ATTACHMENT 25

Opening Testimony of Dr. Robert Moran

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
POWERTECH (USA) INC.,	)	Docket No. 40-9075-MLA
	)	ASLBP No. 10-898-02-MLA-BD01
(Dewey-Burdock In Situ Uranium Recovery Facility)	)	

OPENING WRITTEN TESTIMONY OF DR. ROBERT E. MORAN

I, Dr. Robert E. Moran, do hereby swear that the following written testimony is true to the best of my knowledge:

I. Basis for Testimony as an Expert in Hydrogeology

The opinions below are based on my review of the materials in the hearing record, including those materials referenced in my previous declarations and in the testimony below. My qualifications as an expert in hydrogeology and geochemistry are summarized in this testimony, and are set out more completely in the documents contained in the hearing record that detail my education, training, and experience. My curricula vitae is attached.

By way of summary, I earned my Ph.D. in, Geological Sciences from University of Texas, Austin in 1974 after earning my B.A. in Zoology from San Francisco State College in 1966. I am a hydrogeologist and geochemist with more than 42 years of domestic and international experience in conducting and managing water quality, geochemical and hydrogeologic work for private investors, industrial clients, tribal and citizens groups, NGO's, law firms, and governmental agencies at all levels. Much of my technical expertise involves the quality and geochemistry of natural and contaminated waters and sediments as related to mining, nuclear fuel cycle sites, industrial development, geothermal resources, hazardous wastes, and water supply development. In addition, I have significant experience in the application of remote sensing to natural issues, development of resource policy, and litigation support. I have often taught courses to technical and general audiences, and have given expert testimony on numerous occasions. Countries worked in include: Australia, Greece, Bulgaria, Mali, Senegal, Guinea, Gambia, Ghana, South Africa, Iraqi Kurdistan, Oman, Pakistan, Kazakhstan, Kyrgyzstan, Mongolia, Romania, Russia (Buryatia), Papua New Guinea, Argentina, Bolivia, Chile, Colombia, Guatemala, Honduras, Mexico, Peru, El Salvador, Belgium, France, Canada, Great Britain, United States.

Literature reviewed in preparation of my testimony includes:

Powertech Application for NRC Uranium Recovery License, Dewey-Burdock Project, Feb. 2009:

- Technical Report (TR)
- Environmental report (ER)
- Supplement to Application, Aug. 2009
- Powertech submittals (2010, 2011, 2012)

Abitz, R.J., 2003 (Mar. 3), Declaration of Dr. Abitz, Before U.S. NRC, Atomic Safety & Licensing Board Panel, Administrative Judges, in Matter of: HYDRO Resources, Inc., Crown Point, NM; Docket No. 40-8968-ML.

Abitz, R.J., 2009 (Oct. 31), Comments on Powertech's Proposed Baseline Plan, (R Squared 2009) for the proposed Centennial Site, Colorado, 6 pg.

Abitz, Richard J. and Darling, Bruce K., 2010, ANTHROPOGENIC INDUCED REDOX DISEQUILIBRIUM IN URANIUM ORE ZONES: Abstracts: 2010 GSA Denver Annual Meeting (31 October – 3 November 2010), Paper No. 15-4.

Arendt, J. W., Butz, T. R., Cagle, G. W., Kane, V. E., and Nichols, C. E., 1979 (Dec.), Hydrogeochemical and Stream Sediment Reconnaissance Procedures of the Uranium Resource Evaluation Project, Union Carbide Corporation, Nuclear Division, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tennessee, K/UR-100.

Arizona Game and Fish Department and Commission, 2007 (May), Uranium Mining and Activities, Past and Present; Update for the Arizona Game and Fish Department and Commission. *www.grandcanyontrust.org/documents/gc_agfUranium**Update**.pdf*

Becker, Lawrence D, 1974 (Aug.), A method for estimating magnitude and frequency of floods in South Dakota. U.S. Geol. Survey Water Resources Investigations 35-74.

Bell, H., Gott, G. B., Post, E. V., and Schnabel, R.,1955, Lithologic and Structural Controls of Uranium Deposition in the Southern Black Hills, South Dakota, Geology of Uranium and Thorium, International Conference (1955).

Bell, H. and Bales, W. E., 1954, Uranium Deposits in Fall River County, South Dakota, U. S. Geological Survey, Trace Elements Investigations Report 297.

Bell, H. and Post, E. V., 1971, Geology of the Flint Hill Quadrangle, Fall River County, South Dakota, U. S. Geological Survey, Bulletin 1063-M.

Boggs, J., Mark and A.M. Jenkins, 1980, Analysis of Aquifer Tests Conducted at the Proposed Burdock Uranium Mine Site, Burdock, South Dakota, Tennessee Valley Authority, Office of Natural Resources, Division of Water Resources, Water Systems Development Branch, Report No. WR28-1-520-109, May 1980.

Boggs, J. Mark, 1983, Hydrogeologic Investigations at Proposed Uranium Mine near Dewey, South Dakota, Tennessee Valley Authority, Office of Natural Resources, Division of Air and Water Resources, Water Systems Development Branch, Report No. WR28-2-520-128, October 1983.

Bowles, C. G. and W. A. Braddock, 1963, Solution Breccias of the Minnelusa Formation in the Black Hills, South Dakota and Wyoming. U.S. Geol. Survey Prof. Paper 475-C, pp. C91-C-95.

Bowles, C. G., 1968, Theory of Uranium Deposition from Artesian Water in the Edgemont district, Southern Black Hills. Wyoming Geol. Assoc . 20th Field Conference Guidebook. pp.125-130. George R. Wolf, ed. Casper , Wyoming.

Braddock, W. A., 1957, Stratigraphic and Structural Controls of Uranium Deposits on Long Mountain, South Dakota, U. S. Geological Survey, Bulletin
1063-A.

Braddock, W. A., 1963, Geology of the Jewel Cave Southwest Quadrangle Custer County, South Dakota, U. S. Geological Survey, Bulletin 1063-G.

Bredehoeft, J.D., C.E. Neuzil, P.C. Milly, **1983,** Regional flow in the Dakota aquifer: a study of the role of confining layers: U.S. Geological Survey Water Supply Paper 2237. http://serc.carleton.edu/resources/17057.html

Brobst, D. A., 1961, Geology of the Dewey Quadrangle, Wyoming, South Dakota,
U. S. Geological Survey, Bulletin 1063-B.

Bush, Jerry, 2010 (Mar. 1), Updated Technical Report on the Dewey-Burdock Uranium Project, Custer and Fall River Counties, South Dakota; prepared for Powertech Uranium Corp. (report on their letterhead), 38 pg. plus figures.

Butz, T. R., N. E. Dean, C. S. Bard, R. N. Helgerson, J. G. Grimes, and P. M. Pritz, 1980 (May 31), HYDROGEOCHEMICAL AND STREAM SEDIMENT
DETAILED GEOCHEMICAL SURVEY FOR EDGEMONT, SOUTH DAKOTA; WYOMING; National Uranium Resource Evaluation (NURE) Program; Union Carbide Corp., Nuclear Division, Oak Ridge Gaseous Diffusion Plant, Report Number: K/UR-38, 175 pg. http://www.osti.gov/scitech/biblio/5290332

Cagle, G. W., 1977 (Oct.), The Oak Ridge Analytical Program, Symposium on Hydrogeochemical and Stream Sediment Reconnaissance for Uranium in the
United States, (March 16 and 17), U.S. Energy Research and Development Administration, Grand Junction, Colorado, pp 133-156 [GJBX-77(77)] .

Carter, J. M., D. G. Driscoll and J. F. Sawyer, 2003, Ground-Water Resources in the Black Hills Area, South Dakota. U.S.G.S. Water-Resources Investigations Report 03-4049, Rapid City, South Dakota. *pubs.**usgs**.gov/wri/wri**034049**/wri**034049**_files/wri**034049**p0_10.pdf*

Carter, J.M., Driscoll, D.G., Williamson, J.E., and Lindquist, V.A., 2002, Atlas of water resources in the Black Hills area, South Dakota: U.S. Geological Survey Hydrologic Atlas 747, 120 p.

Casey, R. D. and Wescott, E. M., 1957, Electrical Geophysical Exploration of Paleostream Channels, Edgemont Mining District, Fall River County, South Dakota, U.S. Atomic Energy Commission, Division of Raw Materials.

Catchpole, G. and R. Kuchelka, 1993, Groundwater Restoration of Uranium ISL Mines in the United States, 9 pg.
http://www.uranerz.com/i/pdf/Uranium_Paper_Groundwater_Restoration.pdf

Chamberlin, T. C., 1885, The Requisite and Qualifying Conditions of Artesian Wells: U.S. Geological Survey Annual Report, no. *5,* p. 125-173.

COGEMA, 2003, Irigaray Project (IR), Quarterly Progress Report of Monitor Wells on Excursion Status, License SUA-1341.

Crancon, P., E. Pili, and L. Charlet, 2010, Uranium facilitated transport by water-dispersible colloids in field and soil columns: Science of The Total Environment, Vol. 408, No., (1 April 2010), Pg. 2118-2128.

Cuppels, N. P., 1962, Geologic Environment of an Oxidized Uranium Deposit in the Black Hills, South Dakota, U. S. Geological Survey, Bulletin 1063-C.

Darling, Bruce K., 2008 (Sept. 29), Report on Findings Related to the Restoration of Groundwater at In-Situ Uranium Mines in South Texas; Southwest Groundwater Consulting, LLC report submitted to Blackburn & Carter, Houston Texas, 46 pg.
*nmenvirolaw.org/images/pdf/**TexasRestoration**Study092908.pdf*

Darton, N. H., 1896, Preliminary report on artesian waters of a portion of the Dakotas: U.S. Geological Survey Annual Report, no. 17, pt. 2, p. 609-691.

Darton, N.H., 1901, Geology and water resources of the southern half of the black Hills and adjoining regions in South Dakota and Wyoming: U.S. Geological Survey Annual Report, no. 21, pt. 4, p. 489- 599.

Darton, N. H. and Smith, W. S. T., 1904, The Geology of the Edgemont Folio, U.S. Geological Survey, Folio No. 108.

Darton, N.H., 1905, Preliminary report on the Geology and Underground Water Resources of the Central Great Plains; USGS Professional Paper: 32, 508 PG.
http://pubs.usgs.gov/pp/0032/report.pdf

Darton, N.H., 1909, Geology and Underground Waters of South Dakota; U.S. G.S. Water-Supply Paper 227, 181 pg. http://pubs.usgs.gov/wsp/0227/report.pdf

Davis, R.W., C.F. Dyer, & J.E. Powell, 1961, Progress Report on Wells Penetrating Artesian Aquifers in South Dakota; U.S.G.S. Water-Supply Paper 1534; 100 pg. plus figues.

Davis, J.A. & G.P. Curtis, 2007 (Jan.), Consideration of Geochemical Issues in Groundwater Restoration at Uranium In-Situ Leach Mining Facilities; prepared by U.S.G.S.: NUREG/CR-6870; 150 pg. http://water.usgs.gov/nrp/proj.bib/Publications/2006/davis_curtis_2007.pdf

Dicus, G., Diaz G., McGaffigan, E. Jr., and Merrifield, J., 1999, *Commission Order: CLI-99-22, Nuclear Regulatory Commission.* Albuquerque, New Mexico.

Downey, Joe S., 1984, Geohydrology of the Madison and Associated Aquifers in Parts of Montana, North Dakota, South Dakota, and Wyoming. U.S.G.S. Professional Paper 1273-G, 54 pg.

Driscoll, Daniel G., J. M. Carter, J. E. Williamson, and L. D. Putnam, 2002,
Hydrology of the Black Hills Area, South Dakota; USGS Water-Resources Investigations Report 02-4094, 158 pg.

Driscoll, Fletcher G., 1986, Groundwater and Wells, Second Edit.: Johnson Division, St. Paul, Minn., 1089 pgs.

D'Silva, A. P., Haas, W. J., and Floyd, M. A.,1978 (May), Multilaboratory Analytical Quality Control Program for the Hydrogeochemical and Stream Sediment Reconnaissance, Ames Laboratory, Iowa State University, Ames, Iowa, IS-4433; (Available from National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161).

Ecometrix Inc., Nov. 2008, A Review of Environmental Criteria for Selenium and Molybdenum: prepared for The MEND INITIATIVE; MEND Rept. 10.1.1.

Epstein, Jack B., 2001, Hydrology, Hazards, and Geomorphic Development of Gypsum Karst in the Northern Black Hills, South Dakota and Wyoming,
in Eve L. Kuniansky, editor, U.S. Geological Survey Karst Interest Group
Proceedings, Water-Resources Investigations Report 01-4011, p. 30-37.

Epstein, Jack, B., & Daniel H. Doctor, 2013 (May 22), EVAPORITE KARST IN THE BLACK HILLS, SOUTH DAKOTA AND WYOMING, AND THE OIL PLAY IN THE WILLISTON BASIN, NORTH DAKOTA AND MONTANA; 13TH SINKHOLE CONFERENCE NCKRI SYMPOSIUM 2; p. 161-176. http://www.infocastinc.com/downloads_pdf/bakken11_pre.pdf

Evans, J. E. & D. O. Terry, Jr. 1994. The significance of incision and fluvial sedimentation in the basal White River Group (Eocene-Oligocene), badlands of South Dakota, U. S. A. Sedimentary Geology 90:137-152.

Faillace, E.R. , D.J. LePoire, S.-Y. Chen, and Y. Yuan, May 1997, MILDOS-AREA: An Update with Incorporation of *In Situ* Leach Uranium Recovery Technology: Letter Report, Argonne National Laboratory, Environmental Assessment Division, Argonne, IL.

Finn, T. M., Mark A. Kirschbaum, Stephen B. Roberts, Steven M. Condon, Laura N.R. Roberts, and Ronald C. Johnson, 2010, Cretaceous–Tertiary Composite Total Petroleum System (503402), Bighorn Basin, Wyoming and Montana, Chapt. 3 of Petroleum Systems and Geologic Assessment of Oil and Gas in the Bighorn Basin Province, Wyoming and Montana, USGS Digital Data Series DDS-69-V, 163 pgs.
http://pubs.usgs.gov/dds/dds-069/dds-069-v/REPORTS/69_V_CH_3.pdf

Ford, Bacon and Davis Utah Inc., 1978 (May), Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota, prepared for the U.S. Nuclear Regulatory Commission under contract No. E (05- 1) - 1658.

Freeze, R.A. and J.A. Cherry, 1979, Groundwater; Prentice-Hall, 604 pg.

Galloway, W.E., 1982, Epigenetic Zonation and Fluid Flw History of Uranium-Bearing Fluvial Aquifer Systems, south Texas Uranium Province; Texas Bur. Econ. Geology, Rept. of Investigations No. 119, 31 pg.

Golder Assoc., 2011(Dec.19), Guidance Document on Water and Mass Balance Models for the Mining Industry; Submitted to: Yukon Government, Whitehorse, YK; 248 pg.
http://www.env.gov.yk.ca/publications-maps/documents/mine_water_balance.pdf

Gott, G.B., R.W. Schnabel, 1963, Geology of the Edgemont NE Quadrangle Fall River and Custer Counties, South Dakota, USGS Bulletin 1063-E.

Gott, G.B., D.E. Wolcott, C.G. Bowles, 1974, Stratigraphy of the Inyan Kara Group and Localization of Uranium deposits, Southern Black Hills, South Dakota and Wyoming; U.S.G.S. Prof. Paper 763, 57 pg.

Granger, H, C , 1976, Fluid flow and ionic diffusion and their roles in the genesis of sandstone-type uranium ore bodies: U,S, Geological Survey Open-File Report 76-454, 26 p., 11 f i g s.

Granger, H. C. and C. G. Warren, 1979, Some speculations on the genetic geochemistry and hydrology of roll-type uranium deposits: Wyoming Geological Association Guidebook, Thirtieth Annual Field Conference, 1978, p, 349-361.

Gries, J. P ., 1954, Cretaceous Rocks of the Williston Basin: Bulletin of the American Association of Petroleum Geologists, v. 38, no. 4, p. 443-453.

Gries, J.P., 1958, The Dakota Formation in Central South Dakota: Proceedings of the South

Dakota Academy of Science, v. 37, p. 161-168.

Gries, J. P., Rahn, P. H., and Baker, R. K., 1976, A Pump Test in the Dakota Sandstone at Wall, South Dakota: South Dakota Geological Survey Circular 43, 9 pg.

Harshman, E. N., 1962, Alteration as a guide to uranium ore, Shirley Basin, Wyoming, *in* Short Papers in Geology, Hydrology, and Topography: U.S.G.S. Professional Paper 450-D, p. D8-D10.

Harshman, E. N., 1972, Geology and Uranium Deposits, Shirley Basin Area, Wyoming; U.S.G.S. Prof. Paper 745, 82 pg.

Hall, Susan, 2009, Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain: U.S.G.S. Open-File Report 2009–1143, 36 pgs.

Hays, Tim, 1999, Episodic Sediment-Discharge Events in Cascade Springs, Southern Black Hills, South Dakota. U.S. G.S. Water-Resources Investigations Report 99-4168, 40 pg. *pubs.**usgs**.gov/wri/wri**994168**/pdf/wrir**99.4168**.pdf*

Helgesen, J.O. .J. Jorgensen, R.B. Leonard, and D.C. Signor, 1982, Regional Study of the Dakota Aquifer (Darton's Dakota Revisited): Ground Water V. 20, No. 4, pg. 410—414.

Hem, John, 1985, Study and Interpretation of the Chemical Characteristics of Natural Waters, 3rd Edit.; U.S.G.S. Water-Supply Paper 2254, 264 pg.

Henry, C.D. and R.R. Kapadia, 1980, Trace Elements in Soils of the South Texas Uranium District: Concentrations, Origin, and Environmental Significance; Texas Bur. Econ. Geology, Rept. of Investigations No. 101; 52 pg.

Henry, C.D., W.E. Galloway, G.E. Smith, C.L. Ho, J.P. Morton, J.K. Gluck, 1982, Geochemistry of Ground Water in the Miocene Oakville sandstone—A Major Aquifer and Uranium Host of the Texas Coastal Plain; Texas Bur. Econ. Geology Rept. of Investigations No. 118; 63 pg.

ICMM, 2012 (May), Water Management in Mining: a Selection of Case Studies; 32 pg. https://www.icmm.com/document/3660

Illsley, C. T. and Scott, J. H., 1956, Preliminary Report on Geochemical. Geophysical Exploration of Paleostream Channels, Edgemont Mining District, Fall River County, South Dakota, United States Atomic Energy Commission, Division of Raw Materials.

Illsley, C. T., 1957, Additional Data and Interpretations on Geochemical Geophysical Exploration of Paleostream Channels, Edgemont Mining District, Fall River County, South Dakota; United States Atomic Energy Commission, Division of Raw Materials.

Johnson, Raymond H., Sharon F. Diehl, & William M. Benzel, 2013, Solid-Phase Data from Cores at the Proposed Dewey Burdock Uranium In-Situ Recovery Mine, near Edgemont, South Dakota; U.S.G.S. Open-File Report 2013-1093, prepared in cooperation with the U.S. EPA. http://pubs.usgs.gov/of/2013/1093/

Jones, R. S., Frost, I. C., and Rader, L. F., Jr., 1957, A Comparison of Plants and Soils as Prospecting Guides for Uranium in Fall River County, South Dakota, U. S. Geological Survey, Trace Elements Investigations Report 686.

Kane, V. E., Baer, T., and Begovich, C. L., 1977 (July), Principle Component Testing for Outliers, Union Carbide. Corporation, Nuclear Div., Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tennessee, K/UR-7. United States Department of Energy, Grand Junction, Colorado [GJBX- 71(77)].

Keene, Jack R., 1970 (July), Ground Water Resources of the Western Half of Fall River County, South Dakota; MS Thesis, south Dakota School of Mines and Technology.

Keene, Jack R.,1973, Ground-water Resources of the Western Half of Fall River County, S.D.; South Dakota Department of Natural Resource Development, Geological Survey, Report of Investigations, No. 109, 90 pg.
www.sdgs.usd.edu/pubs/pdf/RI-109%20-%2090%20pages.pdf

Knight Piésold, 2008a, Pump Test Workplan, Dewey-Burdock In Situ Uranium Project, April 25, 2008.

Knight Piésold, 2008b, 2008 Pump Tests: Results and Analysis, Dewey-Burdock In Situ Uranium Project, Final Report, November 2008.

Konikiw, L.J. and J. Bredehoeft, 1992, Ground-water Models Cannot be Validated. Advances *in* Water Resources v. 15, p. 75--83.

Kuipers, J.R. (2000). Hardrock Reclamation Bonding Practices in the Western United States: National Wildlife Federation. Boulder, Colorado, U.S.A., 416 pgs. [This document and a summary can be obtained at: http://www.mineralpolicy.org/publications/pdf/Bonding_Report_es.pdf]

Kuipers, J.R. and A. S. Maest, et. al., 2006, Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements, 228 pages. Available at: http://www.mine-aid.org/ and http://www.earthworksaction.org/publications.cfm?pubID=213 http://www.earthworksaction.org/pubs/ComparisonsReportFinal.pdf

Larimer, Owen J ., 1970, A proposed streamflow data program for South Dakota. U.S. Geol. Survey Open-File Report.

Long, A.J. and L.D. Putnam, 2002, Flow-System Analysis of the Madison and Minnelusa Aquifers in the Rapid City Area, South Dakota—Conceptual Model: U.S. Geological Survey Water-Resources Investigations Report 02-4185.

Long, A.J., M.J. Ohms, and J.D.R.G McKaskey, 2012, Groundwater Flow, Quality (2007-10), and Mixing in the Wind Cave National Park Area, South Dakota: U.S. Geological Survey Scientific Investigations Report 2011-5235, 50 p.

Long, A.J. and J.F. Valder, 2011, Multivariate Analyses with End-member Mixing to Characterize Groundwater Flow: Wind Cave and Associated Aquifers, Journal of Hydrology, v. 409 (2011), p. 315-327.

Longmire, Patrick, Dale Counce, Elizabeth Keating, Michael Dale & Kim Granzow, Aqueous Geochemistry of Uranium and Arsenic: Los Alamos and Surrounding Areas, New Mexico. www.unm.edu/~cstp/Reports/H2O_Session_4/4-1_**Longmire**.pdf

Max-Neef, M., 2014, The Good is the Bad that We Don't Do: Economic Crimes Against Humanity: A Proposal; Ecological Economics. http://dx.doi.org/10.1016/j.ecolecon.2014.02.011

McCarthy, J.F. and J. M. Zachara, 1989, Subsurface Transport of Contaminants: mobile colloids in the subsurface environment may alter the transport of contaminants. Environ. Sci. Technol.. Vol. 23. No. 5. Abstract available at: http://pubs.acs.org/cgi-bin/abstract.cgi/esthag/1989/23/i05/fpdf/f_es00063a001.pdf?sessid=6006l3

McKaskey, J. D.R.G., 2013, Hydrogeologic Framework for the Madison and Minnelusa Aquifers in the Black Hills Area; M.S. Thesis, South Dakota School of Mines and Technology, 62pg.

McMillan, M. E., P. L. Heller, & S. L. Wing. 2006. History and causes of post-Laramide relief in the Rocky Mountain Orogenic Plateau. Geological Society of America Bulletin 118(3/4):393-405.

Miller, S.L., 2005, Influences of Fractures and Geologic Structure on Ground-water Flow Paths in the Mississippian Madison Aquifer in the Rapid City Area, South Dakota: PhD Dissertation, So. Dakota School of Mines and Technology.

Moran, R.E., 1976, Geochemistry of Selenium in Groundwater near Golden, Jefferson County, Colorado. Abstracts with Programs, Geological Society of America. 1976 Annual Meeting. November 8-11, 1976. 8(6):1018.

Moran, Robert E., 2000, Is This Number To Your Liking? Water Quality Predictions in Mining Impact Studies, p. 185-198, *in* Prediction: Science, Decision Making and the Future of Nature. D. Sarewitz, R. Pielke, Jr., and R. Byerly, Jr., eds., Island Press, Washington, D.C., 405 pg. http://www.unc.edu/~mwdoyle/riverretreat2009/Moran_2000.pdf

Mudd, Gavin, 1998, An Environmental Critique of In Situ Leach Mining :*The Case Against Uranium Solution Mining;* Research report prepared for Friends of the Earth (Fitzroy) with The

Australian Conservation Foundation, 154 pg. *www.sea-us.org.au/pdfs/isl/no2isl.pdf*

Naus, Cheryl A., Daniel G. Driscoll, and Janet M. Carter, 2001, Geochemistry of the Madison and Minnelusa Aquifers in the Black Hills Area, South Dakota; U.S.G.S. Water-Resources Investigations Report 01-4129, 123 pg. *pubs.usgs.gov/wri/wri014129/pdf/wri014129.pdf*

Neuzil, C.E., 1980, Fracture Leakage in the Cretaceous Pierre shale and its significance for underground waste disposal: Baltimore, Johns Hopkins Univ., PhD. Thesis, 150 pg.

Neuzil, C.E., J. D. Bredehoeft, and R. G Wolff, 1984, Leakage and fracture permeability in the Cretaceous shales confining the Dakota aquifer in So. Dakota; *in* Jorgensen, D.G. and Signor, D.C., eds., Geohydrology of the Dakota aquifer; Proc. Of the First C.V. Theis Conf. on Geohydrology; Worthington, OH, Nat'l. Water Well Assoc., p. 113—120.

"Old Radiation Study May Pose New Problems for Operators of Active Yellowcake Mills"; Nuclear Fuel, Vol. 5, No. 2, January 21 (1980).

Otton, J.K., & S. Hall, 2009, In-situ recovery uranium mining in the United States: Overview of production and remediation issues. IAEA-CN-175/87
*www-pub.iaea.org/mtcd/meetings/PDFplus/2009/.../08_56_**Otton**_USA.pdf*

Petrotek, 2010, Numerical Modeling of Groundwater Conditions Related to In Situ Recovery at the Dewey-Burdock Uranium Project, South Dakota, November 2010.

Petrotek Engineering, 2012 (Feb.) *Numerical Modeling of Hydrogeologic Conditions: Dewey-Burdock Project, South Dakota, 119 pg.* [prepared for Powertech]
http://pbadupws.nrc.gov/docs/ML1206/ML12062A096.pdf
http://www.powertechexposed.com/2012.02%20MODELING%20OF%20HYDROGEOLOGIC%20CONDITIONS%20DEWEY-BURDOCK%20PROJECT_ML12062A096.pdf

Pilkey, O.H. & Linda Pilkey-Jarvis, 2007, Useless Arithmetic: Why Environmental Scientists Can't Predict the Future; Columbia Univ. Press, 230 pg.

Post E. V., 1967, Geology of the Cascade Springs Quadrangle, Fall River County, South Dakota, U. S. Geological Survey, Bulletin 1063-L.

Powertech (USA), Inc, 2009 (Feb), Dewey-Burdock Project Application for NRC Uranium Recovery License, Fall River and Custer Counties, South Dakota; *Technical Report* (TR); prepared for US NRC; **3103 pgs.**

Powertech (USA), Inc, 2009 (Feb), Dewey-Burdock Project Application for NRC Uranium Recovery License, Fall River and Custer Counties, South Dakota; *Environmental Report* (ER); prepared for US NRC; **2615 pages.**

Powertech (USA), Inc, 2009 (Aug.), Dewey-Burdock Project Supplement to Application for NRC Uranium Recovery License Dated February -2009; Prepared for U.S. NRC, **151 pgs.**

Powertech (USA) Inc., 2011, Dewey-Burdock Project Technical Report RAI Responses, June 2011. Available from NRC ADAMS document server: http://pbadupws.nrc.gov/docs/ML1120/ML112071064.html.

Powertech, 2012 (March), Dewey-Burdock Project Groundwater Discharge Plan, Custer and Fall River Counties, South Dakota; Prepared for: South Dakota Department of Environment and Natural Resources, **189 pg**. [Report to Accompany Inyan Kara Water Right Permit Application] http://denr.sd.gov/des/gw/Powertech/Dewey_Burdock_GDP.pdf

Powertech, 2012 (June), Dewey-Burdock Project Report to Accompany Inyan Kara Water Right Permit Application, Custer and Fall River Counties, South Dakota; Prepared for South Dakota Department of Environment and Natural Resources, **67 pg**. http://pbadupws.nrc.gov/docs/ML1219/ML12192A022.pdf

Powertech, 2012 (June), Dewey-Burdock Project Report to Accompany Madison Water Right Permit Application, Custer and Fall River Counties, South Dakota, **81 pg**. [Prepared for: South Dakota Department of Environment and Natural Resources] http://denr.sd.gov/powertech/wr/Madison/Report/Madison%20Water%20Rights%20Report.pdf

Powertech (USA), Inc., 2012 (Sept.), Dewey-Burdock Large Scale Mine Permit Application; prepared for SD DENR, **505 pgs plus Appendices.**

Price, W.A., 2009, Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. Work performed for MEND Program, by CANMET – Mining and Mineral Sciences Laboratories, Natural Resources Canada, Smithers, BC.

Price, W.A. and J.C. Errington, 1998, Guidelines for Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia. British Columbia Ministry of Energy and Mines.

Rahn, Perry, H., 2013 (Feb.), Permeability of the Inyan Kara Group in the Black Hills area and its Relevance to a Proposed In-situ Uranium Mine; *PRELIMINARY DRAFT* prepared for Joe Allen; 10 pg plus figures.

Ramirez, P. & B. Rogers. 2000. Selenium in a Wyoming grassland conmmunity receiving wastewater from an in situ uranium mine. U.S. Fish and Wildlife Service Contaminant Report # R6/715C/00. Cheyenne, WY. Sept. 31.

Ramirez, P. Jr. and B.P. Rogers. 2002. Selenium in a Wyoming grassland community receiving wastewater from an *in situ* uranium mine. Arch. Environ. Contain. Toxicol. 42:431-436.

Ramsey J.L., R. Blaine, J. W. Garner, J. C. Helton, J. D. Johnson, L. N. Smith and M. Wallace, 2000, Radionuclide and colloid transport in the Culebra Dolomite and associated complementary cumulative distribution functions in the 1996 performance assessment for the Waste Isolation Pilot Plant. Reliability Engineering & System Safety, Vol. 69, Issues 1-3, September 2000, Pages 397-420.

Ryan, J. Donald, 1964, Geology of the Edgemont Quadrangle, Fall River County, South Dakota. U.S. Geol. Survey Bull., 1063-J, 47 p.

Safer Chemicals, 2013, What is TSCA? http://www.saferchemicals.org/resources/tsca.html

Sarewitz, D., R. Pielke, Jr., and R. Byerly, Jr., eds., 2000, Prediction: Science, Decision Making and the Future of Nature; Island Press, Washington, D.C., 405 pg.

Sass, Ron, 2011, Uranium Mining in Texas: Why is it Done That Way? James A. Baker III Institute for Public Policy, Rice Univ., 33 pg.
http://bakerinstitute.org/publications/GCC-pub-SassUraniumMining-032811.pdf

Schnabel, R. W., 1963, Geology of the Burdock Quadrangle, Fall River and Custer Counties, South Dakota, U. S. Geological Survey, Bulletin 1063-F.

Smith, R.B., 2005, Report on the Dewey-Burdock Uranium Project, Custer and Fall River Counties, South Dakota, prepared for Denver Uranium co., LLC, 41 pg.

Smythe, C. C. & A. D. Swank, 1977, The mine plan for Edgemont project, Fall River and Custer Counties , South Dakota and Weston County, WY; *In* TVA files.

South Dakota Department of Game, Fish and Parks (GFP), 2012, Dewey Burdock Comments to the Department of Environmental and Natural Resources"; Received October 23, 2012.

SRK Consulting, 2012 (April), Preliminary Economic Assessment, Dewey-Burdock Project NI 43-101 Technical Report; prepared for Powertech Uranium Corp., 129 pg.
www.power**tech**uranium.com/i/pdf/**Dewey_Burdock**_PEA_2012.pdf

Staub, W.P., N.E. Hinkle, R.E. Williams, F. Anastasi, J. Osiensky, and D. Rogness, 1986, An Analysis of Excursions at Selected In Situ Uranium Mines in Wyoming and Texas; NUREG / CR-3967, ORNL / TM-9956, Oak Ridge Nat'l. Lab, TN.

Swenson, F. A., 1968, New Theory of Recharge to the Artesian Basin of the Dakotas: Geological Society of America Bulletin, v. 79, p. 163- 182.

Tennessee Valley Authority, January 1976, Environmental Information Report - Edgemont, South Dakota, Uranium Mill.

Tennessee Valley Authority, 1976 & 1977 (August), Semiannual Effluent Release Reports Nos. 2 and 4 for the Edgemont, South Dakota, Uranium Mill.

Tennessee Valley Authority, 1977(May 31), Letter report , W. L. O'Toole to G. F. Harmon; TVA Files.

Tennessee Valley Authority (TVA), 1979, Draft Environmental Statement, Edgemont Uranium Mine, 208 pg.

Texas Instruments, Inc. Aerial Radiometric and Magnetic Reconnaissance Survey of Portions of Arizona, Idaho, Montana, New Mexico, South Dakota and Washington,- Hot Springs Quadrangle, South Dakota, Vol. 2-K, U.S. Department of Energy, Grand Junction, Colorado [GJBX-126(79)].

Texas, Instruments, Inc., 1979, Geologic Map of the Hot Springs Quadrangle.

Todd, David Keith, 1980, Groundwater Hydrology; John Wiley & Sons, N.Y., 535 PG.

Union Carbide Corporation, 1979 (December 31), Hydrogeochemical and Stream Sediment Reconnaissance Basic Data for Hot Springs NTMS Quadrangle, South Dakota; Uranium Resource Evaluation Project, Union Carbide Corporation, Nuclear Division, Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tennessee, K/UR-132. UnitedStates Department of Energy, Grand Junction, Colorado [GJBX-27 (80)].

U.S. Energy Information Administration (U.S. DOE), 2005, U.S. Uranium Production Facilities: Operating History and Remediation Cost Under Uranium Mill Tailings Remedial Action Project as of 2000 http://www.eia.doe.gov/cneaf/nuclear/page/umtra/title1map.html http://www.eia.doe.gov/cneaf/nuclear/page/umtra/background.html

U.S. Energy Information Administration (U.S. DOE), 2005, Edgemont Mill Site, Fall River County, South Dakota http://www.eia.doe.gov/cneaf/nuclear/page/umtra/edgemont_title1.html

U.S. EPA, 1976, Toxic substances Control Act. Summary at: http://www2.epa.gov/laws-regulations/summary-toxic-substances-control-act

U.S. EPA, 2007, TENORM Uranium Occupational and Public Risks Associated with In-Situ Leaching; Append. III, PG 1-11.

U.S. EPA, 2007, Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining. EPA 402-R-05-007.

US EPA, 2008, Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining, Volume 1: Mining and Reclamation Background: Previously published on-line and printed as Vol. 1 of EPA 402-R-05-007, January 2006, Updated June 2007 and printed April 2008 as EPA 402-R-08-005, Pg. 3-10. http://www.epa.gov/rpdweb00/docs/tenorm/402-r-08-005-voli/402-r-08-005-v1.pdf

U.S. EPA, 2006 / 2007 Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining Volume 1: Mining and Reclamation Background (PDF) (182 pp, 2.3MB, **also available in chapters below**), [EPA 402-R-08-005] April 2008, originally printed and published on-line a [EPA 402-R-05-007] January 2006, Revised June 2007.

U.S. EPA, 2006 / 2008, Technologically Enhanced Naturally Occurring Radioactive Materials From Uranium Mining Volume 2: Investigation of Potential Health, Geographic, and Environmental Issues of Abandoned Uranium Mines (PDF) (131 pp, 3MB, **also available in chapters below**) [EPA 402-R-08-005] April 2008 (Originally released on-line August 2006 as EPA 402-R-05-007.) http://www.epa.gov/radiation/tenorm/pubs.html

U.S. EPA, 2011 (June), CONSIDERATIONS RELATED TO POST-CLOSURE MONITORING OF URANIUM IN-SITU LEACH/IN-SITU RECOVERY (ISL/ISR) SITES, *Draft Technical Report;* [Includes Attachment A: Development of the Groundwater Baseline for Dewey-Burdock ISL Site in South Dakota; **127 pgs.** http://www.epa.gov/radiation/tenorm/pubs.html#technical-report

U.S. Fish & Wildlife Service, 2007, Comments (FWS/R6 FR-ES) on Generic Environmental Impact Statement for Uranium Milling Facilities (GETS); prepared for U.S. NRC, Wash., D.C.

U.S. Government Accountability Office (GAO), 2013 (June), Observations on the Toxic Substances Control Act and EPA Implementation; **http://www.gao.gov/products/gao-13-696t**

U.S.G.S., 1950, Topographic map, Burdock quadrangle.

U.S. Geol. Survey, 1976, Water Resources Data for South Dakota, Water Year 1976; Water Data Report SD76-1.

U.S.G.S., 1977, WATSTORE printout of flow characteristics for Cheyenne River at Edgemont, Cheyenne River near Hot Springs, Hat Creek near Edgemont, and Beaver Creek near Newcastle.

U.S. Government Accountability Office, 2012, Uranium Mining: Opportunities Exist to Improve Oversight of Financial Assurances; GAO-12-544. http://www.gao.gov/products/GAO-12-544 ; http://www.gao.gov/assets/600/591108.txt

U.S. NRC, 1985, Methods of Minimizing Ground-Water Contamination From In Situ Leach Uranium Mining; Final Report. NUREG/CR-3709.

U.S. NRC (Lusher, J.), 2003, Standard Review Plan for In Situ Leach Uranium Extraction License Applications, Final Report: NUREG-1569.

U.S. NRC (R.C. Linton), 2006(?), Evaluation Report, Review of COGEMA Mining, Inc., Irigaray Mine Restoration Report, Production Units 1 Through 9, Source Materials License SUA-1341.

U.S. NRC, 2009 (July 10), Memorandum from Charles L. Miller, Director, Office of Federal and State Materials and Environmental Management Programs to Chairman Jaczko: "Staff Assessment of Groundwater Impacts From Previously Licensed In-Situ Uranium Recovery Facilities" 2pg. http://pbadupws.nrc.gov/docs/ML0917/ML091770187.pdf

U.S. NRC (specific author unknown), 2009?, Data on Groundwater Impacts at the Existing ISR

Facilities; intended to accompany July 10, 2009 Memo from Charles L. Miller 9pg. http://pbadupws.nrc.gov/docs/ML0917/ML091770385.pdf

U.S. NRC, 2012 (Nov.), Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota; Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities; NUREG-1910; Supplement 4, Vol. 1, Draft Report for Comment**,** Chapters 1 to 4; **505 pgs.**

U.S. NRC, 2014 (Jan.), Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota; Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities; NUREG-1910; Supplement 4, Vol. 1, Final report**,** Chapters 1 to 5; **641 pgs.** http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1910/

U.S. NRC, 2012 (Nov.), Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota; Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities, Supplement 4, Vol. 2, Draft Report for Comment, Chapter 5 & Appendices; NUREG-1910, **353 pgs.**

U.S. NRC, 2013 (March), Safety Evaluation Report for the Dewey-Burdock Project, Fall River and Custer Counties, South Dakota: Materials License No. SUA-1600, Docket No. 40-9075, Powertech (USA) Inc., **244 pg.**

U.S. NRC, 2014 (Jan.), Environmental Impact Statement for the Dewey-Burdock Project in Custer and Fall River Counties, South Dakota; Supplement to the Generic Environmental Impact Statement for In-Situ Leach Uranium Milling Facilities; NUREG-1910; Supplement 4, Vol. 2, Final Report, Chapter 6 thru 11 & Appendices; **669 pgs.**
http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1910/

Van der Lee, Jan, 2008 (Sept.), Mining of Valuable Metals: in situ and heap leaching"; Technical Report. R080929JVDL. Paris School of Mines.

Warren, C.G., H.C. Granger, & J. H. Schock, 1980, Shape of Roll-type Uranium Deposits: U.S.G.S. Open-File Rept. 80-100, 34 pgs.
http://download.egi.utah.edu/geothermal/GL00329/GL00329.pdf

Wicks, John L., S. L. Dean, B. R. Kulander, 1999, Regional tectonics and fracture patterns in the Fall River Formation (Lower Cretaceous) around the Black Hills foreland uplift, western South Dakota and northeastern Wyoming**;** Geological Society, London, Special Publications, v. 169, p. 145-165.

Williamson, J.E. and J.M. Carter, 2001, Water-Quality Characteristics in the Black Hills Area, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 01-4194,196 p.

Wilmarth, V. R. and Smith, R. D., 1957, Preliminary Geologic Map of the Minnekahta Quadrangle, Fall River County, South Dakota, U. S. Geological Survey, Mineral Investigations Field Studies Map MF-67-70.

Wolcott, D. E., Bowles, C. G., Brobst, D. A., and Post, E. V., 1962, Geologic and Structure Map of the Minnekahta Northeast Quadrangle, Fall River and Custer Counties, South Dakota, U. S. Geological Survey, Mineral Investigations Field Studies Map MF-242.

Wyoming DEQ, 2008, Settlement Agreement with Power Resources / Cameco Resources, regarding Highland and Smith Ranch Uranium projects.
http://deq.state.wy.us/out/downloads/LQ%20SA%204231-08.pdf

Yates, M.V., J. A. Brierley, C. L. Brierley, & Steven Follin, 1983, Effect of Microorganisms on In Situ Uranium Mining; APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Vol. 46, No. 4, Oct. 1983, p. 779-784.

II. **Contention 2: Baseline Characterizations are Inadequate**

A. Past Uranium Mining and Other Contamination.

1. *Expert Opinion*: Analyis of impacts from past mining and other contamination are critical to assessing the baseline water quality and potenential impacts of future mining activity at the proposed site.

2. *Basis for Opinion*: The Dewey-Burdock region has been impacted by past mining and related activities, which were permitted by the AEC / NRC, and which have resulted in negative impacts to the local water resources and environment. Activities at the Black Hills Ordinance Depot (operational from 1942 through1967) have also impacted waters in this region. While limited remediation of surface facilities at portions of these two areas has occurred, no remediation of the historic water contamination has occurred at either site.

B. Inadequate Baseline Concept and Baseline Data.

1. *Expert Opinion*: The Application and Final Supplemental Environmental Impact Statement (FSEIS) are inadequate to establish a hydrogeological baseline for the aquifers that would be impacted by the D-B Project.

2. *Basis for Opinion*: Both documents fail to analyze past uranium exploration and mining activities that have degraded the quality of much of the Dewey-Burdock area ground and surface waters. Neither the Application nor FSEIS presents baseline water quality data obtained prior to past mining activities and the contamination from the Black Hills Ordinance Depot. The Application and FSEIS do not address data from samples collected in the early periods of these mining activities.

Instead, the Powertech and NRC Staff assume that the degraded water quality represents "baseline", against which all proposed activities are to be judged. This approach is not scientifically justified as it improperly presents a degraded picture of the original Dewey-Burdock area water quality as a baseline.

C. Fundamental Hydrogeologic Information is Lacking.

1. *Expert Opinion*: The FSEIS and Application lack necessary scientifically-defensible hydrological and hydrogeological information.

2. *Basis for Opinion*: In addition to using a concept of baseline water quality that starts with a degraded aquifer, neither the FSEIS nor Application provides detailed water-related data and information.

Detailed information necessary to develop reliable and scientifically-defensible baseline analysis is not included in the FSEIS or Application. Additional information needed to demonstrate an adequate baseline methodology includes the following categories of information:

-detailed hydrogeologic testing, including long-term aquifer testing, coupled with simultaneous water-quality sampling;
-*detailed* chemical compositions and volumes of all solid and liquid wastes and operating fluids, such as pregnant lixiviant solutions;
-identification of chemical constituents that will be used for aquifer restoration and clean-up standards /criteria for each constituent);
-List of chemical constituents that are likely to require an ACL based on similar projects;
- actual waste disposal methods to be employed;
-detailed analyses and data relating to the specific Underground Injection Control (UIC) Well studies required by the US EPA. EPA approval of the UIC well permits; and,
-Additional structural geologic information, including faults, breccia pipe info., human-induced connectivity.

The Final SEIS states repeatedly that the NRC will require Powertech to collect such detailed data / information **after** NRC license approval, because the Application lacked such data.

The delayed production of this critical baseline information until after licensing is not scientifically defensible as it prevents establishment of a baseline on which to identify, disclose, and analyze the environmental impacts, alternatives, and mitigation measures involved with the Dewey-Burdock project proposal. A scientifically defensible monitoring and mitigation of an operating project is not possible based on the baseline data and analyses I have reviewed.

D. Data Provided Entirely by the Applicant is not an Accepted or Reliable Basis for Analysis.

1. *Expert Opinion*: Analytical results that rely entirely on data provided by the project proponent are not considered reliable by professional hydrogeologists and other water experts.

2. *Basis of Opinion*: Almost none of the relevant Application data, relied upon in the FSEIS, were collected by financially-independent parties. Preparation of most of the documents was directed and paid for by the applicant. The "independent" federal agency with the most, long-term hydrogeologic experience in this region, the Rapid City USGS staff, have not been included as cooperating agencies in the preparation of the FSEIS. Some relevant data collected by USGS was not included in the FSEIS analysis, as it was considered by NRC Staff to be preliminary. In order for the FSEIS to be scientifically acceptable, the available data should have be provided, interpreted, and included in the analysis, and any questions regarding its finality should be noted. Excluding available USGS data results in an unreliable analysis in the FSEIS.

Some of the recent documents provided to NRC Staff by the applicant are largely authored by the applicant, not their consultants. In my experience, this is a signal of significant conflict of interest and the possibility that the consultants were unwilling and unable to give the applicant the desired answer. Many of the significant conclusions in these filings disregard unfavorable details and lack the analytical methods and rigor used by professional hydrogeologists, geochemists, and other water experts. The employment of self-serving analytical methodology does not stand up to accepted scientific methods.

III. Contention 3: The Targeted Production Zones are Unable to Contain Fluids

A. The Targeted Zones are not Hydraulically Isolated

1. *Expert Opinion*: Dewey-Burdock uranium ore zones are not hydraulically-isolated from other geologic units, other aquifers, or zones outside the project area.

2. *Basis for Opinion*: The NRC Staff has disregarded the conclusions of numerous hydrogeologic experts (both Powertech-funded and independent experts) in stating the following (Final SEIS, Exec. Summary, p. xxxvi): "Alluvial aquifers are separated from production zone and surrounding aquifers by thick aquitards (confining units) and, therefore, are not hydraulically connected to production zone and surrounding aquifers."

This incorrect and overly-simplistic statement clearly contradicts expert opinions which state or infer that, long-term, all of the relevant D-B water-bearing zones are hydrogeologically-interconnected (i.e. Keene 1973; Gott, et. al., 1974; TVA, 1979; Butz,

et. al., 1980; Smith, 2005; Boggs & Jenkins, 1980, Boggs, 1983, Bredehoeft et. al., 1983; Knight Piesold, 2008).

Upon conducting extensive pumping tests and monitoring, Boggs (1980) concluded: "The aquifer test results indicate that the Fuson member of the Lakota formation is a **leaky** aquitard separating the Fall River and Lakota aquifers. The hydraulic communication between the two aquifers observed during the tests is believed to be the result of (1) **general leakage through the primary pore space and naturally occurring joints and fractures of the Fuson shall,** and (2) direct connection of aquifers via numerous old unplugged exploratory boreholes." (Emphasis added). *Ibid*, p.31.

After reviewing the relevant data, reports and various combinations of satellite imagery, I also conclude that these relevant Dewey-Burdock water-bearing zones are hydrogeologically-interconnected, especially when subjected to long-term pumping as proposed by the Applicant.

Powertech's management and ground water experts have made inconsistent statements about whether the Dewey-Burdock confining units are leaky or not, varying between individual reports, deposition opinions and public hearing testimony. For example, in the Application and Final SEIS, Powertech and NRC Staff assert that all of the relevant pumping tests indicated that the Dewey-Burdock sandstones behaved as leaky-confined aquifers (SEIS, p. 3-34). The consultants who conducted these pumping tests reported the same conclusions. Nevertheless, the SEIS, p. 3-36, states:

"Based on results of the numerical model, the applicant concluded that vertical leakage through the Fuson Shale is caused by *improperly installed wells or improperly abandoned boreholes."*

It is not unusual for the inter-fingering sands, shales, etc. of sedimentary uranium deposits to be hydrogeologically-interconnected, when pumped, long-term. In fact, it is the norm.

Keene (1973) stated that the existence of improperly plugged uranium test holes has contributed to the drop in yields from flowing wells in the Fall River formation. "This practice is not only wasteful of water, "but will ultimately lead to loss of pressure in the aquifer and possible contamination of the Fall River and Lakota aquifers." Keene, p. 24. Neither the Applicant nor the Final SEIS addressed how the Applicant's proposed ISL mining operation will be affected the 1000s of pre-existing boreholes, many of which have never been plugged correctly.

B. Potential Groundwater-Flow Pathways

1. *Expert Opinion*: Potential groundwater-flow pathways in and near the project area are critical to analyzing the proposal and impacts from operations.

2. *Basis for Opinion*: Dewey-Burdock sediments are hydrogeologically interconnected by several potential pathways, which include:

-inter-fingering sediments;
-fractures and faults;
-breccia pipes and / or collapse structures;
-4000 to 6000 exploration boreholes (Bush, 2010, Update Technical Report, prepared for Powertech, states approximately 6000 drill holes are present at D-B);
-oil test wells.

Drilling of hundreds and thousands of wells since the 1880s has caused a drop in artesian pressure of the various sedimentary aquifers in the southern Black Hills areas (Darton, 1909; Davis, Dyer &Powell, 1961, Keene, 1973). Therefore, many wells and boreholes that formerly flowed to the land surface no longer do so, but still contain water under pressure. Thus, contrary to the FSEIS and Application materials, upward flowing waters in these wells and boreholes can interconnect and mix between the various vertical water-bearing zones without showing any expression at the land surface.

"Interview reports indicate that the yields from the Fall River sands have dropped within recent years. Part of this problem is probably due to incrustation…..However, some of this loss of head may result from the recent uranium exploration program. The author personally saw uranium test holes that were uncased, unplugged, and flowing at the surface. This practice is not only wasteful of water, but will ultimately lead to loss of pressure in the aquifer and possible contamination of the Fall River and Lakota aquifers." Keene (1973) p.24: Re. Fall River Fm:

These inconsistencies make clear that Powertech and NRC Staff have failed to define the detailed, long-term hydrogeologic characteristics and behavior of the relevant Dewey-Burdock aquifers and adjacent sediments. In my opinion, the lack of support for NRC Staff's conclusion renders its conclusion scientifically invalid.

C. <u>Significant Geological Structures Allow Migration</u>

1. *Expert Opinion*: The FSEIS and Application rely on the erroneous claim that no significant geologic structures are present at the D-B Project site that could allow migration of water vertically or horizontally.

2. *Basis for Opinion*: The no-migration premise of the FSEIS and Application is contradicted by numerous published reports, such as: Braddock,1963; Butz, et. al.,1980; Gott, et. al., 1974; Smith, 2005; TVA, 1979. Keene also concluded that the recharge of the Inyan Kara by the Minnelusa formation occurred in part through "fault zones. Keene, 1973, p. 1.

As Keene (1973) noted: "The determination of a recharge rate is extremely important in a study of ground-water conditions of a watershed…" *Ibid*, p.35. While the "usual" methods for obtaining such information "are costly, time consuming and involved

extensive pumping tests, infiltration tests and a relatively large amount of instrumentation…only by the determination of a recharge rate for a particular aquifer can realistic withdrawal rates be applied to preclude 'mining' of our groundwater resources…Determination of a recharge rate for the Fall River Formations would be extremely difficult….because of the contribution of water from the Minnelusa Formation along the faults in the area." *Ibid*, p. 35-36.

The existence of a "trench" in the potentiometric surface of the Fall River aquifer "where the Cheyenne River flows through Inyan Kara rocks…suggests that the Inyan Kara strata are contributing some water to the river…Residents living along the Cheyenne River report that the river will flow at Rocky Ford (T9S R4E) when the river at Edgemont and Hat Creek are dry." Keene (1973), p. 36. Rocky Ford (T9S R4E) is down stream from the D-B site. If the ground water in the Inyan Kara becomes contaminated Applicant's proposed ISL mining operation, such contamination could affect the water quality of the Cheyenne River at or around Rocky Ford. Rocky Ford is in the vicinity of the Black Hills Wild Horse Sanctuary. Thus, the surface waters that run through the Sanctuary's property could be directly impacted by the contamination of the Inyan Kara aquifer.

In addition, review of several forms of D-B-area satellite imagery by myself and senior remote-sensing experts at Front Range Natural Resources, Ft. Collins, CO, shows clearly that this area is intersected by numerous faults and fractures. The imagery also shows evidence of circular geologic features at the land surface, indicating the presence of collapse structures.

D. Breccia and Collapse Features are Present

1. *Expert Opinion:* Breccia pipes/solution or collapse features are present in the project area that are critical to analyzing the hydrological baseline and project impacts.

2. *Basis for Opinion*: Numerous authors state that breccia pipes / collapse structures allow upward flow of ground waters from the Paleozoic formations to the Inyan Kara rocks at the southern margins of the Black Hills [Bowles, 1968; Braddock, 1963; Keene, 1973; Gott, et. al., 1974; TVA, 1979; Butz, et. al., 1980. Carter, et. al., 2003; state such recharge to the Inyan Kara may occur via such pathways.] For example:

Keene cited Bowles 1968 "excellent study of groundwater movement within the Inyan Kara Group for southwestern South Dakota. In this study, Bowles suggests that water in the Lakota and Fall River Formations originates in the Minnelusa formation …then moves upward along the breccia pipes…Some pipes have been reported to have stoped upwards as much as 1300 feet into rocks of the Inyan Kara Group (Bowles, 1968). This allows recharge of the Lakota and Fall River Formations from artesian water rising from the Minnelusa Formation. Keene, p. 1, 31.

However, several Powertech reports and the Final SEIS argue that there is no evidence that breccia pipes or related collapse structures exist within the D-B property [i.e. NRC, 2014(Final SEIS); NRC, 2013 (March), Safety Evaluation Report, p.40; Clarification of Breccia Pipes, LSMPA, Append. 3.2-C. [Sept. 2012].

In Appendix 3.2-C of the Large Scale Mine Permit Application [Powertech 2012 (Sept.)] Powertech presents a map, Plate 2, which shows a red line that supposedly represents the area in which evidence of breccia pipes and collapse structures have been reported. This Plate was modified by Powertech from an original oversize plate in Gott, et. al., 1974, [U.S.G.S. Professional Paper 763], Plate 4. However, Powertech has misrepresented the data on the original U.S.G.S. map, neglecting to include several locations within the outcrop areas of the Inyan Kara rocks that were originally described as being "topographic depressions" or "structures of possible solution origin". Clearly the original U.S.G.S. authors mapped these areas within the Inyan Kara rocks—near the D-B project-- as probable locations of solution features, such as breccia pipes.

Similar circular, topographic features can be seen on modern, satellite imagery of the D-B site and surrounding areas. It is my opinion and that of senior remote-sensing experts at Front Range Natural Resources, Ft. Collins, CO, that these features likely represent solution / collapse structures.

Neither Powertech nor the NRC Staff have presented any detailed interpretations of the D-B structural geology using high-quality satellite imagery. Until such studies have been performed, it is reasonable to assume that these circular features are potential pathways for upward migration of ground waters into the Inyan Kara sediments.

E. NRC Staff Deferred Analysis of Difficult Hydrological Controversies

1. *Expert Opinion*: NRC Staff did not meaningfully consider my comments and opinions in preparing the FSEIS and issuing the License.

2. *Basis for Opinion*: Instead of meaningfully addressing my opinions, or the cited literature confirming the complex hydrology of the project area, this FSEIS and license allowed Powertech to delay conducting detailed hydrogeologic testing and determination of detailed aquifer cleanup standards until after the NRC has given project approval. Detailed hydrogeologic and water quality studies identified in my comments must be conducted in order to support scientifically credible identification, disclosure and analysis of the complex hydrogeological impacts and effects of the D-B proposal. By delaying the response to issues I raised until after the FSEIS and License issue, it is not possible for regulators, other hydrogeologists, or the public to reliably evaluate potential impacts and consequences to natural resources and the environment.

Based on my experience, the delayed analysis raises the question as to whether other relevant applicant-generated or contracted water / hydrogeology-related reports exist, besides those listed in the various Applications and the SEIS. I would expect that other reports do exist, as the reports listed in the Application and SEIS do not include the

critical analysis and information I would expect to find in a scientifically-defensible inquiry. In my opinion, NRC Staff has delayed a full and credible hydrogeological analysis until after the licensing decision, without providing a credible reason for its incomplete analysis.

F. The Petrotek (2012) Model is Unreliable and Biased

1. *Expert Opinion:* The Petrotek (2012) hydrogeologic model does not consider presence of faults, fractures, breccia pipes, or open boreholes, etc. identified by available data.

2. *Basis for Opinion*: The predictions from the Petrotek (2012) flow models are all based on the improper **simplifications and assumptions entered into the model.** At D-B, detailed, long-term testing has not been performed, so Petrotek lacked the detailed information necessary to reliably define many of the hydrogeologic processes. For example, many of the historic pump test data on hydraulic conductivity (vertical and horizontal) differ greatly from the data generated by lab testing of core. Thus the hydraulic conductivity inputs into this model are questionable, and any conclusions about leakage from one water-bearing unit to another are quite speculative. Also, the model assumes that no water flows vertically through some of the bounding geologic units (e.g. the underlying Morrison), but inadequate testing has been conducted to prove this. Likewise, several independent authors have argued that vertical flow does occur through the Morrison into the Inyan Kara. Inadequate data exist to reliably demonstrate the rates of recharge from the Graneros Group and surficial alluvium into the Inyan Kara, or the extent of other surface water-ground water relationships.

The simulations presented in Petrotek (2012) report are unable to reflect the complex inter-fingering of these sediments (facies changes, laterally and vertically), and assume that the Inyan Kara sediments are homogeneous sediments.

Site boring data were used to calculate the tops and bottoms of formations---which were often inconsistent—but these borehole data failed to indicate whether the holes were functionally plugged or acted as conduits for vertical leakage. The statements (by the applicant and Petrotek) that some of the anomalous results are likely the result of leaking boreholes is simply a supposition, not based on actual data obtained from these wells and boreholes. Also, this explanation fails to explain the percentage of error that might be the result of cross-facies leakage, rather than communication through unplugged boreholes and wells.

It is not reasonable for Petrotek (2012) to assume that where historic boreholes and wells have been functionally-plugged in the past, that these plugs remain stable forever. Numerous studies show this is simply untrue, and the various seals, surface casings, plugs, etc, begin to deteriorate after several years, leading to cross-communication between the water-bearing zones.

This flow model assumes that all ground water flow is via porous media and that no permeable faults, fractures or collapse structures act as flow pathways within the D-B property. In this model, even the Dewey Fault is considered a no-flow boundary (see below), despite the fact that Boggs (1983) presents conflicting statements about the Dewey Fault zone (p.12-13). Boggs states it is a barrier to flow, but also that upward recharge may occur at relatively low rates. Obviously detailed testing is needed to answer this question. More importantly, numerous independent investigators have reported the presence of faults within the D-B area, contrary to the claims of the applicant. Additionally, significant information from independent remote-sensing indicate that faults do exist, and that surficial evidence of multiple, circular collapse structures are visible at the D-B site. Likewise, structural interpretations and production data from Cretaceous oil fields indicate that oil and gas have been generated from fractures within shales in these formations. These same Cretaceous formations exist within the D-B region, and it seems obvious that the entire package of D-B area, Cretaceous sediments are fractured. **The Petrotek model wrongly assumes that none of these secondary geologic features transmit water, thus the flow rates are questionable, as would be the changes to water quality resulting from long-term dewatering of the various sand and shale formations.**

The Petrotek (2012) model includes one simulation assuming the presence of **one** collapse structure at the D-B site, and assuming it transmits water vertically at 200 gpm. Evidence exists that several other vertical collapse structure pathways may exist, thus upward flows may be much greater than 200 gpm. However, throughout the FSEIS, the NRC Staff state that no evidence exists for such collapse structures. Despite all of the evidence to the contrary, p. 4-61 of the SEIS P.4-61 states: "Because there is **no evidence for fast flow paths, such as fractures, in the ore-bearing aquifers,** NRC staff conclude that the cone of depression will be maintained during ISR operations."

Computer simulations only provide rough approximations of quantitative results---(flow volumes, not chemistry) even in simple, homogeneous, porous media. Often, when predicted results are compared to future, actual data, the results may be in error by hundreds of percent. One of the main goals of such model exercises is to promote a belief that someone can predict future impacts with real quantitative accuracy (Pilkey, 2007; Sarewitz, et. al. 2000)—which is often untrue. Where unreasonable assumptions and faulty evidence are used, the model cannot be relied upon to disclose impacts or to design monitoring and mitigation measures. Hydrogeological modelling based on uncertain data and assumptions is only useful when supported by numerous simulations based on a range of data and reasonable assumptions, including data and assumptions unfavorable to the project proponent. However, the modelling in the FSEIS does not consider my comments.

Several examples of sections within Petrotek (2012) support my opinion of the unreasonable assumptions and unreliable conclusions in the hydrogeologic modeling are provided:

-pg 8: “The Morrison Formation beneath the Chilson is considered an aquitard for the region and is represented as a **no flow boundary in the model**. The Graneros Group is also considered an aquitard in the region but was included in the model to provide a reference point for water level elevations within the Fall River and Chilson aquifers relative to ground surface.”

-8: “The data within the Project Area are based on site borings. Outside of the Project area, geologic picks are largely based on available oil and gas well logs. The geologic dips of the surfaces are projected out to the model limits.”

- 8: “Therefore, the assumption used in the development of the model is that there is no flow across the (Dewey) fault in either the Fall River or Chilson aquifers. The model domain north of the Dewey Fault system is simulated using the NFB condition.”

-11: “During model construction, there was difficulty in maintaining integrity between the various layers of the model. Based on projection of the available data, some of the layers intersected each other in space. This occurred primarily because the data sets were not entirely consistent,….”

-11: As previously noted, the Fuson ranges from 20 to 80 feet thick across the Project Area (Dewey- Burdock TR), therefore, **a simulated thickness of 45 feet** is a reasonable approximation for purposes of the model.

-12: “Because of the uncertainty in the discharge rates from the pumping and artesian wells, the calibration is considered to be more of a representative steady state than a true steady state calibration.”

-14: “The model was **unable to replicate drawdown in the Fall River** on the scale of what was observed during the test despite extensive efforts to do so. It is possible that the drawdown observed in the Fall River during the 495 gpm pumping test in the Chilson was the **result of improperly completed wells or exploration boreholes that provided a hydraulic connection between the two units.”**

-17: “In summary, changes to the conductance and head of the GHBs in the vicinity of Pass Creek do not appreciably alter the flux of the Fall River and Chilson aquifers across the Project Area, but do result in significant increases to the RSS, indicating a **generally poorer calibration**. **Increasing the recharge rate also changes the calibration substantially and causes large increases in the flux of both the Fall River and Chilson.** Decreasing the recharge has negligible effect on either flux or calibration.”

-18: “For purposes of this modeling effort, the Fall River and Chilson are not subdivided and are each simulated as a single layer within the model.”

-22: "Use of a numerical model can assist in this effort. However, real time monitoring of water levels during operations and adjustment of flow rates in response to water level changes provides the best engineering control to minimize wellfield interference."

-26: "The calibrated numerical model developed for the Dewey-Burdock ISR Project was used to assess the potential hydraulic impacts of a hypothetical breccia pipe release. **A breccia pipe release into the Fall River and or Chilson was simulated by placing an injection well into the model layers** representing those hydrostratigraphic units and running a steady state simulation. **A value of 200 gpm was selected for the simulations. Much higher flow rates have been documented at known breccia pipe locations.** Discharge rates much lower than 200 gpm would probably have minimal impact on ISR operations and could be controlled using engineering practices."

-26: "Because of the large change in the potentiometric surface, the occurrence of discharge from a breccia pipe into either the Fall River or Chilson should be observable with the existing monitor well network and **would definitely be noticed once a monitor ring has been installed around a proposed production unit**."

IV. Contention 4 –Failure to Adequately Analyze Ground Water Quantity Impacts

A. Water Consumption

1. *Expert Opinion*: The applicant will use and contaminate tremendous quantities of ground water, thereby preventing / restricting the use of these waters by others.

2. *Basis of Opinion*: Because differing water use volumes are presented in different sections of the FSEIS, and because of the numerous operational uncertainties, reliable estimates of D-B water use volumes are unclear. The FSEIS confirms that there are known volumes of water the applicant has applied for from the State of South Dakota [SEIS, p. 4-54 & 4-55 (360-361)]:

> Powertech has applied for water from the Inyan Kara: 274.2 ac-ft of water **annually** at a rate of 8500 gpm = 12,240,000 gpd (gallons per day) = **4.5 Billion gallons per year = 89.4 Billion gallons over 20 years.**
>
> Powertech has applied for water from the Madison: 888.8 ac-ft water annually at a maximum rate of 551 gpm = 793,440 gpd = 289,605,600 gallons per year **(289.6 Million gallons per year) = 5.8 Billion gallons over 20 years**.

If deep disposal wells prove feasible, up to about 160 gpm will be required from the Madison. At 160 gpm = 84 Million gallons per year for 20 years = 1.7 Billion gallons over 20 years.

Referring to the Inyan Kara waters, the FSEIS states that consumptive use will be relatively small as only 2 percent of the water will be disposed of as liquid waste (assuming UIC option is accepted). However, this estimate clearly neglects the fact that much of the water from either aquifer will have been contaminated, and that the water undergoing land application will be lost via evaporation / evapotranspiration. In either case, this water is no longer available for present or future uses within the exempted aquifer zone. Clearly, the SEIS under-estimates the volumes of water that are lost or contaminated through these processes.

Because disclosure and analysis of detailed hydrogeologic evaluations have been delayed until after NRC permit approval, it is untenable to state that approval of the application "will not result in average annual withdrawals from the Inyan Kara aquifer that exceed the average annual recharge to the aquifer." Likewise, using such limited testing data and modeling results, any estimates of long-term water level drawdown in either the Madison or Inyan Kara are semi-quantitative, at best.

B. Water Balance

1. *Expert Opinion*: The FSEIS relied on an inadequate and unreliable analysis of water use, and failed to provide a water balance.

2. *Basis for Opinion*: In order to evaluate the adequacy of mine water-related data and water management practices, it is standard practice for EISs and similar mine environmental reports to include a detailed water balance. Such a balance includes measured data for all water inputs and outputs related to all mine operations and all sources of water that might influence these operations. Essentially, any detailed ground water textbook describes the workings of such water balances. Freeze & Cherry (1979) and ICMM (2012) and Golder Assoc. (2011) represent two industry-sponsored studies that describe how water balances should be applied at mine operations.

The water balance in the FSEIS did not follow these accepted methodologies. On page 2-36 the FSEIS (see Fig. 2.1-14) contains what the authors claim is a water balance, but it clearly is not. In fact, it is also labeled as "Typical Project-Wide Flow Rates," which more accurately describes what is contained in the FSEIS. The flow rates calculation is not a water balance for the D-B site or D-B operations. It lacks basic components of a water balance, including detailed, measured data for volumes of water entering the system and losses (e.g. volumes of ground water available in the various aquifers,

evaporation from land-application facilities, volumes under-going UIC injection, etc.), and *fails to calculate an actual balance.* In my opinion, a reliable water balance was not prepared and moreover, could not be prepared until the detailed testing described in my testimony has been completed.

Apparently, this misleading water balance figure was added to the FSEIS to deflect comments noting the lack of water balance in the Draft SEIS. However, NRC has not cured the deficiency by including a flow rate figure, which lacks the basic components of a water balance.

Pursuant to 10 C.F. R. §22.304(d) and 28 U.S.C. §1746, I declare under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Signed on the 20th day of June, 2014

Robert E. Moran, Ph.D.

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EDUCATION

University of Texas, Austin: Ph.D., Geological Sciences, 1974
San Francisco State College: B.A., Zoology, 1966

PROFESSIONAL HISTORY

Michael-Moran Associates, LLC, Partner, 2003 to present
Woodward-Clyde Consultants, Senior Consulting Geochemist, 1992 to 1996
Moran and Associates, President, 1983 to 1992; 1996 to 2003
Gibbs and Hill, Inc., Senior Hydrogeologist, 1981 to 1983
Envirologic Systems, Inc., Senior Hydrogeologist / Geochemist, 1980 to 1981
Tetra Tech Intl./ Sultanate of Oman, Senior Hydrogeologist, 1979 to 1980
Science Applications, Inc., Geochemist / Hydrologist, 1978 to 1979
U.S. Geological Survey, Water Resources Div., Hydrologist / Geochemist, 1972 to 1978
Texas Bureau of Economic Geology, Research Scientist Assistant, summers:1970 & 1971

REPRESENTATIVE EXPERIENCE

Dr. Moran has more than 42 years of domestic and international experience in conducting and managing water quality, geochemical and hydrogeologic work for private investors, industrial clients, tribal and citizens groups, non-governmental organizations, law firms, and governmental agencies at all levels. His experience includes the following representative project assignments.

2003 to Present: Michael-Moran Associates, LLC:

- Contraloría General de la República & IKV Pax Christi, Bogota, Colombia. Provide assistance and training to the independent auditing arm of the Colombian government on mining & environmental audits and legislation.
- The Black Hills Wild Horse Sanctuary, and Bangs, McCullen, South Dakota. Expert opinions and testimony before State regulatory agencies regarding Large-Scale Mine and Water Use permits for the proposed Dewey-Burdock in-situ uranium operations.
- Sims Murray Ltd. and the Town of Florence, Arizona. Review of Town nuisance ordinance related to proposed in-situ mining and aquifer impacts. Expert opinions for litigation.
- Wild Salmon Center & World Wildlife Federation (Russia), Moscow, Russia. Elaboration and presentation of mining and water-related issues to members of Russian government, industry and the environmental communities.

- Citizens of Cañon City / Colorado Citizens Against Toxic Waste, Inc. (CCAT); Cañon City, Colorado. Technical assistance to citizen's group on hydrogeologic and geochemical issues related to contamination from disposal of radioactive, etc. materials at the Cotter uranium mill site.
- Environmental Defender Law Center and GRUFIDES (NGO), Cajamarca, Peru. Review of Environmental documents relating to the Conga Mine; site visit; report preparation.
- Roanoke River Basin Association; Virginia. Assistance on technical issues related to proposed uranium mine and processing facilities; presentations to public and regulators; participation in government planning meetings.
- Human Development Center "Tree of Life"; Bishkek, Kyrgyzstan. Review of operations at Kumtor Gold Mine using funds from Bankwatch, Kiev, Ukraine.
- Za Zemiata (Sofia) and the University Autonoma de Barcelona; Krumovgrad, Bulgaria. Review of the EIS for a proposed gold mine; municipal / public meeting presentations; prepare report using E.U. funds.
- Powder River Basin Resource Council; Oshoto, Wyoming.
  Review of Strata Energy NRC License Application to operate an in-situ leach uranium operation; provide technical opinions.
- Pro Patrimonio (the National Trust of Romania); Brussels, Belgium. Presentation to members of European Union Parliament regarding environmental aspects associated with the proposed Rosia Montana Mine, Romania.
- Trustees for Alaska. Prepared expert report on hydrogeologic and water quality impacts from exploration activities at the Pebble Mine site. Opinions prepared for litigation in Alaska Superior Court on behalf of *Nunamta Aulukestai, et. al. v. State of Alaska, et. al.* (Pebble Limited Partners); deposition and trial testimony.
- Bank Information Center and Earthworks, Washington, D.C. Report on hydrogeologic and geochemical impacts at the proposed Weda Bay, Indonesia, cobalt-nickel mine; delivered to Multilateral Investment Guarantee Agency.
- IKV Pax Christi (Netherlands), Bogota, Colombia. Prepare mining-environmental best practices report for presentation to Colombian Ministry of Environmental Affairs.
- Oglala Sioux Tribe, Western Mining Action Project, Gonzalez Law Firm, South Dakota. Review of Powertech License Application, EIS and provide expert opinions: Dewey-Burdock In Situ Uranium Project.
- Comisión de Gestión Integral de Aguas de Bolivia (Commission for the Integrated Management of Bolivian Waters) and Federación Regional Única de los Trabajadores Campesinos del Altiplano Sud (Regional Farmers Federation of the Southern Altiplano), Bolivia. Review of present mining activities and documents related to the San Cristobal Mine. Activities funded by the Municipality of Colcha K (Potosí, Bolivia), the Centro de Estudios de la Universidad de San Simón, Cochabamba, and Global Green Grants Fund.

- Shute, Mihaly & Weinberger / San Diego State University Research Foundation. Review of hydrogeologic / environmental impacts associated with quarry construction near a university wildlife refuge.
- Sarah Vogel Law Firm, North Dakota. Litigation support and evaluation of environmental impacts resulting from a release of oilfield waters onto livestock lands and waters.
- IKV Pax Christi (Netherlands), Tolima, Colombia. Technical review of proposed La Colosa gold project (Anglo Gold Ashanti); interaction with regulators, civil society and company; prepare recommendations & report.
- Thompson Divide Coalition, Western Colorado. Technical assistance to a consortium of environmental groups in designing and conducting a baseline water sampling program in anticipation of gas drilling activities. Preparation of summary report.
- Global Green Grants / Nature's Own, Papua New Guinea.
  Prepare technical / policy papers on marine disposal of mining wastes.
- SAVIA, School of Ecological Thought / Comision Pastoral Paz y Ecologia, Guatemala. Presentations on ecological aspects of resource legislation to Guatemalan government ministries, high-level officials, and educational institutions. Conduct water quality training classes; assist with development of laboratory capabilities.
- Astrella & Rice, Colorado, U.S.A. Technical assistance in preparing litigation arguments for citizen lawsuit involving alleged drinking water contamination by oil and gas activities.
- Office of the Prime Minister, Iraqi Kurdistan. Development of information infrastructure and management training for numerous ministries in Northern Iraq; done in partnership with faculty of American University, Washington, D.C. Headed an audit team for the Regional Statistics Organization.
- Southwest Research and Information Center / Buryat Regional Organization on Baikal / Mongolia Nature Protection Coalition; Buryatia, Siberia, Russia and northern Mongolia. Technical information exchanges with local NGOs, government officials and mining company staffs.
- Rulison Citizens Group / Public Counsel of the Rockies. Colorado. Development of technical arguments and potential litigation support intended to define environmental issues related to gas development near the Rulison underground nuclear test site. Hearing testimony.
- The Nature Conservancy, Trout Unlimited, Alaska Conservation Foundation, Trustees for Alaska and Renewable Resources Coalition, Alaska. Presentations to public interest groups and development of technical issues and papers relating to construction of the Pebble copper-molybdenum-gold mine, proposed for operation above the largest sockeye salmon fishery in the world.
- Wild Salmon Center, Alaska. Technical evaluation of hydrogeological and chemical issues that may impact fisheries near the proposed Pebble Mine.

- Miller, Axline & Sawyer / Meyers, Nave, Riback, Silver & Wilson / City of Grass Valley, California. Technical and litigation support in a suit alleging contamination by Newmont Mining Corporation; deposition testimony.
- Latin American Water Tribunal. San Salvador, El Salvador. Prepare presentations and conduct workshops on water and water quality. Funding: Heinrich Boll Foundation.
- Alburnus Maior, Rosia Montana, Romania. Evaluation of EIA and preparation of summary report on a proposed gold mine in Transylvania. Funded by the Staples Trust, U.K. and the Open Society Foundation, Romania.
- Asociacion de Desarrollo Social Santa Marta (ADES), El Salvador. Evaluate EIA and related documents, El Dorado Mine; technical presentation at national forum; prepare review report. Funded by DIAKONIA, Swedish Ecumenical Action.
- Alburnus Maior, Romania. Review documents and prepare comments related to development of proposed Rosia Montana Mine for a Romanian NGO.
- La Lumiere, Senegal and WACAM, Ghana. Conducted water quality training sessions for NGO and government staffs, as related to mining and other development activities. Funded by Oxfam America.
- ESRI (Environmental Systems Research Institute). Provide technical assistance to several Iraqi Ministries to define information management needs, deploy map-based systems (GIS), and establish a Middle East-based Center of Excellence to support these ministries. Performed in conjunction with NGA.
- Colectivo Madre Selva, Guatemala. Evaluation of Marlin Mine site, review of EIA and preparation of report; attendance at national and indigenous mining forums; conducted water quality training; review of CAO / IFC documents. Funded partly by Misereor, Catholic Bishops' Development Organization, Germany.

1996 to 2003: Moran and Associates, Inc.:

- International Union for Conservation of Nature and Natural Resources (IUCN, Switzerland). Review of the Mining and Metals Supplement of the Global Reporting Initiative (GRI).
- World Bank, Extractive Industry Review. Member of Advisory Group assisting WB in evaluating extractive industry practices; London, Lisbon.
- Nishnawbe Aski and other Ontario First Nation bands---Ontario, Canada. Review of environmental documents relating to Montcalm Mine, a proposed copper-nickel facility. Activities paid for by Falconbridge Limited.
- Kazakh Institute of Physics and Technology / ISTC---Almaty, Kazakhstan. Technical oversight of environmental program, evaluating migration of radionuc-lides at the Semipalatinsk Nuclear Test site.
- Greenpeace Argentina / Mineral Policy Center---Esquel, Argentina. Review of EIA (water, environ. issues) and conditions at proposed mine in Patagonia.

- Oxfam America / Sahel Development Foundation: Syama Mine, Southern Mali. Review of environmental conditions and documents related to an IFC-funded gold mine (2003); conduct technical workshops and policy meetings with Mali government and press (2004).
- Kivalina Relocation Planning Committee---Alaska. Litigation support to Center on Race, Poverty & the Environment regarding water quality issues, Red Dog Mine. Deposition testimony.
- Asociation de Organismos No Gubernamentales—Santa Rosa de Copan, Honduras. Independent review of water / environmental issues at San Andres mine; funded by Dan Church Aid (Danish government and NGOs) and Christian Aid (English NGO).
- Oxfam America / Friends of the Earth Int'l. / Global Green Grants---Quellaveco, Peru. Independent review of mining, water and environmental issues at request of Asociacion Civil "Labor", Lima.
- Oxfam America / Mineral Policy Center / Environmental Mining Council of B. C.: Tambogrande, Peru. Independent review of mining water and environmental issues. Includes numerous public presentations to citizens and governmental groups, including members of the Peruvian Congress.
- New Mexico Environment Department---New Mexico. Review of cost estimates for water treatment systems for closure plans / bonding calculations, Chino and Tyrone Mines.
- International Institute for Environment and Development—London, U.K. Consultant to MMSD project on sustainable development / mining issues.
- Technical Chamber of Greece---Thrace, Greece. Technical assistance to advisory arm of the Greek government and citizens groups regarding gold mining / environmental issues.
- Malerah-Wahlabul Native Title Claimants / Friends of the Earth—Sydney, Australia. Review of water quality issues related to cyanide leach gold operations on aboriginal lands, and testimony at Land and Environment Court.
- Loeb Aron &Co.---London, U.K. Preparation of report evaluating the Baia Mare, Romania waste spill for an investment banking firm.
- Centro de Investigacion y Planificacion del Medio Ambiental (CIPMA) / World Resources Institute / International Development Research Centre---Chile. Evaluation of environmental costs associated with copper mining in Chile.
- Carl Duisberg Gesellschaft / Univ. of Witwatersrand / United Nations---South Africa. Training in cyanide and environmental technology assessment issues.
- Dogrib Nation / Pape and Salter---Yellowknife, Canada. Geochemical consulting and testimony regarding the proposed Diavik diamond mine.
- Soros Foundation Kyrgyzstan---Bishkek, Kyrgyzstan. Water quality instruction to regulators and NGOs regarding mining, sampling, laboratory procedures, and general environmental issues. Review laboratory.

- General Chemical / Sierra Club---Piceance Basin, Colorado. Review of water quality, treatment, legal and policy issues regarding the proposed Yankee Gulch soda ash mine; hearing testimony.
- Sierra Club Legal Defense Fund / Okanogan Highlands Alliance----Crown Jewel Mine, Washington. Litigation support on water quality, geochemistry, treatment issues to groups opposing proposed gold operation; test case on federal mining law; deposition testimony.
- National Wildlife Federation---Carlota Mine, Arizona. Litigation support for challenge of EPA regarding water quality/ treatment issues at copper mine. Review of TMDL issues related to Pinto Creek for NWF and local citizens.
- International Rivers Network---Review of proposed dam project and associated mine water quality issues at the San Roque site, Philippines.
- Mineral Policy Center---Preparation of technical documents on the environmental behavior, analysis and toxicity of cyanides.
- Holnam Industries---Penrose, Colorado. Ground water quality/ geochemistry study for cement operation.
- World Resources Institute---mining water quality/ geochemistry assistance on Venezuelan forestry / mining environmental regulations, and environmental economics of copper mining practices, Chile.
- U.S. EPA / American Geological Services---French Gulch, Colo. Geochemical / treatment /remediation support at an abandoned mine site; negotiated Superfund issues.
- Stoel Rives / Richmond Hill Mine, So. Dakota. Review water quality treatment and geochemistry issues at a closed gold mine site with discharge violations.
- Nacho Nyak Dun First Nation / Pape and Salter—Yukon, Canada. Evaluation of proposed heap-leach gold mining facilities and practices for native group and barristers.

1992—1996: Woodward-Clyde Consultants, Inc.

-Molycorp / Unocal—Questa, New Mexico. Review of water quality, geochemical, & aquatic biology issues at a molybdenum mine / mill site.

-Minera Escondida Ltda.---Chile. Review of geochemical data for copper mine.

-Homestake Mining---Lead, South Dakota, U.S.A. Review of water quality and geochemical problems and waste rock storage and tailings stability issues.

-U.S. Bureau of Land Management / Summo Minerals—Lisbon Valley, Utah. Review of water quality and geochemistry, and assistance in preparation of an EIS at a proposed copper mining and recovery site.

-Southern Peru Copper Corp.--Toquepala, Peru. Design and oversight of water quality, geochemistry, and remediation issues at an open-pit copper mine, mill, and waste facilities.

-Cortez Mining/ Placer Dome / U.S. Bureau of Land Management - Pipeline Project, Nevada. Review of water quality and geochemistry and preparation of EIS-related reports at this proposed open pit gold site.

-Kennecott Utah Copper. Interacted with the law firm of Bogle and Gates to assist an active metal mining company in defending against a CERCLA listing. Activities involved interpreting water quality/geochemical and other environmental data within the Hazardous Ranking System (HRS) context.

-ASARCO - Leadville, Colorado. Oversight of water quality and geochemical activities at a historic metal mining and processing site where the client is involved in CERCLA negotiations. Interaction with State and EPA representatives and legal staff.

-Cambior Minerals - Metates Mine, Mexico. Water quality and geochemistry evaluation of a new gold property.

-Fraser Stryker and the Lindsey Chemical Co. - Nebraska. Technical support to legal staff involved in negotiations regarding a Superfund industrial processing site.

-W.R. Grace - Motorwheel Site, Michigan. Technical assistance to Grace legal staff involved in CERCLA negotiations at a hazardous waste site.

-Zortman Mining Co. / U.S. Bureau of Land Management. Technical and management responsibilities for water resources and geochemistry tasks in preparation of revised EIS at a gold-cyanide leach site with existing acid drainage problems.

-Echo Bay Mining, Lamefoot Mine, Republic, Washington. Responsible for geochemistry and water quality aspects of a supplemental EIS at a new gold mine site. Development of monitoring, testing and remedial recommendations to the BLM.

-Angelina Farms, Louisiana. Technical support to legal staff of oil production companies accused of contaminating groundwaters with brines.

-Amax Gold / Haile Mining, South Carolina. Water quality consulting at a gold mining site with existing acid drainage problems.

-Chino Mines, New Mexico. Technical evaluation of water quality and geochemical issues associated with leaching operations at an operating copper facility.

1983 to 1992: Moran and Associates, Inc.:

-Shea and Gardner / Rockwell--Rocky Flats Nuclear Plant, Colorado. Reviewed and evaluated geochemical studies; proposed future activities in preparation of potential environmental-criminal litigation.

-Saunders, Snyder, Ross and Dickson / American Water Development, Inc. - San Luis Valley, Colorado. Coordinated water quality and geochemistry activities in support of water rights litigation. Oversaw water quality sampling, evaluated water quality and remote sensing data, assisted attorneys in technical strategy development and opponents' depositions; supplied deposition testimony.

-Arnold and Porter / Keystone Ski Corporation - Keystone, Colorado. Designed water quality and geochemical sampling program for ski area expansion in a previously mined area. Evaluated data and proposed remediation activities.

-Advanced Sciences, Inc. / EG&G - Rocky Flats Nuclear Plant, Colorado. Evaluated existing water quality and geochemical sampling programs; prepared document on non-facility related sources of chemical constituents and background.

-City of Brighton - Brighton, Colorado. Evaluated existing surface and groundwater quality data and suggested remedial activities to deal with excessive manganese and dissolved organic concentrations. Provided testimony to City Council.

-Chadwick & Associates, Inc. / Newmont Mining - Telluride, Red Mountain, Colorado. Provided diverse water quality and geochemical consulting relating to remediation of acid mine drainage problems.

-Intergraph Corp. - Reston, Virginia. Assisted in technical development and marketing of a new environmental data management / GIS product.

-U.S. Forest Service - Salmon, Idaho. Geochemical / water quality consultant at the Beartrack mine site, a proposed cyanide-leach gold project.

-Earth Satellite Corporation / Navajo Nation / Patton, Boggs, and Blow - Window Rock, Arizona. Conducted a preliminary reconnaissance of water resources on the joint-use area of the Navajo/Hopi reservations using satellite imagery.

-Mission-Viejo / Morrison and Forester - Denver Basin, Colorado. Acted as a geochemical consultant in a groundwater rights dispute.

-Bunker Hill Corporation / Dames and Moore - Kellogg, Idaho. Reviewed field and laboratory water quality procedures at a CERCLA metal-mining and processing facility. Audited proposed laboratory.

-Saunders, Snyder, Ross, and Dickson / Adolph Coors Company - Golden, Colorado. Water quality consultant; reviewed data from Central City/Blackhawk, CERCLA site, and determined potential impact to the Coors water treatment plant. Provided testimony at stream classification hearings, Colorado Water Quality Control Commission.

-Colorado Water Resources and Power Authority - San Luis Valley, Colorado. Conducted water quality/geochemical and Landsat evaluations of deep groundwater to aid in development decisions.

-Armstrong, Teasdale, Kramer, Vaughan, and Schlafly / Anschutz Corp.-- Fredricktown, Missouri. Supervised technical activities of a CERCLA / SARA-related lawsuit; acted as a technical liaison with attorneys and regulators; managed consultants; authored reports; deposition testimony.

-Holland and Hart / White and Jankowski / Weller, Friedrich, Ward and Andrew / Breckenridge Ski Corporation - Breckenridge, Colorado. Technical supervision of water quality-related issues in a private lawsuit against Breckenridge Ski Corporation. Managed sampling and data interpretation; interacted with attorneys on strategy and assisted at depositions; authored reports; expert witness.

-Dames and Moore / Hecla Mining Corporation - Leadville, Colorado. Acted as hydrogeological/geochemistry consultant to Hecla on a natural resources damage suit; interacted with attorneys at Davis, Graham and Stubbs.

-Dames and Moore / Davis, Graham and Stubbs - Eagle Mine, Colorado. Supervised water quality/hydrogeology activities in preparation of a legal defense of Gulf and Western Corporation versus the State of Colorado in a natural resources damage suit; supervised and participated in all sampling; QA activities and report preparation; interacted with attorneys and regulators; assisted at depositions; deposition testimony; testified before Colorado Water Quality Control Commission on appropriateness of proposed metals standards.

-Jacobs Engineering - Albuquerque, New Mexico. Prepared policy documents on water quality/geochemistry procedures associated with the Uranium Mill Tailings Remedial Actions Project (UMTRA).

-University of Wisconsin. Designed a proposed groundwater exploration program for Gambia, West Africa, in conjunction with Earth Satellite Corporation.

-Harza Engineering Company / University of Michigan - Senegal, Guinea, and Gambia, West Africa. Evaluated potential impacts of new dam construction within the Gambia River basin. Reviewed local hydrogeology, mining production and exploration data; interacted with local officials.

-Engineering-Science, Inc. Faisalabad, Pakistan. Assisted in design of a well field for a groundwater supply in the central Punjab where high salinity and TDS were major problems; negotiated with local officials; prepared reports for Asian Development Bank.

1981-1983: Gibbs & Hill, Inc.

-Holme Roberts and Owen - Canon City, Colorado. Reviewed and interpreted existing hydrogeology and water quality data at the Cotter uranium mill and tailings; proposed future activities; interpreted background concepts, prepared position papers for attorneys in negotiations with State of Colorado.

-Earth Satellite Corporation - Sultanate of Oman. Conducted an interpretive study of regional groundwater potential in Oman, with the staff of Earth Satellite Corporation. Activities included interpretation of existing geology and Landsat imagery combined with conventional low altitude flight and ground reconnaissance. Prepared reports for government of Oman.

-Anschutz Mining Corporation - Fredericktown, Missouri. Managed water resource-related activities for environmental baseline studies at a proposed cobalt/ nickel mine. Designed sampling programs, oversaw sampling, data interpretation, and report preparation.

-Kemmerer Coal Company - Frontier, Wyoming. Managed and conducted hydrogeologic and water quality studies at a proposed open-pit coal mine. Supervised well installation, aquifer testing, sampling, report preparation; interacted with state regulators.

-Anaconda Copper Company - Rico, Colorado. Conducted an investigation of hydrology, water chemistry, and aquatic biology at a complex-ore mining district.

-Union Carbide Corporation - Uravan, Colorado. Managed and conducted a water quality monitoring program for a proposed uranium tailings disposal area and effluent evaporation basin. Assisted in design of geochemical testing program to evaluate potential leachate quality.

-Anschutz, Mining Corporation - Laredo, Texas. Managed and conducted an investigation of groundwater hydrology and soils geochemistry and associated hazardous wastes at a metal ore handling and reagent storage facility. Designed sampling protocol; prepared reports; negotiated with state regulators; interacted with attorneys at Baker, Botts.

-Snowmass Coal Company - Carbondale, Colorado. Managed and conducted hydrogeology investigation of an underground coal mine with steeply dipping seams.

-Marline Uranium Corporation / Union Carbide Corporation - Danville, Virginia. Managed water resources portion of a baseline investigation at a proposed hard-rock uranium mine site. Oversaw well installation monitoring programs and dewatering investigations.

-Southern Pacific Petroleum - Means, Kentucky. Conducted baseline hydrogeological/geochemical investigations at a proposed oil shale mine and retort facility.

1980-1981: Envirologic Systems, Inc.

-Central Arizona Association of Governments - Globe/Miami, Arizona. Conducted study to determine hydrogeologic/geochemical impact of long-term copper mining and processing facility. Designed monitoring programs; interacted with federal, state, local and tribal officials; prepared numerous reports.

-United Nuclear - Homestake Partners - Milan, New Mexico. Conducted hydrogeological/geochemical evaluation of an existing monitoring program for a uranium milling and waste-disposal facility.

-Homestake Uranium - Marshall Pass, Colorado. Hydrogeological / geochemical evaluation of a proposed, hardrock, open-pit uranium mine.

1979-1980: Sultanate of Oman / Tetra Tech International - Muscat, Oman. Member of Water Resources Council Staff, Sultanate of Oman, based in Muscat, Oman. The Water Resources Council was an inter-ministerial body intended to coordinate all water-related activities within the Sultanate. Duties involved planning and design of surface and groundwater projects (both exploration and utilization) for the Omani government; development of water resources policy for the government; hydrogeological field work on both exploration and resource characterization projects - aquifer testing, borehole geophysics, water quality sampling, hydrogeologic mapping; review of work performed (or planned) by other consultants to the government, published reports on water resources of Oman.

1978-1979: Science Applications Inc.:

-EG&G - Idaho National Engineering Laboratory, Idaho Falls, Idaho. Managed a hydrologic investigation of transuranic nuclide migration in groundwater. Contributed geochemical expertise to evaluation of waste isolation and transport modeling.

-Kerr-McGee Corporation - Grants, New Mexico. Conducted investigation into geochemistry of selenium associated with uranium mining/ milling.

1972—1978: U.S. Geological Survey Water Resources Division; responsible for the design, management, and implementation of the following hydrogeological / geochemical studies:

-Metal-Mine Drainage - Colorado. Study of impacts of mining activities (metals, uranium, coal) on the quality of streams in all major Colorado mining districts.

-Selenium in Groundwater - Golden, Colorado. Hydrogeological / geochemical investigation of selenium, uranium and associated constituents at the margins of the Rocky Flats nuclear plant.

-Geothermal Resources - Colorado. Reconnaissance investigation of potential geothermal resources throughout Colorado.

-Underground Coal Mine Water Quality - Colorado. Evaluation of existing and potential water quality problems from underground coal mines.

-In Situ Uranium Leaching - Grover, Colorado. Study of geochemical and hydrologic processes associated with in situ uranium mining and reinjection of waste products.

-Alluvial Metal Transport - Telluride, Colorado. Investigation of metal (especially chromium) movement from tailings ponds into alluvium.

-Southwest Colorado Groundwater - Colorado. Study to determine availability and quality of groundwater in southwestern Colorado.

-Oil Shale Waters - Piceance Basin Colorado. Evaluation of disposal of saline groundwater discharged to the surface during oil shale development.

-Grace Coal Site - Axial Basin, Colorado. Hydrogeological / water quality study of proposed open-pit coal site.

1970, 1971, Summers: Texas Bureau of Economic Geology. Evaluation of the aqueous geochemistry and biochemistry of Gulf Coastal sedimentary sulfur and uranium deposits and their relationships with hydrocarbons: interpretation of geologic and geophysical logs, water quality data.

PUBLICATIONS, REPORTS AND PRESENTATIONS

Moran, R.E. 1974. Trace element content of a stream affected by metal-mine drainage, Bonanza, Colorado. University of Texas at Austin. Ph.D. dissertation. 168 pp.

Moran, R.E. and D.A. Wentz, 1974. Effects of metal-mine drainage on water quality in selected areas of Colorado, 1972-1973. Colorado Water Conservation Board. Water Resources Circular No. 25, 250 pp.
http://co.water.usgs.gov/publications/pubsnonusgs.html
http://uppergunnisonwaterdocs.com/documents/Water%20Quality-%20Mining/Water%20Quality-%20Mining-03.pdf

Moran, R.E. and D.A. Wentz, 1974. Thermodynamic constraints on Metal Solubilities in a stream affected by mine drainage, Bonanza, Colorado. pp. 54-64,in *Water Resources Problems Related to Mining*. Hadley, R.F. and D.T. Snow (eds.). American Water Resources Association. Minneapolis, Minnesota. 236 pp.

Moran, R.E. and D.A. Wentz, 1974. Trace element content of a stream affected by metal-mine drainage, Bonanza, Colorado pp. 84-91 IN: International Symposium on Water-Rock Interaction Proc. Cadek, J. and T. Paces (eds.). Prague, Czechoslovakia. September 9-19, 1974. Geological Survey, Prague. 464 pp.

Moran, R.E., 1976. Geochemistry of Selenium in Groundwater near Golden, Jefferson County, Colorado. Abstracts with Programs, Geological Society of America. 1976 Annual Meeting. November 8-11, 1976. 8(6):1018.

Moran, R.E. 1978. Migration of Transuranic Nuclides in the Snake River Plain Aquifer, Idaho National Engineering Laboratory, Southeastern Idaho. Submitted to EG&G Idaho.

Moran, R.E. 1979. Available and Potential Water Resources of Oman. Submitted to Water Resources Council, Sultanate of Oman.

Moran, R.E. and J.V. Rouse, 1981. Procedures for Collection of Water Quality Samples and Data. Envirologic Systems, Inc. Denver, Colorado. 61 pp. Prepared for the Central Arizona Assoc. of Gov'ts.

Moran, R.E. 1984. Impacts of Proposed Mining and Hydrogeological Activities on Development within the Gambia River basin, Senegal, Guinea and Gambia. Submitted to Harza Engineering.

Moran, R.E. 1984. Preliminary Design Report, Groundwater Supply, Faislabad, Pakistan. Submitted to Engineering Science, Inc.

Harlan, R.L. and R.E. Moran, 1986. Closure of Metal Mining Sites: Hydrologic, Environmental and Legal Issues. Abstracts from Society of Mining Engineers Meeting, September 7-10, 1986, St. Louis, Missouri.

HRS Water Consultants and R.E. Moran, 1987. San Luis Valley Confined Aquifer Study. Three reports prepared for the Colorado Water Resources and Power Development Authority. http://digital.library.colostate.edu/cdm4/document.php?CISOROOT=/cowaters&CISOPTR=4681&CISOSHOW=4379; http://digital.library.colostate.edu/cdm4/document.php?CISOROOT=/cowaters&CISOPTR=5539&CISOSHOW=4888

Straskraba, V. and R.E. Moran, 1990. Environmental Occurrence and Impacts of Arsenic at Gold Mining Sites in the Western United States: Proceedings, International Symposium on Acid Mine Water in Pyritic Environments, Lisbon, Portugal. September 16-19, 1990; *in* Mine Water and the Environment, Volume 9, Numbers 1-4 / March, 1990, Springer Berlin / Heidelberg; available at: http://www.imwa.info/bibliographie/09_14_181-191.pdf ; http://www.springerlink.com/content/m1721074878301j4/ [abstract].

Moran, R.E., 1990. Environmental Constituents in the Rocky Flats Area - Non-Facility Related Sources Pertinent to Water Quality. Prepared for Advanced Sciences Inc., December 10, 1990.

Patton, C.A., K.M. McGaffey, J.L. Ehrenzeller, R.E. Moran, and W.S. Eaton. "The Hazard Ranking System: Special Considerations for Mining Sites." Presented at the 8th Annual Regional Environmental Business & Management Conference & Expo, Denver, Colorado. October 1994.

Patton, C.A., K.M. McGaffey, J.L. Ehrenzeller, R.E. Moran, and W.S. Eaton. "Superfund Listing of Mining Sites." Presented at the Conference on Tailings & Mine Waste '95, Colorado State University, Fort Collins, Colorado. January 1995.

Moran, R.E. and S. Mernitz. "Acid Mine Drainage and Political Conflicts in the Third Party EIS: Water Resources at Risk." Amer. Instit. of Hydrology, editors Hotchkiss, W.R. et. al., p. RA-36, Minneapolis, Minnesota. 1995.

Davidson, R.R., Peter A. Stauffer, and R.E. Moran, Tailings Impoundment Design -- Striving for Balance, January 1996, *in* Tailings and Mine Waste '96; Proceedings of the Third International Conference on Tailings and Mine Waste, Colorado State University, Fort Collins, Colorado, p. 83-90, A.A. Balkema, Rotterdam.

http://books.google.com/books?id=24-RHMZx3ksC&pg=PA83&lpg=PA83&dq=robert+e.+moran,+water&source=web&ots=PXXi0S_7hb&sig=69RrMICu0wUTrbPHIErbb8tMAuk

Moran, Robert E., 1997, Is This Scenario To Your Liking?---Water Quality Predictions In Mining Impact Studies: Abstract, Geological Soc. of Amer. Annual Mtg.,(Symposium on Predictive Modeling in the Earth Sciences: Application and Misapplication to Environmental Problems), Salt Lake City, UT, Oct.20-23, 1997.

Moran, Robert E., Sept. 1998, Misuse of Water Quality Predictions in Mining Impact Studies (DRAFT): presented at the Geological Society of America's Workshop on Predictions in the Earth Sciences: Use and Misuse in Policy Making, Estes Park, Colo.

Moran, Robert E., 1998, Cyanide Uncertainties—Observations on the Chemistry, Toxicity, and Analysis of Cyanide in Mining-Related Waters: Mineral Policy Center Issue Paper No.1, 16 pg., Wash., D.C. [Incertidumbres Sobre el Cianuro]. (available at:
http://www.earthworksaction.org/pubs/cyanideuncertainties.pdf
http://www.portaec.net/library/pollution/observations_on_the_chemistry.html
http://www.isse.ucar.edu/prediction/report1/case_histories.html
http://www.earthworksaction.org/ewa/pubs/cyanideuncertainties.pdf
and at: http://www.mineralresourcesforum.org/technical/cyanide/cyanidem.htm
http://www.conflictosmineros.net/biblioteca/estudios-e-informes/sustancias-toxicas/cianuro/incertidumbres-sobre-el-cianuro/download.).

Moran, Robert, 1999, A Review of Water Quality Aspects of the San Roque Multipurpose Project, Philippines. Prepared for International Rivers Network.
http://www.irn.org/programs/sanroque/moran.tech.html

Moran, Robert E., 2000, Cyanide in Mining: Some Observations on the Chemistry, Toxicity and Analysis of Mining-Related Waters: *in* Proc. Central Asia Ecology—99, Lake Issyk Kul, Kyrgyzstan, June,1999. (El Cianuro en La Minería: Algunas Observaciones Sobre La Química, Toxicidad y Análisis De Las Aguas Asociadas con La Minería) [Available at
http://www.earthworksaction.org/publications.cfm?pubID=60
www.zpok.hu/cyanide/baiamare/docs/ MoranCyanidePaper0799.rtf
www.claim-gv.org/docs/morancyanidepaper.pdf

Moran, Robert E., 2000, Is This Number To Your Liking? Water Quality Predictions in Mining Impact Studies, p. 185-198, *in* Prediction: Science, Decision Making and the Future of Nature. D. Sarewitz, R. Pielke, Jr., and R. Byerly, Jr., eds., Island Press, Washington, D.C., 405 pg.
http://www.unc.edu/~mwdoyle/riverretreat2009/Moran_2000.pdf

Moran, R. E., 2000, Mining Environmental Impacts---Integrating an Economic Perspective (DRAFT): Centro De Investigacion Y Planificacion Del Medio Ambiente, Santiago, Chile: Internet Forum on Export Markets and the Environment [*at*: http://www.cipma.cl/hyperforum/index.htm and http://www.idrc.ca/mpri/documents/cipmaart3.html and http://www.tei.or.th/pdfdoc/potash_021.pdf (draft), http://enrin.grida.no/case_studies/bor/docs/env-eff-cu-chile.pdf]

Moran, R.E., 2000, Lessons from the Baia Mare Spill---Cyanide, Water Quality and Politics, DRAFT: Invited Presentation, Meeting on Exploitation of Gold Deposits in Thrace, October 14-15, 2000, Thrace, Greece.

Moran, R.E., 2000, Cianuro: Algunos Conceptos Basicos: Informativo Mensual; Sociedad Nacional de Mineria, Petroleo y Energia, Vol. 9, no. 10, pg. 58-59.

Moran, R.E., 2001, More Cyanide Uncertainties: Lessons from the Baia Mare, Romania, Spill---Water Quality and Politics. Mineral Policy Center Issue Paper No. 3, Wash. D.C., 15 pgs. (Más Incertidumbres Asociadas con el Cianuro). (available at: http://www.mineralpolicy.org/publications/issuepapers.php3?nav=4 http://www.earthworksaction.org/ewa/pubs/mcu_final.pdf http://tragua.com/wp-content/uploads/2013/10/incertidumbre-del-cianuro-2.pdf and http://www.zpok.hu/cyanide/baiamare/impacts.htm).

Moran, R.E., 2001, Aproximaciones al Costo Económico de Impactos Ambientales en la Minería. Algunos ejemplos en Estados Unidos y Canadá: Ambiente y Desarrollo. Vol. XVII, Nº1, March 2001, CIPMA, Santiago, Chile, pg.59-66. [Abstract at http://www.cipma.cl/RAD/rad2001_03.htm#mineriaII].

Moran, Robert, 2001(April 18), Citizens Say No to a Gold Mine in Greece: MPC Site Report from Olympias, Greece; Mineral Policy Center, Wash., D.C., 7pgs.

Moran, R.E. and McLaughlin Water Engineers, 2001(May), A Review of Cost Estimates for Collection and Treatment Systems for Closure / Closeout Plans---Chino Mine and Tyrone Mine, 2 reports; prepared for New Mexico Environmental Department.

Moran, R. E., 2001, An Alternative Look at Proposed Mining in Tambogrande, Peru: report prepared for Oxfam America, Mineral Policy Center, and the Environmental Mining Council of British Columbia. [Available at: http://www.earthworksaction.org/publications.cfm?pubID=68 http://www.oxfamamerica.org/art753.html]

Moran, R.E., 2001, Una Mirada Alternativa a la Propuesta de Minería en Tambogrande, Perú: Informe encargado por: Oxfam America, Mineral Policy Center, Environmental Mining Council of British Columbia (available at: http://www.oxfamamerica.org/pdfs/tambo_span.pdf http://www.earthworksaction.org/publications.cfm?pubID=69). http://www.tierralimpia.net/docs/tambo-grande-informe.pdf

Moran, Robert, 2001, Mining Environmental Impacts. Integrating an Economic Perspective, pg. 67—77, *in* Towards the Integration of Environmental, Economic and Trade Aspects in the Mining Sector; Editors: Nicola Borregaard and Claudia Gana, published by Centro de Investigación y Planificación del Medio Ambiente (CIPMA), Santiago, Chile, 257p; available at: http://www.idrc.ca/mpri/documents/cipmaart3.html http://www.idrc.ca/uploads/user-S/11174822421CIPMA_Articulo3.pdf http://enrin.grida.no/case_studies/bor/docs/env-eff-cu-chile.pdf Draft version; [with funds from IDRC (International Development Research Centre), Ottawa, Canadá].

Moran, Robert E., 2002, De-coding Cyanide. A Submission to the European Union and the United Nations Environment Programme: Sponsored by Hellenic Mining Watch, Ecotopia, CEE Bankwatch, FOE Europe, FOE Hungary, FOE Czech Republic, Food First Information and Action Network, Minewatch UK, and Mineral Policy Center, 25 pg. (Decodificando el Cianuro). Available at: http://www.hnutiduha.cz/publikace/studie/kyanidova_studie.pdf , **www.mineralpolicy.org/publications/, http://www.eireview.org/eir/eirhome.nsf/(DocLibrary)/15583282B873481185256BFB00609501/$FILE/Decoding%20Cyanide%20(Feiler).pdf http://aa.ecn.cz/img_upload/8b4cb37fba47da1c76cf3e44aa940cd2/decodingcyanide.pdf http://www.scribd.com/doc/62758433/Decoding-Cyanide**

Moran, Robert E., May 2002, What's the Big Secret? Observations and Comments on San Andrés Mine and Mining Regulation in Honduras [also in Spanish as: Cuál es el Gran Secreto?]. Report prepared for the Development Commission of the Department of Copán and the Association of Non-Governmental Organizations, Santa Rosa de Copán, Honduras. [Prepared with funds from Dan Church Aid (Denmark) and Christian Aid (U.K.)].

Moran, Robert E., 2002, The Quellaveco Mine: Free Water for Mining in Peru's Driest Desert? [Quellaveco: ¿agua libre de costo para la minería en el desierto más seco del Perú?] Report prepared for Asociacion Civil "Labor", Lima, with funds from Oxfam America / Friends of the Earth Int'l. / Global Green Grants. [available at: http://www.labor.org.pe/revision%20EIA%20Quellaveco.pdf and http://www.foei.org/publications/pdfs/quellavecostudy.pdf http://www.bvsde.paho.org/bvsacd/cd27/quellaveco.pdf http://www.cdca.it/IMG/pdf/quellavecostudy_1_.pdf]. http://www.cdca.it/spip.php?article325

Moran, Robert E., 2003, Esquel, Argentina: Predictions and Promises of a Flawed EIA. Prepared for Greenpeace Argentina and the Mineral Policy Center. Available in both English and Castellano at: http://www.mineralpolicy.org/publications/pdf/PredictionsPromisesFINAL.pdf; http://www.greenpeace.org/argentina/contaminaci-n/miner-a-de-oro/esquel-argentina-prediccione; and www.noalamina.i8.com

Moran, Robert E., 2003, EIA de Tambogrande --- ¿Estudios Técnicos o Publicidad? [Tambogrande EIA---Technical Studies or an Advertisement?] Originally presented to NGOs and part of the Peruvian Congress, Lima. Prepared for Asociacion Civil Labor, the Mesa Tecnica de Lima, and Oxfam America. Available in both english and spanish at: http://www.tambogrande.org.pe/informebob.htm , http://www.tambogrande.org.pe/Tambo%20EIA%20SHORT%20Paper-versionMT.pdf. and http://www.tambogrande.org.pe/BOLETIN%20EIA.pdf

Moran, Robert E., 2003, Hydrogeologic and Water Quality Predictive Models as Political Rather Than Technical Tools. Geological Soc. of Amer. Annual Mtg., (Session on Mathematical Modeling of Earth Surface Processes: The Good, the Bad, and the Ugly, Nov.2-5, 2003, Seattle, WA). GSA Abstracts with Programs, Vol. 35, No.6, (Sept. 2003). https://gsa.confex.com/gsa/2003AM/finalprogram/abstract_65036.htm

Oxfam America, Foundation for the Development of the Sahel, and Robert Moran, 2004 (February), Tarnished Legacy: A Social and Environmental Analysis of Mali's Syama Gold Mine: Oxfam America, Washington, D.C. Available at: http://www.oxfamamerica.org/files/OA-Syama_Analysis.pdf http://www.oxfamamerica.org:8381/oxfam/files/OA-Syama_Analysis.pdf

Moran, Robert E., 2005 (February), New Country, Same Story: Review of the Glamis Gold Marlin Project EIA, Guatemala [Nuevo País, la Misma Historia: Revisión del EIA del Proyecto Glamis Gold Marlin,Guatemala] : Prepared for Colectivo Madre Selva, Guatemala City, Guatemala. Available at: http://www.madreselva.com.gt/documento_de_robert_moran.pdf http://www.miningwatch.ca/index.php?/Glamis_Gold/Moran_Glamis_en http://www.miningwatch.ca/index.php?/Glamis_Gold/Moran_Glamis_sp http://www.themininghews.org/pubs/Moran_Marlin_rpt_Feb_2005Eng.pdf http://www.guatemalanetz.ch/dokumente/minen/2004-02-moran_marlin_rpt_sp.pdf http://www.saviaguate.org/documentos.html

Moran, Robert E., 2005, CAO Marlin Mine Assessment: Technical Responses. Available at:

http://www.miningwatch.ca/sites/www.miningwatch.ca/files/Marlin_CAO_Respuesta.pdf
http://www.miningwatch.ca/updir/Marlin_CAO_Response.pdf
http://www.madreselva.com.gt/Guat%20Marlin%20CAO%20Response.pdf and
http://www.madreselva.com.gt/Guat%20Marlin%20CAO%20Respuesta%20Rept.%209-28-05%20FINALTradMFCcorJC.pdf
http://www.bicusa.org/bicusa/issues/Guat%20Marlin%20CAO%20Response%20Rept.%209-28-05%20FINAL.pdf
http://www.cao-ombudsman.org/html-english/documents/MadreSelvaResponseCAOAssessmentReportEnglishwithtechnicalReviewAnnexEnglish_000.pdf
http://www.saviaguate.org/documentos.html

Moran, Robert E., 2005, Technical Review of the El Dorado Mine Project Environmental Impact Assessment (EIA), El Salvador / Revisión Técnica del Estudio de Impacto Ambiental (EIA) del Proyecto Minero El Dorado, El Salvador; prepared for Asociacion de Desarrollo Social Santa Marta (ADES), El Salvador. Available at:
http://miningwatch.ca/index.php?/el_salvador_es/Moran_El_Dorado_en
http://miningwatch.ca/updir/Revision_Tecnica_de_El_Dorado_EIA.pdf
http://www.fairtradefish.org/Technical_Review_El_Dorado_EIA.pdf
http://media.twango.com/m1/original/0057/1507771265e04f07a3038f4cdd0990a9.pdf
http://www.votb.org/elsalvador/Reports/Technical_Review_El_Dorado_EIA.pdf

Moran, Robert, 2006, Assessment of the Rosia Montana EIA Report, Romania: Prepared for Alburnus Maior; funded by Staples Trust, U.K. and Open Society Foundation, Romania. Available at:
http://www.rosiamontana.ro/img_upload/472936e3bca2bc61045730fbb1869240/2.raport_Moran_final.pdf
http://www.osf.ro/en/publicatii.php?id_cat=14 [Includes summary in Romanian.]
http://povesteadevarata.ro
http://www.earthworksaction.org/voices/detail/alburnus_maior#.UP3bJ6GLzZc
http://www.miningwatch.ca/publications/assessment-rosia-montana-environmental-impact-assessment-report-focus-water-and-water

Moran, Robert E., 2007 (Feb. 18), Responses to: Evaluation Report: Environmental Impact Assessment Study for the Rosia Montana Project by Independent Group International Experts [IGIE]. Prepared for Alburnus Maior, Romania. Available at:
http://nyc.indymedia.org/en/2007/03/83619.html
http://www.rosiamontana.ro/Aarhus2/RMoran_Assessment_IGIE_180207_eng.pdf

Moran, Robert, 2007 (June 15), Contestation to the EIA Annex of Gabriel Resources, 15 pg.; Submitted to the Romanian Min. for the Environment and Sustainable Development.

http://www.rosiamontana.ro/img_upload/472936e3bca2bc61045730fbb1869240/2.RMoran_analysis_engl.pdf

Moran, Robert E., 2007, Rulison Oil & Gas, Nuclear Testing and Other Environmental Issues. Presented to the Colorado Oil and Gas Conservation Commission; original version prepared 4-19-07 (Revised 7-24-07); 10pg.

Moran, Robert, 2007 (September), Pebble Hydrogeology and Geochemistry Issues; submitted to Renewable Resource Coalition, Anchorage, Alaska. Available at:
http://www.renewableresourcescoalition.org/MoranSep07.pdf
http://www.savebristolbay.org/atf/cf/%7BE729E68D-22F3-4596-9503-54FE676F2264%7D/MoranSep07.pdf

Moran, Robert E., 2008, Pebble Mine (AK): Technical Background; prepared for Renewable Resource Coalition; 2 pg.
http://www.pebblescience.org/pdfs/Pebble_technical_background.pdf

Moran, Robert E., 2008, Pebble Mine (AK): Water-Related Impacts; prepared for Renewable Resource Coalition; 2 pg.
http://www.ak2uk.com/water-related-impacts.html
http://www.pebblescience.org/pdfs/Pebble_water_impacts.pdf

Moran, Robert E., 2008, Mining Submarine Tailings Disposal [STD]—Summary Concepts: Scientific Group of the London Protocol, 2nd Meeting 19 – 23 May 2008:
www.sjofartsverket.se/pages/15453/31-INF14.pdf
http://www.imo.org/includes/blastDataOnly.asp/data_id%3D21436/INF-14.pdf

Moran, Robert, E. Reichelt-Brushett, Roy Young, 2009, Out of Sight, Out of Mine: Ocean Dumping of Mine Wastes. World Watch, March / April 2009, pg. 30-34.
http://www.greengrants.org/pdf/STD.pdf
http://www.thefreelibrary.com/Out+of+sight,+out+of+mine:+ocean+dumping+of+mine+wastes%3B+The+world%27s...-a0194721480
http://www.minesandcommunities.org/article.php?a=9192
[Part available at: http://www.worldwatch.org/node/6011]

Moran, Robert and IKV Pax Christi, 2009 (May 12), Report on the AGA Mining Project in Cajamarca, Colombia; prepared for IKV Pax Christi, Utrecht, Netherlands.
http://www.ikvpaxchristi.nl/media/files/report-on-the-aga-mining-project-in-cajamarca-12052009_0.pdf

Moran, Robert E. 2009, Mining Water: The San Cristobal Mine, Bolivia / Minando El Agua: La Mina San Cristóbal, Bolivia *in* Minando El Agua: La Mina San Cristóbal, Bolivia. Performed for: CGlAB (Comisión de Gestión Integral de Aguas de Bolivia,

Commission for the Integrated Management of Bolivian Waters) and FRUTCAS (Federación Regional Única de los Trabajadores Campesinos del Altiplano Sud--Regional Farmers Federation of the Southern Altiplano). Funded by the Municipality of Colcha K (Potosí, Bolivia), CESU (Centro de Estudios de la Universidad de San Simón, Cochabamba), and Global Green Grants Fund, U.S.A. http://aguabolivia.org/minando-elagua2/?utm_source=feedburner&utm_medium=email

http://www.somossur.net/index.php?option=com_content&view=article&id=242:minando-el-agua-san-cristobal-bolivia&catid=3:libros-libres

http://www.scribd.com/doc/39973512/Mina-San-Cristobal

Moran, Robert E., 2010, Weda Bay Nickel Review Report [Weda Bay, Indonesia]. Prepared for the Bank Information Center and EARTHWORKS, Washington, D.C., 23 p. Available at: http://www.bicusa.org/en/Article.11986.aspx
http://earthworksaction.org/publications.cfm?pubID=462

Moran, Robert E., 2010, Declaration to NRC, Atomic Safety and Licensing Board, regarding the Dewey-Burdock In Situ Uranium Recovery Facility; Docket No. 40-9075-MLA; 32 pg.
pbadupws.nrc.gov/docs/ML1009/ML100960635.pdf

Moran, Robert E., 2011, Thompson Divide Baseline Water Quality Report; prepared for the Thompson Divide Coalition, Aspen, CO. Available by contacting either Thompson Divide Coalition or the Roaring Fork Conservancy.
http://www.roaringfork.org/sitepages/pid372.php

Moran, Robert E., 2011, Declaration to NRC, Atomic Safety and Licensing Board, Regarding Strata Energy, Inc., (Ross In Situ Recovery Uranium Project); Docket No. 40-9091-MLA; On Behalf of the Natural Resources Defense Council & Powder River Basin Resource Council.

Moran, Robert E., 2011, Ada Tepe Gold Deposit EIS, Krumovgrad, Bulgaria: Technical Comments: prepared for Environmental Association Za Zemiata (Sofia), and the EJOLT project - "Environmental Justice Organizations, Liabilities and Trade" using funds from the European Union; 22 pg.
http://zazemiata.org/v1/fileadmin/content/zlatodobiv/final_krumovgrad_REM_EN_all.pdf
http://www.bluelink.net/files/attachments/final_krumovgrad_rem_en_all.pdf.
http://zazemiata.org/v1/Zlatodobiv-v-Krumovgrad.409.0.html (Bulgarian).

Moran, Robert E., 2011, Site-Specific Assessment of the Proposed Uranium Mining and Milling Project at Coles Hill, Pittsylvania County, VA. Prepared for the Roanoke River Basin Association, VA.
http://blog.rrba.org/wp-content/uploads/2011/11/Report_Moran_Uranium_Coles-Hill.pdf
http://keeptheban.org/?page_id=1308

Moran, Robert E., 2011, Kumtor Gold Facilities, Kyrgyzstan: Comments on Water, Environmental and Related Issues: September 2011. Prepared for Human Development Center "Tree of Life" (Bishkek) and Bankwatch (Kiev) and the Kyrgyz government.
http://bankwatch.org/sites/default/files/Kumtor-MoranReport-31Jan2012.pdf
http://bankwatch.org/sites/default/files/REM%20Kumtor%20report%20FINAL_ru.pdf (Russ).
Related video: http://www.youtube.com/watch?v=uvfWwgEEFJ8

Moran, Robert, 2012, Clean Water—The Price of Gold? *Resource Development and Global Competition for Water; in "* Last Call at the Oasis"*,* pg. 47-65, Edited by Karl Weber, Public affairs Press, New York, 250 pg.

Chambers, Dave, Robert Moran, Lance Trasky, 2012, Bristol Bay's Wild Salmon Ecosystems and the Pebble Mine: Key Considerations for a Large-Scale Mine Proposal: produced in partnership with the Wild Salmon Center and Trout Unlimited:
http://www.wildsalmoncenter.org/programs/north_america/pebblemine.php .
http://www.wildsalmoncenter.org/pdf/PM-Report.pdf

Moran, Robert E., 2012 (March), The Conga Mine, Peru: Comments on the Environmental Impact Assessment (EIA) and Related Issues. El Proyecto Minero Conga, Perú: Comentarios al Estudio de Impacto Ambiental (EIA) y Temas Relacionados. Prepared for Environmental Defender Law Center (U.S.A).
http://derechoshumanos.pe/2012/03/informe-sobre-eia-proyecto-conga/
http://es.scribd.com/doc/84536894/Proyecto-Conga-Comentarios-al-EIA-y-Temas-Relacionados-Por-Robert-E-Moran
http://es.scribd.com/yese2103/d/85066269-Peru-Conga-REM-Rept-English-March-8
http://es.scribd.com/yese2103/d/84560844-Comentarios-Al-EIA-Py-Conga
http://es.scribd.com/doc/84774933/Presentacin-EIA-Conga-Robert-Moran-Ph-Dr
http://www.business-humanrights.org/Links/Repository/1011698
http://denjustpeace.org/
http://www.conflictosmineros.net/contenidos/19/9792

Moran, Robert, 2012, Large-scale Gold Mining: National Natural Resources Treated as Private Assets with Public Environmental Impacts. Int'l. Soc. of Ecological Economics; June, 2012; Rio de Janeiro, Brazil (Abstract).

Greenpeace Argentina and Robert Moran, 2013 (Sept.), Preguntas y Respuestas Sobre Minería, Greenpeace Argentina, Buenos Aires, 18p.

http://www.greenpeace.org/argentina/Global/argentina/report/2013/cambio_climatico/Informe-Moran-mineria.pdf

Moran, Robert, E., 2013 (Dec.), Coal Mining in Cesar, Colombia: 1st Phase Water and Environmental Audit by the Contraloría General of Colombia, June 2013 (CGR Audit Technical Report); prepared with funding and assistance from IKV Pax Christi, Utrecht, Netherlands; 30 pgs.
Minería del Carbón en Cesar, Colombia: 1ª Fase de Auditoría de Agua y Ambiental por la Contraloría General de Colombia, Junio 2013 **(**Informe Auditoría Técnico CGR). Translation finalized 28 Jan. 2014; 35 pgs.