In the Wake of Katrina:
Bioremediation in New Orleans, Louisiana

Introduction

Every city in the United States contains thousands of pounds of chemicals that are toxic and deadly. These chemicals are stored in fuel tanks, warehouses, industries, gasoline stations, dry cleaners, auto-repair businesses, in the garage and under the kitchen sink.

The greater New Orleans area also has a history of oil and chemical industries that generate and store thousands of tons of toxic chemicals.

When hit by the floodwaters and hurricane winds of Katrina and Rita, many of these chemicals floated out of their storage locations and into adjacent neighborhoods. These toxic spills will create long-term health risks to people in contaminated areas unless soil and water are fully cleaned up so that all toxins are removed, broken down into harmless chemicals, or tightly bound so that areas are safe for the our most vulnerable populations: children playing in their yards and schools, and the elderly whose physical health may be compromised.

The project proposed here is to make the first step to cleaning up toxic neighborhoods, schools, elder care centers, churches, gardens and parks safe by identifying where these areas currently contain toxic chemicals, identifying the types and levels of chemicals present, and implementing bioremediation. Bioremediation uses natural organic processes to remove toxins, break them down into harmless chemicals, or bind them tightly into the soil so that they do not move into dust or vegetables grown in the soil.

Project Objectives

The Post-Katrina Bioremediation Project proposes to achieve these objectives:

- Identify areas with toxic chemicals remaining in soils in New Orleans;
- Educate residents on toxic chemical risks, safe alternatives, and remediation;
- Develop effective bioremediation technology for Coastal Louisiana soils and climate;
- Construct and grow the bioremediation plant, fungi, and compost systems;
- Train New Orleans and Coastal Louisiana residents on toxic reduction, avoidance, and remediation; and
- Create an innovative and successful local and worker-owned remediation services business.

A plan to achieve these objectives is presented in the next section

Plan Elements

Environmental Sampling and Analysis

Government and private organizations, including Common Ground Relief, have collected and analyzed soil and water samples from Coastal Louisiana areas affected by Hurricanes Katrina and Rita. While Common Ground tests, as well as data that we have reviewed by other organizations, indicate that many areas of New Orleans are safe, we have identified certain areas where toxic chemicals exist in residential, school, day care, elder care, or park soils.

These areas include:

Lower Ninth Ward. There are fuel tanks in the front yards of homes. Sediment and water are oily and smell of fuel. Monitoring data indicate petroleum hydrocarbons present.

Neighborhoods near Highway 23 Plaquemines Parish south of Myrtle Grove. There are many chemical storage tanks that have been damaged or floated from their foundations. The water and sediment are oily and smell of fuel. Monitoring data indicate petroleum hydrocarbons present.

Neighborhood west of Murphy Oil Refinery. Common Ground samples of water and sediment indicate the presence of petroleum hydrocarbons.

Morrison Road north of Foch Road. Soil analysis indicates the presence of diesel fuel.

This list is NOT complete. There are certainly other sites in addition to those listed here. Conditions at these sites will change as cleanup progresses. Available data do not, however, adequately characterize conditions in areas of particular concern. These areas include the vicinity of the historical Agricultural Street Landfill superfund site, and Vietnamese neighborhoods in East New Orleans.

Additional sampling is proposed to characterize neighborhoods of concern. The plan would include the number of samples, analytical tests, and locations based on known sources and types of toxic chemicals.

Using information on historical land use, toxic chemical storage and transport, flood and wind damage, spill and superfund site locations, and likely migration pathways, New Orleans residents will determine analytical priorities within the available budget.

Toxic Area Mapping

Large-scale neighborhood maps will be created to show potential sources of toxic chemicals measured in soil and water samples. Information on potential sources will be derived from historical records, toxic release inventories, and field surveys.

Information on the presence and concentration of toxic chemicals in New Orleans-area soil and water, compiled from both government and private agency and individual testing will be analyzed for reliability. All data deemed reliable will be located on large-scale and easily readable maps. Measured chemical concentrations, topography and toxic source location information will be used to extrapolate point measurements to delineate areas of potential contamination.

Bioremediation Infrastructure

Bioremediation uses natural and organic process to remove toxic chemicals, tightly bind them onto soil structure, or break them down into harmless substances. Bioremediation requires living organisms adapted to local climate and soil conditions, and to the toxic chemicals present in the environment to be remediated.

Virtually every type of toxic contaminant can be addressed with bioremediation, including petrochemicals, herbicides, pesticides, solvents, pathogens and heavy metals. Petrochemicals, herbicides, pesticides, and solvents are large and complex molecules comprised primarily of carbon, hydrogen, and oxygen molecules. As bacteria and fungi use these molecules as a food source, they are converted from complex and toxic molecules into simple structures, primary carbon dioxide and water.

Toxic metals are elemental and cannot be removed by converting them into simpler and less toxic molecular structures. They must be either extracted from the soil by plants, which are removed for recycling or disposal, or tightly bound into organic soil molecules so that they become unavailable either to transport in small dust particles, or through roots into the leaves and branches of edible plants.

Developing a bioremediation infrastructure means creating and growing the biological systems that will allow large numbers of the bioremediation organisms to grow and be ready for use.

There are several bioremediation processes that will require an infrastructure:

Compost

Compost is a rich and complex mixture of organic material, microorganisms, and nutrients. It is an effective bioremediation agent for several reasons. Compost adds a diverse bacterial population to soil. This bacterial population will prevent the spread of disease-causing bacteria through the soil. Organic material in compost is effective in binding toxic chemicals and metals and preventing their migration either into leaching water or into plants.

Compost is created from tree, leaf, and yard debris and food and food production waste.

Creating compost requires these elements:

- A tract of land where waste can be mixed and stored during the composting process. One-half acre would be adequate for this project.
- A source of wood mulch, leaf, and yard debris. This material is available from local arborists and may be available from government agencies like the Corps of Engineers who are cutting, chipping, and hauling large volumes of tree debris in the Katrina area.
- Using this material for compost saves the cost of transportation to a landfill and disposal costs.
- Food and food processing waste. This material is available from local household and restaurant kitchens

- Equipment for moving and turning waste piles to ensure adequate aeration. Depending on the size of the pile and the project, this may require a small tractor and bulldozer.

Worm Compost

Worm compost is a very rich and well-processed organic material. It has all of the benefits of other composts when applied directly to the soil. Worm compost also contains higher concentrations and more diverse populations of beneficial bacteria than regular compost. It is a valuable source of these bacteria in brewing compost tea (described below).

Worm compost requires a large worm population, a steady source of food waste, an organic bedding material, and protected bins where the worms can live and eat. This project proposes to develop a worm composting system with a total area of 100 square feet in protected space.

Requirements:

- Construction of wooden worm bins, 18-inches deep, with a total area of 100-square feet.
- An enclosed space to contain the bins and working area.
- A heat source and adequate insulation to keep the bins at a temperature of 75 degrees to 95 degrees during all weather conditions.
- A source of bedding: shredded paper.
- A source of food waste suitable for worms: vegetables and fruit, coffee grounds, without dairy, meat, citrus, onions, starches, garlic, or chili peppers.

Compost Tea

Compost tea is a bacteria-rich liquid. When applied to soil, the bacteria in compost tea have several beneficial effects: they suppress disease, help to make nutrient available to plants, and break down toxic organic molecules, herbicides, and pesticides into simple and safe substances: sugars, water, and carbon dioxide. Compost tea is brewed by combining an energy source, nutrients, and bacteria into unchlorinated water and aerating and mixing the liquid for 36 to 48 hours. At the end of this time, the liquid containing millions of bacteria is applied to contaminated soil within an hour or two. These active bacteria immediately work to convert toxic chemicals in the soil into a useable energy source. This project proposes to construct and operate a 100-gallon compost tea brewer.

Requirements:

- 100-gallon water tank
- air pumps;
- tubing
- air stones
- 50-gallon skid sprayer
- backpack sprayers
- humic acid
- fish hydrolysis
- unsulphered molasses
- paint filter sack
- rainwater catch
- shed 500 square feet

Mycroremediation

Healthy soil is permeated with fine threads of living cells. These mycelia, or fungal mats, are an essential part of the biological and chemical processes that recycle plant and animal debris to support life. Fungi raise and lower soil pH to increase plant growth.
They filter disease-causing bacteria and break down wood, paper, and food waste. The enzymes and acids that dismantle wood also effectively break apart toxic petroleum products, pesticides, polychlorinated biphenyls (PCBS), polynuclear aromatic hydrocarbons, virtually any complex organic molecule. The resulting chemicals are simple and harmless compounds that serve as food in the decomposition process.

Requirements:

- pleurotus ostreatus (oyster) mushroom spawn
- fresh coffee grounds
- 5 gallon buckets
- air temperature < 85 degrees
- rainwater catch

Phytoremediation

Phytoremediation uses plants to extract toxic chemicals from the soil. Phytoremediation has been used to remove petrochemicals, pesticides, and polynuclear aromatic hydrocarbons (PAHs)[1] from soil. This remediation method is particularly effective for toxic metals that cannot be broken down into simple and safe components, or tightly bound into soil structures in a way that makes them unavailable either to growing vegetation. It is a method of last resort, however, because it requires removing the plants to either a landfill or to a metal recover process; and these processes must occur in a way to ensure that a problem in one area is not simply exported to another location.

The types of plants that are effective for phytoremediation depend on the specific toxic chemical present in the soil, as well as local soil and climate conditions. Certain ferns, for example, are effective extractors of soil arsenic, which has been measured at unsafe levels in New Orleans soils. Lemon-scented geraniums are effective for removing lead.

Developing phytoremediation infrastructure will consist of identifying appropriate plants for the toxic chemicals present in New Orleans soils and suitable for this growing climate. Once the plants are identified, stocks of seed will be either purchased or grown.

Requirements include:

- Experimental plots with measured levels of contamination.
- Seed or stock for a variety of potentially useful plants.
- Basic gardening equipment.
- Soil testing capability.

Priority Sites

[1] Found in New Orleans Soils.

Priority sites for bioremediation will be identified by evaluating environmental data collected by this project, as well as data from the Environmental Protection Agency, the Louisiana Department of Environmental Quality, the United States Geological Survey, the National Resources Defense Council, and the Louisiana Environmental Action Network.

- High priority sites for immediate remediation will be those with:
- High levels of toxic contamination;
- High exposure for sensitive individuals: children, elderly, or those in ill-health; and
- Communities that are historically under-served because of race or economic privilege.

Preliminary Testing

Sites to be treated will be tested for toxic contamination prior to remediation. Tests may include total petroleum hydrocarbons, metals concentrations, fecal coliform, polycyclic aromatic hydrocarbons, or polychlorinated biphenyls (PCBs), depending on the indications of existing data.
Sites may also be tested for the presence of micro-organisms, depending on funding.

Bioremediation Process

Contaminated sites will be treated with one or more bioremediation methods, depending on the type of toxins present. These methods would include application of organic compost, application of compost tea, application of microfungal mycelia, or planting and harvesting phytoremediation vegetation.

Post-Remediation Testing

Within 6-months of bioremediation, samples will be collected and tested to determine the levels of toxic chemical reduction attributable to bioremediation.

Public Education and Training

A goal of the project is to expand the New Orleans and Coastal Louisiana capacity to transform toxic and dangerous environments into conditions that can support optimum health for the entire population and gardening. A significant element of that capacity is public education and training.

The project proposes to offer a 10-day bioremediation training week in New Orleans in February 2006. The workshop would provide hands-on experiences in constructing and operating each of the project remediation methods. The workshop would be designed to train at least 50 New Orleans and Coastal Louisiana residents in bioremediation techniques.

The 10-day bioremediation workshop would be designed to allow participants who are available only for weekend, afternoon, or evening sessions to participate in shorter, coherent segments of training.

Elements of the training would include:
- Community and home composting;
- Soil sample collection and testing;
- Worm composting;
- Compost tea brewing and application;
- Mycroremediation; and
- Phytoremediation.

Report
A report will be prepared describing the project and its results. The report will include all environmental sampling data, details on the construction of the bioremediation infrastructure, a description of test sites, including toxic levels and the basis for selection.
The report will also present post-remediation toxic levels, identify the most effective methods and recommendations for on-going bioremediation within the Coastal Louisiana environment.

Elements of the project will be included within a video documentary on permaculture principles and practices, produced by Starhawk and Donna Reed.

Schedule

September, October and November 2005: Project design, environmental sampling, data analysis.

November 17 to November 27, 2005: Bioremediation infrastructure: gather compost materials and begin composting; construct 15 square feet of worm composting bins; 100-gallon compost tea brewery; 100-gallons of rainwater catch capacity; beginning to grow mushroom mycelia; garden construction for phytoremediation plants. Identify initial bioremediation sites, test them and make first application.

December - February, 2006: Continue site identification and application of bioremediation methods.

February 2006: Public forum on environmental hazards. Bioremediation workshop. Test bioremediation sites for toxic reductions.

March – June 2006: Continue Bioremediation Treatments

June 2006: Project Report.

Staffing

Lauren Ross, Ph. D., P. E. – Environmental Sampling and Analysis and Technical Oversight

Dr. Lauren Ross is an environmental engineer and owner of Glenrose Engineering, Inc. in Austin, Texas. Her work during the last 25 years has focused on design, monitoring, and remediation systems for groundwater, surface water and soil. Her work includes the development, design, construction management, review, and inspection of state-of-the-art systems to capture and treat storm runoff using pervious pavement, retention/ irrigation, bioretention, sand filtration, infiltration and vegetative filter controls.

Her engineering consulting contributed to the successful Save Our Springs citizen's referendum to protect Barton Springs, the closure of the Gibraltar hazardous waste disposal operations in a low-income and largely African American community near Tyler Texas, and restrictions to end over-pumping of the Edwards Aquifer in San Antonio.

Dr. Ross earned the degree of Doctor of Philosophy in Civil Engineering from the University of Texas at Austin in 1993, her Master of Science in Civil Engineering from Colorado State University in 1982, and her Bachelor of Science in Civil Engineering magna cum laude, from the University of Texas at Austin in 1977.

Skott Kellog – Bioremediation Design and Implementation

Scott is a co-founder and the director of the sustainability program of the Rhizome Collective, a non-profit organization based out of Austin, Texas. (www.rhizomecollective.org)

His work includes the construction and maintenance of numerous ecological tools and technologies on display to the public. These features promote decentralized, autonomous infrastructures and encourage community self reliance in the urban environment. Systems Scott has developed include constructed wetlands for wastewater treatment, intensive urban aquaculture designs,low-tech wind and passive solar systems, and simplified strategies for the bioremediation of contaminated city soils using compost, bacteria and fungi.

Scott serves as the site coordinator for the Rhizome Collective's brownfield project. The brownfield is a ten acre parcel of land covered with hundreds of tons of debris. Along with having the land donated to them, the Collective received an EPA brownfields cleanup award to remove and recycle the debris on the site and transform it into an environmental justice park. Scott has been integral to the planning and implementation of the project.

In addition, Scott is an experienced activist, permaculture teacher and community organizer. He has undertaken extensive study in fields related to ecological design and the natural degradation of pollutants.

Starhawk – Training

Starhawk is one of the most respected voices in modern earth-based spirituality. She is also well-known as a global justice activist and organizer, whose work and writings have inspired many to action. Together with Penny Livingston-Stark and Erik Ohlsen, she coteaches EAT, Earth Activist Training, intensive seminars that combine permaculture design, effective activism, and earth-based spirituality. www.earthactivisttraining.org).

Lisa Fithian - Organizer

Lisa Fithian is a longtime organizer and a certified graduate of a Permaculture Training. She is currently serving at the Project Coordinator for Common Ground.

Community Allies

We have met with and are developing working relationships with the following groups

- Parkway Partners Community Gardens, has made a one acre garden site available for the bioremediation project.
- New Orleans Food and Farm Network,
- Covington Farmers' Markets
- Laughing Crow Nursery, was doing biobrew and composting coffee grounds to make compost and worm teas, teaches permaculture and has warehouse space that's being cleaned up,
- Crescent City Farmers Market, plants etc
- Laughing Buddha Nursery , Does spraying based on anaerobic microbes Has worms, worm castings etc.
- Alliance for Affordable Energy

Materials

Worm Composting		
20 pounds of worms		
Food waste: ideally raw vegetables and fruit, no citrus or spicy		
wood to construct bins	see plans attached	
shed 500 square feet minimum		
rainwater catch system	see below	
paper shredder	5	
shredded office paper		
Compost Tea Brewery		
100-gallon water tank		
air pumps; cfm		
tubing		
air stones		
50 or 100 gallon skid sprayer		
backpack sprayers	3	units
humic acid	5	gallons
fish hydrolysis	5	gallons
unsulphered molasses	5	gallons
paint filter sack	5	
rainwater catch	see below	
shed 500 square feet		
Compost Pile		
1000 square feet of area		
35 hp tractor or Bobcat		
mulch and wood chips	5	cubic yards
green waste (anything that was green when cut): food waste, grass clippings, horse manure	0.5	cubic yards
rainwater catch		
tarps to keep it dry or shed roof	1000	square feet
trailer for loading		
Microfungal Remediation		
pleurotus ostreatus (oyster) mushroom spawn	10	bags
fresh coffee grounds	320	pounds
5 gallon buckets	10	
air temperature < 85 degrees		
rainwater catch		
Phytoremediation		
seeds; species to be determined		
good soil	10	cy
compost	10	cy
1/2 acre garden space		
Rainwater Catch		
gutters	1000	feet
Storage	1000	gallons
plumbing parts		
valves		
pipe		
hose		