**Fundamentals of Drinking-water Treatment**

**NATURE (Nurturing American Tribal Undergraduate Research and Education) Sunday Academy 2017-2018**

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**Project Description:**
Providing access to clean water has been identified as one of 14 grand challenges in engineering in the 21st century by the National Academy of Engineering. This NATURE program lesson aims to provide basic knowledge and skills for the students to test and treat surface water for drinking-water purposes.

**Project Objectives:**
Through this lesson, students will be able to i) recognize the responsibilities of drinking water treatment plant operation and control; ii) identify safe operational procedures, sampling, and laboratory testing techniques; and iii) develop analytical skills by participating in a bench-scale water treatment experiment.

**Session Organization:**
- 11:00-11:30 Cultural connection/brief introduction
- 11:30-12:00 Short lecture on fundamentals of drinking-water treatment; the principles of the turbidity and chlorine measurement; the challenges of drinking-water treatment in terms of the removal of herbicides, pharmaceuticals, and persistent organic contaminants including perfluoroalkyl substances.
- 12:00-12:45 Lunch
- 1:00-1:45 Coagulation and flocculation jar test; turbidity measurement
- 1:45-2:30 Break-point disinfection; residual chlorine measurement
- 2:30-3:00 Wrap up

**ND State Science Standards:**
9-10.2.2 Use appropriate safety equipment and precautions during investigations
9-10.2.6. Design and conduct a guided investigation
9-10.5.4 Identify the short-term and long-term effects of physical processes
9-10.6.1 Use appropriate technologies and techniques to solve a problem
9-10.8.3 Explain how individuals and groups, from different disciplines in and outside of science, contribute to science at different levels of complexity
11-12.1.1 Explain how scientists create and use models to address scientific knowledge
11-12.2.1. Understandings about Scientific Inquiry: Explain how new knowledge and methods emerge from different types of investigations and public communication among scientists
11-12.2.2. Abilities Necessary To Do Scientific Inquiry: Select and use appropriate instruments, measuring tools, and units of measure to improve scientific investigations

11-12.6.2. Technological Design: Identify examples of how new technologies advance science

Materials and Equipment:
Hach 2100Q portable turbidimeter; Hach chlorine (free and total) test kit; beakers; jar tester (if can fit the van); coagulant (alum) stock solution; chlorine (NaOCl) stock solution; pipettes; one gallon of Red River surface water.

Activity I:
The fundamentals of drinking water treatment including coagulation/flocculation and chlorination will be covered. The hands-on activities will be introduced.

Activity II:
Students will perform a bench-scale coagulation and flocculation jar test (rapid mixing: 1 min; slow mixing: 15 min; settling: 20 min) in regular 1000 mL glass beakers. The students will measure initial and residual turbidities of water before and after coagulation and flocculation.

Activity III:
The coagulated water will be disinfected with sodium hypochlorite, and students will learn how to measure residual chlorine and identify the break point. Tap water samples will be also collected and analyzed in terms of the turbidity and residual chlorine.

Wrap-Up & Discussion:
Review coagulation/flocculation and chlorination theories;
Review the principles of turbidimeter and the DPD method for chlorine measurement;
Review the multi-barrier water treatment approach.