POWELL RIVER PROJECT REPORT 2006

Environmental Science Class
SwVCC Governor's School

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ABSTRACT

The Environmental Science students of the Region V Governor's School for Science and Technology participated in an annual research project at the Powell River Education Center located in Wise County, Virginia, during the summer of 2006. The study concentrated on the attributes of strip-mined soil to determine whether mine spoil soil quality is suitable for distinct post-mining activities without application of agrochemical or other land treatments. The test was conducted at three different locations within the Powell River Education Center boundaries. Soil sampling and horizon identification were developed at an undisturbed forest land site near the pavilion to serve as a control. Two other sites, which contain reclaimed mine soil, were chosen in an area below the orchard. One of these sites has been treated with municipal waste sludge.

The sampling was conducted within the soil horizon A at a depth of 15 cm below the surface, with sampling techniques applied to each soil pit. An average of the soil attributes from each location was established. A pit was constructed within an undisturbed forest, which will stand as a control. The soil at the other two locations was compared or contrasted with the soil taken from the undisturbed forest site. The soils at the reclaimed mine land sites were also compared and contrasted to results from previous years. The soil attributes at each location were compared to optimum soil attributes of representative plant needs.

This study shows the methodology and graphs of the facts collected by the Governor's School students during their research in 2006. The research establishes soil data for assessment and comparison purposes for investigations in future years.

This data will be made available to economic development groups, governmental agencies and active coal companies in southwest Virginia. This study will be a valuable resource for the Department of Agriculture, County Extension Agencies and other land management groups.

The Powell River Project is a cooperative research and educational effort devoted to the development of the economic resource potentials of southwestern Virginia. The Powell River Project Center also provides a learning enrichment practice for the SwVCC Governor's School students that provide students with research opportunities to conduct studies on previously donated strip-mined land.

In the past, the SwVCC Governor's School students participated in an on-going study of the growth of Christmas trees on strip-mined land at the Powell River Project Site, located in Wise County, Virginia. Students conducted soil sampling, insect analysis, and dimensional characteristics of the trees.

In 2003, the Director proposed and received funding for the students in the Environmental group to conduct a research project entitled "Soil Attributes as the Powell River Site as Compared to Optimum Soil Characteristics." This study concentrated on soil attributes as compared to optimum soil characteristics for an assortment of post-mining land uses to determine whether mine spoil soil quality is suitable for distinct post-mining activities without application of agrichemical or other land treatments. This research will establish soil data for comparison purposes for future years of investigation. This study is a continuation of the project initiated in 2003.

Additionally, this year, the locations of the soil test sites were mapped using global positioning system (GPS) units. This will enable future studies to locate the test sites for future reference for studies at the same location and/or begin mapping for comparison to future locations.

ACKNOWLEDGEMENTS

Dr. Craig M. Ashbrook, Southwest Virginia Community College

Powell River Education Center

Jon Rockett, Powell River Project

Region V Governor's School Governing Board

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INTRODUCTION

In Southwest Virginia, much of the land has been stripped of its natural resources. Establishing soil conditions that are favorable for plant growth in reclaimed strip mine soil is a major reclamation challenge. The purpose of this study was to collect and analyze soil data from three different locations at the Powell River Site. The seven students of the Environmental Science class examined soil attributes at the three sites, using the forest site as a control, and compared them to representative optimal soil characteristics for post-mining land use. They did this to establish whether the quality of soil on the disturbed land is comparable to undisturbed forest soil and whether the soil in the disturbed areas is suitable for post-mining activities with no application of agrochemicals or other land treatments.

PROCEDURE

The Environmental Science class of the 2006 Region V Governor's School for Science and Technology gathered soil samples at the Powell River Project Center from three soil pits selected randomly at the site. One set of samples was collected from an undisturbed forest site near the pavilion. A second set of samples was collected from an untreated section of reclaimed mine soil near the orchard. The untreated soil consisted of only blended mine spoils. A third set of soil samples was collected from a section of reclaimed mine soil that had been treated with municipal sewage sludge. This section was also in an area near the orchard adjacent to the untreated site. Each of the three plots was sampled using sampling techniques and procedures described in the Soil Science Laboratory Manual for Community College Science Courses by Dr. Craig M. Ashbrook and the LaMotte soil analysis test kits. Samples were taken to determine whether soil nutrients and pH were at acceptable levels in each plot. The Lamotte Soil Analysis Test Kit was used to determine the phosphorus, potassium, nitrogen and pH levels of the sample soil.

There were seven students in the class, so each student ran tests on each of the three sites. Soil pits were dug at each of the three locations and each student took a sample of soil to be tested for primary nutrients (nitrogen, potassium and phosphorus) and pH. Soil density and porosity were not included in this year's study.

The samples were returned to the lab where the soil was analyzed using procedures described in the Soil Science Laboratory Manual for Community College Science Courses by Dr. Craig M. Ashbrook and the LaMotte Soil Analysis Test Kit.

Statistical analysis was conducted using 2 Sample T-test procedures. With this test, the null hypothesis (H_o) states that there are no statistical differences among the samples for a particular characteristic. Mathematically, if the alpha value is less than or equal to the p value in a set of data, the H_o is accepted. If the null hypothesis is rejected, then there is a significant difference between samples. The rejection of the H_o is a clear indicator that soil characteristics are impacting plant development. An alpha

value of 0.05 is used as the critical value for comparisons. Calculations were made using TI – 83 calculators.

This year, soil sampling sites were mapped using global positioning system (GPS) coordinates to record latitude, longitude and elevation of the soil samples.

SUMMARY OF DATA

SOIL ATTRIBUTES - NITROGEN

Testing of seven soil samples each of undisturbed forest, untreated field, and sludge treated field at the Powell River Project Site showed no major statistical difference in the soil nitrogen levels. The average nitrogen level in the undisturbed forest was 11.9 lbs/acre. In the the sludge treated field the average nitrogen level was 19.1 lbs/acre, and decreased to 10.9 lbs/acre in untreated field.

Statistical analysis of the nitrogen tests, using the T-Test procedure, produced a P-value of 0.17 for treated soil compared to forest soil, 0.66 for untreated soil compared to forest soil, and 0.13 for treated soil compared to untreated soil. There was no statistical difference in the nitrogen levels of reclaimed mined land compared to the natural undisturbed forest land at the Powell River Site.

SOIL ATTRIBUTES – POTASSIUM

We found that the average potassium level of undisturbed forest soil was 140.7 lbs/acre. The potassium level in the treated soil averaged 124.4 lbs/acre. The untreated soil had a considerably higher average potassium level of 174.3 lbs/acre.

Statistical analysis using T-test procedures with an alpha value of .05 indicates that there is no significant statistical difference in the potassium levels of reclaimed mine land as compared to the natural undisturbed forest at the Powell River Site. T-test analysis produced a p-value of .59 compared to an alpha value of 0.05 for the average potassium soil levels in the treated mine soil when compared to forest soil. Comparing untreated mine soil to forest soil produced a p-value of 0.30. A p-value of 0.0056 resulted when comparing the untreated mine soil to treated soil. This indicates that there is a significant statistical difference between the potassium levels between the treated and untreated reclaimed sites.

COMPARISON OF SOIL PHOSPHOROUS LEVELS FROM THE TEST SITES

The group average for the seven tests on the undisturbed forest soil was 52.9 lbs/acre. The group average for the treated soil was 137.1 lbs/acre. The group average for the untreated soil was 43.6 lbs/acre. The phosphorous level in the treated soil was higher than both the undisturbed forest and the untreated soil. The phosphorous level of the sludge treated soil was the highest of the three sites tested.

Statistical analysis using T-test produced a p-value of 0.007 compared to an alpha value of 0.05 for the average phosphorous levels in the undisturbed forest and treated soils. There was a significant statistical difference between the phosphorous levels at these two sites. A p-value of 0.71 resulted from comparing the average phosphorous levels in the undisturbed forest and untreated soils. No significant statistical difference was found between the phosphorous levels at these two sites. A p-value of 0.000017 compared to an alpha value of 0.05 for the average phosphorous levels between the untreated and treated soils showed a significant statistical difference between the phosphorous levels at these two sites.

COMPARISON OF SOIL PH TEST

Three types of soil from the Powell River Project: forest soil, treated reclaimed mine soil, and untreated reclaimed soil was tested.

The average pH of undisturbed forest soil was 7.1. The average pH of treated soil was 6.1. The average pH for untreated soil was 6.1.

Statistical Analysis Using T-Test Procedures with an Alpha Value .05 indicates that there is no statistical difference between the pH of the treated and untreated reclaimed mine land soil. However, there was a significant statistical difference between the pH of the reclaimed mine land site and the undisturbed forest soil.

T-Test comparison between forest and treated reclaimed mine land produced a p value of 0.00039 compared to alpha value of .05. This indicates a significant statistical difference between the pH of forest soil and treated reclaimed mine land soil.

T-Test comparison between forest and untreated reclaimed mine land produced a p value of 0.00049 compared to alpha value of .05. This indicates a significant statistical difference between the pH of forest soil and untreated reclaimed mine land soil.

T Test comparison between treated and untreated reclaimed mine land produced a p value of 0.94 compared to alpha value of .05. This indicates no significant statistical difference between the pH of treated and untreated reclaimed mine land soil.

CONCLUSION

After testing the soil samples from the undisturbed forest, the untreated reclaimed mine soil, and the sludge treated reclaimed mine soil sites, our study found no significant difference in nitrogen levels in soils tested from undisturbed forest and reclaimed mine soil and a statistical difference between the treated and untreated reclaimed soil. There was no significant difference in potassium levels between the reclaimed mine soils and the forest soil, but there was a slight difference between the treated and untreated reclaimed soil. There was no difference in the phosphorus levels between the forest soil and untreated reclaimed soil or between the treated versus untreated reclaimed soil, However, there was a significant difference in the phosphorus levels between the forest and treated reclaimed soil with the treated soil at about 2.5 times higher than the forest soil. The pH of the treated and untreated reclaimed soil was slightly acidic while the forest soil was almost neutral at the sites tested.

The nutrient levels in the reclaimed mine land sites were similar enough to the forest site to suggest that the same type of vegetation that is found in the undisturbed forest should be viable in reclaimed mine land soil. The pH of the reclaimed soil was slightly lower than the pH of the forest soil. All pH levels were within optimum pH levels for most forest vegetation. Some selectivity in choosing plants for reseeding reclaimed mine land may be necessary due to the need for more specific pH levels for some plants.

> Many trees and shrubs that are tolerant of acid conditions (including strongly acid conditions below pH 4.5) are available for Virginia landscapes. These plants may often be a better solution than attempting to adjust the soil to a higher pH, particularly where the native soil condition is by nature acidic. For the following trees and shrubs, check their hardiness and heat zone tolerances relative to their suitability for your particular area. Note that most trees and shrubs native to Virginia are adapted to at least slightly acid soils (http://www.ext.vt.edu/pubs).*

*See Charts pages 57 – 60.

POWELL RIVER PROJECT

Location of Soil Samples

Soil sample test sites were located in the Flat Gap Quadrangle using GPS units. GPS data was obtained using the NADRAD 1927 Contrus.

LOCATION	LATITUDE	LONGITUDE	ALTITUDE
FOREST	**N37^0 00” 38.8’**	**W82^0 40” 35.1’**	**2605 FT**
UNTREATED RECLAIMED MINE SOIL	**N37^0 00” 43.0’**	**W82^0 40” 50.5’**	**2568 FT**
TREATED RECLAIMED MINE SOIL	**N37^0 00” 42.7’**	**W82^0 40” 50.3’**	**2568 FT**

Bibliography

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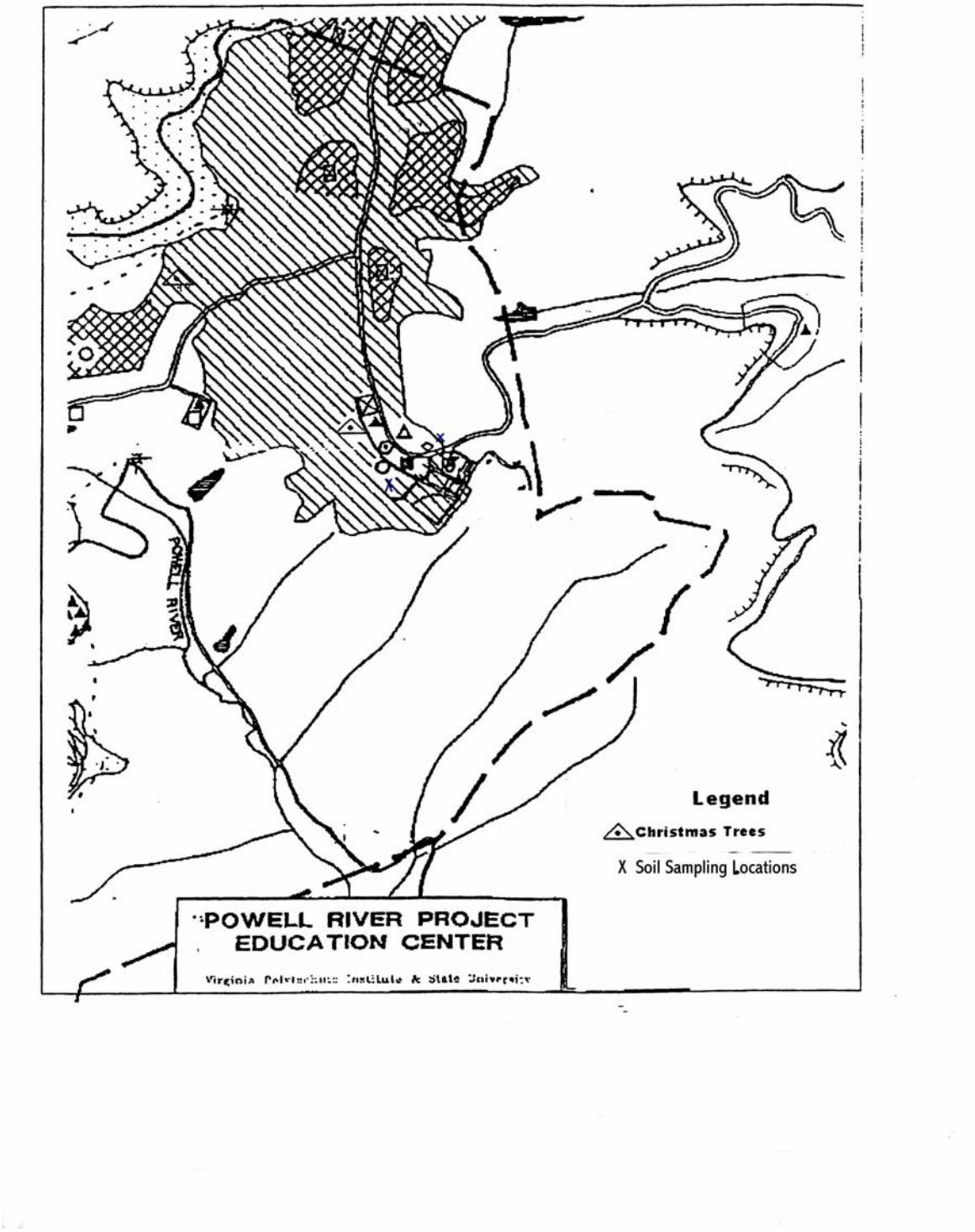
http://msucares.com/pubs/publications/p2311.pdf

http://www.cnr.vt.edu/dendro/forbioeco/htmltext/chapter8.htm

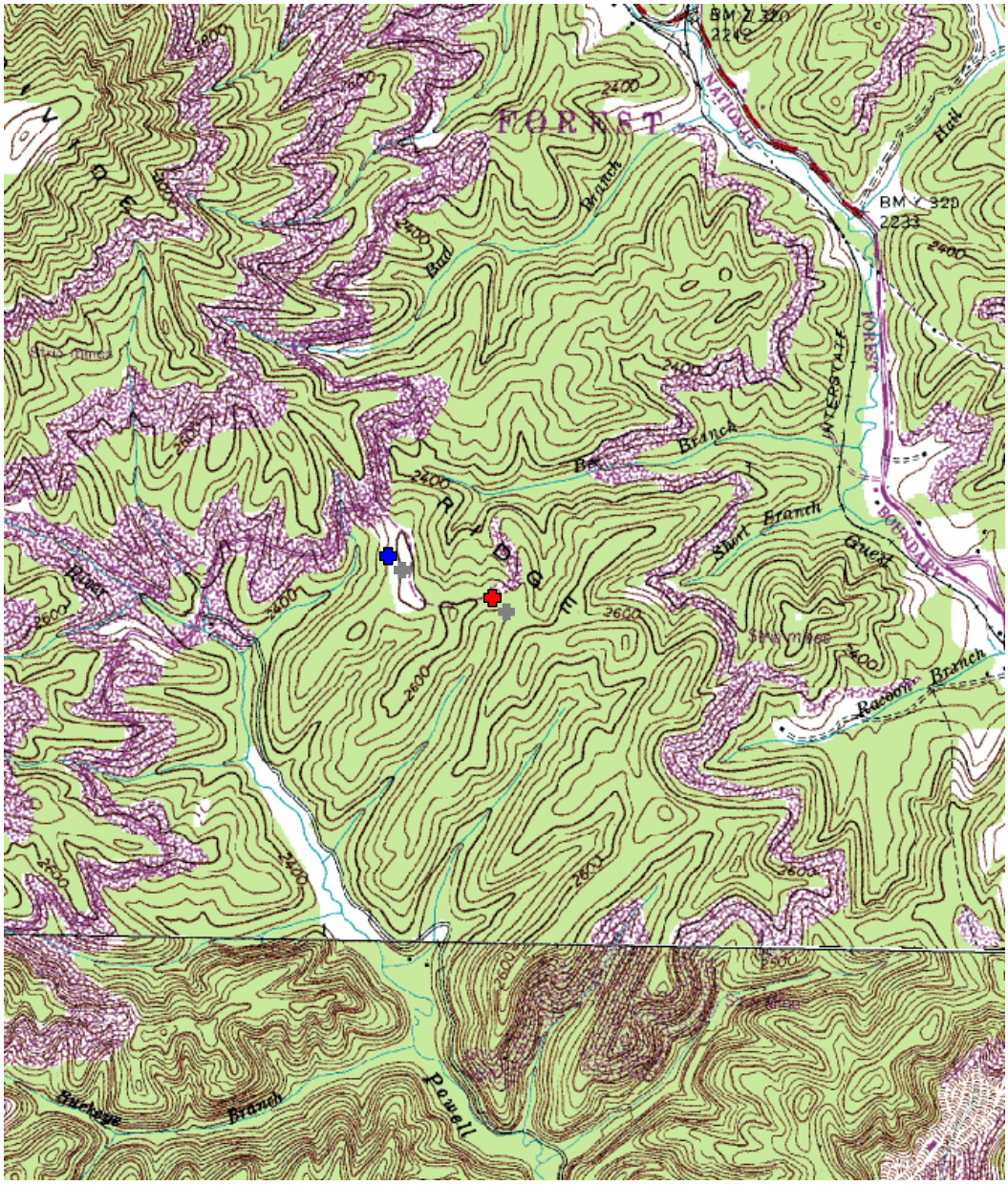
http://www.ext.vt.edu/pubs/trees/430-027/430-027.html#L6

http://www.topozone.com/map.asp?latd=37&latm=0&lats=38.1&lond=82&lonm=40&lons=35.9&datum=NAD27&u=2

APPENDIX A - DATA TABLES AND CHARTS



POWELL RIVER PROJECT
TOPO MAP

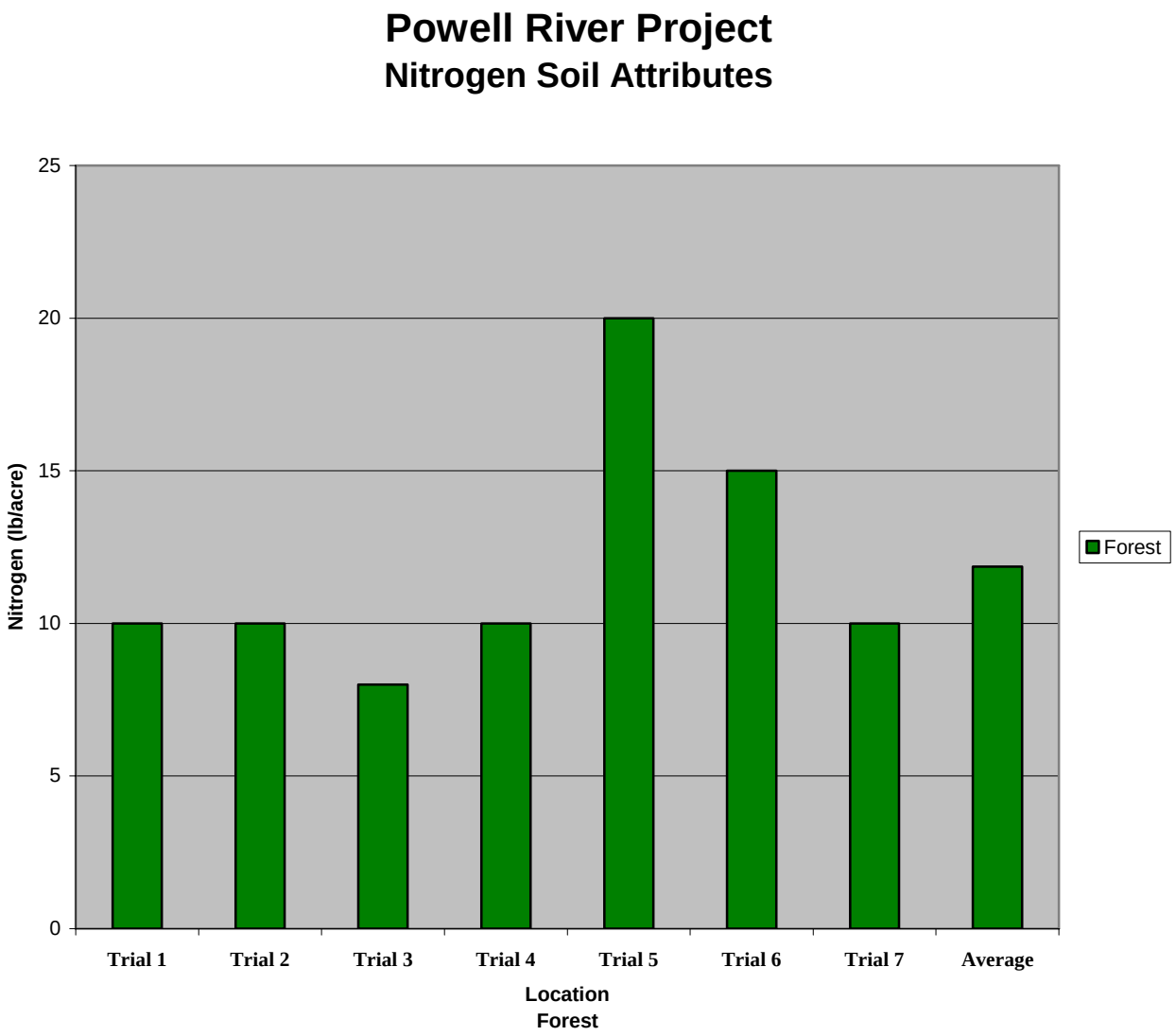


Projection is UTM Zone 17 NAD83 Datum
Reclaimed Mine Site 37° 00' 42.5"N, 82° 40' 51.5"W (NAD27)
Forest Site 37° 00' 38.1"N, 82° 40' 35.9"W (NAD27)
Flat Gap quadrangle

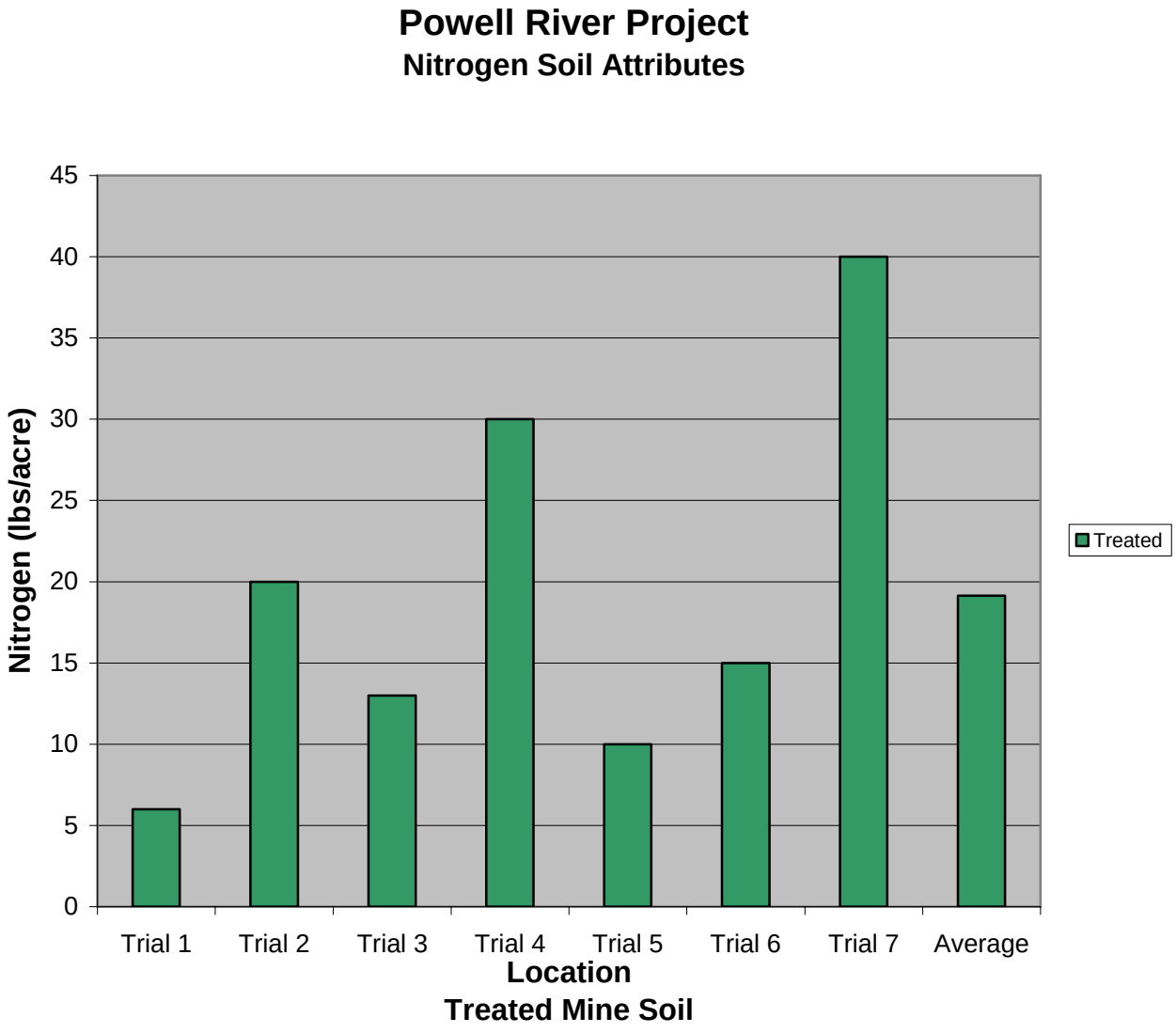
http://www.topozone.com/map.asp?latd=37&latm=0&lats=38.1&lond=82&lonm=40&lons=35.9&datum=NAD27&u=2

Powell River Project
Nitrogen Soil Attributes

Nitrogen			*Site*	*Depth*
Trial 1	10.0		Forest	15 cm
Trial 2	10.0		Forest	15 cm
Trial 3	8.0		Forest	15 cm
Trial 4	10.0		Forest	15 cm
Trial 5	20.0		Forest	15 cm
Trial 6	15.0		Forest	15 cm
Trial 7	10.0		Forest	15 cm
Average	11.9		Forest	15 cm
	Measured in pounds per acre lb/acre.			

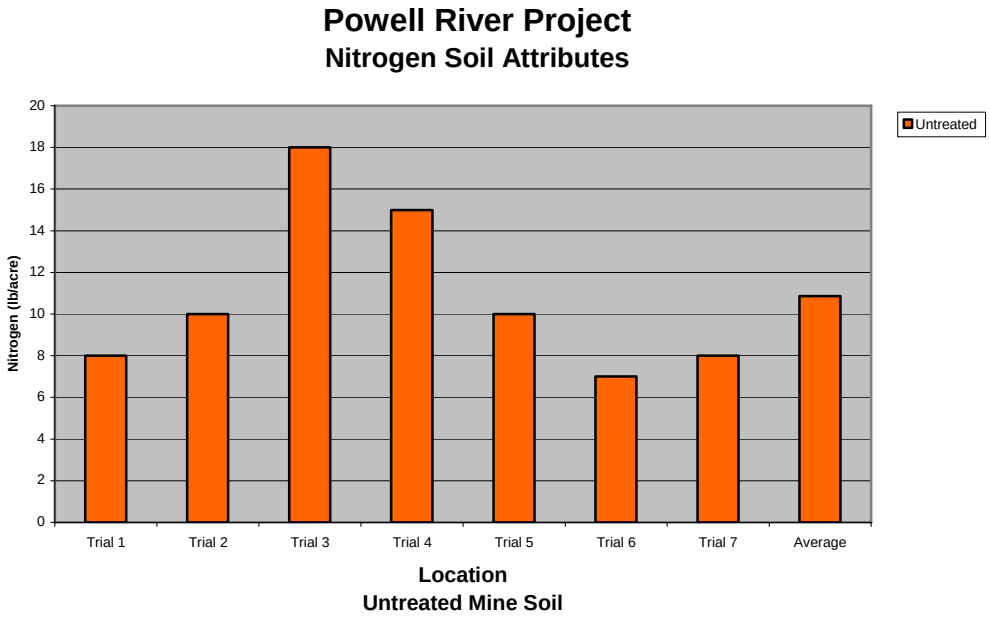

Powell River Project
Nitrogen Soil Attributes
Nitrogen (lb/acre)
25
20
15
10
5
0
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
Location
Forest
Forest

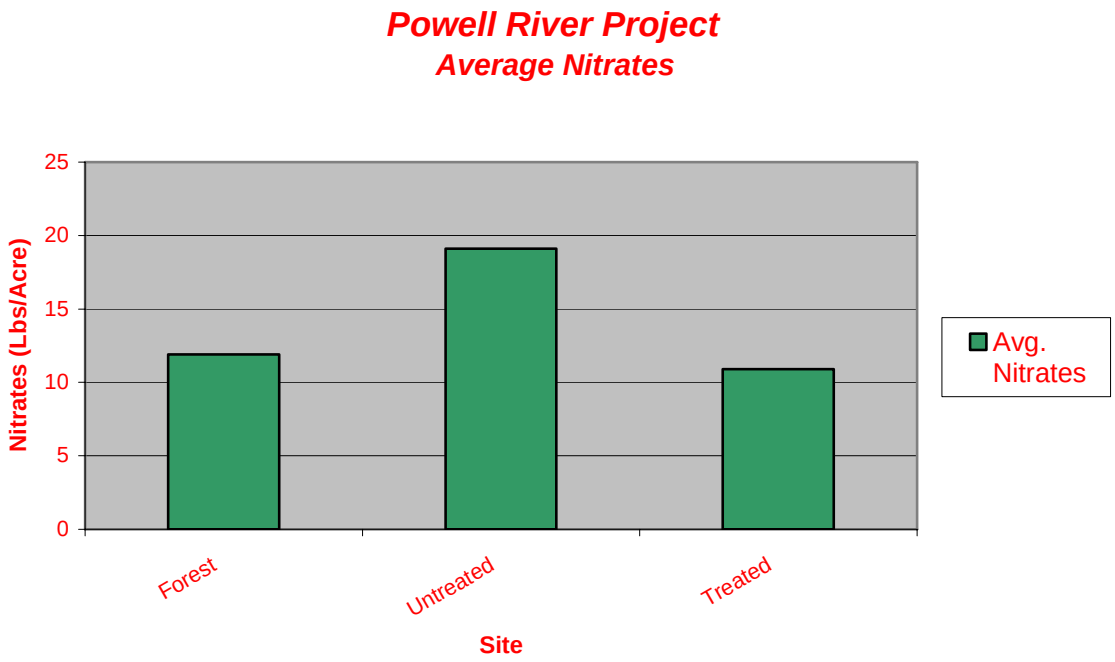
Powell River Project		
Nitrogen Soil Attributes		
Location	*Treated*	*Depth*
Trial 1	6	15 cm
Trial 2	20	15 cm
Trial 3	13	15 cm
Trial 4	30	15 cm
Trial 5	10	15 cm
Trial 6	15	15 cm
Trial 7	40	15 cm
Average	19.1	15 cm
	Measured in pounds per acre lb/acre.	


Powell River Project
Nitrogen Soil Attributes
Nitrogen (lbs/acre)
45
40
35
30
25
20
15
10
5
0
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
Location
Treated Mine Soil
Treated

Powell River Project
Nitrogen Soil Attributes

Nitrogen			*Site*	*Depth*
Trial 1	8		Untreated	15 cm
Trial 2	10		Untreated	15 cm
Trial 3	18		Untreated	15 cm
Trial 4	15		Untreated	15 cm
Trial 5	10		Untreated	15 cm
Trial 6	7		Untreated	15 cm
Trial 7	8		Untreated	15 cm
Average	10.9		Untreated	15 cm
	Measured in pounds per acre lb/acre.			

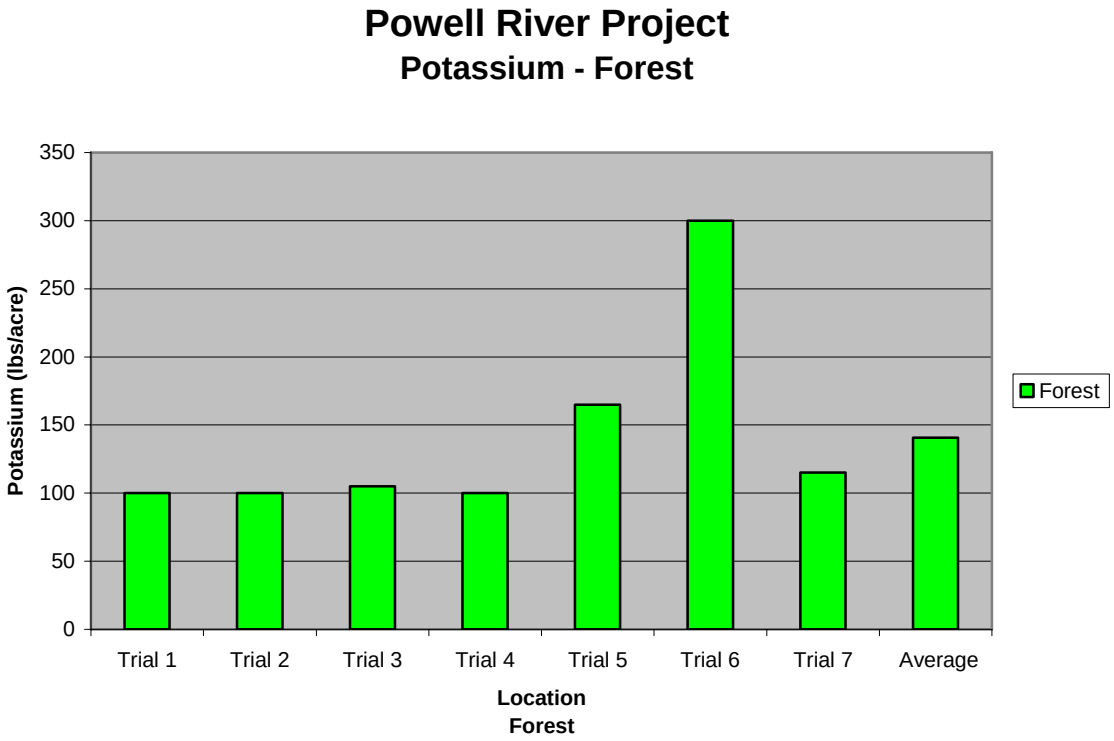

Powell River Project
Nitrogen Soil Attributes
Nitrogen (lb/acre)
0
2
4
6
8
10
12
14
16
18
20
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
Untreated
Location
Untreated Mine Soil


Powell River Project
Average Nitrates
25
20
15
10
5
0
Nitrates (Lbs/Acre)
Forest
Untreated
Treated
Site
Avg. Nitrates

Powell River Project
Potassium Soil Attributes

UNDISTURBED FOREST SOIL				
Sample	*Trial 1*		*Site*	*Depth*
Trial 1	100		Forest	15 cm
Trial 2	100		Forest	15 cm
Trial 3	105		Forest	15 cm
Trial 4	100		Forest	15 cm
Trial 5	165		Forest	15 cm
Trial 6	300		Forest	15 cm
Trial 7	115		Forest	15 cm
Average	140.7		Forest	15 cm

Measured in pounds per acre (lb/acre).

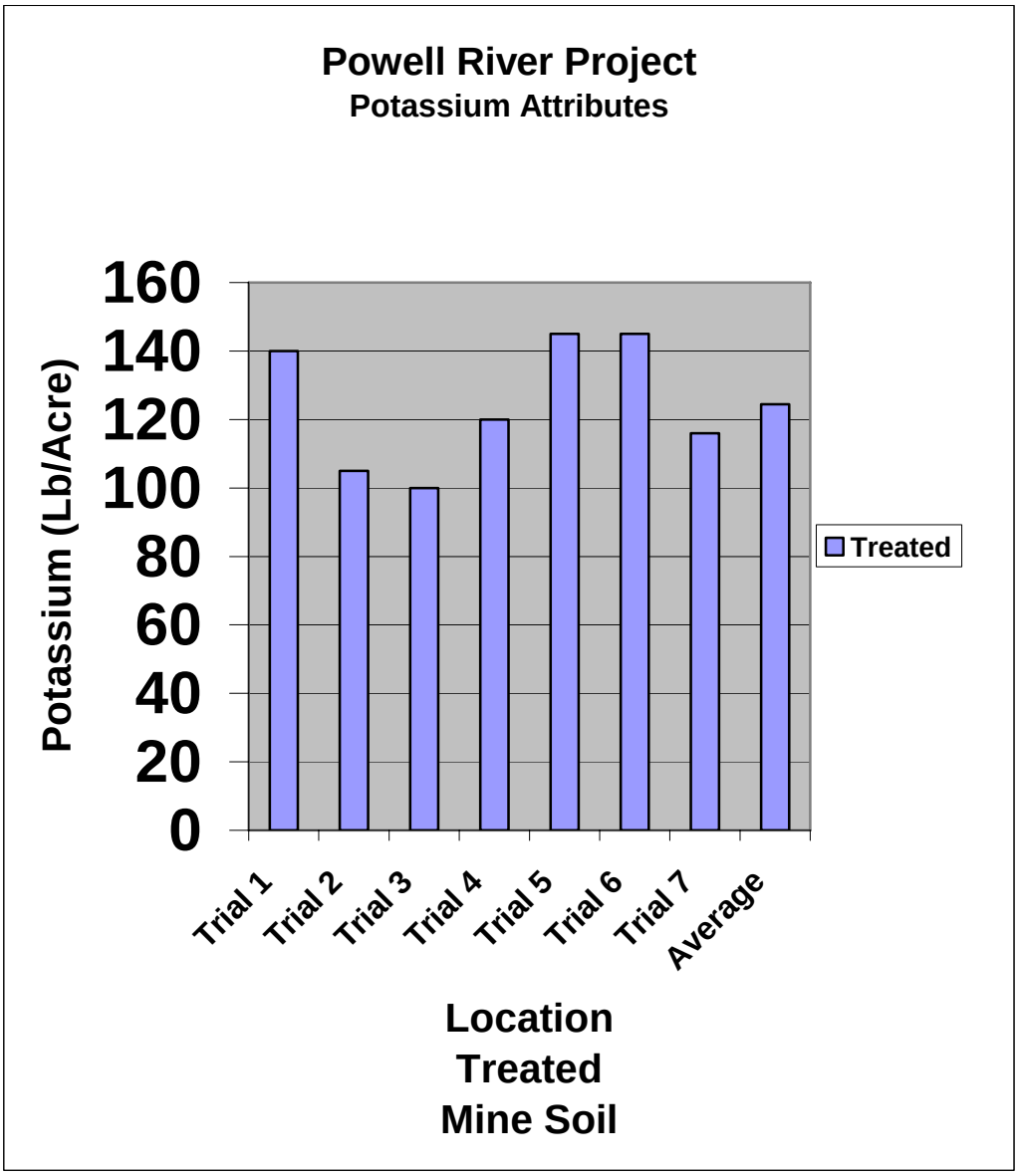

Powell River Project
Potassium - Forest
Potassium (lbs/acre)
350
300
250
200
150
100
50
0
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
Location
Forest
Forest

Powell River Project

Potassium Soil Attributes

Sample	*Treated*	*Site*	*Depth*
Trial 1	**140**	**Treated**	**15 CM**
Trial 2	**105**	**Treated**	**15 CM**
Trial 3	**100**	**Treated**	**15 CM**
Trial 4	**120**	**Treated**	**15 CM**
Trial 5	**145**	**Treated**	**15 cm**
Trial 6	**145**	**Treated**	**15 CM**
Trial 7	**116**	**Treated**	**15 CM**
Average	**124.4**	**Treated**	**15 CM**

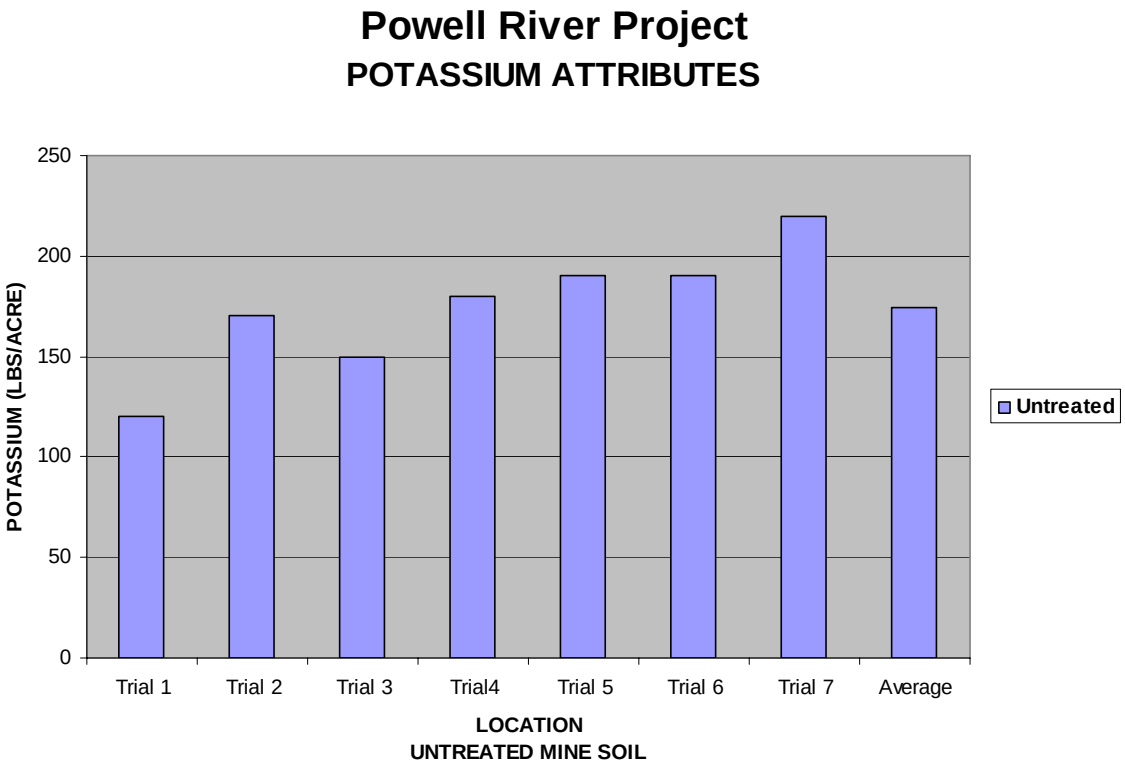
Measured in pounds per acre (lb/acre).


Powell River Project
Potassium Attributes
Potassium (Lb/Acre)
160
140
120
100
80
60
40
20
0
Treated
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
Location
Treated
Mine Soil

Powell River Project
Potassium Soil Attributes

UNTREATED MINE SOIL				
Sample	*Trial 1*		*Site*	*Depth*
Trial 1	120		**Untreated**	15 cm
Trial 2	170		**Untreated**	15 cm
Trial 3	150		**Untreated**	15 cm
Trial4	180		**Untreated**	15 cm
Trial 5	190		**Untreated**	15 cm
Trial 6	190		**Untreated**	15 cm
Trial 7	220		**Untreated**	15 cm
Average	174.3		**Untreated**	15 cm

Measured in pounds per acre (lb/acre).

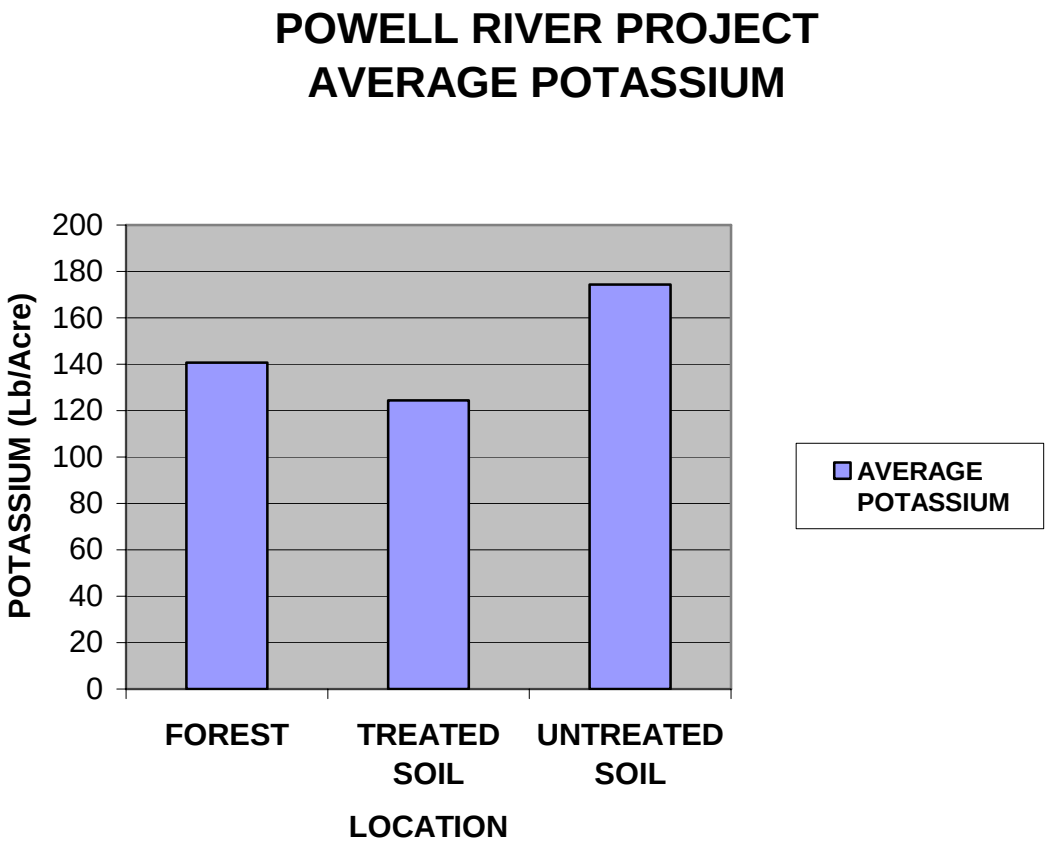

Powell River Project
POTASSIUM ATTRIBUTES
250
200
150
100
50
0
POTASSIUM (LBS/ACRE)
Trial 1
Trial 2
Trial 3
Trial4
Trial 5
Trial 6
Trial 7
Average
LOCATION
UNTREATED MINE SOIL
Untreated

POWELL RIVER PROJECT

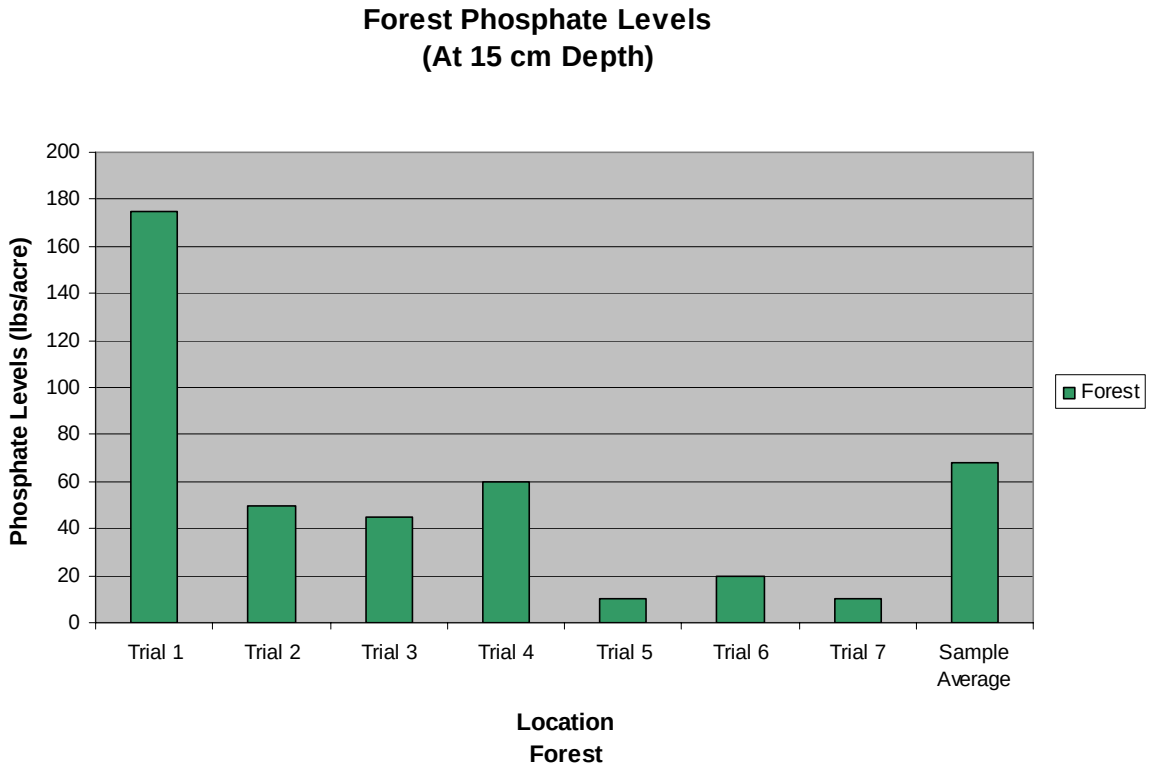
AVERAGE POTASSIUM ATTRIBUTES

LOCATION	LEVEL
FOREST	140.7
TREATED SOIL	124.4
UNTREATED SOIL	174.3

Measured in (Lb/Acre)

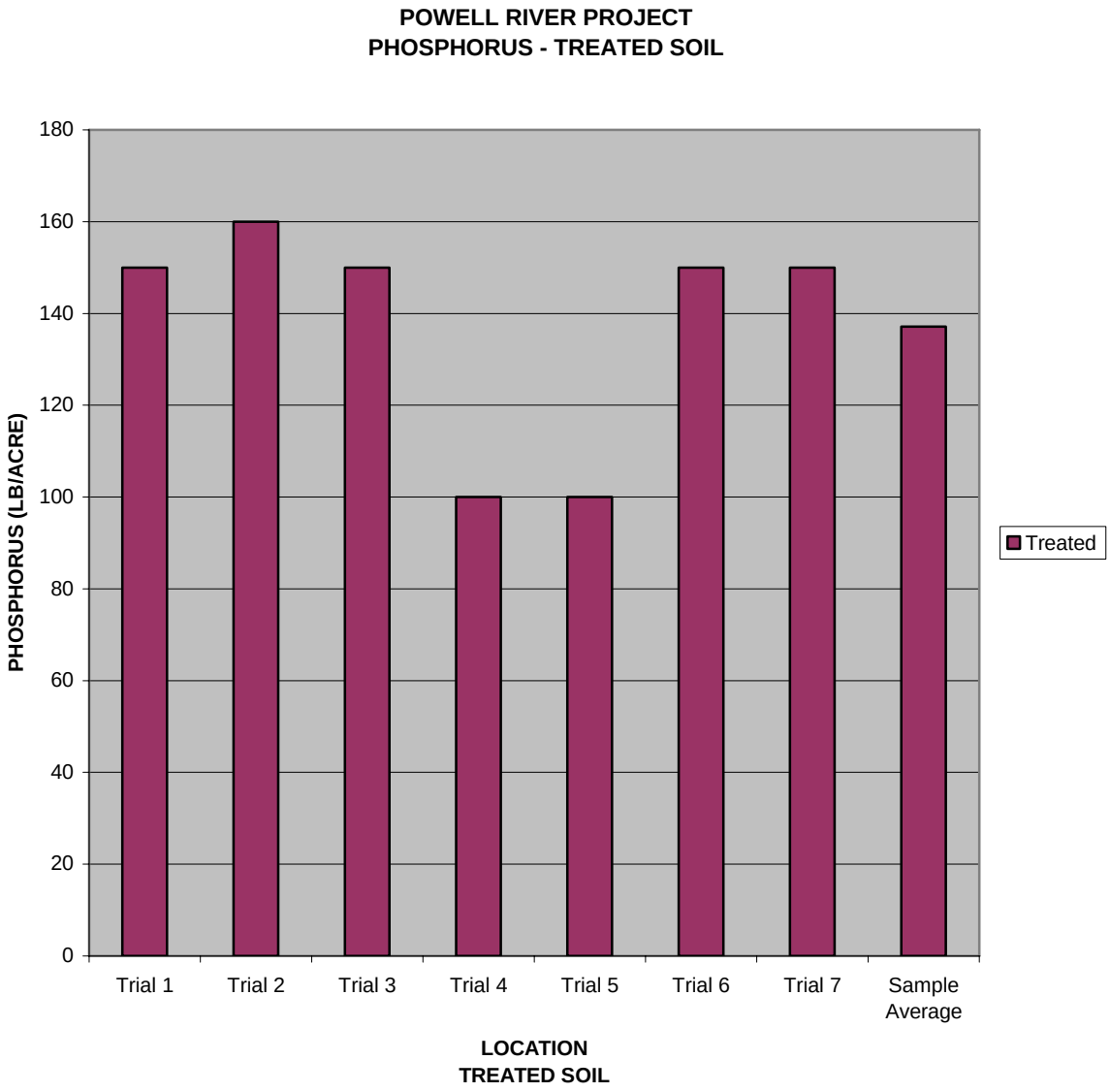

POWELL RIVER PROJECT
AVERAGE POTASSIUM
POTASSIUM (Lb/Acre)
200
180
160
140
120
100
80
60
40
20
0
FOREST
TREATED SOIL
UNTREATED SOIL
LOCATION
AVERAGE POTASSIUM

POWELL RIVER PROJECT			
PHOSPHORUS LEVELS - FOREST SOIL			
Sample	**Pounds Per Acre**	**Location**	**Depth**
Trial 1	175	**Forest**	**15 CM**
Trial 2	50	**Forest**	**15 CM**
Trial 3	45	**Forest**	**15 CM**
Trial 4	60	**Forest**	**15 CM**
Trial 5	10	**Forest**	**15 CM**
Trial 6	20	**Forest**	**15 CM**
Trial 7	10	**Forest**	**15 CM**
Sample Average	52.9	**Forest**	**15 CM**
Measured in lb/acre			

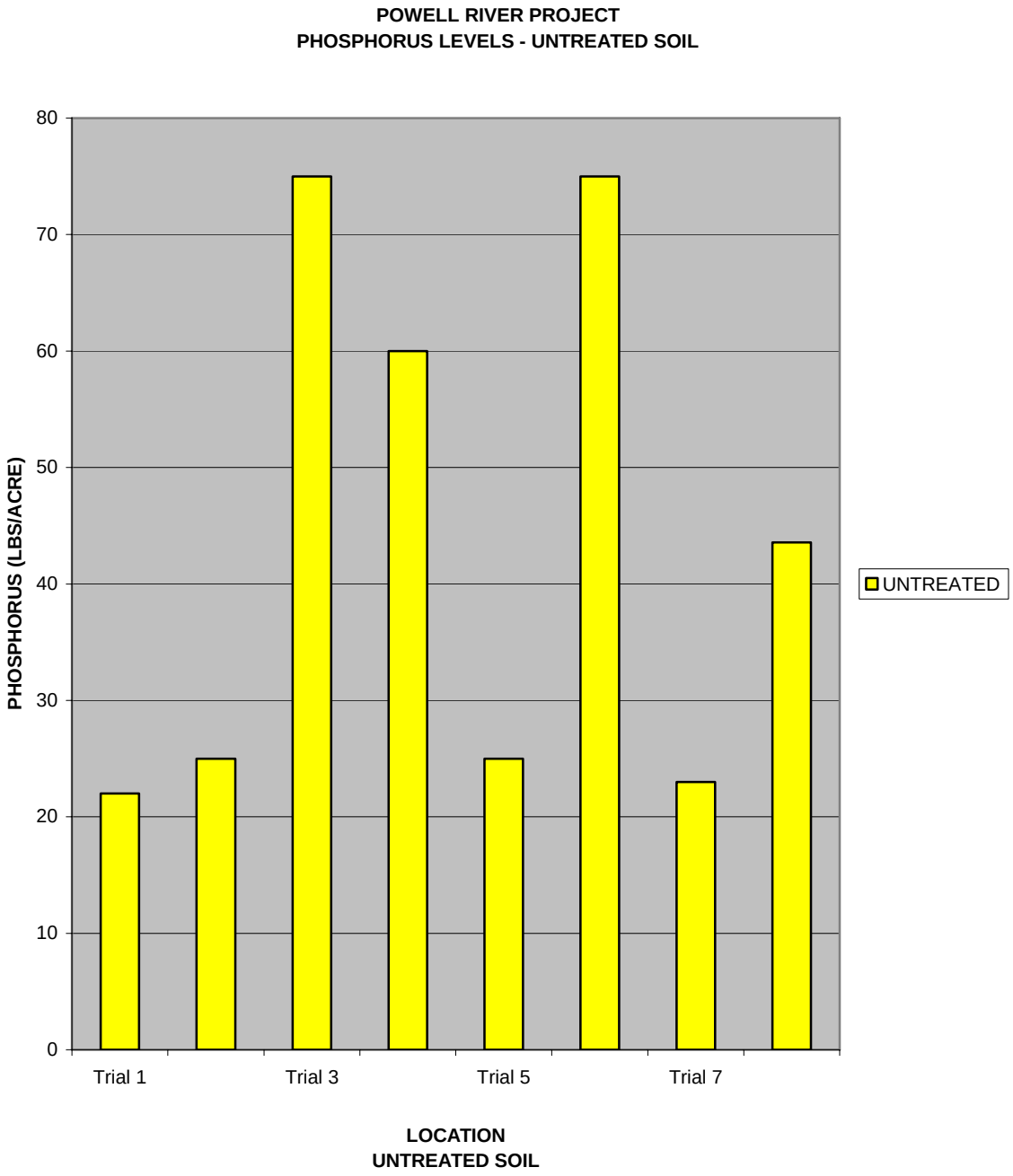

Forest Phosphate Levels
(At 15 cm Depth)
Phosphate Levels (lbs/acre)
200
180
160
140
120
100
80
60
40
20
0
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Sample Average
Forest
Location
Forest

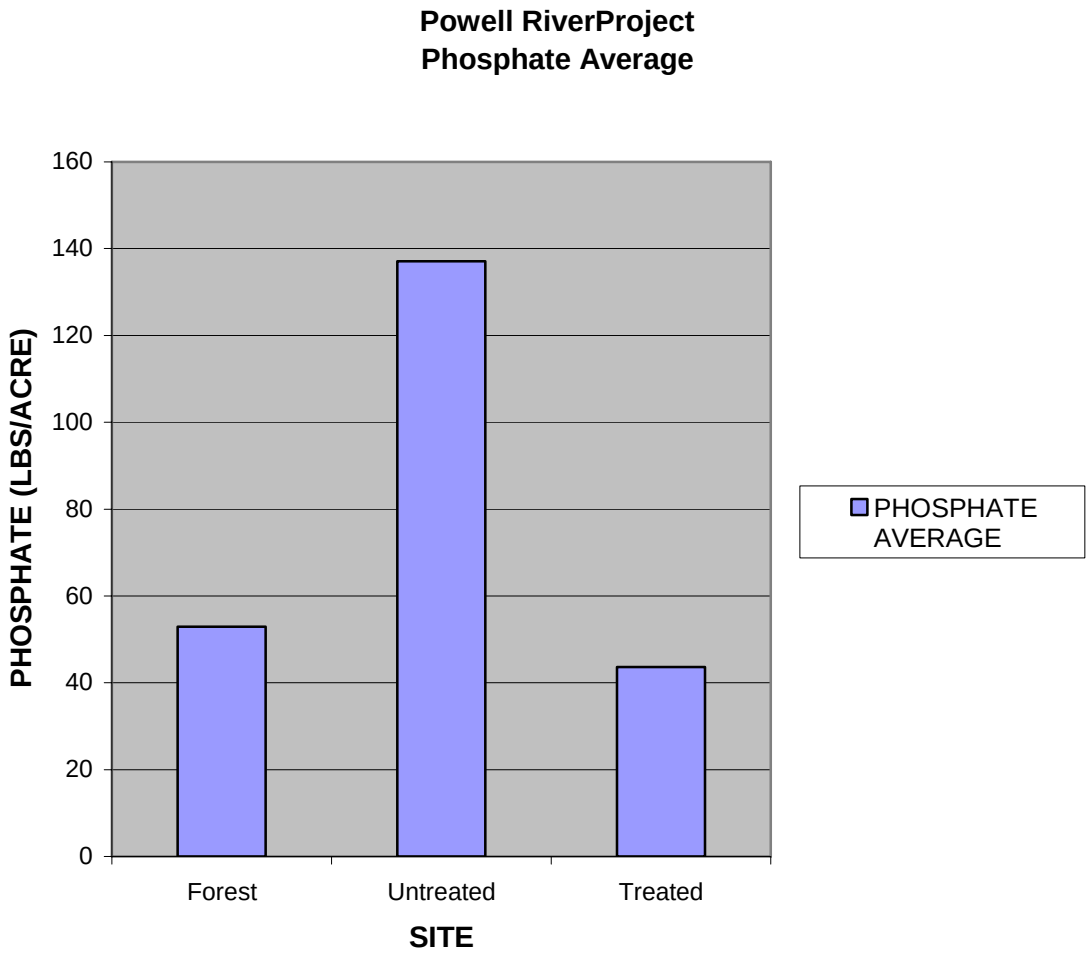
POWELL RIVER PROJECT				
PHOSPHORUS LEVELS TREATED SOIL				
Sample	**Location**	**Depth**	**Amount**	
Trial 1	Treated	15 cm	150	
Trial 2	Treated	15 cm	160	
Trial 3	Treated	15 cm	150	
Trial 4	Treated	15 cm	100	
Trial 5	Treated	15 cm	100	
Trial 6	Treated	15 cm	150	
Trial 7	Treated	15 cm	150	
Sample Average	Treated	15 cm	137.1	

Measured in Pounds per Acre (lbs/acre)

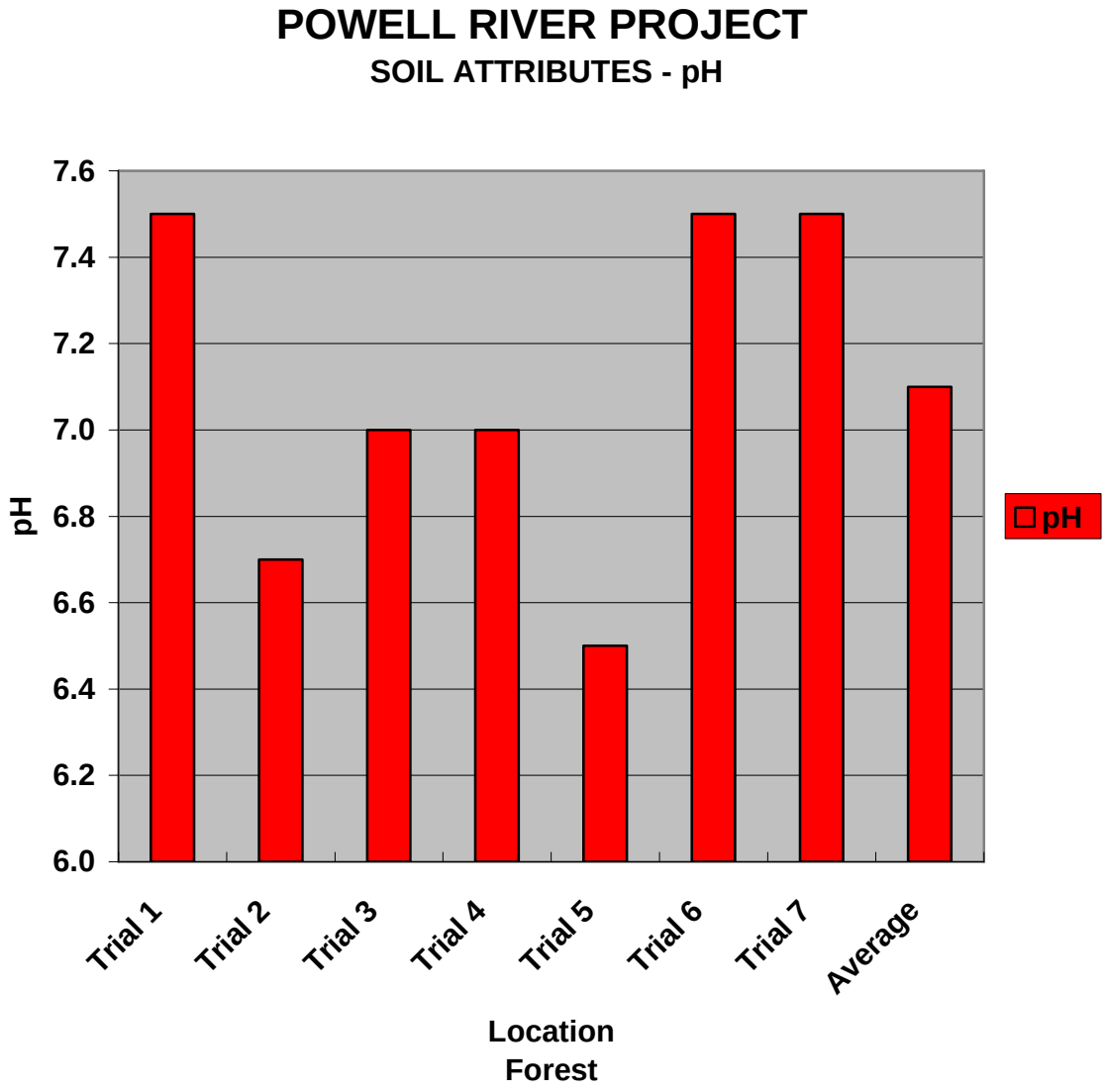

POWELL RIVER PROJECT
PHOSPHORUS - TREATED SOIL
PHOSPHORUS (LB/ACRE)
180
160
140
120
100
80
60
40
20
0
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Sample Average
Treated
LOCATION
TREATED SOIL

POWELL RIVER PROJECT				
PHOSPHORUS LEVELS UNTREATED SOIL				
SAMPLE		**LOCATION**	**DEPTH**	
Trial 1		UNTREATED	15 CM	22
Trial 2		UNTREATED	15 CM	25
Trial 3		UNTREATED	15 CM	75
Trial 4		UNTREATED	15 cm	60
Trial 5		UNTREATED	15 cm	25
Trial 6		UNTREATED	16 cm	75
Trial 7		UNTREATED	17 cm	23
SAMPLE AVERAGE		UNTREATED	15 CM	43.6
Measured in Pounds per Acre (lbs/acre)				

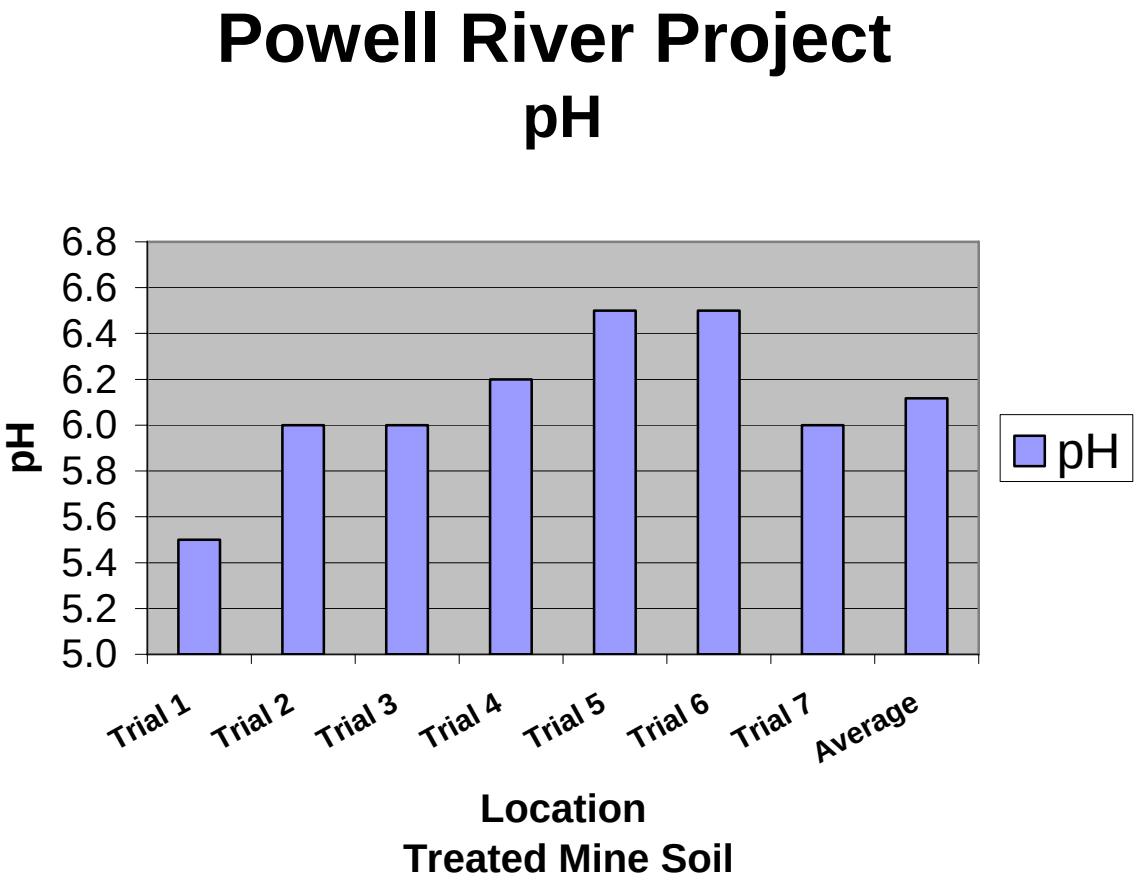

POWELL RIVER PROJECT
PHOSPHORUS LEVELS - UNTREATED SOIL
PHOSPHORUS (LBS/ACRE)
80
70
60
50
40
30
20
10
0
Trial 1
Trial 3
Trial 5
Trial 7
UNTREATED
LOCATION
UNTREATED SOIL


Powell RiverProject
Phosphate Average
PHOSPHATE (LBS/ACRE)
160
140
120
100
80
60
40
20
0
Forest
Untreated
Treated
SITE
PHOSPHATE AVERAGE

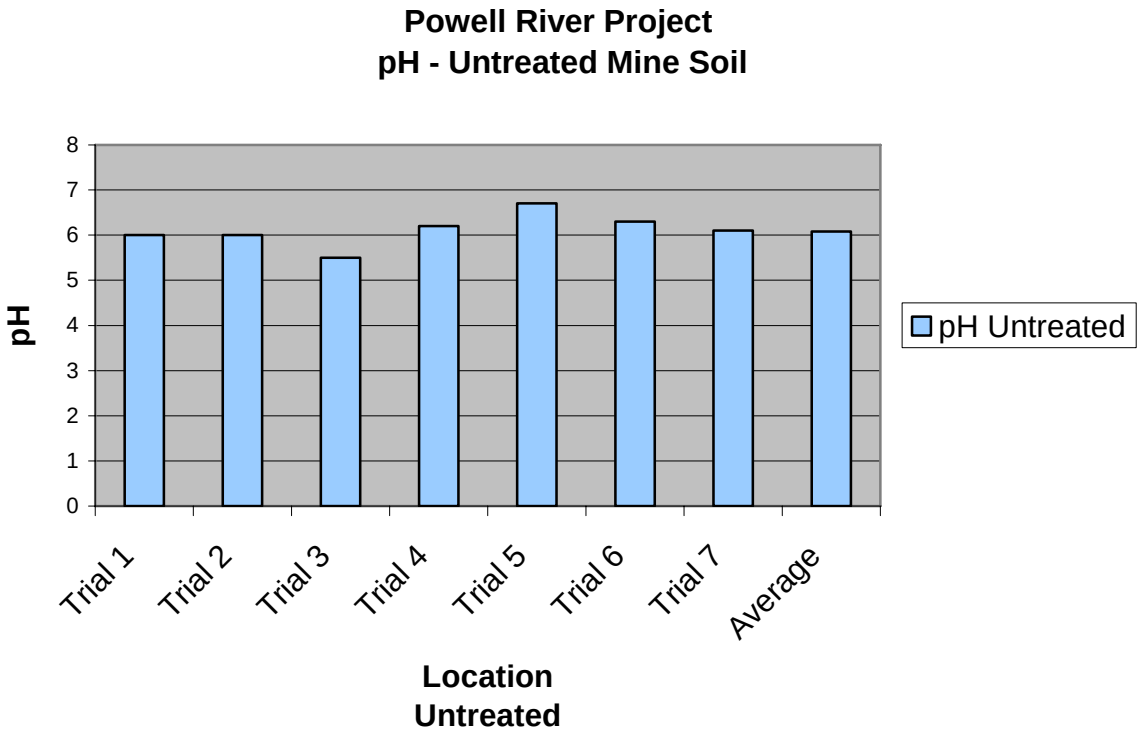
POWELL RIVER PROJECT pH - FOREST			
	pH	Location	Depth
Trial 1	7.5	Forest	15 cm
Trial 2	6.7	Forest	15 cm
Trial 3	7.0	Forest	15 cm
Trial 4	7.0	Forest	15 cm
Trial 5	6.5	Forest	15 cm
Trial 6	7.5	Forest	15 cm
Trial 7	7.5	Forest	15 cm
Average	7.1	Forest	15 cm


POWELL RIVER PROJECT
SOIL ATTRIBUTES - pH
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
pH
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
Location
Forest
pH

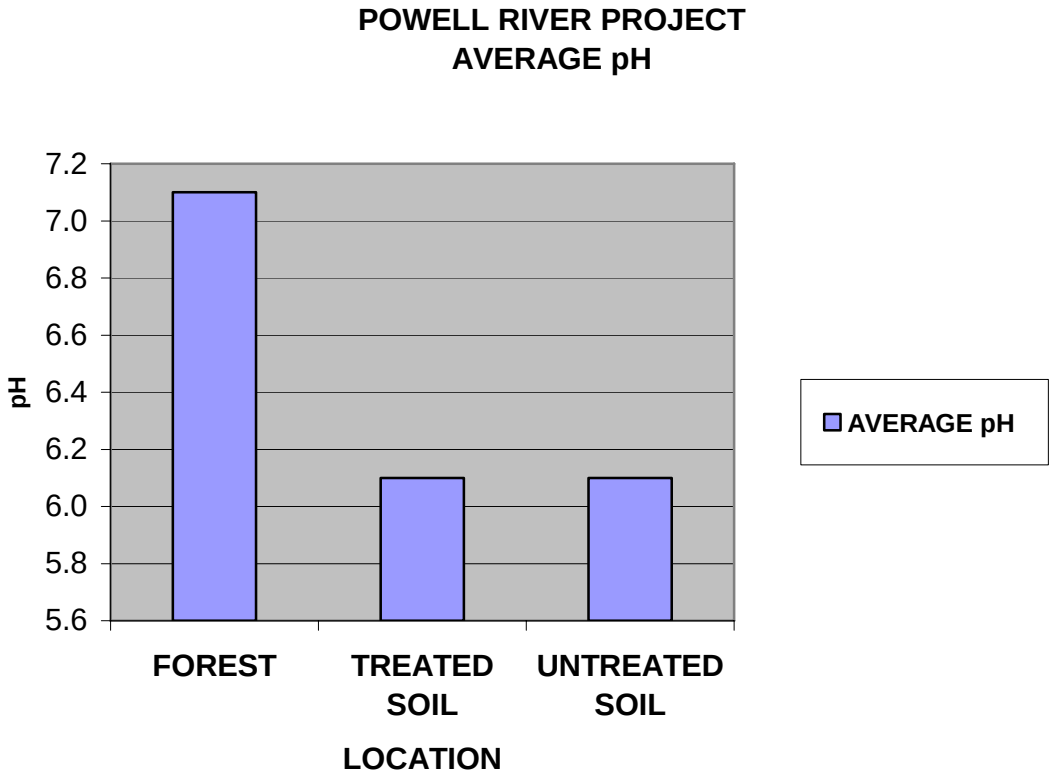
POWELL RIVER PROJECT pH			
Trial	**pH**	**Location**	**Depth**
Trial 1	**5.5**	**Treated**	**15 cm**
Trial 2	**6.0**	**Treated**	**15 cm**
Trial 3	**6.0**	**Treated**	**15 cm**
Trial 4	**6.2**	**Treated**	**15 cm**
Trial 5	**6.5**	**Treated**	**15 cm**
Trial 6	**6.5**	**Treated**	**15 cm**
Trial 7	**6.0**	**Treated**	**15 cm**
Average	**6.1**	**Treated**	**15 cm**


Powell River Project
pH
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
pH
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
pH
Location
Treated Mine Soil

POWELL RIVER PROJECT pH			
Trial	pH	Location	Depth
Trial 1	6.0	Untreated	15 cm
Trial 2	6.0	Untreated	15 cm
Trial 3	5.5	Untreated	15 cm
Trial 4	6.2	Untreated	15 cm
Trial 5	6.7	Untreated	15 cm
Trial 6	6.3	Untreated	15 cm
Trial 7	6.1	Untreated	15 cm
Average	6.1	Untreated	15 cm


Powell River Project
pH - Untreated Mine Soil
pH
8
7
6
5
4
3
2
1
0
Trial 1
Trial 2
Trial 3
Trial 4
Trial 5
Trial 6
Trial 7
Average
pH Untreated
Location
Untreated

POWELL RIVER PROJECT AVERAGE pH	
LOCATION	**LEVEL**
FOREST	**7.1**
TREATED SOIL	**6.1**
UNTREATED SOIL	**6.1**



Comparison of Soil Attributes to Previous Years

Year	Attribute	Forest		Treated		Untreated	
2006	Nitrogen	11.9		19.1		10.9	lb/acre
2006	Potassium	140.7		124.4		174.3	lb/acre
2006	Phosphorus	52.9		137.1		43.6	lb/acre
2006	pH	7.1		6.1		6.1	
Year	Attribute	Forest		Treated		Untreated	
2005	Nitrogen	10.0		11.0		10.8	lb/acre
2005	Potassium	100.0		128.0		116.0	lb/acre
2005	Phosphorus	9.6		20.0		16.0	lb/acre
2005	pH	6.0		6.5		5.9	
Year	Attribute	Forest		Treated		Untreated	
2004	Nitrogen	13.25	lb/acre	13.25	lb/acre	11.75	lb/acre
2004	Potassium	135	lb/acre	118.75	lb/acre	101.5	lb/acre
2004	Phosphorus	18	lb/acre	12	lb/acre	24	lb/acre
2004	pH	5.975		6.225		6.25	
2004	Bulk Density	1.033	g/ml	1.19	g/ml	1.686	g/ml
2004	Particle Density	2.106	g/ml	2.06	g/ml	2.21	g/ml
2004	Porosity	50.95	%	42.23	%	23.71	%
Year	Attribute	Forest		Treated		Untreated	
2003	Nitrogen	35.8	lb/acre	26.7	lb/acre	12.5	lb/acre
2003	Potassium	123.3	lb/acre	156.7	lb/acre	130	lb/acre
2003	Phosphorus	15	lb/acre	61	lb/acre	45	lb/acre
2003	pH	5.75		6.28		6.17	
2003	Bulk Density	1.06	g/ml	1.69	g/ml	1.64	g/ml
2003	Particle Density	1.83	g/ml	2.26	g/ml	2.7	g/ml
2003	Porosity	42.65	%	25.05	%	36.75	%

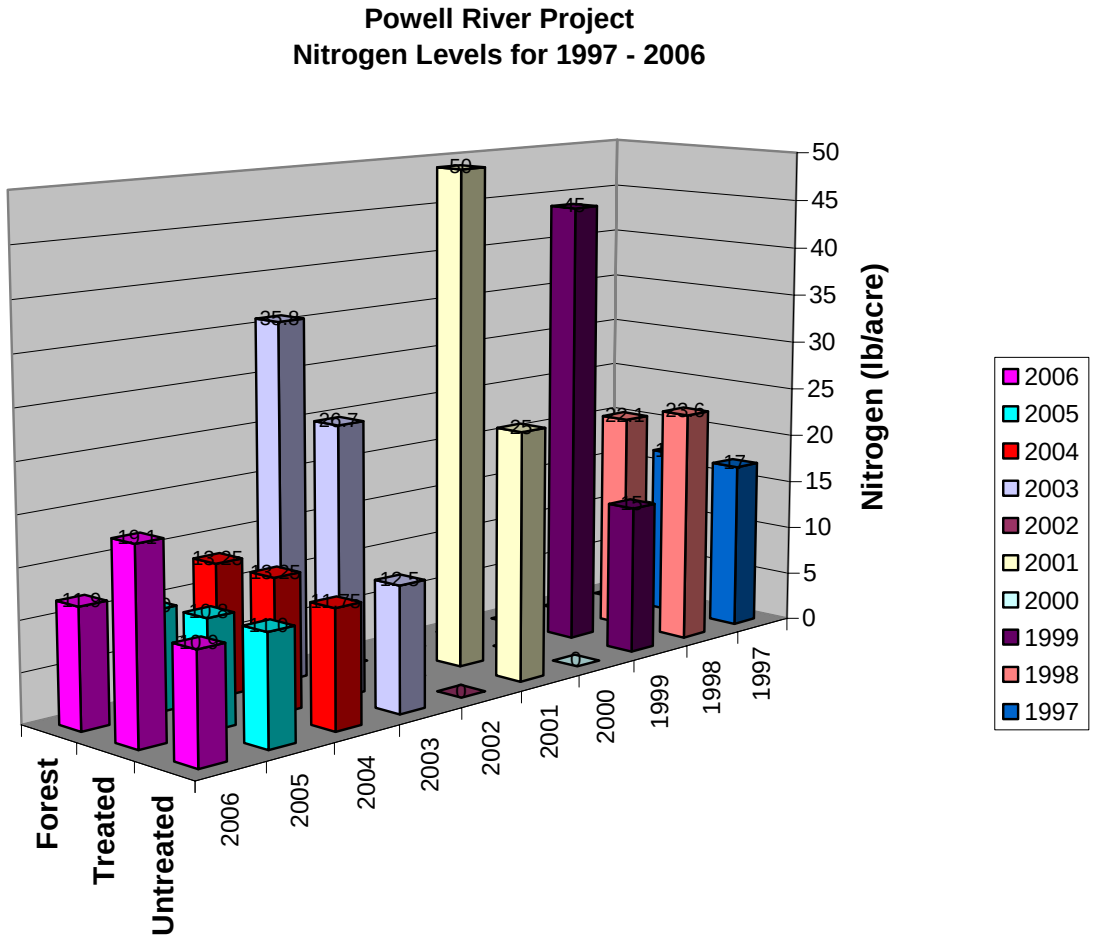
continued

Comparison of Soil Attributes to Previous Years

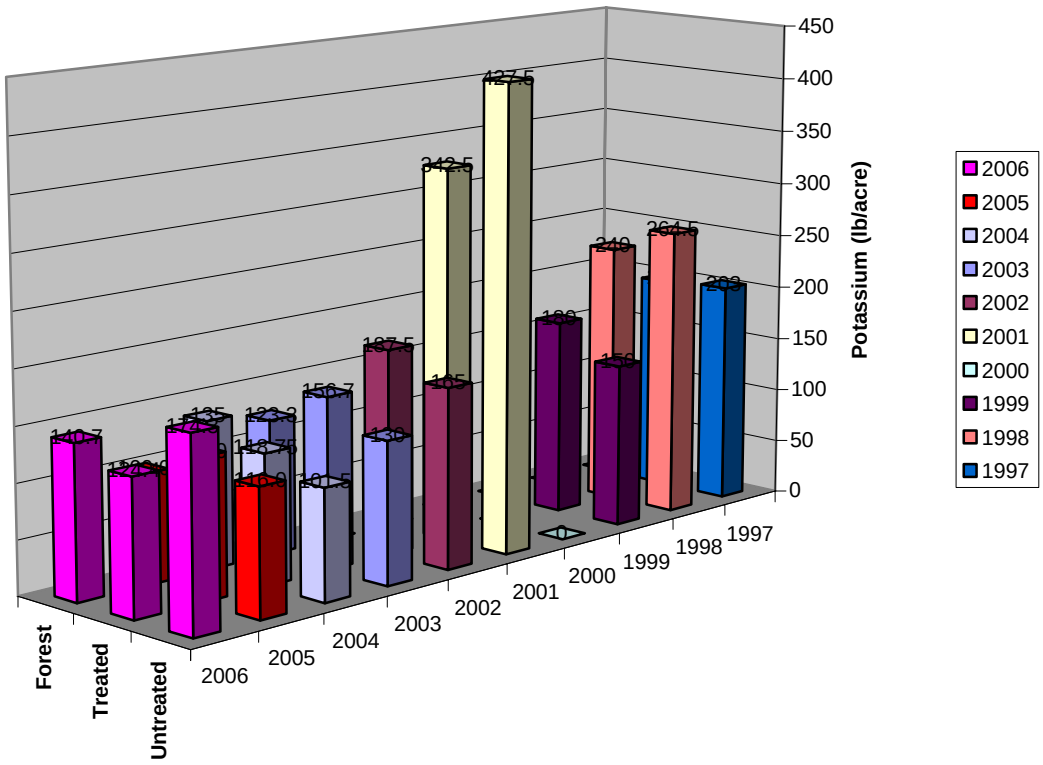
Year	Attribute		Forest		Treated		Untreated	
2002	Nitrogen		NA	lb/acre	NA	lb/acre	NA	lb/acre
2002	Potassium		NA	lb/acre	187.5	lb/acre	165	lb/acre
2002	Phosphorus		NA	lb/acre	76.25	lb/acre	115	lb/acre
2002	pH		NA		NA		NA	
2002	Bulk Density		NA		NA		NA	
2002	Particle Density		NA		NA		NA	
2002	Porosity		NA		NA		NA	
Year	Attribute		Forest		Treated		Untreated	
2001	Nitrogen		NA	lb/acre	50	lb/acre	25	lb/acre
2001	Potassium		NA	lb/acre	342.5	lb/acre	427.5	lb/acre
2001	Phosphorus		NA	lb/acre	200	lb/acre	68.75	lb/acre
2001	pH		NA		5.875		5.5	
2001	Bulk Density		NA	g/ml	NA	g/ml	NA	g/ml
2001	Particle Density		NA	g/ml	NA	g/ml	NA	g/ml
2001	Porosity		NA	%	NA	%	NA	%
Year	Attribute		Forest		Treated		Untreated	
2000	ALL		NA		NA		NA	
Year	Attribute		Forest		Treated		Untreated	
1999	Nitrogen		NA	lb/acre	45	lb/acre	15	lb/acre
1999	Potassium		NA	lb/acre	180	lb/acre	150	lb/acre
1999	Phosphorus		NA	lb/acre	148.3	lb/acre	68.75	lb/acre
1999	pH		NA		6.3		5.44	
1999	Bulk Density		NA	g/ml	NA	g/ml	NA	g/ml
1999	Particle Density		NA	g/ml	NA	g/ml	NA	g/ml
1999	Porosity		NA	%	NA	%	NA	%
					NA - Not Available			
Year	Attribute		Forest		Treated		Untreated	
1998	Nitrogen		NA	lb/acre	22.1	lb/acre	23.6	lb/acre
1998	Potassium		NA	lb/acre	240	lb/acre	264.5	lb/acre
1998	Phosphorus		NA	lb/acre	152.3	lb/acre	90	lb/acre
1998	pH		NA		5.9		5.7	
1998	Bulk Density		NA	g/ml	NA	g/ml	NA	g/ml
1998	Particle Density		NA	g/ml	NA	g/ml	NA	g/ml
1998	Porosity		NA	%	NA	%	NA	%
							continued	

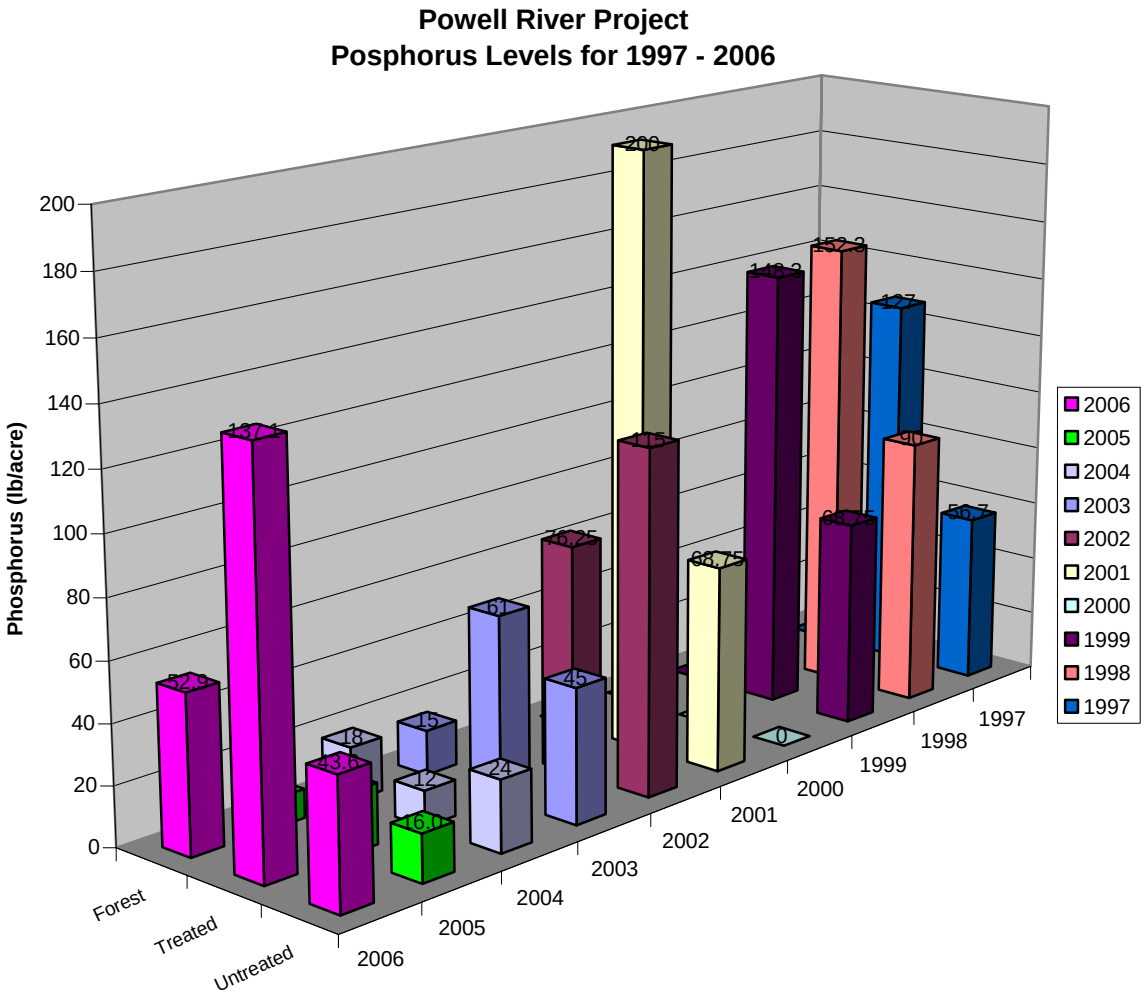
Comparison of Soil Attributes to Previous Years

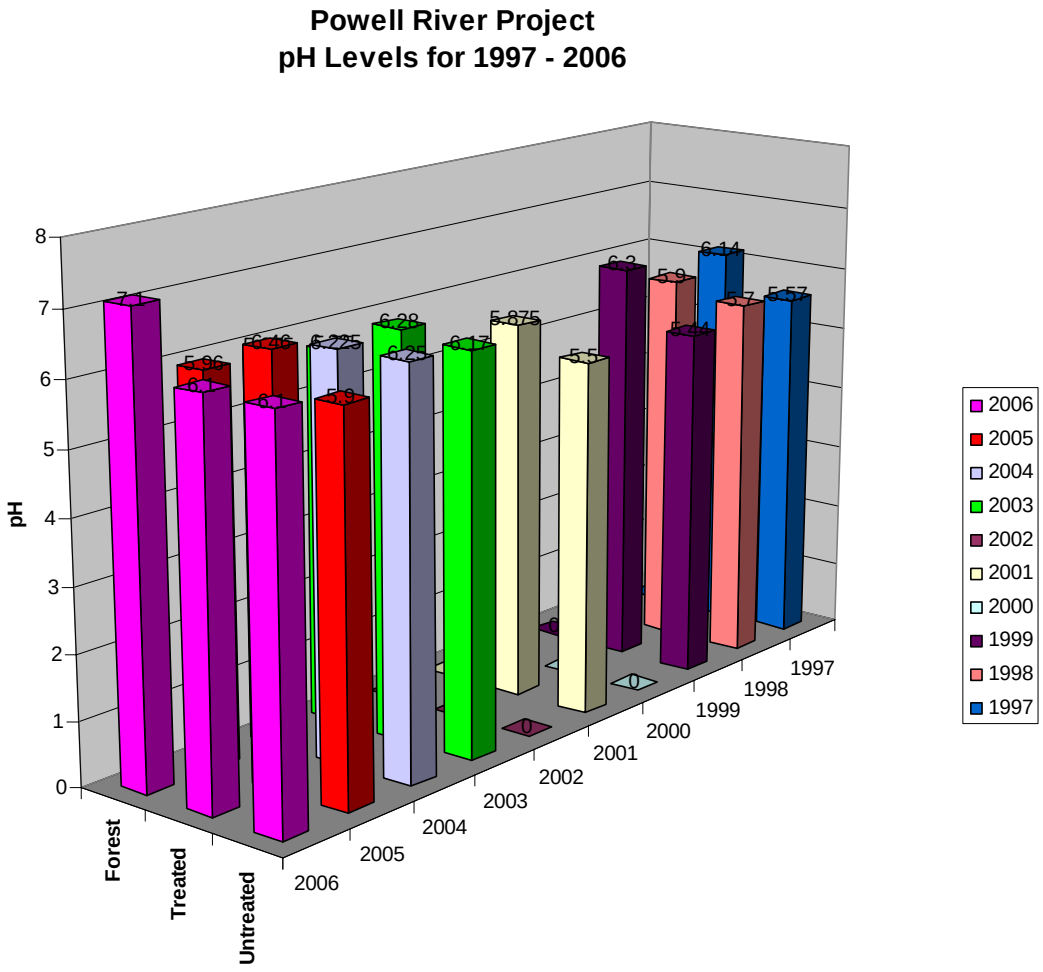
Year	Attribute		Forest		Treated		Untreated	
1997	Nitrogen		NA	lb/acre	17.3	lb/acre	17	lb/acre
1997	Potassium		NA	lb/acre	199	lb/acre	203	lb/acre
1997	Phosphorus		NA	lb/acre	127	lb/acre	56.7	lb/acre
1997	pH		NA		6.14		5.57	
1997	Bulk Density		NA	g/ml	NA	g/ml	NA	g/ml
1997	Particle Density		NA	g/ml	NA	g/ml	NA	g/ml
1997	Porosity		NA	%	NA	%	NA	%
						NA - Not Available		

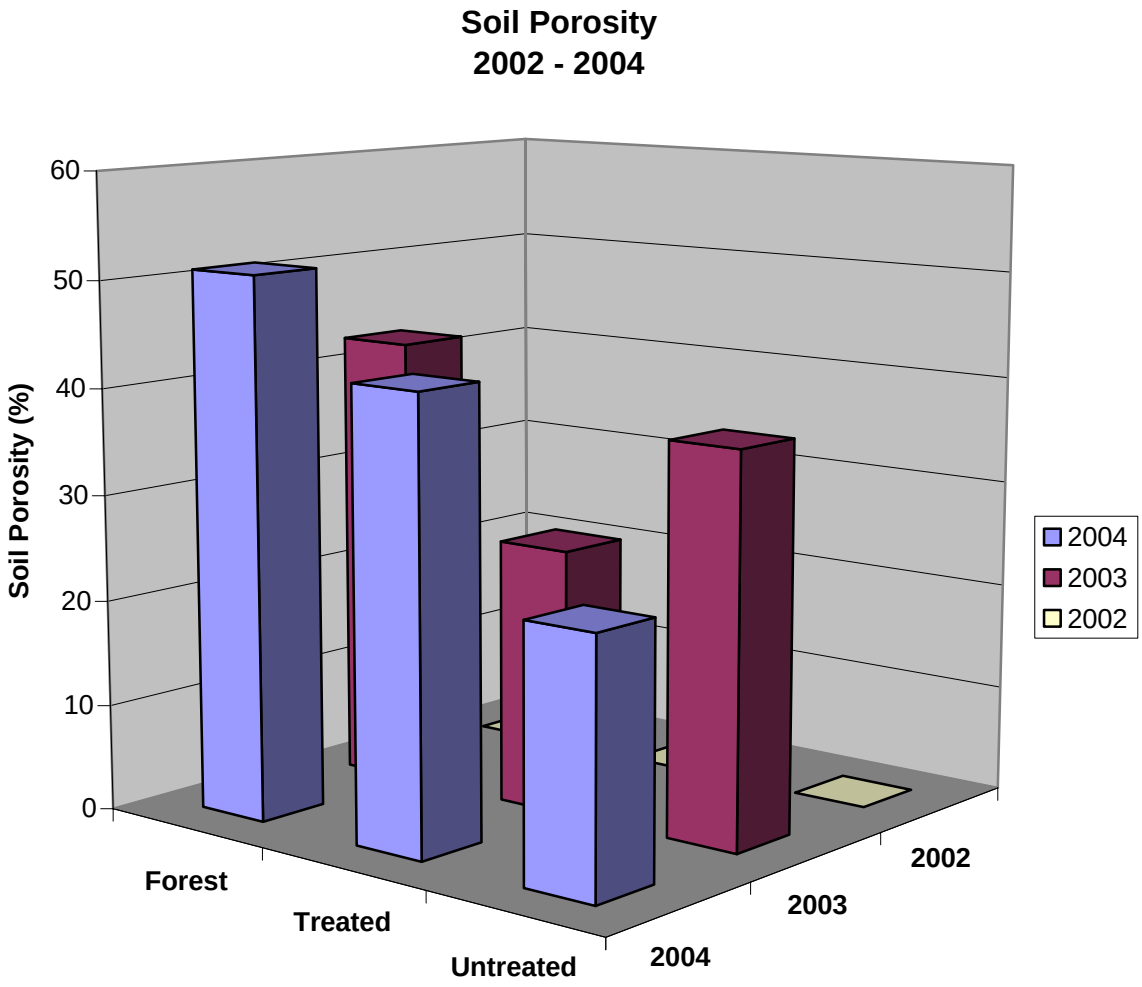

Powell River Project
Nitrogen Levels for 1997 - 2006
Nitrogen (lb/acre)
50
45
40
35
30
25
20
15
10
5
0
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
Forest
Treated
Untreated

Powell River Project
Potassium Levels for 1997 - 2006




Powell River Project
Posphorus Levels for 1997 - 2006
Phosphorus (lb/acre)
200
180
160
140
120
100
80
60
40
20
0
Forest
Treated
Untreated
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
52.9
137.1
43.6
16.0
12
15
18
24
61
45
76.25
209
105
68.75
0
145.2
152.2
68.75
90
127
56.7


Powell River Project
pH Levels for 1997 - 2006
pH
0
1
2
3
4
5
6
7
8
Forest
Treated
Untreated
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997
2006
2005
2004
2003
2002
2001
2000
1999
1998
1997


Soil Porosity
2002 - 2004
Soil Porosity (%)
60
50
40
30
20
10
0
Forest
Treated
Untreated
2004
2003
2002
2004
2003
2002

Trees and shrubs for acid soils

pH 5.0 to 6.5 and above

Trees		Shrubs	
Common Name	**Latin Name**	**Common Name**	**Latin Name**
Balsam and fraser fir	Abies balsamea and A. fraseri	Carolina allspice*	Calycanthus floridus
Maples* (Red)	Acer species	Summersweet*	Clethra alnifolia
Serviceberry*	Amelanchier arborea	Scotch broom	Cytisus scoparius
Hinoki falsecypress	Chamaecyparis obtusa	Cleyera or ternstroemia	Cleyera japonica
Fringetree*	Chioanthus virginicus	Redvein enkianthus	Enkianthus campanulatus
China fir	Cunninghamia lanceolata	Gardenia	Gardenia jasminoides
Franklinia*	Franklinia alatamaha	Witchhazel*	Hamamelis virginiana
Hollies* (Some)	Ilex species	Bigleaf hydrangea	Hydrangea macrophylla
Larch	Larix decidua	Hollies* (Some)	Ilex species
Sweetgum*	Liquidambar styraciflua	Anise	Illicium floridanum
Magnolias* (Some)	Magnolia species	Virginia sweetspire*	Itea virginica
Crabapples	Malus species	Drooping leucothoe*	Leucothoe fontanesiana
Norway and	Picea abies and P.	Mountain	Stewartia

Colorado spruce	pungens	stewartia*	ovata
Longleaf pine*	Pinus palustris		
Eastern white pine*	Pinus strobus		
Scots or Scotch pine	Pinus sylvestris		
White and red oak*	Quercus alba and Q. rubra		
Weeping willow	Salix babylonica		
Sassafras*	Sassafras albidum		
Mountain ash	Sorbus aucuparia		
Japanese stewartia	Stewartia pseudocamellia		
Japanese snowbell	Styrax japonica		
Canadian hemlock*	Tsuga canadensis		

pH 5.0 and below

Trees		**Shrubs**	
Common Name	**Latin Name**	**Common**	**Latin Name**
River birch*	Betula nigra	Bottlebrush buckeye*	Aesculus parviflora
Flowering dogwood*	Cornus florida	Heaths and heathers	Erica species
Japanese dogwood	Cornus kousa	Fothergilla*	Fothergilla species
Japanese cedar	Cryptomeria japonica	Junipers*	Juniperus communis and

American beech*	Fagus grandifolia		J. horizontalis
Carolina silverbell*	Halesia carolina	Mountain laurel*	Kalmia latifolia
Black gum*	Nyssa sylvatica	Loropetalum	Loropetalum chinense
Sourwood*	Oxydendrum arboreum	Japanese pieris*	Pieris japonica
Loblolly pine*	Pinus taeda	Azaleas and	Rhododendron species and
Virginia pine*	Pinus virginiana	rhododendrons* (Some)	hybrids
Golden larch	Pseudolarix kaempferi	Blueberries, huckberries,	Vaccinium species
Douglas fir	Pseudotsuga menziesii	etc.* (Some)	
Pin oak*	Quercus palustris		
Willow oak*	Quercus phellos		

*Native to Virginia (http://www.ext.vt.edu/pubs/trees)

Table 2: Preferred soil pH ranges for Mississippi tree species.*

Common Name	Scientific Name	pH Range	Common Name	Scientific Name	pH Range
Ash, Green	*Fraxinus pennsylvanica*	3.6-7.5	Oak, Shumard	*Q. shumardii*	4.4-6.2
Baldcypress	*Taxodium distichum*	4.6-7.5	Oak, Southern Red	*Q. falcata*	5.0-7.0
American Beech	*Fagus grandifolia*	5.0-7.5	Oak, Water	*Q. nigra*	3.6-6.3
River Birch	*Betula nigra*	4.5-6.0	Oak, White	*Q. alba*	4.5-6.2
Blackgum	*Nyssa sylvatica*	4.6-7.0	Oak. Willow	*Q. phellos*	3.6-6.3
Cottonwood	*Populus deltoides*	3.6-7.5	Paulownia	*Paulownia tomentosa*	6.0-8.0
Dogwood	*Cornus spp.*	5.0-8.0	Pecan	*Carya illinoensis*	4.8-7.5
Hackberry	*Celtis occidentalis*	5.0-7.5	Persimmon	*Diospyros virginiana*	4.4-7.0
Hickory	*Carya spp.*	4.5-7.5	Pine, Loblolly	*Pinus taeda*	4.5-7.0
Magnolia, Southern	*Magnolia grandiflora*	5.0-6.0	Pine, Longleaf	*P. palustris*	4.5-7.0
Maple, Red	*Acer rubrum*	4.4-7.5	Pine, Shortleaf	*P. echinata*	4.5-7.0
Oak, Cherrybark	*Quercus pagodafolia*	4.5-6.2	Pine, Slash	*P. elliottii*	4.5-7.0
Oak, Live	*Q. virginiana*	6.0-7.5	Redcedar, Eastern	*Juniperus virginiana*	6.0-7.5
Oak, Northern Red	*Q. rubrum*	4.5-6.0	Sweetgum	*Liquidambar styraciflua*	3.6-7.5
Oak, Nutall	*Q. nutallii*	3.6-6.8	Sycamore	*Platanus occidentalis*	4.4-7.5
Oak, Post	*Q. stellata*	5.0-7.5	Walnut, Black	*Juglans nigra*	5.0-7.5

*Adapted from Williston, H.L., and R. LaFayette. 1978. Species Suitability and pH of Soils in Southern Forests. USDA Forest Service. Southeastern Area, State and Private Forestry. Forest Management Bulletin. 4 pp.

http://msucares.com/pubs/publications/p2311.pdf

Comparison between New England soil, Roan Mountain forest soil and optimum nutrient values (Soil Attributes as Viable Agents in Red Spruce Mortality…, Dr. Craig Ashbrook)
Value in (ppm)

Location	pH	N	K	P
New England	6.40	40	140	40
Roan Mountain	5.09	10.54	69.37	4.07
Mean Optimum	6.50	55	190	75