

**RED RIVER GEOSCIENCE EDUCATION –  
A THREE-SCHOOL PILOT PROGRAM IN NORTHEASTERN NORTH DAKOTA**

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## INTRODUCTION

The Red River of the North (Red River) watershed, part of the Hudson drainage system, encompasses northeastern South Dakota, eastern North Dakota, northwestern Minnesota, and the southern portion of the Canadian Province of Manitoba. The north-flowing Red River mainstem and tributary system developed in the wake of the northward retreat of Wisconsinan glaciers forming Glacial Lake Agassiz at the close of the Pleistocene. The upper and middle reaches of tributaries occur in glacial till and beach deposits, while lower reaches of the tributaries and the Red River mainstem flow through the prime agricultural land characterized by a very-low-relief setting composed of the silty clay deposits of the Agassiz lake bottom.

Over the last century, agricultural crops have replaced the native tall grass prairie ecosystem of the region, and the increased population has resulted in increased demands on the water resources of the region and subsequent changes to the drainage system. The Red River watershed is currently central to public dialogue that addresses the need to ensure adequate water for human use, mitigate flooding, and ensure the health of the natural ecosystems for the economic health of the region. Sound input into these discussions requires knowledge of the evolution of the natural landscape and system ecology with regard to the distribution of geological materials and processes. In response to this need, the Energy & Environmental Research Center (EERC), with funding from the U.S. Environmental Protection Agency (EPA) and the National Science Foundation (NSF) and in collaboration with the Red River Basin River Watch (RRBRW), developed and tested a Red River Geoscience Education (RRGE) pilot program in three high schools in northeastern North Dakota. This paper describes the goals and components of the RRGE pilot program, summarizes activities to date, and provides a view for future activities.

## RRGE OVERVIEW

Building on the RRBRW tributary-monitoring activities initiated in the Minnesota portion of the watershed, the RRGE pilot project is providing a collaborative approach to science teacher development and student education using the Red River watershed. The hands-on approach features locally

relevant, firsthand geoscience content, with field, laboratory, and instrument technology training in themes relating to riparian habitats, hydrology, and human impact on water quality. RRGE objectives include the following:

- Provide area high school students with the opportunity to gain real-world experience in scientific research and to prepare them for university classes and possible science careers.
- Develop students' critical-thinking and problem-solving skills as they participate in data collection and assessment procedures in local watershed studies.
- Provide area educators with readily available and useful geoscience activities, focused on water issues to be used in the field and in the classroom.
- Develop water quality baseline data that are acceptable to natural resource managers and regulatory personnel.
- Strengthen cooperation among the variety of science education stakeholders divided among various political, institutional, and economic interests.

Schools from three North Dakota districts (Grand Forks; the consolidated district comprising Mayville, Portland, Clifford, and Galesburg; and Edinburg) are taking part in the RRGE program. The students use physical, chemical, and biological monitoring of local waters as a basis for critical thinking and problem solving. Under the tutelage of science professionals and using established protocols, students performed 1) water quality monitoring, 2) physical characterization of field sites, 3) analysis of selected parameters in the laboratory, and 4) activities that relate the resulting data and observations to the local geology and environmental geochemistry. Participating teachers are offered 1) training in field sampling and laboratory analytical techniques; 2) technical training in the use of geographic information systems (GIS); and 3) technical support in the field, laboratory, and classroom activities. Teachers also receive local area background information for activities, lesson plans, and sample lessons.

The scientific integrity, utility, implementation, and sustainability of the program are ensured through partnerships with schools, existing water-related educational programs, and sources of facilitators and technical expertise. These groups include the University of North Dakota (UND), Red River Basin River Watch (RRBRW), the Red River Riparian Project (RRRP), City of Grand Forks Water Treatment Plant (GFWTP), Upper Midwest Aerospace Consortium (UMAC), North Dakota State University (NDSU), Project WET staff at the North Dakota State Water Commission (NDSWC), and Turtle River State Park (TRSP). Periodic evaluation is an important component of the program. Project scientists meet regularly with participating teachers to discuss implementation methods and make changes as needed. All teachers and project partners participate in an annual project debriefing in June to review the previous year and make recommendations for the following. The program is also subject to external review by an education professor from Northland College, Ashland, Wisconsin.

#### RRGE PROGRAM COMPONENTS

RRGE components include educator training and materials, monitoring activities, laboratory activities, and an annual field session.

##### **Educator Training**

The RRGE program provides orientation and training workshops and GIS training to participating teachers. A 2-day training session focuses on orientation to the program and to Red River Basin geology, field and laboratory training including a practice monitoring event, and a 6-hour Project WET teacher workshop introducing the Project WET K–12 Curriculum and Activity Guide. Teachers receive a copy of the RRGE source book, which includes several publications on Red River Basin ecology, water resource issues, and monitoring guides (e.g., *Volunteer Stream Monitoring: a Methods Manual* [1]). GIS workshops introduce teachers to the concept of GIS and ArcView GIS software and then the application of GIS to the analysis and presentation of water quality-monitoring data. The teachers also receive training on handheld Global Positioning System (GPS) units.

##### **Monitoring Activities**

Water quality monitoring involves field collection of site data and water samples for analysis in the classroom. Students travel to the monitoring sites (e.g., see Figure 1 in Hartman et al., this symposium) by bus or van, record field data, photograph the site, and collect and preserve water for transport to the school. Field data include dissolved oxygen; conductivity; salinity; air and water temperature; stream depth and flow; transparency; weather, phenological, and physical observations; and annual stream cross sections. On the return to school, students follow established protocols to complete several analyses: total phosphorus, nitrate/nitrite nitrogen,

ammonia, fecal coliforms, turbidity, pH, and dissolved oxygen by titration. Quality assurance and quality control (QA/QC) elements written into the protocols assist students in the evaluation of their data. They record their results in a spreadsheet in preparation for uploading to a monitoring data Web site or GIS software for presentation.

Sampling is being conducted at the following locations. Edinburg High School is sampling at two sites on the Park River located upstream of bridge on ND Hwy 32 and downstream of the Red River Riparian Program restoration site in the Park River Bible Camp. MayPort CG High School is sampling at three sites in Mayville–Portland located on the Goose River upstream of the dam in Mayville, on the Goose River downstream of the dam in Mayville, and at the Oxbow Pond in the city park. Red River High School is sampling at three sites in the Grand Forks area located on English Coulee at the bridge on County Road 5 (southwest of Grand Forks), upstream on English Coulee upstream at the bridge on ND Hwy 81 (north of Grand Forks), and on the mainstem of the Red River on the upstream side of the Sorlie Bridge in downtown Grand Forks.

##### **Laboratory Activity**

During this activity, dubbed Laboratory Field Experience (LFE), students bring samples of local surface water and groundwater to an EPA-certified laboratory where they characterize the water and use this information in subsequent problem-solving activities. They learn about the natural (geologic) and human influences on water occurrence and quality in the Red River watershed, analyzed several water samples using commercial equipment under the tutelage of analytical chemists, and identify mystery water samples using deductive reasoning and the knowledge gained through the LFE activity. Students also tour a water treatment plant and learn about physical and chemical water treatment. Experimental parameters vary by venue. At the EERC Analytical Research Laboratory (ARL), parameters: calcium, iron, magnesium, potassium, sodium, chloride, nitrate, phosphate, sulfate, alkalinity, electrical conductivity, pH, total dissolved solids, total suspended solids, transparency, and dissolved oxygen. At the Grand Forks Water Treatment Plant (GFWTP), students determine calcium and magnesium as hardness, total hardness, iron, chloride, nitrate, phosphate, sulfate, alkalinity, ammonia, electrical conductivity, pH, total dissolved solids, total suspended solids, turbidity, and dissolved oxygen. Other parameters such as fecal coliform bacteria are presented to them based on previous analyses or estimates of likely concentration. The mystery samples included waters from tributaries, the Red River mainstem, wells, bogs, agricultural processing, precipitation, saline slough water, and municipal wastewater and are intended to provide an overview of the variability of waters in the region.

### Summer Field Camp

A 5-day Red River High School (RRHS) Summer Field Camp is a collaborative effort by RRHS faculty, the EERC, Grand Forks Water Treatment Plant, and Turtle River State Park. Students participate in hands-on field and classroom activities focused on the Turtle River subwatershed. Orientation includes a crash course in geoscience, water quality, GIS, and handling digital still and moving camera editing software. Geoscience activities include nine exercises comprising a combination of geologic mapping, geomorphologic assessment, geology in fluvial analysis, stream bed materials and bedforms, geology and water quality, regional geologic analysis, geology and ecology, geoscience and environmental assessment applications of GIS, changes in geologic setting from the headwaters of the Turtle River to its confluence with the Red River, and geologic variables in runoff and stage prediction. Water quality concepts take center stage as students investigate five sites along the Turtle River from mouth to headwaters. Field data and water collection take place as described above in the monitoring activities. Students take collected water to the GFWTP and analyze parameters listed above in the LFE section with direction from GFWTP chemists. Students use ArcView GIS and digital video technology to document their work and present their results.

### RESULTS, DISSEMINATION, AND FUTURE ACTIVITIES

To date RRGE has involved five teachers, 166 students, and twelve facilitators. The facilitators include six chemists, Jenny Sun (EERC), Carolyn Nyberg (EERC), Charlene Crocker (EERC), Craig Locher (GFWTP), Steve Kolar (GFWTP), and Andy Job (GFWTP); three geologists, Joseph Hartman (EERC and UND Department of Geology and Geological Engineering [GGE]), Alan Schlag (UND GGE), and Dan Daly (EERC); an environmental scientist, Dave Rush (Red River Regional Council, formerly of the EERC); and two student interns, Stacie Laducer (EERC) and Lindsay Beard (EERC). Activities during the period August 2000 to March 2002 are summarized in Table 1.

Dissemination of the RRGE-related materials has occurred through presentation, packet distribution, Internet publication, and interaction with other regional water-related programs. The concept has already been presented at two educator workshops and water festivals (MAEE Conference, August 8, 2001; and Manitoba STA Workshop, October 19, 2001). The instructional packet will be distributed to educators and preservice teachers as the occasion arises, as well as to the Red River Center for Watershed Education (RRCWE), which is working to build curricula for water-education in the Red River Basin and serve as a regional clearinghouse for water-related educational programs. Internet publication of the materials on the EERC Web site will occur in the Spring of 2002 and will be available

through links to several key Web sites in the region, including the FM River Web site hosted by Prairie Public Television as part of the EPA-sponsored FM River EMPACT project. The Red River Basin River Watch Director has expressed a desire to implement geoscience components of RRGE with students in the Minnesota portion of the Red River Basin in 2002, and the GFWTP's agreement to participate enables the LFE component to be marketed to schools in the 24 school districts within a 60-mile radius of Grand Forks.

A RRGE packet describing the program and educational materials is in preparation. Plans are to continue to collect river-monitoring data at the existing sites and expand the program to include more schools in the basin through a collaboration with RRBRW, River Keepers (in the Fargo–Moorhead metropolitan area), and the Red River Center for Watershed Education. The project team is looking for avenues of support for sustaining RRGE activities beyond the pilot project.

The impact of this project's activities are greater science literacy in the communities participating in the program and a successful model for bringing the "hands on—minds on" approach to geoscience education to the high schools of the Red River watershed. Because the pilot includes both rural and urban school districts, the unique problems associated with both groups can be explored and addressed, yielding a program exportable throughout the Red River watershed and beyond.

### REFERENCES

1. U.S. Environmental Protection Agency, 1997, Volunteer Stream Monitoring: A Methods Manual: EPA Publication 841-B-97-003 (Nov. 1997), 211 p.

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Table 1  
**RRGE Monitoring, Laboratory, and Training Activities.**

Date	Activity	Location	School	Students	Scientists
8/22/00 to 8/23/00	Workshop	EERC ARL	All schools	4 science teachers	2 EERC geologists, 1 EERC environmental scientist, 1 EERC chemist; 1 RRBRW trainer, 1 Project WET facilitator
10/19/00	Monitoring	Red River	Grand Forks Red River	9 field biology and geology students	1 EERC environmental scientist, 1 EERC chemist; 2 UND students
10/19/00	GIS Workshop	Red River High School	All schools	3 teachers	1 UMAC GIS trainer
3/13/01	LFE	EERC ARL	Grand Forks Red River	11 field biology or geology students	1 EERC geologist, 3 EERC chemists
4/10/01	LFE	EERC ARL	May-Port CG	18 chemistry students	1 EERC geologist, 3 EERC chemists
4/17/01	LFE	EERC ARL	May-Port CG	18 chemistry students	1 EERC geologist, 3 EERC chemists
4/18/01	Monitoring	Park River	Edinburg	9 chemistry students	1 EERC geologist, 1 EERC chemist, 1 RRRC environmental scientist
4/24/01	Monitoring	English Coulee Red River	Grand Forks Red River	20 geology students	1 UND geologist, 1 EERC chemist
5/1/01	Monitoring	Goose River	May-Port CG	40 chemistry students	2 UND geologist, 1 EERC chemist
5/3/01	Monitoring	Park River	Edinburg	13 chemistry students	1 EERC geologist, 1 EERC chemist, 1 RRRC environmental scientist
5/11/01	Monitoring	English Coulee Red River	Grand Forks Red River	14 geology students	1 UND geologist, 1 EERC chemist
5/15/01	Monitoring	Goose River	May-Port CG	40 chemistry students	2 UND geologist, 1 EERC chemist
5/17/01	Monitoring	English Coulee Red River	Grand Forks Red River	18 geology students	1 UND geologist, 1 EERC chemist
6/4/01 to 6/8/01	Field Camp	Turtle River, Red River High School	Grand Forks Red River, Bismarck Shiloh	6 high school students	1 EERC geologist, 1 EERC chemist, 3 WTP chemists
6/11/01	Annual Review	EERC	All schools	3 teachers	2 EERC geologists and 1 chemist, 1 RRRC environmental scientist, 1 NDSU education professor
9/26/01	LFE	GF WTP	May-Port CG	18 chemistry students	1 EERC geologist, 1 EERC chemist, 2 WTP chemists
9/28/01	LFE	GF WTP	May-Port CG	18 chemistry students	1 EERC geologist, 1 EERC chemist, 2 WTP chemists
10/1/01	LFE	EERC ARL	Edinburg	15 physics students	1 EERC geologist, 1 UND geologist, 2 EERC chemists
10/9/01	Monitoring	Park River	Edinburg	15 physics students	1 UND geologist, 1 EERC chemist, 1 RRRC environmental scientist

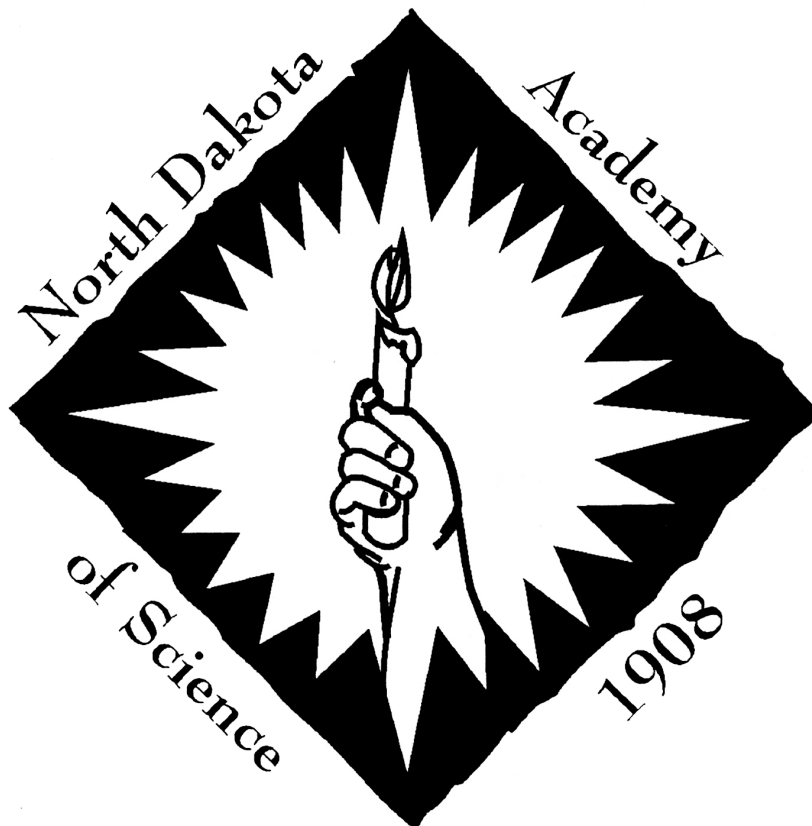
EERC ARL = Energy & Environmental Research Center, RRBRW = Red River Basin River Watch, UND = University of North Dakota, UMAC = Upper Midwest Aerospace Consortium, RRRC = Red River Regional Council, GF WTP = Grand Forks Water Treatment Plant.

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