

[2018] Project Abstract

For the Period Ending June 30, 2021

PROJECT TITLE: State-wide reconnaissance of SARS-CoV-2 in drinking water supplies

PROJECT MANAGER: Timothy M. LaPara

AFFILIATION: University of Minnesota, Dept. of Civil, Environmental, and Geo- Engineering

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: M.L. 2018, Chp. 214, Article 4, Sec. 02, Subd. 10

APPROPRIATION AMOUNT: \$59,297

AMOUNT SPENT: \$54,280

AMOUNT REMAINING: \$5,017

Sound bite of Project Outcomes and Results

There were concerns that SARS-CoV-2, the virus that causes COVID-19, could contaminate drinking water supplies. In this study, we investigated 30 drinking water samples from homes around the State of Minnesota supplied by either a private well or a public water system, testing for SARS-CoV-2. To date, we have not been able to detect SARS-CoV-2 in any Minnesota drinking water samples.

Overall Project Outcome and Results

Soon after the COVID-19 pandemic began, it was observed that the SARS-CoV-2 was detectable in the feces of infected individuals and thus was likely to be present in raw sewage. With this knowledge, researchers developed techniques to monitor the extent of COVID-19 spread in communities by quantifying the virus in untreated municipal wastewater. Given the presence of this virus in raw sewage, concerns were expressed that it could contaminate our public and private drinking water supplies, either from leaky sewer pipes, municipal wastewater effluent, or septic systems. Although well-functioning public water and wastewater facilities are typically very good at preventing the spread of disease via the fecal-to-oral route, this project was undertaken to confirm that SARS-CoV-2 was not contaminating our drinking water. Because SARS-CoV-2 is a pathogen that infects the lungs, the risk of exposure from water supplies is via inhalation of water droplets while showering or other uses. We therefore used filters to collect the microorganisms from 30 high-volume drinking water samples (sample volume: 500-1000 liters) from various locations within the State of Minnesota. These samples were obtained from homes supplied by private wells that do not employ any treatment as well as from homes supplied by public water systems that treat the water, including but not necessarily limited to, disinfection with chlorine. We were unable to detect SARS-CoV-2 in any of these samples; positive-control sewage samples collected from a municipal wastewater treatment plant, however, confirmed that our assays were working and could detect SARS-CoV-2 in water samples. Our results, therefore, provided evidence to suggest that, at the time of our study in the spring and summer of 2020, SARS-CoV-2 was not present in our public and private water supplies and that drinking water was not a likely route of exposure to SARS-CoV-2.

Project Results Use and Dissemination

We have shared our results with LCCMR staff and with Kirsti Marohn from Minnesota Public Radio (MPR) and Greg Stanley from the *Minneapolis Star Tribune*. We also presented our research results at the annual meeting of the Minnesota section of the American Water Works Association (September 24, 2020) and during an online seminar hosted by the Minnesota Pollution Control Agency (December 9, 2020).



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2020 ENRTF Work Plan (Main Document)

Today's Date: August 25, 2021

Final Report

Date of Work Plan Approval:

Project Completion Date: June 30, 2021

PROJECT TITLE: State-wide reconnaissance of SARS-CoV-2 in drinking water supplies

Project Manager: Timothy M. LaPara

Organization: University of Minnesota

College, Department, or Division: Dept. of Civil, Environmental, and Geo- Engineering

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Web Address: <http://www.cege.umn.edu/directory/faculty-directory/lapara.html>

Location: Statewide

Total Project Budget: \$59,297

Amount Spent: \$54,280

Balance: \$5,017

Legal Citation: M.L. 2018, Chp. 214, Article 4, Sec. 02, Subd. 10 as extended by M.L. 2020, First Special Session, Chp. 4, Sec. 2

Appropriation Language: \$439,000 the second year is from the trust fund to an emerging issues account authorized in Minnesota Statutes, section 116P.08, subdivision 4, paragraph (d).

M.L. 2020 - Sec. 2. ENVIRONMENT AND NATURAL RESOURCES TRUST FUND; EXTENSIONS. [to June 30, 2021]

PROJECT STATEMENT:

Emerging Issue: The State of Minnesota, the United States of America, and the entire world are currently in the middle of the worst disease pandemic since the “Spanish flu” of 1918. This pandemic is caused by a novel coronavirus, officially designated as SARS-CoV-2 and also known as COVID-19. While several pathways of SARS-CoV-2 transmission are well known (via aerosols, direct contact, etc.), relatively little is known about the fate of this virus in our water infrastructure. Recent scientific publications have reported substantial quantities of SARS-CoV-2 in untreated municipal sewage, but nothing is known about the fate of this virus once it reaches the environment. We hypothesize that drinking water utilities that treat surface water (e.g., Minneapolis Water Works, St. Paul Regional Water Services) offer a robust treatment process, with filtration and chlorine disinfection, that should protect public health against all viruses, including SARS-CoV-2. In contrast, recent research has demonstrated that numerous viruses (e.g., norovirus, avian influenza) can survive in and be transported by groundwater and contaminate drinking water wells. We hypothesize, therefore, that SARS-CoV-2 will also contaminate our groundwater (via septic systems, leaking sewers, and other pathways) and potentially eventually contaminate some drinking water supplies. Our concern about the safety of drinking water is particularly focused on public water supplies that use groundwater but do not practice disinfection and on private homes that are supplied water from private wells. There is an obvious and urgent need to perform this work as quickly as possible to limit the spread of SARS-CoV-2 during this pandemic and to protect the health of Minnesotans.

Proposed Work: We will collect microorganisms in water from public water systems (supplied by both surface water and by groundwater) and from private homeowners (i.e., private wells). “Large volume” water samples (> 200 gallons) will be processed in the field using a membrane-filtration technique that we have used in previous and ongoing projects. These samples will be preserved and stored until we are able to extract and purify RNA (i.e., we are concerned about the current availability of laboratory supplies), which will then be quantified by quantitative reverse transcriptase polymerase chain reaction (RT-qPCR) (i.e., the same assay used to identify patients infected by SARS-CoV-2).

II. OVERALL PROJECT STATUS UPDATES:

First Update January 31, 2021

Large-volume samples were collected from numerous public water supplies and private homes as well as the primary clarifiers from a wastewater treatment facility within the State of Minnesota. Metagenomic DNA and RNA was extracted and purified from all of these samples and used as template for quantifying a handful of genetic targets, including SARS-CoV-2 (the causative agent of the COVID-19 pandemic), crAssphage, and total bacteria. Both SARS-CoV-2 and crAssphage were successfully quantified from the wastewater samples, validating that our method can successfully quantify these organisms. In contrast, all of the drinking water samples tested negative for both SARS-CoV-2 and crAssphage. The concentrations of bacteria in these samples, however, were consistent with the levels that we have observed in prior research, further suggesting that our methods would detect SARS-CoV-2 if it had been present in these samples. Our results, therefore, provide no evidence to suggest that SARS-CoV-2 has entered our public and private water supplies and pose a threat to public.

Amendment Request (February 11, 2021)

We are requesting an amendment to our budget. In our original budget, we did not request any financial support to hire undergraduate researchers because, at that time, the University of Minnesota did not allow us to hire undergraduate students because of safety reasons related to the COVID-19 pandemic. Furthermore, our original budget was originally excessive for travel and for equipment repair (contingency), but deficient for professional services (i.e., use of the University of Minnesota Genomics Center) and for materials/supplies. At the present time, we would like to hire one or two undergraduate researchers to collect and process additional

water samples. We would like to use the remaining funds (\$9,013) to cover undergraduate salary, travel, supplies, and services to collect additional samples. The specific requested changes are:

- Increase Professional/Technical/Services by \$2,500, to \$7,500.
- Increase Equipment/Tools/Supplies by \$5,450, to \$17,751.
- Reduce Travel by \$5,950, to \$1,750.
- Reduce the equipment repair contingency to \$0.

Amendment Approved by LCCMR 2/23/2021

Final Report between project end (June 30) and August 15, 2021

Soon after the COVID-19 pandemic began, it was observed that the SARS-CoV-2 was detectable in the feces of infected individuals and thus was likely to be present in raw sewage. With this knowledge, researchers developed techniques to monitor the extent of COVID-19 spread in communities by quantifying the virus in untreated municipal wastewater. Given the presence of this virus in raw sewage, concerns were expressed that it could contaminate our public and private drinking water supplies, either from leaky sewer pipes, municipal wastewater effluent, or septic systems. Although well-functioning public water and wastewater facilities are typically very good at preventing the spread of disease via the fecal-to-oral route, this project was undertaken to confirm that SARS-CoV-2 was not contaminating our drinking water. Because SARS-CoV-2 is a pathogen that infects the lungs, the risk of exposure from water supplies is via inhalation of water droplets while showering or other uses. We therefore used filters to collect the microorganisms from 30 high-volume drinking water samples (sample volume: 500-1000 liters) from various locations within the State of Minnesota. These samples were obtained from homes supplied by private wells that do not employ any treatment as well as from homes supplied by public water systems that treat the water, including but not necessarily limited to, disinfection with chlorine. We were unable to detect SARS-CoV-2 in any of these samples; positive-control sewage samples collected from a municipal wastewater treatment plant, however, confirmed that our assays were working and could detect SARS-CoV-2 in water samples. Our results, therefore, provided evidence to suggest that, at the time of our study in the spring and summer of 2020, SARS-CoV-2 was not present in our public and private water supplies and that drinking water was not a likely route of exposure to SARS-CoV-2.

Amendment Request

We made an error in our previous amendment request in that we shifted too much money from the travel budget to other portions of the budget. We overspent our travel budget by \$1,014.52, although our overall project budget was underspent by \$5,017. We therefore request that we be allowed to increase our travel budget by \$1,015 and reduce our Equipment/Tools/Supplies budget by \$1,015.

Amendment Approved by LCCMR 9/17/2021

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 Title: Sample raw and treated drinking water and wastewater and private wells.

Description: We will collect microorganisms in water from public water systems (supplied by both surface water and by groundwater) and from private homeowners (i.e., private wells). "Large volume" water samples (> 200 gallons) will be processed in the field using a membrane-filtration technique that we have used in previous and ongoing projects. These samples will be preserved and stored until we are able to extract and purify the genetic material (RNA) in order to quantify the disease-causing viruses present. We will also collect samples of raw wastewater from a few wastewater treatment facilities to track the occurrence of the SARS-CoV-2 virus around the state.

ACTIVITY 1 ENRTF BUDGET: \$29,649

Outcome	Completion Date
1. Use filtration membranes to collect/concentrate microorganisms in large volume (~200 gallons) water samples.	<i>June 12, 2020</i>
2. Collect wastewater grab samples as positive controls	<i>June 12, 2020</i>

First Update January 31, 2021

We collected and processed 30 large-volume samples between May 4, 2020 and June 30, 2020. These samples were collected from public water supplies that use surface water as a source, public water supplies that use groundwater as a source, and private water supplies (i.e., private groundwater wells). We also collected and processed a half-dozen wastewater samples to use as positive-controls for our analytical methods.

Final Report between project end (June 30) and August 15, 2021

We collected and processed an additional 21 large-volume samples in May and June of 2021. These samples were collected from public water supplies that use surface water as a source, public water supplies that use groundwater as a source, and private water supplies (i.e., private groundwater wells).

In total, 51 large-volume water samples were collected from public water supplies and private water supplies between May 2020 and June 2021. The sources of these water samples included both surface water and groundwater.

ACTIVITY 2 Title: Analyze samples for SARS CoV-2 and other pathogens.

Description: We will extract and purify RNA, which will then be used to quantify SARS-CoV-2 and other disease-causing viruses by quantitative reverse transcriptase polymerase chain reaction (RT-qPCR) (i.e., the same assay used to identify patients infected by SARS-CoV-2).

ACTIVITY 2 ENRTF BUDGET: \$29,648

Outcome	Completion Date
1. Develop and test analytical methods (quantitative RT-PCR) using appropriate standards and blanks.	<i>May 31, 2020</i>
2. Extract and test samples collected during Activity 1.	<i>June 30, 2020</i>

First Update January 31, 2021

Metagenomic DNA and RNA were extracted and purified from all samples that were collected. The RNA was then converted to DNA using a reverse transcriptase enzyme and used for template during quantitative polymerase chain reaction. The application of the reverse transcriptase enzyme posed a significant challenge as all of the wastewater samples that we collected inhibited the function of this enzyme, preventing us from quantifying SARS-CoV-2 concentrations in sewage. Through trial-and-error, however, we were able to find commercially available enzymes that were not inhibited by the contents of our sewage samples. Once we achieved this milestone, we were able to successfully quantify SARS-CoV-2 in sewage, which was necessary as a positive control. That is, all of our drinking water samples tested negative for SARS-CoV-2, but we needed to successfully quantify SARS-CoV-2 from a positive control sample to confirm that our negative results from drinking water were legitimate negative results rather than false negatives.

Final Report between project end (June 30) and August 15, 2021

There was no effort in this activity during this project period. In the prior activity period, we analyzed 30 large-volume water samples and obtained no evidence that SARS-CoV-2 was present in either public or private drinking water supplies.

IV. DISSEMINATION:

Description: We will provide data on the quantities of SARS-CoV-2 in drinking water to LCCMR and to Minnesota Department of Health (MDH) staff as soon as we generate reliable data. These data will be organized by drinking water type (surface water vs. groundwater source, disinfected vs. not disinfected, public water supply vs. private well). We will also publish our results in the peer-reviewed technical literature (likely via open access format). If needed, we will coordinate with MDH staff to properly release our findings to the general public so as to avoid unnecessary public response and/or panic.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the [ENRTF Acknowledgement Guidelines](#).

First Update January 31, 2021

We have shared our results with LCCMR staff and with Kirsti Marohn from Minnesota Public Radio (MPR) and Greg Stanley from the *Minneapolis Star Tribune*. We also presented our research results at the annual meeting of the Minnesota section of the American Water Works Association (September 24, 2020) and during an online seminar hosted by the Minnesota Pollution Control Agency (December 9, 2020).

Final Report between project end (June 30) and August 15, 2021

There was no dissemination effort during the most recent project period. In the Fall/Winter of 2020, however, we presented our results to both the scientific community (i.e., a conference presentation and as presentation to the MPCA) and the general public (i.e., via Minnesota Public Radio and the Minneapolis Star Tribune).

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

Explanation of Capital Expenditures Greater Than \$5,000:

Explanation of Use of Classified Staff:

Total Number of Full-time Equivalent (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours for entire duration of project: 523	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: 0.25
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Total Number of Full-time Equivalent (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Contract Personnel Hours for entire duration of project: N/A	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE: N/A
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VI. PROJECT PARTNERS:

- A. Partners outside of project manager's organization receiving ENRTF funding -NONE
- B. Partners outside of project manager's organization NOT receiving ENRTF funding -NONE

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted April 1 and October 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2021

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet

B. Visual Component or Map

C. Parcel List Spreadsheet- n/a

D. Acquisition, Easements, and Restoration Requirements- n/a

E. Research Addendum- waived

Attachment A: Project Budget Spreadsheet
 Environment and Natural Resources Trust Fund
 M.L. 2020 Budget Spreadsheet



Legal Citation:
 Project Manager:
 Project Title:
 Organization:
 Project Budget:
 Project Length and Completion Date:
 Today's Date:

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget	Amount Spent	Balance
BUDGET ITEM				
Personnel (Wages and Benefits)		\$ -	\$ -	\$ -
Professional/Technical/Service Contracts		\$ -	\$ -	\$ -
Equipment/Tools/Supplies		\$ -	\$ -	\$ -
Capital Expenditures Over \$5,000		\$ -	\$ -	\$ -
Fee Title Acquisition		\$ -	\$ -	\$ -
Easement Acquisition		\$ -	\$ -	\$ -
Professional Services for Acquisition		\$ -	\$ -	\$ -
Printing		\$ -	\$ -	\$ -
Travel expenses in Minnesota		\$ -	\$ -	\$ -
Other		\$ -	\$ -	\$ -
COLUMN TOTAL		\$ -	\$ -	\$ -
SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT				
	Status (secured or pending)	Budget	Spent	Balance
Non-State:		\$ -	\$ -	\$ -
State:		\$ -	\$ -	\$ -
In kind:		\$ -	\$ -	\$ -
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS				
	Amount legally obligated but not yet spent	Budget	Spent	Balance
		\$ -	\$ -	\$ -

FINAL Attachment A: Project Budget Spreadsheet
 Environment and Natural Resources Trust Fund
 M.L. 2020 Budget Spreadsheet
 Legal Citation: M.L. 2018, Chp. 214, Article 4, Sec. 02, Subd. 10 Emerging Issues
 Project Manager: Timothy M. LaPara
 Project Title: State-wide reconnaissance of SARS-CoV-2 in drinking water supplies
 Organization: University of Minnesota
 Project Budget: \$59,297
 Project Length and Completion Date: 2 months, June 30, 2021
 Today's Date: August 17, 2021



ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Revised budget 8/25/21	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	\$ 32,476	\$ 31,296	\$ 1,180
<i>Timothy LaPara, Project Manager (75% salary, 25% fringe benefits).40% FTE for 1.5 months. Overall project coordination, sampling, data analysis, report writing. \$10,827</i>			
<i>Raymond Hozalski, Co-Project Manager (75% salary, 25% fringe benefits).40% FTE for 1.5 months. Overall project coordination, sampling, data analysis, report writing. \$11,940</i>			
<i>Taegyu Kim, Post-doctoral researcher (75% salary, 25% fringe benefits).40% FTE for 1.5 months. Analysis of samples, data analysis. \$3,045</i>			
<i>2 Undergraduate researchers (100% salary, 0% fringe benefits). 25% FTE for 10 weeks. Sample collection and processing. \$6,664</i>			
<i>Technician or Post-doc (75% salary, 25% fringe benefits). 100% FTE for 1.5 months. Sampling, data analysis. \$6,665</i>			
Professional/Technical/Service Contracts:			
<i>University of Minnesota Genomics Center: next generation DNA sequencing, digital droplet polymerase chain reaction, DNA quantification, etc.</i>	\$ 7,500	\$ 6,737	\$ 763
Equipment/Tools/Supplies			
<i>Membrane Filters (\$20 per sample;100 samples- \$2000); RNA extraction kits (\$10 per sample- \$1000); RT-qPCR supplies (\$6.50 per assay; 8 assays per sample- \$5200); Miscellaneous supplies (expendable glassware, reagents, etc- \$3921)</i>	\$ 16,556	\$ 13,482	\$ 3,074
Travel expenses in Minnesota			
<i>University vehicle rental and hotel stays to collect water samples. Reimbursement will be according to University of Minnesota guidelines.</i>	\$ 2,765	\$ 2,765	\$ -
Other			
<i>Equipment repair contingency</i>	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ 59,297	\$ 54,280	\$ 5,017

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status	Amount	Spent	Balance
Non-State:				
		\$ -	\$ -	\$ -
State:				
		\$ -	\$ -	\$ -
In kind:				
<i>Because the project is overhead free, laboratory space, electricity, and other facilities/adminstrative costs (54% of direct costs excluding permanent equipment and graduate student tuition benefits) are provided in-kind.</i>	Secured	\$ 32,021	\$ -	\$ 32,021
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	Amount legally obligated but not yet spent	Budget	Spent	Balance
<i>Example: M.L. xxxx Chap. xx Sec. xx Subd. xxx</i>		\$ -	\$ -	\$ -