
CHRISTOPH WELS

EDUCATION

Ph.D., Hydrogeology, University of British Columbia, 1995
Fellowship, Environmental & Soil Chemistry, Syracuse University, 1991
M.Sc., Watershed Hydrology, Trent University, Ontario, 1989
B.Sc., Environmental Sciences, Trent University (Freiburg University), 1985

PROFESSIONAL REGISTRATION

Professional Geoscientist, APEGBC
Licensed Geologist/Hydrogeologist, Washington State

EXPERIENCE

SUMMARY

Christoph Wels has over 20 years of experience in: design & implementation of site investigations and monitoring of mine impacts on groundwater resources; the development of groundwater flow and solute transport models to study current impacts and to evaluate the effectiveness of remedial activities; the design of mine dewatering systems for open pit and underground workings; study of waste rock hydrology including physical characterization, field monitoring and numerical modeling of key processes (infiltration, internal air flow and seepage); and the design of engineered covers for waste rock and tailings using numerical modeling and field trials.

Christoph Wels has been a third-party reviewer of pre-feasibility investigations and permitting documents on behalf of government agencies, mining companies and other consulting firms for project in Canada (YT, NWT, Labrador), USA, Australia, Germany and Chile.

PROJECT EXPERIENCE (SELECTED STUDIES)

MINE PERMITTING & BASELINE STUDIES

Prairie Creek Mine, NWT (2008-present) for Canadian Zinc (CZN)

- Design & implement groundwater monitoring program at Prairie Creek Mine
- Prepare hydrogeological baseline study for DAR application
- Develop groundwater flow model for Prairie Creek Mine site
- Assist CZN in DAR submission and EA process

Granites Gold Mine, Australia (2008 - present) for Newmont Australia

- Complete groundwater baseline study required for permitting of the Dead Bullock Soak (DBS) Deep U/G project;
- Develop a 3D groundwater flow model of the DBS Deeps U/G project to assess groundwater inflow and potential impacts on open pits backfilled with tailings
- Predict groundwater impacts for alternative options of tailings storage facilities (Quorn North and GTD South) at the Granites using groundwater flow and transport model
- Provide recommendations for final selection of TSF expansion at the Granites for permitting

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GROUNDWATER IMPACT & SEEPAGE CONTROL STUDIES

Las Tortolas Mill Site, Chile (2010-present) for Anglo American Chile (AACH)

- Detailed site characterization program (drilling and installation of monitoring wells) to delineate the seepage plume downstream of the Main Dam of the Las Tortolas TSF and the El Bosque irrigation areas
- Develop and calibrate groundwater flow and solute transport models to assess future groundwater impacts and seepage interception options
- Design of seepage interception systems for the Muro Principal and the El Bosque areas

El Soldado Mine Site, Chile (2010-present) for Anglo American Chile (AACH)

- Detailed site characterization program (drilling and installation of monitoring wells) to delineate the seepage plume from the El Torito TSF in the Estero de Cobre valley
- Develop and calibrate groundwater flow and solute transport models to assess future groundwater impacts and seepage interception options
- Design of seepage interception systems for the Muro Principal and the El Bosque areas

Granites Gold Mine, Australia (2006 - present) for Newmont Australia

- Complete detailed site characterization to evaluate impacts on local groundwater due to historic seepage from tailings storage facilities (paddock TSFs and backfilled open pits)
- Develop 3D groundwater flow and solute transport model to assess future migration of seepage plume at the Granites;
- Design & Implement seepage recovery systems for GTD01/03 and Bunkers Hill TSFs

Anvil Range Mining Complex, Yukon Territory (2004 - 2009) for Deloitte Touche (Interim Receiver on behalf of Federal Government of Canada)

- Assess acid rock drainage from waste rock piles and design seepage interception system
- Develop water & load balance model for Rose Creek Tailings Storage Facility
- Design Groundwater Interception System for Alluvial Aquifer (using pumping tests and 3D MODFLOW model)

TAILINGS WATER BALANCE STUDIES

Steepbank and Millenium Mine, Ft McMurray, Alberta (2010 - 2009) for Suncor Energy Ltd.

- Perform water balance studies to understand the drying and consolidation of polymerized mature fine tailings (TMFT) using laboratory and field tests
- Assist Suncor in planning and operation of its Tailings Reductions Operations (TRO)
- Assist Suncor in monitoring and management of monitoring data
- Optimize tailings management to reduce water losses and make-up requirements

Escondida Mine, Chile (2007 - 2009) for BHP Billiton

- Review historic and proposed future tailings management for Laguna Seca TSF
- Design & implement a tailings characterization program (in-situ and laboratory)

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- Develop and calibrate a water balance model for Laguna Seca TSF to assess water losses and make-up requirements
- Optimize tailings management to reduce water losses and make-up requirements

Collahuasi Mine, Chile (2002 - 2004) for Minera Dona Ines de Collahuasi (MDIDC)

- Design & implement a tailings characterization program (in-situ and laboratory) for tailings from Ujina and Rosario pits
- Develop and calibrate a water balance model for Pampa de Pabellon TSF to assess water losses and make-up requirements

Chuchicmata Mine, Chile (2002 - 2003) for Codelco

- Design & implement a tailings characterization program (in-situ and laboratory) for tailings in Tranque de Talabre
- Develop and calibrate a water balance model for Tranque de Talabre TSF to assess water losses and make-up requirements

MINE CLOSURE PLANNING

Rum Jungle (Abandoned) Mine Site, Australia (2010 - present) for NT Dept of Resources (Australia)

- Design & implementation of a detailed hydrogeological site characterisation (incl. drilling, well installations, and hydraulic testing);
- Groundwater flow and groundwater quality monitoring to assess impact of ARD on East Finnis River and local bedrock aquifer(s);
- Development of a 3D groundwater flow model to assess current seepage conditions and contaminant loading to the East Finnis River and the local aquifer(s);
- Assessment of alternative closure strategies using the 3D groundwater flow model;

Mt Morgan (Abandoned) Mine Site, Australia (2003 - present) for Qld. Dept Natural Resources (Australia)

- Design & implementation of a detailed hydrogeological site characterisation (incl. drilling, well installations, and hydraulic testing);
- Groundwater flow and groundwater quality monitoring to assess impact of ARD on Dee River and local aquifer;
- Development of a 3D groundwater flow model to assess current seepage conditions and contaminant loading to the Dee River and the local aquifer(s);
- Assessment of alternative closure strategies using the 3D groundwater flow model;

Giant Mine, NWT (2001 - 2006) for SRK Canada and DIAND

- Participation in “Hydrogeological Expert Meetings” to review and critique hydrogeological studies carried out at the Giant Underground Gold Mine prior to 2001;
- Participation in hydrogeological studies in support of the Arsenic Trioxide Management Study;

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- Development of a 3D groundwater flow model (as senior supervisor) to assess current groundwater conditions at the Giant Underground Mine and to evaluate closure options (reflooding, partial reflooding etc.);

Woodcutters Mine, Northern Territories, Australia (2000 - 2009) for Newmont Australia.

- Hydrogeological field investigation (drilling) and design of a groundwater monitoring program
- Development of a 3D groundwater flow and transport model (using MODFLOW & MT3D) to assess reflooding of underground workings/open pit and post-closure groundwater quality
- Development of a 2D seepage model (using HYDRUS) to determine fate of seepage from waste rock pile
- Assistance in the development of closure criteria & post-closure monitoring

Questa Mine Tailings Impoundments, Questa, New Mexico, U.S.A. (1997-2002) for Molycorp Inc.

- Development of a Closure Plan for Questa Tailings Facility
- Modeling of infiltration through soil covers into tailings (using SOILCOVER) to assess alternative designs of a soil cover for final closure of the tailings facility
- Modeling of seepage (using SEEP/W) through tailings to predict the rate of dewatering of tailings over time
- Development of a regional and local 3D groundwater flow model to evaluate fate of tailings seepage in local and regional aquifer systems
- Design, Instrumentation and Monitoring of Test Plots to measure the performance of storage covers

Faro Mine Complex, Yukon, Canada (1996-97) for Anvil Range Mining Corp.

- Development of integrated closure plan for extensive mining complex (3 open pits, waste rock, tailings)
- Modeling of seepage from flooded open pit through fractured bedrock
- Development of a 3D groundwater model to assess seepage from tailings facility into alluvial aquifer

THIRD PARTY REVIEW

Collahuasi Mine, Chile (2010) for X-Strata, Anglo American, and Mitsui

- Technical review of three groundwater models developed by Collahuasi's consultants to predict future groundwater extraction from Coposa basin, Michincha basin and Rosario Pit
- Assess feasibility and risks of groundwater supply for mine expansion to 160 ktpd

Las Tortolas and El Soldado Mines, Chile (2008) for Anglo American Chile (AACH)

- Review groundwater impacts due to tailings seepage at Los Tortolas and El Torito tailings impoundments;
- Review groundwater modeling completed by local consultants;
- Recommend preferred seepage mitigation options for tailings seepage plumes;

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Cantung Mine, NWT (2008) for Indian & Northern Affairs Canada (INAC)

- Review & comment on the Abandonment & Reclamation Plan for the Cantung Mine
- Review hydrogeological & hydrogeochemical studies for the Cantung Mine and provide recommendations to INAC on its adequacy
- Assist INAC in the review of the Water License Application for the Cantung Mine

Tamerlane Pine Point Pilot Project, NWT (2007) for Mackenzie Valley Environmental Impact Review Board (MVEIRB)

- Review hydrogeological aspects of EA application
- Provide review comments and recommendations to MVEIRB
- Attend technical session on EA application on behalf of MVEIRB

PROFESSIONAL HISTORY

2011-present	Corporate Consultant, Robertson GeoConsultants Inc. (Canada)
2001-2010	Principal, Robertson GeoConsultants Inc. (Canada)
1995-2001	Senior Hydrogeologist, Robertson GeoConsultants Inc. (Canada)
1989	Hydrogeologist, Chalk River Laboratories, AECL, Ontario
1985-86	Hydrochemist, Freiburg Municipality, Germany

SELECTED PUBLICATIONS

Wels, C. and R. Zapata, 2010, "Assessment of Tailings Seepage from In-pit Tailings Storage Facility Using a 3D Groundwater Flow Model", Paper presented at Mine Closure 2010, June 2010, Santiago, Chile.

Zapata R. Wels, C. and J. Bourne 2010, "Assessment of Post-Closure Flooding of Potentially Acid-Generating (PAG) Waste Rock Backfilled into Bonanza Ledge Open Pit, Canada", Paper presented at Mine Closure 2010, June 2010, Santiago, Chile.

Wels, C., Laura Findlater and Chris McCombe, 2009, "Contaminant Load Balance Study for Mount Morgan Mine, QLD, Australia". Paper presented at Securing the Future and 8th ICARD, June 23-26, 2009, Skellefteå, Sweden.

Wels, C. and Laura-Lee Findlater, 2009, "Groundwater Modeling as a Tool for Closure Planning: Prediction of Zinc Transport for Alternative Cover Scenarios". Paper presented at Securing the Future and 8th ICARD, June 23-26, 2009, Skellefteå, Sweden.

Wels, C., Findlater, L., and C. McCombe, "Assessment of Groundwater Impacts at the Historic Mount Morgan Mine Site, Queensland, Australia. In proceedings of the 7th International Conference on Acid Rock Drainage, St Louis, MO, 26-30 March 2006.

Wels, C., Robertson A. MacG., Madariaga, P.M., 2004, "Water Recovery Study for Pampa Pabellon Tailings Impoundment, Collahuasi, Chile". In proceedings of the 11th Annual Conference on Tailings and Mine Waste, Vail, Colorado, USA, 10-13 October, 2004.

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Wels, C., Findlater, L., Shaw, S. and Laurencont, T., 2004, "Mt Morgan Mine - A Case Study of ARD Impacted Groundwater". In proceedings of Mine Water 2004 - Process, Policy and Progress, Newcastle upon Tyne, United Kingdom, 20-24th September, 2004, pp. 235-245.

Wels, C. and Robertson, A. MacG, 2003, "Conceptual model for estimating water recovery in tailings". In proceedings of the 10th International Conference on Tailings and Mine Waste, Vail, Colorado, USA, 12-15 October, 2003, pp. 87-94.

O'Kane, M., and C. Wels, 2003, "Mine Waste Cover System Design – Linking Predicted Performance to Groundwater and Surface Water Impacts", In proceedings of the Sixth International Conference on Acid Rock Drainage, Cairns, Queensland, Australia, 14-17 July, 2003, pp. 341-350.

Shaw, S., Wels, C., Robertson, A., Fortin, S., and B. Walker, 2003, "Background characterization study of naturally occurring acid rock drainage in the Sangre de Cristo