

SCHULTE ASSOCIATES LLC

EXECUTIVE MANAGEMENT CONSULTANTS

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05 - 0447

MAY - 2 2005

April 30, 2005

Legislative Commission on Minnesota Resources
Room 65, State Office Building
100 Reverend Dr. Martin Luther King, Jr. Boulevard
St. Paul, MN 55155

**RE: Final Work Program Report: "Continuous Indoor Air Quality
Monitoring in Minnesota Schools"**

Dear LCMR Staff:

Attached per our Work Program for subject project are three copies of our Final Work Program Report, dated April 30, 2005. The legal citation for this project is: Minnesota Laws 2003, Chapter 128, Article 1, Section 9, Paragraph (12c).

The project has nationwide significance and, according to the eight participating schools, it was a big success! It will be featured in the May edition of *ASHRAE Journal* magazine. Thank you for your advice and support throughout this effort.

Please give me a call if you have any questions, or need additional information. We would be happy to brief you, LCMR members, or other legislators on these results at your request.

Sincerely,



Robert H. Schulte
Project Manager

Attachment (3 copies)

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LCMR Final Work Program Report

Date of Report: April 30, 2005
Date of Next Status Report: Not applicable
Date of Work program Approval: June 25, 2003
Project Completion Date: June 30, 2005.

I. PROJECT TITLE: Continuous Indoor Air Quality Monitoring in Minnesota Schools.

Project Manager: Robert H. Schulte
Affiliation: Schulte Associates LLC
Mailing Address: 9072 Palmetto Drive
City / State / Zip : Eden Prairie, Minnesota 55347
Telephone Number: (952) 949-2676
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Web Page address:

Total Biennial LCMR Project Budget:	LCMR Appropriation:	\$300,000
	Minus Amount Spent:	<u>\$297,640</u>
	Equals Balance:	\$2,360

Attachment A, Budget Detail, dated April 30, 2005 is attached.

Legal Citation: ML 2003, Chap. 128, Art. 1, Sec. 9, Subd. (12c).

Appropriation Language:

"12c Continuous Indoor Air Quality Monitoring in MN Schools **\$300,000**

12 (c) Continuous Indoor Air Quality Monitoring in Minnesota Schools \$150,000 the first year and \$150,000 the second year are from the trust fund to the commissioner of natural resources for an agreement with Schulte Associates, LLC to provide continuous, real-time indoor air quality monitoring in at least six selected schools."

II. and III. PROJECT SUMMARY AND RESULTS:

This project used innovative fixed-base continuous real-time indoor air quality (IAQ) monitoring technology and the Internet to investigate and characterize the IAQ in 85 representative classrooms and other spaces in eight selected Minnesota K-12 schools. Potential IAQ improvement and energy cost savings opportunities made possible by the continuous data were estimated.

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The results show that many of the project schools needed better ventilation, and several had school-wide significant deficiencies. They also demonstrate that a recent initiative by the Minnesota Department of Education to improve ventilation in schools is working. However, state efforts to encourage ventilation improvements and energy conservation are not being sufficiently coordinated. The schools are using project results to successfully and dramatically improve their IAQ. These improvements are often being done inexpensively using operating or maintenance adjustments, once school staffs have actual IAQ data that enable them to identify problems and measure results. Potential energy conservation opportunities in the eight schools totaled about \$55,000/year, including relatively modest amounts of additional energy that would be required to remedy the discovered ventilation inadequacies.

This study has potentially major statewide and national significance. It represents the first time that IAQ in multiple classrooms in multiple schools have been monitored and analyzed side-by-side continuously and simultaneously for an entire school year. The project identified other recent studies that have found a correlation between inadequate school ventilation levels and increased student absenteeism. If such absenteeism study results are combined with IAQ data from projects like this LCMR effort, it could fundamentally change the benefit/cost equation for ventilation standards in schools. This project also demonstrated that ventilation and IAQ adequacy in multiple schools can be certified continuously from a single, remote location over the Internet. More detailed project results can be viewed on a website developed as part of the project at: www.mnk12IAQEnergyuse.org.

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Monitoring, Project Management & Project Report

Description: Provide continuous (24 hours per day, 7 days per week), real-time IAQ monitoring in at least 8 rooms in each participating school (more than 80 rooms total) simultaneously for two years. Key IAQ parameters including temperature, relative humidity, carbon monoxide (CO), carbon dioxide (CO₂) and organic odors/gases will be monitored using the PureTrac[®] environmental monitoring service by PureChoice, Inc., a Minnesota company. IAQ data will be made available to participating schools and the project team for viewing on-line on the Internet. Data for each school will be archived in a database, and made available on the Internet for analysis. This Result also includes all Project Manager services and the Project Final Report.

Deliverables for this Result 1 included, for each Participating School:

- A. Installation of PureTrac[®] continuous IAQ monitoring technology in each of the schools, and completion of initial system user training.
- B. Continuous IAQ data from at least 8 schoolrooms for the duration of the Biennium collected and archived in a secure database. One additional year of

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monitoring will be provided to each school by the Project Team at no additional charge (to August 31, 2006).

- C. Secure access to their IAQ data.
- D. All project coordination, management and financial reporting services, including liaison with LCMR, participating schools and Project Team.
- E. Development, editing and delivery of all 12 monthly project reports, one Project Summary Report, and one Final Project Report, to be delivered in Microsoft Word format in electronic form. Due Dates: Monthly reports for 12 consecutive months during first year of project. Project Summary Report and Final Project Report due April 30, 2005.

PureChoice, Inc. provided Deliverables 1A through 1C. Schulte Associates LLC, Project Manager, provided Deliverables 1D and 1E.

Summary Budget Information for Result 1:	LCMR Budget	\$	167,000
	Minus Amount Spent	\$	164,640
	Balance	\$	2,360

Budget details and component breakdowns are provided at Attachment A. The remaining balance shown represents the final two months of IAQ monitoring (May and June 2005) that are funded by the project and remain to be provided to the schools and invoiced to the project as of the date of this Final Project Report. Accordingly, on June 30, 2005 the project balance will be zero.

Completion Date: June 30, 2005

This Result #1 is completed, with the sole exception of the final two months of IAQ monitoring service that is being provided to the schools through June 30, 2005. Details are provided in the Project Summary Report and the Project Final Report documents that are provided as Attachments D and E.

Result 2: Expert IAQ Data Analysis

Description: Provide IAQ Expert services and associated out-of-pocket expenses for analysis of the continuous IAQ data during the first year of the project. Monthly IAQ reports will be provided by the IAQ Expert to each participating school for twelve months, identifying trends and recommendations for improved IAQ. IAQ data will be summarized to characterize the IAQ in participating schools; results will be related to recent research regarding IAQ effects on student health. This Result also includes IAQ Expert Services for the Project Report.

Deliverables for this Result 2 included:

- A. Monthly IAQ Expert consulting services during the first 12 months of the project, including analysis of continuous IAQ data for each participating school.

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- B. Expert input to monthly IAQ Expert reports to each participating school, provided in electronic form in Microsoft Word format.
- C. Characterization of IAQ conditions in the participating schools for the IAQ parameters measured.
- D. A literature review of recent and current national research regarding IAQ and children's health for the parameters measured in this project.

Sebesta Blomberg & Associates (Barry Bridges) performed Deliverables 2A through 2C of this Result 2, and provided consulting input to Deliverable 2D. Grimsrud & Associates (David Grimsrud) performed Deliverable 2D, and provided consulting input to Deliverables 2A through 2C.

Summary Budget Information for Result 2:	LCMR Budget	\$ 79,000
	Minus Amount Spent	\$ 79,000
	Balance	\$ 0

Budget details and component breakdowns are provided at Attachment A.

Completion Date: December 31, 2004

This Result #2 is completed. Details are provided in the Project Summary Report and the Project Final Report documents that are provided as Attachments D and E.

Result 3: Identify Energy Conservation Opportunities

Description: A related and supporting project not included in this LCMR request, "Schools Air Monitoring Project for Learning and Energy Efficiency (SAMPLE²)", is a Minnesota Conservation Improvement Program (CIP) project recently approved for implementation by the Minnesota Department of Commerce (DOC). SAMPLE² is energy conservation-focused, and will install continuous IAQ and energy monitoring in three to five Minnesota K-12 schools to identify the energy conservation opportunities enabled by such monitoring. As approved by the DOC, multiple utilities will sponsor SAMPLE² schools across the state, and results are scheduled to be available in time for application to this LCMR project.

This Result 3 will extrapolate the energy findings of the energy-focused SAMPLE² project to the additional population of schools in this LCMR project that is primarily IAQ-focused. This information is included in the Project Final Report.

Deliverables for this Result 3 included:

- A. An extrapolation of SAMPLE² Conservation Improvement Program findings in Minnesota K-12 schools as they apply to LCMR participating schools with similar energy equipment and IAQ characteristics.

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B. A section in the Project Summary Report that summarizes the results of this analysis.

Altec Energy Systems performed this Result 3.

Summary Budget Information for Result 3:	LCMR Budget	\$	6,000
	Minus Amount Spent	\$	6,000
	Balance	\$	0

Budget details and component breakdowns are provided at Attachment A.

Completion Date: April 30, 2005

This Result #3 is completed. Details are provided in the Project Summary Report and the Project Final Report documents that are provided as Attachments D and E.

Result 4: School Maintenance Staff Tools

Description: Provide on-line case studies and maintenance tools on the Internet for school maintenance personnel to enable them to interpret and use continuous, real-time IAQ data on an ongoing, sustained basis, consistent with their health, safety and environmental management plan (M.S. Section 123B.57). Design input to be provided by the Minnesota Association of School Maintenance Supervisors (MASMS).

Deliverables for this Result 4 included:

A. Development and posting of on-line maintenance tools for school maintenance personnel.

Altec Energy Systems performed this Result 4.

Summary Budget Information for Result 4:	LCMR Budget	\$	48,000
	Minus Amount Spent	\$	48,000
	Balance	\$	0

Budget details and component breakdowns are provided at Attachment A.

Completion Date: December 31, 2004

This Result #4 is completed. Details are provided in the Project Summary Report and the Project Final Report documents that are provided as Attachments D and E.

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V. TOTAL LCMR PROJECT BUDGET:

All Results: Personnel:	\$185,900
All Results: Equipment (leased):	\$98,000
All Results: Development:	\$0
All Results: Acquisition:	\$0
All Results: Other (Travel):	<u>\$16,100</u>

TOTAL LCMR PROJECT BUDGET: \$300,000

Attachment A, Budget Detail, is attached.

Explanation of Capital Expenditures Greater Than \$3,500:

The PureTrac[®] continuous IAQ monitoring technology for the project was provided as a leased data service as part of Result 1. PureChoice, a contractor for Result 1, will be responsible for all PureTrac[®] technology installation, operation, maintenance, spares, replacements and support throughout the project term. The monitoring technology to be located at the participating schools will be fixed in place for the duration of the project term (two years). An additional one year of service will also be provided at no additional cost to the schools by PureChoice following the project term. This additional period of monitoring is intended to promote sustainability of project results, by giving the participating schools the opportunity to react to project recommendations, to enact changes, and to measure results.

Use of related hardware, software and other supporting facilities located at PureChoice associated with the PureTrac[®] monitoring service and used for processing, reporting and archiving project data, including Internet website capabilities for data access by the participating schools, will be similarly made available for use by the participating schools throughout the two-year project term, plus the additional year PureChoice will provide.

Although the PureTrac[®] technology and systems to be used are designed to physically operate for time periods beyond three years, the use of this technology dedicated to the project 24 hours a day will probably represent most if not all of its market life. At the end of the project and the additional one year of monitoring service, the Participating Schools will be offered the option of continuing the monitoring service at the then-current monthly service rate. However, they will have no obligation to do so.

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VI. PAST, PRESENT AND FUTURE SPENDING:

A. Past Spending:

As outlined in Result 3, above, this LCMR project used the results of the related SAMPLE² project for energy conservation information for the LCMR participant schools. As approved by the Department of Commerce, the SAMPLE² project resulted in a \$135,000 Conservation Improvement Program (CIP) expenditure by Minnesota Power for three Minnesota schools starting October 1, 2002 and prior to July 1, 2003.

B. Current Spending:

The Minnesota Power-sponsored SAMPLE² project described above was completed during the initial months of the LCMR project, resulting in an additional \$21,880 in expenditures between July 1, 2003 and November 2003.

C. Required Match (if applicable): A match is not required by the appropriation for this project. Nevertheless, results from the SAMPLE² project funded by one or more Minnesota utilities via CIP legislation will be used in Result 3 of this project, thereby leveraging CIP funds for the LCMR project.

D. Future Spending:

The following future spending sources and amounts apply to this project:

- In addition to project funds provided via the LCMR, PureChoice, Inc. provided leased equipment for IAQ monitoring and two years of IAQ monitoring service in two of the eight schools, plus they are providing an additional, third year of IAQ monitoring for all eight schools at no additional charge. This additional year of service will conclude on August 31, 2006. The value of this is about \$55,000. Schulte Associates LLC and Sebesta Blomberg provided Project Manager and IAQ Expert services, respectively, for two of the eight schools at no additional charge. The value of this is about \$22,000.
- Funding for IAQ improvements identified in this project are available via Minnesota Department of Education Health and Safety Funds. Note: Such funds are available for improvements, but not identifying improvements.
- Also, funding for energy conservation improvements identified in Result 3 will be eligible for funding via utility CIP programs.
- Additional health and energy-related efforts are also contemplated via the federal government's "No Child Left Behind" Act, Title V, Subpart 18: "Healthy and High Performance Schools", signed into law January 8, 2002.

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VII. DISSEMINATION:

The data and results of this project have been disseminated and shared in multiple ways:

- The real-time and archived IAQ monitoring data for each school is continuously available for viewing by each school on the Internet using a secure password on any Internet-compatible personal computer located anywhere throughout the project period. PureChoice, a Project Team member and provider of the PureTrac[®] monitoring service, will provide an additional year of monitoring service to each school following the two-year Biennium project period.
- Each participating school may download and keep their IAQ data from the Internet at any time, and store it on an Excel spreadsheet or Access database of their choice.
- Each participating school may use their continuous IAQ data for interesting and useful student science, math, statistics or environmental studies projects at their option. Several schools have indicated they have done this during the project.
- Each participating school may release their continuous IAQ data to third parties involved in maintaining or updating their school energy and IAQ management equipment. Note: Each school will have sole authority regarding who (outside the Project Team and LCMR) may view that school's detailed IAQ data.
- Monthly IAQ Expert reports (included in Result 1) were provided to each participating school during the first 12 months of the project.
- A copy of the Final Project Report (included in Result 1) summarizing all Results of the project will be provided to each school at the conclusion of the first year of the project.
- An Internet website has been developed and established per Result 4 to disseminate on-line maintenance tools to school maintenance personnel. The website address is: www.mnk12IAQEnergyuse.org. With current funding, the website will continue to be operational through December 31, 2005.
- A link on the PureChoice website (www.purechoice.com) will be established to provide information regarding current status of project activities and current/upcoming project events.
- The Project Team has delivered and will deliver project presentations as the participating schools and their School Boards request them.
- Subject to applicable confidentiality provisions with the participating schools (established in a project participation agreement that was completed with each

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school), the project results have been and will be made available upon request to legislative, industry or other bodies interested in IAQ topics, legislation and building standards development related to schools. For example, the Team has made a presentation to the Minnesota Association of School Business Officers (MASBO), and will do another one to MASBO on May 5. The Team has also done presentations for the Minnesota Department of Health, the Minnesota Department of Education, and the Energy and Environmental Resources Committee of the National Association of Regulated Utility Commissioners (NARUC).

- The project will be the subject of an article called "Continuous IAQ Monitoring" in the May 2005 edition of *ASHRAE Journal*. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) is the leading national authority on building ventilation issues such as those addressed in this LCMR project.

Each participating school has the right to control release by the Project Team of all specific, detailed IAQ data for their school to third parties other than the Project Team and the LCMR. It is planned that generic, summary-level information describing the entire project that does not identify specific schools with specific data will not be subject to this limitation. In addition, because this project will be funded by public monies, detailed IAQ data from each participating school shall be subject to release under the authorization of the LCMR to any party with appropriate legal or regulatory authority to view it.

VIII. LOCATION:

Participating Schools

The project was performed at the eight selected schools listed on Table 1. These candidate schools were all briefed on the goals and content of the project, including what responsibilities and support would be expected of them as participants. They subsequently all submitted Letters of Interest for participating on the project to the Project Manager. Copies of these Letters of Interest are available for the LCMR's review, if requested.

Attachment B provides a map of the locations of these schools around the state.

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Table 1
LCMR Project
Participating Schools

School District or School	City	Zip Code
Chisholm Senior High School	Chisholm	55719
Countryside Elementary School	Edina	55424
Fergus Falls Middle School	Fergus Falls	56537
Highland Elementary	St. Paul	55116
Mankato East High School	Mankato	56002
Orchard Lake Elementary	Lakeville	55044
Renville County West High School	Renville	56284
St. Anthony Middle/High School	St. Anthony Village	55418

These schools were selected from a larger group of applicant schools, based on the following criteria:

- Schools located across the state of Minnesota. As shown on Attachment B, the Project Team worked hard to ensure there would be candidate schools located around the state. The monitoring technology used in the project uses the Internet for data collection and reporting. So, with the exception of periodic Project Team travel and visits to each school to coordinate activities, from a project operational perspective the schools could be physically located anywhere.
- Schools representing the diversity of school types and energy-using systems typically used in similar schools in Minnesota. Although the size of the sample of participating schools will be relatively small in this project, the participating schools were selected such that they represent building types, applications and energy systems frequently found in Minnesota schools. This was done to make the project findings useful to a wider population of Minnesota schools.
- Schools those are most interested in actively participating in the project. As discussed below, the project does not require any out-of-pocket expenditure by the participating schools. Nevertheless, to make the project most effective it involved schools whose administration and personnel were most interested in participating and making the most out of it.

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Responsibilities of the Participating Schools

The candidate schools were all briefed on their responsibilities as participant schools, and they acknowledged that in their Letters of Interest. Their responsibilities were to provide the following to the project:

- Their interest in IAQ and energy conservation topics in schools.
- A local school staff contact person to coordinate activities with the Project Team.
- Access to the school's persistent Internet connection.

These are the same responsibilities that were fulfilled by schools that participated in the Project Team's companion SAMPLE² project, which had been in operation since November 2002 and was completed during the LCMR project. Experience in that project had shown the schools can accomplish their participation without additional, out-of-pocket expenditures on their part.

IX. REPORTING REQUIREMENTS:

Periodic work program progress reports were submitted as follows:

- Report #1: September 30, 2003
- Report #2: January 31, 2004
- Report #3: June 30, 2004
- Report #4: April 30, 2005 (Project Summary Report and Final Project Report)

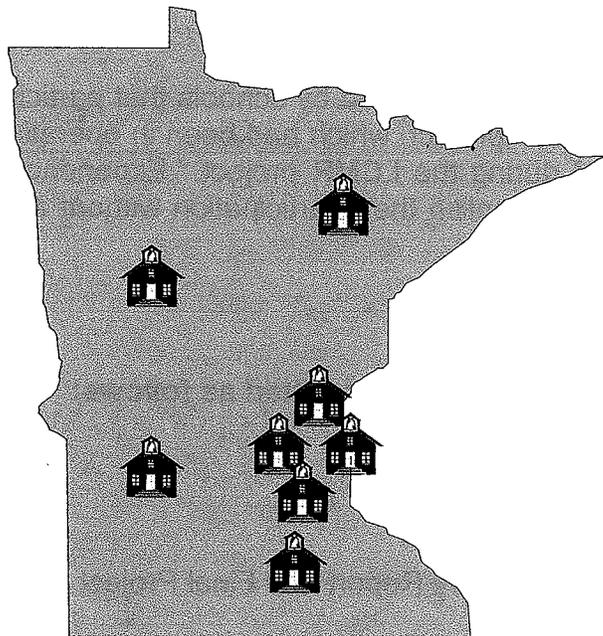
This Report #4 includes the Project Summary Report, which provides the detailed results of the one-year analysis period and includes Project Team recommendations. It also includes the Final Project Report, which summarizes all results and includes a follow-up with each Participating School to identify what actions they have taken on the results and recommendations provided in the Project Summary Report.

X. RESEARCH PROJECTS: This project has not been designated as a Research Project by the LCMR. As a result, the Research Addendum does not apply.

XI. Attachments

- Attachment A: Budget Detail
- Attachment B: Participating Schools Map
- Attachment C: Final Project Abstract
- Attachment D: Project Summary Report
- Attachment E: Project Final Report

Attachment B
LCMR Project
Participating School Locations



- **Chisholm**
- **Edina**
- **Fergus Falls**
- **Highland Elementary (St. Paul)**
- **Lakeville**
- **Mankato**
- **Renville County West**
- **St. Anthony-New Brighton**

Proposal Title: Subdivision 12(c): "Continuous Indoor Air Quality Monitoring in Minnesota Schools"

Project Manager Name: Robert H. Schulte, Schulte Associates LLC

LCMR Requested Dollars: \$300,000 (for at least six schools)

2003 LCMR Proposal Budget	Result 1 Budget: \$167,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 2 Budget: \$79,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 3 Budget: \$6,000	Amount Spent (4/30/05)	Balance (4/30/05)
	<i>Monitoring, Project Mgmt and Project Report</i>			<i>Expert IAQ Data Analysis</i>			<i>Identify Energy Conservation Opportunities</i>		
BUDGET ITEM									
Contracts									
Professional/technical (with whom? and for what?)	PureChoice, Inc.: Provide PureTrac IAQ monitoring services and support, and IAQ database. Includes Work Program Deliverables 1B, 1C and 1D. Schulte Associates LLC: Provide Project Manager, coordination and liaison services for all 6 schools and project partners, write final project report. Includes Work Program Deliverables 1A, 1E and 1F.			Sebesta Blomberg & Associates: Provide IAQ Expert analysis services and monthly reports for all 6 schools. Includes Work Program Deliverables 2A, 2B and 2C, and consulting input to 2D. Grimsrud & Associates: Provide IAQ Expert input to characterization of IAQ in schools and resulting recommendations. Includes Work Program Deliverable 2D, and consulting input to 2A, 2B and 2C.			Altec Energy Systems: Correlate energy conservation results of SAMPLE2 CIP project with results of LCMR schools. Includes Work Program Deliverables 3A and 3B.		
Total Contract Personnel	\$ 71,600	\$ 71,600	\$ -	\$ 79,000	\$ 79,000	\$ -	\$ 4,400	\$ 4,400	\$ -
Total Contract Equipment	\$ 94,000	\$ 91,640	\$ 2,360	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Space rental: NOT ALLOWED	X	X	X	X	X	X	X	X	X
Travel expenses in Minnesota	\$ 1,400	\$ 1,400	\$ -	\$ -	\$ -	\$ -	\$ 1,600	\$ 1,600	\$ -
Travel outside Minnesota (where?)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ 167,000	\$ 164,640	\$ 2,360	\$ 79,000	\$ 79,000	\$ -	\$ 6,000	\$ 6,000	\$ -

Notes:

1. Travel in Minnesota will include installation, analysis and project coordination trips to each participating school, and between project partner offices for coordinating meetings

Result 4 Budget: \$48,000	Amount Spent (4/30/05)	Balance (4/30/05)	Total Project Budget	Amount Spent (4/30/05)	Balance (4/30/05)
<i>School Maintenance Staff Tools</i>			<i>All Results</i>		
			TOTAL FOR BUDGET ITEM		
Altec Energy Systems: Develop on-line case studies and school maintenance tools. Includes Work Program Deliverable 4A.					
\$ 47,100	\$ 47,100	\$ -	\$ 202,100	\$ 202,100	\$ -
\$ -	\$ -	\$ -	\$ 94,000	\$ 91,640	\$ 2,360
X	X	X	X	X	X
\$ 900	\$ 900	\$ -	\$ 3,900	\$ 3,900	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 48,000	\$ 48,000	\$ -	\$ 300,000	\$ 297,640	\$ 2,360

Proposal Title: Subdivision 12 (c): "Continuous Indoor Air Quality Monitoring in Minnesota Schools"

Project Manager Name: Robert H. Schulte, Schulte Associates LLC

LCMR Requested Dollars: \$300,000 (for at least 6 schools)

2003 LCMR Proposal Budget	Result 1 Budget: \$167,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 2 Budget: \$79,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 3 Budget: \$6,000	Amount Spent (4/30/05)	Balance (4/30/05)
	<i>Monitoring, Project Mgmt and Project Report</i>			<i>Expert IAQ Data Analysis</i>			<i>Identify Energy Conservation Opportunities</i>		
BUDGET ITEM									
Contracts									
Professional/technical (with whom? and for what?)	PureChoice, Inc.: Provide PureTrac IAQ monitoring services and support, and IAQ database. Includes Work Program Deliverables 1B, 1C and 1D.								
Total Contract Personnel	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Contract Equipment	\$ 94,000	\$ 91,640	\$ 2,360	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Space rental: NOT ALLOWED	X	X	X	X	X	X	X	X	X
Travel expenses in Minnesota	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Travel outside Minnesota (where?)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ 94,000	\$ 91,640	\$ 2,360	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Notes:

1. Travel in Minnesota will include installation, analysis and project coordination trips to each participating school, and between project partner offices for coordinating meetings

Result 4 Budget: \$48,000	Amount Spent (4/30/05)	Balance (4/30/05)	Total Project Budget	Amount Spent (4/30/05)	Balance (4/30/05)
<i>School Maintenance Staff Tools</i>			<i>All Results</i>		
			TOTAL FOR BUDGET ITEM		
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ 94,000	\$ 91,640	\$ 2,360
X	X	X	X	X	X
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ 94,000	\$ 91,640	\$ 2,360

Attachment A: Budget Detail for 2003 Proposals - Partner Summary: Schulte Associates LLC (Revised 4/30/05)

Proposal Title: Subdivision 12(c): "Continuous Indoor Air Quality Monitoring in Minnesota Schools"12

Project Manager Name: Robert H. Schulte, Schulte Associates LLC

LCMR Requested Dollars: \$300,000 (for at least 6 schools)

2003 LCMR Proposal Budget	Result 1 Budget: \$167,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 2 Budget: \$79,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 3 Budget: \$6,000	Amount Spent (4/30/05)	Balance (4/30/05)
	<i>Monitoring, Project Mgmt and Project Report</i>			<i>Expert IAQ Data Analysis</i>			<i>Identify Energy Conservation Opportunities</i>		
BUDGET ITEM									
Contracts									
Professional/technical (with whom? and for what?)	Schulte Associates LLC: Provide Project Manager, coordination and liasion services for all 6 schools and project partners, write final project report. Includes Work Program Deliverables 1A, 1E and 1F.								
Total Contract Personnel	\$ 71,600	\$ 71,600	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total Contract Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Space rental: NOT ALLOWED	X	X	X	X	X	X	X	X	X
Travel expenses in Minnesota	\$ 1,400	\$ 1,400	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Travel outside Minnesota (where?)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ 73,000	\$ 73,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Notes:

1. Travel in Minnesota will include installation, analysis and project coordination trips to each participating school, and between project partner offices for coordinating meetings

Result 4 Budget: \$48,000	Amount Spent (4/30/05)	Balance (4/30/05)	Total Project Budget	Amount Spent (4/30/05)	Balance (4/30/05)
<i>School Maintenance Staff Tools</i>			<i>All Results</i>		
			TOTAL FOR BUDGET ITEM		
\$ -	\$ -	\$ -	\$ 71,600	\$ 71,600	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
X	X	X	X	X	X
\$ -	\$ -	\$ -	\$ 1,400	\$ 1,400	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ 73,000	\$ 73,000	\$ -

Attachment A: Budget Detail for 2003 Proposals - Partner Summary: Sebesta Blomberg (Revised 4/30/05)

Proposal Title: Subdivision 12(c): "Continuous Indoor Air Quality Monitoring in Minnesota Schools"

Project Manager Name: Robert H. Schulte, Schulte Associates LLC

LCMR Requested Dollars: \$300,000 (for at least 6 schools)

2003 LCMR Proposal Budget	Result 1 Budget: \$167,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 2 Budget: \$79,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 3 Budget: \$6,000	Amount Spent (4/30/05)	Balance (4/30/05)
	Monitoring, Project Mgmt and Project Report			Expert IAQ Data Analysis			Identify Energy Conservation Opportunities		
BUDGET ITEM									
Contracts									
Professional/technical (with whom? and for what?)				Sebesta Blomberg & Associates: Provide IAQ Expert analysis services and monthly reports for all 6 schools. Includes Work Program Deliverables 2A, 2B and 2C, and consulting input to 2D.					
Total Contract Personnel	\$ -	\$ -	\$ -	\$ 43,000	\$ 43,000	\$ -	\$ -	\$ -	\$ -
Total Contract Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Space rental: NOT ALLOWED	X	X	X	X	X	X	X	X	X
Travel expenses in Minnesota	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Travel outside Minnesota (where?)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ -	\$ -	\$ -	\$ 43,000	\$ 43,000	\$ -	\$ -	\$ -	\$ -

Notes:

1. Travel in Minnesota will include installation, analysis and project coordination trips to each participating school, and between project partner offices for coordinating meetings

Result 4 Budget: \$48,000	Amount Spent (4/30/05)	Balance (4/30/05)	Total Project Budget	Amount Spent (4/30/05)	Balance (4/30/05)
<i>School Maintenance Staff Tools</i>			<i>All Results</i>		
			TOTAL FOR BUDGET ITEM		
\$ -	\$ -	\$ -	\$ 43,000	\$ 43,000	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
X	X	X	X	X	X
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ 43,000	\$ 43,000	\$ -

Attachment A: Budget Detail for 2003 Proposals - Partner Summary: Grimsrud & Associates (Revised 4/30/05)

Proposal Title: Subdivision 12(c): "Continuous Indoor Air Quality Monitoring in Minnesota Schools"

Project Manager Name: Robert H. Schulte, Schulte Associates LLC

LCMR Requested Dollars: \$300,000 (for at least 6 schools)

2003 LCMR Proposal Budget	Result 1 Budget: \$167,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 2 Budget: \$79,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 3 Budget: \$6,000	Amount Spent (4/30/05)	Balance (4/30/05)
	<i>Monitoring, Project Mgmt and Project Report</i>			<i>Expert IAQ Data Analysis</i>			<i>Identify Energy Conservation Opportunities</i>		
BUDGET ITEM									
Contracts									
Professional/technical (with whom? and for what?)				Grimsrud & Associates: Provide IAQ Expert input to characterization of IAQ in schools and resulting recommendations. Includes Work Program Deliverable 2D, and consulting input to 2A, 2B and 2C.					
Total Contract Personnel	\$ -	\$ -	\$ -	\$ 36,000	\$ 36,000	\$ -	\$ -	\$ -	\$ -
Total Contract Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Space rental: NOT ALLOWED	X	X	X	X	X	X	X	X	X
Travel expenses in Minnesota	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Travel outside Minnesota (where?)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ -	\$ -	\$ -	\$ 36,000	\$ -	\$ -	\$ -	\$ -	\$ -

Notes:

1. Travel in Minnesota will include installation, analysis and project coordination trips to each participating school, and between project partner offices for coordinating meetings

Result 4 Budget: \$48,000	Amount Spent (4/30/05)	Balance (4/30/05)	Total Project Budget	Amount Spent (4/30/05)	Balance (4/30/05)
<i>School Maintenance Staff Tools</i>			<i>All Results</i>		
			TOTAL FOR BUDGET ITEM		
\$ -	\$ -	\$ -	\$ 36,000	\$ 36,000	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
X	X	X	X	X	X
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ -	\$ -	\$ -	\$ 36,000	\$ 36,000	\$ -

Attachment A: Budget Detail for 2003 Proposals - Partner Summary: Altec Energy Systems (Revised 4/30/05)

Proposal Title: Subdivision 12(c): "Continuous Indoor Air Quality Monitoring in Minnesota Schools"

Project Manager Name: Robert H. Schulte, Schulte Associates LLC

LCMR Requested Dollars: \$300,000 (for at least 6 schools)

2003 LCMR Proposal Budget	Result 1 Budget: \$167,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 2 Budget: \$79,000	Amount Spent (4/30/05)	Balance (4/30/05)	Result 3 Budget: \$6,000	Amount Spent (4/30/05)	Balance (4/30/05)
	Monitoring, Project Mgmt and Project Report			Expert IAQ Data Analysis			Identify Energy Conservation Opportunities		
BUDGET ITEM									
Contracts									
Professional/technical (with whom? and for what?)							Altec Energy Systems: Correlate energy conservation results of SAMPLE2 CIP project with results of LCMR schools. Includes Work Program Deliverables 3A and 3B.		
Total Contract Personnel	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 4,400	\$ 4,400	\$ -
Total Contract Equipment	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Space rental: NOT ALLOWED	X	X	X	X	X	X	X	X	X
Travel expenses in Minnesota	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,600	\$ 1,600	\$ -
Travel outside Minnesota (where?)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 6,000	\$ 6,000	\$ -

Notes:

1. Travel in Minnesota will include installation, analysis and project coordination trips to each participating school, and between project partner offices for coordinating meetings

Result 4 Budget: \$48,000	Amount Spent (4/30/05)	Balance (4/30/05)	Total Project Budget	Amount Spent (4/30/05)	Balance (4/30/05)
<i>School Maintenance Staff Tools</i>			<i>All Results</i>		
			TOTAL FOR BUDGET ITEM		
Altec Energy Systems: Develop on-line case studies and school maintenance tools. Includes Work Program Deliverable 4A.					
\$ 47,100	\$ 47,100	\$ -	\$ 51,500	\$ 51,500	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
X	X	X	X	X	X
\$ 900	\$ 900	\$ -	\$ 2,500	\$ 2,500	\$ -
\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
\$ 48,000	\$ 48,000	\$ -	\$ 54,000	\$ 54,000	\$ -

2003 Project Abstract

For the Period Ending June 30, 2005

TITLE: "Continuous Indoor Air Quality Monitoring in Minnesota Schools"
PROJECT MANAGER: Robert H. Schulte
ORGANIZATION: Schulte Associates LLC
ADDRESS: 9072 Palmetto Drive, Eden Prairie, MN 55347
WEB SITE ADDRESS: www.schulteassociates.com
FUND: Minnesota Environmental and Natural Resource Trust Fund
LEGAL CITATION: ML 2003, Chap. 128, Art. 1, Sec. 9, Subd. (12c).

APPROPRIATION AMOUNT: \$300,000

Overall Project Outcome and Results

This project used innovative fixed-base continuous real-time indoor air quality (IAQ) monitoring technology and the Internet to investigate and characterize the IAQ in 85 representative classrooms and other spaces in eight selected Minnesota K-12 schools. Potential IAQ improvement and energy cost savings opportunities made possible by the continuous data were estimated.

The results show that many of the project schools needed better ventilation, and several had school-wide significant deficiencies. They also demonstrate that a recent initiative by the Minnesota Department of Education to improve ventilation in schools is working. However, state efforts to encourage ventilation improvements and energy conservation are not being sufficiently coordinated. The schools are using project results to successfully and dramatically improve their IAQ. These improvements are often being done inexpensively using operating or maintenance adjustments, once school staffs have actual IAQ data that enable them to identify problems and measure results. Potential energy conservation opportunities in the eight schools totaled about \$55,000/year, including relatively modest amounts of additional energy that would be required to remedy the discovered ventilation inadequacies.

This study has potentially major statewide and national significance. It represents the first time that IAQ in multiple classrooms in multiple schools have been monitored and analyzed side-by-side continuously and simultaneously for an entire school year. The project identified other recent studies that have found a correlation between inadequate school ventilation levels and increased student absenteeism. If such absenteeism study results are combined with IAQ data from projects like this LCMR effort, it could fundamentally change the benefit/cost equation for ventilation standards in schools. This project also demonstrated that ventilation and IAQ adequacy in multiple schools can be certified continuously from a single, remote location over the Internet. More detailed project results can be viewed on a website developed as part of the project at: www.mnk12IAQEnergyuse.org.

Project Results Use and Dissemination

Project results and the Final Project Report have been:

- Posted on a website developed as one of the project deliverables (www.mnk12IAQEnergyuse.org).
- Briefed to the MN Departments of Health and Education.
- Briefed to the National Association of Regulatory Commissioners, Energy and Environmental Resources Sub-Committee.
- Briefed to two statewide meetings of the Minnesota Association of School Business Officials (MASBO).
- Accepted by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) for publication as an article in the May 2005 issue of *ASHRAE Journal*, the leading industry publication in building ventilation issues nationwide.