Bioremediation and Shoreline Restoration[1]

The goal for the Harlem River Waterfront is to ensure that the open space areas meet standards for active parkland. Because this park will be used for active water recreation, this means also **bringing the river to its highest use**, e.g. fishing and swimming.

Rip rap, pilings, or rocky habitat at the deep-water edge of restored salt marshes like the Spuyten Duyvil and others to be restored along the Harlem can be designed and built to incorporate areas for attached organisms, **from mussels to barnacles to oysters and seaweeds.** The front walls of the sheet piling used to construct or restore salt marsh system can be fitted with a textured concrete or pumice-like foam glass to promote colonization of the walls with organisms, increasing habitat as well as water filtration, such as barnacles, green, brown, and red algae, and perhaps sponges, anemones, oysters, and sea squirts. The overall system will then be comprised of functioning salt marsh habitat on the tidal flats and a biologically diverse community of attached organisms living on the vertical walls of each terrace.

A bioremediation approach is recommended **during redevelopment of the BOA sites and where opportunities arise throughout the upland slope**. Biological, biogeochemical and ecological approaches to remove or sequester pollutants, diminish the risk of contact, and increase the scale of natural features and ecosystem services in the Harlem River BOA, are both aesthetic and cost-effective methods of improving environmental quality. Because many, perhaps most of the BOA sites are contaminated with gasoline, fuel or heating oil-based hydrocarbons, as well as a few widely used metals from the prior industrial period, most notably lead, remediation can become substantially less costly.

Biological, biogeochemical and ecological approaches to remove or sequester pollutants **diminish the risk of contact, and increase the scale of natural features and ecosystem services** in the Harlem River Brownfield Opportunity Area may provide both an aesthetic that people are willing to vote for as well as a cost structure in line with the value added to environmental quality.

The following 4 (four) suggested approaches were proposed and accepted by two New York State agencies in 2008. The methods chosen would be based on pollutant and time constraints.

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[1] Excerpted and edited from the Bronx Council for Environmental Quality (BCEQ) 2007 Harlem River Brownfield Opportunity Area (BOA) Step 1 Nomination, pp 69-73. http://www.bceq.org/2008/09/07/harlem-river-brownfiled-opportunity-area-boa/

1. Hydrocarbons

Bioremediation with soil microbes has been a successful method for cleaning soils contaminated with hydrocarbons and can be enhanced by using plants which act to build up a diverse rhizosphere environment. Phytoremediation techniques were developed to provide a **cost-effective alternative** to traditional excavation and landfilling operations. Given potentially widespread contamination, and what have served as inhibitory costs to date, bioremediation and phytoremediation may be the methods of choice to move forward on a broad front in the Harlem River BOA.

2. Phytoremediation for Heavy Metals

Metals may also be moved out of the soil matrix and into plant material, in a process termed phytoremediation. Through environmental modifications including soil amendments, plantings, and irrigation, metals may be more selectively removed by this technique. It is also much **less energy intensive and less costly than typically soil excavation, transport and landfilling.** Physically excavating contaminated soils incur high material handling and tipping costs, ranging from about a hundred thousand to roughly a million dollars per acre. This method has the advantage of immediately eliminating identified chemical contaminants but requires land set aside in perpetuity as unproductive landfill as well as an immediate cash commitment of a hundred dollars a cubic yard, or in some cases more, for mitigation and disposal.

Phytoremediation, on the other hand, incurs what are often much more modest costs as compared to excavation and landfilling. Removal of metals by plants cannot, however, meet environmental quality standards in very short timeframes, since metal uptake is proportional to plant mass grown on site and frequently requires 2 –3 growing seasons and/or multiple harvests to achieve target concentrations.

3. Heavy Metal Sequestration by Constructed Marsh Systems: Designing for Sulfide-Metal Binding in Wetlands and Groundwater Systems

Because many of the BOA sites have high water tables and surfaces with low infiltration rates, it may be difficult to construct or install soil systems. In this case, specific above or below **ground wetland treatment** environments can be used to sequester metals and/or mineralize hydrocarbons. Below grade environments could be created or enhanced below or next to contaminated landscapes or with highway or roadway runoff in the Harlem River watershed. Sulfur and iron are both readily available waste materials in the New York City waste stream and could be utilized to augment the behavior of natural systems around the Harlem River.

4. Humic-Metal Binding in Constructed Wetlands

Wetlands, in calcium rich environments, and humic matter are also mechanisms for removing heavy metals. Each of these provides an ecosystem service if situated in and around potential sources of metals. Restoring marsh systems along the edges of the Harlem River or capturing stormwater in high pH groundwater systems could incorporate these valuable services, along with the many other benefits provided by vegetated green spaces, wetland areas, or groundwater catchment and treatment zones designed for pollutant removal. Nutrient rich soil and wetland systems also break down hydrocarbons, at concentrations substantially higher than those found in Brownfields. Because of the value they add to local properties, as well as affording local human and wildlife populations protection against chemicals of concern, incorporating natural attenuation and enhancements to increase bioremediation in this BOA may offer substantial cost-effective mitigation measures to the redevelopment of the Harlem River BOA.