Personal Data

Date of Birth: August 29, 1957

Address:

Department of Civil Engineering

Faculty of Engineering, U. of K.

Khartoum, Sudan

Residency: Omdurman, Sudan

Nationality: Sudan, USA

Social Status: Married and a father to three boys (ages 29, 28, and 17 years) and one girl (age 23 years).

Languages: Reading and writing proficiency in Arabic and English.

Conferences,Workshops & Seminars

- Symposium on Mine Water and Environmental Impacts, Johannesburg, Republic of South Africa, 7-13 September 1998.

- PTFI Modeling Training Workshop, Instructed by Elfadil Azrag, HCI, Tembagapura, Irian Jaya, Indonesia August 1998.

- Hydraulics Division of the American Society of Civil Engineers 1993 Conference, San Francisco, USA, 25-30 July 1993.

- Computational Methods in Water Resources IX Conference, Denver, USA, June 1992.

- International Course on Urban Drainage in Developing Countries, Essen, Federal Republic of Germany, November 12-30, 1990.

- Seminar in Natural Coagulants in Water Treatment, Yogyakarta, Indonesia, October 1989 .

- Microbiological for Sanitary Engineers: Application to Wastewater treatment Plants Operation, University of Leeds, Leeds, UK, May 1988.

Research and Development within HCI:

MINEDW and FEMCAD Code development

Scope: HCI has developed a state-of-the-art, three-dimensional, finite element ground-water flow code to simulate mine dewatering in complex hydrogeologic systems. This code, designated *MINEDW*, can be used to:

- Estimate passive inflows (i.e., with no active dewatering facilities such as wells in operation) to pits and underground openings under two-regime (i.e., both laminar and non-laminar) flow conditions,

- Evaluate potential effects of alternative active dewatering systems,

- Simulate the infilling of a "pit lake" after mining and dewatering cease,

- Predict local and regional environmental impacts of dewatering, and

- Estimate the height of seepage faces in pit highwalls to assist in evaluation of slope stability.

Role: Currently I am the custodian of the program within HCI. *MINEDW* was original written by Timothy J. Durbin I verified, tested, and modified the original code to handle more diverse hydrologic feature among the important changes that I included in the code:

- Collapsing grid to handle gradual pit excavation.

- Simulation of high-flow and high-pressure drill holes usually in the underground mine workings.

- Routing of natural streams networks where interaction with ground-water is a function of stage within the stream and head in the aquifer.

- Introduction of "mass lumping" technique versus "the consistent solution"

- Incorporation of 3-D full conductivity tensor.

- Incorporation of solution for large diameter wells and simulation of inundated mine's underground workings.

- Incorporation of dynamically changing hydraulic properties of rock mass.

- Simulation of non-linear (non-Darcian) flow in the modeled faults.

- # Computer Skills

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HARDWARE	OPERATING	Computer	HW DESIGN

	SYSTEMS	LANGUAGES	TOOLS
PC, Macintosh, FTP Servers, Remote Servers, Routers, Hubs, Switches, MCU	UNIX, MSDOS, Windows 2000/NT/XP	FORTRAN, Basic, C++. Knowledge of others e.g. HTML, Pascal, Java, SQL	PBasic (Basic Stamp) for MCU's

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- *One of my responsibilities at Hydrologic Consultants, Inc. (HCI) was to manage the company's computer resources hardware and software. I was in charge of selecting and constructing desktop computers, servers or workstation. I am very comfortable in programming for any purpose using most of the popular computer programming languages (e.g. Fortran, VBasic, C++). Before leaving the University of Khartoum. I actively participated in building the computer resources of the faculty of Engineering and Architecture. I taught short courses in programming and database management.*
- I am the principal author of HCI proprietary codes (e.g. FEMCAD, VMINEDW) and one of the principal authors of the commercial software LDMS (laboratory database management system) by Tribal Software, Inc. of Cheyenne, Wyoming, USA.*I developed application programs in C++ for the Palm Pilot (PDA) to display and search the whole Qoran in Arabic language and one to compute the prayer times in any location in the globe given the longitude and the latitude.*

Employment & Professional Experience

Associate Professor *(Civil Engineering Department, Faculty of Engineering)*

- Teaching courses in Environmental Engineering modeling, Plumbing for water supply and wastewater, Hydraulics, Hydraulic structures, Water Treatment, Computer Applications in Water Resources, Sanitary Sewer Network Design.

- Master of science programs coordinator and Environmental Engineering Laboratories manager.

- Researcher and supervisor for four environmental engineering research projects.

- Developed an analysis tool for numerical modeling training for graduate students in water resources and in environmental engineering.

- As a Private Consultant:

o Undertook the investigation of water resources usage and development projects in the Government of Southern Sudan.

o   Predicted dewatering requirements (via use of numerical modeling) for the Management of Water TableRise around Booster Station 140, Burgan Oil Field, Kuwait.

o   Evaluation of feasibility design City of Omdurman sewerage system network.

o   Evaluation of design and rehabilitation of an industrial wastewater treatment plant.

o   Evaluation of design and rehabilitation of Khartoum's wastewater pumping stations.

o   Evaluation of design and rehabilitation of Algooz Wastewater Treatment plant (Khartoum's First and oldest WWT).

Associate Researcher (Water Resources Division)

- Conducted research projects and consulting in the fields of hydrology, water management, and environmental engineering.

- Development and implementation of multiple numerical models.

- Administering and teaching short courses and on the job training while initiating new research ideas.

- As the principal investigator in the project developed the draft Uniform Potable-Water Plumbing Code for Kuwait (UPPCK)

- As a Project Manager; investigated and managed the project of "leakage problem in the freshwater pipe network of the State of Kuwait" to estimate the magnitude of the problem, causes, and recommendations for enhancement of the network

- Built a numerical model for the backbone of the pipe network of the State of Kuwait

- Developed a numerical model for the management and interactions of the fresh water lenses in northern Kuwait (using the international code FeFlow)

- Developed a graphical user interface FTCGUI for post-processing and analysis of output numerical models including KISR's FTC package for groundwater flow, transport, and compaction

- Application of the FTC package to predict the impact of Al-Atraf well field

- Developed a treatment unit to treat groundwater polluted with hydrogen sulfide

- Developed a treatment unit to remove ammonium polluted groundwater in the Petrochemical Industrial Complex

- Consult on management of demand of the potable water saving project by investigating the patterns of use within residential areas in Kuwait.

Associate Engineer

- Development and verification of codes that include state-of-the-art concepts in ground-water hydrology to facilitate integrated water-resources management.

- Development and validation of Eulerian-Lagrangian finite-element code to predict contaminant transport.

- Development of deforming grid algorithm to simulate excavation of a pit and to facilitate solution time in mine dewatering models.

- Development and validation of code to compute pertinent statistical parameters for finite element models.

- Development of pre-processing and post-processing codes for finite element models.

- Modification of finite element codes to incorporate hydrogeological processes such as evapotranspiration, pit lake infilling, and ephemeral streams.

- Investigation of design alternatives for removal of volatile organic compounds.

- Design of subsurface horizontal drainage system to control ground-water seepage into city's building and parking lots.

- Design of pumping system to control ground-water contamination plume.

- Design of small rubber dam for feasibility study.

- Investigation of hydraulics and sediment transport in natural streams and man-made channels.

- Modification of finite difference solute transport code (MT3D) to accommodate kinetic equilibrium of solute and solids.

- Evaluation of pipe network connecting extraction wells relative to proposed extension and rehabilitation.

- Development and verification of algorithm for particle tracking in finite element and finite difference models.

- Training company's employees in the use of numerical modeling and company's proprietary codes. 30% of time was dedicated for research and development.

- Teaching international courses and workshops in the implementation of numerical modeling in complex environments.

Lecturer

- Taught graduate and undergraduate courses on urban drainage, wastewater collection and treatment, design of water supply and wastewater treatment facilities, water chemistry, and environmental modeling.

- Taught extension courses in computer application to police officers and practicing engineers.

- Supervised four M.S. and co-supervised one Ph.D. research projects.

- Research focused on numerical modeling of drainage systems and modeling of treatment systems.

Independent Consultant

- Water supply, surface drainage, and sanitation components of Greater Khartoum structural plan for year 2000.

- Design of water supply and wastewater treatment facilities and pipe networks.

- Evaluation of water supply and sanitation in rural area. Project involved collection of baseline data, identification of basic needs for water supply and sanitation, and design of plan to improve these systems.

- Evaluation of existing water supply, fire fighting, rain-runoff drainage, and sanitary systems for two textile factories. Project included proposed rehabilitation of systems.

- Evaluation of proposal to improve urban sanitation system

- Preparation of Environmental Impact Assessment of UNICEF's Handpump and Sanitation program in Sudanese province.

Staff Engineer

- Prediction of effects of irrigation pumping in the vicinity of the Arkansas river on the river's base flow which has implications on the Arkansas river compact between the Stats of Kansas and Colorado.

- Built an "irrigated response model" to predict amount of pumping needed for irrigation and other agricultural activities as result of changes in availability of allocated surface water and selling prices of crops.

- Modifying HEC-6 sediment transport model to include super-critical flow.

- Dynamic graphical presentation of output from ground-water models.

- Developed my first finite element two-dimensional groundwater model for flow and solute transport.

- Developed a groundwater optimizing package for water levels and solute management. Applied the optimization package to manage the groundwater levels in the San Bernardino County (South California) to solve the water rise problem in the Amphes theater in Hollywood.

Key Skills

- Research to design Solutions.

- Analytical/Problem Solving Skills.

- Numerical Modeling.

- Environmental Engineering Designs.
- Team Leadership Skills.
- Advanced Programming.

- Teaching/Training.

- Bilingual (English/Arabic).

Registrations

Professional Engineer registered in Colorado (No. 29779), Iowa (14284), Nevada (013302), and Oregon (19498PE).

.(American Society of Civil Engineers (needs renewal

.(American Water Works Association (needs renewal

.(National Ground Water Association (needs renewal

Representative Environmental Projects

Waste Management of Colorado, Inc:

County Line Landfill, Douglas County, Colorado

Scope: HCI constructed a numerical model to evaluate whether leachate from the landfill posed a risk to nearby municipal water-supply wells. The model simulated geologic formations of the Denver Basin into which the municipal wells are completed. Transport of dissolved chemicals was simulated for 100 years into the future. Results of the modeling provided a foundation for decision making for State and county agencies.

HCI also investigated areas immediately north of the landfill to delineate contamination in the shallow ground water using an on-site gas chromatograph. Based on results of the field screening and subsurface characterization from drilling, a ground-water remediation system was selected and installed.

HCI designed and installed a ground-water interceptor trench and a collection system to capture dissolved chemicals within a shallow ground-water plume. The system made use of contrasting geologic units to freely drain ground water above a low-permeability claystone. The system, which collects ground water at a rate of six gpm, was installed for less than $100,000 and has successfully prevented migration of the plume.

Role: At the beginning of the project I was the project manager constructed a MODFLOW model to resolve a dispute between the mine and a rancher. HCI was retained as their consultant for the scope mentioned above, for this scope I developed the finite element numerical model, which is still in use by HCI. I coupled the flow model with the solute transport model for the WAD cyanide plume investigation and participated in the design and ran all needed simulations. I designed and supervised the installation of a flume network in natural streams to investigate the infiltration capacity of the natural courses within the hydrologic basin.

Burlington Northern and Santa Fe Railway:

West Burlington Locomotive Repair Facility, West Burlington, Iowa

Scope: HCI completed a supplemental remedial investigation on a 1200-acre parcel where a locomotive repair facility has operated for approximately 75 years. The objective was to characterize the presence of organic and metal constituents in surface water, ground water, sediments, and soil. Site investigations included the installation of 14 Waterloo in bedrock coreholes in addition to installationÔMulti-Level Sampling Systems of traditional monitoring wells and piezometers. The multi-level system and monitoring wells provided an initial means for obtaining geologic information (e.g., fracture spacing, aperture) and ground-water quality. The water quality data revealed the presence of non-aqueous phase (DNAPL) tetrachloroethylene (PCE) at depths of 185 feet in a fractured limestone/dolomite aquifer. Detailed geologic information revealed that the DNAPL PCE moved downdip but upgradient (from a ground-water flow perspective) from the PCE handling facility; and had descended along a fracture pattern to a low point on top of a shale aquitard.

For this project, HCI developed specific protocols for water-quality sampling that are different than USEPA standard sampling protocols. The changes in protocol were necessary because purging three to five casing volumes of water would have produced mixing of the hydrogeologic zones. HCI also developed protocols for isotope sampling that aided in determining sources of water.

Based on the geologic and water-quality information at the facility, a ground-water flow and solute transport model was developed to simulate flow and transport over a three-square mile area. The model was used to predict the movement of organic compounds for a 30-year period of time. HCI also performed a focused analysis of remedial options and demonstrated that no cost-effective option existed to remediate ground water. The modeling work also showed that no users of the aquifer would be adversely affected by a "no action" alternative.

Results from the field and modeling investigations were submitted to the Iowa Department of Natural Resources (IDNR), and provided a foundation for regulatory decision making. The IDNR accepted HCI's recommendation of continued surface-water and ground-water monitoring at the facility, and agreed that ground-water remediation was neither cost effective nor necessary. Consequently, HCI prepared, and is implementing, a site-wide, five-year water quality monitoring program.

Role: I constructed the numerical model, coupled with solute transport, and ran all required simulation. I designed piping and treatment system to treat all the VOC by gas stripping for feasibility level.

Union Pacific Railroad Dompany:

Sequoia Station, California

Scope: HCI is performing a series of analytical solution in litigation support to assess the extent and the fate of PCE and TCE contaminant at an old railway station which also used to receive PCE from a nearby dry-cleaner house.

Role: selected appropriate analytical technique and computer program to solve the one-dimensional solute transport model.

Union Pacific Railroad:

Sacramento Former Railyard Project, Sacramento, California

Scope: HCI constructed a detailed ground-water flow and solute transport model to evaluate the fate and transport of volatile organic compounds in the area around the Sacramento Railyard. The models have been used to focus remedial investigation activities and to assist in evaluating and selecting cost-effective remedial designs for extracting organic compounds from ground water. As part of the modeling effort, HCI geochemists conducted field and laboratory measurements to estimate the rate of degradation of chlorinated volatile organic compounds.

Role: I constructed the numerical model, coupled with solute transport, and ran all required simulation. I investigated the fate of the plume and test the impact of dewatering activities in city center.

Client Confidential:

Diamond Mines, Republic of South Africa

Scope: HCI is currently evaluating the dewatering practices at two diamond mines that have evolved from surface to underground operations. We re-designed and expanded the field data collection program and developed a ground-water model to evaluate various options (including method and timing) of dewatering the very water-sensitive kimberlites pipes.

Role: I was the project manager and constructed the numerical model, which is still in use by HCI**.**

Barplats Mines Limited/Impala (Barplats):

Crocodile River Mine, Republic of South Africa

Scope: A three-dimensional, finite element ground-water flow model has been developed by Hydrologic Consultants, Inc. of Colorado (HCI) to predict the dewatering requirements for re-opening and expanding of the Crocodile River Mine (CRM) and the potential drawdown in the nearby water table induced by the dewatering. The mine is composed of old submerged workings and proposed open cast and extensive underground workings. The model was based on geologic data provided by Barplats and hydrogeologic data collected by KLM Consulting Services (KLMCS).

Important hydrologic components incorporated into the model include the basic geologic framework including the Commando and Eastern dykes, the old and proposed new mine workings, the Hartbeespoort Reservoir, the Crocodile River, rainfall, and infiltration of irrigation from wells and channel diversion.

Role: I was the project manager I constructed the numerical model and produced needed documentation.

Client Confidential:

Diamond Mine, Canada

Scope: HCI built a large, fully three-dimensional, finite-element, ground-water flow model numerical model to predict the quantity of water discharge from a diamond mine in northern Canada that is situated under a lake. To predict the quantity of discharge of the proposed mine the mining plan and the changes in hydraulic conductivity in surrounding rock mass was incorporated in the numerical model. The model was used to define the potential amount and distribution of ground-water inflow to the various mine workings over time under the currently

proposed mine plan. The hydrologic model was coupled to a solute transport model to predict the changes in the percentage of Lake Water versus connate water. Particle tracking technique was used to predict the fate of mine contaminated water.

Role: I was the project manager, constructed the numerical model, and provided all the simulations and analysis of model output. The model is still in use by HCI and the client.

Publications & Presentations

- *Atkinson, L.C.,* Durbin, T.J., and *Azrag, E.A.,* 1992, Estimating the effects of non-Darcian flow on inflow to a pit and slope stability: Preprint No. 92-156 of paper presented at 1992 Annual Meeting of Society for Mining, Metallurgy, and Exploration, Phoenix, Arizona, 4 p.

- *Azrag, E.A., Ugorets, V.I.,* and *Atkinson, L.C.,* 1998, Use of a finite element code to model complex mine water problems: Preprint of paper to be presented at International Mine Water Association Symposium, Johannesburg, South Africa, September, 11 p.

- *Azrag, E.A.,* and Yousif, H., 1988, Use of natural coagulants in water supply treatment – a comparison study: Proceedings of Natural Coagulants Seminar, Indonesia.

- *Azrag, E.A.,* Durbin, T.J., and Nour El-Din, N.N., 1986, Two-dimensional simulation of solute transport by finite-element method: Microsoftware for Engineers, v. 2, n. 3, p. 171-180.

- *Azrag, E.A.,* Yagoub, I., and Abu Sin, M., 1987, Environmental Impact Assessment of the Application of the Hand-pump project in Western Sudan, A study presented to the United Nations International Children's Emergency Fund (UNICEF), Khartoum, Sudan.

- *Azrag, E.A.,* 1983, Nitrogen removal mechanisms in overland flow wastewater treatment: M.S. thesis, University of California-Davis.

- *Azrag, E.A.,* 1987, Management of Aquifers versus Hydraulics and Solute Transport: Ph.D. Dissertation, University of California-Davis.

- *Hanna, T.M.*, *Azrag, E.A.* and *Atkinson, L.C.,* 1994, Use of an analytical solution for preliminary estimates of ground-water inflow to a pit: Mining Engineering, v. 46, no. 2, p. 149-152.

- *Horner, Jim, Azrag, E.A., et. al.,* 1997, Application of Renewable Energy in Rural Water Supply, NREL, Golden, CO.

- *MacDonald, A., and Azrag, E.A.,*2002, Predicting Ground-Water Inflow to an Underground Mine beneath a Lake in Northern Canada, paper will be presented at 2003 Annual Meeting of Society for Mining, Metallurgy, and Exploration.

- *Akber, Mukhopadhyay, E. Azrag, E. Al-Awadi, A. Al-Haddad,H. Al-*Qallaf (KISR No. 8533) "Distribution and Source of Nitrogen Compounds in the Groundwater of Kuwait (WM002C)" Journal of Applied Geochemistry (under review).

- *A Fadlelmawla, E. Azrag," Simple Yet Significant: Water Auditing as Demand Management Tool" 7th Gulf Water Conference* "Water in the GCC-Towards an Integrated Water Resources Management", 19-23 November, Kuwait 2:871-880.

Technical Reports (KISR years 2003-2007)

- *E. Azrag, D. Pearson, J. Al-Kandari*"Estimation of Leakage from the Freshwater Network in Kuwait (WM024C)", Confidential, Final Report, December 2007.

- *E. Azrag and M. Al-Otaibi,*"Development of Water Code of Practice for Internal Plumbing in Kuwait (WM023C), Confidential, Final Report (KISR No. 8838), July 2007.

- *M. Al-Otaibi, A. Fadlelmawla, E. Azrag, K. Hadi, M. AlSenafy,*"Optimum Utilization Strategy for the Fresh Groundwater Lenses at Raudhatain Field, Phase II (WM017C)", Restricted, Final Report (KISR No. 8672), April 2007.

- *M. Al-Otaibi, A. Fadlelmawla, E. Azrag, K. Hadi, M. AlSenafy,*"Optimum Utilization Strategy for the Fresh Groundwater Lenses at Raudhatain Field, Phase III (WM017C)", Restricted, Final Report (KISR No. 8672R), November 2007.

- *A. Fadlelmawla, E. Azrag, A. Haji, H. Ghoneim, A. Al-Khalid, H. Naseeb* "Initiating Water Auditing at KISR (WM018K)", Restricted, Final Report (KISR No. 7745), June 2005.

- *A. Al-Haddad, A. Mukhopadhyay, E. Azrag, M. AlSenafy, H. Ghoneim, A. Al-Khalid, K. Al-Fahad* "Investigations on the Occurrence of Hydrogen Sulfide in the Groundwater of Kuwait City (WM013C), Confidential, Final Report (KISR No. 7986), January 2006.

- *F. Székely, M. Al-Otaibi, A. Mukhopadhyay, E. Azrag, M. Al-Murad* "Computer Analysis of the Impact made by Wells on Aquifer Systems in Kuwait (WM007C)", Restricted, Final Report (KISR No. 7157), May 2004.

- *M. Al-Senafy, A. Fadlelmawla, K. Al-Fahad, A. Al-Haddad, A. Al-Khalid, E. Azrag, K. Hadi* "Assessment of Potential Groundwater Contamination and Associated Environmental Impacts at PIC Plants in Shuaiba, Kuwait (WM015C)", Confidential, Final Report (KISR No. 7376), November 2004.

- ***A. Mukhopadhyay***, *E. Al-Awadi, E. Azrag, T. Rashid, H. Al-Qallaf, H. Ghoneim* "Assessment of Groundwater Pollution from Oil Fires and Evaluation of Remedial Procedures (WH019C)" – Final Report (KISR No. 7434), December *2004.*

- ***M. Al-Senafy***, *E. Azrag, A. Al-Khalid* "Assessment of Groundwater at the Hunting and Equestrian Club (WM003S), Restricted, Final Report (KISR No. 6962), November 2003.

Technical Reports (Selected From HCI Years 1997-2001):

- Hydrologic Consultants, Inc., 2001, PREDICTED QUANTITY OF WATER DISCHARGE FROM SNAP LAKE MINE, report prepared for AMEC Simons Mining and Metals Vancouver, British Columbia, October.

- Hydrologic Consultants, Inc., 2001, 2001 UPDATE OF NUMERICAL GROUND-WATER FLOW MODELING FOR McCOY/COVE MINE LANDER COUNTY, NEVADA, report prepared for Echo Bay Minerals Company McCoy/Cove Mine Battle Mountain, Nevada, November.

- Hydrologic Consultants, Inc., 2001, Conceptual hydrogeologic model and ground-water flow modeling of Grasberg mine and surrounding area Addendum VI DESCRIPTION OF 2001 UPDATED AND EXTENDED REGional Ground-Water Flow Model, report prepared for P.T. Freeport Indonesia Tembagapura, Indonesia, November.
- Hydrologic Consultants, Inc., 2001,"NUMERICAL MODELLING PREDICTIONS OF POTENTIAL EFFECTIVENESS OF DEWATERING FOR BLOCKS 4 AND 5 FINSCH MINE, reportprepared for KLM Consulting Services (Pty) Ltd. Lanseria**,** Republic of South Africa, April.
- Hydrologic Consultants, Inc., 2000, PREDICTED DEWATERING REQUIREMENTS FOR RE-OPENING OF CROCODILE RIVER MINE AND ASSOCIATED HYDROLOGIC MPACTS, report prepared for KLM Consulting Services Lanseria, Republic of South Africa, October.

- Hydrologic Consultants Inc. Of Colorado, 2000, PREDICTION OF FATE AND EXTENT OF CYANIDE EMANATING FROM PIÑON TAILINGS IMPOUNDMENT AT TWIN CREEKS MINE, report prepared for Newmont Mining Corporation, September.

- Hydrologic Consultants, Inc., 1999, 1999 UPDATE OF HYDROGEO-CHEMICAL MODEL AND PREDICTION OF CHEMICAL COMPOSITION OF COVE PIT LAKE LANDER COUNTY, NEVADA, report prepared for Echo Bay Minerals Company McCoy Mine Battle Mountain, Nevada, August.

- Hydrologic Consultants, Inc., 2000, 1999 UPDATE OF NUMERICAL GROUND-WATER FLOW MODELING FOR NEWMONT MINING CORPORATION'S LONE TREE MINE HUMBOLDT COUNTY, NEVADA, report prepared for Newmont Mining Corporation, January.

- Hydrologic Consultants, Inc., 1998, CONCEPTUAL HYDROGEOLOGIC MODEL AND GROUND-WATER FLOW MODELING OF GRASBERG MINE AND SURROUNDING AREA IRIAN JAYA, INDONESIA ADDENDUM III Detailed Simulation of Grasberg Pit Area for Design of Dewatering and as Hydrologic Input to Slope Stability Analysis HCI-867 Prepared for P.T. Freeport Indonesia Tembagapura, Indonesia October.

- Hydrologic Consultants, Inc., 1998, 1998 ANNUAL UPDATE OF GROUND-WATER FLOW MODEL FOR LONE TREE MINE, report prepared for Newmont Gold Company, October.

- Hydrologic Consultants, Inc., and Pells Sullivan Meynink, Australia, 1998, **AN** INTEGRATED SURFACE-WATER AND GROUND-WATER STUDY OF 240K MILL WATER SUPPLY, report prepared for P.T. Freeport Indonesia Tembagapura, Indonesia, June.

- Hydrologic Consultants, Inc., 1998, CONCEPTUAL HYDROGEOLOGIC MODEL AND GROUND-WATER FLOW MODELING OF GRASBERG MINE AND SURROUNDING AREA IRIAN JAYA, INDONESIA ADDENDUM II Detailed Simulation of East Ertsberg Underground Mining and Dewatering, report prepared for P.T. Freeport Indonesia Tembagapura, Indonesia, February.

- Hydrologic Consultants, Inc., 1997, CONCEPTUAL HYDROGEOLOGIC MODEL AND GROUND-WATER FLOW MODELING OF GRASBERG MINE AND SURROUNDING AREA IRIAN JAYA, INDONESIA ADDENDUM I, December.

- Hydrologic Consultants, Inc., 1997, Update of Model including Simulation of 300k Mine Plan and Mill Water-Supply Alternatives, report prepared for P.T. Freeport Indonesia Tembagapura, Indonesia, December.

- Hydrologic Consultants, Inc., 1997, CALIBRATION OF GROUND-WATER FLOW MODEL FOR THE SACRAMENTO RAIL YARD, report prepared for Union Pacific Railroad October.

Selected Technical Memorandum (Selected From HCI Years 1998-2002):

- DATE: 11 September 2002

SUBJECT: Statistical Analysis of Particle Tracking Simulations and Predicted Changes in Net Outflow from Northern Lakes

- DATE: 29 August 2002

SUBJECT: Updated Ground-Water Flow Model of Snap Lake Diamond Project and Predicted Post-Closure Flow Away from Mine Based on Particle Tracking

- DATE: 30 July 2002

SUBJECT: Response to Information Requests Snap Lake Diamond Project

Environmental Assessment Report

- DATE: 17 May 2002

SUBJECT: Response to Information Requests

- DATE: 18 March 2002

SUBJECT: Interpretation of Pumping Test in Kimberlite at Venetia Mine

- DATE: 6 March 2002

SUBJECT: Assessment of Spinner Logs of LDD Wells 173, 174, 176, and 177 on 65 Level at Finsch Mine

- Date: 21 January 2002

Subject: Analysis of Step-Drawdown Data from Finsch Mine

- DATE: 6 July 2001

SUBJECT: Preliminary Estimates of Inflow to Snap Lake Mine – Expansion Case

- DATE: 9 July 2001

SUBJECT: Revised Estimates of Inflow to Snap Lake Mine   Expansion Case

- DATE: 6 July 2001

SUBJECT: Preliminary Estimates of Inflow to Snap Lake Mine – Expansion Case

- DATE: 28 June 2001

SUBJECT: Snap Lake Ground-Water Inflow Model

- DATE: 4 April 2001

SUBJECT: Design of Aquifer Test at 25 Bypass on 763 Level at Premier Mine

- DATE: 24 October 2000

SUBJECT: Description of Model Used to Estimate Passive Inflow to Montcalm Mine

- DATE: 20 October 2000

SUBJECT: Estimate of Inflow to Proposed Montcalm Mine

- DATE: June 7, 2000

SUBJECT: Updated Predictions of Dewatering Requirements for McCoy/Cove Mine

- DATE: June 16, 1999

SUBJECT: Predicted Effects of Phased Shutdown of Pumping at Cove Pit

- DATE: 14 January 1999

SUBJECT: Proposed Ground-Water Flow Modeling for Finsch Mine

- DATE: 31 December 1999

SUBJECT: Calculated Hydrologic Budgets within Portions of Hydrologic Study Area

- DATE: 25 May 1999

SUBJECT: DRAFT – Recommendations for Installing Flumes in Underground Workings

- DATE: 19 February 1999

SUBJECT: Proposed Methodology for Predicting Water Quality of Discharge from Carstenszweide Drainwells

- DATE: 11 February 1999

SUBJECT: Differences Between Model-Predicted and Currently Measured

Ground-Water Discharges

- DATE: June 5, 1998

SUBJECT: Description of Loop Structure within MINEDW

Academic Qualifications

- University of California (Davis, California) – Doctor of Philosophy in Civil Engineering, 1987.

- University of California (Davis, California) – Master of Science in Civil Engineering, 1983.

- University of Khartoum (Khartoum, Sudan) – Bachelor of Science in Civil Engineering, 1980