Before the Public Utilities Commission of the State of South Dakota

IN THE MATTER OF THE APPLICATION BY TRANSCANADA KEYSTONE PIPELINE, LP FOR A PERMIT UNDER THE SOUTH DAKOTA ENERGY CONVERSION AND TRANSMISSION FACILITIES ACT TO CONSTRUCT THE KEYSTONE PIPELINE PROJECT	HP 07-001 DIRECT TESTIMONY OF Arden D. Davis Ph.D, P.E. November 13, 2007

Please state your name and address for the record.

Arden D. Davis, Ph.D., P.E., 1014 Milwaukee Street, Rapid City, South Dakota 57701

Please state your professional qualifications and background.

I have been involved in the fields of ground water and environmental contamination since 1978. I hold a B.A. degree in Geology from the University of Minnesota, and M.S. and Ph.D. degrees in Geological Engineering from South Dakota School of Mines and Technology. I am a registered professional engineer in South Dakota (no. 4663). Since 1985 I have taught courses involving ground water, ground-water contamination, geological engineering, and environmental pollution at South Dakota School of Mines and Technology. I have also presented expert witness testimony in numerous cases, and have assisted the State of South Dakota in ground-water contamination problems, including the Williams Pipe Line / Hayward Elementary School site in Sioux Falls.

Have you provided a copy of your resume with your testimony?

Yes

What potential impact could the TransCanada-Keystone Pipeline have on ground water in South Dakota?

The potential effects of a crude-oil leak on ground-water supplies are of paramount concern. The proposed TransCanada-Keystone Pipeline would cross the recharge areas of several large shallow aquifers in eastern South Dakota.

What impact on water quality, public safety and the environment in general would a crude oil leak from the TransCanada-Keystone Pipeline cause?

Crude oil contains aromatic hydrocarbons, including benzene, toluene, ethylbenzene, and xylene.

Benzene is of particular note because it is a carcinogen and its maximum contaminant level (MCL) in drinking water is 5 parts per billion. Benzene is soluble in ground water and can be transported downgradient toward receptors such as private wells and public water-supply wells.

Because of benzene's solubility and its allowable limit of only 5 parts per billion in drinking water, a crude oil pipeline leak could contaminate a large volume of ground water in shallow glacial aquifers of eastern South Dakota.

Have you had experience with other petroleum pipeline leaks and what was the result in your opinion?

Leaks from pipelines have occurred in the past in South Dakota and have threatened ground-water supplies. These include a pipeline leak from Williams Pipe Line Company near water-supply wells for the City of Sioux Falls. A large leak occurred north of the City of Sioux Falls on glacial till near the Big Sioux aquifer. In addition, a gasoline leak from an above-ground storage tank at the Williams Pipe Line facility in Sioux Falls caused serious contamination to a shallow aquifer, took years to clean up, and resulted in considerable cost. The Hayward Elementary School had to be abandoned and relocated. Reports of these leaks are available in the files of the South Dakota Department of Environment and Natural Resources.

TransCanada has stated that leaks on the Keystone Pipeline would be unlikely and that their state-of-the-art monitoring systems will detect leaks and shut the pipeline down so they it can be fixed. Should South Dakota feel reassured by that statement?

The Frequency-Volume Study of Keystone Pipeline Report, (Appendix A), dated May 1, 2006, filed by DNV Consulting as part of the TransCanada permit application indicates on page 19, Table 5-2, that a leak rate of less than 1.5% of pipe volume could go undetected for 90 days for below-ground pipe. At 591,000 barrels per day of pipe volume, 1.5% could represent as much as 8,865 barrels per day or 372,330 gallons per day (591,000 x 1.5% = 8,865 barrels x 42 gallons/barrel = 372,330 gallons).

Page 20, Figure 5-1, of the same report indicates a leak detection and verification time of 138 min (2.3 hours) for a leak rate of 1.5%. The leak rate for this detection time is approximately 200 barrels per hour (BPH) or 8,400 gallons. This potentially could result in a leak of about 19,320 gallons (2.3 hr x 200 barrels/hr x 42 gallons/barrel).

It appears, therefore, that larger volumes of oil could leak over a longer time (e.g., 90 days), if the leak rate is less than 1.5%. A leak of 19,320 gallons or greater could contaminate a large volume of ground-water supplies because of the solubility of crude oil components such as benzene, toluene, ethylbenzene, and xylene. Even a small leak of less than 1.5% located in a remote area, where it could go undetected for days, weeks, or months, would cause serious damage to ground water and drinking water supplies.

Federal rules that regulate the siting, construction, and operation of hazardous liquid pipelines (which include crude oil pipelines) require that areas defined as geologically sensitive High Consequence Areas (HCA's) and Unusually Sensitive Areas (USA's) which include public water supplies, be given special consideration and protection. In your opinion, are there aquifers and ground-water resources in the area being crossed by this project that are geologically sensitive and need protection under state and federal law?

It is my opinion that the proposed pipeline will cross shallow aquifers with ground-water resources that are geologically sensitive. These include ground water that is used for public water supplies. It would be desirable for these areas to have protection under state and federal law.

Regarding down stream transport of an oil spill, TransCanada assumes that any spill would be intercepted five miles downstream of the release location. Based on your experience and knowledge of the area, are there locations or drainages along the pipe route where a spill may be intercepted within 5 miles of the leak?

Based on my experience and knowledge of the area, it appears that there are several locations such as stream drainages, along the pipe route, where oil from a leak could be transported more than five miles downstream from the release location before being intercepted.

What could be done by TransCanada and/or the State of South Dakota to protect against contamination of ground water?

I urge the South Dakota Public Utilities Commission to require TransCanada to explore and consider an alternate route for the proposed TransCanada-Keystone Pipeline that would not cross shallow aquifers. There would be less risk of contamination of ground-water aquifers if the pipeline were routed based on geological information and soils that are less permeable and that are not located over shallow aquifers.

Additional protection such as thicker pipe or a second, outer sheathing for the pipeline also should be considered, along with improved leak-detection systems, and more isolation valves to reduce the amount oil that leaves the pipe in the event of a pipe failure and shut down.

Please state whether you believe the project will pose a threat of serious injury to the environment or the inhabitants within the siting area?

I believe the proposed project will pose a threat of serious injury to the environment and to the social and economic condition of the inhabitants in the siting area. As mentioned earlier, crude oil contains soluble components such as benzene, which can seriously impair ground-water quality in the event of a leak.

Please state whether you believe the project will substantially impair the health, safety and welfare of the inhabitants in the siting area?

I believe the proposed project has the potential to substantially impair the health, safety, and welfare of the inhabitants in the siting area.

Please state whether you believe the project will comply with applicable laws and rules?

I defer to legal and regulatory officials on this question.

Please state whether you believe the project will interfere with the orderly development of the region?

It is my opinion that the proposed project has the potential to interfere with the orderly development of the region, with regard to the possibility that valuable ground-water resources could be contaminated by a leak from the planned pipeline, potentially disrupting public water supplies.

Does this conclude your direct testimony?

Yes.

Would you be available to present testimony and respond to questions on a dated schedule during the formal hearing process set for December 3 to December 14, 2007?

Yes

Date this 13th day of November, 2007.

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Arden D. Davis, Ph.D., P.E.

Arden D. Davis
Resume

Dr. Davis is a native of Minnesota. He received a B.A. degree in geology from the University of Minnesota and M.S. and Ph.D. degrees in geological engineering from South Dakota School of Mines and Technology.

Dr. Davis currently is Professor in the Department of Geology and Geological Engineering at South Dakota School of Mines and Technology. Since 1982 he has served as Instructor, Assistant Professor, Associate Professor, Professor, and Chairman of the Department of Geology and Geological Engineering. During that time he has worked on digital modeling of ground-water flow as well as transport and dispersion of subsurface contaminants. He teaches courses in ground water, digital modeling of ground-water flow and contaminant transport, ground-water geochemistry, analytical methods in ground water, and geological engineering design.

Dr. Davis is a Registered Professional Engineer in South Dakota. He also is a member of the Society for Mining, Metallurgy, and Exploration (SME). He has served as associate editor and reviewer for the journal of Ground Water, and as a book reviewer for the Bulletin of the Association of Engineering Geologists. He is chairman of the Council of Education and the Accreditation and Curricular Issues Committee of the Society for Mining, Metallurgy, and Exploration. From 2002 to 2007, Dr. Davis served on the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology(ABET). In 2007, he was appointed to the ABET Board of Directors.

During his career at South Dakota School of Mines and Technology, Dr. Davis has worked extensively on ground-water projects and geological engineering site evaluations. He has been an investigator in more than forty funded research projects. As a consultant he has provided expert witness testimony in cases involving environmental contamination and disposal of waste. He also has given technical assistance to the South Dakota Department of Environment and Natural Resources in the review of mining plans and ground-water contamination problems, including Superfund sites.

In his service to South Dakota School of Mines and Technology, Dr. Davis has acted as Geological Engineering Program Coordinator and ABET Coordinator for geological engineering accreditation. This has included revision of the geological engineering curriculum, origination and teaching of new engineering design courses, and preparation of ABET reports. He also is active in ground-water protection efforts, and in 1998 received the Virginia Simpson Award for community service in the Rapid City area. In 2007, he received the Ennenga Award for Excellence in Teaching.

Arden D. Davis

Academic rank:	Professor, Dept. of Geology and Geological Engineering	
Education:	B.A. - 1971	University of Minnesota (Geology)
	M.S. - 1979	South Dakota School of Mines and Technology (Geological Engineering)
	Ph.D.- 1983	South Dakota School of Mines and Technology (Geological Engineering)

Registered Professional Engineer (South Dakota; No. 4663)

Experience:	2006 - present	Professor S.D. School of Mines and Technology
	2002 - 2006	Chairman Dept. of Geology and Geological Engineering S.D. School of Mines and Technology
	1995 - 2002	Professor S.D. School of Mines and Technology
	1989 - 1994	Associate Professor S.D. School of Mines and Technology
	1984 - 1989	Assistant Professor S.D. School of Mines and Technology
	1982	Instructor
	1976-1982	Teaching and Research Assistant
	1978	Shell Development (Shell Oil Company)

Teaching:	Digital Modeling of Ground-Water Flow Systems, Ground Water, Ground-Water Geochemistry, Geochemistry, Analytical Methods in Ground Water, Advanced Ground Water, Engineering Field Geology, Geological Engineering Design Project
Consulting:	Ground-water hydrologist and geological engineering consultant for numerous projects over past twenty-five years involving ground-water contamination, aquifer evaluation, low-level radioactive waste site evaluation, spring-flow measurements, and mine site development.
Funded research:	Projects involving ground-water contamination, ground-water resource evaluation, aquifer vulnerability, water quality, and mine waste.
Community service:	Ground-water protection efforts (see following pages).

Theses: Thirty six M.S. theses and eleven Ph.D. dissertations supervised.

Consulting:

2007	Siting of new Madison wells for public water supplies in the Black Hills.
2006	Modeling of ground-water flow and biodegradation of benzene.
2005	Modeling of ground-water flow and gasoline contamination.
2004	Ethylene dibromide contamination; expert witness.
2003	Alliance of Architects and Engineers; expert witness.
2002	Alliance of Architects and Engineers; expert witness.
2001	Consolidated Engineers & Materials Testing; GeoTek; expert witness.
2000	Hillcrest Spring Water; Rapid City Landfill; expert witness.
1999	Boyd County LLW Monitoring Committee; Gill Landfill modeling.
1998	Boyd County LLW Monitoring Committee; Rapid City Landfill.
1997	Boyd County LLW Monitoring Committee; Terra, Inc., modeling.
1996	Terra, Inc., modeling; Boyd County LLW Monitoring Committee.
1995	Terra, Inc.; modeling for City of Ida Grove, Iowa; Vogel Paint and Wax.
1994	Keystone Gold Project, Keystone, South Dakota.
	Dunbar Resort: proposed railroad grade, Deadwood, South Dakota.
	Vogel Paint and Wax Superfund Site, Maurice, Iowa.
1993	Keystone Gold Project, Keystone, South Dakota.
	Vogel Paint and Wax Superfund Site, Maurice, Iowa.
	Low-level radioactive waste site evaluation and modeling.
1992	City of Rapid City: criteria for private wastewater disposal facilities.
	Nitrate contamination from mine waste.
1991	Corrosion problems during geothermal heating.
1990	Low-level radioactive waste site evaluation.
	South Dakota Department of Environment and Natural Resources: cyanide contamination.
1989	Wastewater facility site evaluation.
	South Dakota Department of Environment and Natural Resources: review of mine plan, northern Black Hills.
1988	Expert witness: gasoline contamination of ground water.
1987	South Dakota Department of Environment and Natural Resources: modeling of gasoline contamination.
	Utility Engineering Company: aquifer test evaluation.
	Gasoline contamination of ground water.
1986	South Dakota Department of Environment and Natural Resources.
1985	South Dakota Department of Environment and Natural Resources: ground-water contamination.
1983	Rosebud Sioux Tribe: aquifer evaluation.
1981	Save Wyoming Water: drawdown calculations.
	South Dakota Public Utilities Commission: aquifer evaluation.
1981	Evans Plunge, Hot Springs, South Dakota: spring discharges.
1979	U.S. Environmental Protection Agency; Engineering Science, Inc.

Community Service:

Assisted City of Rapid City and Pennington County in determining aquifer vulnerability in the Rapid City area. Assisted U.S. Environmental Protection Agency and South Dakota Department of Environment and Natural Resources as member of Technical Advisory Team, Gilt Edge Superfund Site.

Selected Publications:

Davis, A.D., 1986, Deterministic modeling of dispersion in heterogeneous permeable media: Ground Water, v. 24, no. 5, p. 609-615.

Davis, A.D., 1987, Determination of mean transmissivity values in the modeling of ground water flow, in Proceedings of International Conference on Solving Ground Water Problems with Models: National Ground Water Association, Dublin, Ohio, p. 1162-1174.

Davis, A.D., and Riding, D.R., 1989, A three-dimensional model of ground-water flow in the Madison aquifer at Annie Creek mine, northern Black Hills, South Dakota, in Proceedings of International Conference on Solving Ground Water Problems with Models: National Ground Water Association, Dublin, Ohio, p. 409-423.

Rizk, Z.S., and Davis, A.D., 1991, Impact of the proposed Qattara Reservoir on the Moghra aquifer of northwestern Egypt: Ground Water, v. 29, no. 2, p. 232-238.

Davis, A.D., 1992, Review of "Finite Element Techniques in Ground Water Flow Studies," in Bulletin of the Association of Engineering Geologists, v. 29, no. 4, p. 431-432.

Davis, A.D., 1994, Education of future ground-water professionals: Ground Water, v. 32, no. 5, p. 706-707.

Rahn, P.H., Davis, A.D., Webb, C.J., and Nichols, A.D., 1996, Water quality impacts from mining in the Black Hills, South Dakota, USA: Environmental Geology, v. 27, no. 1, p. 38-53.

Rahn, P.H., and Davis, A.D., 1996, An educational and research well field: Journal of Geoscience Education, v. 44, p. 506-517.

Rahn, P.H., and Davis, A.D., 1996, Gypsum foundation problems in the Black Hills area, South Dakota: Environmental and Engineering Geoscience, v. II, no. 2, p. 213-223.

Davis, A.D., Heriba, A., and Webb, C.J., 1996, Prediction of nitrate concentrations in effluent from spent ore: Mining Engineering, v. 48, no. 2, p. 79-83.

Davis, A.D., and Zabolotney, G.A., 1996, Ground-water flow simulations for the determination of post-mining recharge rates at the Belle Ayr Mine: Mining Engineering, v. 48, no. 11, p. 80-83.

Davis, A.D., and Rahn, P.H., 1997, Karstic gypsum problems at wastewater stabilization sites in the Black Hills of South Dakota: Carbonates and Evaporites, v. 12, no. 1, p. 73-80.

Webb, C.J., Davis, A.D., and Paterson, C.J., 1998, Comprehensive inventory of known abandoned mine lands in the Black Hills of South Dakota: Mining Engineering, v. 50, no. 7, p. 84-86.

Davis, A.D., Webb, C.J., and Durkin, T.V., 1999, A watershed approach to evaluating impacts of abandoned mines in the Bear Butte Creek basin of the Black Hills: Mining Engineering, v. 51, no. 9, p. 49-56.

Davis, A.D., Long, A.J., and Wireman, M., 2000, Sensitivity of the Madison aquifer to contamination in the Rapid City area of the Black Hills, in Strobel, M.L., and Davis, A.D., eds., Hydrology of the Black Hills: South Dakota School of Mines and Technology Bulletin No. 20, p. 12-19.

Davis, A.D., Capehart, W.J., Hjelmfelt, M.R., Kenner, S.J., Johnson, C.S., and Naus, C.A., 2000, Coupling of a ground-water model to atmospheric and surface-water models in the complex terrain of the Black Hills, in Strobel, M.L., and Davis, A.D., eds., Hydrology of the Black Hills: South Dakota School of Mines and Technology Bulletin No. 20, p. 65-72.

Davis, A.D., Long, A.J., and Wireman, M., 2002, KARSTIC: a sensitivity method for carbonate aquifers in karst terrain: Environmental Geology and Water Science, v. 42, no. 1, p. 65-72.

Davis, A.D., and Webb, C.J., and Beaver, F.W., 2003, Hydrology of the proposed National Underground Science Laboratory at the Homestake Mine in Lead, South Dakota: Preprint 03-59, Society for Mining, Metallurgy, and Exploration, Littleton, Colorado.

Webb, C.J., Davis, A.D., and Johnson, C.S., Environmental evaluation of the Belle Eldridge Mine near Deadwood, South Dakota: Accepted for publication, Mining Engineering.

Davis, A.D., Beaver, F.W., and Stetler, L.D., 2003, Engineering problems of gypsum karst along the Interstate 90 development corridor in the Black Hills of South Dakota, in Johnson, K., and Neal, J., eds., Evaporite Karst and Engineering Problems in the United States: Oklahoma Geological Survey Circular 109.

Webb, C.J., and Davis, A.D., 2003, Arsenic remediation of drinking water using modified limestone: ACS Paper 726161, American Chemical Society.

Webb, C.J., Davis, A.D., and Dawadi, S., 2003, Investigation of the formation of arsenic-containing minerals on a limestone base (abstract): Geological Society of America, Annual Meeting.

Lisenbee, A.L., Stetler, L.D., Paterson, C.J., Redden, J.A., Davis, A.D., Hargrave, R., Peltzer, B., Nonnast, D., Bielstein, K., and Alexander, D., 2003, EDMap-sponsored geologic mapping in the Black Hills development corridor, South Dakota (abstract): Geological Society of America, Annual Meeting.

Miller, S.L., Davis, A.D., Lisenbee, A.L., Long, A.J., Putnam, L.D., Lester, J.L., and Hargrave, R.G., 2003, Vulnerability mapping (1:24,000) of the Madison aquifer near Rapid City, South Dakota (abstract): Geological Society of America, Annual Meeting, Seattle, Washington.

Davis, A.D., Webb, C.J., and Nelson, K.C., 2004, Acid rock drainage and the potential for impacts at selected abandoned mine sites in the Black Hills National Forest: Preprint 04-49, Society for Mining, Metallurgy, and Exploration, Littleton, Colorado, 3 p.

Davis, A.D., and Webb, C.J., 2005, Progress toward a National Underground Science and Engineering Laboratory at the Homestake Mine in Lead, South Dakota: Preprint 05-33, Society for Mining, Metallurgy, and Exploration, Littleton, Colorado, 3 p.

Miller, S.L., Kenner, S.J., Davis, A.D., and Silva, A.J., 2005, Characterization of naturally occurring acid rock drainage and impacts to the North Forks of Rapid Creek and Castle Creek in the Black Hills near Rochford, South Dakota: Proceedings, South Dakota Academy of Science, v. 83, p. 83-89.

Davis, A.D., and Webb, C.J., Progress toward a Deep Underground Science and Engineering Laboratory at the Homestake Mine in Lead, South Dakota: Pending revisions, Mining Engineering.

Miller, S.L., Davis, A.D., and Lisenbee, A.L., 2005, Vulnerability (risk) mapping of the Madison aquifer near Rapid City, South Dakota (abstract), in Kuniansky, E.L., ed., u.S. Geological Survey Karst Interest Group Proceedings: U.S. Geological Survey Scientific Investigations Report 2005-5160, p. 163.

Stetler, L.D., and Davis, A.D., 2005, Gypsum and carbonate karst along the I-90 development corridor, Black Hills, South Dakota (abstract), in Kuniansky, E.L., ed., U.S. Geological Survey Karst Interest Group Proceedings: U.S. Geological Survey Scientific Investigations Report 2005-5160, p. 134.

Epstein, J.B., Davis, A.D., Long, A.J., Putnam, L.D., and Sawyer, J.F., 2005, Field Trip Guide 2, Karst features of the northern Black Hills, South Dakota and Wyoming, in Kuniansky, E.L., ed., U.S. Geological Survey Karst Interest Group Proceedings: U.S. Geological Survey Scientific Investigations Report 2005-5160, p. 232-282.

Davis, A.D., Webb, C.J., Dixon, D.J., Sorensen, J.L., and Dawadi, S., 2006, Arsenic removal from drinking water by limestone-based material: Preprint 06-034, Society for Mining, Metallurgy, and Exploration, Littleton, Colorado, 3 p.

Davis, A.D., Webb, C.J., Dixon, D.J., Sorensen, J.L., and Dawadi, S., 2007, Arsenic removal from drinking water by limestone-based material: Mining Engineering, v. 59, no. 2, p. 71-74.

Davis, A.D., Webb, C.J., and Sorensen, J.L., 2007, Environmental reclamation and monitoring of the abandoned Belle Eldridge Mine near Deadwood, South Dakota: Preprint 07-39, Society for Mining, Metallurgy, and Exploration, Littleton, Colorado, 3 p.

Webb, C.J., Campbell, C., Davis, A.D., Dawadi, S., Dixon, D.J., and Sorensen, J.L., 2006, Arsenic remediation of drinking water using limestone-based material: American Chemical Society, Division of Environmental Chemistry, ACS Symposia Paper 941321.

Valder, J.F., and Davis, A.D., Pumping test and assessment of the Deadwood aquifer at Jewel Cave National Monument, Custer County, South Dakota (abstract): Geological Society of America, Annual Meeting, October, 2006, Philadelphia, Pennsylvania.

Davis, A.D., 2006, Case 4: Geological engineer, in Baura, G.D., Engineering ethics: an industrial perspective, Chapter 16, Case studies: Elsevier Academic Press, Burlington, Massachusetts, 220 p.

Selected Presentations:

Rahn, P.H., and Davis, A.D., 1991, Hydrogeology of a proposed low-level radioactive waste disposal site near Butte, Nebraska: Association of Engineering Geologists, Proceedings of 34th Annual Meeting, Chicago, Illinois.

Wang, J., Hjelmfelt, M.R., Capehart, W.J., Kenner, S.J., and Davis, A.D., 1998, Coupled atmospheric-hydrologic numerical simulation of a flash flood event: Part 1. Atmospheric simulation: American Meteorological Society, Hydrology Conference, Phoenix, Arizona.

Davis, A.D., and Long, A.J., 1998, Ground-water issues in the coupling of a subsurface flow model to atmospheric and surface-water models in complex terrain: GEWEX Continental-Scale International Project, Annual Meeting, St. Louis, Missouri.

Davis, A.D., Webb, C.J., and Nelson, K.C., 2004, Acid rock drainage and the potential for impacts at selected abandoned mine sites in the Black Hills National Forest. Presented at 2004 SME Annual Meeting, Denver, Colorado.

Sorensen, J.L., Davis, A.D., Webb, C.J., Dixon, D.J., and Fivecoate, R.I., 2004, A limestone-based process for removal of arsenic from drinking water: 15th Annual South Dakota Ground-Water Quality Conference, March, 2004, Pierre, South Dakota.

Fivecoate, R.I., Sorensen, J.L., Davis, A.D., Dixon, D.J., Webb, C.J., and Dawadi, S., 2004, Characterization of limestone used in the removal of arsenic from water: Presented at Western South Dakota Hydrology Conference, April, 2004, Rapid City, South Dakota.

Davis, A.D., Webb, C.J., Dixon, D.J., and Williamson, T.E., 2004, A limestone-based process for removal of arsenic from drinking water: Presented at Western South Dakota Hydrology Conference, April, 2004, Rapid City, South Dakota.

Webb, C.J., Davis, A.D., and Dawadi, S., Investigation of the formation of arsenic-containing minerals on a limestone base: Presented at Geological Society of America, Annual Meeting, Division of Geochemistry, Denver, Colorado.

Webb, C.J., and Davis, A.D., Arsenic remediation of drinking water using modified limestone: American Chemical Society, Anaheim, California.

Miller, S.L., Davis, A.D., and Lisenbee, A.L., Long, A.J., Putnam, L.D., Lester, J.D., and Hargrave, R.G., 2004, Vulnerability mapping of the Madison aquifer near Rapid City area, South Dakota: Western South Dakota Hydrology Conference, Rapid City, South Dakota, April, 2004.

Lisenbee, A.L., Davis, A.D., Paterson, C.J., Stetler, L.D., Miller, S.L., and Hargrave, R.G., 2004, Geologic atlas of the Rapid City West 7.5-minute quadrangle: Western South Dakota Hydrology Conference, Rapid City, South Dakota, April, 2004.

Davis, A.D., and Webb, C.J., 2005, Progress toward a National Underground Science and Engineering Laboratory at the Homestake Mine in Lead, South Dakota: Annual Meeting, Society for Mining, Metallurgy, and Exploration, Salt Lake City, Utah, February, 2005.

Davis, A.D., Webb, C.J., Dixon, D.J., and Sorensen, J.L., 2006, Arsenic removal from drinking water by limestone-based material: SME Annual Meeting, Technical Program: Limestone – Nature's Miracle Rock; March, 2006, St. Louis, Missouri.

Davis, A.D., 2006, Modeling of natural biodegradation of gasoline contamination at a site in eastern South Dakota: Presented at 18th Annual Environmental and Ground Water Quality Conference, March, 2006, Pierre, South Dakota.

Sorensen, J.L., Davis, A.D., Dixon, D.J., and Webb, C.J., 2006, Development of an agglomeration process to increase the efficiency of limestone-based material for removing metals from drinking water: Presented at 18th Annual South Dakota Ground-Water Quality Conference, March, 2006, Pierre, South Dakota.

Sorensen, J.L., Davis, A.D., Dixon, D.J., and Webb, C.J., Controlling factors on arsenic removal from water by limestone-based material: Western South Dakota Hydrology Conference, April, 2006, Rapid City, South Dakota.

Webb, C.J., Campbell, C., Davis, A.D., Dawadi, S., Dixon, D.J., and Sorensen, J.L., 2006, Arsenic remediation of drinking water using limestone-based material: American Chemical Society, Division of Environmental Chemistry, Symposium on Current Status of Research on Arsenic Remediation, 231st National Meeting, March 26-30, Atlanta, Georgia.

Davis, A.D., Dixon, D.J., and Sorensen, J.L., 2006, Fixed-bed adsorption column studies and engineering scale-up design of a limestone-based metals removal technology: Eastern South Dakota Water Conference, Brookings, South Dakota, November, 2006.

Valder, J.F., and Davis, A.D., 2006, Pumping test and assessment of the Deadwood aquifer at Jewel Cave National Monument, Custer County, South Dakota: Geological Society of America, Annual Meeting, October, 2006, Philadelphia, Pennsylvania.

Hocking, C.M., Lisenbee, A.L., and Davis, A.D., 2007, Vulnerability of the Madison aquifer, Hayward quadrangle, South Dakota: Western South Dakota Hydrology Conference, April 19, 2007, Rapid City, South Dakota.

Johnson, D., Lisenbee, A.L., and Davis, A.D., 2007, Aquifer characteristics of Precambrian basement rocks in the Pactola Dam quadrangle, South Dakota: Western South Dakota Hydrology Conference, April 19, 2007, Rapid City, South Dakota.

Lisenbee, A.L., Francisco, E.M., Davis, A.D., and Pellowski, C., 2007, Vulnerability of the Inyan Kara aquifer, Hermosa and Hermosa NW quadrangles, Black Hills Development Corridor: Western South Dakota Hydrology Conference, April 19, 2007, Rapid City, South Dakota.

Francisco, E.M., Lisenbee, A.L., and Davis, A.D., 2007, Aquifer vulnerability in the Blackhawk quadrangle, South Dakota: Western South Dakota Hydrology Conference, April 19, 2007, Rapid City, South Dakota.

Davis, A.D., Webb, C.J., Sorensen, J.L., and Valder, J.F., 2007, Environmental monitoring of the abandoned Belle Eldridge Mine near Deadwood, South Dakota: Western South Dakota Hydrology Conference, April 19, 2007, Rapid City, South Dakota.

Valder, J.F., and Davis, A.D., 2007, Pumping tests in the Deadwood aquifer at Jewel Cave National Monument, Custer County, South Dakota: Western South Dakota Hydrology Conference, April 19, 2007, Rapid City, South Dakota.

Sorensen, J.L., Davis, A.D., Dixon, D.J., and Hocking, C.M., 2007, Further testing of limestone-based material for arsenic removal from small water systems: Western South Dakota Hydrology Conference, April 19, 2007, Rapid City, South Dakota.

Davis, A.D., and Skaggs, G.L., 2007, ABET Engineering Criteria Training: Society for Mining, Metallurgy, and Exploration, February 24, 2007, Denver, Colorado.

Patent Application:

Process and apparatus to reduce the amounts of arsenic in water: Dr. Cathleen J. Webb, Dr. Arden D. Davis, and Dr. David J. Dixon; U.S. Patent Application Serial No. 10/861,586; patent pending. Continuation-in-part filed in 2006.

Related research:

Grainger Prize for Sustainability: HydroTech Engineering and Rohm & Haas (collaboration): Limestone-based arsenic-removal method; selected for Round II of competition. Field tests in Bangladesh and China. Field test planned for Keystone, South Dakota.

Recent Research Funding:

U.S. Geological Survey 104b Grant Program / South Dakota Water Resources Institute: Development of an agglomeration process to increase the efficiency of limestone-based material to remove metals from drinking water: Dr. Arden D. Davis and Dr. David J. Dixon, $10,897.

U.S. Geological Survey 104b Grant Program / South Dakota Water Resources Institute: Fixed-bed adsorption column studies and engineering scale-up design of a limestone-based metals removal technology for small water supply systems: Dr. Arden D. Davis and Dr. David J. Dixon, $12,918.

U.S. Geological Survey 104b Grant Program / South Dakota Water Resources Institute: Leaching tests for encapsulation of waste after arsenic removal from drinking water: Dr. Arden D. Davis, Dr. David J. Dixon, and Dr. M.R. Hansen; $11,873.

U.S. Department of the Interior, National Park Service; Jewel Cave Pumping Test; Dr. Arden D. Davis, Principal Investigator; $8,800.

U.S. Bureau of Land Management: Belle Eldridge Mine Sampling and Monitoring, Phase III, $4,500 (additional); Arden D. Davis, Principal Investigator.

West Dakota Water Development District: Determination of historic ground water pollution problems, Part II: Pactola Dam, Rapid City West, and the North One-Half of Rockerville quadrangles; $9,162; Dr. Alvis L. Lisenbee, Principal Investigator; Dr. Arden D. Davis, Co-Principal Investigator.

West Dakota Water Development District: Aquifer susceptibility study of the Pactola Dam quadrangle, South Dakota: Part II – Precambrian: $9,112; Dr. Alvis L. Lisenbee, Principal Investigator; Dr. Arden D. Davis, Co-Principal Investigator.

West Dakota Water Development District: Aquifer mapping (1:24,000) of the Hermosa NW quadrangle; $13,538; Dr. Alvis L. Lisenbee, Principal Investigator; Dr. Arden D. Davis and Dr. Larry Dr. Stetler, Co-Principal Investigators.

West Dakota Water Development District: Preliminary aquifer vulnerability and susceptibility study of the Blackhawk quadrangle; $15,988; Dr. Alvis Lisenbee, Principal Investigator; Dr. Arden D. Davis, Co-Principal Investigator.

West Dakota Water Development District: Geologic mapping of the Mt. Rushmore quadrangle, South Dakota; $14,970; Dr. Alvis Lisenbee, Principal Investigator; Dr. Arden D. Davis, Co-Principal Investigator.

West Dakota Water Development District: Aquifer vulnerability study of the Rockerville quadrangle, South Dakota; $14,763; Dr. Alvis Lisenbee, Principal Investigator; Dr. Arden D. Davis, Co-Principal Investigator.

Phase I Small Business Innovation Research Grant, U.S. Environmental Protection Agency, Limestone-Based Material for Arsenic Removal from Drinking Water: Dr. Cathleen J. Webb, Dr. Arden D. Davis, Dr. David J. Dixon, and Dr. Terrence L. Williamson; $100,000.

Phase II Small Business Innovation Research Grant, U.S. Environmental Protection Agency, Limestone-Based Material for Arsenic Removal from Drinking Water: Dr. Cathleen J. Webb, Dr. Arden D. Davis, Dr. David J. Dixon, and Dr. Terrence L. Williamson; $225,000.

National Science Foundation, Statewide Partnership to Support Technology Innovation and Entrepreneurship in South Dakota (PFI), University of South Dakota: Arsenic Removal from Drinking Water; John C. Lofberg, Dr. Arden D. Davis, and Dr. David J. Dixon; $35,826.