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Introduction

This study will investigate the development of landscape settings designed to improve environmental quality within the Sparkill Creek Watershed in Rockland County, New York. The focus will be on the creation of large and small-scale water quality improvement interventions in the Sparkill Gap section of the Watershed. A preliminary master plan will be prepared which proposes watershed and stormwater management interventions for a selected site. This site will both, improve water quality in the Sparkill Gap, and serve as demonstrations for application elsewhere within the watershed. In doing this, local citizens will have the opportunity to increase their awareness and understanding of natural processes and proper management of the Sparkill water resources.

Background

Sparkill Creek

The main stem of the Sparkill Creek begins on the western slope of Clausland Mountain, Rockland County, New York, dropping over 300 feet, to the Orangetown lowlands. The Sparkill criss-crosses New York State route 303 southward through Orangetown, New York where urban land-use increases. Past the Town and County sewage treatment plants, the Sparkill enters Tappan, New York and then crosses the New York - New Jersey State line into Northvale, New Jersey, where it hair-pins through strip malls, gas stations, grocery stores, a car wash, fast food and light industry. Back into New York, the Sparkill continues its path to the Hudson, traveling through Palisades, Sparkill and Piermont. In Piermont the freshwater Sparkill interfaces the tidal and estuarine portion and flows into the Piermont Marsh. The marsh is designated, a Significant Coastal Fish and Wildlife Habitat by New York State Department of Environmental Conservation (NYSDEC) and a National Estuarine Research Reserve by the United States Division of Fish and Wildlife. The creek flows for a distance of approximately seven miles and its watershed area is approximately 11 square miles.

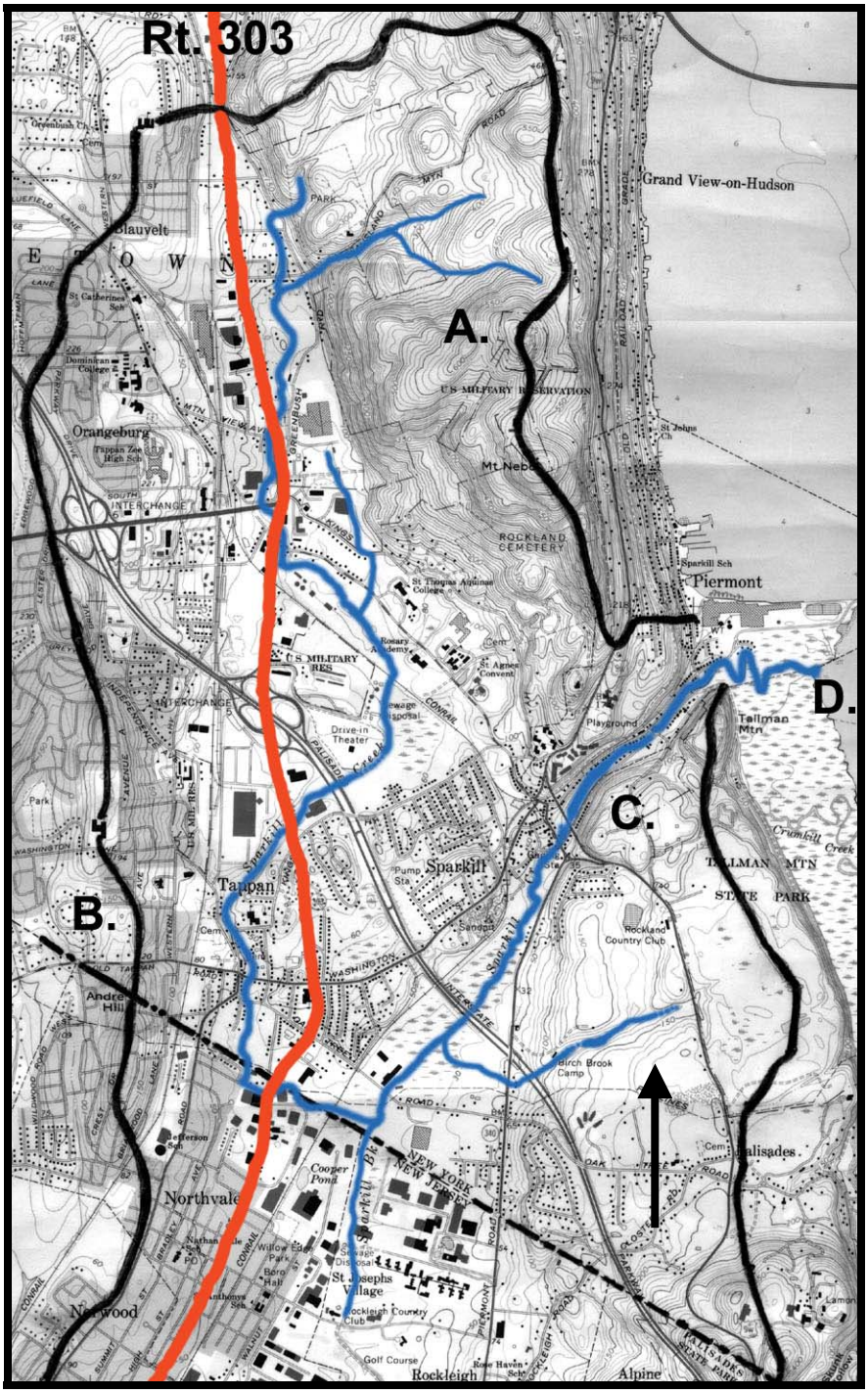

Figure 1: Study Area Context Map. Watershed boundary (black), Route 303 (red), Sparkill (blue). Other key features. A. Clausland Mountain. B. NY-NJ state border. C. Sparkill = Gap Study Area. D. Piermont Marsh. USGS Quadrangle, Nyack, New York, scale is equal to 1" = 4000'.

Sparkill Gap Study Area

The study area is located along the Sparkill Creek between the political borders of Sparkill, New York and Piermont, New York. This section is referred to as The Sparkill Gap. It's a pronounced east-west valley, breaking perpendicularly through the north-south Palisades ridge. Greater than 90% of the watershed's drainage exists upstream from this location. The western boundary of the study area is Valentine Avenue at the Skating Pond and the eastern boundary is the end of Ferdon Mill Pond at the Rockland Road crossing. The northern boundary is South Piermont Road, and the southern boundary is Ferdon Avenue.

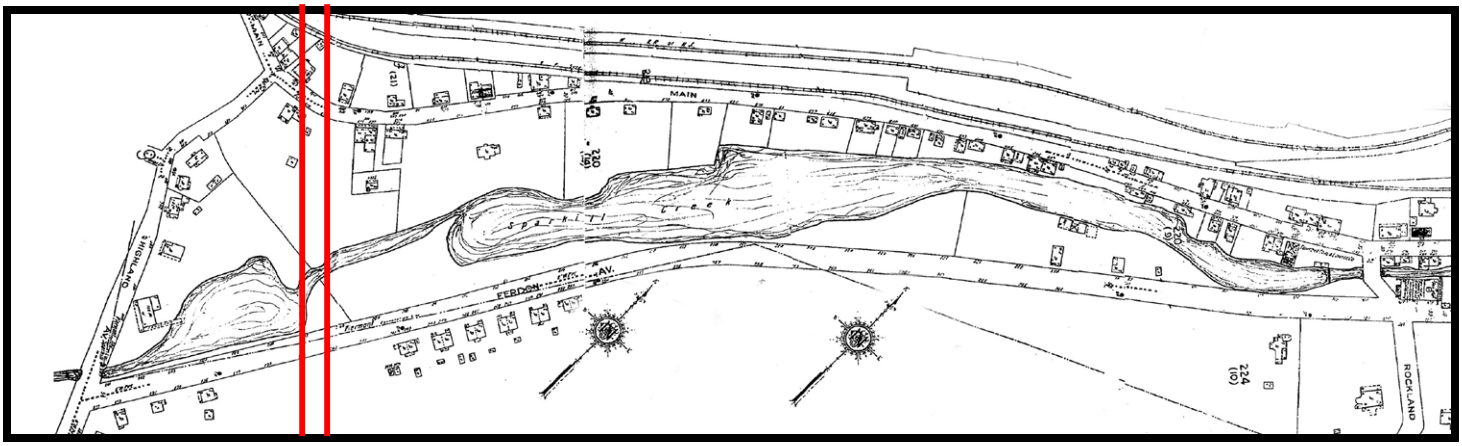

Figure 2: Sparkill Gap Study Area. The Sanborn Map Company originally produced this map in 1927 (Cooke and Lawson, 2003). Since its production property lines have remained similar, however, the area has gained a steel viaduct crossing for Rt. 9W, depicted by the red lines.

Beginning from the western boundary, the creek flows west to east across the site. The Sparkill enters the site as straight channel flow, as a result of being constrained by a 2.5-foot high wall that forces the stream into a tight channel along the edge of Moore's Pond, which is considerably silted and of poor ecological integrity. This land is owned by United Water Incorporated, but leased by the Town of Orangetown for recreation, primarily skating in winter. The lot has a "refreshment shack" at the corner of Ferdon and Valentine Avenues (at the location of previous ice house) that is utilized as a hot chocolate stand for skaters. The skating site has a service road on the north side of the pond that links Valentine Avenue to the United Water well-pump house. At the eastern end of the pond the ownership transfers to the New

York State Department of Transportation (NYSDOT), as their maintenance right-of-way for the NYS Route 9W viaduct. The first concrete dam is situated just below the viaduct crossing.

Figure 3: The Skating Pond Area (Moore's Mill Pond). A. Looking eastward down Ferdon Avenue, original mill location, shown as converted icehouse (Photo courtesy of George Lynch). B. A prime skating location, route 9W viaduct in background (Photo courtesy of Orangetown Historical Society, 2003). C. Replacement icehouse on western side of pond. (Photo courtesy of Orangetown Historical Society, 2003). D. Existing conditions December 2003 (Personal photo collection).

The creek continues downstream into the Brookside Wildlife Sanctuary section of the Gap. This isolated wetland habitat is a natural haven for wildlife, with combinations of lotic and lentic conditions and well established riparian buffers. One-quarter mile east of the 9W viaduct, the creek transitions out of the Sanctuary and into a wide and shallow flow. This section is known as Ferdon Mill Pond. Residential lots line the northern and southeast side. At the eastern end of the site, a second dam retains the water of this pond. More significant than the first, this dam is regularly used in flood management. This area is inundated with sediment, has been braiding and island building since Hurricane Floyd (which exceed the 100 year flood with over 12” inches of rainfall in 24 hours) in 1999.

Figure 4: Brookside Wildlife Sanctuary and Ferdon Mill Pond. A. Just below the skating pond, dam and viaduct, the Sparkill flows east into the Sanctuary. B. Absorbed and obscured by the nature of the site, this sign is hidden from typical views. C. Upstream sediment has filled Ferdon Mill Pond forming flats and small islands, minimizing storage potential. D. Elevated water levels in Ferdon Mill Pond section.

Site Geology

Analysis of the Gap and surrounding topography suggests that until million to fifteen million years ago the Hudson may have followed a course different from its present route (Stanne, Panetta, Forist, 1996). The Hudson is believed to have crossed through the Palisades at the Sparkill Gap. The palisades are 225 million year old diabase that formed where Africa and North America split. The gap formed as a fault in the diabase, which eroded easily, allowing the Hudson to flow southwest across the Watchungs Mountains, connecting to the Hackensack- Meadowlands complex and the Atlantic Ocean (Stanne, Panetta et al. 1996).

Site History: Greater than 300 years ago

Native Americans lived throughout the Sparkill watershed. The Sparkill creek system provided tremendous natural resources. Transportation, food, and the people were intricately interwoven with their waterways and wetlands. Their communities consisted of wigwams clusters and large tracts of farming in close proximity to the waterways. The Tappan's were the local tribe. It is said that the name Tappan comes from, *tephanne*, the word for cold stream (Hudson River Defense League, HRDL 1993). Their spring and summer diets were taken from the local waters, which provided shad, striped bass, sturgeon, eels, alewives, smelt, bass, perch and oysters (*Piermont*, 1996). Historically, the creek was navigable for about a mile inland. Tradition says that the Sparkill Gap may have been where Henry Hudson first stepped ashore in 1609, possibility meeting with the tribes or in search of sweetwater (*Piermont*, 1996 & HRDL, 1993).

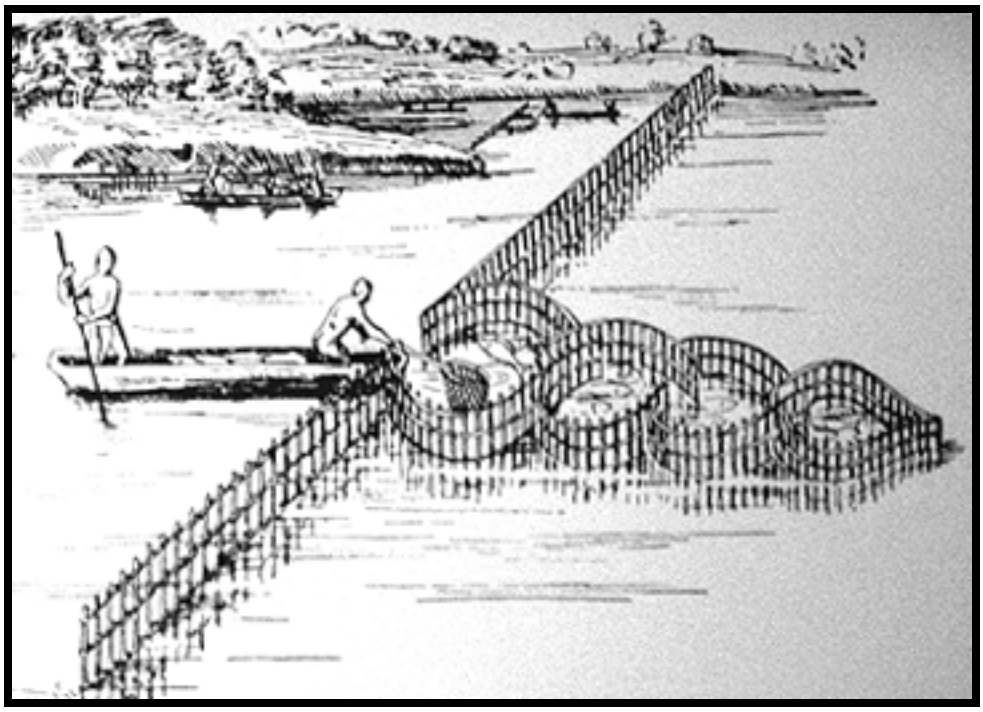

Figure 5: Fish Trap or weir, engraved by Theodore DeBry after a drawing by John White in 1590. (Courtesy of the Orangetown Historical Society, Sparkill Exhibit, 2003).

The Tappan's became more displaced as European encroachment increased. In 1684, 15 families formed the Tappan Patent (*Piermont*, 1996). They found the marsh alive with ducks, geese, swans, and shore birds. They described the deer, as fat as any Holland cow, with

oysters lining the banks, and ten species of fish in the bay (*Piermont*, 1996). So extensive was the game, including wolves, bears, mountain lions, and elk that it was difficult to image a time they would disappear (*Piermont*, 1996). The natural wealth of the region provided the population excesses. They found success in the trade of crops and furs.

The landing where the Sparkill meets the Hudson was a natural point of entry westward into the hinterland. The transportation of goods, people, news and services became dependent on Dutch boats, called Sloops that ran into the Hudson's shallow tributaries. These shallow draft vessels reach inland to the farms of the Sparkill watershed. The vast natural resources, combined with access to transportation via the waterways, served to supply the markets of New York City with produce and goods. For a century, the Sparkill Gap was centered on family, farm, community, church, (HRDL, 1993). Because of the increasing economic traffic through the Gap, it was only natural to create a commercial center at its mouth. The landing had gristmills, warehouses, stores, and the first dam to be built along the creek.

Site History: The Revolutionary Years

Self-reliant farmers along the creek gathered in a Tappan, New York, tavern on July 4, 1774 and created the Orange Town Resolutions. The resolutions called for allegiance to the cause of liberty from the oppressor, England. These resolutions predated the Declaration of Independence by two years (*Piermont*, 1996). The revolutionary war began in the summer of 1776 when a two-hour naval battle erupted just off shore of the gap, in what is now the Tappan Zee Bay (HRDL, 1993). The creek quickly became an important military position during the Revolution. The small community was divided among Loyalists and Patriots. At the head of navigation, a mile inland from the mouth of the creek, a mill became a Patriot warehouse for war material (HRDL, 1993). There were raids by British soldiers and guerilla bands of renegades. Local militiamen patrolled the shore, day and night, against enemy small craft waiting to enter the creek. Both armies often visited the town center, of what is now Piermont, and skirmishes between Colonialists and Loyalists were commonplace (HRDL, 1993). In May of 1783, the terms of British surrender were agreed upon at the De Witt House in Tappan, New York, between General Washington and Sir Guy Charlton. The following day the first official 17-

gun salute to the sovereign nation echoed from the *HMS Perseverance* anchored just off the shore of the Gap (*Piermont*, 1996).

Site History: The Railroad Years

Change was in the air at the beginning of the 19th century. Life was quiet but increasingly prosperous. Populations in the Gap significantly changed when construction of the Erie Railroad through the Sparkill Gap began in 1832 (*Piermont*, 1996). Due to its geographic location and existing interstate commerce laws, (first break in the Palisades north of New Jersey) the Sparkill Gap was an ideal choice as the site for the Erie Railroad terminus. Being a local resident, Eleazer Lord, the railroad's founder and president, approved of this location.

In April 1851, the 447-mile railroad line that started at the confluence of the Sparkill Creek and Hudson River connected small, far-flung wilderness communities (*Piermont*, 1996). Eleazer Lord, renamed this region Piermont, referring to the 4,000-foot pier the railroad company built into the Hudson River and the mountains that frame the Gap (*Piermont*, 1996). United States President Millard Fillmore, along with four cabinet members and other dignitaries, rode the inaugural Erie Line to Dunkirk, New York. The President insisted on riding in the open on a flat car, so he could have a better view of the countryside (*Piermont*, 1996). At the time, this was the longest railroad in America, and in the world. It ushered in an unprecedented level of prosperity for the Sparkill Gap region (*Piermont*, 1996).

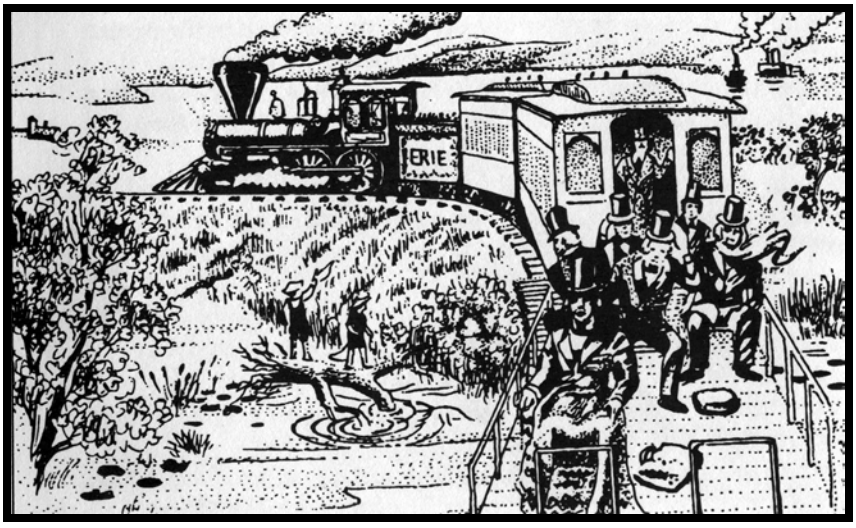

Figure 6: Drawing of the inaugural Erie Railroad going across the Sparkill on its way out of Piermont. (Image courtesy of *Piermont: Three Centuries*, via the Historical Society of Rockland County, 1996).

Site History: The Recent Years

Trains were a part of the Piermont landscape until 1966. As railroads began to exit the scene, and the age of automobiles entered. The Palisades Interstate Parkway was constructed through the watershed in the early 1900's and in the 1950's the Tappan Zee Bridge was constructed in the 1950's, connecting to the Palisades Interstate Parkway, new economic activity, opportunities and development entered the region. The self-sufficient farm clusters along the creek were long gone and the land was being fragmented into housing developments, shopping centers, parking lots, and industrial sites. The Sparkill had lost its natural flow regime. Natural springs that fed it were covered, dams were built and channels were created for flood control. These large-scale landscape changes began to dramatically affect the character and health of the creek (HRDL, 1993).

Understanding an Urbanized Watershed

Sparkill Watershed

A watershed is the area of land that contributes water to a chosen water feature such as a wetland, pond, lake, stream or river. Anything that happens in, or to, the water at any point during its flow toward the designated water feature can affect everything else further downstream. The water quality and quantity traveling through these watersheds play a critical role in a balanced environment. The water links the various landscape systems in which it flows, carrying and depositing nutrients, minerals, pollutants and sediment farther downstream. The ecological healths of water features generally depend on a high ratio of open space areas to impervious surface areas. The more urbanization or impervious surfaces a watershed has, the more polluted and impacted the receiving waters will be. Residential and commercial land-uses within the Sparkill Creek watershed have been steadily increasing with the era of the automobile this past century.

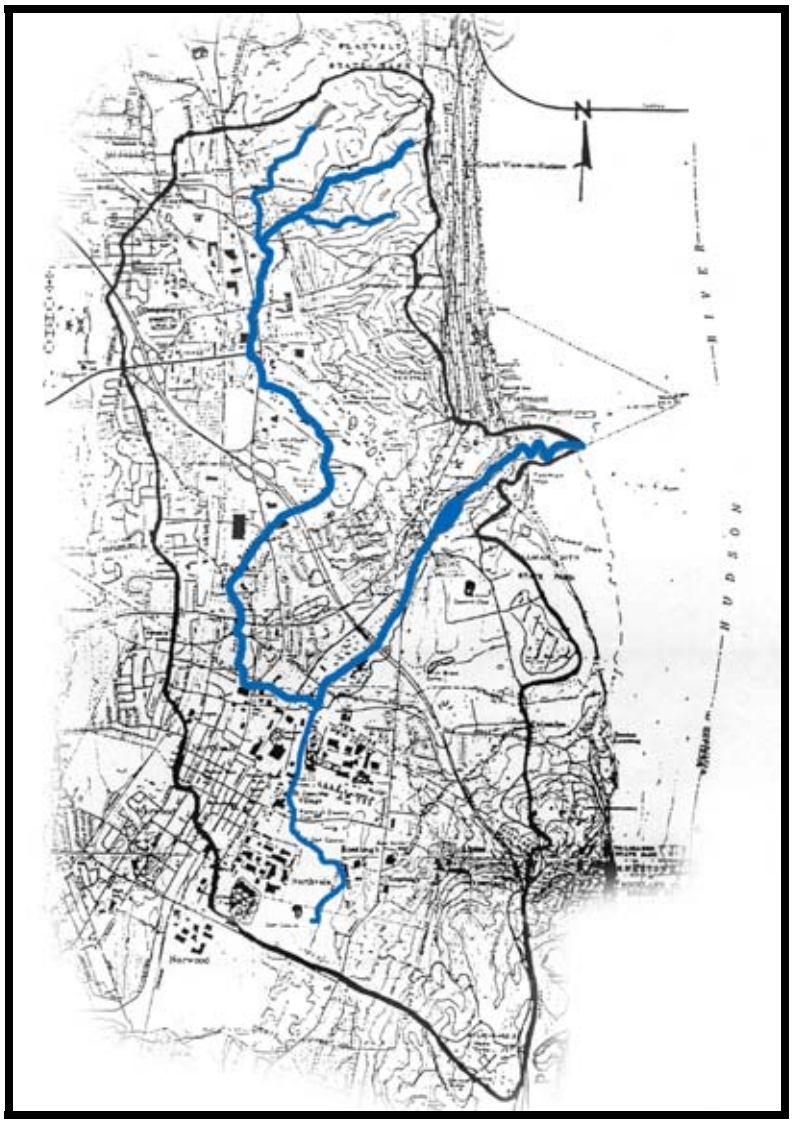

Figure 7: **Sparkill Watershed Boundary Map: Sparkill Watershed (black outline) drains approximately 11 square miles of typical suburban sprawl into the Piermont Marsh at the Hudson River (Goodkind and O'Dea, Sparkill Flood Control Analysis, 1999).**

Recent GIS analysis reveals that developments of urban landscapes have grown from 25.12% percent of the total watershed area in 1953, to 54.42% percent of the total watershed area in 1991 (Tang, 1996). Tang classifies urban landscapes as any impervious surface. With increased urbanization, Tang found declines in wetlands and forested areas. The decline in the physical habitat of the stream, coupled with lower base flows and higher stormwater pollutant loads, has severe impacts on the aquatic community (CWP, 2001). Urbanization impacts aquatic insects, fish, and amphibians, even at low percentages of impervious areas. New developments appear to cause declining richness, diversity, and abundance of aquatic life (CWP, 2001).

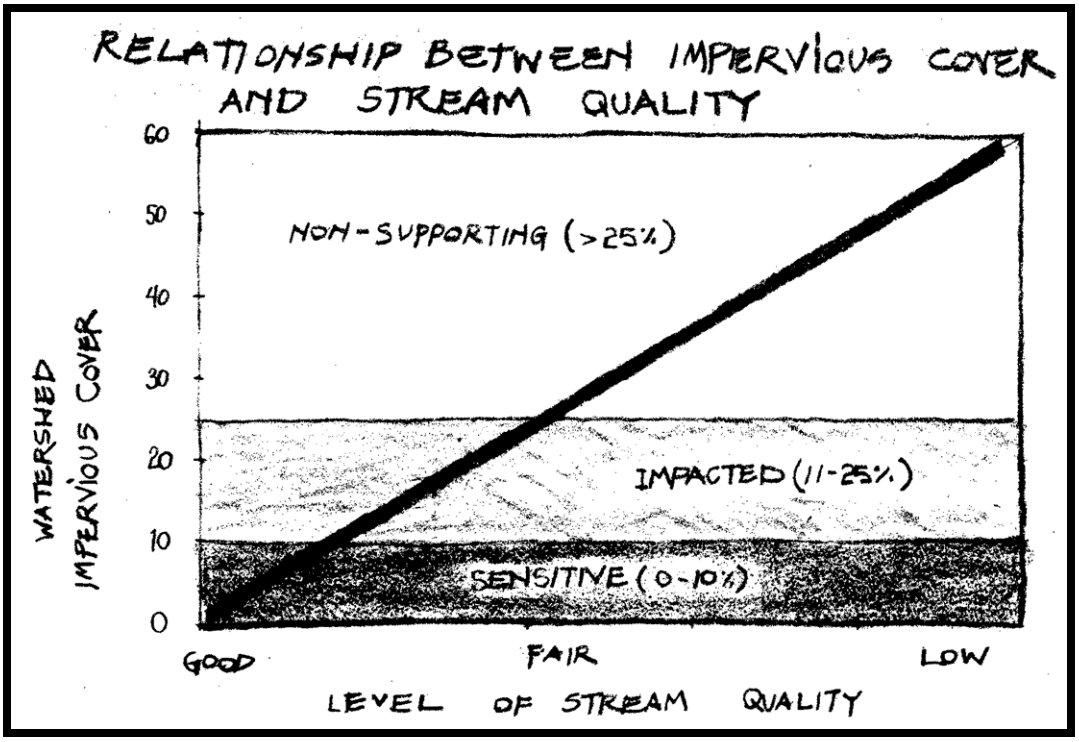

Figure 8: **This graph shows that as the percentage of impervious cover increases; stream quality decreases (Center for Watershed Protection Slide, 2003).**

Urban Stream Degradation

Urban stream systems are arguably the most extensively degraded and disturbed aquatic systems in North America (Schueler 1987). Impermeable rooftops, pavement, and non-point pollution affects the hydrology, geomorphology, water quality, and aquatic ecology of urban streams. Typical urban effects include increased overland flow and storm runoff volume, increased peak flows, decreased groundwater flow, increased suspended particulates, sedimentation of fine particles, increased channel erosion, increased input of nutrients and toxic substances (Hession, Johnson et. al. 2000). The severity of urbanization impacts on aquatic systems has created an urgency for the restoration of management of urban streams and watersheds (Hession, Johnson et.al., 2000). Therein lies the shifting point of understanding.

In order to improve environmental conditions of any body of water, one would need to understand the historical and current development patterns within its watershed. This concept is the basis for the creation of the non-profit 501(c)3 corporation, Center for Watershed Protection (CWP) in 1992. The centers mission is to "provide local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources: our streams, lakes and rivers" (http://www.cwp.org/mission.htm, 2003). The center utilizes a multi-disciplinary approach which requires citizens, and all levels of government to work together for watershed planning, watershed restoration, stormwater management, watershed research, better site design, education, outreach, and watershed training.

Stormwater Pollutants Associated with Urbanization

The connection of watersheds to stream and river health is increasingly realized as our culture continues in its current development patterns. Pollutants associated with human activity are diverse and abundant. The Center for Watershed Protection identifies the following as the typical urban and industrial stormwater pollutants: suspended solids; nutrients like nitrogen and phosphorus; metals like copper, zinc, lead, and cadmium; bacteria; pesticides and herbicides; and temperature. Conventional rooftops, roads, parking lots and other impervious surfaces no longer allow rainfall to soak into the land. Rain events of sufficient intensity and duration will create runoff conditions; thus transferring these pollutants directly from the urban environment into surface and ground water resources.

Runoff and Impervious Land Cover

The increase in the volumetric runoff coefficient (Rv) is a function of site (watersheds) imperviousness. The runoff coefficient (Rv) expresses the fraction of rainfall that is converted into stormwater runoff. The general trend shows a direct increase in percentage of runoff with increased impervious cover. For example, a one-acre parking lot on average produces 16 times more stormwater runoff than a one-acre meadow each year (Schueler, 1994). The concentration and delivery of these pollutants can significantly impair water quality and ecological integrity.

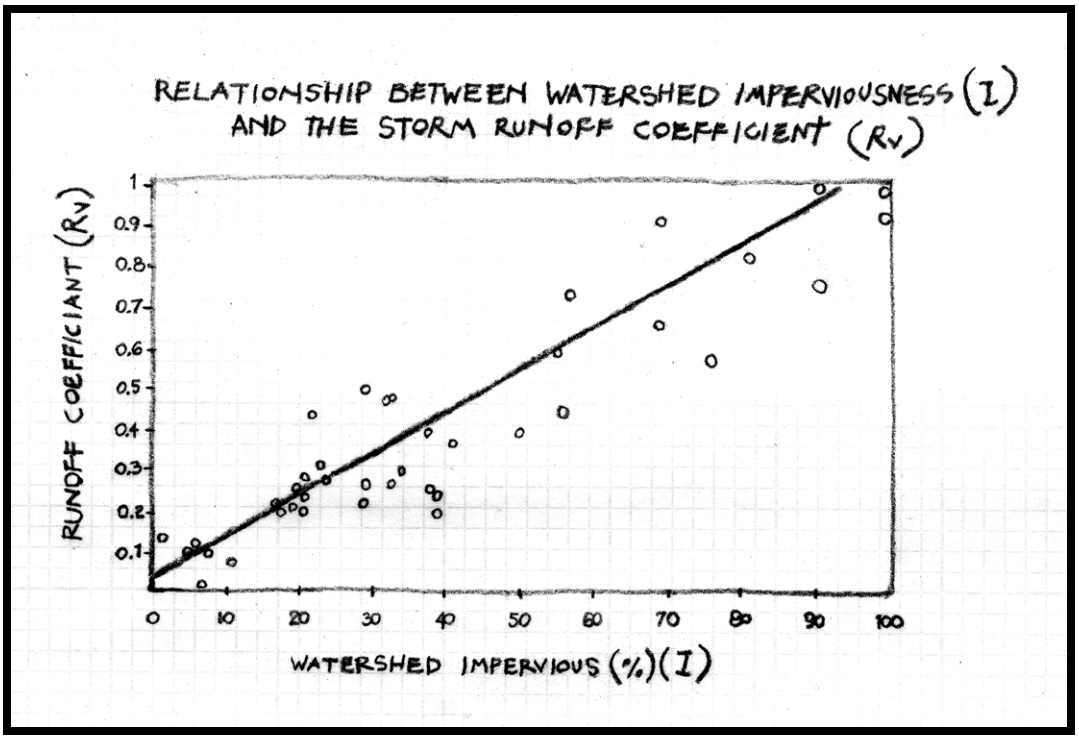

Figure 9: **This graph shows that as the percentage of watershed imperviousness increases, the volumetric runoff coefficient increases as well (Center for Watershed Protection Slide, 2003, adapted from Schueler, 1987)**

Geomorphology and Urbanization

The increase in volume is translated into natural stream systems whose conditions are not designed for the new runoff volumes. The Center for Watershed Protection identifies the following as, effects of urbanization on geomorphology: stream widening and erosion; fragmentation of riparian and tree canopies; reduced fish passage; degradation of habitat structure; decreased channel stability; decreased substrate quality; loss of pool-riffle structure and embeddedness of water body.

Urbanization and Habitat

The conditions of urbanization are translated into the disturbance of the natural flow regime, which effects habit. The Center for Watershed Protection identifies the following as, effects of urbanization on habitat: decline in habitat value of streams; loss of buffer zones (riparian); loss of large woody debris; creation of fish barriers; a shift in the energy cycles and increased algal growth.

Sparkill Creek Assessments

A long history and tradition of human interaction with the Sparkill Creek has existed for thousands of years. It is clear that large-scale changes have been occurring within the Sparkill Watershed. The encroachment of urbanization has been altering the creeks water quality and ecosystems health. However now more than ever, physical and cultural disconnects have taken place, thus causing a rift in environmental connectivity between the land-use and watershed health. This rift makes it critical to monitor and study the creek conditions as they change with development. Environmental monitoring provides the community and political decision makers the chance to be made aware of the existing conditions and help to find ways of improving conditions. The following are some examples of recent Sparkill Creek Assessments:

Hudsonia - An Ecological Assessment

In 1993, Hudsonia Ltd. conducted a first ecological assessment of the Sparkill. It was noted:

> We found a stream that was severely degraded due to inadequate erosion and siltation control in the watershed, untreated stormwater runoff, removal of streamside vegetation, and possibly untreated sewage overflow. Massive sediment deposition in the stream has damaged and destroyed essential fish and invertebrate habitats. The fish community was dominated by species tolerant of polluted water or otherwise degraded streams; abundance and diversity were low. The invertebrate community was also sparse with low diversity. We suspect nutrient loading and possible pesticide contamination from runoff derived from lawns and garden, and two golf courses. Chloride concentrations were high in water samples taken from the lower Sparkill; road salt is the likely source. We recommend further studies to assess the population of the endangered Eastern Mud minnow (we found none, but there are historic records from the Sparkill). We recommend investigations to determine the primary sources of sediments and other pollutants into the stream. (Stevens, Hudsonia Report, 1993).

Sparkill Creek Flood Control Analysis

Due to chronic flooding problems in the Sparkill watershed, the Rockland County Drainage Agency hired Goodkind and O'Dea, Inc., an independent engineering firm to complete a comprehensive Sparkill Flood Control Analysis. The final report was completed in 1999 and the results confirmed what the community and Hudsonia had already began to notice, that high levels of sedimentation and erosion are taking place, clearly a system out of balance. They specifically attributed the findings to an increase of urbanization in the

watershed and alteration of the natural drainage system (Goodkind & O'Dea, 1999). They also state, "Development within the watershed area has resulted in an increase in the severity of flooding along the creek" (Goodkind & O'Dea, 1999). As described in Figure 1., increased impervious surfaces will increase volumetric runoff. The domino effect continues, impacting the geomorphology and balance of the stream. From there the habitat becomes damaged, and the ecological integrity is compromised. Interestingly these conditions are the primary cause of poor fish diversity in another Sparkill Creek study.

Fish Assemblages of the Sparkill

Saint Thomas Aquinas College (STAC,) Biology Professor, John Rosko conducts an ongoing evaluation of fish populations in the Sparkill with his undergraduate Ecology students. The Rockland County, Journal News described their efforts.

> THE JOURNAL NEWS, June 21, 1998.
> "Researchers Cast their Lines into the Sparkill"
> By Kathryn Winiarski.
>
> A disturbing picture has emerged, they say. Only 16 species of fish were found to live in the Sparkill Creek, a low diversity that signifies a troubled ecosystem. At least seven sunfish are infected with a parasite, a nematode that makes one eye bulge. Trash is common. Hundreds of tires lay wedged in the mud alongside shopping carts and bundles of barbed wire. Sediment runoff from land is the biggest threat to the creeks inhabitants, researchers say. Sediment smothers fish eggs. The creek is nearly impassable in some locations because the mud is so deep (Winiarski, 1998).

Rosko stated, "It renders the waters uninhabitable for most native species. This is a heavily stressed creek. It is severely impacted by humans. We anticipated we would not find a great diversity of life because the area is so populated. I would sure like to see that change. It probably can recover quite a bit" (Winiarski, 1998).

Hudson River Basin Watch - Rapid Bioassessment

In February 2002, Hudson River Basin Watch (HRBW) performed a modified rapid bioassessment on the Sparkill Creek as part of a stream training workshop at the Lamont-Doherty Earth Observatory. Physical, chemical and biological data were collected on the flow entering the Sparkill Gap. The data collected fell outside the parameters established for a healthy stream. The impaired water quality observed in this study reflects the aforementioned assessments. In conjunction with previous studies, a longitudinal assessment of the main stem

testing reach was possible; and based on this data, the Lamont-Doherty assessment recommends that the Sparkill be added to the NYSDEC Impaired Waters 303(d) list. The report also emphasized the need for community education on the effects of residential and urban practices on the creek, and that a continual monitoring effort be initiated in the watershed (Nolan, 2002).

Sparkill Creek Conservation Initiatives

Brookside Protective Association

When our environment is threatened or damaged, the local community takes notice. If the threat or loss of environments becomes to great, the concerned will organize and promote protective actions. As far back as 1901, a group of early conservationists and outdoor sportsmen realized intrinsic values of the Sparkill Gap, as a natural place. They joined together to create the first Sparkill Creek conservation association and they called themselves the Brookside Protective Association. They conducted game population studies, and fish and fowl stocking programs within the context of the Sparkill Creek for many years. In 1966, it received a 25-year lease for a game refugee, which is a critical component within the Sparkill Gap wetland complex. The refuge is referred to as Brookside Wildlife Sanctuary.

Sparkill Creek Watershed Protection Association

Due to increasing development in the Sparkill Watershed, flooding and general degradation became obvious. In the 1970's, federally funded channelization of the Sparkill Creek's floodplains and tributaries was proposed by the Rockland County Drainage Agency (Cacioppo, 2003). A grass-roots campaign to stop the $9 million project was lead by local citizen Barbra Porta Hutchinson. "A meandering creek is naturally slowed", Porta Hutchinson said. "But the government's answer was to straighten and channelize creeks, line them with rip rap and create long ditches. Besides the loss of aesthetics, flora and fauna, we felt it was a plan that would not work." (Cacioppo, 2003). The Sparkill Creek Watershed Protection Association called on the efforts of many local citizens. They wrote letters, and garnered the bipartisan support of elected officials and influenced public opinion. The channelization plan was defeated. "It was saving wetlands and floodplains that made all the difference," Porta Hutchinson said. "If the project had gone forward, all the wetlands would be developed by now,

and the Sparkill Creek would be dry" (Cacioppo, 2003). Community members must act as watchdogs to protect their natural resources from continual environmental threats.

Sparkill Watershed Conservancy

Initiated in 1999, Sparkill Watershed Conservancy (SWC) was created to help resolve the continued problems of degradation with the Sparkill Creek Watershed. The mission of the group is "to preserve and protect open spaces, waters, and the biodiversity of the Sparkill watershed, from its headwaters on Clausland Mountain to its confluence with the Hudson River" (Mercurio, 1999). Following an educational symposium on Sparkill Creek fish populations by John Rosko of STAC, an exit survey was conducted on behalf of the SWC. The most revealing question in the survey was, "Based on tonight's presentation and the degree of habitat degradation within the Sparkill Creek Watershed, how would you rate the importance of conservation?" The choices were, (a) urgently important, (b) seriously important, (c) moderately important, (d) somewhat important, (e) not important. Thirteen surveys were completed, 73% rated conservation as urgently important and 27% classified the need as seriously important. In the November 2000 issue of, *The Nyack Villager* (a monthly local newspaper), they did a spot for the Sparkill Watershed Conservancy. The brief excerpt states:

> A new grass roots organization is being formed to address an old problem. The Sparkill Watershed Conservancy seeks to protect natural habitat along the banks of the Sparkill Creek and to advocate environmental common sense throughout the watershed that feeds the creek. Plans are underway for stream clean-ups, education initiatives and the promotion of good land use to provide some protection and public awareness of the ecological health of the region (*The Nyack Villager*, Staff, 2000).

By this time the SWC assembled a professional, experienced, and diverse group of local citizens that met on a regular basis as the Steering Committee. Most recently, the group attained non-profit 501(c)3 status, creating eligibility for grants as well as other funding opportunities. While progress has been slow, local, county and state environmental groups, scientists, educators and local citizens now recognize the group and its intentions.

Watershed Management and Water Quality Improvement

Rocky Mountain Way

"The Rocky Mountain Institute is an entrepreneurial nonprofit organization that fosters the efficient and restorative use of natural, human and other capital to make the world more secure, just, prosperous, and life sustaining"(http://www.rmi.org/, 2003). They inspire business, civil society, and government to design integrative solutions that create true wealth. They encapsulate holistic solutions to restore the balance to waterways:

> The watershed perspective is conducive to a holistic view of environmental problems and their solutions. For example, stormwater runoff should not be seen as a nuisance to be managed at some low point of a property or some downstream position in a watershed. Wet-weather issues such as sewer overflows and stream channel erosion can be successfully addressed by multiple, small, unobtrusive measures incorporated into developments or retrofitted into the existing built environment. The techniques are many, but the approach is consistent: "softening" the urban landscape to allow water to soak into the soil, where it nourishes plants, recharges aquifers, and supports the base flow of streams during dry periods. Soil and vegetation can also filter, transform, bind up, or otherwise neutralize much of the pollutants found in urban stormwater runoff.
>
> In these ways, water is turned from a potential destroyer of habitat and biodiversity, and into a resource for the environment and communities. Indeed, onsite stormwater management measures - impervious surface reductions, permeable pavements, small surface and subsurface infiltration basins, bioretention cells, vegetated swales, soil rehabilitation, high-performance plantings, green roofs, and others. These interventions can support wildlife habitat, beautify properties and neighborhoods, provide recreational amenities, create rewarding jobs, reduce urban "heat island" effects, and more. Better to implement these common sense measures than costly, infrastructure such as stormwater detention facilities, expansions of sewer lines and treatment plants.
>
> Protecting and restoring streams and wetlands is another important component of watershed management. "Bioengineering" and similar organic-based approaches to stabilizing streambanks renew the hydraulic and biological functioning of waterways. Further, it is important, not just to protect existing aquatic and riparian systems, but also to restore lost streams and wetlands wherever possible. Removing culverts in order to "daylight" previously buried streams and dried-up wetlands are an especially dramatic and useful restoration activity. Among its many benefits, daylighting can reduce flooding problems caused by undersized culverts; cut the costs of replacing deteriorated culverts; improve water quality by exposing flows to air, sunlight, vegetation, and soil. Daylighting projects provide new urban recreational amenities and wildlife habitat. They benefit nearby residents and businesses by improving property values, generating pedestrian traffic and reconnect people to nature by restoring something that once seemed lost forever (http://www.rmi.org/, 2003).

The Rocky Mountain Institute summarizes all of the most current management practices, restoration techniques, and ecological philosophies regarding watersheds and creek rehabilitation. It is this type of plan that should be implemented across the country and across the world, to protect the freshwater resource. The Sparkill Watershed is at scale such that significant improvement can be made to the environmental quality of the area, if actions are ever initiated.

Sparkill Watershed Management Plan

Rod Johnson, former Piermont Trustee, developed a comprehensive management plan in 1999. His plan was to study the watershed and promote land-use guidelines that protect the Sparkill from local pollution and runoff (Samuels, 2000). This proposal was submitted to the NYS DEC, Waterway Restoration Grants Program. The need and importance for study was acknowledged and awarded to the Village of Piermont. The plan called for developing an intermunicipal organization, which would designate a *Sparkill Watershed Study Team.* This team would work with a consultant to inventory the watershed and draft the Sparkill Creek Water Quality Improvement Plan. The plan would be refined through public review and an Official Sparkill Creek Water Quality Improvement Plan would then be finalized. The proposal, as others, also calls for ongoing public education.

People of the Sparkill community were excited about the potential of the project. In June 2001, Rockland County Executive, John Murphy, and Rockland County Drainage Agency Director, Ed Devine, lead a walking tour of a Sparkill Creek bank areas in Tappan, that were undergoing site “repairs” to eroding stream banks (remove sediment with excavator and rip-rap). In a follow-up letter sent by Mr. Murphy he states, “Betsey Saetre will provide coordination and back-up and start to create the mailing list for a joint County-Town Sparkill advisory committee.” SWC members, Aleksandra Becnel and Paul Malone called Ms. Saetre to inquire about the status of this advisory committee. They were told, that no committee exists and it is not being planned per se (Becnel, Malone. 2001). Aleksandra Becnel and Paul Malone then sent a letter to the Orangetown Supervisors Office stating, “A forum for communication between the Rockland County Drainage Agency and the citizens of Orangetown is crucial at this point in the Creek’s existence, to assure the healthy future of its waters and its banks. We trust our Supervisor can facilitate action” (Becnel, Malone, 2001).

While no joint committees exist as of yet, and no progress has been made on the Sparkill Creek Water Quality Improvement Plan, the Village of Piermont discusses the existence of the Sparkill Creek Watershed Improvement grant In the 2002 annual Village

review an excerpt states, “We have received a grant and commissioned a study to create a watershed protection program for the Sparkill Creek” (O’Brien, 2003). This past summer, during a Village of Piermont Board meeting the Mayor, and Trustees were asked the status of the Sparkill Creek grant for Water Quality Improvement. The summarized response was, “Talk to Rod Johnson, he was involved in writing the grants, we don’t know. That was the weirdest grant and we don’t know what to do with it.” Creek conditions continue to degrade as each storm tumbles by.

An Educational Initiative

Sparkill Creek Exhibit

Good new for the Sparkill in 2003. The Orangetown Historical Museum and Archives, in Pearl River, NY, hosted an extensive exhibit that focused on the Sparkill Creek in the face of modern development. I was allowed a private viewing of the exhibits for the purpose of this capstone project. The exhibit displayed historic photographs, prints, paintings, maps, videos, and artifacts. Interactive displays of flora and fauna were adjacent to a tank of creek fish provided by John Rosko. A scale diorama of the creeks pollution, which included hubcaps, bottles, beer cans, cigarettes, polystyrene and fast-food wrappers (Cacioppo, 2003).

While only a temporary exhibit, Mary Cardanis of the Orangetown Historical Museum, was pleased with the turn out and community interest. This multi-media exhibit drew many people to the museum for the first time, including myself. The creek obviously has a staying power within the community, people care and are concerned.

Education at the Sparkill Gap

The museum exhibit was the most recent affirmation of the need to become aware and involved with the future of the Sparkill. The exhibit was an educational tool that provided comprehensive insight to the issues facing the Sparkill Creek. Education of the community is essential. Richard Wagner, author of *Environment and Man,* 1974, states this, in his chapter titled The Urban Suburban Environment:

> The need for ecological control over the land use has been demonstrated again and again. But assuring that an ecologist plays a significant part in land use planning does not necessarily lead to ecologically sound land usage, for there are strong local political and economic pressures and financial control always seems to be in someone else’s hands.

> Only public opinion will sway those who control land development and persuade them that ecologically sound solutions are ultimately the best solutions.

The last sentence is an imperative component to this capstone project. The initiation and beginning of positive change begins with an educated public. The community should be reminded that their opinion and voice could create momentous environmental changes in the health of the landscape. The information provided in this proposal will provide a place to reconnect some of the long disconnected realizations and understandings. Anyone interested in watershed protection could learn about the watershed processes and considerations while experiencing a durable suburban oasis. Here, awareness and understanding connections to the natural system will create a climate where ecologically sound solutions will be chosen over conventional engineering techniques.

Significance of Study

This study is going to propose designs for landscape alterations to selected sites within the Sparkill Gap. The designs will emphasize landscape development and management practices that will lead to improved water and overall environmental quality within the selected sites and for downstream environments. The study will also propose educational opportunities that can be derived from such alterations to the selected sites. In fact, physical facilities to support the educational opportunities will be included as part of the proposed landscape alterations.

The ingredients for restoration are in order. A degraded system exists, as do the concerned citizens, and political entities responsible for management of the resources. If the project were completed, it would provide a new opportunity for all visitors to the Sparkill Gap to explore the natural and cultural richness while exposed to interventions and restoration practices. The plan will be proactive in the sense that its designs will be improving the environmental health of the gap while interactively, providing valuable examples of landscape alternatives. These alternatives will not only help protect the Sparkill Gap, but also the ecological integrity of the entire watershed.

Goals

There is a substantial amount of research that examines the plight of Sparkill Creek. People care about their local resource, but don't always have a complete understanding of the critical issues. My personal goal is to increase community awareness of the threats to the Sparkill's environmental health and provide examples of alternative landscape solutions. These ideas will be explored through planning and ecologically conscious site design. These designs will be applied to the area within the Sparkill Gap section of the Sparkill Creek, particularly the Skating Pond area. The Preliminary Master Plan will incorporate a Watershed-based Environmental Learning Center, demonstration projects, and an interpretive trail system. The facilities will be designed as an outdoor classroom experience that will provide educational and physical access to the underutilized Sparkill Gap. The plan will provide learning opportunities directly related to the site conditions, as well as the context of the watershed. The ideas presented in the plan will invigorate public opinion about this place and create a movement for proactive community and government watershed actions.

Objectives

Objective 1 Understand the Sparkill Gap Study Site through Site Analysis.

Objective 2 Produce a Preliminary Master Plan for the Sparkill Watershed-based Environmental Learning Center within the Sparkill Gap. This plan will include sighting of the education center, demonstration projects, and an interpretive trail system.

Methods

Objective 1 Understand the Sparkill Gap Study Site through Site Analysis.

Designers understand that in the early steps of the creative process it is crucial to have a thorough understanding of the site. Particularly true for an environmental based education center, an extensive knowledge of the environmental conditions is a must. Having an intimate relationship with the site is crucial for success. This is particularly true when designing an environmentally based education center that is going to reinforce ecological restoration concepts with land-use demonstrations. Site visits to the Sparkill Gap have been a consistent part of my life since childhood. However, these future site visits will take on a different dimension. Using the tools of landscape interpretation and detailed observation this place will be studied closer then ever before.

CAD for the Sparkill Gap study area has already been drawn via the Rockland County Planning Department, New City, New York. While scale and data layers are unknown to this point, they will be the working base maps for inventory and analysis. The site inventory and analysis will confirm the accuracy of the drawings and expose additional characteristics that reveal the opportunities and constraints (Booth, 1983). Booth also cites the following as some basic survey components to consider:

1. Property lines with bearings and distances, if known.
2. Topography.
3. Existing Vegetation.
4. Bodies of Water and Wetlands.
5. Buildings (height, location, windows, style).
6. Other structures (walls, fences, telephone poles, hydrants).
7. Roads, driveways, parking, walks and paths.
8. On and off-site utilities (electric, gas, water, storm/sanitary sewer).
9. Landscape Context (adjoining roads, nearby buildings, bodies of water, schools).

To consider the existing hydrology, aquatic and riparian systems health, the project will utilize the National Weather and Climate Center's (NWCC) Technical Note 99-1, Stream Visual Assessment Protocol (2001). This protocol call was a collaborative effort between the National Weather and Climate Center, the Wetland Science Institute, the Watershed Science Institute,

and the Wildlife Habitat Management Institute. The original intent of this document was for NYS Resource Conservationists and Conservation Engineers field technicians. Their staff used this protocol to evaluate the overall ecological condition of streams. The primary use of the protocol is for the inventory and analysis steps of developing a conservation plan, priority settings and pre- and post-assessments to evaluate the effectiveness of contracts and conservation plans. The protocol address water quality and physical habitat resource concerns. The Stream Visual Assessment Protocol covers the essential chemical, biological, and physical, conditions using a method which relatively east to conduct and with low levels of expertise. Photographs and field sketches will also be included in the fieldwork to support written documentation.

To integrate an important, relevant, and stylish design aesthetic I will conduct a brief survey of an adjacent property, the Tallman Mountain State Park. Exploration of this site will provide important examples of local design details derived from local materials. This park includes trails, swimming pools, a track and field, basketball, tennis and nature enjoyment. Design details and ideas generated from Tallman will be combined with elements of case studies, primary literature review, and the site analysis to derive the specific layout and design elements for completion of the Sparkill Watershed focused, environmental learning center.

Methods

Objective 2 Produce a Preliminary Master Plan for the Sparkill Watershed-based Environmental Learning Center within the Sparkill Gap. This plan will include sighting of the education center, demonstration projects, and an interpretive trail system.

The Sparkill Watershed Education Center Plans will be derived from a combination of sources: the completed site analysis, stream habitat protocols and other watershed design manuals. However, studying environmental education center precedents, the will allow designer to explore the full range design of possibilities. The case studies selected all had two common threads: both are environmentally based education centers and are focused around a water body. The case studies utilize a wide range of demonstration projects, interpretive trail systems and other mediums for environmental communication and experiences.

Dyken Pond Environmental Education Center

The Dyken Pond Environmental Education Center is located Cropseyville, which is situated in Rensselaer County, New York. The purpose of Dyken Pond is to offer activities and workshops dedicated to environmental education. All the programs are open to both adults and children. Group programs are offered to schools, scout troops, lake associations, outdoor clubs or any group with a minimum of 6 people. Classes include environmental science, current environmental issues and outdoor living skills. The pond area features extensive trails: five miles on county lands and two miles on private conservation lands. These trails are continuous and range from shorter self-guiding interpretive trails to the Dyken Pond Long Trail, many of which featuring wild woods, streams, ponds, and fields containing diverse plant and animal life. They exist for both our enjoyment and appreciation as well as for us to protect and preserve our world (www.dykenpond.org, 2003).

Mission Creek Greenway Project

The Mission Greenway Project is located in Kelowna, British Colombia, Canada. This project is inspiring; it involves a seven-kilometer Children's Interpretive Public Greenway that follows Mission Creek from a Okanagan Lake and through the city of Kelowna. With phase one complete, plans are being made for phase two. Ideas include trail surfacing, pedestrian bridges, parking at the trailheads, interpretive kiosks, a wetland boardwalk, picnic tables and benches. The Friends of Mission Creek Society cites school children as major contributors to the success of the Greenway. They were encouraged to participate by School Superintendent Ron Rubadeau who designated their involvement in the Greenway as a citizenship program. Student involvement included creek clean-ups, and the creation of artworks and written material for the interpretive signs.

An interesting component of this case study is the Habitat Enhancement component in the river. The project was undertaken in August 2000 in cooperation with Okanagan University College Institute for Freshwater Study. The purpose of the study was an attempt to increase the numbers of Kokanee salmon returning each year to Mission Creek. As part of the study, a demonstration "riffle" was installed to enhance the spawning habitat. It was placed adjacent to the existing spawning channel. The riffle is a rock structure designed to modify the flow of water, and to divert the flow to create ideal substrate (bottom gravel) conditions to encourage spawning (Figure 3). Dr Peter Dill, who undertook the study, has now completed an assessment of the effectiveness of the riffle and has confirmed its success (http://greenway.kelowna.bc.ca/html, 2003).

Ridgeway State Park - Interactive Education

This Colorado State Park recently received funds from the EPA to facilitate improved environmental education opportunities. The park provides a landmark outdoor classroom with fully handicap-accessible facilities, which allow thousands of students experience nature first hand. A grant provided for a two-person environmental education team that coordinates programs thereby, extending the education season by four months each year. The audience is challenged to observe and investigate the parks ecosystems, apply critical thinking skills, and reflect on the use of stewardship to preserve the park's natural resources. They state their ultimate goal is to "create a knowledgeable and skillful students who improve academically while becoming stewards of the area's natural resources as lifelong learners (http://www.epa.gov/enviroed/grants/CO02.htm, 2003).

Eib’s Pond Education Center

Of all case studies I reviewed, this one resembles the Sparkill Gap situation the most, because of its uncharacteristic natural beauty amidst urbanization and abusive land practices. Eib's Pond Park is a neglected 17-acre freshwater wetland in northeastern Staten Island, which had great potential to become a valuable open space amenity. In 2001, the Design Trust funded a development phase to increase advocacy for the park. Based on their extensive involvement with Eib's Pond Park, the Fellows produced a promotional booklet documenting current conditions and park amenities. This booklet received an award from the American Society of Landscape Architects in 2002. The purpose of the project was to build advocacy for the park, which is located in an underserved urban community (http://designtrust.org/doc/eibs.html, 2003).

The intent of the brochure was to give people a sense of how good design and community involvement can work together to turn a place around. **Users' statements in response to the question:** "Why is the brochure important?"

- Reverend Hattie Smith-Davis, President of Fox Hill Tenant Association: Because we can get it out to people who would contribute something, even if its just to sit down in a meeting and give ideas. It's visibility: it says whom we are, what we are and why we are, and it offers something interesting to read and look at.

- Steve Cain, Partnership for Parks: It is especially important for this park, because it is a hidden jewel. A fundraising tool. It catches my attention, as an educator and as a person. I think someone picks it up and says: Wow! Look at all that's going on here. Debi Rose (Democrat running for city council) said that she would talk to corporate sponsors about Eibs, as soon as she had something to give them to explain what is going on there. The brochure makes us look more cohesive. At an educational level, it helps introduce the lot of people aren't even aware that it's there. It is a great outreach tool.

- Joe Carroll, Manager, CBI, said that the brochure would be a useful advocacy tool", in order to show that Elb's Pond Park IS "the right place for people to put their money.

The plan worked. An outdoor classroom was designed and built on Eib’s Pond site as an “activating structure”. The small structure enhances the seventeen-acre wetland park's extraordinary potential as wildlife refuge, educational environment, and social center. The Classroom is both a destination to be attained and an entry point towards new environmental experiences. It hovers over its wetland site, allowing access, but also designed to protect, the fragile wetland zone. Weaving together land, water, city, and park, its purpose is to reveal surroundings, and make them physically and psychologically available in new ways. It can seat up to 28 children and it’s within a five-minute walk from the local primary school (http://www.asla.org/meetings/awards/awds02/eibs_pond_park_brochure.html, 2003).

Cedar River Watershed Education Center

This case study peaked my interest for two reasons. The first reason being that the focus of this educational center is specifically on watershed issues, which is also central to the Sparkill Gap project. Secondly, the Jones and Jones Landscape Architecture Associates designed the project, which interest me because of meeting Brent Jones during his recent visit to SUNY ESF this past semester and learning about his design philosophies, principals and projects.

> Located in the Cedar River Watershed, just outside Seattle, Washington the watershed education center opened it doors in Fall 2001. Since then it has been serving students, families, corporate groups, researchers and scientists. Jones and Jones designed with respect for the natural landscape and with a focus on recycled materials. The facility echoes in design what the center will achieve through its programs. The buildings are arranged in a cluster of five with covered walkways and roofs of sod. The Cedar River Watershed Education Center integrates green design in all aspects of the project: architecture, engineering, landscape architecture, and construction process. They believe that green design equals good design and helps confirm our ever-expanding knowledge that by practicing sustainable design we can live in fulfilling and ecological ways.
>
> The education Center is the gateway to discovering how the land and water connect to you. The center has a *learning laboratory* where student explore the science of the watershed, complete with microscopes, turbid meters and other laboratory equipment. The other education center buildings include a *conference center*; to host groups and meetings, a *research library*; to provide support for local watershed studies, a *food court*, and an *interpretive hall*. This hall tells the story of the watershed through hands-on, interactive exhibits to help visitors understand the complex issues surrounding watershed land-use practices (www.cedarriver.org/about/discover.shtml,2003).

Regarding the Sparkill Watershed Education Center, this facility's concept plan will undoubtedly implement site-specific stormwater management techniques, streambank restoration, and general habitat improvements . These types of demonstration projects are outlined in the Rocky Mountain Way section of the proposal, as well as, in the following design documents. These sources provide precedents for site development and design ideas.

1) *Design of Stormwater Filtering Systems*. (1996). By Richard A. Claytor and Thomas R. Schueler. The Center for Watershed Protection. Silver Springs, Maryland. This comprehensive document covers stormwater filtering designs and components for improving stormwater quality and quantity. The document provides matrixes for native plant selections, specific techniques to abatement pollutants, and design detail schematics for construction.

2) *Low -Impact Development Design Strategies – An Integrated Design Approach* (1999). By Prince George's County , Maryland, Department of Environmental Resources; Programs and Planning Division. This benchmark resources provides proactive solutions to combat urbanizations impacts . the five focuses are Site Planning, Hydrology, Distributed IMP Technologies, Erosion and Sediment Control and Public Outreach.

3) *New York State – Stormwater Management Design Manual* (2001). By Center for Watershed Protection for the NYS Dept. of Environmental Conservation. Albany, New York. This document is provided for municipal governments meeting the Phase II stormwater regulations. The manual outlines accepted stormwater management practices. The manual provides performance criteria, design examples and maintenance schedules.

4) *A Citizen's Streambank Restoration Handbook*. (1995). By Karen Firehock and Jacqueline Dorety. Published by Save Our Streams Program; Izaak Walton League of America, Inc. This publication provides clear design solutions to restore the natural cohesion of root systems along stream banks. Restoration of this critical habitat can be done at various scales providing, with improvements in water quality, habitat, and stream bank stability.

5) *Inland Fisheries Management in North America* (1999, 2nd ed.) Chapter 10, titled, Stream Habitat Management, was written by Donald J. Orth and Ray J. White. This ecologically focused reference provides sound information regarding the requirement s for healthy stream systems, methods of enhancement, and development strategies restoration projects.

Schedule

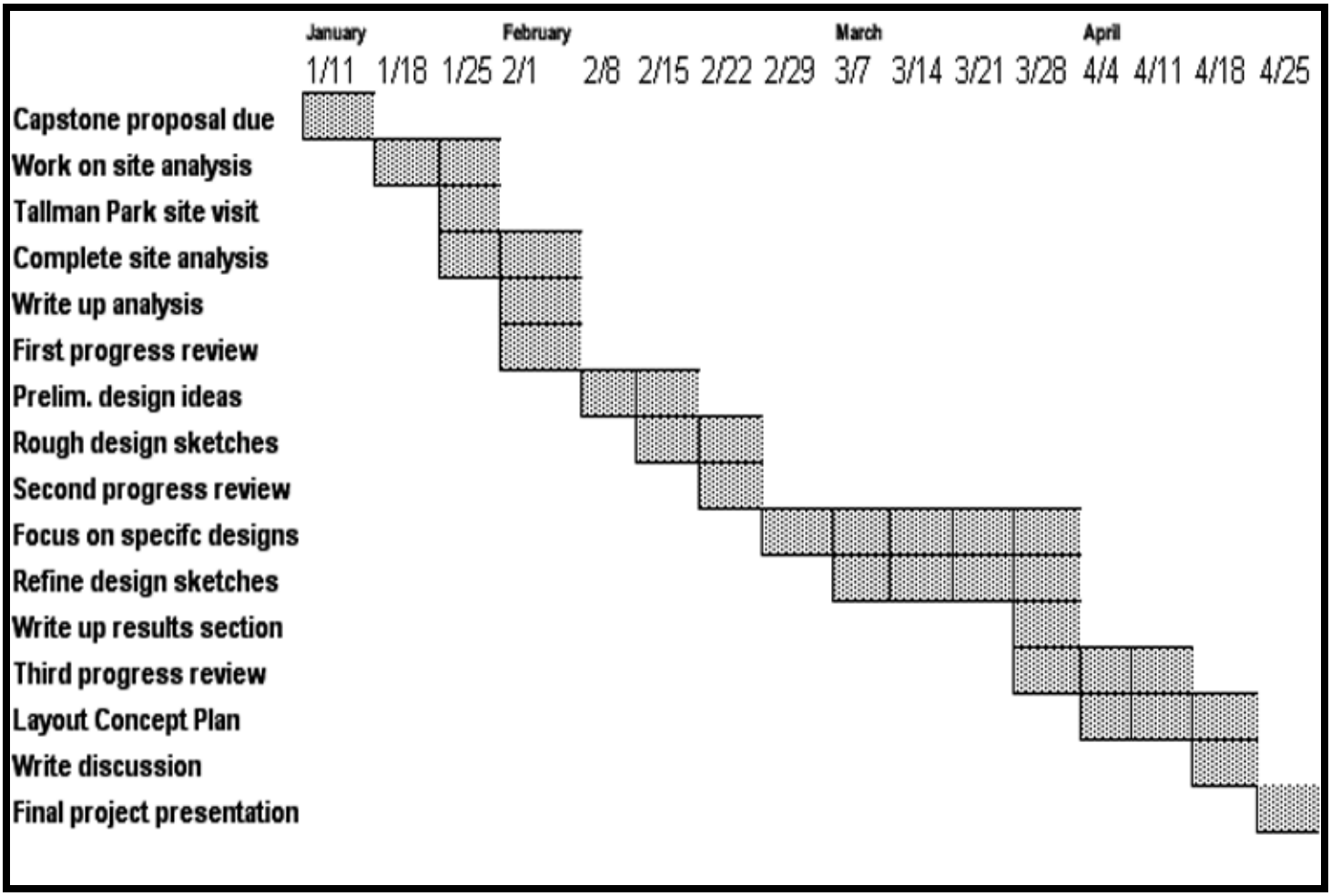

Table 1: Proposed schedule for the spring 2004 Master's of Landscape Architecture design project. Items may be subject to change.

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