SECTION 4 - WATER QUALITY

Section 4.1 WATER QUALITY ASSESSMENTS

All waters in New York State are assigned a letter classification that denotes their "best uses." In brief, the classifications are as follows:

Class A	Drinking water (and all other uses below).
Class B	Swimming and boating (and all other uses below).
Class C	Fishing and fish propagation. Possibly swimming and boating, but may be limited.
Class D	Fishing, but not fish propagation. Possibly swimming and boating, but may be limited.

An additional designation of T indicates that the river supports trout survival. If a river also supports trout propagation, TS is added.

There are specific numeric and narrative standards that apply to the different classifications. For example, the pH of A, B, and C waters must be between 6.5 and 8.5. The dissolved oxygen concentration for A, B and C trout spawning waters (TS) cannot be less than 7.0 mg/L from other than natural conditions. Except for Class A waters, nutrients (nitrogen and phosphorus) are regulated only by a narrative standard: "None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages."

For more information on stream classifications and standards, see: *NY State Codes, Rules and Regulations Title 6, Chapter X: Part 701: Classifications-Surface Waters and Groundwaters*[1] and *Part 703: Surface Water & Groundwater Quality Standard*[2]:
The classification of the Lower Non-tidal Rondout Creek is as follows:

From the Eddyville Dam to Kerhonkson	Class B
From Kerhonkson to the mouth of the Vernooy Kill	Class B(T)
From Vernooy Kill to Sandburg Creek	Class C(T)
From Sandburg Creek to Honk Lake	Class C
From Honk Lake to the Rondout Reservoir dam	Class C(TS)

Many of the tributaries to the Lower Non-Tidal Rondout are designated trout and/or trout spawning waters, and a few are Class A drinking water streams (in addition to tributaries to the Rondout Reservoir).

[1] http://www.dec.ny.gov/regs/4592.html#15992

[2] http://www.dec.ny.gov/regs/4590.html#16133

For more information on classifications in the Rondout Creek Watershed, see: *NY State Codes, Rules and Regulations Title 6, Chapter X, Part 855: Rondout River, Rondout Creek and Wallkill River Drainage Basin*[3]

WATER QUALITY ASSESSMENTS – BACKGROUND AND METHODS

Background

The NYSDEC Division of Water, Bureau of Water Assessment and Management, is responsible for monitoring New York State waters to determine overall quality of waters, trends in water quality, and to identify water quality problems and issues. This monitoring effort is coordinated through the Rotating Integrated Basin Studies (RIBS) Program. RIBS monitoring produces 2 years of data on the each of the state's 17 major drainage basins in a 5-year cycle. In year one of the sampling effort, screening sampling is conducted on a large number of waterbodies; in year two, a smaller number of locations are intensively sampled. In the screening year, only habitat assessments and macroinvertebrate sampling are conducted; in the intensive year, water chemistry, bottom sediment and invertebrate tissue chemistry, toxicity testing, macroinvertebrate assessments, and habitat assessment are done.

In 2002, the NYSDEC completed an extensive Biological Assessment of the Rondout Creek Watershed. In the next (most recent) 5-year cycle for the Rondout (2007-2008), the NYSDEC was only able to assess a few sites in the Rondout Creek Watershed because of the large area that the state must cover each year. In 2007, they sampled one site on the Rondout Creek and one site on each of two major tributaries, Sandburg Creek in the Village of Ellenville and Mill Brook in the Town of Rochester. No intensive sites were located on the Rondout in 2008, but one location in Kerhonkson at State Route 44/55 was sampled as part of a special study on nutrients.

Recognizing the need for more water quality data on a smaller scale, the NYSDEC Hudson River Estuary Program (HREP) provided funding to Hudson Basin River Watch (HBRW) in 2007 to assess 15 sites in the Rondout Creek Watershed. HBRW selected sites based on input from the Rondout Creek Watershed Council (RCWC), the New York State Department of Environmental Conservation (NYSDEC), and the New York City Department of Environmental Protection (NYCDEP). Sites that were selected included those sites that had never been studied by the NYSDEC or NYCDEP, sites on some of the smaller tributaries, and those that had been identified as potential areas of concern in the 2002 assessment completed by the NYSDEC. Two of the 15 sites were located above the Rondout Reservoir; their results are not discussed in this watershed management plan, as they likely do not significantly impact the water quality of the Lower Rondout Creek.

In 2009 and 2010, the Rondout Creek Watershed Council contracted with HBRW to assess two additional sites each year on the Sandburg Creek to try to determine the location of impacts on this major tributary to the Rondout.

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[3] http://www.dec.ny.gov/regs/4559.html#16947

Methods

The assessments mentioned above were "Biological Assessments" using NYSDEC Stream Biomonitoring Unit methods (used both by NYSDEC and HBRW). The primary indicators of water quality in these assessments are freshwater benthic macroinvertebrates (BMIs). BMIs are larger-than-microscopic invertebrate animals that live in and on stream bottoms, including aquatic insects, worms, clams, snails, and crustaceans. BMIs are useful water quality indicators because different species have different sensitivities to environmental impacts. They are less mobile than fish, and thus cannot avoid discharges or other pollution. Unlike chemical indicators, BMIs provide a picture of overall, integrated water quality, including synergistic effects; substances lower than detectable limits, and non-chemical impacts to the habitat, such as siltation or thermal changes.

Live BMI samples are collected in riffle habitats using a kick net, then preserved and identified in a laboratory under a microscope. The results are used to calculate four different "metrics" that are then averaged to find an overall water quality score for each site. Calculation of the metrics is based on the types and number of organisms present and known tolerances of different organisms to various amounts and types of pollutants. The overall water quality score is called a "Biological Assessment Profile" (BAP) and is ranked on a scale from 0 to 10, with 10 indicating the best water quality. The BAP can fall into one of four categories of pollution impact, with each category corresponding to a specific quarter of the scale: "severely impacted" = 0-2.5, "moderately impacted" = 2.5-5.0, "slightly impacted" = 5.0-7.5, and "non-impacted" = 7.5-10.

The results are also used to generate an "Impact Source Determination" (ISD) for each site. The NYSDEC Stream Biomonitoring Unit uses a method called "Impact Source Determination" (ISD) to identify types of impacts that may negatively affect water quality. The BMI community at a site is compared to existing models of known communities indicative of certain types of impacts. If no model exhibits at least a 50% similarity to the sampled community, then the ISD results are inconclusive. The following table lists the seven ISD models ("classes") used by the NYSDEC [4].

[4] Riva-Murray, K., et. al., 2002. Impact Source Determination with Biomonitoring Data in New York State. Northeastern Naturalist, 9(2):127-162.

Table 1. Descriptions of Impact Source Determination (ISD) classes used by New York State Department of Environmental Conservation for stream biomonitoring.

ISD Class	Description
Natural	Minimal human impacts. Includes pristine stream segments and those receiving discharges that minimally affect the biota.
Nonpoint nutrients	Mostly nonpoint agricultural and sources with similar impacts. Includes row crop runoff, golf course runoff, well-treated sewage effluent, and urban runoff. May include pesticide effects.
Toxic	Industrial, municipal, or urban runoff. May include municipal waste-water treatment plant discharges that include industrial wastes, and (or) are characterized by high ammonia or chlorine levels.
Organic	Sewage effluent and (or) animal wastes. Includes conventional waste-water treatment plant discharges, livestock waste inputs, and failing septic systems.
Complex	Municipal and (or) industrial. Includes industrial point sources and municipal waste-water treatment plant discharges that include industrial wastes. May also include combined sewer overflows and urban runoff.
Siltation	Sites affected by moderate to heavy deposition of fine particles.
Impoundment	Includes upstream lake or reservoir releases, dammed stream segments, or stream segments with upstream areas of natural pond, wetland, or sluggish zones.

For more information about the NYSDEC Stream Biomonitoring Unit methods, visit http://www.dec.ny.gov/chemical/23847.html

Other basic physical and chemical parameters are also assessed at each site. Physical parameters include depth, width, current velocity, percent canopy cover, percent embeddedness, percent of different substrate sizes, aquatic vegetation present, and habitat quality Chemical parameters include dissolved oxygen, pH, conductivity, and temperature. These are measured with a calibrated digital "Hydrolab Quanta Water Quality Monitoring System."

WATER QUALITY ASSESSMENTS - FINDINGS

Mainstem Rondout

The Lower Non-Tidal Rondout Creek maintains fairly good water quality, but numerous point and non-point sources of pollution in the watershed may threaten the health of the river, as many areas are showing slight signs of human impact.

The 2007 assessment by HBRW, combined with data from the NYSDEC, found the water quality to be "non-impacted" below the Rondout Reservoir at Lackawack, but "slightly impacted" at the Eastern Correctional Facility (both sites in the Town of Wawarsing). The water quality continued to be "slightly impacted" at several sites downstream in the towns of Wawarsing and Rochester (Port Ben Road in East Wawarsing, two sites in Kerhonkson, a site in Accord, and the Alligerville Bridge). The water quality did not recover to "non-impacted" until the town of Rosendale, at the County Route 7 bridge, but then dropped back down to "slightly impacted" after the State Route 32 bridge in Rosendale, downstream of the Rosendale Wastewater Treatment Plant (WWTP). The river then became "moderately impacted" further downstream, below the confluence with the Wallkill River and the large hydroelectric dam at Sturgeon Pool.

The 2002 NYSDEC assessment showed trends similar to the 2007 HBRW assessment, with sites in Wawarsing found to be "slightly impacted," although the recovery to "non-impacted" occurred much earlier, in Accord (Town of Rochester). The 2002 assessment did not sample downstream of Rosendale.[5]
The most recent data on the Rondout is from 2008 when the NYSDEC sampled just one site, which showed that the Rondout was still "slightly impacted" at the 44/55 bridge in Kerhonkson (Town of Wawarsing)[6].

These water quality assessments were based on analyzing samples of the stream invertebrate community ("Biological Assessments"). Note that no surveys of the Rondout Creek were undertaken in the Town of Marbletown because this methodology cannot be used in areas close to large impoundments.

Tributaries

Most tributaries were found to be "non-impacted" in both 2002 and 2007. A few tributaries, including Peters Kill, Kripplebush Creek, and Saunders/Stony Kill were found to be "slightly impacted," but due to natural habitat or weather conditions rather than human impact. The Mill Brook was found to be "slightly impacted" in 2002 but "non-impacted" in 2007.

The main tributary that requires further investigation is Sandburg Creek, a major tributary that flows through the Village of Ellenville before entering the Rondout south of Napanoch. In both 2002 and 2007, the Rondout dropped by one water quality category (from "non-impacted" to "slightly impacted) between the sites upstream and downstream of where the Sandburg flows into the Rondout.

The Sandburg Creek flows east through rural Sullivan County to the Hamlet of Spring Glen in Wawarsing. It then turns north, flowing through the old Nevele Grande Resort site and the currently operating Honors Haven Resort. It then flows through the Village of Ellenville. On the outskirts of the village, the Sandburg receives discharge from the Ellenville WWTP. Shortly thereafter it is met by the "non-impacted" Beer Kill, and then the Rondout.

In 2002, the Sandburg Creek was "non-impacted" at Canal Street in the Village of Ellenville. In 2007, it was "slightly impacted" at Canal Street and also just downstream of the Ellenville WWTP. In 2009, HBRW assessed the creek at two sites upstream of Ellenville, in the Hamlet of Spring Glen and at the Honors Haven Resort golf course. Both sites were found to be "non-impacted." In 2010, the Sandburg was "slightly impacted" (but close to "non-impacted") at a site just downstream from the Honors Haven Resort golf course and "non-impacted" at Canal Street in the Village of Ellenville.

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[5] Bode, R.W., et al., 2002 Rondout Creek Biological Assessment. NYSDEC, Albany, NY

[6] Alexander J. Smith, NYSDEC Stream Biomonitoring Unit, email correspondence, October 2010

More information is needed to flush out the condition of the Sandburg Creek and its impact on the Rondout. In 2007, flow conditions were fairly low, so the BMI community may have been more vulnerable to the various runoff and discharge influences than in 2010, when flow conditions were higher. However, without having multiple samples from each site in each year, it is difficult to determine whether the different results reflect true water quality changes or natural variation inherent in the biological community and sampling methodology.

Unfortunately there is no data for 2010 on the status of the Rondout downstream of the Sandburg. It would be interesting to know if the Rondout was still "slightly impacted" downstream of the Sandburg even though the Sandburg at Canal Street was "non-impacted" in 2010. In 2002, this was the case: the Sandburg at Canal Street was "non-impacted" and the Rondout in East Wawarsing was "slightly impacted." Impacts that year could have come from urban runoff from the Hamlet of Napanoch and/or from the Napanoch WWTP. Not enough sites were sampled to tease out these possible impacts.

Map 1 shows the sites sampled in 2007 by HBRW and NYSDEC in the Lower Non-tidal Rondout Creek Watershed. Map 2 shows a close up of the sites sampled in the Town of Wawarsing in 2007. Maps 3 & 4 show the sites sampled on the Sandburg Creek by HBRW in 2009 and 2010. On each map, the level of impact found at each site is indicated.

Tables 1 and 2 list all sampling sites from 2002 to 2010, their locations, BAP scores, ISD classes (where available), and stream classifications.

For more detailed information on the water quality assessments at each site sampled by HBRW, see Appendix ___.

INSERT MAPS HERE

Table 1. Biological Assessment Profile (BAP) Scores, Water Quality Assessments, and ISD Results, By Year Sampled for the Mainstem Rondout (sites listed from upstream to downstream).
Note: Site #'s are listed for HBRW sites. Site #'s are not available for DEC sites. It is noted where DEC and HBRW used the same sites. Not all information is available for all sites. Additional information from DEC sites can be obtained from the NYSDEC Bio-monitoring Unit. Additional information from other sites can be obtained from HBRW.

Site #	Town, Village, or Hamlet	Location	Year, BAP, Assessment, ISD	Classification
RN03 & DEC	Lackawack	Sportsmen Rd	2002: Non-impacted, Natural 2007: 7.91, Non-impacted, NPS nutrients & Natural	C(TS)
RN07	Wawarsing	Eastern Correctional	2007: 7.20, Slightly impacted, Natural	C(T)
RN08 & DEC	Wawarsing	Port Ben Rd	2002: Slightly-impacted, Natural & NPS nutrients 2007: 6.30, Slightly impacted, NPS nutrients	C(T)
RN09 & DEC	Kerhonkson	Rte 44/55	2002: Slightly impacted, Complex 2007: 6.20, Slightly impacted, NPS nutrients 2008: 6.83, Slightly impacted, Organic and Complex	B or B(T)
RN09 A	Kerhonkson	DEC river access	2007: 6.20, Slightly impacted, NPS nutrients & Complex	B

DEC	Accord	Upstream of Rochester Creek confluence	2002: Non-impacted, Siltation	B
RN10	Accord	5011 Rte 209	2007: 6.10, Slightly impacted, NPS nutrients (Naturally poor habitat)	B
RN12	Alligerville	Alligerville bridge	2002: Non-impacted, Natural 2007: 7.20, Slightly impacted, NPS nutrients & Organic	B
DEC	Rosendale	Rte 7	2002: 8.6, Non-impacted, Natural 2007: 8.0, Non-impacted, Siltation	B
RN14	Rosendale	Downstream of Rosendale WWTP	2007: 6.20, Slightly impacted, NPS nutrients	B
RN15	Rosendale/Esopus	895 Creeklocks Rd	2007: 4.80, Moderately impacted, Organic & Complex & NPS nutrients	B

TABLE 2. Biological Assessment Profile (BAP) Scores, Water Quality Assessments, and ISD Results, By Year Sampled for Tributaries to the Rondout Creek (listed from upstream to downstream).
Note: Site #'s are listed for HBRW sites. Site #'s are not available for DEC sites. In some cases, DEC and HBRW used the same sites. Not all information is available for all sites. Additional information from DEC sites can be obtained from the NYSDEC Bio-monitoring Unit. Additional information from other sites can be obtained from HBRW.

Site #	Creek	Town, Village, or Hamlet	Location	Year, BAP, Assessment, ISD	Classification
DEC	West Beer Kill	Ellenville	Old Greenfield Rd & Rte 52	2002: Non-impacted	B(TS)
DEC	Beer Kill	Ellenville	Rte 209	2002: Non-impacted	C(T)
RN04	Beer Kill	Ellenville	Cape Ave	2007: 8.80, Non-impacted, Natural & NPS nutrients	C(T)
RN05A	Sandburg Creek	Spring Glen	Old Rte 209	2009: 8.95, Non-impacted, NPS nutrients	B(TS)
RN05B	Sandburg Creek	Wawarsing	Honors Haven Golf Course	2009: 8.50, Non-impacted, NPS nutrients	B(T)
RN05C	Sandburg Creek	Wawarsing	Downstream of Honors Haven Golf Course	2010: 7.36, Slightly impacted, NPS nutrients	B(T)
RN05D & DEC	Sandburg Creek	Ellenville	Canal St	2002: 8.26, Non-impacted 2007: 6.19, Slightly impacted, NPS nutrients & Organic 2010: 8.37, Non-impacted, NPS nutrients	B(T)
RN05	Sandburg Creek	Ellenville	Downstream of Ellenville WWTP	2007: 6.50, Slightly impacted, NPS nutrients, Complex	B(T)
RN06	Fantine Kill	Ellenville	Beckley Dr	2007: 8.40, Non-impacted, Natural	B(T)
DEC	Vernooy Kill	Wawarsing	Rte 209	2002: Non-impacted	Part C(TS)
DEC	Mill Brook	Mill Hook	Roundout Valley Resort	2002: 6.89, Slightly impacted, NPS nutrients 2007: 7.53, Non-impacted	A(TS)
DEC	Rochester Creek	Mill Hook	Mettacahonts Rd	2002: Non-impacted	A(TS)
RN11	Saunders Kill/Stony Kill	Rochester	Just downstream of confluence	2007: 7.50, Slightly-impacted, NPS nutrients	AA(T)
DEC	North Peters Kill	Whitfield	Canyon Lake Rd	2002: Non-impacted	Part A(T)
DEC	Peters Kill	Rochester	St. Josen	2002: Slightly impacted (skewed due to moss & midges)	B(T)
DEC	Kripplebush Creek	Kripplebush	Rte 209	2002: Slightly impacted (naturally poor habitat)	C(TS)
RN13	Cottekill Brook	Marbletown	Lucas Tpke	2007: 8.14, Non-impacted, Natural	C(TS)

HBRW Training	Tan House Brook	Marbletow n	Snyder Estate	2006: 7.08, Slightly impacted	C
DEC	Coxing Kill	High Falls	School Hill Rd	2002: Non-impacted	C(T)

Water Quality Standards

None of the sites assessed by HBRW violated the pH or dissolved oxygen standards for their classification. However, when a river is “moderately” or “severely” impacted based on a biological assessment, it is likely that the river is no longer meeting its uses. The site on Creeklocks Road downstream of the confluence with the Wallkill was “moderately impacted.” This section of the river is class B, which includes swimming, boating, fishing and fish propagation. A “moderately impacted” river may not be able to support these uses.

The Creeklocks Road site was the only “moderately impacted” site. But a majority of sites scored as “slightly impacted.” Thus while much of the river may still be supporting its uses, it is no longer in a completely natural state, and the aquatic community is experiencing some stress from human impacts.

It is also important to note that the assessments did not include bacteriological sampling, so it is not known if the river is meeting its standard for coliform bacteria. This is an important indicator of health for a Class B (swimming) river.

POTENTIAL SOURCES OF IMPACTS

Non-point Source Pollution

“Non-point nutrients” was by far the most common source of impact indicated by the ISD. This ISD class refers mainly to inputs of nitrogen and phosphorus, which can cause excess algal growth, depressed oxygen conditions, and negative impacts to the aquatic community. In 2007, the ISD indicated “non-point nutrients” for almost all mainstem Rondout sites except the Eastern Correctional Facility in Wawarsing. “Non-point nutrients” were also indicated for almost all the tributaries that were “slightly impacted.”

Non-point nutrients can come from a variety of sources including agricultural areas, golf courses, and urban areas. In addition these nutrients can come from “well-treated sewage effluent” which refers to effluent from septic systems or WWTPs in which the organics have been broken down but nutrient concentrations remain. There is widespread agricultural activity in the Rondout Valley, but it may be more likely that the Rondout’s drop to “slightly impacted” below the confluence with the Sandburg Creek is from urban runoff entering Sandburg Creek from the Village of Ellenville and contributions from various WWTP discharges.

Point Source Pollution

There are several SPDES discharges in the Rondout Creek Watershed in the Town of Wawarsing, none in the towns of Rochester and Marbletown, and one in the Town of Rosendale. The 2007 assessments looked at sites upstream and downstream of four wastewater treatment plants (WWTPs): Ellenville, Napanoch, Kerhonkson, and Rosendale.

The Ellenville WWTP did not cause any significant change in the BAP score of the Sandburg Creek; the site upstream of the Ellenville WWTP (Canal Street) was already "slightly impacted." Thus non-point urban runoff from the village or some other impact upstream may have caused the water quality impacts on the Sandburg Creek in 2007. However, wastewater effluent could have prolonged the creek's recovery. Similarly, the Napanoch and Kerhonkson WWTPs did not cause any significant changes in the BAP score of the Rondout Creek; the sites upstream and downstream of each WWTP were all "slightly impacted." The discharges could have, however, been responsible for prolonging the river's recovery.

The ISD classes "Organic" and "Complex" indicate that municipal WWTPs could be one source of impact, among other possible sources. In 2007, the ISD indicated "Complex" at two sites that were downstream of WWTPs: Ellenville and Kerhonkson. "Complex" also appeared at Route 44/55 in 2002 and "Complex and "Organic" appeared at that site in 2008. "Organic" also appeared at the Alligerville Bridge in 2007.

None of the three WWTPs in the area (Ellenville, Napanoch, and Kerhonkson WWTPs) had any violations of their SPDES permit standards during any of the years in which water quality assessments occurred.[7]
Further downstream in Rosendale, the river had recovered to "non-impacted," but dropped to "slightly impacted" just downstream of the Rosendale WWTP. The Rosendale WWTP does on occasion violate its standard for total suspended solids, but there were no violations in the months of August and September of 2007.[8]

It is possible this drop is partially due to habitat differences. BMI's are found in riffles, shallow areas where the water moves quickly over rocky bottoms. Downstream of the WWTP, the riffle spanned the width of the river, but was not as long as it was wide. Ideally, a riffle should be twice as long as the width of the river. Upstream of the WWTP, the riffle met those criteria.

Impoundments and Channelization

The Rondout Reservoir dam did not exert any noticeable effect on water quality. The macroinvertebrate community at Lackawack was "non-impacted" both in 2002 and 2007.

The most impacted site in the whole watershed (found to be "moderately impacted" in the 2007 HBRW assessment) is located downstream from the confluence with the Wallkill River and is greatly affected by large changes in flow from the Central Hudson hydroelectric dam at sturgeon pool. Below are photos taken at that site at 5pm one day (shortly after a release) and 9am the

[7] Leonard M. Distel, Supervisor, Town of Wawarsing, and Mike Ryman, Chief Operator, Village of Ellenville Sewer Department, personal communications, November 2010.

[8] Terry Johnson, Water and Sewer Superintendent, Town of Rosendale, personal communication, October 2010.

following day after the high waters had subsided. The difference in flow in that 16-hour period is significant.

Site RN15, Creeklocks Road
September 15, 2007, 5 p.m.

Site RN15, Creeklocks Road
September 16, 2007, 9 a.m.

The old Delaware and Hudson Canal channel connects to Sandburg Creek upstream of the Village of Ellenville and the Honors Haven Resort. It did not exert any noticeable effect on water quality. The macroinvertebrate community was "non-impacted" at the Honors Haven resort in 2009 and "slightly impacted" (but close to "non-impacted") in 2010.

RECOMMENDATIONS

Controlling Non-point Source Nutrients

Non-point nutrients can be controlled through storm water management. The NYSDEC provides storm water management guidance to municipalities through its "Municipal Separate Storm Sewer Systems" (MS4) program[9]. MS4s are any system that conveys storm water, such as roads, pipes, catch basins, curbs, gutters, ditches, man-made channels, or storm drains. They can be owned or operated by a State, city, town, borough, county, parish, district or other public body that discharges into the waters of the United States. The municipal separate storm sewer is designed or used for collecting or conveying stormwater that is not a combined sewer or part of a Publicly Owned Treatment Works (POTW). Municipalities that are designated as "MS4 Communities" through the NYSDEC Phase II Stormwater Permit Program must develop, implement, and enforce a "Storm water Management Program" (SWMP) to reduce pollution to the "maximum extent practicable" (MEP) to protect water quality. SWMPs must include six

[9] Overview of the Municipal Separate Stormwater Sewer System (MS4) Phase II Stormwater Permit Program. A Summary of MS4 Phase II Permit Requirements. Revised August 2003 http://www.dec.ny.gov/docs/water_pdf/ms4_overview.pdf

"minimum control measures," including:

1. Public Education and Outreach;
2. Public Involvement/Participation;
3. Illicit Discharge Detection and Elimination;
4. Construction Site Runoff Control;
5. Post-Construction Runoff Control; and
6. Pollution Prevention/Good Housekeeping at municipal sites and operations.

Public education and outreach is important because people value their waterways and implementing this measure will help them to understand what they can do to protect and restore the health of their waterbodies. This will also provide the basis for public support for other control measures and projects related to the waterways. The public education and outreach program should include information about the impacts of stormwater discharges on waterbodies, pollutants and their sources, and preventative measures that can be taken to reduce their occurrence. A possible program for this might include speakers to community groups and schools, utility bill insets, displays at events or malls, and news articles or radio spots.

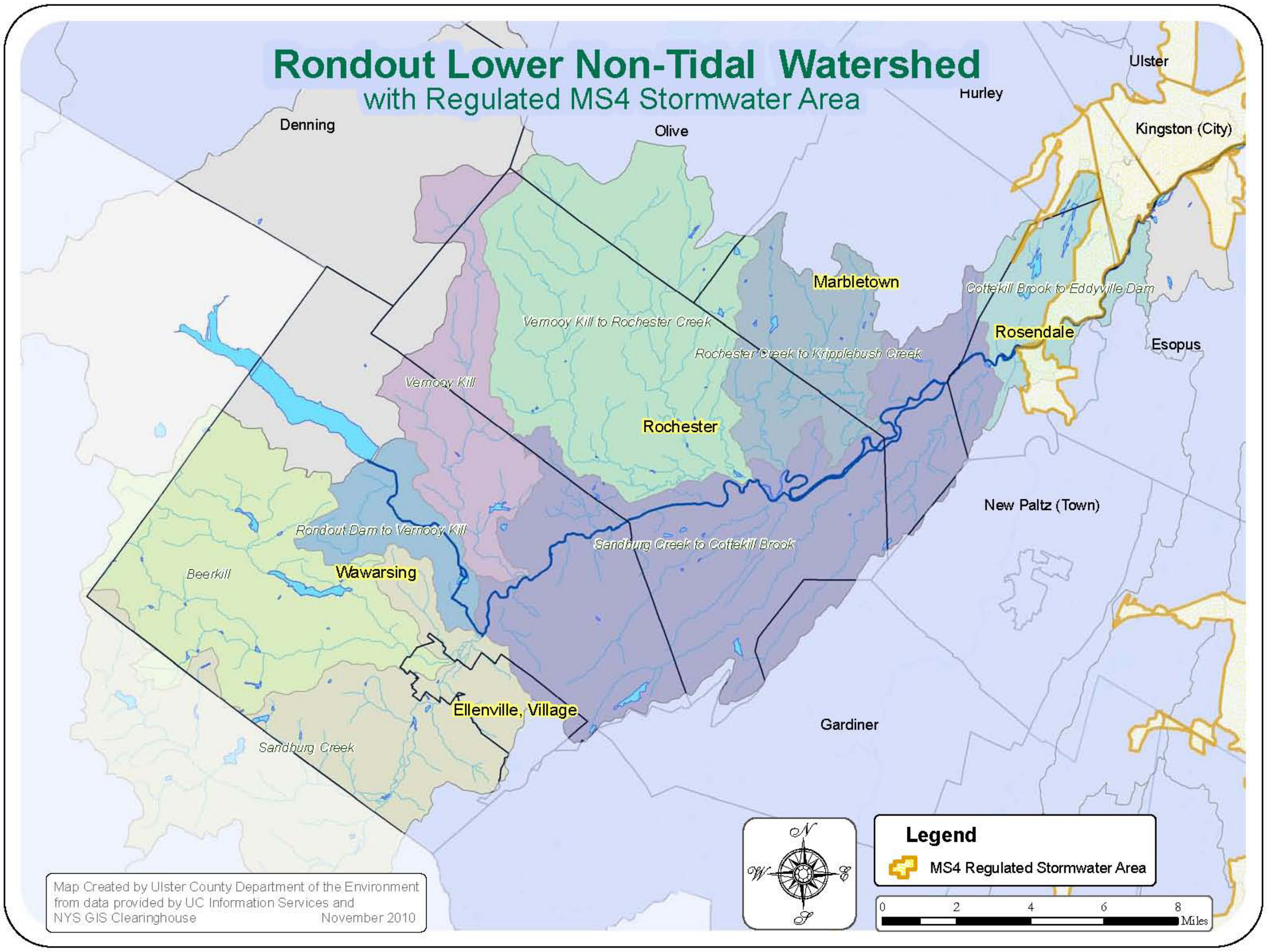
Public involvement and participation will help MS4s cultivate stronger programs and higher compliance levels if they involve people in the SWMP from the beginning. The public involvement must also comply with public participation and involvement provisions of the Clean Water act, as applicable. The public involvement/participation program will identify key individuals and groups who are interested in or affected by the SWMP. It will also describe the activities the MS4s will perform to provide program access and gather needed input. To ensure the public has the ability to become and remain involved the name contact person for the SWMP must be published. Also the draft annual report must be presented before submitting the annual report, at a meeting that is open to the public with time for public input. The summary of the input and comments should be included in the annual report, and the final report should be made available for public inspection. The program might include activities such as forming an advisory committee that will work in corroboration with other municipalities, and encouraging citizen volunteer programs for beach cleanups, litter removal and stream monitoring.

Illicit discharge detection and elimination will reduce the amount of discharges that enter the system through direct or indirect connections. This results in inadequately treated discharges that contribute high levels of pollutants, including toxics, heavy metals, oils and grease, viruses and bacteria that enter waterbodies. The municipalities must develop, implement, and enforce a program to detect and eliminate illicit discharges into the MS4.Another requirement is the creation of a map showing the location of any points where an MS4 discharges to either the waters of the U.S. or to another MS4, and the names and location of all waters of the U.S. The formation of an ordinance or other regulatory mechanism, that will prohibit illicit discharges into the storm sewer system and implement appropriate enforcement procedures and actions is a major regulatory aspect to detect illicit discharges. Additionally municipalities should develop and implement a program to detect and address non-stormwater discharges to the system. Public employees, businesses and the general public of hazards associated with illegal discharges will increase public awareness and involvement, will simultaneously strengthening the previous requirements. Measurable goals and appropriate management practices should be implemented to ensure the reduction of all pollutants of concern from illicit discharges to the stormwater system to the MEP. Possible programs for this measure might include conducting shoreline surveys, inspecting storm sewers, and establishing citizen watch groups.

Construction site runoff control requires measurable goals and appropriate management practices to ensure the reduction of all pollutants of concern from illicit discharges to the stormwater system to the MEP. A program to reduce pollutants in stormwater runoff to the MS4 from construction activities that disturb land of one acre or more must be developed and implemented. However, if construction is on land less than one acre, is part of a larger common plan of development or sale, it must be included in the program. The program should at a minimum provide the development and implementation of an ordinance or other regulatory mechanism to control erosion and sediment control management practices, and the implementation of sanctions to ensure compliance, if needed. Site plan review procedures that will incorporate consideration of potential water quality impacts, with pre-construction site plans to ensure consistency with local sediment and erosion control requirements must also be included. Finally procedures for site inspections and enforcement of control measures, and education and training for construction site operators about the requirements is necessary to ensure the successfulness of construction site runoff control. MS4s need to become familiar with the SPDES General Permit for Stormwater Discharges from Construction Activity because their program must, at a minimum, provide equivalent protection to this permit.

Post construction site runoff control is important because as runoff flows over land altered by development, it picks up pollutants that are then transferred into the waterways. Prior planning and design for minimization of pollutants in post construction areas is a cost effective approach to stormwater quality management. MS4s must develop and implement a program that reduce the discharge of pollutants to the MEP, through the use of ordinances or other regulatory mechanism to address post construction runoff from development and redevelopment. As with construction site runoff control, post construction site runoff requires that there are measurable goals, management practices, and controls in place to ensure the reduction of all pollutants to the MEP. Inspection of development and redevelopment sites must be carried out to insure compliance and penalize violators. In addition to inspecting sites the use of zoning ordinances and other regulatory mechanisms must be used to successfully reduce construction runoff.

Pollution prevention and good housekeeping measures for municipal operations will reduce or prevent pollution from the operation and maintenance activities, which can become sources of pollutants that need to be minimized through the SWMP. Good housekeeping measures for municipal operations will reduce or prevent pollution form entering nearby waterbodies with stormwater runoff. MS4s must develop and implement an operation and maintenance program that will reduce and prevent the discharge of pollutants to the MEP from activities such as park and open space maintenance, roadway maintenance, adjustments to local geography to affect the continuous movement of water on, above and below the landscape. As a guideline the management practices identified in the NYS Management Practices Catalogue for Nonpoint Source Pollution Prevention should be utilized as needed. Possible program activities are the development of maintenance schedules and inspection procedures for structural and non-structural controls, and coordinate with flood control managers to identify and address environmental impacts from flood management projects.



The towns of Marbletown and Rosendale are the only MS4 communities in the Lower Non-Tidal Rondout Creek Watershed. They have implemented successful SWMPs. Table 4.1 outlines specific practices used by these communities. Current efforts to manage and educate about stormwater have been successful. Rosendale has found that flooding has decreased due to increased inspection and maintenance of post construction best management practices. Marbletown found that stormwater trainings for contractors resulted in improved erosion and sediment control at construction sites. When economically feasible, Marbletown plans to incorporate runoff reduction techniques and green infrastructure in the routine upgrade of existing stormwater conveyance systems and municipal operations.[10]

[10] Stormwater Management Program Annual Report, 2009, Town of Marbletown. Stormwater Management Program Annual Report, 2009, Town of Rosendale.

Table 4.1: Practices Implemented in MS4 communities in LNT Rondout Creek Watershed

Practice Implemented	Marbletown	Rosendale
Developed educational materials on stormwater management and related issues.	x	x
Encouraged public involvement in stream clean ups.	x	x
Encouraged public involvement in community meetings to review SWMPs.	x	x
Mapped 100% of stormwater outfalls and screened for dry weather discharges.	x	x
Hosted public presentations on Better Site Design and Low Impact Development	x	
Provided stormwater training sessions for town employees	x	
Marked stormdrains		x
Corrected illicit discharges (failing septic systems)		x
Implemented and enforced regulatory mechanisms to control illicit discharges and manage stormwater runoff from construction sites and new developments, post-construction.	x	x

Other municipalities in the watershed can follow the examples set by Marbletown and Rosendale to educate and involve the public in stormwater issues and implement practices that eliminate illicit discharges and reduce stormwater runoff and resulting non-point source pollution from construction sites, new developments, and municipal operations.

Check what towns have done and be sure to credit them. Rochester creek clean up; riparian buffer plantings, etc.

An illicit discharge is a discharge that enters a MS4 system directly or indirectly, but it is not a discharge that MS4 systems are designed to process. They could include: sanitary wastewater, septic tank effluent, car wash wastewaters, improper oil disposal, radiator flushing disposal, laundry wastewaters, spills from roadway accidents, and improper disposal of auto and household toxics. Other non-stormwater discharge flows that may not be considered "illicit discharges" but can cause non-point source pollution include water line flushing, irrigation water, foundation and footing drains, residential car washing, swimming pool discharges, street wash water, and fire fighting activities. In addition to mapping and inspecting MS4 outfalls, mapping potential sites of illicit discharges could be a helpful strategy in controlling stormwater pollution. For example, if septic systems along a river corridor were mapped, this could help identify potential hot spots of pollution and help to target future sites for stream monitoring efforts.

Point Source Pollution

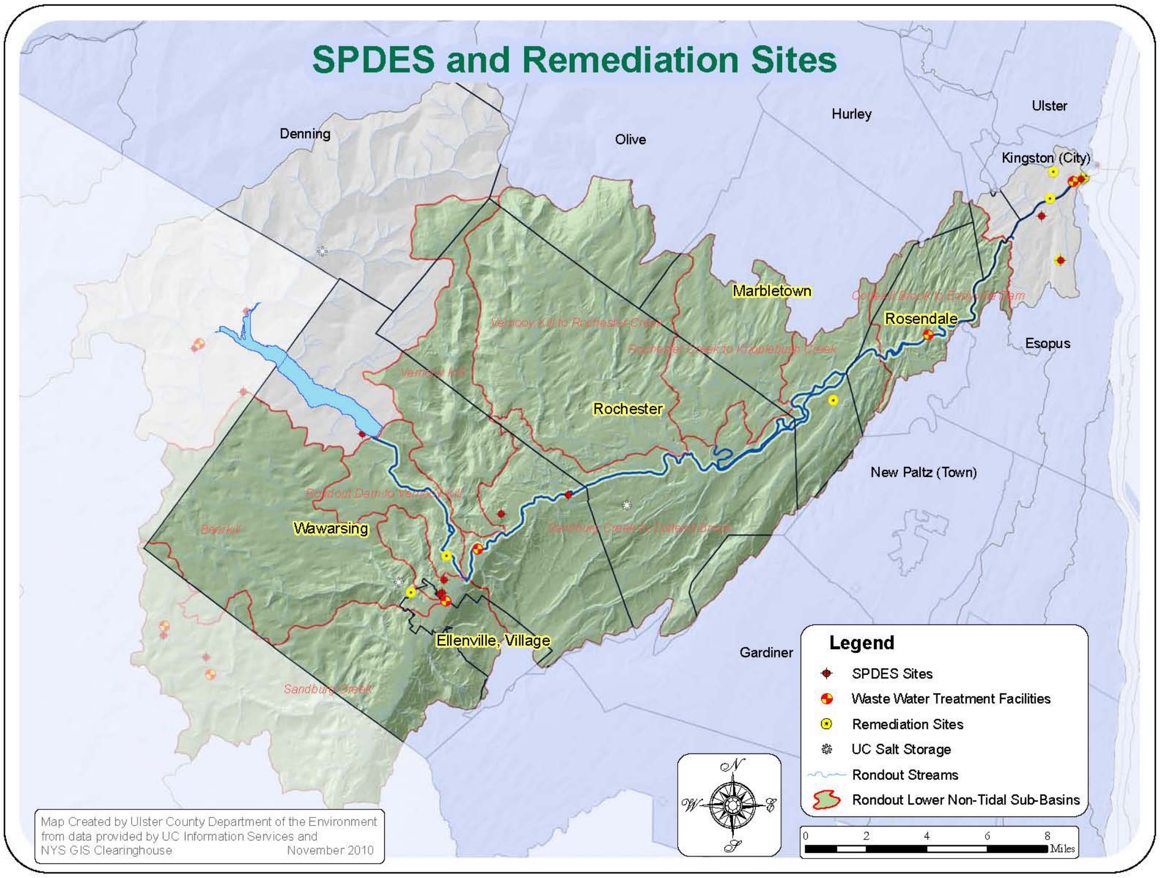
While none of the WWTPs in Wawarsing appeared to have a significantly negative influence on the Rondout Creek based on the 2007 study, they may be prolonging the river's recovery. It would be important to monitor the operations of these SPDES discharges for violations and continue to conduct water quality assessments upstream and downstream of their locations. Regarding the Rosendale WWTP, it would be helpful to consult with NYSDEC Biomonitoring Unit about the habitat quality in the site to help judge if it may have influenced the "slightly-impacted" water quality result.

There are currently no active landfills in the lower non-tidal Rondout, however closed landfills do exist (Table XX) in each of the towns and could act as a potential source of point source pollution.[11]

Town	Active dates	Closure dates
Wawarsing	1975-1993	1997
Marbletown	1977-1982	NA
Rochester	1973-1993	1996
Rosendale	1978-1993	1998

Add other info on Point Source Pollution: Landfills, other SPDES sites. Refer to SPDES Appendix.

[11] Laibach, Terry; Ulster County Solid Waste Management, email communication November 2010



<u>Further Studies</u>

In addition to conducting water quality assessments up and downstream of SPDES discharges, it would be helpful to assess water quality upstream and downstream of any significant stormwater discharges that are detected, or of stormwater runoff control measures that are implemented. This will help determine whether water quality impacts are coming from point sources or non-point sources of pollution.

The ISD indicated nutrients as the most common source of impact in the watershed. Nutrients are likely coming from many non-point sources in the watershed, so reducing stormwater runoff could reduce this source of pollution. In addition, "Well-treated sewage effluent" is another possible source of excess nutrients. WWTPs are usually required to remove organic and toxic materials from their effluent, but often not required to remove nutrients such as phosphorus. More research on this potential source of nutrients from WWTPs would be helpful.

Excess nutrient loading into a river can lead to eutrophication – a situation that can cause oxygen levels to drop below what is needed to sustain a healthy aquatic community. "Cultural" (human caused) eutrophication of surface waters has become a major source of water quality impairment throughout the US. In response, the United States Environmental Protection Agency (USEPA) has devised a national strategy for the development of regional nutrient criteria. New York State has an effort underway to revise its narrative nutrient standard.

The NYSDEC has recently developed a method of measuring stream nutrient enrichment using BMIs called the "Nutrient Biotic Index" (NBI).[12] The level of eutrophication in a stream can be calculated based on the tolerance of the various BMI taxa to phosphorus and nitrogen. For further exploration on the impact of nutrients in the Rondout Creek Watershed, the data discussed in this section could be analyzed using this methodology.

It would also be important to conduct an assessment of coliform bacteria on the Rondout. Each community along the river could provide input on what areas are used for swimming, and a study could be designed accordingly, using NYS Department of Health standards for coliform bacteria at bathing beaches. This assessment would be especially useful in the High Falls area, where swimming is popular and no water quality assessment has ever been conducted.

Another recommended area of further study is the Sandburg Creek and the Rondout in Wawarsing. A study that included assessments of the Lackawack, Honors Haven, Canal Street, Ellenville WWTP, Eastern Correctional, and Port Ben Road sites, plus an additional site on the Rondout upstream of Sandburg Creek but downstream of the Hamlet of Napanoch, would help determine the following:

- The level of impact in the Sandburg Creek
- Where the impact may be coming from (Honors Haven golf course, Village of Ellenville urban runoff, or Ellenville WWTP).
- The level of impact in the Rondout Creek in Napanoch and East Wawarsing.
- Where the impact may be coming from (Sandburg Creek, Napanoch area urban runoff, or the Napanoch WWTP).

There are numerous factors that affect the health of a river. With continued water quality assessment, and reduction of the human impacts found, the relatively good health of the Rondout can be protected, and even improved.

Section 4. 2 Managing Water Resources: Stormwater and Wastewater

Management of water in communities and on the landscape is an age-old issue. Drainage practices for rainwater and melting snow have evolved for thousands of years. In earlier times, before most communities had sewer systems for wastewater, water draining from streets in cities and other communities would also carry human waste, animal manure and garbage. Over time, sewer systems were developed to carry water away from populated centers, and early systems did not provide any treatment so raw sewage was discharged to water bodies. Treatment standards for wastewater (water carrying human waste and other concentrated waste sources from industry) have gradually become tighter over time as impacts on waterways increase and

[12] Smith, A.J., et. al., 2009. Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State, p. 53. NYSDEC, Albany, NY.

become more apparent. Meanwhile, the water quality impacts of rain and melting snow flowing into local waterways, which is now called stormwater runoff, did not get as much attention for many years. After the Federal Clean Water Act was enacted in 1972, large amounts of Federal funding were allocated for building and upgrading wastewater treatment plants and collection sewers. But it was not until 1990 that Phase 1 of the Federal regulations was enacted to address stormwater discharges from larger communities. Regulations addressing discharges from smaller communities and from construction sites were first enacted by NY State in 2003 (Phase 2). Since then, stormwater programs have evolved, and newer ideas about using green infrastructure for both stormwater and wastewater management have begun receiving more attention. This section provides background information on these programs and trends and discusses some important next steps for advancing these strategies in the Rondout watershed and surrounding region.

The NYS DEC stormwater programs require all construction sites that meet certain thresholds to obtain a stormwater permit. For smaller sites, this permit requires an erosion and sediment control plan implemented during construction, with site practices that are temporary until the construction is completed. For larger sites, permanent stormwater management practices that follow state guidelines must be designed and installed during construction, and then maintained after that. In addition, the Phase 2 program enacted in 2003 applies to certain municipalities known as MS4s, which stands for municipal separate storm sewer systems (i.e., M and four S's.) MS4 municipalities are designated based on a formula that factors in total population and population density in specific census blocks, and are the same geographic areas that are defined as "urbanized areas" by the US Census. MS4 municipalities are required to implement a local stormwater program that includes six components, which are called "minimum measures." The six minimum measures are described, along with other details on these issues, in Section 4.1.

In addition to local governments that are subject to the MS4 requirements (towns, villages and cities, which are known as traditional MS4s with land use control), other entities are also regulated as MS4s. Counties are termed traditional non-land use control MS4s and must do certain things that are also required of the local MS4s. Non-traditional MS4s are public organizations that have physical facilities located within MS4 designated areas, which are regulated if they exceed certain thresholds regarding the type of facilities they have and how many people work or live on their property (they include state and federal prisons, office complexes, hospitals; state transportation agencies; university campuses, public housing authorities, and schools). Finally, there's an MS4 designation for industrial facilities, and if they meet regulatory thresholds they must comply with New York State's Multi-Sector General Permit (MSGP) for Stormwater Discharges Associated with Industrial Activities [1]. .

The Importance of Impervious Surface

The Phase 2 stormwater program requirements for construction sites originally focused on temporary erosion control measures for most sites, and for larger projects, permanent stormwater management practices that mostly utilized conventional designs (i.e., without much focus on green infrastructure.) More recently, in 2010, NYS DEC released updated permit requirements and design guidelines for stormwater planning and practices in new development. The state's

[1] http://www.dec.ny.gov/docs/water_pdf/gp0601.pdf

program now includes a greater emphasis on minimizing the impacts of hydrologic changes caused by development. With the goal of preserving the natural functions of watersheds that help to keep water clean, support healthy ecological systems, and keep streams and riparian systems relatively stable. This newer green infrastructure approach to stormwater permitting and the design of stormwater plans and practices comes out of on an understanding of the impacts of impervious surfaces.

As land use changes in a watershed from undeveloped to developed, the impact of stormwater on water resources also changes. Land that is largely undeveloped, with no roads, parking or buildings, generally produces very little surface runoff. Forests, grasslands and other natural upland areas have a great capacity to absorb precipitation as it falls, or snow as it melts. Much of this water percolates down through the soil and recharges groundwater, and some of this groundwater flows underground and eventually re-emerges as surface water at lower points in the landscape, very often in streams. This flow of groundwater to streams, known as base flow, provides a large proportion of the total flow in smaller streams, especially in the summer and other dry periods when there's little rainfall.– However, it can take weeks or months for water to percolate through the ground before it reaches a stream.

Compare this scenario to what happens to precipitation in a highly-developed landscape. Roads, parking and other impervious surfaces typically prevent water from reaching the underlying soils, thus blocking the recharge of groundwater. Most water that reaches impervious surfaces simply flows downhill over the surface, relatively rapidly, until it reaches a stormwater collection system, stream, or other waterbody.

Another factor that affects how water moves through the watershed is trees and other vegetationTrees intercept rainfall by temporarily storing water on their leaves and bark. This water eventually drips to ground or evaporates into the atmosphere. . Trees and plants also pull water up through their roots and use it for their growth, and in the process water is released from the leaves as water vapor, a process called transpiration. The combination of plant transpiration and the evaporation of water from soil surfaces is called evapotranspiration. Evapotranspiration and rainfall interception in an vegetated landscape, has a major influence on the storage and movement of water through a watershed,
Figure 4.2.1 depicts these concepts, including the fact that surface runoff is higher and base flow is lower in a more highly developed landscape.

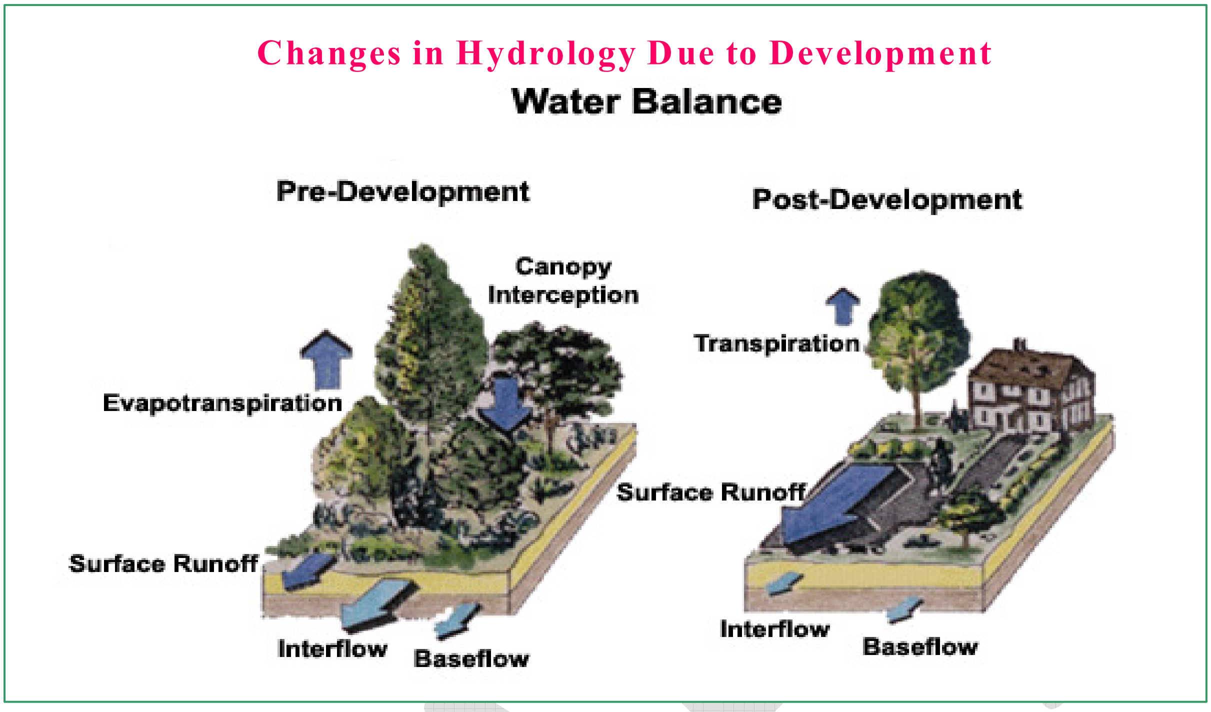
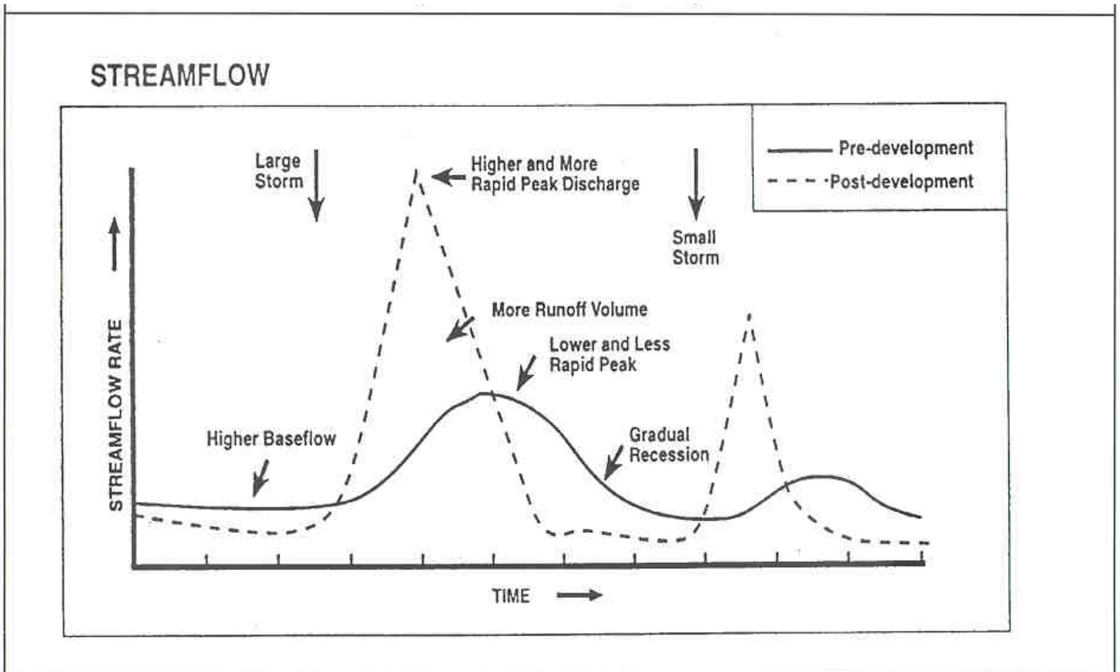


Figure 4.2.1: This diagram illustrates the increase in runoff and decrease in groundwater recharge (interflow and baseflow) that results from increased impervious surface.

As watersheds become more developed and impervious surfaces increase, major impacts occur to the hydrology of streams and other waterbodies, and on water quality itself. In a very lightly developed watershed, where the total impervious cover is well under 10%, there is little surface runoff and healthty groundwater recharge provides a relatively steady flow of water in streams. In more heavily developed watersheds, as the percentage of impervious cover rises above 10% and reaches 20% or higher, there is an increase in surface runoff and a decrease in infiltration resulting in less groundwater recharge. The increase in volume of water reaching the stream channel causes stream flow to rise rapidly during storms, which often causes new erosion or flooding problems and can exacerbate existing problems. *(Add here – any examples in Rondout basin? Add qualifier, i.e. we don't know whether it has happened here?)*

Figure XX illustrates some of these concepts by comparing two different stream flow patterns. The pre-development scenario (solid line in this graph) shows that stream flow rises relatively slowly after a storm begins, and then gradually recedes after the storm. The post-development scenario (dashed line on the graph) represents a more highly developed watershed.), The rapid flow of surface runoff to the stream causes a sudden spike in stream flow, followed by a rapid decline. Also, stream flow is lower during dry periods between storms in the post-development scenario, due to reduced base flow from groundwater.

Figure XX. Change in Hydrograph following development (Schueler, 1987).



The impervious surfaces and conveyance systems of developed sites result in an earlier and higher peak discharge rate.

Another key impact of impervious surfaces is also related to the fact that they seal off the natural infiltration process in which water percolates down through the soil and groundwater. As water seeps through the soil layer in a relatively intact, vegetated landscape, it comes into contact with the soil, the roots of trees and plants, and the diverse ecosystem of microbes and other life forms that live underground. These natural ecosystems provide tremendous filtering and uptake capacity for removing nutrients and other pollutants from water. Stormwater management systems of various kinds are intended to utilize some of these soil-based processes, as well as processes that occur in surface water bodies such as wetlands, ponds and streams. Green infrastructure, also known as low impact development, is a term describing practices and design concepts for stormwater and wastewater management that emphasizes replicating the processes that are at work in a healthy watershed. These practices purify water and return it to the local ecosystem while helping to maintain groundwater recharge and streamflow as much as possible.

The impact of impervious surfaces, and limiting the percentage of impervious cover in a watershed, is a key aspect of watershed planning, protection and restoration. Along with the effects of non-point source pollutants and point source pollutants on water quality per se, these hydrologic changes from development of the landscape are some of the most fundamental issues and challenges we face. As our understanding of the importance of these issues has grown over the past 10-20 years, watershed planning and restoration methods have emerged to try and limit these changes as new development takes place, and attempt to mitigate some of the impacts to water quality in areas that are already more urbanized.

Green Infrastructure for Stormwater Management

In the environmental planning, design and regulatory sectors, there is a growing focus on the concept of green infrastructure for managing water resources. Green infrastructure, in this context, refers broadly to a set of design principles and specific practices for using the inherent qualities and functions of soils, vegetation, and other components of natural ecosystems to provide a sustainable approach for managing water. US EPA, NYS DEC, and many other agencies and organizations have adopted policies and specific programs that clearly support the benefits and advantages of green infrastructure. The use of these practices are being encouraged over conventional gray infrastructure systems where stormwater treatment practices are usually added at the end of the pipe, to meet basic regulatory requirements. There are significant challenges, however, to fully implementing this approach. These challenges are discussed below in the Green Infrastructure for Wastewater Management section, because the most fundamental issues are common to both sectors.

Applying green infrastructure principles, in the broadest sense, should begin with a regional- and community-scale evaluation of streams and their associated floodplains as well as adjacent wetlands and ponds. The community's master plans should emphasize that preserving these riparian areas as largely or completely undeveloped is the most sustainable way of managing and protecting water resources and should focus new development in other areas. Protecting or restoring streambanks and stream channels, floodplains, wetlands, as well as forests and other uplands, preserves the natural functions of the landscape in areas that are planned to remain largely undeveloped or lightly developed, thus helping to maintain a healthy watershed.

At a site-specific scale, green infrastructure generally means stormwater management practices that are designed to replicate the natural functions and processes that occur in undeveloped landscapes as water is absorbed by the soil and percolates down to groundwater. Green infrastructure, therefore, places a great emphasis on the value of infiltrating water into the ground, instead of sending it over the surface or in underground pipes directly to a stream. Green infrastructure also includes a major focus on using trees and other plants, as part of engineered ecological systems to manage water, utilizing the nutrient uptake,evapotranspiration, and soil filtration functions of vegetated systems to more closely mimic natural watersheds. Some of the key physical, chemical and biological processes that are involved in the function and performance of green infrastructure practices include:

- settling of silt and sediment in ponds and wetlands;
- filtration and removal of solids as water travels through soils or other media;
- adsorption of certain nutrients and other substances to the surface of soil particles (this is one important mechanism for phosphorus removal, and for some other nonpoint pollutants);
- uptake of phosphorus and nitrogen compounds by vegetation as they grow (these materials act as fertilizers);
- evapotranspiration mechanisms (described above); and
- a number of biological and chemical processes involving microbes in the soil and groundwater that break down certain nutrients and other substances.

Site-scale GI practices include:

- **Bioretention areas (including rain gardens):** , designed to collect and infiltrate much or all of the water flowing into them..
- **Vegetated swales and vegetated filter strips**: designed to convey water, allowing it to flow overland to lower areas while providing some water quality treatment and infiltration along the way.
- **Planting and maintaining trees**: including trees planted in tree pits designed to provide enough available soil volume for trees to be healthy, especially along urban streets and sidewalks where trees typically don't have enough room to grow without damaging sidewalks or other hard infrastructure.
- **Pervious pavement, (includingpaving bricks, and porous asphalt and concrete:**) allows runoff to infiltrate into the ground.
- **Green roofs and green walls**: vegetated systems that are designed to be integrated with buildings or other structures and can provide energy efficiency benefits in addition to managing stormwater runoff.
- **Rain barrels or cisterns**: capture water for storage and reuse

See Appendix L for more information about specific GI practices and related technical guidance.

Green infrastructure in the Hudson River estuary region

For several years, the NYS DEC Hudson River Estuary Program has provided education and technical assistance to encourage the use of low impact development (LID), which is in many ways the same as green infrastructure. Another term used for the same general set of ideas is Better Site Design. The Estuary Program has provided grants to support review of local codes to identify areas where existing codes make LID and GI challenging for developers and to recommend code revisions. The program has also supported implementation of a number of demonstration projects. More recently, the Hudson Valley Regional Council has partnered with Hudson River Sloop Clearwater and the Hudson River Watershed Alliance to initiate a regional green infrastructure planning program with Federal funding administered by the NYS DEC (see http://hudsonvalleyregionalcouncil.com/ for more information.) The Estuary Program has a number of GI demonstration projects in the Hudson Valley listed at this web page http://www.dec.ny.gov/lands/58930.html and more are being planned and implemented across the region.

ADD HERE: *In the lower non-tidal Rondout watershed, green infrastructure concepts and practices are being implemented (local examples, etc.)…*

I think the following section is too editorial for a management plan. Maybe focus on specific challenges in the municipalities – do the municipalities code's support GI?

Green Infrastructure for Wastewater Management *(This section needs to specifically mention where there are centralized systems in the 4 lower non-tidal towns and needs to be cross-referenced to Martha's section on water quality). (Add beautiful graphics)*

While using green infrastructure for stormwater management has gained relatively broad acceptance among regulatory agencies and other stakeholders, the same cannot be said for wastewater systems. There is growing support and interest for using certain green infrastructure practices, such as contructed wetlands among regulators and design professionals,. A broader, more comprehensive implementation of GI principles for wastewater planning and management, however, raises questions and challenges that remain daunting.

A green infrastructure approach for wastewater utilizes many of the same principles and strategies that underlie a GI strategy for stormwater:

- Manage water onsite or close to the source,
- Minimize the use of gray infrastructure to move water longer distances,
- Use the natural capacity of soils and vegetation to filter and treat water,
- Place a very high priority on dispersing water into soils instead of directly discharging it to a stream or river, and
- Ensure the water recharges groundwater to maintain pre-development hydrology and base flow to streams as much as possible.

If this framework is followed, the resulting treatment infrastructure can protect water quality, maintain groundwater recharge, and provide a relatively energy efficient, sustainable approach for managing wastewater. The existing approach for managing wastewater, by contrast, tends to favor larger, centralized sewer systems that convey wastewater to larger treatment plants serving entire communities, or even regional-scale systems serving a number of municipalities. Regulatory agencies are traditionally much more comfortable with this centralized approach, because it is simpler to maintain regulatory oversight and enforcement on a single discharge point for treated water, rather than monitoring dozens or even hundreds of smaller discharges distributed throughout the community. Yet this distributed (or decentralized) paradigm is basically inherent in a green infrastructure approach to stormwater, and to wastewater.

It is possible to use some elements of green infrastructure concepts and principles even in a larger, more centralized wastewater system. The treatment plant itself, for example, could use reed beds or constructed wetlands for treatment, and the dispersal of treated effluent can be done using land application, such as spray irrigation or drip irrigation systems, to discharge water to soil-based systems that include vegetation. . Yet many of the benefits of more complete implementation of a green infrastructure approach to wastewater management are not available using this centralized model. The capital costs and other impacts, including energy and chemical usage, of building and maintaining larger networks of sewers in a centralized collection system are high. The cost of the pipe network can be 60% or more of the total system cost. At a time when financial resources for maintaining or restoring infrastructure are very tight, these issues should warrant a serious re-consideration of assumptions that underlie the centralized wastewater management paradigm, which dates from the 19th century or earlier and has basically not been revised in over 100 years.

There are other major impacts of centralized wastewater systems, which tend to go unrecognized. Larger sewer systems, especially as they get older, tend to allow a lot of groundwater and surface runoff to enter the system during wet weather through cracks, joints, manholes, etc., a problem known as infiltration and inflow. Less well known is the tendency for these failures to allow raw sewage to leak out into groundwater. Installation of larger sewer lines also changes the watershed's hydrology in several ways, including moving wastewater longer distances, and also creating preferential flow paths for groundwater along sewer lines and other underground utility corridors that can lower the local water table and drain smaller wetlands and streams. Larger systems may also facilitate land use and development patterns that contradict local or regional planning goals, in part by encouraging sprawl.

In sum, the conventional approach to wastewater planning and infrastructure development that has been followed by most communities in our region for decades, has many substantive problems and adverse impacts, which are not widely discussed. The strong and widespread support for a green infrastructure strategy for stormwater that has emerged in recent years provides a new opportunity for dialogue about the same basic set of ideas and goals as they apply to wastewater management.

<u>Meeting the Challenge of State and Local Policies for Green Infrastructure</u>

There are significant challenges to implementing green infrastructure for stormwater and for wastewater. While the new NYS DEC stormwater regulations and design guidance prioritize green infrastructure for new development, DEC has reservations about how effective green infrastructure for stormwater management may be in addressing long-term control plans to meet regulatory goals of combined sewer overflow (CSO) in many area cities. The central challenge seems to be establishing a framework that provides adequate assurance for effective maintenance and quality control for hundreds of smaller, local (decentralized) stormwater practices. The same challenge exists for wastewater planning for unsewered areas, and is also relevant for wastewater infrastructure upgrades in existing sewer systems. Unless state agencies and local government can collaborate to find solutions for this challenge, the full potential of green infrastructure as a more cost-effective, sustainable and beneficial approach for environmental restoration and economic revitalization will not be realized.

There have been some recent policy developments in NY State that are directly relevant to these issues. The NYS Environmental Facilities Corporation (the agency that administers funding for municipal water and sewer infrastructure), NYS Energy Research and Development Authority (NYSERDA), NYS DEC, and the NYS Department of Health co-authored an infrastructure planning and policy memo in 2008, Promoting Smart Growth and Energy Efficiency through the State Revolving Funds[2]), and a related document, New York Clean Water State Revolving Fund Sustainability Initiative Advisory Group Recommendations, June 2010[3]**.** These policies go a long way towards incorporating many of the green infrastructure principles and goals described above, including the linkages to land use planning and avoiding sprawl, and energy efficiency benefits. While the value of decentralized approaches is noted in them, they do not include any focus on the benefits of returning water to local ecosystems for groundwater recharge, avoiding larger pipe networks and their attendant adverse impacts, or the importance of using soils and vegetation as energy efficient, sustainable components of the water treatment process. Further development of these state policies to recognize and include these hydrologic

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[2] www.nysefc.org/docs/smart_growth_draft_final__12-01-08.pdf
[3] www.nysefc.org/docs/srf_sustainability_initiative_june_15_2010_final.pdf

and water quality benefits of green infrastructure for wastewater management is a key next step that can be supported by watershed management programs such as those for the Rondout.

Even more recently, a new state law was enacted in NY, the Smart Growth Public Infrastructure Policy Act[4], which supports some of the same principles and goals. This law requires state agencies to develop policies to integrate land use, environmental, economic, and historic preservation, into funding decisions regarding infrastructure investments.

Integrated Water Management

Integrated water management is an emerging concept that recognizes that decision-making about water infrastructure and water resources planning has traditionally been done in a compartmentalized way. Drinking water supply, stormwater management, and wastewater management have almost always been done separately. As research and experience in the field increases, more sophisticated watershed planning and management perspectives have taken hold. It is becoming clear that a compartmentalized approach is not adequate to implement a sustainable, long-term planning framework for water resources. Managing these sectors separately has major limitations for achieving water resources goals, such as water quality protection and restoration, maintaining adequate quantities of water for human and ecosystem needs, and limiting flooding, erosion and other adverse impacts. In addition, there are significant linkages between water infrastructure and other issues, including energy use and efficiency potentials, energy production, economic development and revitalization, meeting other infrastructure needs (e.g., transportation, solid waste management, food production, etc.), habitat protection and restoration, and recreation. Work is currently taking place to identify opportunities for greater energy efficiency and cost savings and exploring the possibility of creating revenue streams by producing energy from wastewater or solid waste, recapturing nutrients from wastewater, or producing hydropower in municipal drinking water systems where water is flowing downhill and generators can be installed in the system. These ideas have important potential for leveraging available resources to invest in better watershed protection strategies. Another term being used to describe integrated water management is sustainable water infrastructure, and, where other infrastructure components, such as solid waste and energy production potentials are included, integrated resource management. *(ADD HERE – web links for more information)*

[4] www.assembly.state.ny.us/leg/?default_fld=&bn=A08011%09%09&Summary=Y&Text=Y