Everybody benefits from a healthy environment and all of us can make a contribution if we understand more about the concept of phytoremediation. Therefore, designing a site that incorporates education about the benefits of phytoremediation, and how it works, is extremely important.

When school children are given the opportunity of learning about phytoremediation as part of their daily educational experience, they are more likely to incorporate phytoremediation in their later lives. Making phytoremediation fun and interactive enhances the entire educational experience.
Demographics: Miami Beach

Population: 82,779

Hardiness Zone: because of Miami's tropical climate, the plant hardiness zone is 10b.

Languages: Spanish: 55%, English: 33%

Site Location Map

Area Map of Fienberg Fischer School

School Information

Total Enrollment

Site Entrances

This site is currently the location of the Fienberg Fisher K-8 Center.
This elementary school focuses on academic excellence, community involvement, social and emotional growth, art, international education and technology, as well as being an eco-friendly school.

This is an ideal site for a phytoremeditation project.
View from 14 St. across the site to the neighboring building
View from 14 St. toward school buildings
Walkway separating site from school building

Surrounding Area:
- Institutional
- Commercial shopping
- Low-density multi-family
- High-density multi-family

Building Heights:
- One Story
- Two Story
- Three Story
- Four Story

Site Images:
- 15th St
- 11th St Meridian Ave
- W Washington Ave
- Collins Ave

Building map with various sections marked:
- Site Location
- One Story
- Two Story
- Three Story
- Four Story
Design Goals
Design to educate students and community members about the benefits of phytoremediation.

Incorporate the use of phytoremediation as part of the school's educational experience.

Demonstrate how phytoremediation can improve the quality of greywater produced in a school.

Identify how phytoremediation can assist in enhancing air quality.

Develop an understanding of how stormwater can indicate the level of toxins in our environment.

Use design elements to enhance student learning.

Curriculum
Four areas of educational focus:

Phytoremediation/Root System
Greywater
Stormwater
Air Quality / Green Walls

Fienberg Fischer teaches kindergarten through 8th grade. This curriculum is for grades 1-5.

What is Phytoremediation
Why is Phytoremediation important
What is Stormwater

What is Greywater
Why is Greywater important
Benefits of using Greywater

Amount of Greywater being cleaned

How do Phytoremediation work
How do Green Walls work

Grades/Ages: Learning Concepts:

1st grade: 6-7 years old
2nd grade: 7-8 years old
3rd grade: 8-9 years old
4th grade: 9-10 years old
5th grade: 10-11 years old

The educational experience covers four areas:

Phytoremediation/Root System
Greywater
Stormwater
Air Quality / Green Walls

Fienberg Fischer k-8
Vacant Shed
Vacant Shed
Vacant Shed

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Vacant Shed
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Vacant Shed
Entry point to the site viewed from the school building

Plants that uptake toxins on the site and surrounding area

Materials - Permeable Paver Walkway

These permeable pavers will be used for the walkway. They will intrigue the school children to question how permeable pavers work.

Grey water collection area

Air quality testing area

Grey water functional system

Misting system

Stor mwat er

Domino stor mwat er

FT

0       10        20          50

N

Storage point is appropriate for planting zone 10b

Plants

Green Wall

Baker's Cord Grass

Spartina bakeri

Bearoded Iris

Iris germanica

Blue Flag

Iris virginica

Common Duckweed

Lemna minor

Duck Potato

Sagittaria lancifolia

Golden Canna

Lather Leaf Fern

Acrostichum danaeifolium

Pickerelweed

Pontederia cordata

Spider Plant

Chlorophytum comosum

Virginia Willow

Itea virginica

Water Hyacinth

Eichhornia crassipes

English Ivy

Heder a helix

Lavender Trumpet Vine

Clytostoma callistegioides

Lather Leaf Fern

Rumohra adiantiformi

Spider Plant

Chlorophytum comosum

Narrow Leaved Cattail

Typhha angustifolia

New Zealand Flax

Phormium tenax

Boston Fern

Nephrolepis exaltata

Castor Bean

Ricinus communis

English Daisy

Bellis perennis

Ivy Geranium

Pelargonium peltatum

Janet Craig Dracaena

Dra c aena deremensis

Peace Lily

Spathiphyllum wallisii

Rubber Plant

Ficus elastica

Stor mwat er

All toxins below are found in Asphalt

Petroleum

Polyycyclic Aromatic Hydrocarbon (PAH)

Carbon

Sulfur

Nitrogen

Fuel Oil

Crude Oil

Air Quality

Benzene (Formed by natural process and human activity)

Polyycyclic Aromatic Hydrocarbon (PAH)

Polychlorinated Biphenyl (PCB's) (Used until 1970's, still exist in the air)

Carbon mono xide (Formed from incomplete combustion of fuel)

VOC's (Released into the air as gases)

Arsenic (Caused from emission sources)

Cobalt (O ccurs naturally)

L ead (O ccurs naturally)

Manganese (O ccurs naturally)

Nickel (O ccurs naturally)
The four aspects of teaching about phytoremediation in an educational environment:

I. Phytoremediation
II. Greywater
III. Stormwater
IV. Air Quality
School children learn best by seeing and doing. At the Fienberg Fischer Center the school children will learn about phytoremediation by interacting with aeroponically grown plants and experiencing the science of phytoremediation in action.

**Construction Document of Aeroponic System**

**Phytoremediation Educational Element**
Greywater from Student hand-wash sinks

Florida law requires 1 sink per 30 students*

841 students /30 sinks = 28.03 i.e. 29 sinks

Each sink uses 10 gallons/day from September-May (School Year)**

Each sink uses 1 gallon/day from June-August (Vacation)

School Year usage/day = 29 sinks x 10 gallons/sink/day = 290 gallons generated

Vacation usage/day = 29 sinks x 1 gallon/sink/day = 29 gallons generated

The design incorporates 3,072 sq ft of green walls that recycle greywater x 0.09 = 276 gallons of water used by green walls***

95% of greywater is used by green walls

* Florida Department of children and families

** Calculation derived from information on http://www.gardenbeet.com/living-walls.html

***http://wiki.answers.com/Q/How much water does the sink use per minute

Greywater Math and Corresponding Green Walls

Visualize

School Year usage/day = 29 sinks x 10 gallons/sink/day = 290 gallons generated

290 gallons represented by 290 one gallon milk jugs

95% of greywater is used by green walls

Section of Greywater System
Greywater Educational Element

The first step in the phytoremediation process is demonstrated when the red light flashes. This indicates that the boy's bathroom sink is being used and greywater is flowing through the system. The yellow light flashes when the girl's bathroom sink is being used. This highlights the educational aspect of a simple daily activity that produces greywater, having a scientific consequence through phytoremediation.
When greywater is removed from the collection bowl it is tested at this testing center which is designed to create a fun learning environment for the school children. The children can sit on the grass, or on tall stools in front of a green wall where they test the grey water and the recycled water while being able to see the physical results of the science at work.

Another part of the learning experience is to carry the stormwater in buckets to this testing area for testing purposes.

Supplies needed for testing water quality:
* enough supplies for 3-10 people at a time
  * sample collection jar
  * pH test tube
  * dissolved oxygen vial
  * temperature strips
  * color chart
  * pencils
  * 100 dissolved oxygen reagent tablets
  * gloves
  * hand wash station
Stormwater Volume Calculation

Average Monthly Rainfall: 5 Inches

\[
5/30 = 0.16 \text{ (Average Daily Rainfall)}
\]

\[
0.16/12 = 0.0138 \text{ (Average Daily Rainfall per foot)}
\]

\[
0.0138 \times 30,000 \text{ sq ft} = 416.664 \text{ (Stormwater Volume in Cubic Feet per day)}
\]

\[
416.664/7.48 = 55.70 \text{ gallons per day (Average Stormwater Volume of gallons per day over the 30,000 sq ft area.)}
\]

55 Gallon Barrel represents 55 Gallons of water over a 30,000 sq ft area.

Section 'A - Stormwater Process

1. Stormwater from the roof is drained into a series of tanks.

2. The water flows down the slope back to the pond.

Section 'B - Domino Effect Element

Illustration of tipping bowl
School children have an opportunity of playing in this area, while watching the water flow from the bowls into the pond. They can also watch the activation of the fountain which is triggered when water runs into the stormwater collection area. All these activities link science with education.
Children learn better when they are in a clean and safe environment. This includes educating them about the air that they breathe. This section creates a fun and interactive way to test air quality.

**Air Quality Testing Station**

The Misting Station is automatically activated when sensors detect toxins in the air. When activated, the station emits a colored mist that corresponds to a color-coded toxin identified on the walkway. This educates the children about the names and presence of toxins in their environment.

**View of Misting Station**

The colorful spinning wheel in the center of the air quality testing area spins when pushed by the school children. The children use the testing stations on the right to test the toxins in the air and they record each test result by the name of the toxin. In this process they learn the names of the toxins and how often the toxins appear in their own school environment. This is another example of a fun learning experience.

**Plan View of Air Quality Testing Station**

The colorful spinning wheel is the center of the air quality testing area spins when pushed by the school children. The children use the testing stations on the right to test the toxins in the air and they record each test result by the name of the toxins. In this process they learn the names of the toxins and how often the toxins appear in their own school environment. This is another example of a fun learning experience.

*Case Study: Living Systems. Innovative Materials and Technologies for Landscape Architecture. Birkhauser*
The design uses specific elements to respond to the exploration of phytoremediation. The design of the elements is appropriate for learners of the target age group to benefit interactively by seeing the connection between science and nature in an educational environment.