Results (or Consequences) of Remediation at Lemon and Mill Creek Sites, Staten Island, New York

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Introduction:

Lemon Creek and Mill Creek are two sites impacted by metals contamination. (See Figure 1.0) Both locations share common history in that they were active industrial sites for over one hundred years. Manufacturing operations ended at both locations and the buildings demolished. Development plans for the sites are still pending.

The S.S. White Dental Supply Company factory was located near Lemon Creek on the southern shore of Staten Island facing Raritan Bay. This facility manufactured dental instruments and amalgams from 1937 to 1986. Suspected contaminants include copper, lead, zinc, and mercury.

Mill Creek (AKA Nassau Creek) is a small tidally flushed creek located 3 km from the opening of the Raritan Bay. It is located adjacent to a facility that was previously used to recover metals from old telephone transmission cables. This facility closely resembled a smelting operation. The Tottenville Copper Company was located adjacent to Mill Creek in 1900. By 1941, the plant was operating as the Nassau Smelting and Refining Company. In 1971, it became the Nassau Recycling Corp where copper, lead and zinc were recovered from old telephone cables. This creek received effluent from the smelting facility for approximately 40 years (the mid 1930's through the late 1970's). As a result, the site received a Superfund designation for contamination. (EPA ID: NYD086225596)

The Mill Creek site is located on the western shore of Staten Island facing New Jersey. Mill Creek is located along the Arthur Kill Waterways known for frequent oil discharges by passing vessels.

For more than a century, chronic pollution from industrial facilities along the Arthur Kill has severely degraded its' water quality (Crawford, etal., 1994). Furthermore, anthropogenic pollution has caused the fertile marshlands to deteriorate. Due to the potential toxicity and transference up the food chain, chemical pollution continues as a major concern in coastal ecosystems (Goto, Wallace, 2010).

Remediation efforts were conducted at both locations in 2000. These efforts consisted of removing contaminated soil. Both sites are still under investigation to determine the present contamination levels.

Live worms and grass shrimp samples were collected at both sites in 2007. Tissues obtained from these samples were used to compare body burdens of metals before and after remediation.

Shrimp and worms are used to assess the biological health of a wetlands site where contamination is suspected. Worms collected for this study live amidst the contaminated sediments. Shrimp live higher in the water column and are relatively mobile. Shrimp and worms take up pollutants internally during normal feeding. Once digested the pollutant is retained in tissues. Animals higher in the food chain have the ability to "accumulate" toxins by eating contaminated prey.

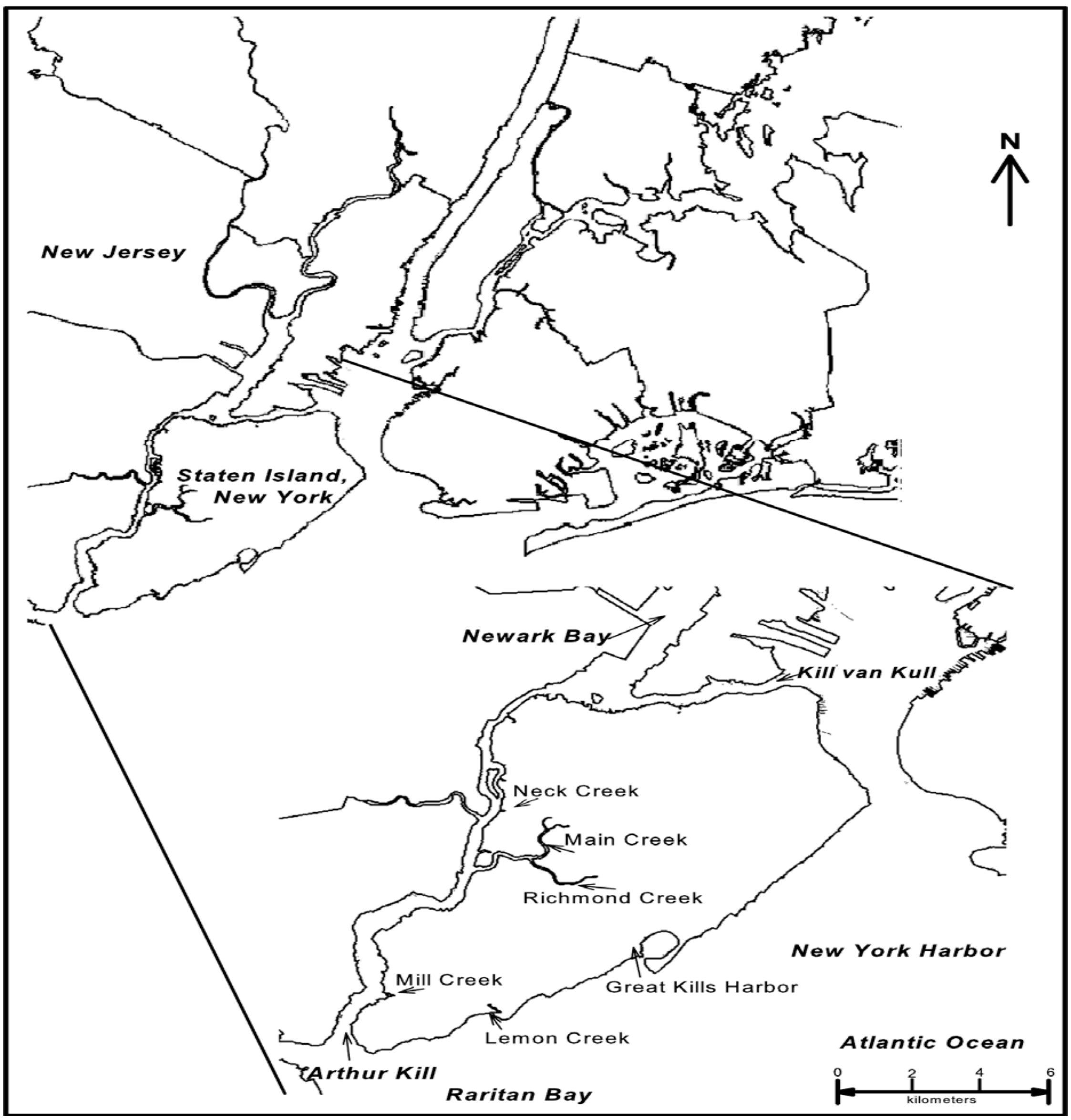

Figure 1. Map of study sites along the Arthur Kill Waterways and along the south shore of Staten Island (Goto, Wallace, 2010).

Brief Geological History of the Region

The earth has witnessed four major glacial ages in the past 2 million years. The most recent glacial age, the Wisconsin, began approximately 90,000 years ago. When it ended about 22,000 years ago, the Wisconsin glacier covered all of what is now New York City. The glacier's southern boundary is outlined by a terminal moraine that crosses Staten Island (See Figure 2 below).

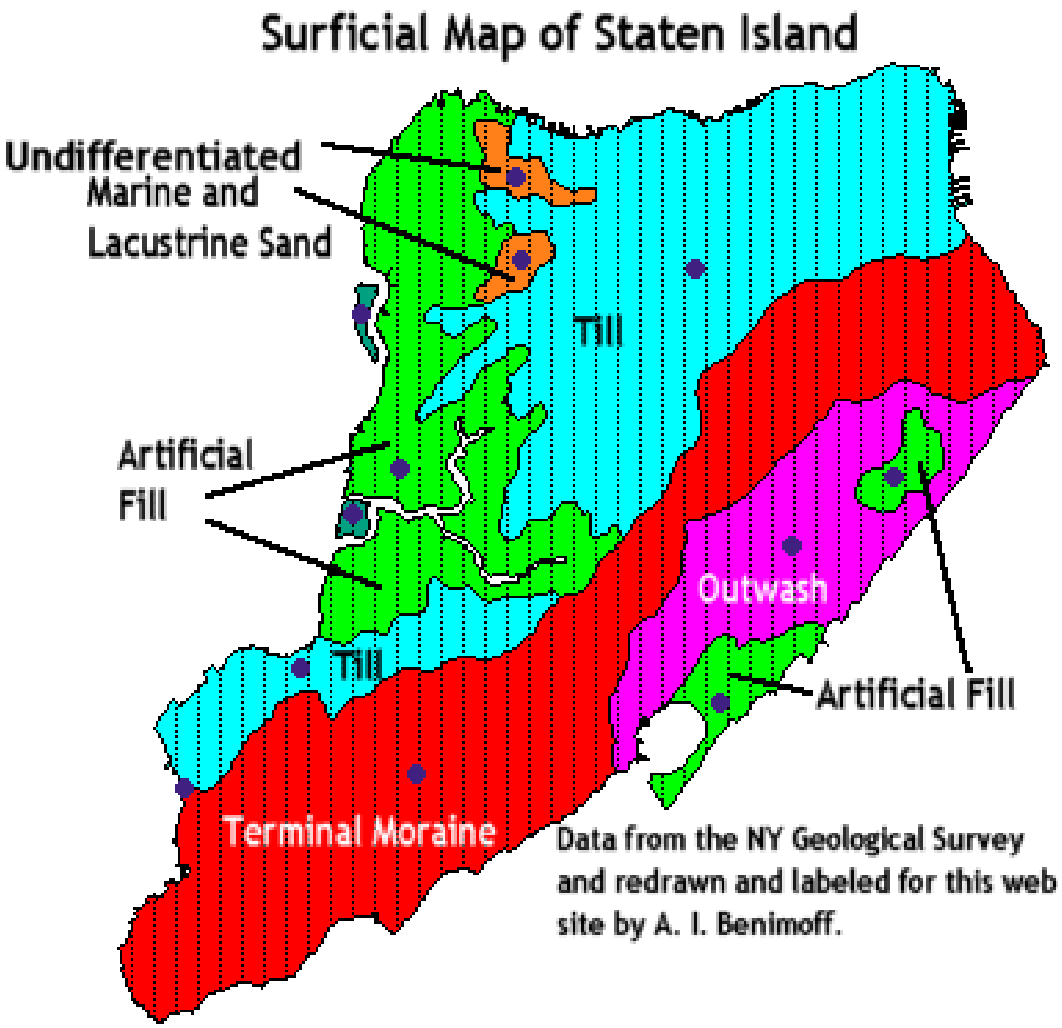

Figure 2. Terminal moraine shows glacier's southern boundary (Benimoff, Ohan, 2003).

As the glacial ice melted, a blanket of loose, unconsolidated, poorly sorted glacial till was left behind. Glacial melt water also deposited outwash plain sediment south of the terminal moraine. (Benimoff, Ohan, 2003)

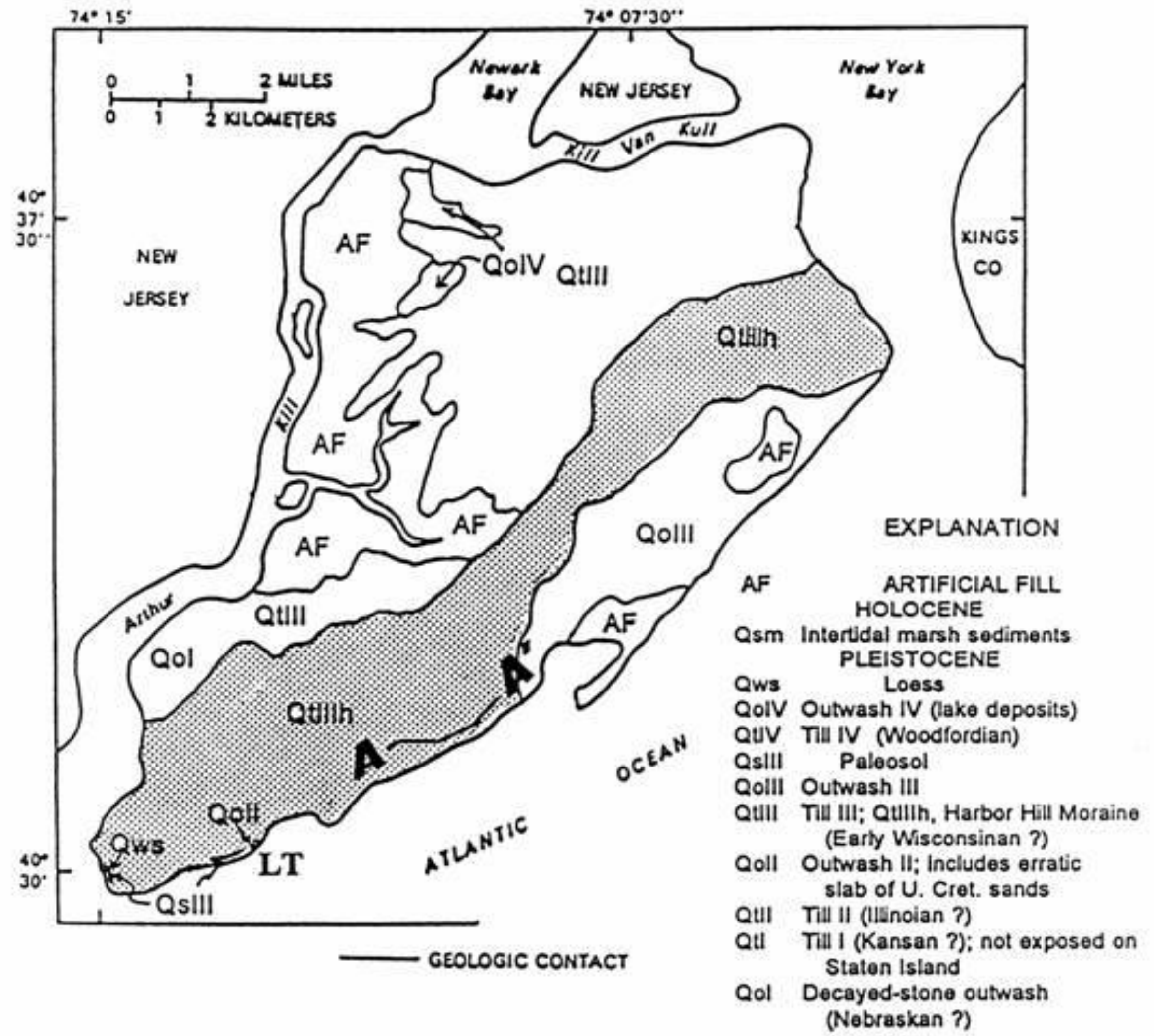

Figure 2.1 Map of surficial deposits on Staten Island modified from Sanders and Merguerian, (1994). Map produced Sanders using outline from Soren, (1988) and Caldwell (1989). Shaded area is the Harbor Hill Moraine; LT on diagram is a light tower on the shore of Princes Bay.

The Vital Role of Salt Marshes

Salt marshes play a vital role in supporting all forms of life. Marshes like Lemon Creek act as natural filtration systems improving water quality by trapping pollutants that would otherwise contaminate bays and oceans. Salt marshes are also among the richest wildlife habitats. Marshes support wildlife by providing a productive habitat for many species.

When the last glaciers melted, the oceans rose to their current levels. Sediments washed from land were deposited offshore in narrow sandy strips. These formed long islands parallel to the shoreline. The pounding ocean surf and a relatively calm landward shore bound these barrier islands.

The presence of saltwater makes survival difficult for most vegetation. Marshes further reduce erosion by trapping sediments that would otherwise be washed away. A resilient species of cord grass (*Spartina alterniflora*) was able to colonize the beaches, and mudflats despite being covered twice daily by ocean tides. This cord grass is still abundant along the Atlantic coast.

As this specialized grass spreads, its' stems trap floating debris. Sediments and particles of decaying matter slowly build up forming a nutrient rich mud that supports a complex food web. For example, the fiddler crab (*Uca*) and ribbed mussels (*Geukeasia demisea*) have formed a mutually beneficial relationship with the cord grass. Crabs and mussels benefit by feeding on decaying matter trapped by cord grass roots. The cord grass benefits from the burrowing activity of the fiddler crab, which aerates the soil. The mussels' excretion provides necessary nitrogen for the cord grass to thrive.

At the end of each season, the cord grass dies creating a spongy peat. Each year the peat layer raises the surface of the marsh enabling it to colonize new territory. This makes it possible for new plants with less salt tolerance to colonize the peat. This increases plant diversity that may invite other plant or animal species to join. The death of the cord grass also permits the formation of separate plant communities, an intertidal marsh, and a salt meadow.

Lemon Creek

This site is located just northeast of the light tower in Figure 2.1 inside Lemon Creek Park's 77 acres of narrow oak filled slopes that surround a sizable tidal marsh area. The creek and salt marsh represent the last remnants of a wetland system that flows through Bloomingdale Woods. Lemon Creek is one of a few relatively undisturbed tidal marshes on Staten Island. Our viewing site will be on a bridge on Hylan Boulevard, which runs across Lemon Creek. (40˚31'03.66"N; 74˚12'04.01"W from Google Earth).

NYC Dept. of Parks and Recreationwww.nycgovparks.org)

Mill Creek

Mill Creek is located near the confluence of the Arthur Kill and the Raritan Bay has been polluted from historic smelting activities. The Tottenville Copper Company, a metal processing plant was established adjacent to Mill Creek in 1900. By 1941, the plant was operating as the Nassau Metals and Refining Company. Thirty years later the plant was renamed the Nassau Recycling Plant whose chief purpose was to recycle copper and zinc from old telephone cables.

Mill Creek runs through the property formerly occupied by the metals smelting and refining plant. The location is less pristine than the Lemon Creek site chosen for this tour. Our viewing site will be on Arthur Kill Road looking west toward New Jersey. (40˚31'12.15"N; 74˚14'23.24"W from Google Earth) The Arthur Kill, a 25-mile long tidal strait, runs northeast to southwest from Newark Bay to Raritan Bay and separates Staten Island from New Jersey. Despite improvements in recent years, levels of trace metals and PCB's in some sediment remain high. Accidental discharge of petroleum products into the Arthur Kill is a chronic problem due to the number of oil transfer facilities. Although major oil spills occur infrequently, many small oil spills occur each year. These events are compounded due to the low flushing and increased residence time of water. Urban runoff containing petroleum products also adds to the burden on this system. Mill Creek is a typical marsh within the Arthur Kill system. Mill Creek is located just south of the Outerbridge Crossing on the New York side.

Results of this study:

As of the date this field guide was written, the results of this investigation are still be evaluated. These results will be discussed during the field visits and hard copies will be available during the NYSGA conference in September 2010.

Road Log.

Leaving main entrance to CSI, 2800 Victory Blvd. Staten Island, New York 10314 to Mill Creek, near 4996 Arthur Kill Road, Staten Island, New York 10307. Total distance is approximately 9.41 miles, (MapQuest)

1. Leave through front gate at CSI. Turn left onto Victory Blvd. toward Richmond Avenue 0.5 miles
2. Make left turn onto Richmond Avenue. Proceed along Richmond Avenue past the Staten Island Mall, which will be on your left. Section of Fresh Kills Landfill will be on your right. 3.2 miles
3. Stay on your right as you go past the mall. Take Drumgoole Road West leading toward Korean War Veterans Parkway. 0.3 miles
4. Take Korean War Veterans Parkway South toward Outerbridge Crossing. (Do not get on the bridge!) 2.7 miles
5. Take the Maguire Avenue/Bloomingdale Road exit. Follow arrows to Arthur Kill Road. 0.2 miles
6. Proceed to Drumgoole Road West. 0.4 miles
7. Continue on Drumgoole Road. Note, Drumgoole Road West becomes Veterans Road East 0.5 miles
8. Turn left onto Englewood Avenue. 0.1 mile
9. Turn left onto Veterans Road West 1.0 miles
10. Turn left onto Arthur Kill Road 0.6 miles
11. Viewing location is a small bridge over Mill Creek. Vehicles may be parked off road on the right facing New Jersey.

Directions from Mill Creek to Lemon Creek Bridge (Hylan Blvd). The distance is approximately 3.07 miles from Mill Creek. (MapQuest)

1. Turn left, proceed north on Arthur Kill Road toward Richmond Valley Road.

2. Turn right onto Richmond Valley Road. 0.2 miles
3. Turn right onto Page Avenue. 1.0 mile
4. Turn left onto Hylan Blvd. 1.6 miles
5. Turn right onto Bayview Avenue. Walk to over on Hylan Blvd.

References:

Benimoff, A.I., and Ohan. A.A. (1996) Highlights of Staten Island Geology, *in* Field Trip Guide for the 68th annual meeting of the New York State Geological Association eds. A.I. Benimoff and A.A. Ohan pages 125-138

Caldwell, D.H., 1989, Surficial geology map of New York, Lower Hudson sheet: New York State Museum Map and Chart Series 40 scale 1:250,000.

Goto, Daisuke;Wallace, William G., 2010, Relative importance of multiple environmental variables in structuring benthic macro faunal assemblages in chronically metal polluted salt marshes, Marine Pollution Bulletin, 60,363-375.

New York City Department of Parks and Recreation "Salt Marshes in New York City Parks- Lemon Creek", www.nycgovparks.org)

Perez, M.H.; Wallace, W.G. 2004, Differences in Prey Capture in Grass Shrimp, *Palaemonetes pugio,* Collected Along an Environmental Gradient, Archives of Environmental Contamination and Toxicology. 46, 81-89.

Sanders, J. E.; and Merguerian, Charles, 1994, Glacial geology of the New York City region, p. 93-200 *in* Benimoff, A. I., *ed*., The geology of Staten Island, New York: Geological Association of New Jersey Annual Meeting, 11th, Somerset, NJ, 14-15 October 1994, Field guide and proceedings, 296 p.

Soren, Julian, 1988 Geologic (sic) and geohydrologic reconnaissance of Staten Island, New York: United States Geological Survey Water Resources Investigations Report 87-4048,22p