FINAL REPORT

2001 Project Abstract
For the Period Ending June 30, 2004

TITLE:.....The SOILS Project: Science Outreach and Integrated Learning on Soil
PROJECT MANAGER: ..... Patrick Hamilton
ORGANIZATION:..... Science Museum of Minnesota
ADDRESS:..... 120 W. Kellogg Blvd., St. Paul, MN 55102
FUND: .....Environment and Natural Resources Trust Fund
WEB ADDRESS: .....http://www.smm.org/
LEGAL CITATION:.....ML 1999, Chap. 231, Sec. 16, Subd. 11f
APPROPRIATION AMOUNT:.....$250,000

Overall Project Outcome and Results

The 1,200-square-foot Science House was built to serve as the laboratory/classroom/office for the Big Back Yard, the Museum's new 1.2-acre outdoor science park. Science House is also a research project in that its goal is to provide all of the energy it needs to heat, cool, and power itself on an annual basis through its photovoltaic roof.

With the Big Back Yard open to the public, Science House now is the center for soil lab activities. Dissecting microscopes and a videomicroscope allow visitors up-close views of the invertebrate life in soils. Remote-sensing tools permit visitors to measure for themselves environmental variables in the park, such as surface temperatures and soil moisture. Students from the Museum's Youth Science Center play a lead role in presenting these activities to park visitors.

The Big Back Yard both houses exhibits and serves as an educational landscape itself. It is designed to convey the concepts that urban landscapes can enhance human and ecological health by the incorporation of perennial plants and plant communities that not only satisfy conventional landscape architecture needs but also produce food and wildlife habitat and protect and enhance urban soils.

Project Results, Use, and Dissemination

Science House building has been honored with several awards:

- *Excellence in Building Educational Achievement Award*, The Energy & Environmental Building Association, October 18, 2003, Chicago.
- *Environmental Achievement Award in the Energy Category*, Minnesota Environmental Initiative, May 6, 2004, Minneapolis.
- *Environmental Sensitivity Award*, Minneapolis-St. Paul Chapter of the Construction Specifications Institute, May 10, 2004, Minneapolis.

Science House has hosted several professional conference field trips:

- *EnvironDesign* conference, Saturday, April 24
- *Affordable Comfort* conference, April 27
- *EnergySmart America* conference, May 11

Science House will be the subject of a session at the November 2-5 AIA Minnesota Convention and will be included in the zero-emissions building session at the November 16-18 Build Boston conference.

Date of Report: ..... August 19, 2004
LCMR Final Work Program Report

Project Completion Date: ..... June 30, 2004

I. THE SOILS PROJECT: Science Outreach and Integrated Learning on Soil

Project Manager: ..... Patrick Hamilton
Affiliation: ..... Science Museum of Minnesota (SMM)
Mailing Address: ..... 120 W. Kellogg Blvd., St. Paul, MN 55102
Telephone Number: 651-221-4761
E-Mail: ..... hamilton@smm.org
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Web Address: ..... http://www.smm.org

Total Biennial Project Budget:

$LCMR:	$250,000	**$ Match:**	$832,526
- $ LCMR Amount Spent:	$250,000	**- $ Match Amount Spent:**	$832,526
= $ LCMR Balance:	$0	**= $ Match Balance:**	$0

A. Legal Citation: ML 1999, Chap. 231, Sec. 16, Subd. 11f

Carryforward Language: The availability of the appropriations for the following project is extended to June 30, 2004: ML 2001, 1st Special Session, Ch. 2, Sec. 14, Subd. 18, paragraph (b): 011f Science Outreach and Integrated Learning on Soil.

THE SOILS PROJECT: Science Outreach and Integrated Learning on Soil
$125,000 the first year and $125,000 the second year are from the trust fund to the Science Museum of Minnesota to develop a soils experiment center and demonstration plots to increase the awareness of soil science and soil health. This appropriation must be matched by at least $100,000 of nonstate money. This appropriation is available until June 30, 2002, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

B. Status of Match Requirement: Alida Messinger signed a letter of agreement with the Science Museum on April 7, 1999 to provide $50,000 for the design and construction of Science House. The Minnesota Department of Commerce notified the Science Museum in a letter dated May 28, 1999 that it is making $50,000 in federal State Energy Program funds available to the museum for the design and construction of Science House.

II. and III. FINAL PROJECT SUMMARY:

Overall Project Outcome and Results

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IV. OUTLINE OF PROJECT RESULTS:

Objective 1. SOILS Experiment Center:
SMM will develop in the outdoor space at the new riverfront museum a 1,400 ft^2 structure that will serve as greenhouse, soils lab/classroom, and soil science exhibit area. As much as possible, building materials will be obtained from the Green Institute's *building deconstruction program.* Working with the Minnesota Renewable Energy Society and other knowledgeable organizations and individuals, the Center will be a working model of energy efficiency and alternative energy.

LCMR Budget:	$144,000	Match:	$830,026
Balance:	$0	Match Balance:	$0

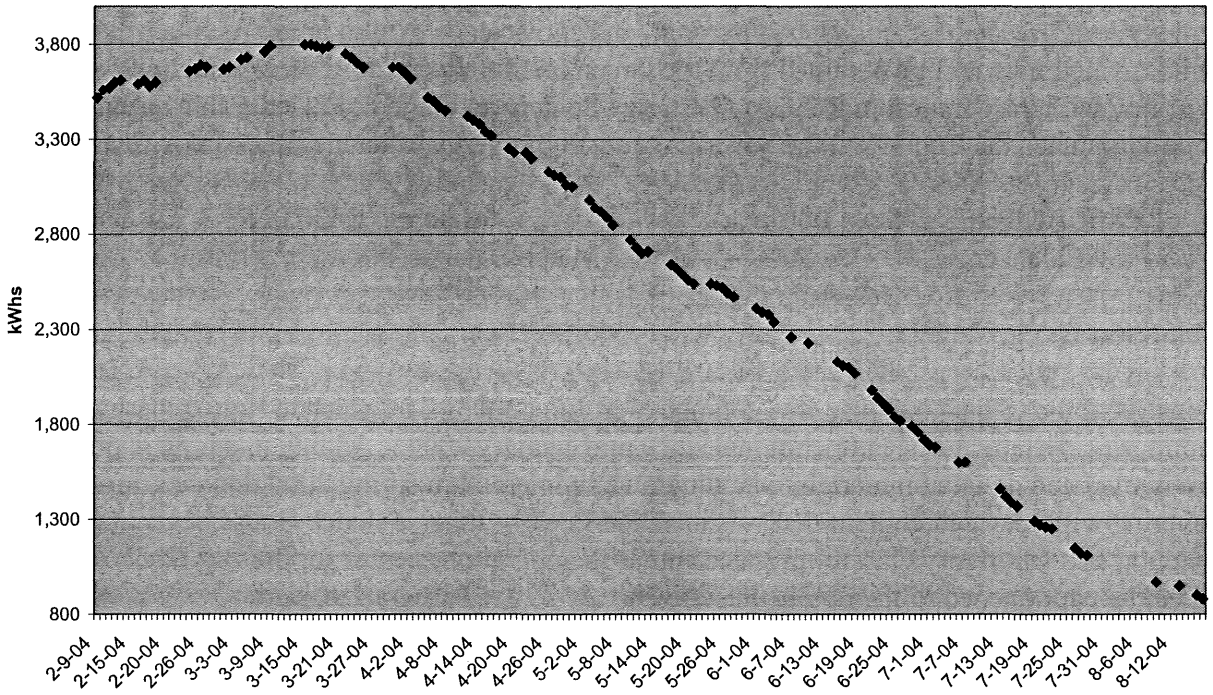
Final Status:

Construction of Science House was completed in June 2003. The Science House energy monitoring system has been operational since mid January 2004. Adding to a long list of discounted and donated materials, Mannington Commercial in spring 2004 donated floor covering with recycled content that was installed in early June. Science House began its full function as a laboratory/classroom space and as the operations center for the Big Back Yard when the park opened to the public on June 26.

Janis LaDouceur, design architect for Science House, was selected by AIA to be honored at its national convention in June in Chicago as one of five best young architects in the U.S. Science House was the subject of a feature article in the May/June issue of Eco-Structure magazine.

Through the 03/04 winter, the electric meter in Science House slowly scrolled forward and reached its highest reading of 3,800 kWhs on March 16. Since that time, Science House has almost daily been generating a net surplus of electricity (which it feeds back to the Science Museum) and the electric meter has scrolled backward to 880 kWhs as of August 17.

Science House Electric Meter Readings
from February 9 through August 17, 2004



Objective 2. SOILS Exhibits:

The SOILS Experiment Center will house exhibits about basic soil science, with a focus on the invertebrate and microbial life of soils. The Center also will include information on the St. Croix Watershed Research Station's research on fingerprinting sediment sources in agricultural watersheds.

LCMR Budget:	$46,000	Match:	$0
Balance:	$0	Match Balance:	$0

Final Status:

Plans and layouts for the cabinets, countertops, and sink for the Science House laboratory activities were developed during spring 2004. The Science Museum's exhibit shop then fabricated and installed them. Concurrent with this design and fabrication work, Jim Roe, lead exhibit developer for the Big Back Yard, worked with Sue Thao, program manager for the Big Back Yard, and Theresa Berrell, Youth Science Center program manager, to research and develop soil invertebrate laboratory activities and environmental monitoring tools activities. Dissecting microscopes and a videomicroscope now allow visitors up-close views of the invertebrate life in soils. Remote-sensing tools permit visitors to measure for themselves environmental variables in the park, such as surface temperatures and soil moisture. Students from the Museum's Youth Science Center play a lead role in presenting these activities to park visitors.

A $125,000 grant from the University of Minnesota's Initiative for Renewable Energy and the Environment in January combined with a $25,000 gift from Doug Dayton in December permitted the Museum to proceed with constructing and planting a 17,000-square-foot prairie maze at the eastern end of the Big Back Yard. The Museum selected Natural Environments, Inc. to construct the prairie maze in May and construction of the maze was completed in early June. The planting of the maze was performed by student interns from the University of Minnesota's Cedar Creek Natural History Area. This work was overseen by Dr. David Tilman, University of Minnesota's Department of Ecology, Evolution, and Behavior, Troy Mielke, Cedar Creek Natural History Area project manager, and Dr. Shawn Schottler, St. Croix Watershed Research Station. Plants were donated and/or discounted by the U. of M.'s Department of Ecology, Evolution, and Behavior, Prairie Moon Nursery, Kinnickinnic Natives, and Stillwater Area High School.

Preliminary interpretation is in place. More in-depth interpretation will be developed during winter 2005 and installed in early summer 2005. While solving the maze, visitors will gain insights into the relationships between biodiversity and ecosystem productivity, the potential of perennial cover crops, such as prairie plantings, to remove carbon dioxide from the atmosphere and sequester it in soils, and the potential of native prairie vegetation to serve as a source of biomass energy.

A $3,500 grant from the Two Feathers Funds at the Saint Paul Foundation in April along with $6,000 in support from American Express Financial Advisors allowed the Museum to contract with Paul Red Elk of Prairie and Woodland Wisdom to construct and plant a turtle effigy medicinal garden and a three sisters garden (the planting of corn, beans, and squash together) at the western end of the Big Back Yard, in the vicinity of the Science House building. These gardens highlight Native American herbal plant lore and the conservation and propagation of traditional varieties of Native American vegetables. Paul completed his work in the middle of June. Plant labels and graphic storyboards interpret these gardens to Big Back Yard visitors.

Objective 3. Permaculture Demonstration:
SMM will use its outdoor Science Park to demonstrate the principles of permaculture. The landscape will be designed, installed, and interpreted to convey the concepts that urban landscapes can improve their human and ecological health by the incorporation of perennial plants and plant communities that not only satisfy conventional landscape architecture needs but also produce food and wildlife habitat and protect and enhance urban soils.

LCMR Budget:	$38,800	Match:	$0
Balance:	$0	Match Balance:	$0

Final Status:

In early 2004, the Science Museum worked with a landscape architect with Barr Engineering and Paul Red Elk of Prairie and Woodland Wisdom to develop a landscape plan for the Big Back Yard. This plan incorporated both native vegetation plantings and permaculture into the Big Back Yard.

Valley Crest was the landscaping firm selected to implement the landscape plan. All plant material was in place by the middle of June. Since that time, 30-day and 60-day walkthroughs with the Science Museum, Barr Engineering, PCL, and Valley Crest have taken place to assess the health of the plant material and to identify needs to replace dead plants. The generally cool summer permitted good establishment of the plant material. Replacement of dead plants will take place after Labor Day.

Storyboards describing the permaculture plantings of the Big Back Yard and plant labels have been installed in the park.

Big Back Yard Permaculture Plant List:

QTY	Type	Common Name	*Botanical Name*
1	Tree	Apple, Liberty	*Malus 'Liberty'*
1	Tree	Apricot 'Sungold'	*Prunus 'Sungold'*
1	Tree	Apricot, 'Moongold'	*Prunus 'Moongold'*
16	Perennial	Asparagus	*Asparagus*
8	Shrub	Blueberry, Chippewa	*Vaccinium 'Chippewa'*
8	Shrub	Blueberry, Northblue	*Vaccinium 'Northblue'*
8	Shrub	Blueberry, Polaris	*Vaccinium 'Polaris'*
1	Tree	Cherry 'North Star'	*Prunus 'North Star'*
1	Tree	Cherry, 'Mesabi'	*Prunus 'Mesabi'*
1	Tree	Cherry-plum 'Red Diamond'	*Prunus 'Red Diamond'*
2	Tree	Cherry-plum 'Sapalta'	*Prunus 'Sapalta'*
2	Tree	Cherry-plum, 'Compass'	*Prunus 'Compass'*
24	Shrub	Currant, Redlake	*Ribes 'Redlake'*
34	Shrub	Gooseberry, Pixwell	*Ribes 'Pixwell'*
2	Vine	Grape, Bluebell	*Vitis 'Bluebell'*
2	Vine	Grape, Edelweiss	*Vitis 'Edelweiss'*
2	Vine	Grape, Himrod	*Vitis 'Himrod'*
2	Vine	Grape, Reliance	*Vitis 'Reliance'*
2	Vine	Grape, Valiant	*Vitis 'Valiant'*
15	Shrub	Hazelnut	*Corylus americana*
2	Vine	Kiwi, Arctic Beauty	*Actinidia kolomitka 'Arctic Beauty'*
2	Vine	Kiwi, Arctic Issai	*Actinidia arguta 'Arctic Issai'*
4	Perennial	Lovage	*Levisticum officinale*
9	Perennial	Oregano	*Origanum heracleotianum*
1	Tree	Plum 'Alderman'	*Prunus 'Alderman'*
2	Tree	Plum 'Toka'	*Prunus 'Toka'*
19	Shrub	Raspberry, Boyne	*Rubus 'Boyne'*
4	Perennial	Rhubarb	*Rheum*
5	Shrub	Serviceberry, Allegheny	*Amelanchier 'Allegheny'*
5	Shrub	Serviceberry, Regent	*Amelanchier 'Regent'*

8	Perennial	Strawberrry, Ft. Laramie	*Strawberry Everbearing*
8	Perennial	Strawberry, Allstar	*Strawbery June Bearing*
20	Perennial	Strawberry, Wild	*Fragaria vesca 'Alexandria'*
8	Perennial	Thyme, Pink Chintz	*Thymus vulgaris*

Objective 4. SOILS Youth Programs:

8th grade students as part of SMM's existing Lab Partners program will be trained to run programs for museum visitors in the SOILS Experiment Center. SMM will make the soil science programs of the SOILS Experiment Center integral to its focused field trips (short classes developed by SMM for visiting schools), its Investigators' Club (SMM-based classes for gifted and talented students), and to the St. Paul Saturn School (SMM provides science classes for the school.)

LCMR Budget:	$21,200	Match:	$2,500
Balance:	$0	Match Balance:	$0

Final Status:

The YES (Youth Environmental Science) team officially wrapped up its work in February 2004 with the completion of a soils outreach program with three community after-school sites. Following completion of the outreach project, the team evolved into the Park Crew with funding from the National Center for Earth-surface Dynamics. The Park Crew will work to interpret the exhibits in the Big Back Yard to visitors through the summer. During the 2004/2005 school year, the Crew will provide earth science outreach to communities. This new Youth Science Center team consists of 5 of the 7 youth from the YES team and an additional 7 youth hired specifically for the Park Crew position.

The last project the YES team tackled was in preparation for the transition from YES team to Park Crew. In anticipation of the earth science outreach program, the YES team piloted a new outreach design in January and February using information the team had learned about soils. The new design is based on feedback from community partners who would like to encourage their young children to make the connection between teenagers doing science and science itself. The partners feel that this could be achieved by exposing their program participants to a consistent group of teenagers who "looked like them" and do science in a fun and engaging way during multiple visits, within a relatively short period of time.

The YES team visited three "Project Spirit" after-school sites, reaching approximately 40 children, ages 6-11, in nine separate visits (the team visited each site three times) to the sites. The team focused on two major topics related to soils – soil formation and urban runoff and its effects on aquatic food webs. The team related the science content using experiments, art, and games. The Project Spirit staff was pleased with the visits and has asked the group to come back to work with their children again. The Park Crew will use this design with slight modifications in an outreach program slated to begin in October 2004.

The Park Crew is currently working shifts in the Big Back Yard. The crew is responsible for 24, 4-hour shifts in the park each week. Their responsibilities include working with visitors as

general interpreters of the park, leading visitors in hands-on activities, maintaining (watering, weeding) the butterfly gardens planted by the YES team in summer 2003 and the two Native American gardens planted in the park this past spring. Additionally, each youth is spending some of their time at the National Center for Earth Surface Dynamics at the St. Anthony Falls Lab, working with graduate students to better understand the content of the Big Back Yard and to gain exposure to professions in science.

FISCAL YEARS	99/01						01/02										02/03										03/04									
MONTHS	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	S	O	N	D	J	F	M	A	M	J
Science House																																										
Research & planning			X	X	X	X																																			
Design							X	X	X	X	X	X	X	X	X	X	X	X	X																						
Construction																				X	X	X	X	X	X	X															
Exhibits																																									
Research																										X	X	X	X	X	X	X	X	X	X						
Design																																			X	X	X				
Fabrication																																						X	X	X	X	X
Permaculture Demonstration																																									
Research & planning																															X	X	X								
Design																																X	X	X							
Installation																																		X	X				X	X	
SOILS Youth Programs																																									
Lab Partners program																															X	X	X	X	X	X	X	X	X	X	X	X

V. DISSEMINATION:

Science House and related exhibits, demonstration/test plots, and youth programs will be a major element of the outdoor space at the new riverfront Science Museum of Minnesota. It will be accessible to the 1.25 million people expected to visit the museum annually and will be highly visible to everyone boating, driving, biking, and walking past the new Museum.

VI. CONTEXT:

A. Significance: Topsoil is a precious natural resource, yet many human activities have contributed to a long-term decline in its health, both in rural and urban areas. Science House will inform a wide variety of audiences about soil science/health, and will use the new museum as a site where applied research can take place that advances the current state of knowledge regarding how soil can be conserved.

B. **Time:** All objectives will be completed by June 30, 2004.

C. Budget Context: Soil education is a new program initiative at the Science Museum. Science House will in installed in the Big Back Yard, the outdoor space at the new museum.

VI1. BUDGET:

Personnel

	% Time Spent on Project	$Cost
Patrick Hamilton, SMM	14% over two years	18,500
Chris Krumm & Jim Roe, SMM	25% over three years	39,650
Project Designer, (tbd), SMM	19% over two years	15,000
Graphic Designer, (tbd), SMM	25% over four months	4,000
Youth Program Manager, (tbd), SMM	15% over one year	6,200
Lab Partners (8th grade youth interpreters), SMM	N/A	15,000
Exhibit fabricators, SMM	N/A	16,000
Dan Engstrom, St. Croix Watershed Research Station	N/A	in-kind
Mark Zumwinkle, Minnesota Department of Agriculture	N/A	in-kind
Staff, Dept. of Soil, Water & Climate, U. of M.	N/A	in-kind
Staff, Peer Environmental & Engineering Resources, Inc.	N/A	in-kind
Norm Mofjeld, MAPSS	N/A	in-kind
Tom Jackson, MAPSS	N/A	in-kind
Equipment		
Lab equipment for the SOILS Experiment Center		18,000
Equipment for the demonstration/test plots		5,000
Acquisition		
None		0
Development		
Engineering and construction documents		7,600
Construction of the SOILS Experiment Center		146,150
Other		
Soils Experiment Center casework		4,100
Materials and supplies for the fabrication of exhibits		11,000
Site preparation for the demonstration/test plots		5,000
Permaculture plantings and maintenance		33,800
Total		**350,000**

VIII. COOPERATION:

Mark Zumwinkle, Minnesota Department of Agriculture
Various staff, Dept. of Soil, Water & Climate, University of Minnesota
Various staff, Peer Environmental & Engineering Resources, Inc.
Various teachers, Saturn School
Norm Mofjeld and Tom Jackson, Minnesota Association of Professional Soil Scientists

IX. LOCATION:

Science House with its associated exhibits, demonstration/test plots, and youth program will be located in the outdoor space at the new riverfront Science Museum of Minnesota, in the city of St. Paul and the county of Ramsey.

X. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted no later than June 30, 2000; December 31, 2000; June 30, 2001; December 31, 2001, June 30, 2002; December 31, 2002; June 30, 2003; December 31, 2003; and June 30, 2004. A final work program report and associated products will be submitted by June 30, 2004.

Attachment A: Deliverable Products and Related Budgets	**Result 1**	**Result 2**	**Result 3**	
	Research	Design	Construction	ROW TOTAL
Objective 1: Science House				
Personnel:				
Patrick Hamilton, SMM	7,000	4,000	4,500	15,500
Mark Zumwinkle, Minnesota Department of Agriculture	in-kind	in-kind	in-kind	in-kind
Staff of the Dept. of Soil, Water, & Climate, U. of M.	in-kind	in-kind	in-kind	in-kind
Engineering and construction documents		7,600		7,600
Construction			120,900	120,900
COLUMN TOTAL	*7,000*	*11,600*	*125,400*	*144,000*
Match Resources				
Science Museum staff/Owner's Representative				46,375
Professional Consultants				157,563
Construction				626,08?
COLUMN TOTAL				*830,0.*
	Result 1	**Result 2**	**Result 3**	
	Research	Design	Fabrication	ROW TOTAL
Objective 2. SOILS Exhibits				
Personnel:				
Patrick Hamilton, SMM	1,000	1,000		2,000
~~Chris Burda~~, Jim Roe, SMM	5,000	5,000	3,000	13,000
Graphic Designer, (tbd), SMM		3,000	1,000	4,000
Two Exhibit Fabricators, SMM			16,000	16,000
Dan Engstrom, St. Croix Watershed Research Station	in-kind			in-kind
Staff of the Dept. of Soil, Water, & Climate, U.of M	in-kind			in-kind
Staff of Peer Environmental & Engineering Resources, Inc.	in-kind			in-kind
Tom Jackson, MAPSS	in-kind			in-kind
Exhibit materials and supplies			11,000	11,000
COLUMN TOTAL	*6,000*	*9,000*	*31,000*	*46,000*

Objective 3. Permaculture Demonstration				
Personnel:				
Patrick Hamilton, SMM	500	500		1,000
Jim Roe, SMM	4,000	4,000	3,500	11,500
Staff of the Dept. of Soil, Water, & Climate, U. of M.	in-kind	in-kind	in-kind	in-kind
Staff of Peer Environmental & Engineering Resources, Inc.	in-kind	in-kind	in-kind	in-kind
Norm Mofjeld, MAPSS	in-kind	in-kind	in-kind	in-kind
Equipment			5,000	5,000
Demo./test plot site preparation, planting, & maintenance			21,300	21,300
COLUMN TOTAL	*4,500*	*4,500*	*29,800*	*38,800*
	Result 1	**Result 2**		
	Youth Supervision	Lab Parters		ROW TOTAL
Objective 4. SOILS Youth Programs				
Personnel:				
Theresa Berrell, Youth Program Manager, SMM	6,200			6,200
Mark Zumwinkle, Minnesota Department of Agriculture	in-kind	in-kind	in-kind	in-kind
Lab Partners (8th grade youth interpreters), SMM		15,000		15,000
COLUMN TOTAL	*6,200*	*15,000*		*21,200*
Match Resources				*2,500*