



# **Effectiveness of Phytoremediation for Removing Contaminates from Water**

**Joe Hillers, Coupeville**

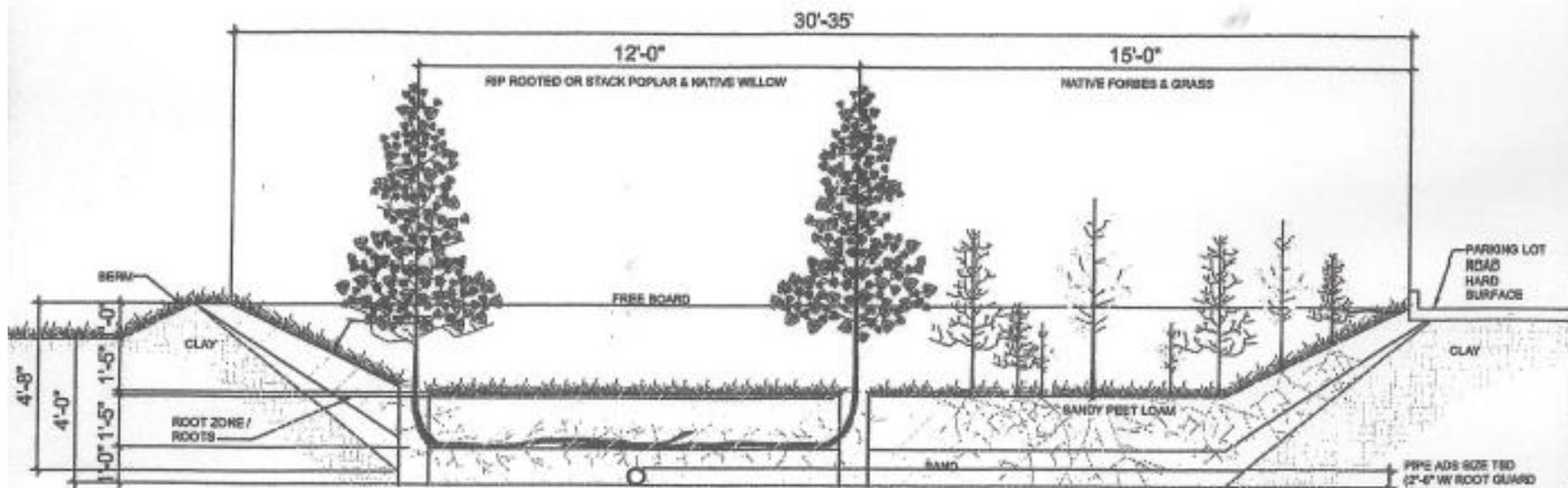
**Lou Licht, Ecolotree, North Liberty, Iowa**

**Willow and Poplar shoots are used in our phytoremediation experiments because they will develop roots on every part of the shoot that is below ground. This allows the development of a deep root system.**

**Willow and Poplar also survive under wet conditions.**

# **Phyto-Swale Experiment**

**A water filtering swale was built in Coupeville to catch and filter storm water from a 7 acre commercial development. This swale was built with an underlying drain pipe running the length of the swale to collect the water after it has filtered through the soil and roots.**



**The swale is located behind the Island Transit Parking Lot on South Main Street.**

**National Park Service provided the land.**

**Town of Coupeville built the swale.**

- **Willow and Poplar shoots were planted in trenches ~ 8 inches below the surface of the swale in 11/2010.**
- **Trees were planted perpendicular to the flow of the swale.**
- **Trenches were spaced ~ 3' apart for the 250' length of the swale.**





- **Water samples were collected every other week from the inflow to the swale and from the outflow pipe.**
- **Water samples were collected during the rainy seasons of 2010/11, 2011/12, 2012/13.**
- **Averages of all 3 sampling seasons will be shown.**

# Phyto-Swale Results

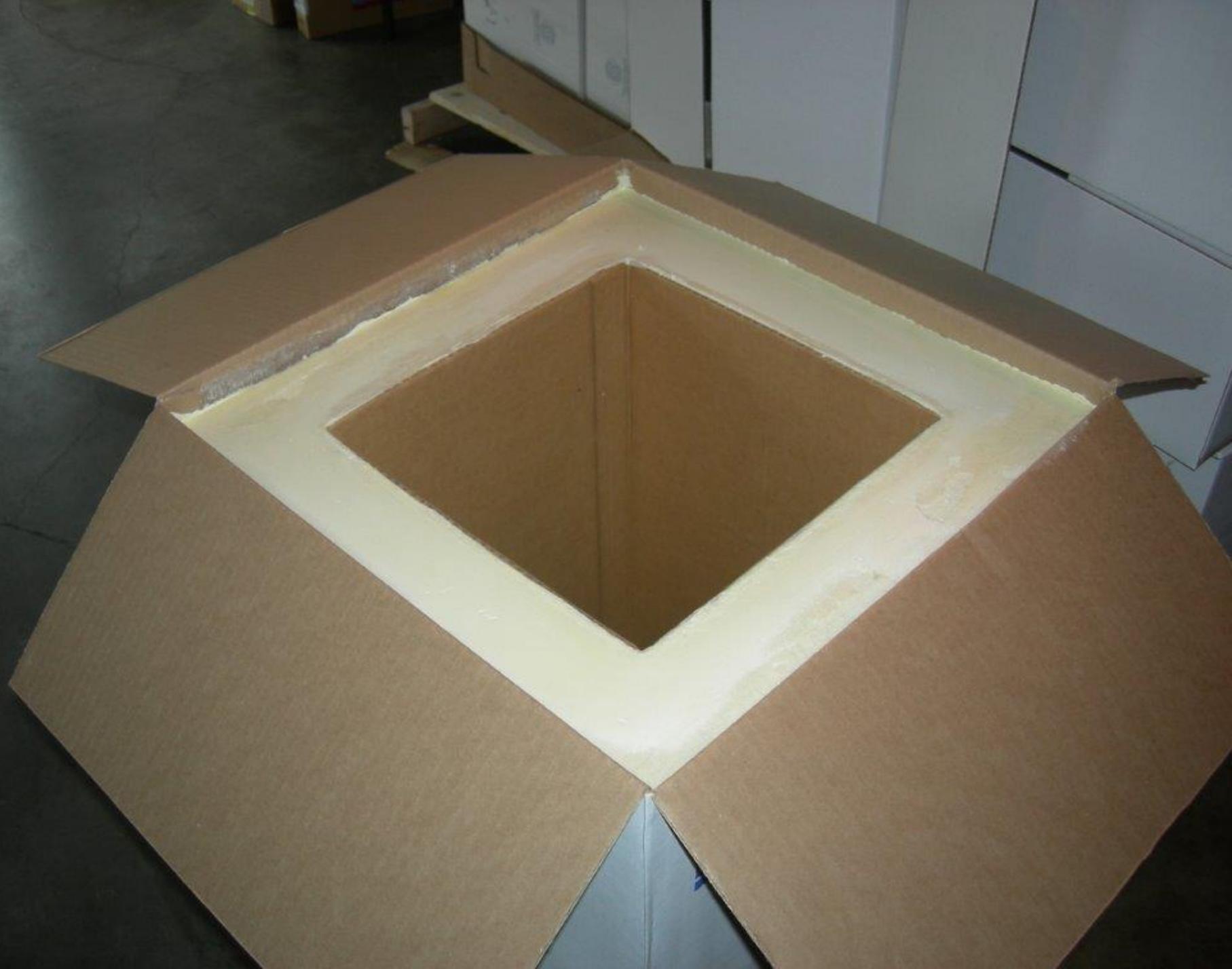
Effect of filtering storm water through soils and roots on nitrate, phosphate, copper and pH

	Total			
	<u>Nitrate</u>	<u>Phosphate</u>	<u>Copper</u>	<u>pH</u>
	mg/L	mg/L	mg/L	
<b>Averages</b>				
<b>Inflow</b>	<b>.24</b>	<b>.10</b>	<b>.004</b>	<b>7.4</b>
<b>Outflow</b>	<b>.14</b>	<b>.08</b>	<b>.004</b>	<b>6.9</b>

# **Phyto-Box Experiment**

**An experimental box was developed to test the effectiveness of 'soil' and tree roots in removing contaminants from the outflow water from the Coupeville Treatment Plant.**

**Each box was 1' X 1' and 34" deep. A perforated drain tube was inserted into the bottom of each box.**



**Four different growing mediums or 'soils' were used in the 15 experimental boxes.**

- 3 boxes contained only perlite – no trees.**
- 3 boxes contained only perlite plus trees.**
- 3 boxes contained clay soil plus perlite plus trees**
- 3 boxes contained sandy soil plus trees**
- 3 boxes contained sandy soil plus compost plus trees**

**2 willow shoots and 4 poplar shoots were planted in each box receiving trees. The shoots were about 4' in length and were planted the full depth of the boxes.**

**This planting regime was designed to create a dense root mass the full depth of the boxes.**



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**The trees were planted in the boxes in 6/2011.  
The boxes were moved to the Treatment Plant  
9/2011.**

**Outflow water from the Treatment Plant was  
applied automatically 3-4 X/day.**



**Nitrate levels (mg/L) of**  
**Plant Effluent & Phyto-Box output with Different Growing**  
**Mediums**

**Trees not leafy**

<b><i>Date</i></b>	<b><i>Plant Effluent</i></b>	<b><i>GROWING MEDIUM</i></b>				
		<b><i>Perlite Only</i></b>	<b><i>Perlite + Trees</i></b>	<b><i>Heavy Soil + Perlite</i></b>	<b><i>Sandy Soil</i></b>	<b><i>Sandy Soil + Compost</i></b>
<b><i>11/04/11</i></b>	<b><i>7.5</i></b>	<b><i>2.3</i></b>	<b><i>1.7</i></b>	<b><i>3.0</i></b>	<b><i>2.7</i></b>	<b><i>1.3</i></b>
<b><i>11/18/11</i></b>	<b><i>13.5</i></b>	<b><i>2.0</i></b>	<b><i>0.0</i></b>	<b><i>1.0</i></b>	<b><i>1.0</i></b>	<b><i>0.0</i></b>
<b><i>03/26/12</i></b>	<b><i>8.6</i></b>	<b><i>0.1</i></b>	<b><i>0.2</i></b>	<b><i>3.0</i></b>	<b><i>1.2</i></b>	<b><i>1.3</i></b>
<b><i>03/12/13</i></b>	<b><i>9.3</i></b>	<b><i>1.2</i></b>	<b><i>1.0</i></b>	<b><i>0.4</i></b>	<b><i>0.0</i></b>	<b><i>0.0</i></b>
<b><i>12/16/14</i></b>	<b><i>9.1</i></b>	<b><i>--</i></b>	<b><i>ND</i></b>	<b><i>ND</i></b>	<b><i>ND</i></b>	<b><i>ND</i></b>

**Phosphate Levels (mg/L) of  
Plant Effluent & Phyto-Boxes with Different Growing Mediums**

**Trees Not Leafy**

<b><i>Date</i></b>	<b><i>GROWING MEDIUM</i></b>					
	<b><i>Plant Effluent</i></b>	<b><i>Perlite Only</i></b>	<b><i>Perlite + Trees</i></b>	<b><i>Heavy Soil + Perlite</i></b>	<b><i>Sandy Soil</i></b>	<b><i>Sandy Soil + Compost</i></b>
<b><i>11/04/2011</i></b>	<b><i>10.0</i></b>	<b><i>3.6</i></b>	<b><i>2.7</i></b>	<b><i>2.5</i></b>	<b><i>4.0</i></b>	<b><i>6.0</i></b>
<b><i>11/18/2011</i></b>	<b><i>6.3</i></b>	<b><i>2.3</i></b>	<b><i>1.3</i></b>	<b><i>0.2</i></b>	<b><i>0.9</i></b>	<b><i>4.1</i></b>
<b><i>03/26/2012</i></b>	<b><i>3.0</i></b>	<b><i>0.8</i></b>	<b><i>0.7</i></b>	<b><i>0.3</i></b>	<b><i>0.3</i></b>	<b><i>1.3</i></b>
<b><i>03/12/2013</i></b>	<b><i>6.5</i></b>	<b><i>3.3</i></b>	<b><i>0.3</i></b>	<b><i>0.5</i></b>	<b><i>0.2</i></b>	<b><i>1.2</i></b>

**Metals are another water contaminate**

**Treatment plant effluent and Phyto-Box outflow were tested for 23 metals by the King County Environmental Lab., Seattle**

**Tests were done on August 23, 2014 (trees leafy) and December 17, 2014 (trees not leafy).**

**Analysis was only done on boxes with trees.**

**Funding for this testing was provided by the  
Island County Marine Resources Comm.**

# Metals content of Plant Effluent & Phyto-Box Outflow

## Plant Effluent > Box Output

Metal	Plant Effluent		Heavy Soil		Sandy Soil	
	Effluent	Perlite	+Perlite	Soil	+ Compost	Sandy Soil
Copper	46	11	5	3	9	
Zinc	177	10	13	16	63	

## Plant Effluent < Box Output

Metal	Plant Effluent		Heavy Soil		Sandy Soil	
	Effluent	Perlite	+Perlite	Soil	+ Compost	Sandy Soil
Iron	93	168	1515	19893	17193	
Nickel	2.3	2.9	13.2	25.5	30.2	

Selected results when there were significant differences between effluent and output for both times measured.

All measures are  $\mu/L$ .

# **Fecal Coliform Counts**

**Modifications to the Treatment Plant operation made available outflow water that was pre-ultraviolet treatment. This allowed the application of water containing Fecal Coliforms to the Phyto-Boxes.**

**2 boxes containing Heavy Soil + Perlite + trees;  
2 boxes containing Sandy Soil + trees and 2  
boxes containing Perlite Only (no trees) were  
sampled.**

**Samples were prepared and evaluated by  
Coupeville Plant personnel who routinely  
evaluate Fecal Coliform samples for regulatory  
purposes.**

# Fecal Coliform counts (cfu/100ml) of plant effluent (n=1) and averages of the outflow from the phyto boxes (n=2)

		<u>Phyto-Box Growing Medium</u>			
<b>Sampling Date</b>	Plant Effluent	Heavy Soil+ Perlite	Sandy Soil	Perlite Only	
<b>May 17, 2015</b>	9300	1375	145	NM	
<b>June 16, 2015</b>	3700	1580	1040	475	

# **Ebey Landing Outflow**

**Water flowing from the intermittent stream at Ebey's Landing has been found to be high in Nitrates and Fecal Coliforms by Island County Public Health.**

**Water samples were collected from this stream for the month of April, 2013. One gallon of this water was applied to each box containing Ebey Prairie soils every day of April.**



**Water samples were taken from the stream outflow and the 9 sampled boxes on April 25, 2013.**

**The 9 sampled boxes were those containing Ebey's Prairie soils and trees.**

**Samples were analyzed by Edge Analytical in Burlington.**

## Nitrate, Phosphate and Fecal Coliform Counts of Stream Outflow Water and Phyto-Box Outputs

	<u>Soil Medium</u>			
	<u>Outflow</u>	<u>Heavy Soil + Perlite</u>	<u>Sandy Soil</u>	<u>Sandy Soil +Compost</u>
Nitrate( $\mu$ /L)	29.6	1.2	0.0	0.0
Phosphate( $\mu$ /L)	0.8	0.04	0.5	1.0
Fecal Coli. (cfu/100 ml)	----	0.6	0.0	0.0

Outflow water was not analyzed for Fecals but 2 readings done by the Dept. of Health during April 2013 were 2800 and 32 cfu/100 ml.

# Conclusions

- 1. Filtering water through 'soil' and roots or perlite only will greatly reduce the nitrate level.**
- 2. Filtering water through 'soil' and roots will reduce phosphate level.**
- 3. Perlite is not as effective at reducing P levels as soil and roots.**

## **Conclusions(cont'd)**

- 4. Filtering Treatment Plant effluent through soil and roots greatly reduced the levels of copper and zinc but increased the levels of iron and nickel.**
- 5. Filtering Treatment Plant effluent through soil and roots appears to reduce the number of Fecal Coliforms.**

## Thanks

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