowners, coordination with land trusts, and planning tools such as conservation overlay zones, critical environmental areas, and conservation subdivision guidelines. Establishment of a biodiversity network does not necessitate outright purchase and protection of all lands, but it does require careful planning and innovative designs to maintain a permeable landscape, where wildlife does not perish due to vehicular traffic, lawnmowers, stormdrain pitfalls, household pets, and impassable barriers.

While habitat connections at the regional scale are very important, finer-scale assessment of the watershed is needed to identify the importance of local-scale connections; e.g., forested connectivity between clusters of woodland pools, or connections between core wetlands and upland overwintering habitats used by northern cricket frog. Because they provide important landscape links, stream corridors should be analyzed to evaluate the condition of riparian buffers and identify opportunities for restoration or conservation. (See Figure 3.)

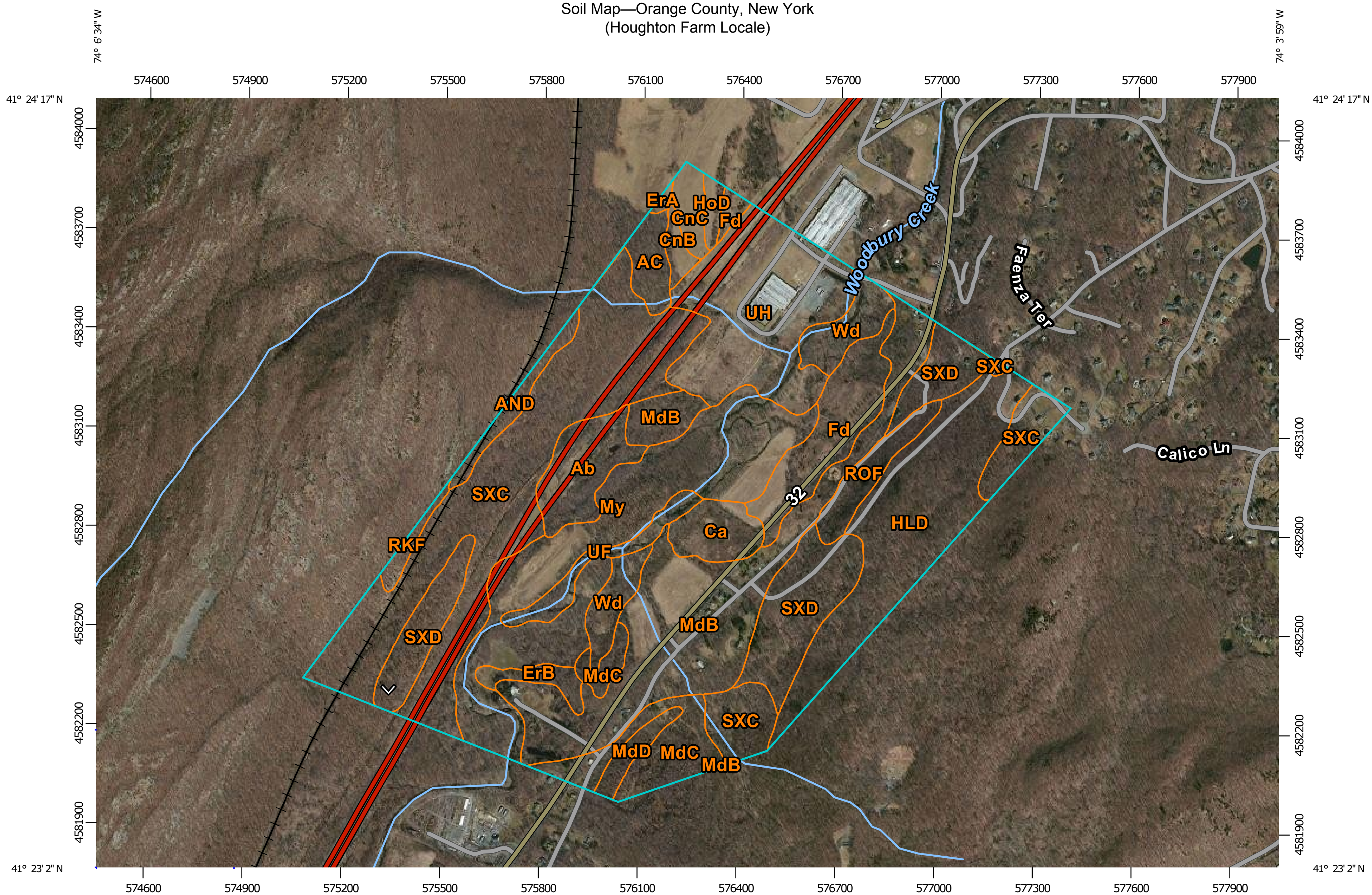
Threats and Conservation Opportunities

- **Data gaps.** More information is needed to build a strong smart growth plan for the watershed, which preserves cores and connections for biodiversity, while adequately addressing the needs for future growth of human communities. The Orange County Watershed Authority may want to convene an advisory committee to identify priority data gaps, pursue further studies, and refine recommendations to implement a plan for conserving Moodna's conservation network.
- **Updates to County plans.** Orange County's "Priority Growth Areas," which suggest future population growth centers, contradict the recommendations set forth in the Orange County Open Space Plan for biodiversity cores and connections. For example, a priority growth area is projected for the area between Goosepond and Schunnemunk Mountains, but this same area was identified as an important corridor in the open space plan. These discrepancies should be resolved or compatible priorities should be established to accommodate future development in appropriate areas. The upcoming update of the county comprehensive plan presents an excellent opportunity to reevaluate these recommendations.

- **Southern Wallkill Biodiversity Plan.** Recommendations in the Southern Wallkill Biodiversity Plan (Miller et al. 2005) should be reviewed and implemented by all appropriate stakeholders. The Hudson River Estuary Program can provide technical assistance to facilitate implementation. Similar studies in other portions of the watershed should be considered.
- **Land trust partners.** The Orange County Land Trust is a likely partner to implement the Moodna Creek Watershed Plan recommendations to develop a strategy for establishing a biodiversity network. They can assist with determining key parcels, exploring landowner incentive programs, and considering voluntary protection measures to maintain important cores and connections.
- **Local and intermunicipal action.** Local municipalities can incorporate biodiversity recommendations of the Moodna Creek Watershed Plan into their comprehensive plans, and explore intermunicipal agreements to promote a more landscape-level vision for the future of the watershed.
- **Planning board education.** Due to intense development pressure and the sheer volume of applications before planning boards, the standard “planning” process at the municipal level focuses less on actual planning and more on decision-making. Planning boards in the watershed should be offered training to understand the recommendations of the watershed plan, how the plan fits into their role as land-use decisionmakers, and how they can be partners in plan implementation. In addition, planning board members should be offered training on local biodiversity resources, planning considerations, and how the State Environmental Quality Review (SEQR) process can be used most effectively to support conservation-oriented planning.
- **Environmental commissions and NRIs.** More local-scale information is needed to elucidate both the landscape and local core and connection priorities (see discussion above). Where they are not already engaged, watershed municipalities can empower environmental commissions to become effective partners in the planning process. Environmental commissions should be charged with developing municipal NRIs and/or open space plans, as set forth in the State of New York General Municipal Law, Article 12-F Section 239-x and 239-y, and should serve as important advisory bodies to town boards, planning boards, and zoning boards of appeals and contribute substantially to environmental reviews. They too should be offered training to facilitate their conservation work.
- **Habitat assessment guidelines.** Considering biodiversity early in the planning process can be beneficial to all stakeholders. Municipalities can use “Habitat Assessment Guidelines” to supplement larger-scale maps and inventories with site-specific information. Habitat Assessment Guidelines are being used by several planning boards in Ulster and Dutchess County to identify important resources early in the planning process, and to have preliminary discussions on conservation priorities before serious site planning begins. This has been found to save time and resources for both the decision-making boards and the applicants, and often eliminates the need for a ‘positive declaration’ during the SEQR process. Moodna Creek watershed municipalities should explore similar guidelines.

Attachment D:
NRCS Soils Maps and Reports

Soil Map—Orange County, New York
(Houghton Farm Locale)



Map Scale: 1:16,400 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Orange County, New York
Survey Area Data: Version 14, Dec 15, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

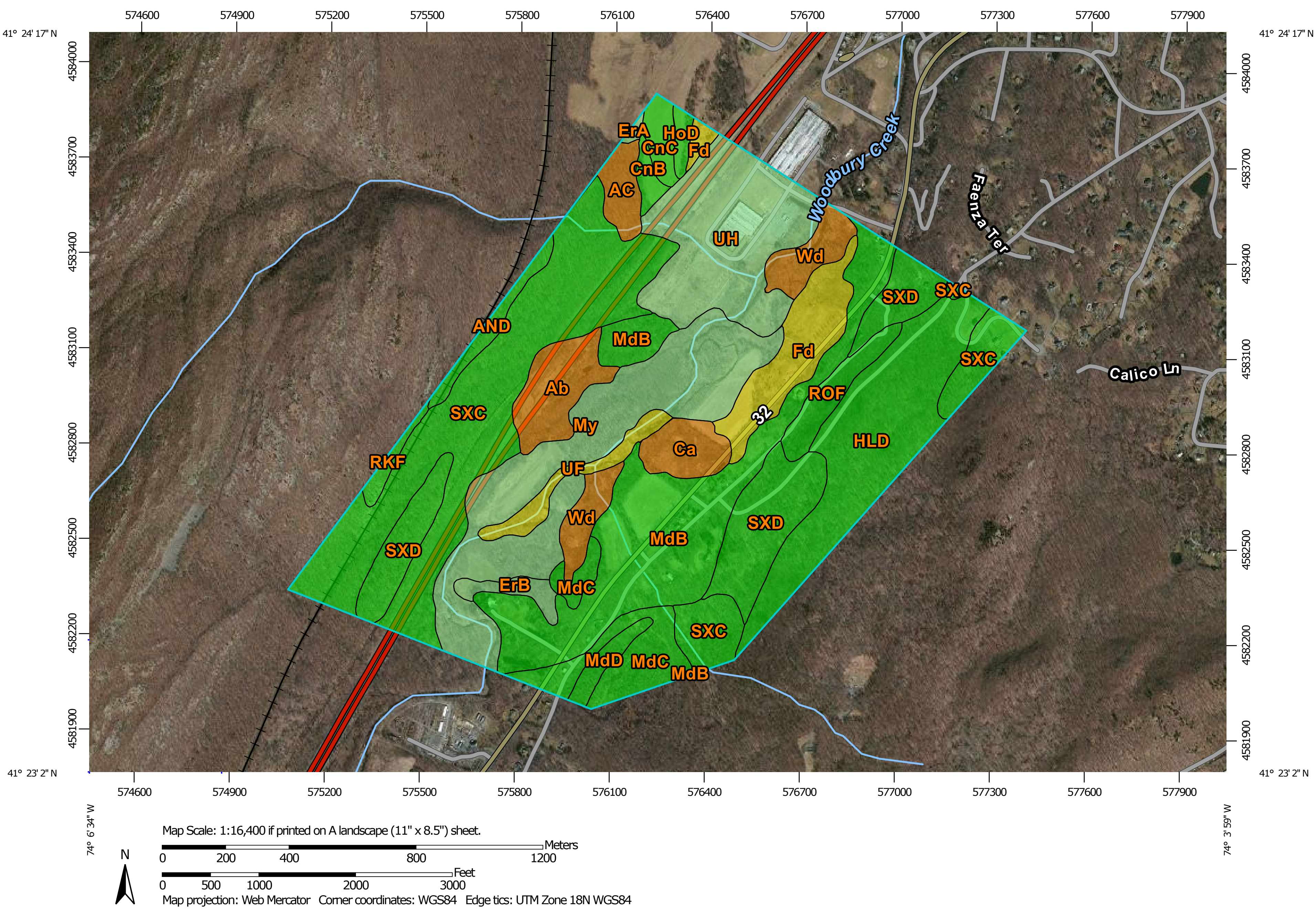
Date(s) aerial images were photographed: Mar 26, 2011—Apr 16, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Orange County, New York (NY071)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ab	Alden silt loam	16.8	2.9%
AC	Alden extremely stony soils	7.6	1.3%
AND	Arnot-Lordstown complex, moderately steep	5.9	1.0%
Ca	Canandaigua silt loam	10.6	1.8%
CnB	Chenango gravelly silt loam, 3 to 8 percent slopes	3.1	0.5%
CnC	Chenango gravelly silt loam, 8 to 15 percent slopes	5.5	0.9%
ErA	Erie gravelly silt loam, 0 to 3 percent slopes	0.8	0.1%
ErB	Erie gravelly silt loam, 3 to 8 percent slopes	4.9	0.8%
Fd	Fredon loam	25.1	4.3%
HLD	Hollis soils, moderately steep	57.5	9.9%
HoD	Hoosic gravelly sandy loam, 15 to 25 percent slopes	2.5	0.4%
MdB	Mardin gravelly silt loam, 3 to 8 percent slopes	82.1	14.2%
MdC	Mardin gravelly silt loam, 8 to 15 percent slopes	22.2	3.8%
MdD	Mardin gravelly silt loam, 15 to 25 percent slopes	4.7	0.8%
My	Middlebury silt loam	74.5	12.9%
RKF	Rock outcrop-Arnot complex, very steep	2.9	0.5%
ROF	Rock outcrop-Hollis complex, very steep	9.7	1.7%
SXC	Swartswood and Mardin very stony soils, sloping	115.7	20.0%
SXD	Swartswood and Mardin very stony soils, moderately stee p	47.1	8.1%
UF	Udifluvents-Fluvaquents complex, frequently flooded	8.5	1.5%
UH	Udorthents, smoothed	55.0	9.5%
Wd	Wayland soils complex, non-calcareous substratum, 0 to 3 percent slopes, frequently flooded	17.4	3.0%
Totals for Area of Interest		**579.7**	**100.0%**

Hydric Rating by Map Unit—Orange County, New York
(Houghton Farm Locale)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Hydric (100%)

Predominantly Hydric (66 to 99%)

Partially hyrdic (33 to 65%)

Predominatly nonhydric (1 to 32%)

Nonhydric (0%)

Not rated or not available

Soil Rating Lines

Hydric (100%)

Predominantly Hydric (66 to 99%)

Partially hyrdic (33 to 65%)

Predominatly nonhydric (1 to 32%)

Nonhydric (0%)

Not rated or not available

Soil Rating Points

Hydric (100%)

Predominantly Hydric (66 to 99%)

Partially hyrdic (33 to 65%)

Predominatly nonhydric (1 to 32%)

Nonhydric (0%)

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Orange County, New York
Survey Area Data: Version 14, Dec 15, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Apr 16, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydric Rating by Map Unit

Hydric Rating by Map Unit— Summary by Map Unit — Orange County, New York (NY071)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Ab	Alden silt loam	95	16.8	2.9%
AC	Alden extremely stony soils	95	7.6	1.3%
AND	Arnot-Lordstown complex, moderately steep	0	5.9	1.0%
Ca	Canandaigua silt loam	95	10.6	1.8%
CnB	Chenango gravelly silt loam, 3 to 8 percent slopes	0	3.1	0.5%
CnC	Chenango gravelly silt loam, 8 to 15 percent slopes	0	5.5	0.9%
ErA	Erie gravelly silt loam, 0 to 3 percent slopes	5	0.8	0.1%
ErB	Erie gravelly silt loam, 3 to 8 percent slopes	5	4.9	0.8%
Fd	Fredon loam	55	25.1	4.3%
HLD	Hollis soils, moderately steep	0	57.5	9.9%
HoD	Hoosic gravelly sandy loam, 15 to 25 percent slopes	0	2.5	0.4%
MdB	Mardin gravelly silt loam, 3 to 8 percent slopes	0	82.1	14.2%
MdC	Mardin gravelly silt loam, 8 to 15 percent slopes	0	22.2	3.8%
MdD	Mardin gravelly silt loam, 15 to 25 percent slopes	0	4.7	0.8%
My	Middlebury silt loam	5	74.5	12.9%
RKF	Rock outcrop-Arnot complex, very steep	0	2.9	0.5%
ROF	Rock outcrop-Hollis complex, very steep	0	9.7	1.7%
SXC	Swartswood and Mardin very stony soils, sloping	0	115.7	20.0%
SXD	Swartswood and Mardin very stony soils, moderately stee p	0	47.1	8.1%

Hydric Rating by Map Unit— Summary by Map Unit — Orange County, New York (NY071)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
UF	Udifluvents-Fluvaquents complex, frequently flooded	55	8.5	1.5%
UH	Udorthents, smoothed	5	55.0	9.5%
Wd	Wayland soils complex, non-calcareous substratum, 0 to 3 percent slopes, frequently flooded	90	17.4	3.0%
Totals for Area of Interest			**579.7**	**100.0%**

Description

This rating indicates the proportion of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is designated as "hydric," "predominantly hydric," "partially hydric," "predominantly nonhydric," or "nonhydric" depending on the rating of its respective components and the percentage of each component within the map unit.

"Hydric" means that all components listed for a given map unit are rated as being hydric. "Predominantly hydric" means components that comprise 66 to 99 percent of the map unit are rated as hydric. "Partially hydric" means components that comprise 33 to 66 percent of the map unit are rated as hydric. "Predominantly nonhydric" means components that comprise up to 33 percent of the map unit are rated as hydric. "Nonhydric" means that none of the components are rated as hydric. The assumption here is that all components of the map unit are rated as hydric or nonhydric in the underlying database. A "Not rated or not available" map unit rating is displayed when none of the components within a map unit have been rated.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as being hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

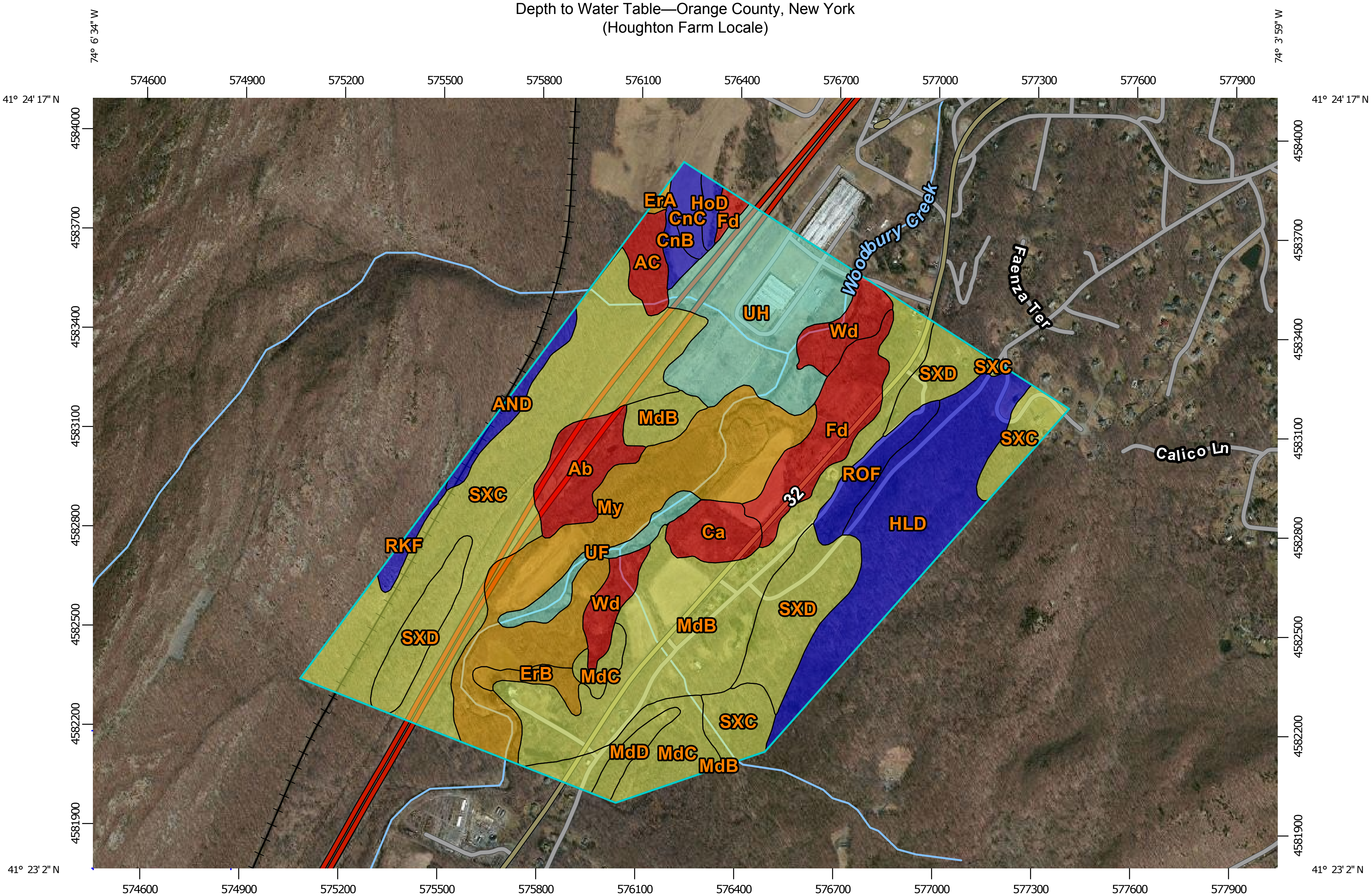
Rating Options

Aggregation Method: Percent Present

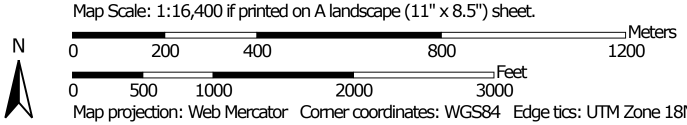
Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Depth to Water Table—Orange County, New York
(Houghton Farm Locale)



Map Scale: 1:16,400 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Soil Rating Lines

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Soil Rating Points

0 - 25

25 - 50

50 - 100

100 - 150

150 - 200

> 200

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Orange County, New York
Survey Area Data: Version 14, Dec 15, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2011—Apr 16, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Depth to Water Table

Depth to Water Table— Summary by Map Unit — Orange County, New York (NY071)				
Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
Ab	Alden silt loam	0	16.8	2.9%
AC	Alden extremely stony soils	0	7.6	1.3%
AND	Arnot-Lordstown complex, moderately steep	>200	5.9	1.0%
Ca	Canandaigua silt loam	0	10.6	1.8%
CnB	Chenango gravelly silt loam, 3 to 8 percent slopes	>200	3.1	0.5%
CnC	Chenango gravelly silt loam, 8 to 15 percent slopes	>200	5.5	0.9%
ErA	Erie gravelly silt loam, 0 to 3 percent slopes	31	0.8	0.1%
ErB	Erie gravelly silt loam, 3 to 8 percent slopes	31	4.9	0.8%
Fd	Fredon loam	15	25.1	4.3%
HLD	Hollis soils, moderately steep	>200	57.5	9.9%
HoD	Hoosic gravelly sandy loam, 15 to 25 percent slopes	>200	2.5	0.4%
MdB	Mardin gravelly silt loam, 3 to 8 percent slopes	54	82.1	14.2%
MdC	Mardin gravelly silt loam, 8 to 15 percent slopes	54	22.2	3.8%
MdD	Mardin gravelly silt loam, 15 to 25 percent slopes	54	4.7	0.8%
My	Middlebury silt loam	38	74.5	12.9%
RKF	Rock outcrop-Arnot complex, very steep	>200	2.9	0.5%
ROF	Rock outcrop-Hollis complex, very steep	>200	9.7	1.7%
SXC	Swartswood and Mardin very stony soils, sloping	54	115.7	20.0%
SXD	Swartswood and Mardin very stony soils, moderately stee p	54	47.1	8.1%

Depth to Water Table— Summary by Map Unit — Orange County, New York (NY071)				
Map unit symbol	**Map unit name**	**Rating (centimeters)**	**Acres in AOI**	**Percent of AOI**
UF	Udifluvents-Fluvaquents complex, frequently flooded	122	8.5	1.5%
UH	Udorthents, smoothed	137	55.0	9.5%
Wd	Wayland soils complex, non-calcareous substratum, 0 to 3 percent slopes, frequently flooded	0	17.4	3.0%
Totals for Area of Interest			**579.7**	**100.0%**

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

LOCATION ALDEN NY CT PA NJ

Established Series
Rev. WEH-ERS-PSP
10/2009

ALDEN SERIES

The Alden series consists of very deep, very poorly drained soils in depressions and low areas on upland till Plains. They formed in a silty local depositional mantle overlying till. Slope ranges from 0 to 8 percent. Saturated hydraulic conductivity is moderately high or high in the surface layer and low to moderately high in the subsoil and substratum.The mean annual temperature is about 48 degrees F., and mean annual precipitation is about 36 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, active, nonacid, mesic Mollic Endoaquepts

TYPICAL PEDON: Alden silt loam on a 1 percent slope in a pasture. (Colors are for moist soil unless otherwise noted.)

A-- 0 to 7 inches; black (10YR 2/1) mucky silt loam; moderate coarse granular structure; friable; many fine roots; 5 percent gravel; slightly acid; clear wavy boundary. (2 to 9 inches thick.)

Bg1-- 7 to 15 inches; gray (N 5/) silt loam; weak fine subangular blocky structure; friable; few roots; few fine pores; 5 percent gravel; few fine prominent yellowish brown (10YR 5/4) redoximorphic concentrations; slightly acid; clear wavy boundary.

Bg2-- 15 to 30 inches; dark gray (10YR 4/1) silt loam; weak coarse prismatic structure parting to weak coarse subangular blocky; friable; few fine pores with faint patchy clay linings; 5 percent gravel; few fine and medium distinct yellowish brown (10YR 5/4) redoximorphic concentrations; neutral; gradual wavy boundary. (Combined thickness of the Bg horizon is 12 to 40 inches.)

C-- 30 to 72 inches; grayish brown (10YR 5/2) gravelly loam; weak medium plate-like divisions; firm; few fine pores; 20 percent gravel; slightly effervescent in lower part; common fine prominent yellowish brown (10YR 5/6) redoximorphic concentrations; slightly alkaline.

TYPE LOCATION: Wyoming County, New York; Town of Warsaw, 700 feet north of U.S. Rt. 20A and 50 feet west of Adams Rd. USGS Castile, NY topographic quadrangle; Latitude 42 degrees, 44 minutes, 47 seconds N. and Longitude 78 degrees, 4 minutes, 55 seconds W. NAD 1927.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 19 to 48 inches. Depth to free carbonates is greater than 40 inches. Rock fragments range from 0 to 15 percent in solum and from 5 to 35 percent in the C horizon.

The Ap or A horizon has hue of 10YR and 2.5Y, value of 2 or 3, and chroma of 0 through 2. Texture of the fine-earth fraction ranges from fine sandy loam to silt loam. Some pedons do not have a mucky surface. Structure is weak or moderate granular. Consistence is friable or very friable. Reaction ranges from strongly acid through neutral. Some undisturbed areas have an 0 horizon 2 to 6 inches thick.

The Bg horizon has hue of 5YR through 5Y or 5GY, or is neutral with value of 4 through 6, and chroma of 0 through 2. Redoximorphic concentrations are few to many and distinct or prominent. Texture of the fine-earth fraction ranges from very fine sandy loam or silt loam to silty clay loam. Structure is subangular blocky, which may be within coarse or very coarse prisms, or it is massive. Consistence is friable or firm. Reaction ranges from moderately acid through neutral.

Some pedons have an Eg horizon with platy structure, color value of 5 or 7 and chroma of 0 or 1. Texture is similar to the Bg horizon.

The C horizon has hue of 5YR through 5Y,or neutral, value of 3 through 6, and chroma of 0 through 3. Redoximorphic features are few to many and faint to prominent. Texture of the fine-earth fraction is fine sandy loam, loam, silt loam, or silty clay loam. It is massive or has weak plate-like divisions. Reaction ranges from moderately acid through slightly alkaline to a depth of 40 inches, and ranges from slightly acid through moderately alkaline at depths greater than 40 inches.

COMPETING SERIES: The Lyons series is in the same family. Lyons soils have free carbonates at depths less than 40 inches.

The Atherton, Birdsall, and Canandaigua soils are members of related families. Atherton soils have dominant chroma of more than 2 within a depth of 30 inches. Birdsall soils have a coarse-silty particle size control section and Canandaigua soils have a fine-silty particle-size control section.

GEOGRAPHIC SETTING: Alden soils are nearly level and are in depressions on till plains. Slope ranges from 0 to 3 percent. The soils formed in loamy till with an 18 to 40 inch thick mantle of local depositional material. Mean annual temperature ranges from 46 to 51 degrees F; mean annual precipitation ranges from 28 to 48 inches; and mean annual frost-free period ranges from 140 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: Alden soils are very poorly drained associates of the well drained Bath and Valois soils, the moderately well drained Cambridge, Langford and Mardin soils, the somewhat poorly drained Erie, Venango, and Volusia soils, the poorly drained Ashville soils, and the poorly and very poorly drained Chippewa soils all of which are on uplands. Alton, Chenango, and Howard soils are on nearby outwash terraces. Wayland soils are in nearby valley flood plains. Chippewa soils are in depressions.

DRAINAGE AND PERMEABILITY: Very poorly drained. The potential for surface runoff is negligible or very low. Saturated hydraulic conductivity is moderately high or high in the surface layer and low to moderately high in the subsoil and substratum.

USE AND VEGETATION: Most areas are wooded, with stands of alder, red and silver maple, green and black ash, hemlock, white cedar, willow, and elm. Some areas are cleared and are largely used for pasture. Some abandoned cleared areas are reverting back to hydrophytic shrubs and herbaceous plants.

DISTRIBUTION AND EXTENT: Western Connecticut, northern New Jersey and Allegheny Plateau of New York and northern Pennsylvania. MLRA 140, 101, and 144A. The series is moderately extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Erie County, New York, 1929.

REMARKS: Original classification placed Alden in the great group of Haplaquepts. Because of changes in the 5th edition to `Keys to Soil Taxonomy' this soil now classifies in the new great group of Endoaquepts. Competing series may change as similar soils are reclassified. This description restricts the series to upland areas with the soil developed wholly or partly in loamy local alluvium underlain by till.

Diagnostic horizons and features recognized in the typical pedon include:

1) Mollic Epipedon - the zone from the surface to a depth of 7 inches (A horizon)
2) Cambic horizon - the zone from 7 to 30 inches (Bg horizons)
3) Aquepts suborder - aquic moisture regime, and low chroma matrix with redoximorphic features within a depth of 20 inches (Bg horizon)

Soil Interpretation Record No.: NY0100, NY0101

National Cooperative Soil Survey
U.S.A.

LOCATION CANANDAIGUA NY+VT

Established Series
Rev. CER-WEH-PSP
02/2013

CANANDAIGUA SERIES

The Canandaigua series consists of very deep, poorly and very poorly drained soils formed in silty glacio-lacustrine sediments. These soils are on lowland lake plains and in depressional areas on glaciated uplands. Slope ranges from 0 to 3 percent. Mean annual temperature is 49 degrees F. and mean annual precipitation is 39 inches.

TAXONOMIC CLASS: Fine-silty, mixed, active, nonacid, mesic Mollic Endoaquepts

TYPICAL PEDON: Canandaigua silt loam, in a cultivated field on a 1 percent slope. (Colors are for moist soil unless otherwise stated.)

Ap -- 0 to 8 inches; very dark gray (10YR 3/1) silt loam; moderate fine and very fine subangular blocky structure; friable; many fine roots; neutral; abrupt smooth boundary. (6 to 9 inches thick.)

Bg1 -- 8 to 12 inches; light brownish gray (10YR 6/2) silt loam; weak very coarse prismatic structure parting to weak fine subangular blocky; friable; many fine roots; common medium and fine pores; many medium distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) masses of iron accumulation in the matrix; neutral; clear irregular boundary.

Bg2 -- 12 to 19 inches; gray (10YR 6/1) silt loam; strong very coarse prismatic structure parting to moderate fine and medium subangular blocky; friable; few fine and medium roots; common medium pores with faint patchy clay films on surfaces along pores; gray (10YR 5/1) on all faces of peds; many medium faint light gray (10YR 7/2) areas of iron depletion in the matrix and distinct strong brown (7.5YR 5/6) masses of iron accumulation in the matrix; neutral; clear wavy boundary. (Combined thickness of the Bg horizon is 5 to 30 inches.)

BC -- 19 to 30 inches; light brownish gray (10YR 6/2) silt loam; moderate medium and thick platy structure parting to weak fine subangular blocky; friable; gray (10YR 6/1) on all faces of peds; many medium distinct light brown (7.5YR 6/4) and strong brown (7.5YR 5/6) masses of iron accumulation in the matrix; slightly effervescent, slightly alkaline; gradual irregular boundary. (0 to 16 inches thick.)

C -- 30 to 72 inches; gray (10YR 6/1) and light brown (7.5YR 6/4) thin strata of silt loam and very fine sandy loam; massive; friable; common medium distinct strong brown (7.5YR 5/8) masses of iron accumulation in the matrix and pinkish gray (7.5YR 6/2) areas of iron depletion in the matrix; strongly effervescent, moderately alkaline.

TYPE LOCATION: Orleans County, New York; 300 feet east of the Gaines Basin Road, 450 feet south of Allen Road intersection. USGS Albion, NY topographic quadrangle; Latitude 43 degrees, 13 minutes, 46 seconds N. and Longitude 78 degrees, 13 minutes, 25 seconds W., NAD 1927.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 20 to 40 inches. Depth to free carbonates commonly ranges from 18 to 60 inches, but some pedons lack carbonates within a depth of 80 inches. Rock fragments are commonly absent, but range up to 10 percent by volume in random subhorizons of some pedons. Below depths of 40 inches rock fragments can range up 30 percent in some pedons.

Ap and A horizons have hue of 5YR through 2.5Y, or are neutral, with value of 2 or 3 and chroma of 0 through 2. They are silt loam, very fine sandy loam, loam, or fine sandy loam. They have weak to strong, granular or subangular blocky structure. In some pedons, O horizons range from a trace to 6 inches thick overlying an A horizon. Reaction ranges from moderately acid to slightly alkaline.

The Bg horizon has hue of 5YR through 5GY, or is neutral, value of 4 through 7, and chroma of 0 through 2. Texture is silt loam, very fine sandy loam, or silty clay loam, with thin, random subhorizons in some pedons having lighter or heavier textures. Structure is very fine to coarse, subangular or angular blocky, either primary or within coarse or very coarse prisms. Consistence is friable to very firm. Redoximorphic accumulations are common to many. Reaction ranges from moderately acid to slightly alkaline.

BC horizons are similar to Bg horizon except for presence of free carbonates in many pedons. Structure is usually weaker and can include platy structure.

The C horizon has hue of 5YR to 5G or is neutral, value of 3 through 6, and chroma of 0 through 4. It consists of thin strata ranging from fine sand to silty clay to a depth of at least 40 inches. Below a depth of 40 inches some pedons have a loamy, nonstratified 2C and 3C horizons. Reaction ranges from slightly acid to moderately alkaline.

COMPETING SERIES: There are no series in the same family.

The Alden, Birdsall, Lamson, Minoa, Raynham, and Wegatchie series are members of closely related families. Alden soils have fine-loamy particle-size control sections. Birdsall and Raynham soils have coarse-silty particle-size control sections. Lamson and Minoa soils have coarse-loamy particle size control sections. Wegatchie soils have frigid temperature regimes.

GEOGRAPHIC SETTING: Canandaigua soils are nearly level soils mainly on glacial lake plains, but are also in depressional areas of glaciated uplands where water-sorted sediments have accumulated to a depth of more than 40 inches. Slope is mainly less than 1 percent, but ranges up to 3 percent. Mean annual temperature ranges from 46 degrees to 53 degrees F.; mean frost-free season ranges from 140 to 200 days; and mean annual precipitation ranges from 28 to 50 inches The elevation commonly ranges from 100 to 1300 feet but the range includes up to 1750 feet above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: Canandaigua soils are the wettest of a drainage sequence that includes the Dunkirk, Collamer, and Niagara series. Lighter textured Amboy, Arkport, Galen, Lamson, Minoa, Wallington and Williamson soils, and heavier textured Hudson, Lakemont, Madalin, Odessa, Rhinebeck, an Schoharie soils are also on associated lake plains. Honeoye, Lansing, and Ontario soils and their wetter associates are on nearby glacial till plains. Alton, Howard, and Palmyra soils and their wetter associates are on associated glacial outwash terraces.

DRAINAGE AND PERMEABILITY: Poorly and very poorly drained. The potential for surface runoff is very low or ponded. Permeability is moderate in the surface layer, moderate or moderately slow in the subsoil, and moderately slow and substratum.

USE AND VEGETATION: Much of the area is drained and used for truck crops and for growing beans, corn, hay and pasture. Undrained woodlots contain soft maple, swamp elm, white and black ash, white cedar, and hemlock.

DISTRIBUTION AND EXTENT: Lake plains of New York and Vermont, and locally in upland depressions. MLRA 101, 127, 139, 140, 141, 142, and 144A. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Ontario County, New York, 1949.

REMARKS: This soil now classifies in the subgroup of Mollic Endoaquepts. Competing series are expected to change as similar soils are reclassified.

Diagnostic horizons and other features recognized in the
typical pedon are:
(1) Ochric Epipedon - from 0 to 8 inches (Ap horizon), does not meet thickness requirements for a mollic epipedon.
(2) Cambic horizon - from 8 to 30 inches (Bg and BCg horizons).
(3) Aquepts suborder - Aquic moisture regime, and matrix with 2 chroma or less and redoximorphic features within 20 inches of the soil surface (Bg horizon).
(4) CEC activity class calculated as active from pedon S88NY-009-11

National Cooperative Soil Survey
U.S.A.

LOCATION FREDON NY+CT MA NJ PA VT

Established Series
Rev. CFE-RS-SMF
05/2011

FREDON SERIES

The Fredon series consists of very deep, poorly and somewhat poorly drained soils formed in glaciofluvial materials. Fredon soils are on outwash terraces and outwash plains. Saturated hydraulic conductivity is moderately high or high in the solum and high or very high in the substratum. Slope ranges from 0 to 8 percent. The mean annual temperature is about 9 degrees C. (48 degrees F.) and the mean annual precipitation is about 940 mm. (37 inches).

TAXONOMIC CLASS: Coarse-loamy over sandy or sandy-skeletal, mixed, active, nonacid, mesic Aeric Endoaquepts

TYPICAL PEDON: Fredon silt loam in a hayfield at an elevation of about 158 meters (520 feet). (Colors are for moist soil unless otherwise stated.)

Ap--0 to 18 centimeters (0 to 7 inches); very dark gray (10YR 3/1) silt loam; weak fine granular structure; very friable; many roots; less than 5 percent gravel; neutral; abrupt smooth boundary. (10 to 25 centimeters (4 to 10 inches) thick)

Bg1--18 to 32 centimeters (7 to 13 inches); grayish brown (10YR 5/2) silt loam; weak coarse and very coarse (76 to 102 mm. across (3 to 4 inches)) prismatic structure parting to moderate fine subangular blocky structure; friable; many roots; common fine faint brown (10YR 4/3) iron concentrations and few medium distinct yellowish brown (10YR 5/4) iron concentrations; 5 percent rock fragments; neutral; clear wavy boundary.

2Bg2--32 to 56 centimeters (13 to 22 inches); gray (10YR 5/1) gravelly fine sandy loam; weak coarse prismatic structure parting to moderate fine subangular blocky structure; friable; few roots; thin clay films in pores; many medium prominent strong brown (7.5YR 5/8) iron concentrations; 20 percent rock fragments; neutral; clear wavy boundary. (Combined thickness of the B horizons is 18 to 69 centimeters (7 to 27 inches).)

2C1--56 to 127 centimeters (22 to 50 inches); dark grayish brown (2.5Y 4/2) gravelly loamy sand; single grain; loose; few roots in upper part; 20 percent fine gravel; discontinuous lenses of light olive brown (2.5Y 5/4) very fine sand; neutral; abrupt wavy boundary.

2C2--127 to 203 centimeters (50 to 80 inches); interbedded very dark grayish brown (10YR 3/2) and dark grayish brown (2.5Y 4/2) very gravelly sand; single grain; loose; 40 percent rock fragments; moderately alkaline; calcareous.

TYPE LOCATION: Washington County, New York; town of Cambridge; 46 meters (150 feet) south of Perry lane at a point about 0.80 kilometers (one-half mile) west of the intersection of Perry Lane and New York Route 372; in a hayfield; USGS Cambridge quadrangle; latitude 43 degrees, 1 minute, 56 seconds N.; longitude 73 degrees, 24 minutes, 26 seconds W., NAD 27.

RANGE IN CHARACTERISTICS: Thickness of solum ranges from 56 to 102 centimeters (22 to 40 inches). Depth to bedrock is more than 183 centimeters (6 feet). Content of rock fragments ranges from 0 to 35 percent in the A and B horizons, and from 0 to 65 percent in the 2C horizons. Unless limed the soil ranges from strongly acid to neutral in the solum and from moderately acid to moderately alkaline in the 2C horizon.

The A and Ap horizons have hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 or 2. They are loam, fine sandy loam, very fine sandy loam, or silt loam.

BA horizons, where present, typically have the same characteristics as the B horizons and are 0 to 4 inches thick.

The B horizons have hue of 7.5YR to 5Y, value of 4 to 6, chroma of 1 to 4. They are loam, fine sandy loam, very fine sandy loam, or silt loam in the fine earth fraction. The B horizon has weak or moderate subangular blocky, weak coarse prismatic or moderate coarse platy structure. It ranges from very friable to firm in subhorizons.

BC horizons, where present, typically have characteristics similar to the B horizons and are 0 to 5 inches thick.

The 2C or 2Cg horizon has hue of 5YR to 5Y or is neutral, value of 3 to 6, and chroma of 0 to 4. It is coarse sand to loamy fine sand in the fine-earth fraction, and is commonly stratified. It may be calcareous or noncalcareous.

COMPETING SERIES: There are no other series currently in the same family.

The Halsey, Raypol, Red Hook, Rexford, and Walpole series are similar soils in related families. Halsey soils have chroma of 2 or less dominant in all horizons to a depth of 75 centimeters (30 inches). Raypol Soils have an acid reaction class. Red Hook soils have a coarse-loamy particle-size control section. Rexford soils have a coarse-loamy particle size control section and a fragipan. Walpole soils have a sandy particle-size control section.

GEOGRAPHIC SETTING: Fredon soils are level to gently sloping with slope gradients of 0 to 8 percent. They are on terraces that are slightly above the lowest depressions and stream floodplains. The soils formed in glaciofluvial material derived from slate, shale, sandstone, some limestone and small amounts of granitic gneiss. Climate is temperate and humid. Average annual temperature ranges from 7 to 11 degrees C. (45 to 52 degrees F.) and average annual precipitation from 864 to 1270 mm. (34 to 50 inches) usually distributed evenly throughout the year. Frost-free days range from 130 to 240.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bath, Dutchess, Halsey, Hazen, Hero, Palmyra, Phelps, and Wassaic soils on nearby landscapes. Well drained Bath, Dutchess, and Wassaic soils formed in till on nearby uplands. The well drained Hazen and Palmyra soils, moderately well drained Hero and Phelps soils, and very poorly drained Halsey soils are in drainage sequences with Fredon soils.

DRAINAGE AND PERMEABILITY: Fredon soils are commonly poorly drained but the range includes somewhat poorly drained. Runoff is negligible to medium. The water table is commonly less than 30 centimeters (1 foot) but ranges to within 46 centimeters (1 1/2 feet) of the surface from October to June in most years. Saturated hydraulic conductivity is moderately high or high in the solum and high or very high in the substratum.

USE AND VEGETATION: Used as woodland, pasture and cropland. Natural vegetation is dominantly red maple, elm, willow, and ash and some sedges and wetland plants. Some areas have been cleared and are used for pasture or cropland.

DISTRIBUTION AND EXTENT: Glaciofluvial landforms in Connecticut, Massachusetts, New York, New Jersey, Pennsylvania, and Vermont; MLRAs 101, 139, 140, 142, 144A, and small mesic areas within MLRA 144B. The series is moderately extensive with a total extent of about 24,000 to 30,500 hectares (60,000 to 75,000 acres).

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts

SERIES ESTABLISHED: Warren County, New Jersey, 1951.

REMARKS: With the revision in 2007 the typical pedon location is moved from Warren County, New Jersey in southern MLRA 144A to Washington County, New York in northern MLRA 144A. Data collected in the update soil survey activities for Warren and Sussex Counties, New Jersey did not support the maintenance of the official series type location for this series in that portion of MLRA 144A.

Geographic coordinates were determined in this revision from an interpretation of the narrative description of the location in the published Soil Survey of Washington, New York (September 1975). Dry color for the Ap horizon was not provided in the typical pedon but is presumed ochric. Cation-exchange activity class was estimated from a review of data for similar soils. Fredon soils were previously correlated in published surveys in Maine. Soil temperature regimes in Maine have been determined to be frigid and cryic.

Diagnostic horizons and other features recognized in the typical pedon include:

1. Ochric epipedon - from 0 to 18 cm. (0 to 7 inches) - Ap horizon.
2. Cambic horizon - from 18 to 56 cm. (7 to 22 inches)- Bg horizons.
3. Aquepts suborder - evidenced by matrix chroma of 2 or less and redox concentrations within 50 cm. (20 inches) of the soil surface - Bg horizons.
4. Aeric subgroup - as evidenced by matrix hue of 10YR or yellower and chroma of 2 with no redox concentrations in the zone from 56 cm. to 75 Cm. (22 to 30 inches) - 2C1 horizon.
5. Contrasting particle-size family within the control section that is coarse-loamy to 56 cm. (22 inches) and sandy or sandy-skeletal to a depth of 100 cm. (40 inches).

National Cooperative Soil Survey
U.S.A.

LOCATION WAYLAND NY+OH PA

Established Series
WEH-MF-PSP
09/2013

WAYLAND SERIES

The Wayland series consists of very deep, poorly drained and very poorly drained, nearly level soils formed in recent alluvium. These soils are in low areas or slackwater areas on flood plains. Saturated hydraulic conductivity is moderately high or high in the mineral soil. Slope ranges from 0 through 3 percent. Mean annual temperature is about 8 degrees C (46 degrees F) and mean annual precipitation is about 1080 mm (42.5 in).

TAXONOMIC CLASS: Fine-silty, mixed, active, nonacid, mesic Fluvaquentic Endoaquepts

TYPICAL PEDON: Wayland silt loam, on a 1 percent slope in a pasture of native grasses. (Colors are for moist soil.)

A -- 0 to 15 cm (0 to 6 in); very dark grayish brown (10YR 3/2) silt loam; light brownish gray (10YR 6/2) dry; strong medium and coarse granular structure; friable; common fine prominent yellowish brown (10YR 5/8) masses of iron accumulation within old root channels; neutral; clear smooth boundary (5 to 23 cm (2 to 9 in) thick).

Bg1 -- 15 to 30 cm (6 to 12 in); dark grayish brown (10YR 4/2) silt loam; weak fine and medium subangular blocky structure; friable; slightly sticky; many fine roots in upper part; common medium distinct dark yellowish brown (10YR 4/4) masses of iron accumulation in the matrix; slightly acid; clear smooth boundary.

Bg2 -- 30 to 46 cm (12 to 18 in); grayish brown (10YR 5/2) silt loam; weak fine and medium subangular blocky structure; friable; slightly sticky; many fine roots in upper part; common medium distinct yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) masses of iron accumulation in the matrix; slightly acid; clear wavy boundary. (Combined thickness of the Bg horizon ranges from 30 to 64 cm (12 to 25 in).

C1 -- 46 to 117 cm (18 to 46 in); gray (5Y 5/1) silt loam; massive; friable; common medium distinct strong brown (7.5YR 5/8) masses of iron accumulation in the matrix; neutral; abrupt wavy boundary.

C2 -- 117 to 183 cm (46 to 72 in); gray (5Y 6/1) silty clay loam; massive; firm in place, slightly plastic; common medium distinct strong brown (7.5YR 5/8) masses of iron accumulation in the matrix; slightly effervescent; slightly alkaline.

TYPE LOCATION: Chautauqua County, New York; in the town of Kiantone; 1/4 mile south of the intersection of U.S. Highway 62 and New York State Route 60, 1/4 mile east of U.S. Highway 62. USGS Jamestown, NY topographic quadrangle; Latitude 42 degrees, 03 minutes, 06 seconds N. and

Longitude 79 degrees, 11 minutes, 38 seconds W., NAD 1927.

RANGE IN CHARACTERISTICS: Thickness of the solum ranges from 38 to 79 cm (15 to 31 in). Thickness of the silty deposits over stratified materials ranges from 91 cm (36 in) to more than 152 cm (60 in). Bedrock is deeper than 152 cm (60 in). Depth to carbonates ranges from 61 to 152 cm (24 to 60 in). Rock fragments are commonly absent but can range up to 5 percent by volume within a depth of 91 cm (36 in) and from 0 to 30 percent below depths of 91 cm (36 in). Rock fragments are mostly gravel or cobbles.

The A or Ap horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 or 2, or it is neutral. It is fine sandy loam, silt loam or silty clay loam with or without mucky analogs. It has moderate or strong, fine through coarse, granular or subangular blocky structure. Reaction ranges from strongly acid through neutral. Thickness of the A or Ap is 5 to 23 cm (2 to 9 in).

The B horizon has hue of 7.5YR to 5Y, value of 3 to 6, and chroma of 0 to 2. The texture is silt loam or silty clay loam. Structure is weak or moderate, fine, medium, or coarse subangular blocky through weak or moderate, coarse prismatic. Consistence is friable or firm and usually contains high chroma redoximorphic features. Reaction ranges from strongly acid through neutral.

The C horizon has hue of 7.5YR through 5Y or has gleyed hues including 5BG, 5GY, and 5G, with value of 3 through 6, and chroma of 1 or 2, or the horizon is neutral. It is silt loam or silty clay loam but includes loam textures below 102 cm (40 in). The C horizon is massive. It is friable or firm and usually contains high chroma redoximorphic features. Reaction ranges from strongly acid through moderately alkaline.

The 2C horizon, where present, has color ranges similar to the C horizon. Texture ranges from fine sandy loam through silty clay loam in the fine-earth fraction. Reaction ranges from moderately acid through moderately alkaline.

COMPETING SERIES: The Melvin, Rahm, and Stanhope series are in the same family. Melvin soils have a mean annual temperature of greater than 10 degrees C (50 degrees F) and are formed in alluvium of non-glacial origin. Rahm soils have a buried acid paleosol within 102 cm (40 in). Stanhope soils lack carbonates within 152 cm (60 in).

The Aetna, Atkins, Holderton, Saco, Shoals, Sloan, Stendal, Wakeville, and Wyalusing series are similar soils in related families. Aetna soils have a buried mollic epipedon. Atkins and Stendal soils are strongly acid throughout; in addition, Atkins soils have a fine-loamy particle-size control section. Holderton soils have a coarse-loamy particle-size control section, Wakeville soils have a coarse-silty particle-size control section, and both soils have dominant chroma of 3 or more in a subhorizon between 25 to 76 cm (10 to 30 in). Saco and Shoals soils have a coarse-silty particle-size control section. Sloan soils have a mollic epipedon. Wyalusing soils have a coarse-loamy over sandy or sandy skeletal particle-size control section.

GEOGRAPHIC SETTING: Wayland soils are on nearly level or depressed parts of flood plains of streams receiving runoff from uplands that contain some calcareous drift. They are mainly in or bordering areas of Wisconsin glaciation. Slope ranges from 0 through 3 percent. The climate is humid temperate. Mean annual precipitation ranges from 795 to 1725 mm (31 to 68 in); mean annual temperature ranges from 6 to 11 degrees C (43 to 52 degrees F), and mean frost-free period ranges from 105 to 180 days. The elevation ranges from 50 to 600 m (164 to 1968 ft) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Chenango, Hamlin, Howard, Middlebury, Palmyra, Teel, Tioga, and Wakeville series. Chenango, Howard, and Palmyra soils do not have aquic moisture regimes and formed in adjacent gravelly outwash deposits. Well drained Hamlin, moderately well drained Teel, and somewhat poorly drained Wakeville soils are in a drainage sequence with Wayland soils. Middlebury and Tioga soils also formed in alluvial deposits but do not have aquic moisture regimes and have coarse-loamy particle-size control sections.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly and very poorly drained. The potential for surface runoff is negligible to very high. Saturated hydraulic conductivity is moderately high or high in the mineral soil. An apparent water table is at the surface or to a depth of 15 cm (0.5 ft) below the surface with occasional ponding and it is subject to flooding.

USE AND VEGETATION: Native vegetation is red maple, alder, willow, and other trees tolerant of wet sites. Some areas have been cleared and drained, and are used for growing pasture or crops.

DISTRIBUTION AND EXTENT: Southern and western New York, northern Pennsylvania and north-eastern Ohio. MLRAs 101, 139, 140, 142 and 144A. The soils are of large extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts

SERIES ESTABLISHED: Steuben County, New York, 1931.

REMARKS: Wayland series were classified as Entisols and classified to Mollic Fluvaquents. Most pedons have a B horizon and those pedons with a B horizon will now classify as Inceptisols and classified to Fluvaqentic Endoaquepts to the eighth edition. Older surveys using Wayland series need to consider which classification is suitable for their surveys.

Wayland soils that lack carbonates above 152 cm and that were previously correlated in published surveys have been identified for investigation as a future MLRA project.

Diagnostic horizons and other features recognized in this pedon include:
1. Ochric epipedon - the zone from 0 to 15 cm (0 to 6 in) (A horizon).
2. Cambic horizon - the zone from 15 to 46 cm (6 to 18 in((Bg horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION MIDDLEBURY NY+PA VT

Established Series
JWW-WEH-PSP
06/2011

MIDDLEBURY SERIES

The Middlebury series consists of very deep, moderately well drained nearly level soils formed in recent alluvium. These soils are on flood plains. Permeability is moderate in the surface layer, subsoil and upper part of the substratum, and rapid or moderately rapid in the lower part of the substratum. Slope ranges from 0 to 3 percent. Mean annual temperature is 49 degree F., and mean annual precipitation is 36 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, mesic Fluvaquentic Eutrudepts

TYPICAL PEDON: Middlebury silt loam, on a 1 percent slope in a cultivated field. (Colors are for moist soil unless otherwise stated.)

Ap -- 0 to 8 inches; brown (10YR 4/3) silt loam; moderate fine granular structure; very friable; many fine roots; moderately acid; abrupt smooth boundary. (7 to 12 inches thick.)

Bw1 -- 8 to 13 inches; brown (10YR 4/3) silt loam; weak medium subangular blocky structure; friable; common fine roots; many fine pores; slightly acid; clear wavy boundary.

Bw2 -- 13 to 20 inches; dark yellowish brown (10YR 4/4) loam; weak medium and coarse subangular blocky structure; friable; few fine roots; common fine pores; common fine faint brown (10YR 5/3) masses of iron accumulations within the matrix; slightly acid; clear wavy boundary.

Bw3 -- 20 to 25 inches; brown (10YR 4/3) fine sandy loam; weak coarse subangular blocky structure; very friable; few fine roots; common fine pores; neutral; many medium distinct grayish brown (2.5Y 5/2) masses of iron depletions within the matrix; clear wavy boundary. (Combined thickness of the Bw horizon is 6 to 34 inches.)

C1 -- 25 to 31 inches; brown (10YR 4/3) fine sandy loam; massive; very friable; common fine pores; many medium distinct grayish brown (2.5Y 5/2) masses of iron depletions within the matrix; neutral; clear wavy boundary.

C2 -- 31 to 43 inches; yellowish brown (10YR 5/4) sandy loam; massive; very friable; common fine pores; many fine and medium distinct grayish brown (2.5Y 5/2) masses of iron depletions within the matrix; neutral; gradual wavy boundary.

C3 -- 43 to 72 inches; grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) stratified gravely sandy loam; single grain; very friable; 25 percent rock fragments; neutral.

TYPE LOCATION: Ulster County, New York; Town of Rochester, 1,320 feet southwest of Boice Mill Road, about 1 mile northwest of intersection of Boice Mill Road and U. S. Route 209. USGS Kerhonkson, NY topographic quadrangle; Latitude 41 degrees, 47 minutes, 29 seconds N. and Longitude 74 degrees, 17 minutes, 23 seconds W. NAD 1927.

RANGE IN CHARACTERISTICS: Solum thickness ranges from 15 to 45 inches. Bedrock is deeper than 60 inches. Rock fragments range from 0 to 20 percent by volume in individual horizons within a depth of 40 inches and 0 to 50 percent below 40 inches.

The Ap or A horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. It ranges from fine sandy loam to silt loam in the fine earth fraction. It has weak or moderate, granular or subangular blocky structure. It is friable or very friable. Reaction ranges from strongly acid to slightly acid, and where limed can range to neutral. Depth of the A horizon ranges from 2 to 5 inches.

The B horizon has hue of 7.5YR through 5Y, value of 3 through 5, and chroma of 2 through 4. High chroma redoximorphic features can occur in all subhorizons. Low chroma redoximorphic features occur in the lower B horizons within 24 inches of the soil surface. The B horizon ranges from fine sandy loam to silt loam and include very fine sandy loam. Individual subhorizons can be gravely. It has weak or moderate, subangular blocky or prismatic structure. It is friable or very friable. Reaction ranges from moderately acid to neutral.

The C horizon has hue of 7.5YR through 5Y, value of 4 through 6, and chroma of 1 through 4. There are common to many high and low chroma redoximorphic features. The C horizon ranges from fine sandy loam to silt loam in the fine earth fraction above a depth of 40 inches, but includes stratified sand and gravel below depths of 40 inches. Consistence is very friable to firm. Reaction ranges from very strongly acid to neutral.

COMPETING SERIES: The Beckville series are the only other series in the same family. Beckville soils have carbonates between 20 to 40 inches from the soil surface.

The Basher, Hamlin, Lobdell, Oldenburg, Philo, Pope, Teel, Tioga, Weaver, Waterford, and Winooski series are similar soils in related families. Basher and Philo soils have less than 60 percent base saturation within 30 inches of the soil surface. Hamlin soils have coarse-silty particle-size control sections and lack 2 chroma redoximorphic features within 24 inches. Lobdell and Weaver soils have fine-loamy particle-size control sections. The Oldenburg soils have a mean annual temperature of 53 degrees F or greater. Pope soils have less than 60 percent base saturation within 30 inches, and lack 2 chroma redoximorphic features within 24 inches. Teel and Winooski soils have coarse-silty particle-size control sections. Tioga soils lack 2 chroma redoximorphic features within 24 inches of the soil surface. Waterford soils are somewhat poorly drained and have free calcium carbonates in the lower part of the control section.

GEOGRAPHIC SETTING: Middlebury soils are level and nearly level soils on flood plains and second bottomlands, and on some alluvial fans in sites where water tables are high part of the year. The soils formed in post glacial alluvium predominantly from areas of shale and sandstone with some lime bearing material. Mean annual precipitation ranges from 30 to 39 inches; mean annual air temperature ranges from 45 to 51 degrees F.; mean frost free season ranges from 120 to 170 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Hamlin, Teel, and Tioga soils, and the Chenango, Howard, Palmyra, and Wayland soils. Chenango, Howard, and Palmyra soils formed in adjacent gravelly outwash deposits on terraces. Wayland soils are poorly drained and very poorly drained, and formed in silty alluvium.

DRAINAGE AND PERMEABILITY: Moderately well drained. The potential for surface runoff is very low to very high. Permeability is moderate in the surface layer, subsoil and upper part of the substratum, and rapid or moderately rapid in the lower part of the substratum.

USE AND VEGETATION: A high proportion of the acreage has been cleared and is used to grow hay, corn, small grains, and pasture. Less extensive areas are used to grow vegetable and nursery crops. Wooded areas support popular, willow, elm, red oak, sycamore, and sugar maple.

DISTRIBUTION AND EXTENT: New York, Indiana, Vermont, and Pennsylvania. MLRAs 101, 139, 140, 144A and 147. The series is moderately extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Tioga County, Pennsylvania, 1929.

REMARKS: Diagnostic horizons and other features recognized in the typical pedon are:
(1) Ochric Epipedon - from 0 to 8 inches (Ap horizon)
(2) Cambic horizon - from 8 to 25 inches (Bw horizon)

2003-Activity class is changed from active to superactive based on lab data from 5 pedons from NY in Tioga-Middlebury catena.

National Cooperative Soil Survey
U.S.A.