`Sources and Risks of Waterborne Pathogens in the El Paso del Norte Region

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Abstract: Vigilant water quality monitoring is very important for compliance with government standards and in the interest of the public. The Rio Grande river is the natural boundary between the U.S. and Mexico and is the only source of surface water for the El Paso, Texas and Ciudad Juarez, Mexico area known as the El Paso del Norte region. Agriculture, farming, domestic activities, and effluent from local wastewater treatment plants increase the contamination potential of water supplies along the region. Monitoring of selected sites along the Rio Grande river has showed the occurrence of *Cryptosporidium* and *Giardia*. Higher pathogen levels were observed during the non-irrigation season when the river flow is dominated by wastewater effluents. This indicates that there could be an increased risk of using the river water as a source of drinking water during the winter if it is not properly treated. Therefore, the objective of this research is to determine the sources and risks of contamination in the Rio Grande river and assess the potential impact to human health. These efforts will aid our understanding of effective treatment of wastewater and drinking water. With this increased understanding, we will be able to make recommendations for wastewater and drinking water treatment, and aid in developing cost effective treatment strategies.

Statement of Critical Regional Water Problems: El Paso relies on both surface water and ground water as sources of drinking water. El Paso is also in a unique location because it borders with Las Cruces, New Mexico and Ciudad Juarez, Chihuahua both of which utilize the same groundwater and surface water supply. Surface water is supplied by the Rio Grande river which serves as a border between Texas and Mexico. The ground water resources, the Hueco and Mesilla Bolsons, are not easily recharged and have been declining and becoming saline at a rapid rate for the last forty years. As a result, El Paso is considering the utilization of Rio Grande river winter return flows for drinking water. *This proposal aims to bring a better understanding of the sources of pathogen contamination in the Rio Grande river. The infectivity determination of* Cryptosporidium *and* Giardia *in wastewater effluents and their impact on river water quality represents a serious data gap for performing accurate risk assessment.*

Nature, Scope, and Objectives of the Research: The Environmental Protection Agency's (EPA) Science Advisory Board concluded in 1990 that exposure to microbial contaminants such as bacteria, viruses, and protozoa (e.g., *Giardia lamblia* and *Cryptosporidium*) was the greatest remaining health risk management challenge for drinking water suppliers (4). Due to increasing populations and decreasing amounts of water supplies some areas use surface water rivers, lakes, and reservoirs for public drinking water using conventional filtration and disinfection. However, conventional treatment has been found to be inadequate for removing *Cryptosporidium*. For this reason, Cryptosporidium *has recently become the focus of new U.S. EPA water quality regulations. However, source water with high* Giardia *levels may also challenge conventional treatment. Identification of the sources and potential health risks are essential to ensure elimination of contamination and to minimize the impact on human disease.*

Research previously undertaken by the Texas AgriLife Research Center as part of the Rio Grande Basin Initiative revealed higher pathogen levels in the non-irrigation season, when water flow is dominated by wastewater effluent (1). It is assumed that higher pathogen levels in winter return flow water leads to increased health risk in utilizing the winter return flows for drinking water. However, the infectivity of the *Cryptosporidium* and *Giardia* in the wastewater effluents needs to be determined to properly calculate the potential risks.

The principle objectives of this proposal are to 1) define the sources and risks of contamination in the Rio Grande river; 2) determine the infectivity of Cryptosporidium and Giardia *in wastewater effluents; and, 3) perform a microbial risk assessment for Rio Grande river winter return flows as a source of drinking water.* The proposed activities are outlined below and include:

1. Utilizing bacterial source tracking of source water and pollution source identification to characterize and quantify sources of fecal contamination;
2. Determine infectivity of *Cryptosporidium* and *Giardia* in wastewater effluents; and,
3. Conduct a quantitative risk assessment for Rio Grande winter return flow water.

Overview of Approach and Study Area

El Paso County, Texas relies on both surface water and groundwater for municipal water supply. Currently, El Paso Water Utilities (EPWU) supplies about 90% of all municipal water in El Paso County with all surface water supplied by the Rio Grande (3). One of the major challenges of using the Rio Grande river as a source of drinking water is the appropriate treatment for this heavily utilized resource. The Rio Grande water is highly variable in quality and is affected by agricultural return flows, urban runoff, wildlife, and effluent from local wastewater treatment plants. Quality is variable especially in the winter because the majority of the flows in the river are from local wastewater treatment plants. Pathogen levels are much higher during the non-irrigation season when compared with the irrigation season. Since the Rio Grande is the only annually renewable water supply, El Paso and, in the future, other municipal and industrial water utilities in the El Paso del Norte region will increase their use of this resource.

For this proposal, three sampling sites have been selected along the Rio Grande river: two wastewater treatment plants and the Rio Grande source water for the drinking water treatment plant immediately downstream from the wastewater treatment plants. Sampling site 1 is the effluent from the Sunland Park, NM wastewater treatment plant. This plant has uses conventional chlorine disinfection and has been cited numerous times in the past for treatment deficiencies. Site 2 is the Northwest Wastewater Treatment Plant in El Paso, TX. The Northwest treatment plant uses chlorination and UV disinfection. Both treatment plants contribute greatly to the winter return flows observed in the El Paso region of the

river. Just downstream from these plants the Rio Grande river is divided between the US and Mexico, with water for the US flowing into the American canal. Site 3 is the American canal immediately upstream from the Robertson Umbenhauer (Canal) drinking water treatment plant. This site is impacted the most from the winter return flow coming from sites 1 and 2. Samples from all sites will be collected monthly during the project.

Tasks to be Completed

Task 1: Utilizing bacterial source tracking method to characterize and quantify sources of fecal contamination.

Bacteroidales are a group of obligately anaerobic organisms that represent the dominant bacteria of the large intestine. Their abundance in feces makes them an excellent indicator organism for direct detection by molecular methods. In addition, there is a substantial amount of genetic diversity among different members of the group. This diversity has allowed researchers to identify host-specific markers that can be used to distinguish between different sources of fecal contamination. The main advantages of using the PCR detection of *Bacteroidales* species to identify sources of fecal pollution are that it is library independent, fast and relatively easy to perform. Our laboratory is currently using quantitative PCR (qPCR) to identify the magnitude of *Bacteroidales* concentrations at key points in watersheds. For the proposed source tracking, we will use the same *Bacteroidales* qPCR approach to assess the sources and magnitude of human and animal fecal pollution sources impacting the Rio Grande during the summer irrigation and winter return flow seasons. This information will be incorporated into the microbial risk assessment.

Task 2: Determine the infectivity of *Giardia* and *Cryptosporidium* in wastewater effluents.

To determine if oocysts found in the wastewater effluents present a public health risk, cell culture methods will be employed to examine infectivity of recovered oocysts. *Cryptosporidium* cell culture infectivity assays using human ileocecal adenocarcinoma cells (HCT-8 cells) labeled by an indirect antibody procedure and examined by epifluorescence will be used to determine the levels of infection. For *Giardia*, a reverse transcription qPCR method will be used to estimate the numbers of viable cysts in wastewater effluents. The levels of infectious *Cryptosporidium* and *Giardia* will be incorporated into risk models.

Task 3: Conduct a risk assessment for Rio Grande winter return flows.

Risk assessment may be defined as the qualitative or quantitative characterization and estimation of potentially adverse health effects associated with exposure to environmental hazards. A standard methodology for risk assessment is to identify hazards, assess the dose-response relationship, to evaluate exposure, and to characterize risk. The occurrence of enteric microbial pathogens in water has been examined, and the related quantitative microbial risk assessments have been performed over several decades (2). For this proposal we seek to conduct a risk assessment of the Rio Grande wastewater effluents using cell culture assays.

Results Expected from this Project:

Due to the concern of impending water shortages, El Paso is looking to utilize the Rio Grande winter return flows as a source of drinking water. It is critical to identify the sources and health risks associated with this plan. The developed risk assessment will include important data generated by this project to properly address *Cryptosporidium* and *Giardia* risks and in the implementation of effective water treatment. *Results will be broadly disseminated among stakeholders to effectively address surface water treatment and appropriate management of water resources.*

References

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