2005 Project Abstract
For the Period Ending June 30, 2007

TITLE:	Hennepin County Beach Water Quality Monitoring Project
PROJECT MANAGER:	Susan Palchick, Ph.D., MPH
ORGANIZATION:	Hennepin County Epidemiology and Environmental Health
ADDRESS:	1011 First Street South, Suite 215 Hopkins, MN 55343
WEB SITE ADDRESS:	www.hennepin.us
FUND:	Environment and Natural Resources Trust Fund.
LEGAL CITATION:	ML 2005, First Special Session, Chp. 1, Art. 2, Sec. 11, Subd. 7(l).

APPROPRIATION AMOUNT: $100,000

Overall Project Outcome and Results

This project is designed to develop a predictive model for on-site determination of beach water quality to prevent outbreaks of waterborne illness and to provide related water safety outreach to the public.

From July 2005 through August 30, 2007, Hennepin County temporary staff collected, recorded, and analyzed beach water quality data using a handheld five-sensor sonde for shallow depth and beach survey observations at 11 Hennepin County beaches (1129 samples in 2005, 1431 samples in 2006, 2007 pending). Temperature, pH, dissolved oxygen, conductivity, and turbidity were measured, along with the directly observed variables bather counts, animal counts, beach management techniques, location of storm water outlets and rainfall. After a trial run in 2006, rainfall, solar radiation, wind speed, and wind direction were also measured hourly at automated meteorological stations at Bryant, French, and Weaver Beaches in 2007.

In the fall of 2006, a contracted lake water quality consultant, Dr. Greg Olyphant, developed multivariate time-series regression models predictive of *E. coli* levels based on data for Bryant and French beaches. These models are specific to each beach and will facilitate decisions about when the beach should be closed or reopened based on current information. This precludes waiting the 24 hours for *E. coli* laboratory results, the present accepted practice, based on EPA beach closure guidelines. Using meteorological station data, we collected additional samples in 2007 and will attempt to validate the Bryant and French models..

Results from this study were presented at the 2007 International Conference on Diseases Communicable to Man in Nature in Madison, WI. Additional results will be compiled and made available in electronic form to other local health and park departments at no charge. The public education component of this project involves posting summary water quality data and beach user information on a publicly accessible website.

LCMR 2005 Work Program – Status Report #5

Date of Report: August 15, 2007
Date of Work program Approval: July 1, 2005
Project Completion Date: June 30, 2007

I. PROJECT TITLE: Hennepin County Beach Water Quality Monitoring Project

Project Manager: Susan Palchick, PhD, MPH
Affiliation: Hennepin County Epidemiology and Environmental Health

Mailing Address: 1011 First Street South, Suite 215,
City / State / Zip: Hopkins, MN 55343
Telephone Number: 612-543-5200
E-mail Address: epi-envhlth@co.hennepin.mn.us
FAX Number: 952-351-5222
Web Page address: www.hennepin.us

Location: 57 public beaches in Hennepin County, Minnesota.

Total Biennial LCMR Project Budget:	**LCMR Appropriation:**	**$ 100,000**
	Minus Amount Spent:	**$ 100,000**
	Equal Balance:	**$ 0**

Legal Citation: ML 2005, First Special Session, Chp. 1, Art. 2, Sec. 11, Subd. 7(l).

Appropriation Language:
Hennepin County Beach Water Quality Monitoring Project
$50,000 the first year and $50,000 the second year are from the trust fund to the commissioner of natural resources for an agreement with Hennepin County to develop a predictive model for on-site determination of beach water quality to prevent outbreaks of waterborne illness and provide related water-safety outreach to the public.

II. and III. FINAL PROJECT SUMMARY:

From July of 2005 through August 15, 2007, Hennepin County temporary staff collected, recorded, and analyzed beach water quality data using a handheld five-sensor sonde for shallow depth and beach survey observations at 11 Hennepin County beaches. The variables measured were temperature, pH, dissolved oxygen levels, conductivity, and turbidity, along with an extensive list of observed variables that include bather counts, animal counts, beach management techniques, location of storm water outlets, and most importantly, rainfall. After a trial run in 2006, rainfall, solar radiation, wind speed, and wind direction have also been measured on an hourly basis at automated meteorological stations at Bryant, Clifton-French Park, and Weaver Beaches in 2007.

In the fall of 2006, a contracted lake water quality consultant, Dr. Greg Olyphant, Indiana University, developed multivariate time-series regression models predictive of *E. coli* levels based on collected data for Bryant and Clifton-French Park beaches. These models are specific to each beach and are intended to facilitate decisions about when the beach should be closed or reopened based on current information measured at the beach. This precludes waiting the 24 hours required for growth of *E. coli* in the laboratory, as is the present generally accepted practice, based on EPA beach closure guidelines. Using meteorological station data, we are collecting additional water samples in 2007 and we will attempt to validate the Bryant and Clifton-French Park models and develop a model for Weaver Beach in 2007. Results from this study will be compiled and made available in electronic form to other local health and park departments at no charge.

The public education component of this project involves posting summary water quality data and beach user information on a publicly accessible website.

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Beach Water Analysis and Data Collection
Description: Hennepin County and its partners, Minneapolis Park and Recreation Board, Three Rivers Park District and the City of Minnetonka, began the project on July 5, 2005. The sampled beaches listed below remained consistent between 2005 and 2007:

Baker Park beach on Lake Independence in Medina
Bryant Park beach on Bryant Lake in Eden Prairie
Riley Lake beach on Riley Lake in Eden Prairie
Clifton-French Park beach on Medicine Lake in Plymouth
Beaches on Lakes Nokomis, Calhoun, and Harriet in Minneapolis
Weaver Lake Park beach on Weaver Lake in Maple Grove
Shady Oak Park beach on Shady Oak Lake in Minnetonka

The first result of this project is extensive data involving four days per week water sample collection for laboratory *E. coli* analysis and water quality measurements using portable recorders (pH, turbidity, water temperature, dissolved oxygen, etc.) from 11 of the 57 beaches in Hennepin County from 2005-2007. Lake water data including daily recorded air temperature, rainfall, wind speed and direction information were also recorded. In 2006, a total of 1431 *E. coli* samples were collected and analyzed by the Minneapolis Public Health Laboratory. This data has been added to the 1129 samples taken in 2005. Samples are still being collected in 2007.

In July of 2006, additional equipment and measurements were requested by the contracted lake water quality consultant (Greg Olyphant, Indiana University). This resulted in the purchase and installation of a weather station at the Clifton-French Park location to measure wind speed, wind direction, solar radiation, and rainfall. Two additional weather stations were purchased and installed in 2007.

Personnel: $26,018 in salaries for two temporary interns for 27 weeks to collect the beach water samples, monitor the water quality with a handheld probe and enter collected data into the computer data base for analysis in Result #3. All other personnel costs for program management and information technology staff salary to develop the database for data entry will be in-kind, totalling $9,150. Sampling will continue through August 2007 and expenses of approximately $5000 will be covered by Hennepin County.

Equipment: The equipment needs changed during the grant interval, as we recognized a greater need for meteorlogical data and had to deal with equipment failures of data loggers and probes. Over the life of the grant we purchased three weather stations to provide hourly records of meterological data. These data were essential for model development. Those weather stations and the lake water quality portable data logger and probes will be used by partner agencies in the future to continue beach quality monitoring in their areas. The weather stations purchased in 2007 exceeded budget by $546.35, and this cost will be covered by Hennepin County. The City of Minneapolis has a lake water portable data logger and probes that will be used as part of the project for an in-kind of $4,000.

Other: The amount of money budgeted for laboratory fees changed from year to year as we tried to anticipate the weather and other factors. The final budget of $45,080 in laboratory fees for *E.coli* indicator organism analysis of 3,220 beach water samples by the Minneapolis Public Health Laboratory was below the actual amount spent, and the remainder will be covered by Hennepin County. Sampling will continue through August 2007 to provide data for model validation.

Summary Budget Information for Result 1:

Revised LCMR Budget	**$ 90,000**
Spent	**$ 90,000**
Balance	**$ 0**

Result Status:

- In the first year, two temporary staff collected samples from July 5 through August 31 using one YSI sonde with 5 water quality-monitoring probes and a data logger was purchased for data collection to match Minneapolis' probe used as an in-kind. A total of 1,129 samples were collected and analyzed for *E. coli* by the Minneapolis Public Health Laboratory. Corresponding data were collected, recorded on the data loggers, and downloaded into a database for the measurements taken in the same location where *E. coli* grab samples were collected. A preliminary review of the data was completed (by permanent staff not funded by the grant, or in-kind) to provide direction for the 2006 sampling season.

- In 2006, temporary staff collected samples for the entire season at the same beaches as in 2005. A total of 1,431 samples were collected and analyzed for *E. coli* by the Minneapolis Public Health Laboratory. A new weather

station was added to Clifton French Park collection site in August 2006, upon the recommendation of the contracted beach water quality consultant. This station collected data on rainfall, solar radiation, wind speed, and wind direction. This data was added to data collected from the handheld units.

- Predictive models for two of the beaches, Bryant Lake Beach and Clifton-French Park on Medicine Lake, were developed by the water quality consultant and submitted to Hennepin County using 2005 and 2006 data. The models are patterned on Indiana University's previously developed SWIMCAST models for beach closures, warnings and reopenings. . Both Hennepin county models predicted actual *E. coli* concentrations with greater than 90% accuracy.

- Recognizing that further sampling of data is needed to validate the models, two additional meteorological stations were employed to collect supporting data to validate predictive models developed the year before and one new model. These were placed at Bryant and Weaver beaches. LCMR funds were used for temporary staff to do sampling, laboratory processing of samples, transportation to collect samples and additional weather stations in May and June, 2007. Hennepin County funds will be used to continue collecting data for the remainder of the summer after the June 30, 2007 project completion date. Hennepin County funds will also be used to pay the consultant to complete the models with the additional data. The data from partial 2005 season, and complete seasons from 2006 and 2007 will be included in the final report to be completed by December, 2007.

Result 2: Public Education and Information Outreach
Description: The second result of the project is to provide public outreach on beach use safety. The residents of Hennepin County need to be better informed about when and why beaches are closed and reopened. Initially, this project proposed developing a website and regular news releases for the distribution of educational information and beach water monitoring results as they become available. Instead, we opted to utilize other resources already established and readily available. The Minnesota Department of Health maintains a general beach safety web site (http://www.health.state.mn.us/divs/eh/beaches/index.html). The Minnesota Pollution Control site (http://www.mnbeaches.org/) contains general information and links to beach data throughout Minnesota. Data specific to Hennepin County are found on the Hennepin County website (http://wwwa.co.hennepin.mn.us/portal/site/HCInternet/menuitem.3f94db53874f9b6f68ce1e10b1466498/?vgnextoid=f5c826b92c9fc010VgnVCM1000000f094689RCRD), or enter www.co.hennepin.mn.us and search for swimming beach.

Other: $0 will be spent on printing public information. All public information developed by existing staff and made available to the public on the website will be in-kind.

Summary Budget Information for Result 2:

Revised LCMR Budget	**$ 0**
Spent	**$ 0**
Balance 04/07	$ 0

Result 3: Analysis of Collected Data
Description: The third result is to analyze all the collected data and construct a predictive statistical model for public beach water quality that can be used to determine the water quality concurrently on-site at the beach instead of waiting 24 hours for the indicator organism (*E. coli*) water analysis results from the laboratory.

In-house staff did the preliminary data cleaning and analysis. We were fortunate to work with Greg Olyphant, water quality consultant from Indiana University, on developing the predictive models for the beaches. Using Hennepin County data, he developed multivariate time-series regression models to predict public beach water quality. In-kind staff time to perform statistical analysis of data was covered by Hennepin County. .

Unfortunately, the sampling seasons of 2006 and half of 2005 were not sufficient to develop and test the models adequately. Therefore, we are continuing sampling in 2007 to enhance development of the predictive models, studying the correlations between the *E.coli* levels of the water samples and the collected water quality parameters and meteorological data. The development of a predictive models for Clifton-French Beach on Medicine Lake and Bryant Lake Beach were completed by Dr. Olyphant and submitted to Hennepin County. These were patterned on Indiana University's SWIMCAST method. Both models predicted actual *E. coli* concentrations with greater than 90% accuracy. Further sampling was needed to validate the models' performance. Additional automated meteorological equipment was obtained to collect supporting data for validation.

Sampling resumed at the 11 beaches on May 29, 2007, and continues to the present. Samples were to be collected twice per day in the morning and early afternoon, but the schedule has been truncated for much of the summer because of repeated sonde malfunction. Final data sets will be sent for Bryant, Clifton-French Park and Weaver beaches at the conclusion of the sampling period. The hourly data from Bryant and Clifton-French Park will be used to validate the SWIMCAST models derived last year, when hourly data were not available. The models are intended to advise the public about beach closures, warnings and reopenings.

Summary Budget Information for Result 3:

Revised Budget	**$ 10,000**
Spent	**$ 10,000**
Balance 04/07	**$ 0**

Result Status:

- *E. coli* data for all lakes were sent to beach water quality consultant Dr. Greg Olyphant, from which he constructed a correlation matrix and identified three lakes with 1) multiple exceedances of the EPA *E. coli* standard and 2) low correlations in *E. coli* concentrations with the other Hennepin County lakes. The beaches with multiple exceedances were Clifton-French Park, Bryant and Weaver.
- The Clifton-French Park Lake model had an unusually high multiple correlation coefficient (R) of 0.71, indicating that the six independent variables included in the model predicted *E. coli* concentration well. The variables were: water conductivity, wind direction, cloudiness, bird counts, people counts, and an interaction term, water conductivity x cloudiness.
- Dr. Olyphant returned a predictive model for Bryant Lake Beach in November, 2006, which had an even higher multiple correlation coefficient (R=0.77) than the one obtained for Clifton-French Park Beach. Seven variables were included in the model: conductivity, turbidity, pH, air temperature, cloudiness, wave height, and an interaction term air temperature x wave height. The Clifton-French Park and Bryant models are patterned on the SWIMCAST model of predicting beach closures, warnings and reopenings developed by Dr. Olyphant and others at Indiana University.
- The E.coli level at Weaver Lake Beach varied too little (only four exceedances of the EPA guideline in 2005-6) to permit development of a predictive model.
- Preliminary data from 2007 sampling have been sent to Dr. Olyphant for review. He will analyze these data plus data collected in July and August, 2007 and produce appropriate models by December, 2007.

Result 4: Final Report Production and Publication
Description: The fourth and final result will be to produce a written report of the findings from the study and make it available to other local health and park departments with public beach monitoring programs.

Other: $0 for production and publication of the final written report of the project. $3,000 of in-kind existing staff or graduate student time will be incurred writing the final report. This report will not be printed, but instead made available in an electronic form on the website. The report will be available by December, 2007.

Summary Budget Information for Result 4:	**LCMR Budget**	**$ 0**
	Balance	**$ 0**

Completion Date: 12/01/07

V. TOTAL LCMR PROJECT BUDGET:

	BUDGET	FINAL AS OF 6/30/07	REMAINING
All Results: Personnel:	**$ 23,879**	**$ 23,879**	**$ 0**
All Results: Equipment:	**$ 20,115**	**$ 20,115**	**$ 0**

All Results: Other:	**$ 56,006**	**$ 56,006**	**$ 0**
TOTAL:	**$100,000**	**$ 100,000**	**$ 0**

TOTAL LCMR PROJECT BUDGET: $ 100,000

Explanation of Capital Expenditures Greater Than $3,500: The initial lake monitoring equipment as listed below totaled $8,255.03:

	t	Actual
YSI 650 MSD Display/data logger	1	$ 2,125.00
YSI 6820 Ten sensor sonde	1	$ 3,140.75
YSI 6562 Dissolved oxygen probe	1	$ 500.00
YSI 6561 pH probe replacement kit	1	$ 210.00
YSI 6136 Turbidity probe	1	$ 1,139.00
YSI 6090 Field cable	1	$ 390.00.
Tax and freight		$ 522.81
Allowance for repairs or parts for both systems		$ 227.47
Total for all components:		$ 8,255.03

The Minneapolis Park and Recreation Board currently has a similar water monitoring system that will be used in this grant project, providing $4,000 of in-kind ($10,000 total cost amortized over five years equals $2,000 per year). The YSI system purchased with LCMR grant funds will be maintained and shared among project partners in beach water monitoring activities after June 30, 2007.

In addition, three weather stations were purchased for $12,348.73. The $546.35 that is over budget will be covered by Hennepin County.

VI. PAST, PRESENT AND FUTURE SPENDING

Other Funds being spent during the Project Period: Each of the four Project Partners will provide one permanent staff member to serve on the Project Team which will meet monthly to oversee the project. This in-kind staff salary over two years will total approximately $11,520. The Project Partners will continue their existing beach monitoring programs in addition to the proposed project, incurring a combined in-kind of at least $54,250 over two years. An additional $9,500 of Hennepin County in-kind will be incurred for providing the office space, telephones, computers, and all other office supplies for the interns. In-kind for Result #1 will total $9,150 for management of the project and information technology staff salary to set up the database for measurements collected and $4,000 for the use of Minneapolis' monitoring equipment. In-kind for Result #2 will total $11,188 for staff salary to develop educational materials that will be made available to the public on the website. In-kind for Result #3 will total $7,000 in existing staff salary and/or graduate student time for statistical analysis of data. In-kind for Result #4 will be $3,000 in existing staff or graduate student time to write a final report to be made available to the public on the website. All told, in-kind contributions will total $109,608.

Past Spending: Hennepin County, the Three Rivers Park District, the Minneapolis Park and Recreation Board, and the City of Minnetonka have all conducted beach water monitoring since the early 1980s. In the past five years alone, the combined spending of these agencies on beach water monitoring exceeded $120,000 and is a public health priority.

Future Spending: Hennepin County will cover the expenses incurred through sampling and monitoring after June 30, 2007. Hennepin will also assume the responsibiility of compensating the consultant for the completion of the model. All partners will continue beach sampling in their jurisdictions to the extent that their programs allow.

VII. PROJECT PARTNERS: The Project Team was made up of staff members from the four Project Partners and acted as the technical committee overseeing the project. The Project Team members are: John Barten, Water Resources Manager, Three Rivers Park District; Sara Aplikowski, Water Resources Coordinator, Minneapolis Park and Recreation Board; John Weinand, Environmental Health Supervisor, City of Minnetonka; and Susan Palchick, Hennepin County Manager Environmental Health and Epidemiology (replacing Lynn Moore, Supervising Environmenalist, Hennepin County).

VIII. DISSEMINATION: This project proposes developing a website and regular news releases for the distribution of educational information and beach water monitoring results as they become available. Multi-lingual brochures and signs will also be developed and made available in electronic form on the website to help inform beach users of their responsibilities for keeping beaches safe and open for use with basic safety and hygiene rules. The fourth and final result will be to produce a written report of the findings from the study and make it available in an electronic format to other local health and park departments with public beach monitoring programs.

IX. **LOCATION**
The project is taking place in Hennepin County, sampling 11 beaches on nine lakes.

X. REPORTING REQUIREMENTS: Periodic work program reports will be submitted not later than December 1, 2005; May 1, 2006; and December 1, 2006. A final work program report and associated products will be submitted by June 30, 2007.

XI. RESEARCH PROJECTS: Not applicable.

Changes in grant fund distribution to the Hennepin County Beach Water Quality Monitoring Project:

Result #1: Beach Water Analysis and Data Collection

Result #1	July 2004 Budget	April 2005 Budget	Dec, 2006 Budget	March, 2007 Budget	August, 2007*
Personnel	$27,000	$26,018	$21,076	$23,879	$23,879
Equipment					
Car leases	$3,000	$2,300	$3,000	$4000	$3500
Probe & data logger	$7,500	$10,470	$12,515	$20,115	$20,115
Lab fees	$46,368	45,080	$36,506	$42,006	$42,506
Total Result 1	$83,868	$83,368	$73,097	$90,000	$90,000

* Explanation of changes August 2007
Actual Personnel was $2000 +$1354.42. Only charge grant budgeted $2000 plus $802.77

Actual Laboratory was $9553.60. Charge grant $5500 previously budgeted for this category plus not spent in direct operating costs.

Actual equipment was $8146.35. Charge grant budgeted $7600.

Result #2	July 2004 Budget	December 2006 Budget	March, 2007 Budget
Public information	$6,132	$6,903	$0

Result #3	July 2004 Budget	December 2006 Budget	March, 2007 Budget
Water quality consultant	$10,000	$20,000	$10,000

No change to results #4.

Attachment A: Budget Detail for 2005 Projects

Proposal Title: Hennepin County Beach Water Quality Monitoring Project

Project Manager Name: Susan Palchick

LCMR Requested Dollars: $ 100,000

1) See list of non-eligible expenses, do not include any of these items in your budget sheet
2) Remove any budget item lines not applicable

2005 LCMR Proposal Budget	Result 1 Budget:	Revised Budget 3/07 for Result 1	Amount Spent for Result 1	Balance for Result 1	Result 2 Budget:	Revised Budget 3/07 for Result 2	Amount Spent for Result 2	Balance 3/07 for Result 2	Result 3 Budget:	Amt Spent 3/07 for Result 3	Balance for Result 3	Total Amt Spent	Total Balance	TOTAL FOR BUDGET ITEM
	Beach Water Analysis and Data Collection				*Public Education and Information Outreach*				*Analysis of Collected Data*					
BUDGET ITEM														
PERSONNEL: Intern to collect samples and take water quality readings. Salary only, no benefits.	13,009	12,213	12,213	$0								$12,213	$0	$12,213
PERSONNEL: Intern to collect samples and take water quality readings. Salary only, no benefits.	13,009	11,666	11,666	$0								$11,666	$0	$11,666
Contracts														
Professional/technical: The Minneapolis Public Health Laboratory will process 3220 beach water samples at $14 per sample for *E. coli* following EPA protocol.	45,080	42,506	42,506	$0								$42,506	$0	$42,506
Professional/technical: Contract with an information technology firm to develop a website to post beach safety and testing information.					$6,132	$0	$0	$0				$0	$0	$0
Professional/technical: Contract with a consultant expert on lake water quality to interpret the data analysis and develop a predictive model for closing and reopening beaches that pose a health risk to swimmers.									$10,000	$10,000	$0	$10,000	$0	$10,000
Other direct operating costs: The lease of 2 cars and gasoline for five months for interns to take water quality measurements, collect water samples and deliver samples to the lab.	2,300	3,500	3,500	$0								$3,500	$0	$3,500
Equipment/Tools: Purchase one portable YSI model data logger, a ten sensor sonde, cable, and three water quality monitoring probes.	10,470	20,115	20,115	$0								$20,115	$0	$20,115
COLUMN TOTAL	83,868	90,000	90,000	$0	$6,132	$0	$0	$0	$10,000	$10,000	$0	$100,000	$0	$100,000

* Explanation of changes
Actual Personnel was $2000 +1354.42. Only charge grant budgeted amount $2000 plus $802.77

Actual Laboratory was $9553.60. Charge grant $5500 budgeted for this category plus $500 not spent in direct operating costs.

Actual equipment was $8146.35. Only charge grant the budgeted $7600