Restoration of Silver Bow Creek Water Quality in Butte Area One by Restoring Tree Growth in the Butte Priority Soils Operable Unit Boundary

Submitted to

Butte Natural Resource Damage Restoration Council (BNRC)

Submitted by

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Dated: October 16, 2015

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A) Project Summary and Map

This proposal is submitted in response to the Butte Natural Resource Damage Restoration Council (BNRC) solicitation for proposals for small projects that would improve Butte Area One natural resources or related natural resource-based recreational services pursuant to the December 2012 Butte Area One Final Restoration Plan and an amendment to that plan approved by the Governor of Montana on July 8, 2014. Montana Tech of the University of Montana (Montana Tech) proposes to conduct a small restoration project under this solicitation titled "Restoration of Silver Bow Creek Water Quality in Butte Area One by Restoring Tree Growth in the Butte Priority Soils Operable Unit Boundary." The project will be conducted jointly on the Montana Tech campus and in four areas located within the Butte Priority Soils Operable Unit Boundary designated for tree planting by the Butte Silver Bow Government. Once this proposal is approved, Montana Tech project personnel will meet with Butte Silver Bow Government and Natural Resource Damage Program (NRDP) officials to determine the locations where trees will be planted.

The proposed project will help restore water quality and maintain stream flow in Silver Bow Creek where it flows through Butte Area One. Trees native to Butte, Montana will be grown in an underground greenhouse located in the Underground Mine Education Center (UMEC) on Montana Tech's campus and planted in the Butte Priority Soils Operable Unit Boundary to help restore vegetative ground cover within the watershed contributing to stream flow in Silver Bow Creek. Establishment of these trees will prevent soil and tailings from eroding and being deposited in Silver Bow Creek where they could degrade water quality and choke stream flow.

The cost of the proposed project is $80,000. Tables 1 and 2 present a summary of the cost details for the proposed project. Montana Tech faculty and students will conduct the proposed project, which will start with the beginning of Fall Semester at Montana Tech in August 2016. Figure 1 presents a map showing the location of Butte Area One, the Butte Priority Soils Operable Unit Boundary, and the UMEC. The four areas in the Butte Priority Soils Operable Unit Boundary where trees will be planted, will be determined after the proposed project is approved.

B) Project Goals and Objectives

Currently, soils and tailings in the Butte Priority Soils Operable Unit Boundary lack adequate vegetation cover to prevent soils and tailings from eroding. The eroded sediments are being transported via surface runoff to Silver Bow Creek within Butte Area One where they degrade water quality and affect stream flow patterns. Montana Tech is proposing a small project to help restore and maintain water quality and stream flow in Silver Bow Creek within Butte Area One by preventing erosion of soils and tailings in the Butte Priority Soils Operable Unit Boundary.

Preventing erosion of soils and tailings will be facilitated by planting trees in four areas within the Butte Priority Soils Operable Unit Boundary.

Montana Tech proposes to develop an underground greenhouse/tree farm approximately 100 feet below the surface in the UMEC (the old Orphan Boy Mine) on its campus. Tree seedlings native to the Butte, Montana area will be grown from seeds in the greenhouse, hardened in a sheltered area, and planted in the Butte Priority Soils Operable Unit Boundary. Seedlings grown in the underground greenhouse will also be made available to any reclamation project desiring trees, such as Montana Tech's native re-vegetation project and Norm DeNeal's tree project. It is anticipated that the greenhouse will accommodate up to 4,000 seedlings a year. The tree seedlings grown in the underground greenhouse will be better able to tolerate the harsh growing conditions in Butte, Montana than those grown in other greenhouses. They will be hardened for growing in the harsh Butte climate and they will be grown in the soils and tailings in which they will be planted in the Butte Priority Soils Operable Unit Boundary.

The proposed project will explore the combination of several proven concepts into what is believed to be a solution for re-establishing long-term tree growth and survival in the Butte Priority Soils Operable Unit Boundary. The proven concepts that will be applied in the research conducted on the proposed project include:

- Growing tree seedlings in an underground greenhouse grown from seeds.
- Growing trees directly in the degraded mine soils without applying topsoil for a growing medium.
- Potential for amending degraded soils with sewage sludge to improve their ability to provide for long-term growth and survival of trees.
- Long-term growth and survival of trees in soils containing high metal concentrations.
- Long-term growth and survival of trees in an arid environment with minimal human intervention.

While the success of the research conducted in the proposed project cannot be guaranteed, it is believed that since all of the concepts that will be applied to the research conducted are proven, that the research will lead to a successful solution for re-establishing long-term tree growth and survival in the Butte Priority Soils Operable Unit Boundary.

An underground greenhouse is a proven concept. The Anaconda Company in late 1970 developed an underground tree farm in the Kelley Mine. The project successfully grew approximately 10,000 tree seedlings from seeds that were ready for planting on Anaconda Company reclamation sites. The trees were also successfully acclimated for growth and survival in the cold arid climate of Butte, Montana. Proof of this concept are the trees growing on the Continental East mine dump area. Unfortunately, the Kelley Mine tree farm and its seedlings were flooded after the Anaconda Company closed the Berkley Pit in 1983 and shut off the mine pumps flooding the Kelley Mine. The proposed project will build on the successes of that project by growing seedlings specifically for the harsh growing conditions that exist in the Butte Priority Soils Operable Unit Boundary.

Research work conducted by the University of Kentucky and others documents that trees can be successfully grown in blasted and weathered overburden without the presence of topsoil (Conrad, 2002; ARRI, 2011). The blasted overburden eventually weathers into topsoil, but not for years after trees are planted in it.

Reuter (1997) documents several projects where sewage sludge was applied to degraded mine soils, successfully adding organics, nitrogen, and phosphorus to the soils improving growing conditions in the soils. It was found that application of sewage sludge also increased the pH of the soils, helping control both acid production and solubility of toxic materials in the soils. One of the documented projects was located in New Mexico which has an arid climate similar to that of southwestern Montana. Marx et al. (1995) discusses the benefits of applying sewage sludge to forest and degraded lands. Benfeldt (1999) documents the improvements to mine soils 16 years after the application of sewage sludge to the soils. Vaitkute, et al. (2010) documents how the application of sewage sludge as a soil amendment enhanced the growth of Silver Birch and Scotch Pine trees. Reuter (1997) also reports that sewage treatment technology has significantly improved since the 1970s in its ability to remove toxins and other contaminants from wastewater making sewage sludge obtained from treatment plants "relatively clean".

Research conducted by Seo, et al. (2008) found that planting of trees tolerant to heavy metal concentrations can help stabilize up to 22% of the heavy metals contained in metalliferous spoils on abandoned mine sites in Korea. The proposed project will concentrate on growing Mountain Ash trees (sorbus aucuparia) which are native to the Butte Priority Soils Operable Unit Boundary (Anderson, 2014). Mountain Ash trees are tolerant of acidic soils (Appleton, et al., 2015), which exist in the Butte Priority Soils Operable Unit Boundary. The project proposes to utilize local seeds gathered directly from the Butte Priority Soils Operable Unit Boundary.

Finally, trees once grew in the Butte Priority Soils Operable Unit Boundary in the past before it was settled, without human intervention. It is believed that trees should be able to grow and survive again without human intervention.

The long-term goal of the proposed project is to restore and maintain water quality in Silver Bow Creek by growing trees. To accomplish this goal, it will be necessary to enhance the survivability and long-term growth potential of planted tree seedlings. The underground greenhouse proposed in this project will provide that capability. It is also envisioned that the proposed project will become a long-term research resource available to other projects focused on restoring the Butte landscape with native trees long after the proposed project is completed. The long-term goal will be accomplished by pursuing the following objectives:

- Establish a functional underground greenhouse in the Montana Tech UMEC.
- Sample and analyze soils and tailings from prospective planting sites in the Butte Priority Soils Operable Unit Boundary to determine if there are any needed amenities.
- Gather seeds from native tree species growing in the Butte area; pretreating and priming them for germination. Table 3 presents a list of trees native to the Butte area.

- Plant the germinated seeds in Butte Priority Soils Operable Unit Boundary soils and tailings and nurse the resulting seedling to maturity.
- Harden the seedlings in a semi-sheltered environment for approximately two months prior to planting.
- Plant seedlings on the selected sites.

Growing trees, especially in Butte, Montana, can be labor intensive, expensive, and require long-term maintenance. Another goal of the proposed project is to develop trees that can successfully grow in the Butte Priority Soils Operable Unit Boundary with minimal human intervention after planting. This is typically practiced for re-vegetation during mine reclamation under Section 515(b)19 of PL 95-87: The Surface Mining Control and Reclamation Act (Hall, et al., 2009). Thus, there are no plans for watering, controlling competing vegetative growth, protecting against tree damage, tree replacement, etc. in the proposed project. It is desired to see if the growing trees will become a self-perpetuating ecosystem. If this is the case, growing trees in the Butte area in the future will become much cheaper and successful than it currently is as a result of the proposed project.

C) Project Benefits

The proposed project will help restore and maintain water quality and stream flow patterns in Silver Bow Creek where it flows through Butte Area One. Trees native to Butte, Montana will be grown in an underground greenhouse in the UMEC located on Montana Tech's campus and planted in the Butte Priority Soils Operable Unit Boundary to help restore vegetative ground cover within the watershed that contributes to stream flow in Silver Bow Creek. Establishment of trees will prevent soil and tailings from eroding and being deposited in Silver Bow Creek where they could degrade water quality and choke stream flow.

The proposed project will combine research with tree seedling growth to provide a resource for Butte that produces thousands of tree seedlings each year adapted to the climate, soil, and tailings conditions that exist in the Butte Priority Soils Operable Unit Boundary where they will be grown. The project will provide trees that have the capability for long-term survival and growth because they will be germinated and grown into seedlings in soils and tailings collected from the areas in the Butte Priority Soils Operable Unit Boundary where they will actually be planted. The soils and tailings will be evaluated to determine if they lack nutrients or contain substances toxic to the long-term growth and survival of the trees. Use of sewage treatment sludge as a potential amendment to the soils and tailings to enhance the long-term growth and survival of the planted trees will also be evaluated. It is believed that applying sewage sludge, at a minimum, will add organic material to the soils and tailings which will help retain soil moisture in the growing media and may also provide some pH adjustment to acidic conditions that may exist in the soils and tailings. Both of these amendments should facilitate long-term tree growth and survival.

The methods and techniques used and evaluated in the proposed project will focus on promoting survivable trees with low human intervention and maintenance. The proposed project is designed to be a synergistic resource working with other reclamation projects in the Butte area.

Why is the proposed project unique? The underground greenhouse will be a year-round facility that does not require supplemental heat to be operable. It is also insulated from inclement weather. The temperature in the UMEC is approximately 50° Fahrenheit year-round. It will not require heating and will operate at lower utility costs than a typical surface greenhouse. This will result in lower cost tree seedlings. While it might be argued that an underground greenhouse will require grow lights while a surface greenhouse will not. Grow lights today are energy efficient and lower in cost to operate than heating a greenhouse. It is noted that even surface greenhouses still need grow lights to supplement the photoperiod during the winter months. It is believed that the use of grow lights in the underground greenhouse is partially an offsetting cost with a surface greenhouse and that the difference will be less than the cost of heating a surface greenhouse during colder weather conditions, especially in Butte, Montana.

The underground greenhouse will serve as a starter system and incubator for developing seeds into hearty tree seedlings. The progression of preparing seedlings for planting is a staged process requiring year-round operation. When planting trees, knowledge of the optimal season (i.e. time) for planting is advantageous for growth success. In an underground greenhouse, multiple staging cycles can be in play at any given time, facilitating year-around use of the facility.

What makes growing trees in an underground greenhouse for the proposed project better than purchasing them from a Montana state nursery? Trees grown in the underground greenhouse will cost less and be specifically tailored to successfully grow in the harsh Butte environment. For example:

- Trees will be grown from locally obtained seeds.
- The trees will be grown from seeds germinated in the soils and tailings in which they will actually be planted. The soils and tailings will be analyzed for necessary amenities and supplements.
- Seedling attrition is less costly than failure of mature trees.
- A higher density of seedlings can be planted at a lower cost than for mature trees.

It is believed that the measures incorporated into the proposed project will result in significantly improved reclamation of the Butte Priority Soils Operable Unit Boundary through tree growth. This will result in improved and maintained water quality in Silver Bow Creek in Butte Area One. Finally, it is projected that this can be accomplished with lower development and maintenance costs.

D) Project Implementation

The goal and objectives for the proposed project will be accomplished through performing the following steps:

1) Develop a functional underground greenhouse in Montana Tech's UMEC. Figure 2 shows the underground greenhouse site.
   a) Mine site clean-up:

- The greenhouse location requires rubble removal, installation of roof and wall support, construction of a back wall, and installation of a door.

b) Structures:
   - Installation of overhead metal lattice frames to hold grow lights. Additional structures will include tables, trays, cones, and an equipment backboard.

c) Electrical:
   - Extend electrical service from bottom of UMEC mine shaft to greenhouse location.

d) Network:
   - Extend computer network drops from bottom of UMEC mine shaft to greenhouse location. Two simplex drops for cameras and one duplex for a control computer and an extra for a notebook computer will be installed.

e) Lighting:
   - Install grow lights

f) Photoperiod:
   - Install computer controlled timer to control grow lights.

g) Irrigation:
   - Install computer controlled irrigation and misting system.

h) Monitoring:
   - Install controllers for monitoring temperature, humidity, and visual systems in the greenhouse.

2) Sample, collection, and laboratory analysis of soils and tailings from prospective planting sites to determine any needed amenities.
   a) Select proposed planting sites with input from Butte Silver Bow Government.
   b) Collect soil and tailings samples.
   c) Analyze samples for amenity needs.
   d) Amend soils and tailings and batch for greenhouse growing media.
   e) Recommend site amenities.

3) Gather local seeds from native Butte tree species and pretreat them, priming them for germination.
   a) Determine tree species required for site reclamation plan (See Table 3).
   b) Gather local seeds.
   c) Determine target planting timeframe.
   d) Establish staging.
      - Determine staging scheduling for seed preparation, germination, growing start, and optimum planting season. Harden seedlings for one or two months prior to planting.
   e) Pretreat seeds (priming) for germination.

4) Incubation phase: plant germinated seeds in site soils and tailings and nurse to seedling maturity. The length of time that this varies with tree specie, but is anticipated to take up to four months total.
   a) Stock media.
   b) Transfer sprouts.
   c) Nurse to hearty seedling.

5) Acclimation phase: harden tree seedlings in a semi-sheltered environment for approximately two months.
   a) Hardening.
      - When seedlings are grown inside a controlled climate, they do not have the opportunity to develop the strength and structure to live out in the Butte climate. The seedlings need to get acclimated (hardened) from the perfect environment to the harsh, windy, cold nights and hot days of the real world.
   b) Site.
      - The hardening-off site will be semi-sheltered; not an enclosed surface greenhouse, but also not a true outdoor exposure either.
   b) Methodology.
      - To harden off seedlings, they are gradually introduced to the outdoors. It is advantageous to store the seedlings in trays to make transporting easier.
   c) Staging.
      - Hardening off is a gradual process, exposing the seedlings to the true environment, a little at a time.

6) Plant seedlings on selected sites.
   a) Labor.
      - Tree planting will be performed using project personnel, collaborators, and volunteer labor.
   b) Methodology.
      - The slit method of planting seedlings is faster than the hole method. Using a planting bar, shovel, or spade, a vertical slit is made in the soil. The seedling roots are inserted in the slit and it is then closed at both the top and the bottom. Proper handling techniques will be employed.
   c) Coverage density.
      - Cover density will be predetermined. Overcrowding the seedlings will be avoided and batches deployed to match available labor pool.
   d) Maintenance.
      - It is desirable to grow trees in the Butte Priority Soils Operable Unit Boundary with minimal human intervention after planting. This is typically practiced for re-vegetation during mine reclamation under the Surface Mining Control and Reclamation Act. Thus, there are no plans for watering, controlling competing vegetative growth, protecting against tree damage, tree replacement, etc. in the proposed project. It is desired to see if the growing trees will become a self-perpetuating ecosystem.
   e) Follow-up.
      - Monitoring, thinning/relocation.

All of the work required for the proposed project will be performed by Montana Tech project personnel, collaborators, and/or volunteers. The site locations for all the work proposed on this project will be conducted on public land owned by either Montana Tech or the Butte Silver Bow Government.

E) Project Schedule, Invoice Submittal, and BNRC Walk-through

Figure 4 presents a schedule for the work to be performed on the proposed project. The project will begin in August 2016 and end in August 2021. Additional funding will be sought to keep the project going beyond the August 2021 completion date. While the proposed length of the proposed project is five years, the majority of the funding will be spent during the first four years of the project.

During the performance of the project, Montana Tech will submit Quarterly Progress Reports to the BNRC describing the work accomplished during the quarter and listing the work that remains to be completed on the project. At the completion of the project, Montana Tech will submit a final report to the BNRC describing the work accomplished on the project.

Invoices will be submitted by Montana Tech to the BNRC for work completed on the project on a quarterly basis. At the completion of the project, Montana Tech will submit a final invoice to the BNRC.

It is anticipated that BNRC personnel will tour the underground greenhouse and the sites where trees have been planted with Montana Tech project personnel at the end of each project year to inspect the greenhouse facilities and the growth and survival of planted trees. Growing trees is a long-term project. Thus, the proposed project has no fixed expiration date. However, it is anticipated that the trees still growing at the end of five years of the project will give an adequate indication of the success or failure of the project.

F) Monitoring Activities

Success or failure of the proposed project will be determined by the number of planted trees that survive each year of growth in the Butte Priority Soils Operable Unit Boundary. A 50% survival rate of planted trees will be considered as a successful project. The survival rate of trees will be determined at the end of each year of the project. There is no money in the budget specifically for monitoring the survival rate of the planted trees. Dr. Conrad's collaboration match on this project includes monitoring of the growth of the planted trees.

G) Budget

The cost of the proposed project is $80,000. Tables 1 and 2 present a summary of the cost details for the project.

H) Matching Project Support

Montana Tech will provide $86,098 in matching support for Dr. Conrad's time on the proposed project. Table 1 summarizes Montana Tech's matching project support.

I) Collaboration Support

The Clark Fork Watershed Education Program (CFWEP) and Ms. Kellee Anderson, Montana State University Extension Agent for Butte Silver Bow County will provide collaborative support for the proposed project. Letters of collaborative support are provided in Appendix A.

J) Future Expansion of Proposed Project

Montana Tech will apply for other grants and funding opportunities to support and expand the proposed project. Montana Tech plans to make tree seedlings available to any organization planting trees for reclamation purposes in the Butte Area One and elsewhere in the vicinity, if approved by BNRC/NRDP. While the proposed project will target tree species native to Butte Montana, Montana Tech researchers hope in future projects to investigate the planting of any hearty tree capable of withstanding Butte's climate. Potential sources of funding for support and expansion of the proposed project include:

- Office of Surface Mining and Reclamation Technology Transfer Grants
- Mile High Conservation District 223 Grants
- National Fish & Wildlife Association
- Dennis & Phyllis Washington Foundation
- Wells Fargo
- Major retail chains serving Butte

K) Key Project Personnel

Key Montana Tech personnel who will work on the proposed project include:

- Paul W. Conrad, PhD, PE, Principal Investigator
- Michael Kukay. MS, Co-Principal Investigator
- Mining Engineering Graduate Student to be determined later

Dr. Conrad worked as a researcher on the Starfire Mine High-Quality Reforestation Project at the University of Kentucky from 1999 – 2002. The project evaluated various methods of constructing replaced growing media on reclaimed surface coal mining operations and their impact on tree growth to determine the best way to reconstruct growing media to enhance tree growth with the goal of re-establishing forestlands. Mr. Kukay developed and ran the underground tree farm in the Kelley Mine for the Anaconda Company during the 1970s. That project successfully grew approximately 10,000 tree seedlings ready for planting on reclamation sites. Appendix A presents the bio sketches of the key project personnel.

L) Publications

The Montana Tech graduate student who works on the proposed project will prepare a thesis for their Master's Degree presenting the results of their work on the project. Montana Tech will also prepare a manuscript(s) for presentation at a professional meeting(s) and/or for peer-review and publication presenting the results of the project.

M) References

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Vaitkute, D., E. Baltrenaite, C.A. Booth, and M.A. Fullen, "Does Sewage Sludge Amendment to Soil Enhance the Development of Silver Birch and Scots Pine?", Hungarian Geographical Bulletin, Vol. 59, No. 4, 2010, pp. 393-410.

N) Figures

Figure 1: Project Location Map

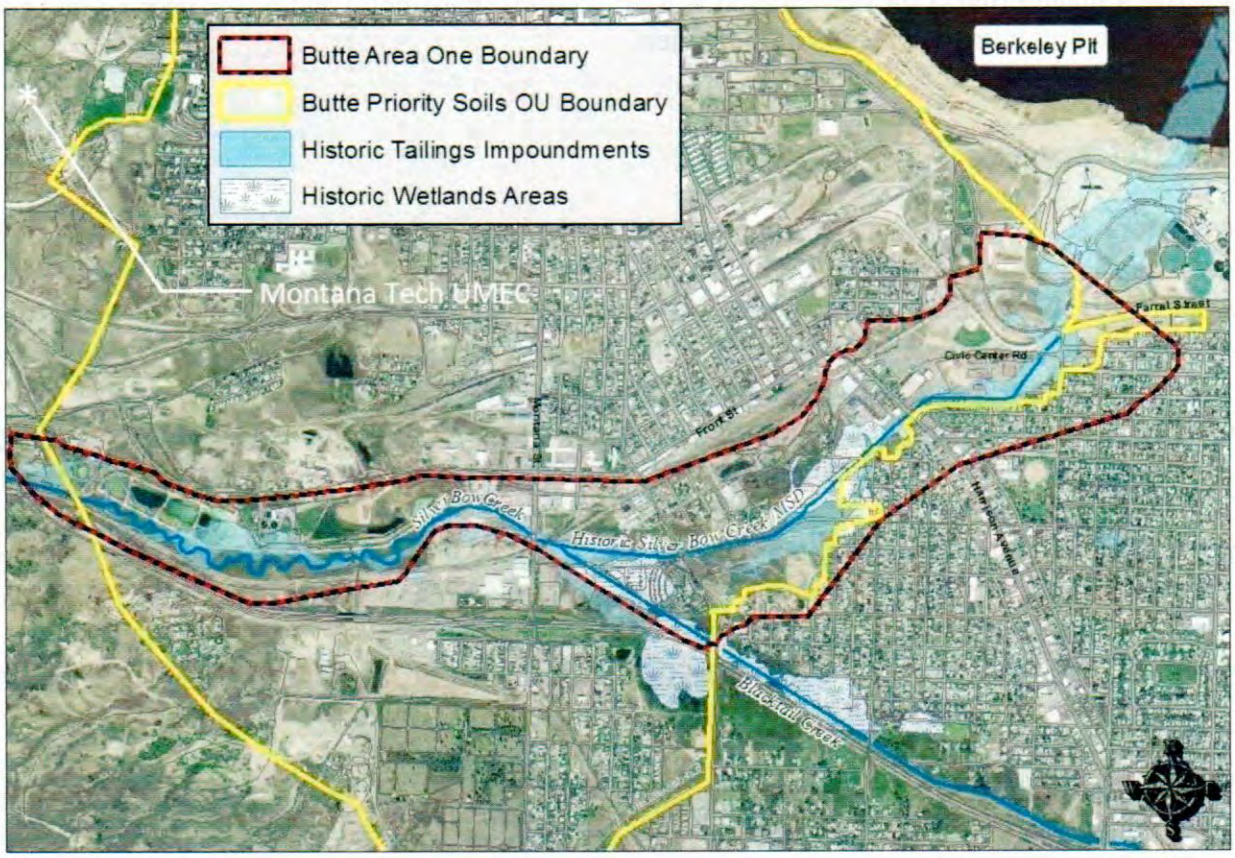

Figure 2: Underground Greenhouse Location

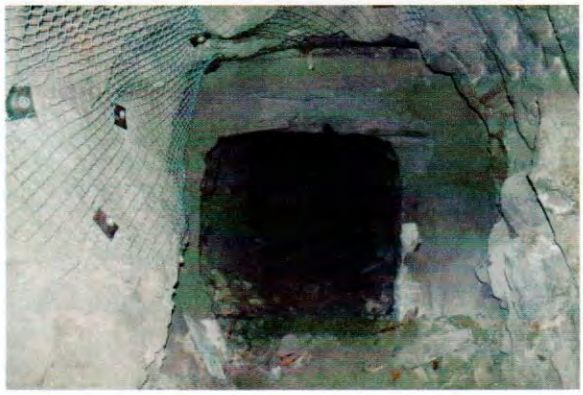

Figure 3: Project Schedule

Item	Year	2016					2017												2018											
	Month	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Develop Underground Greenhouse		X	X	X	X	X																								
Soils & Tailings Collection and Sampling		X	X	X																										
Gather Seeds		X	X	X					X	X	X	X	X	X	X	X					X	X	X	X	X	X				
Tree Incubation & Growing					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Tree Acclimation									X	X	X	X									X	X	X	X						
Plant Trees											X	X	X	X	X						X	X	X	X	X	X				
BNRC Greenhouse Inspection						X												X								X				
Planted Tree Monitoring, Thinning, Relocation									X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X		
BNRC Plant Site Walk-throughs														X												X				

Item	Year	2019												2020												2021							
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Develop Underground Greenhouse																																	
Soils & Tailings Collection and Sampling																																	
Gather Seeds				X	X	X	X	X	X	X	X					X	X	X	X	X	X												
Tree Incubation & Growing		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												
Tree Acclimation				X	X	X	X									X	X	X	X														
Plant Trees						X	X	X	X	X						X	X	X	X	X	X												
BNRC Greenhouse Inspection													X								X												
Planted Tree Monitoring, Thinning, Relocation				X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X					X	X	X	X	X	X
BNRC Plant Site Walk-throughs									X												X												X

O) Tables

Table 1: Project Cost Summary

			Grant Request	Cost Share
Salaries and Benefits				
Graduate Student		Per Month		
36 month(s) (8 semesters)		$ 1,200.00	$ 43,200	
Paul W. Conrad (PI)				
1 month per year for 5 years		$ 10,379.00		$ 55,103
3% increase in Years 2, 3, 4 & 5				
Benefits (Graduate Student 3% & P. Conrad 25%)			$ 1,296	$ 13,776
Total Salaries and Benefits			$ 44,496	$ 68,879
Underground Green House				
Supplies (See Attached)			$ 7,200	
Contracted Services (See Attached)			$ 8,000	
Soil/growing media testing			$ 3,000	
Trees (Seed Collection)			$ 394	
Travel				
mileage	1,400 miles	$0.65 /mile	$ 910	
Total Direct Costs			$ 64,000	$ 68,879
Indirect Costs	@	**25 % of Total Direct Costs**	$ 16,000	$ 17,220
Total Estimated Cost			**$ 80,000**	**$ 86,098**

Table 2: Underground Greenhouse Construction Cost Summary

ITEM	DESCRIPTION	UNIT COST	QTY	SUPPLIES	CONTRACTED SERVICES
Structures					
Frames	Overhead metal frames Installation	$4,400	1	$4,400	
Tables	2' W x 10' L Premium Stationary Greenhouse Bench	$287.50	4	$1,150	
Lighting					
Electrical Installation	Wires,Main supply cable,lighting towards site,all installations	$5,000	1		$5,000
Monitoring Station					
Atmospheric monitoring panel	iGrow 800 Controller with Vent Control options and S-module which allows monitoring from a computer or smartphone	$1,000	1	$1,000	
Network (Internet) Istallation	Cost of Labor,panels and wires	$3,000	1		$3,000
Wall Mount	Ergotron LX Wall Mount system with CPU Holder (for in-house monitoring station)	$650	1	$650	
			TOTAL	**$ 7,200**	**$ 8,000**

Table 3: Trees Native to Butte, Montana

Quaking Aspen
Douglas Fir
Mountain Ash
Canada Red Choke Cherry
Engelmann Spruce
Subalpine Fir
Creeping Juniper
Potentilla

Appendices

Appendix A: Collaborative Support Letters

Cfwep.Org

The Clark Fork Watershed Education Program fosters environmental stewardship and scientific decision-making through place-based learning.

MontanaTech
THE UNIVERSITY OF MONTANA
INSTITUTE FOR EDUCATIONAL OPPORTUNITIES

October 9, 2015

Dr. Paul Conrad
Montana Tech
1300 W. Park
Butte, MT 59701

As director for the Clark Fork Watershed Education Program (Cfwep.Org), I am very pleased to give a letter of support to Dr. Paul Conrad for his proposed BNRC project. Dr. Conrad's vision for creating an underground greenhouse to raise native tree stock for re-vegetation of the Butte Hill is compelling. As an organization, Cfwep.Org continually seeks to increase our partnerships throughout the community, thereby ensuring that our students are afforded the maximum number of opportunities possible to work and study within this landscape. Through this project, we will be able to provide another excellent stewardship and education opportunity for Butte students.

We are committed to:

- Identifying students who are interested and willing to help plant trees, collect native seeds, and complete minor field studies such as tree growth, soil sampling, and assessment of tree health.
- Providing logistical support for field trips with Montana Tech students and/or Butte High/Butte Central High School students.
- Provide outreach advertisement and support through our publication, The Montana Steward, our website, and our radio show.

As stewards of this landscape, we value each opportunity for students to engage in improving our community. This project will enable students to connect to the restoration and remediation of our landscape in a very personal and rewarding way. Additionally, the skills of monitoring and assessing the success of the project will prove valuable for our students who are pursuing STEM studies. We look forward to working with Dr. Conrad.

Sincerely,

Rayelynn Connole
Director, Cfwep.Org

Cfwep.Org | Institute for Educational Opportunities | Montana Tech | 1300 West Park St. | Butte, MT 59701 | (406) 496-4790
www.cfwep.org

MONTANA
STATE UNIVERSITY
EXTENSION

October 9, 2015

Dr. Paul Conrad
Montana Tech
1300 W. Park
Butte, MT 59701

Silver Bow County Extension Office

As MSU Extension Agent for Butte Silver Bow City/County, I am pleased to give a letter of support to Dr. Paul Conrad for his proposed BNRC project. Dr. Conrad's proposed underground greenhouse and the native trees that will be grown there will produce trees that ought to grow and thrive in the ever changing Butte climate. His work will help to re-vegetate trees in the Butte Area.

The Butte Silver Bow County MSU Extension Office is committed to supporting the proposed project with:

Species and location selection
Outreach for planting efforts
Evaluation of planting

Sincerely,

Kellee Anderson,
Butte Silver Bow Co MSU Extension Agent

Montana State University, U.S. Department of Agriculture and Montana Counties Cooperating. MSU Extension is an equal opportunity/ affirmative action provider of educational outreach.

305 West Mercury
Butte, MT 59701-1659
www.msuextension.org

Tel (406) 723-0217
Fax (406) 723-5345
Email silverbow@montana.edu

Mountains & Minds

Appendix B: Resumes of Key Project Personnel

Biographical Sketch for Paul W. Conrad

Department of Mining Engineering, Montana Tech of the University of Montana
Butte, MT. 59701, (406) 496-4620, pconrad@mtech.edu

Educational Experience

Pennsylvania State University	BS Mining Engineering	1982
Pennsylvania State University	MS Mining Engineering	1990
University of Kentucky	PhD Mining Engineering	2002

Professional Experience

Montana Tech	Professor	2002-Present
University of Kentucky	Research Assistant	1999-2002
GAI Consultants, Inc.	Lead (Project) Engineer	1991-2000
PA Dept. of Transportation	Civil Engineer-Bridge	1988-1991
Davis, Renn & Shrader	Engineer	1987-1988
WS Frey Company	Engineer/Foreman	1987
Penn State Dept. of Mineral Engr.	Graduate Assistant	1986-1987
PA Bureau of Abandoned Mine Recl.	Civil Engineer-II	1984-1986
Erdman, Anthony & Assoc.	Highway Construction Inspector	1984
L. Robert Kimball & Assoc.	Highway Construction Inspector	1982-1984
Eastern Associated Coal Corp.	Shuttle Car Operator/Laborer	1975-1977

Selected Publications

Conrad, P.W., R.J. Sweigard, D.H. Graves, J.M. Ringe, and M.H. Pelkki, "Impacts of Spoil Conditions on Reforestation of Surface Mined Land", Mining Engineering, Vol. 54, No. 10, 2002, pp. 39-46.

Conrad, P.W., R.J. Sweigard, J.C. Yingling, D.H. Graves, and J.M. Ringe, "Use of Ripping to Alleviate Excessive Compaction on Reclaimed Surface Mined Land", Transactions 2002, Society for Mining, Metallurgy, and Exploration, Inc., Littleton, CO, 2002, pp.159-165.

Sweigard, R.J., P.W. Conrad, V. Badaker, J.C. Yingling, D.H. Graves, and J.M. Ringe, "Methodology for Evaluating the Suitability of Spoil Conditions for Reforestation", Transactions 2004, Society for Mining, Metallurgy, and Exploration, Inc., Littleton, CO, 2004, pp. 143-148.

Conrad, P.W., R.J. Sweigard, V. Badaker, D.H. Graves, and C.D. Barton, "The Impact of Surface Applied Mulches on Selected Physical Properties of Reclaimed Mountaintop Removal Sites", International Journal of Mining, Reclamation and Environment, Vol. 22, No. 3, 2008, pp. 222-236.

Conrad, P., R. Sweigard, K. Hunt, D. Graves, C. Barton, and V. Badaker, "Long-Term Changes in Selected Spoil Characteristics on Reforested Surface-Mined Land", Transactions 2008, Society for Mining, Metallurgy, and Exploration, Inc., Littleton, CO, 2008, pp. 75-80.

Liu, X., J.Q. Wu, P.W. Conrad, S. Dun, C.S. Todd, R.L. McNearny, W.J. Elliot, H. Rhee, and P. Clark, "Impact of Surface Coal Mining on Soil Hydraulic Properties", 2015 Transactions (pending), Society for Mining, Metallurgy, and Exploration, Inc., Littleton, CO, 2015, 12 pp.

Biographical Sketch for Michael Kukay

Network Services, Montana Tech of the University of Montana
Butte, MT. 59701, (406) 496-4673, mkukay@mtech.edu

Educational Experience:

Montana College of Mineral Science and Technology, BS Computer Science	1990
Montana College of Mineral Science and Technology, BS Environmental Engineering	1977

Professional Experience:

Montana Tech	Director, Network Services	1999-Present
Montana Tech	Manager, Micro Computing and Networks	1993-1999
Montana Tech	Network and Micro Software Specialist	1990-1993
Montana Tech	Student/Computer Technician	1987-1990
Montana Power Co.	Director, Environmental Support	1978-1987
The Anaconda Co.	Environmental Engineer	1977-1978

Relevant Activities:

- ✓ Upgraded and advanced a successful design of an underground tree farm 3,900 feet below the surface in the Kelley Mine. Operated and successfully grew approximately 10,000 tree seedlings produced for Anaconda Co. reclamation projects.
- ✓ Evolved a seed pre-treatment process priming seeds for germination.
- ✓ Developed a mature tree transplanting protocol for Anaconda Co. sites.
- ✓ Trained a reclamation & hydro-seeder crew.
- ✓ Established several reseeding projects on Anaconda Co. property.
- ✓ Designed several irrigation systems for reseeded projects.