

R. ALLAN DAKIN, M.Sc., P.Eng.

Principal Senior Hydrogeologist

Education: 1976. M.Sc., Earth Sciences, specializing in Hydrogeology, University of Waterloo, Waterloo, Ontario, Canada.

1965. B.E., Civil Engineering, University of Canterbury, New Zealand.

*Qualifications
and Experience:*

Mr. Dakin joined Piteau Associates in 1979 and is now Vice-President and head of the Groundwater Group. His area of specialization is in groundwater engineering and hydrogeology. Since 1979, Mr. Dakin has coordinated over 250 groundwater projects in Canada and other parts of the world. He has experience with a wide range of groundwater studies involving geology, computer modeling, aquifer systems analysis, environmental and geothermal assessments, and hydrogeochemistry for both civil engineering and mining projects.

Mining related projects have involved assessment and design of hydrogeological aspects of dewatering and seepage control, depressurization of low permeability rock, contaminant migration in subsurface, and environmental impact assessment of proposed new mines.

Civil engineering projects carried out include hydrogeological aspects of seepage control, ground disposal of treated sewage effluent and groundwater supply. These studies typically have involved evaluation of geology, supervision of drilling and field testing. Many have also included geothermal and geochemical studies, groundwater hydraulic analysis, and evaluation of possible long term hydraulic and water quality impacts and assessment of costs.

Mr. Dakin's environmental hydrogeological assessments have included:

- regional studies for siting waste containment and disposal facilities
- management of leachate issuing from sanitary and industrial landfills
- impacts of sewage effluent drainfields and spilled liquids
- clean up of contaminated soil and groundwater
- design of groundwater supply and monitoring systems
- design of contaminant containment systems at waste handling facilities
- anthropogenic developments in urban areas and peat bogs

Mr. Dakin has worked on projects in Chile, China, Costa Rica, Guinea, Mexico, the Philippines, South Africa and Swaziland.

Memberships:

Association of Professional Engineers and Geoscientists of British Columbia (Member of Environment Committee, since 1984)
American Water Works Association
International Association of Hydrogeologists (B.C. Representative)
National Water Well Association
British Columbia Groundwater Association
Canadian Geothermal Association

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EMPLOYMENT HISTORY

<i>1979/Present</i>	PITEAU ASSOCIATES ENGINEERING LTD. Vice-President, Head of Groundwater Group
<i>1976/1979</i>	GOLDER BRAWNER ASSOCIATES Vancouver, B.C. Canada Senior Hydrogeologist
<i>1969/1976</i>	ROBINSON ROBERTS AND BROWN/PITEAU GADSBY MACLEOD LTD. North Vancouver, B.C. Canada Hydrogeologist
<i>1967/1969</i>	WATER AND SOIL DIVISION, MINISTRY OF WORKS Wellington, New Zealand Hydrologist
<i>1966/1967</i>	WILKINS AND DAVIES TAYLOR WOODROW Wellington, New Zealand Site Engineer
<i>1964/1966</i>	IAN MACALLAN AND CO. Wellington, New Zealand Structural Engineer

The following presents a detailed summary of Mr. Dakin's experience.

- Mining*
- Hydrogeological studies for environmental impact assessment of proposed new mines including Hat Creek Coal Project (B.C.); Con Mine, Yellowknife (NWT); Line Creek Mine (NWT); Colorado Coal Mine (USA); Cerro Crucitas project (Costa Rica); and Marcopper Mine tunnel (Philippines).
- Hydrogeological studies for mine dewatering and slope depressurization including Lake Asbestos Mine, Black Lake (Quebec); Rockdale Lignite Project near Austin (Texas); Palabora Mine (South Africa); Los Bronces Mine (Chile); Byron Creek Project (B.C.); and West End Mine (Idaho).
 - Evaluation of seepage flows through proposed tailings dams and waste rock dumps at Canada Tungsten Mine (NWT); Kitsault Mine Project, Alice Arm (B.C.); and Y Gold Mine Project (China).

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- Design of pit dewatering systems and preliminary design and costing of input and peripheral dewatering systems for open pit mines such as Key Lake Uranium Project (Northern Saskatchewan); Hat Creek Coal Project, Cache Creek (B.C.); Dentherm Coalspur Project, Carol Lake Mine (Labrador); and B.C. Coal, Harmer Ridge Mine (B.C.).
- Mine water supply: Didi Project (Guinea); Cheni Gold Project (B.C.); and Paredones Project, La Paz (Mexico).

Industrial

Hydrogeology studies for liquid discharges to ground, including: Haney Fire Fighting School, B.C.; CN Railway/ethylene dichloride spill, Ft. Langley, B.C.

- Clean up of spilled xylene and evaluation of gasoline migration from about eight sites where gasoline had leaked from a storage tank.
- Assessment of soils and groundwater contamination at former industrial sites involving a wide range of organic and inorganic contaminants, some of which were dense non-aqueous phase liquids, including B.C. Hydro's Murrin parking lot site, Mainland Manufacturing Plant, Burlington & Northern Railway Yards and Stadco Forest Products wood treatment facility.
- Development of guidelines for groundwater monitoring for the British Columbia Ministry of Environment, and a Groundwater Mine Development Manual.
- Dewatering and seepage control for construction excavation: Halifax-Augusta Building Excavation, Vancouver; Roberts Bank Superport; Alouette Dam Project; proposed Holly Meadows storm water storage reservoir; Chesapeake housing development; Breaks Gravel Pit; and many construction projects in the Vancouver area. Consultation on on-going dewatering program for Pony Creek dam reconstruction project, Oregon.
- Development of wells for water supply to salmon hatcheries for Canadian Department of Fisheries and Oceans involving well fields with capacities ranging from 100 to 600 L/s, including Chehalis River, Quesnel River, Bowron River, Stewart River, Alouette River, Mathers Creek, Christian Creek, Clearwater, Finn Creek, Spius Creek, Chilliwack River Facilities.
- Redevelopment of existing wells. Assessment of chemical encrustation, biofouling and silt plugging of operating wells, including Fraser Valley Trout Hatchery, Alouette No. 2 well and wells at Eagle River and Spius Creek Hatcheries.

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Municipal

Sewage effluent disposal. Hydrogeological investigation and preparation of design criteria for the land application of treated sewage effluent. Examples are: spray irrigation system (Osoyoos, B.C.), rapid exfiltration basin (northeastern B.C.), numerous drainfields for absorbing sewage effluent from package treatment plants and septic tank systems, ranging from 1 to 600m³/day capacity. Some of the more recent drainfield systems include: Paldi Estates Ltd. (600m³/d), Rowils Estates Ltd. (36.5m³/d) and Endeavour Developments Ltd. (156.8m³/d), all of which are located on the east coast of Vancouver Island.

- Groundwater seepage control and storm water disposal: Evaluation of water table elevation control for Brookwood Subdivision, Langley; Ground disposal of storm water, Chilliwack, B.C.; Storm water discharge to a subsurface detention systems and assessment of impact of urban development on nearby residential areas and on stream base flows, Surrey and Mission, B.C.
- Water supply: Site investigation and design of wells for groundwater supply systems including projects in: Whitehorse (Yukon), Trail, Elkford, Trail, Langley, Grand Forks, Gabriola Island and many small communities throughout British Columbia
- Sanitary landfills: Hydrogeological investigations for site evaluation of proposed landfills in the Tofino-Ucluelet area (B.C.) and in Burns Bog, Delta and on Matsqui Indian Reserve, B.C.; assessment of leachate movement from and existing landfill Richmond landfill (B.C.) and Hartland Road Landfill (Victoria, B.C.).
- Regional groundwater supply assessments involving development of maps, sections, well log and water chemistry data base and review of groundwater water level and quality trends for the Hoppington and Aldergrove aquifers in Langley, the Grand Forks aquifer and fractured bedrock in Swaziland

Specialty Studies

Developed guidelines for regional scale groundwater mapping in B.C. and on-site sewage disposal systems in the lower Fraser Valley

- Reviewed and evaluated potential impacts from proposed scheme to develop storage reservoirs for natural gas in a deep sedimentary basin in the Fraser Valley. Appeared as an expert at public hearings and subsequently monitored potential impacts while drilling was in progress.
- Swaziland Groundwater Survey Project: Involved hydrogeological mapping, geophysical surveying for well site locations, training of personnel, assistance with setting up a national water well act and preparation of a computerized data base for government well records.

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- Expert Witness: Mr. Dakin has appeared as an expert witness at a number of Environmental Appeal Board and Special Commission Hearings, as well as Court Cases. A listing of this information can be provided upon request.
- Assessment of the hydrology of peat bogs and the potential environmental impacts from anthropogenic development in bogs. Examples include: construction of solid waste and land development landfills, road building and cranberry farming.
- Assessment of geothermal resources and groundwater heat storage systems. These include hydrogeochemical evaluations of hot springs and assessment of development potential, and hydrothermics for groundwater heat storage and/or cooling of buildings.

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PUBLICATIONS

Introduction to Groundwater Hydrology. 1979. Proceedings of B.C. Water and Waste Association Seminar on Groundwater, Burnaby, B.C. Jan. 15-16. 25 pp.

Hydrogeology of Municipal Landfills; With Reference to Situations in British Columbia. 1982. Presented to seminar on landfills held in North Vancouver, and sponsored by the Greater Vancouver Regional District, October 21. 55 pp.

Origin of Dissolved Solids in Groundwaters of Mayne Island, British Columbia, Canada. 1983 - With R.N. Farvolden, J.A. Cherry and P. Fritz. Journal of Hydrology, Vol. 63, p. 233-270.

Microcomputers Applied to Groundwater Resource Modelling. 1983 - With A.T. Holmes. Paper presented to B.C. Water and Waste Association meeting held in Richmond, B.C. 20 pp.

Potential Impacts of Discharged Treated Sewage Effluent on Groundwater Quality. 1985. Proceedings of B.C. Water and Waste Association Spring Seminar, Richmond, B.C. June 3-4. 14 pp.

Photo Voltaics for Water Pumping in Developing Countries. 1985 - With P.R.B. Ward. B.C. Professional Engineer. p. 12-15.

Preservation of Groundwater Quality in British Columbia: Be Vigilant Now and Avoid a Lot of Problems Later. 1985. Paper presented to B.C. Water and Waste Association Annual Conference held in Penticton, B.C. 11 pp.

Investigation and Development of a Supplementary Groundwater Source for the Village of Fruitvale, B.C. 1988 - With A.T. Homes. Paper Presented to B.C. Water and Waste Association Annual Conference held at Whistler, B.C. 12 pp.

Monitoring, Migration and Control of an Ethylene Dichloride Contaminant Plume in a Gravel Aquifer. 1988 - With A.T. Holmes. Proceedings of International Groundwater Symposium on Hydrogeology of Cold and Temperate Climates and Hydrogeology of Mineralized Zones, Halifax, Nova Scotia Canada, May 1 to 5. p. 41-50

Hydrogeological Studies in Southern Lowveld Area, Swaziland. 1988 - With A. Vilakati and D.J. Balfour. Proceedings of International Groundwater Symposium on Hydrogeology of Cold and Temperate Climates and Hydrogeology of Mineralized Zones, Halifax, Nova Scotia Canada. May 1 to 5. p. 52-59.

Monitoring of Water Pressures and Inflows: Chapter 4.8. 1989 - Handbook on Mine Monitoring Prepared by Rock Mechanics and Strata Control Committee of Canadian Institute of Mines. 10 pp.

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Practical Aspects of Hydrogeology Studies for Hydrocarbon Migration in British Columbia, 1990. With A. Holmes and D. Tiplady. In Subsurface Contamination by Immiscible fluids, (Weyer Ed.), Balkema, Rotterdam. Proceedings of the International Conference on Subsurface Contamination by Immiscible Fluids, Calgary, Alberta, April 18 - 20. p. 465-474.

Contaminant Migration in Groundwater. 1991 - A paper presented at a seminar on Groundwater Quality, organized by the Technical University of Nova Scotia, in Vancouver. 12 pp.

Groundwater Contamination From Agricultural Sources in the Lower Fraser Valley. 1991 - B.C. Professional Engineer, October issue. p. 30-32

Potential Impacts of Discharged Sewage Effluent on Groundwater Quality. 1991 - A paper presented at a seminar on Groundwater Quality, organized by the Technical University of Nova Scotia, in Vancouver. 15 pp.

Characterization of Hydrogeologic Features in Bedrock Dominated Terrain, With Examples from Swaziland. 1992 - With A. Vilakati and D. J. Tiplady. Proceedings of International Association of Hydrogeology Symposium, Hamilton, Ontario, Canada. May 10-13.

Renovation of Sewage Effluent Using Ground Disposal Methods. 1992 - Presented at AQUA-92 National Water Show and Conference, Vancouver. 15 pp.

Groundwater Resources of Swaziland. 1992 - Report prepared for Canadian International Development Agency (CIDA) and Swaziland Department of Geological Surveys and Mines. 55 pp. (plus figures, tables and maps).

Potential Impacts of Discharged Treated Sewage Effluent on Groundwater Quality. 1994 - Presented at 1st Conference on Small Waste Water Systems. Organized by British Columbia Water and Waste Assn. 15 pp.

Fraser Lowland: Groundwater Resources of the Lowlands and Plains. 1994 In Groundwater Resources of British Columbia. Groundwater Section, BC Environment and Environment Canada. p.9.1 - 9.29

Hydrogeochemistry of Fractured Sedimentary Bedrock of the Southern Gulf Islands of British Columbia, Canada; With Implications for Groundwater Supply. 1995 Paper presented to 26th International Association of Hydrogeologists (IAH) Congress held in Edmonton, Canada (June 4-10). 6 pp.

Concepts of Ground Heat Source Systems. - With Reference to the Heat Pump System Installed at the Sandspit Airport, B.C. 1996. Paper presented at the Canadian Geothermal Association Technical Meeting, held in Vancouver, B.C. Canada on April 30th 1996. 6 pp

Groundwater Contamination from Wastewater in British Columbia. 1999. Paper presented at a seminar on Decentralized Sewage Treatment – Alternatives to the Big Pipe, held in Burnaby, B.C. Organized by British Columbia Water & Waste Association. 14 pp.

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Development Impacts on the Hydrology of Peat Bogs, Vancouver, British Columbia. 1999.
In proceedings of Wetlands & Remediation – an International Conference, held in Salt Lake City,
Utah. Nov. 16-17, 1999. Means, J. L. and Hinchee, R. E. editors. Published by Battelle Press.
p.95-102.

SUMMARY OF HYDROGEOLOGICAL SERVICES
PROVIDED FOR LEGAL CASES BY R. ALLAN DAKIN

COE ET. AL. vs. OWNERS OF STRATA PLAN KAS 1311 (1997-present): Reviewed reports on soils and groundwater in an area around an existing community sewage effluent ground disposal system. Mr. Dakin supervised the construction of monitoring wells and prepared an opinion on the cause of high water table conditions on a neighbour's property.

Outcome: On going
Client Contact: Nigel Kent, Clark Wilson, Vancouver, B.C.

POLLUTION ABATEMENT AND POLLUTION PREVENTION ORDER OS-14991 (1998-present): Reviewed reports on contamination of groundwater and soils at a site located near the Fraser River. Mr. Dakin prepared a report summarizing his opinion on past activities which caused the contamination and its subsurface dispersal. His report was used as evidence at hearings to determine responsible parties under the B.C. Waste Management Act.

Outcome: On going
Client Contact: Mark Myers and Randy Aliment, Williams Kastner & Gibbs PLLC, Seattle, Washington, U.S.A.

CANADIAN FOREST PRODUCTS LTD. vs. DOMTAR INC. AND STELLA-JONES INC. (1997-present): Reviewed reports on contamination of groundwater and soils on CanFor's property and on a neighbouring property. Conducted field tests and prepared a report setting out his opinions on groundwater migration across a property boundary.

Outcome: On going
Client Contact: Michael Jordan, Canadian Forest Products Ltd., Vancouver, B.C.
Craig Ferris and William Everett, Lawson Lundell Lawson & McIntosh, Vancouver, B.C.

CENAM CONSTRUCTION LTD. vs. ROBERT HOWAT, APPROVING OFFICER MOT&H (1994-present): Reviewed reports on a groundwater supply source for a proposed residential subdivision and prepared opinion reports for the property developer who was appealing a decision made by a BC Ministry of Transportation and Highways (M)T&H Subdivision Approving officer. Mr. Dakin also coordinated the completion of production wells, monitoring wells and a survey of local area residents using groundwater, as part of the court mandated settlement.

Outcome: Conditional subdivision approval was issued
Client Contact: Klaus Roethel, Cenam Construction Ltd., Vancouver, B.C.
Peter Kenward, McCarthy Tétrault, Vancouver, B.C.

ALPHA MANUFACTURING INC. vs. R. DRIEGER (1997): Prepared opinion reports for the appellant who was appealing a decision made by the Regional Waste Manager, regarding the placement of fill in a peat bog. The field studies and ensuing reports focused on assessing the potential for environmental impacts resulting from landfilling, using demolition and land clearing waste materials in the foundations of a proposed industrial property located in a peat bog, just south of River Road, Delta. Mr. Dakin also appeared as an expert witness at Environmental Appeal Board hearings held in Richmond in mid September 1995 and in August 1997.

Outcome: Appeal rejected
Client Contact: Ernie Bauer, Alpha Manufacturing Inc., Delta, B.C.
Glen Bell, Richardson and Bell, West Vancouver

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ENDEAVOUR DEVELOPMENTS LTD. PERMIT APPEAL (1995): Prepared an opinion report for the appellant who was appealing a decision of the Regional Waste Manager to reject an application for discharging a 156.8 m³/day flow of treated sewage effluent into the ground. This report focused on hydrogeological aspects of the proposed drainfield, which is located in the Saratoga Beach area, on the East coast of Vancouver Island. Mr. Dakin also appeared at Environmental Appeal Board hearings on June 28th and August 31st, 1995

Outcome: Permit was issued with some requirements
Client Contact: Adolf Schiel, Endeavour Developments Ltd., Surrey
Peter Kenward, McCarthy Tétrault, Vancouver

KEN AND MARLENE GOERES APPEAL (1995): Carried out field studies and prepared an opinion report for the appellant who was appealing a decision of the Regional Waste Manager to reject an application for discharging a 74m³/day flow of treated sewage effluent into the ground. This report focused on hydrogeological aspects of the proposed drainfield, which is located in the Saratoga Beach area, on the East coast of Vancouver Island. Mr. Dakin also appeared at Environmental Appeal Board hearing on December 4 & 5th, 1995

Outcome: Appeal rejected
Client Contact: Ken and Marlene Goeres, Surrey
Nicholas Hughes, McCarthy Tétrault, Vancouver

7437 HOLDINGS LTD. PERMIT APPEAL (1994 to 1998): Prepared opinion reports for the appellant (a wholly owned subsidiary of North Shore Disposals Ltd.). These reports focused on hydrogeological aspects of a proposed landfill using demolition and land clearing waste materials as foundation material at a proposed industrial property on River Road, Delta. Mr. Dakin also appeared as an expert witness at Environmental Appeal Board hearings held in Delta in June 1994 and at a Ministry of Environment appeal hearings held in December, 1995 and February 1998.

Outcome: Awarded a conditional permit
Client Contact: Gerry Wild; North Sore Disposals Ltd., New Westminister
Glen Bell, Swinton & Company, Vancouver

MARRALL HOLMES LTD. vs. ACTTON PETROLEUM SALES LTD. (1994): Prepared an opinion report for the plaintiff's lawyer, for submission to a court hearing in New Westminister. This report focused on the source and distribution and probable age of hydrocarbon contamination of soils found in the basement of a residential building, located on Scot Road, Surrey.

Outcome: Judge did not rule in favour of the plaintiff
Client Contact: Brian Schreiber, McQuarrie Hunter, New Westminister

SUMMARY OF HYDROGEOLOGICAL SERVICES
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PAYLESS GAS CO. (1972) vs. B.C. HYDRO AND POWER AUTHORITY (1992): Prepared an opinion report for the defense. This focused on liability issues and hydrogeological aspects of impact and costs of site remediation of fuel oil spillage at a former power generating plant site, located on Bare Point, Chemainus.

Outcome: Settled out of court
Client Contact: Linda Loo; Singleton Urquhart MacDonald, Vancouver

NORTH FRASER HARBOUR COMMISSION vs. HARDY BBT LIMITED (1992): Prepared an opinion report for the defense. This focused on hydrogeological aspects of personnel liability and cost of site remediation resulting from coal tar spillage at a former asphalt shingle manufacturing plant site, located on Oak Street, Vancouver.

Outcome: Ongoing
Client Contact: Rodney Urquhart; McCarthy Tétrault, Vancouver
John Singleton, Singleton Urquhart MacDonald, Vancouver

CITY OF GRAND FORKS vs. CHEVRON CANADA LIMITED (1990): Prepared information for plaintiff. This focused on hydrogeological aspects of municipal water well contamination, resulting from gasoline leaking from a service station, located at the intersection of Hwy. No. 3 and 19th Street, Grand Forks.

Outcome: City of Grand Forks settled for cost of damages and a replaced water well
Client Contact: David Lunney; Farris Vaughan Willis & Murphy, Vancouver

BRITISH COLUMBIA TELEPHONE COMPANY vs. GULF CANADA et al (1988): Prepared an opinion report for plaintiff. This focused on hydrogeological aspects of the cause of damage to cable conduits resulting from a leak of gasoline at a service station, located at the intersection of No. 3 Road and Williams Road, Richmond.

Outcome: BC Tel settled for cost of damages
Client Contact: Alan Hopkirk; Swinton and Company

BRITISH COLUMBIA TELEPHONE COMPANY vs. PHILLIPS CABLE et al (1988): Prepared information for plaintiff. This focused on hydrogeological aspects of the cause of damage to cable conduits resulting from a leak of gasoline at a service station, located at the intersection of Burnside Road and Harriet Street, Victoria.

Outcome: BC Tel settled for cost of damages
Client Contact: Robert Sloman; Farris Vaughan Willis & Murphy, Vancouver

BRITISH COLUMBIA TELEPHONE COMPANY vs. SHELL CANADA et al (1986): Prepared an opinion report and appeared in court as an expert witness for the plaintiff. Issue related to hydrogeological aspects of the cause of damage to cable conduits, resulting from leaking gasoline from a service station located on Richter Street, Kelowna.

Outcome: BC Telephone was awarded cost for damages
Client Contact: David Lunney; Farris Vaughan Willis & Murphy, Vancouver

SUMMARY OF HYDROGEOLOGICAL SERVICES
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SKEENA CHARLOTTE REGIONAL DISTRICT vs. FOWNES CONSTRUCTION et al (1986):

Prepared opinions for defendant on hydrogeological aspects of water well construction and determination of sustainable well yields, Queen Charlotte City.

Outcome: Fownes Construction, and others, settled with the Regional District
Client Contact: Robert Sewell; McCarthy Tétrault, Vancouver

PHILIP ELLIS vs. CHEVRON CANADA LIMITED (1985): Prepared an opinion report and provided evidence for plaintiff in a court trial seeking compensation for loss of revenue resulting from a gasoline leak at a service station located on Cleveland Street, Squamish.

Outcome: Mr. Ellis was awarded compensation for business losses
Client Contact: Jack Margach, Q.C.; McNeney Morrison, Vancouver

HOMEOWNER vs. WATER WELL DRILLING COMPANY (circa 1978): Provided evidence in court on behalf of the plaintiff, in a trial seeking damages resulting from artesian well water flowing into a house basement.

Outcome: Contractor was required to pay cost of damages
Client Contact: Andrew Berna; Andrews Taylor & Company, Kamloops

HOMEOWNER vs. OKANAGAN BUILDERS LIMITED (circa 1973): Provided evidence in court for the defense during a trial involving damages resulting from sewage effluent seeping into a house basement.

Outcome: Okanagan builders had to pay cost of damages