IPRO 344

BUILDING A COMMUNITY GARDEN

Summer Semester 2006

IPRO 344 *Blake Davis, *Dr. Schug, Joeseph Chojnowski, Natalie Clemens, Saul Esparza, Shahir Gerges, Veronica Hernandez, Stephanie Herrera, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert, Rachael Winter.

IPRO 344: Building a Community Garden
Lab Report

Project Background:

IPRO 344 investigated methods for safe, low-cost community gardening in the urban setting. Most community gardens within large cities are sited in vacant lots that have been previously built upon. When the structures that once occupied these sites were demolished, the debris filled the basements of the structures, and was then covered by a shallow layer of nutrient poor dirt. The resulting vacant lots pose two problems for community gardening. First, the ground becomes tough and nearly impossible to manually prepare for gardening purposes. Second, the presence of lead and mercury from the paint and other construction materials has been incorporated into the soil, which can be harmful when transferred into plants which are then ingested. Since most community gardens in low-income neighborhoods do provide food, it became the aim of IPRO 344 to inexpensively grow plants which would be safe to eat in an urban community garden.

Division of Research:

Organizations of tasks were divided equally and efficiently to provide desired results in the short amount of time given.

Digging trenches:

Ditch Witch, Joeseph Chojnowski, Natalie Clemens, Saul Esparza, Shahir Gerges, Veronica Hernandez, Stephanie Herrera, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert, Rachael Winter.

Filling existing soil:

Joeseph Chojnowski, Natalie Clemens, Saul Esparza, Shahir Gerges, Veronica Hernandez, Stephanie Herrera, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert, Rachael Winter.

Filling organic soil:

Joeseph Chojnowski, Natalie Clemens, Saul Esparza, Shahir Gerges, Veronica Hernandez, Stephanie Herrera, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert, Rachael Winter.

Finding and placing fencing:

Joeseph Chojnowski, Saul Esparza, Vincenzo Procaccio, Shahir Gerges, Edward Peck.

Choosing appropriate plants:
Veronica Hernandez, Emma Sweikert, Kaylyn Siefkas, Kristina Schaefer.

Promoting and talking to sponsors:
Sara Pfau and Shahire Gerges.

Organizing and obtaining supplies:
Joeseph Chojnowski, Natalie Clemens, Saul Esparza, Shahir Gerges, Veronica Hernandez, Stephanie Herrera, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert, Rachael Winter.

Cleaning the site:
Saul Esparza, Shahir Gerges, Veronica Hernandez, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert.

Watering and maintaining the plants:
Natalie Clemens, Rachael Winters, Stephanie Herrera, Kristina Schaefer.

Soil and plant testing:
Kaylyn Siefkas, Kristina Schaefer, Dr. Schug

Research:
Joeseph Chojnowski, Natalie Clemens, Saul Esparza, Shahir Gerges, Veronica Hernandez, Stephanie Herrera, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert, Rachael Winter.

Documentation:
Joeseph Chojnowski, Natalie Clemens, Saul Esparza, Shahir Gerges, Veronica Hernandez, Stephanie Herrera, Thomas Hittie, Shannon Lucid, Edward Peck, Sara Pfau, Vincenzo Procaccio, Janina Samuels, Kristina Schaefer, Kaylyn Siefkas, Emma Sweikert, Rachael Winter.

Constraints:

Time:

The time period given for this project was June 10th to July 29th of 2006, which gave our group eight weeks to pick a site, prepare the site, plant and maintain the project and test for metals.

Budget:

The project budget was $500.00. This was used to bring in the organic soil. Therefore, it left the group no money to test the soil and plants. The solution to this was to find a facility on campus or at a different location to do the testing free of cost. This resolution is still in progress.

Watering and Maintaining Plants:

The plants were watered every other day, or at the most, every third day. They were watered evenly and consistently. The water used was Chicago city water or rain water. The plants were weeded regularly when the weeds invaded the space of the crops, and there was one weeding where the weeds around the trenches were cleared too. The plants were thinned out after they started to crowd each other.

Research:

Testing the original soil to determine the quantity of heavy metals within the site provides a basis for the expected levels of heavy metals within the plants. Next, the metals in the plants from both the original and the "clean" soil can be compared to determine whether the gardening methods which were employed had an impact on the plants. Unfortunately, due to the time constraints, no tests have been performed yet. In order to draw conclusions from this community research project, the garden will continue to be maintained until August 11, 2006, so that the required tests can be performed.

In our research, We were to select certain plant species that would grow within our project's time frame of 50 days, hot and humid climate and contaminated soil. Crop plants are the fast growing and their root capacity can accumulate high levels of lead such as sunflower, Indian mustard, tobacco, rye, spinach, and corn. But, the most promising plant to clean up the environment is Indian Mustard (*Brassica juncea* Family, cabbage family) by phytoextraction. Phytoextraction is using green plants on site to remove and reduce heavy toxic metals from the soil. This plant not only accumulates contaminated pollutants in their tissues but also uses the toxics as nutrients. The root cleans up the surface soil and up to one foot of depth. It was difficult to find Indian mustard in Chicago. But, the Mustard tendergreen (Heirloom) and Florida broadleaf mustard, a family species of *Brassica juncea* were chosen because of their similar characteristics with Indian mustard and met the project's requirement.

Mustard tendergreen (Heirloom): Seeds grow within 35 days in late summer heat, and mature in cool weather.

Florida broad leaf mustard: Seeds easily grown in the north and grow in 45 days. This plant species grows up to three feet in height.

Conclusion:

The experimental portion of this IPRO related to nutrient testing and the heavy metal testing of the soil and plants. After purchasing a Nutrient Test, the original soil on the garden site was tested. The results indicated that the soil needed to be fertilized due to a lack of phosphorus, nitrogen, and potash. The pH of the soil was slightly acidic (pH 6.5). There were numerous fiascos to be able to complete the heavy metal testing of the soil. The Environmental Protection Agency Method 3050B: Acid Digestion of Sediments, Sludges, and Soils was used to prepare the soil for flame atomic absorption spectrometry. This method incorporated the use of several acids and heat to digest the matter. After running the FLAA, it was determined that there was no lead (0.0005 ppm) in the organic soil, while there was lead (0.005651 ppm) in the original site soil.
Details of the experiments and results can be found in Appendix 1.

Through the final research of this project we hope to better inform the City of Chicago, Botanical Gardens, Chicago Green Corps, etc. of the factors involved in community gardens and different strategies that make them cost effective and safe. Hopefully, this will encourage organizations to fund and build more community gardens throughout the city.

References:

Raskin, Ilya and Burt D. Ensley. *Phytoremediation of Toxic Metals:Using Plants to Clean Up the Environment.* New York, New York: John Wiley & Sons, Inc. 2000.

Environmetal Protection Agency. *Brownsfields Technology Primer: Selecting and Using Phytoremediation for Site Cleanup.* http://www.brownfieldstsc.org/pdfs/phytoremprimer.pdf

Appendix 1

Experimental Methods & Some Results

EPA Method 3050B: Acid Digestion of Sediments, Sludges, and Soils

*This is the Environmental Protection Agency's digestion of soils. They have several protocols to use. We chose to use this method since the chemicals were obtainable, inexpensive, and lab equipment & space was limited. The chemicals were obtained from the Biological, Chemical, and Physical Sciences (BCPS) Department storage room with the assistance of Weinjing Zhao. Dr. Ken Schugg provided the lab space and equipment needed to conduct the experiment.
This method also provided preparation for soil analysis sampling by flame atomic absorption spectrometry (FLAA).

Procedure

1.1 Mix the sample thoroughly to achieve homogeneity and sieve, if appropriate and necessary, using a USS #10 sieve. All equipment used for homogenization should be cleaned according to the guidance in Sec. 6.0 to minimize the potential of cross-contamination. For each digestion procedure, weigh to the nearest 0.01 g and transfer a 1-2 g sample (wet weight) or 1 g sample (dry weight) to digestion vessel. For samples with high liquid content, a larger sample size may be used as long as digestion is completed.
NOTE: All steps requiring the use of acids should be conducted under a fume hood by properly trained personnel using appropriate laboratory safety equipment. The use of an acid vapor scrubber system for waste minimization is encouraged.

1.2 Add 10 mL of 1:1 HNO_3 , mix the slurry, and cover with a watch glass or vapor recovery device. Heat the sample to 95ºC ± 5ºC and reflux for 10-15 minutes without boiling. Allow the sample to cool, add 5 mL of concentrated HNO_3, replace the cover and reflux for 30 minutes. If brown fumes are generated, indicating oxidation of the sample by HNO_3, repeat this step (addition of 5 mL of conc. HNO_3) over and over until no brown fumes are given off by the sample indicating the complete reaction with HNO_3. Using a ribbed watch glass or vapor recovery system, either allow the solution to evaporate to approximately 5 mL without boiling or heat at 95ºC ± 5ºC with boiling for 2 hours. Maintain a covering of solution over the bottom of the vessel at all times. Let sample cool.

1.3 After step 1.2 has been completed and the sample has cooled, add 2 mL of water and 3 mL of 30% H_2O_2. Cover the vessel with a watch glass or vapor recovery device and return the covered vessel to the heat source for warming and to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until efferevescence subsides and cool the vessel.

1.4 Continue to add 30% H_2O_2 in 1-mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged. Do not add more than a total of 10 mL of 30% H_2O_2.

1.5 Cover the sample with a ribbed watch glass or vapor recovery device and continue heating the acid-peroxide digestate until the volume has been reduced to approximately 5 mL or heat at 95ºC±5ºC without boiling for two hours. Maintain a covering of solution over the bottom of the vessel at all times.

1.6 Add 10 mL conc. HCl to the sample digest and cover with a watch glass or vapor recovery device. Place the sample on the heating source and reflux at 95ºC±5ºC for 15 minutes.

1.7 Filter the digestate through Whatman No. 41 filter paper (or equivalent) and collect filtrate in a 100 mL volumentric flask. Make to volume and analyze by FLAA or ICP-AES.

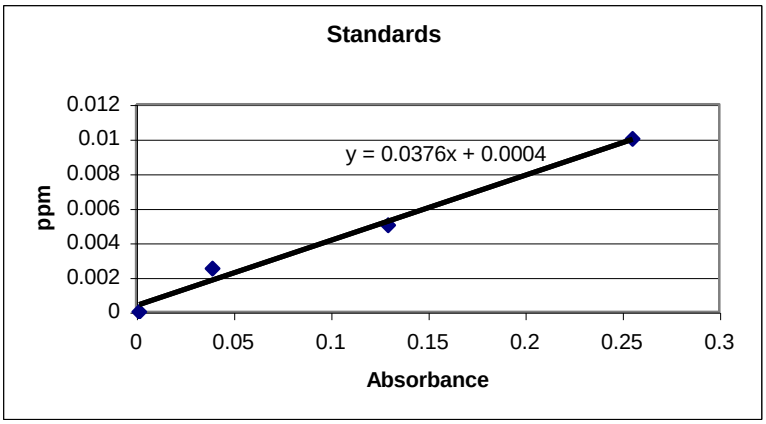
Results

It was determined that the amount of lead in the new soil was none (0.0005 ppm). The amount of soil in the Site soil was 0.005651 ppm. This was determined using the standards and a linear equation. Table 1 expresses this result. Graph 1 indicates the linear line used.

Table 1. Absorbency Readings

	Absorbance 1	Absorbance 2	Absorbance 3	Avg. Absorbance	ppm	calculated ppm
Control	0.002	0.002	0.001	0.001666667	0	0.0004
Std 1	0.038	0.041	0.039	0.039333333	0.0025	0.0018664
Std 2	0.128	0.129	0.132	0.129666667	0.005	0.0052754
Std 3	0.256	0.255	0.255	0.255333333	0.01	0.0100005
Organic soil	0.003	0.003	0.003	0.003	unknown	0.0005128
Site Soil	0.14	0.138	0.141	0.139666667	unknown	0.005651

Graph 1. Standards Graph



The actual µg/kg of lead in the soil has not been determined yet do to the lack of a working equation. There currently too many unknowns to determine perform that calculation.

Soil pH and Nutrient Testing: rapidest ® Soil Test Kit

*This soil testing kit was obtained online and was used to test contaminated soil for the nutrients.

Procedure for pH Testing

1.1 Collect a soil sample from the location being tested. Take soil that is four inches below the surface. Avoid touching the sample with hands. Put the sample in a clean container. Break up the soil and remove organic material, small rocks, and lime particles.
1.2 Fill the bottom of the pH-testing container to the "soil fill line" with soil sample.
1.3 Separate proper capsule over the container and pour powder into chamber.
1.4 Using the dropper, add deionized or bottled water to the "water fill line".
1.5 Cap the container, and mix vigorously by shaking for approximately one minute.
1.6 Let set for one minute to allow color to develop.
1.7 Check results using the indicator on the box to determine the soil pH.

Results of pH Test

The results for the pH test indicated that the soil pH was 6.5, which is slightly acidic. Even though it is slightly acidic, it still should be able to effectively contribute to soil growth.

Procedure for Potash, Nickel, and Phosphorus Testing

1.1 Collect a soil sample from the location being tested. Take soil that is four inches below the surface. Avoid touching the sample with hands. Put the sample in a clean container. Break up the soil and remove organic material, small rocks, and lime particles.
1.2 Using deionized or bottled water, pour in a plastic or glass bottle. Add the soil. The ratio should be 5:1, water to soil.
1.3 Shake vigorously for two minutes to mix well.
1.4 Let contents settle undisturbed. This can take from 30 minutes to 24 hours.
1.5 Using dropper, fill the box of each test to line with water sample. Do not unsettle the contents at the bottom of the container.
1.6 With color coordinated tablets and boxes for specific test, break the tablet above the water. Pour tablet contents into container.
1.7 Cap the boxes and shake vigorously for 1 minute.
1.8 Let contents settle for 10 minutes.
1.9 Read the results in natural light using the color indicators on the box for each specific test.

Results for Potash, Nickel, and Phosphorus Tests

The results of these tests indicated the following for each test. For the Potash test, it was depleted. There was an adequate amount of Phosphorus in the soil. There was a deficient amount of Nitrogen in the soil. Since nothing is sufficient or surplus, the soil from the site should be fertilized to promote more growth of the plants.