

SUMMARY

Francisco has 18 years of experience in water assessments for oils and gas, metals mining, deep disposal and contamination evaluations. Francisco's experience has been collected from projects in Canada, UK, Peru, Ecuador, Colombia, and Spain where he has managed and participated in a wide range of water related assignments. His experience is based on the unconventional heavy oil/bitumen and gas energy projects (coal, shale, oil-sands) in Canada and USA, metals mining projects in Peru and Ecuador and Colombia and hydrogeological projects in UK and Spain. These assignments comprised site investigations for conceptual level, prefeasibility and feasibility levels, EIA, ES, environmental baselines studies, and closure plans.

In relation to unconventional gas Francisco has experience in Tier II studies (water-for-life strategy), sustainable water management plans, hydrogeological base line groundwater modeling, hydrochemistry and surface water and groundwater interaction studies. He is currently leading the water assessment (surface and groundwater) for the first unconventional coal synthetic gas development plant in Canada, and the deepest in the world, on behalf of SwanHills Synfuels Ltd <http://swanhills-synfuels.com/>. This project involves hydrogeological modeling, testing, sampling regulatory applications for deep injection of steam and water injection into coal seams, for gas CH₄, CO₂ and H₂ production for power generation. Additionally, it involves deep injection of waste into deep confined reservoirs,

Francisco has provided technical support for gas venting modeling in the Marcellus shale gas project for Shell Energy USA, and water resources management expertise related to water supply projects for municipalities in Canada, water utilities companies in UK, and aquifer management plans in Colombia. Also he has managed projects for oil-sands producers, where assessing sustainable yields and understanding groundwater and surface water interactions were key components.

Francisco has direct experience in the use of modeling tools such as FEFLOW, MODFLOW, NETPATH and PHREEQC for assessing water management and hydrochemical implications from water related projects in environmentally sensitive areas. See Colombia case. http://www.igme.es/internet/boletin/2002/113_3_2002/%209-ARTICULO%20EVIDENCIAS%20DE.pdf

Francisco is currently technical reviewer for Mine, Water and Environment Journal, is a member of the Technical Committee for the 3RD International Congress on Water Management in the Mining Industry Santiago–Chile June 6-8, 2012, <http://www.waterinmining.com/evento2012/> where He presented: “*Elements to define groundwater flow in Paramos zones in Colombia*”. In the 5th WaterTech Symposium presented the topic “*Hydrochemical Assessment of the Devonian Keg River Formation*” in Banff-Canada, April 11-12, 2012, <http://www.esaa-events.com/watertech/2012Abstracts/Abstract26.pdf> and recently presented the topic “*Hydrochemical and Environmental Isotopic Contributions to the Northern Athabasca Regional Groundwater Flow Modelling*” at the International Association of Hydrogeologists Congress, Niagara, Ontario, Canada Sept, 17-21 2012.

PROFESSIONAL EXPERIENCE

2010 – Present **Senior Hydrogeologist, Worley Parsons Group. Calgary, Alberta**

Water Resources Study in support of an In Situ Coal Gasification project in SwanHills Alberta, Canada, 2011-2012

A water resources study was carried out in support of a compliance report to be submitted to the ERCB board as part of a new initiative for unconventional gas development in Alberta on behalf of SwanHills Synfuels Ltd. The assessment comprises a regulatory review and tiered options assessment following the Water for Life strategy. The project comprised assessment of a regional and local hydrogeological baseline construction, understanding saline-non-saline water aquifer interactions, modeling and prediction of heat and groundwater flow effects from deep (1200 m) in-situ mining and deep wastewater disposal options identification and ranking.

Shell Gas Casing Venting – Modelling and Prediction 2012

This project is still ongoing and it has been developed to assess potential gas effects from deep shale gas fracking into shallow aquifers present in the Marcellus area. Francisco's role was as a technical reviewer and technical assistance for the ground water modeling component.

Hydrogeological Assessment of Potential Migration Selenium from Teck Coal Mining Operations in British Columbia 2012

A study was conducted for the Teck Group to assess the potential for selenium contaminant transport and migration from coal waste piles and pits into surface water and groundwater.

Sustainable Water Management Plan for the Town of High River

This study was conducted to provide estimates of aquifer safe yields, delineate areas of surface water and groundwater interaction, estimate aquifer vulnerability and risk assessment, define areas for further explorations and propose a plan for sustainable aquifer management. Catchment, aquifer and well-field assessments encompassing modeling (FEFLOW) surface water and groundwater interactions, baseline monitoring, pumping test analysis and groundwater chemistry and contaminant surveying and delineation.

Hydrogeological Assessment of Deep Injection of Brine into the Devonian Formations at Suncor Firebag Lease 2012-2013

This assessment is currently being carried out for Suncor Energy as part of a licence review for an existing wastewater license disposal issued by the Alberta Energy Board. This assignment involves a hydrochemistry and isotopes data collection, groundwater modelling, hydrochemical interpretation, of saline and non-saline water of the Keg River Formation native water at a steam assisted gravity drainage (SAGD) facility in Alberta, Canada.

Hydrogeological Assessment of the Keg River Formation near Husky Sunrise Lease

This assessment was carried out for Husky Energy as part of an application to the ERCB for wastewater license disposal. This assignment involved hydrogeological Modelling (FEFLOW), hydrochemical interpretation, hydrochemical modelling (NETPATH) of saline and non-saline water from wells installed in the Keg River Formation as part of an ERCB license application at a SAGD facility.

Resume

Shell Carmon Creek EIA –Hydrogeology Component

A hydrogeological assessment was carried out for Carmon Creek SAGD facility EIA which involved hydraulic testing and sampling of the Paddy-Cadotte Aquifer and estimate of environmental likely effects from dewatering this unit for water supply. This assessment is at review stage and a SIR document was sent to AENV for approval.

Total Joslyn Mine Sidewide Hydrogeological Assessment

A monitoring report was sent Total with results describing the groundwater conditions pertaining to this site. The report included a sitewide assessment to identify potential dewatering risks posed by the proposed mine pit to existing surface water and groundwater. The assessment comprised a full set of groundwater level monitoring data, groundwater modelling (FEFLOW) chemistry assessment and full interpretation of environmental isotopes such as ^{18}O , ^2H , ^{34}S , Sr, ^7B , ^{13}C results.

Suncor Energy-Athabasca River Study

Hydrochemical and environmental isotope assessment (^{18}O , ^2H , ^{34}S , Sr, ^7B , ^3H , ^{13}C , ^{14}C) was carried out as part of the Athabasca River Assessment Program to address effect from mining into surface waters.

Cía Minera Milpo SAA-Lima-Perú. Water Supply Alternatives Assessment for Futura UM Hilarión

Surface water, hydrochemical and isotopic studies were conducted to construct a groundwater conceptual model of the area to identify potential water supply sources to the Future Hilarión Mine. Connections between springs flows and groundwater were assessed. GIS, aerial photographs interpretation, groundwater chemistry, environmental isotopes (^{18}O and Deuterium) were sampled and analysed to propose a site hydrogeological conceptual understanding. Surface water modelling and potential groundwater sources were explored with EM geophysical data.

Cía Minera Milpo-Lima Peru. Hydrogeological Study Comunidad San Juan de Milpo and Mina El Porvenir Cerro de Pasco

Hydrogeological and hydrochemical study to identify potential connections between springs flows and mine dewatering. GIS, Aerial photographs interpretation, groundwater chemistry, environmental isotopes (^{18}O and Deuterium) and Tritium were sampled and analysed to propose a site hydrogeological conceptual understanding, water alternatives sources and potential areas to be explored for groundwater supply.

2008 – 2010

Senior Hydrogeologist, Klohn Crippen Berger Ltd. Calgary Alberta

Shell Energy Inc. Fort McMurray, AB. Tailings Pond External Facility Groundwater Investigation. Aquifer dewatering and Sustainable Yield interpretation from well performance test interpretation applying Eden-Hazel and Bierschenk-Wilson approximations as part of a cut-off wall feasibility design.

Suncor Energy Inc. Fort McMurray, AB. Effects of Gas Ex-solution at the NSE Basal Aquifer
A site investigation was designed in 12 monitoring wells and 2 pumping wells to investigate the gas ex-solution effects on the variability of storage and hydraulic conductivity in the Basal aquifer at the NSE Mine.

Resume

Suncor Energy Inc. Fort McMurray, AB. SECW-Pumping Test Analysis STP Kame Aquifer

A report was submitted to the client with hydrogeological results including hydraulic Aqtesolv derived parameters. The software was applied to assess the hydraulic connectivity between several hydrogeological units following a 10-day constant rate pumping test.

Suncor Energy Inc. Fort McMurray, AB. NSE winter programme 2010-Winter Site Investigation Design. Design of 2010 winter site investigation for the Basal and the Limestone aquifers for the NSE mine.

Suncor Energy Inc. Fort McMurray, AB. NSE winter programme 2009- Winter Site Investigation Design

Design of 2009 winter site investigation for the Basal and the Limestone aquifers for the NSE mine.

Suncor Energy Inc. Fort McMurray, AB. MD9 Groundwater Compliance Report

This work entailed the design of a groundwater monitoring plan. Borehole logs and geophysical survey data were reviewed and surface water drainage and groundwater flow directions maps were constructed. New monitoring recommendations for borehole installations were included in a written report sent to the client.

Suncor Energy Inc. Fort McMurray, AB. NSE Pumping Tests and Slug Tests Analysis and Interpretation

Borehole logs were reviewed, pumping test details were reviewed, quality of water level data was checked and water level data vs. time was inserted in AQTESOLV. The results were reviewed and hydraulic conductivity values were obtained. A 3-days constant rate pumping test was reviewed and interpreted and the results were included in a summary table to be analysed in conjunction with other hydrogeological information at a later stage during this project.

Suncor Energy Inc. Fort McMurray, AB. Steepbank River Mapping Investigation

This project comprised a geological assessment of the river banks, river water sampling, analysis of river flows from two gauging points. EM Geophysical data was reviewed and interpreted to identify potential evidence of river-aquifer connections. A groundwater contours map from the shallow and deep aquifers was produced and compared with river bed elevations to identify potential aquifer discharge locations.

Seabridge Gold Inc. Vancouver, BC. Numerical Modelling of a Tailings Management Facility at KSM

The project comprised a review of drilling logs, packer tests, slug tests in order to construct a conceptual and numerical model in FeFlow capable of predicting potential flow seepage from a tailing management facility design.

Iamgold Inc. Cuenca, Ecuador. Quimsacocha Groundwater Baseline Report

For this assignment a review of the geology and drilling logs and hydraulic testing data was carried out in order to construct an Environmental Baseline for the groundwater volcanic system present at the Quimsacocha Mine, in the Equatorian Andes.

Minera Antamina. Lima, Peru. Antamina Closure Plan

As part of a regulatory requirement a hydrogeological assessment comprising stratigraphic units identification and mapping, hydrogeological cross-sections construction, groundwater flow data

Resume

collection and assessment, groundwater flow directions identified recommendations for new drilling locations and a general surface water monitoring plan.

2006 – 2008 **Principal/Senior Hydrogeologist, Scott Wilson Ltd, International Division
Guilford – UK**

Anglian Water. PLC. NSE Hydroecological and Environmental Impact Assessment of the Greywell and Itchel Sources Hampshire – England

Hydrogeological and hydroecological assessment, and environmental impact assessment from two groundwater abstraction from sources. Electromagnetic flow meters were installed on the Whitewater River and piezometers were installed in the main aquifers of the Greywell Fen area and supported with and supplemented with monthly flow accretion profiles.

SouthEast Water. PLC. Hydrological, hydrogeological and Hydrochemical Monitoring Program of the Rother Catchment. Kent – England

Monitoring program of surface water and groundwater sources in the Rother Catchment. The monitoring program was used as a support for an environmental impact assessment from groundwater and surface water abstraction Information. The monitoring comprised pumping tests from 7 sources supported with water level records acquired from dataloggers installed in 21 points located across the River Rother Catchment area.

SouthEast Water. PLC. Hydrogeological and Environmental Impact Assessment Crowhurst Bridge AMP-4 Phase 2. East Sussex – England

Field assessment and interpretative study which comprised the following: conceptual model, drilling programme, pumping tests design and execution, surface water and groundwater interaction assessment, groundwater augmentation scheme, and the hydrochemical evaluation of Fe and Mn ions present in groundwater.

SouthEast Water. PLC. Desk Top Study for the Eastern Rother Catchment East Sussex – England

Desk-top study was carried out to produce a data review and data gap assessment. A preliminary conceptual model was designed to be supplemented by a drilling program, and pumping tests programme in order to identify groundwater effects of a groundwater augmentation scheme and to determine the origin of Fe and Mn ions present in the groundwater.

Anglian Water PLC. Environmental Appraisal Barford and Marlingford Groundwater Sources Norfolk – England

Hydrogeological and hydroecological assessment of impacts on groundwater abstraction licenses from 2 sources. The impacts were assessed on ESAs, SSSI sites, existing licenses, surface water and groundwater around the Marlingford Area, supported with water level records acquired from dataloggers installed in 47 monitoring points and supplemented with flow accretion profiles.

Environment Agency -Anglian Region Drilling and Borehole Installation Supervision-Norfolk – England

Project manager for the preparation of drilling specifications document, drilling contract preparation, field supervision, testing and sampling of 14 monitoring boreholes in the Crag and Chalk aquifers. Drilling rigs used for this assignment techniques included percussion and rotary equipment.

Resume

SouthEast water. PLC. Coggins Mill WTW. Water Resource Assessment. Phase 2 Study Kent - England

Water resources and environmental impact assessment of groundwater abstraction from three pumping boreholes on the surface water and groundwater around the Coggins Mill Catchment. This project also provided a thorough assessment of the water treatment works (WTW) engineering capacity and its deployable output.

Anglian Water PLC. Environmental Impact Assessment Barford Source-Norfolk – England

Hydrogeological program which comprised an ecological assessment of ESAs, SSSI sites, pumping tests, piezometer drilling, continuous monitoring records of water levels from 23 points, which covered existing licenses on surface water and groundwater to assess the potential impacts around the Barford Area.

SouthEast Water PLC. Water Resource Evaluation Study. Phase I Coggins Mill Water Treatment Works. Kent – England

Groundwater resources assessment study and a deployable output assessment. The project was focused on borehole assessments (geophysical logging, CCTV survey, pumping tests and water sampling), spring surveys and surface water monitoring intending to assess the potential to increase the total groundwater output from the Ashdown Beds aquifer into the adjacent Water Treatment Works (WTW).

DoE-Kingdom of Bahrain. Regional Groundwater Assessment of Bahrain and South Arabia Region. North Bahrain - Bahrain

This project was undertaken as a desk-top study which involved identification of main hydrogeological units, main groundwater flow direction between the East of the Arabian Peninsula and Kingdom of Bahrain. This study was followed by an environmental risk assessment.

2002 – 2005

Hydrogeologist , Water Research Centre Swindon - UK

J. Routledge & Sons. Review of Waste Acceptance Criteria For Whitemoss Landfill. Skelmersdale- West Lancashire - England

Waste and groundwater analysis to be screened against the Waste Acceptance Criteria Legislation (WAC) and applied as a source term in Landsim 2.5 model for a hazardous waste assessment of a landfill. This project was part of an (PPC) EA requirement towards reaching a hazardous waste derogations status on behalf of the client.

Oxbury & Company-Flagship Housing Group. Site Investigation, Groundwater Risk Assessment and Human Health Risk Assessment On green Road Brampton. Suffolk. East Anglia - England

Characterization of a heavily contaminated soil, R&D 20 and CLEA modeling applied and a remediation plan was designed. Ground investigation and monitoring review were used to support a remediation strategy. Soil investigation in a mercury contaminated soil area, groundwater drilling investigation, leachate analysis, mercury speciation, the risk assessment to groundwater and human health was carried out with the R&D20 model and the CLEA model. The hot spot were identified and the contaminated soil was removed from the site.

RMC-UK-Limited. Modelling of Berkyn Manor Farm, Poyle. Environmental Impact

Resume

Assessment from Quarry Dewatering. Surrey – England

Groundwater modelling of dewatering and delineation of mitigation measures for two mineral extractive sites. Both projects were carried out using G-Vistas (MODFLOW) for prediction of dewatering scenarios, environmental impacts and mitigation measures.

BP. Risk Assessment in Chesham Old Site. Buckinghamshire - England

Conceptual understanding to evaluate the migration of a chlorinated solvents plume to environmental receptors. A quantitative groundwater risk assessment using the R&D20 model and RISC () modelling software was also carried out for this assignment.

Environment Agency-Midlands Region Lecheate Migration Assessment into the Unsaturated Zone. Nottinghamshire - England

Contaminant migration modelling study using Landsim V2.5. The study was carried out in the Burnstamp site. The modeling was used as a tool for planning and designing drilling depths and as a tool to predict leachate migration.

Southern Water PLC Intrusive Site Investigations at Morestead Road / St. Catherine's Hill Waste Water Treatment Works. Hampshire- England

Catchment study, drilling core recovery, organic and inorganic water sampling and pumping test interpretation carried out in 19 boreholes drilled into the Chalk aquifer at Morestead road / St. Catherine's Hill waste water treatment works.

Environment Agency-Site Characterization of the Dartmoor cSAC. Cornwall- England

Geological and hydrogeological assessment of Dartmoor cSAC, review of consents and GIS information.

2001 – 2002

Hydrogeologist, Water Management Consultants Ltd Shrewsbury - United Kingdom

Environment Agency – Midlands Region-Groundwater Conceptual Model for the Upper Avon Catchment. England

For this desk-top study relevant information was collected in order to propose a conceptual model of the groundwater management units (GWMU) of the Upper Avon Catchment. The Resource Assessment Management Strategy (RAMS) was implemented to account the groundwater availability from each GWMU. This information was linked with the surface water and ecology components.

2002 – 2001

Advisor - Hydrogeologist, Institute of Hydrology Meteorology and Environmental Studies. Bogota – Colombia

COPOMAGDALENA. MoE Colombia. Magdalena-Cauca Basin. Environmental Baseline Study- Bogota - Colombia

Environmental Baseline Study. The main project objective was to provide elements for environmental, hydrologic and land planning around the wider catchment of Colombia. The project report was produced with information collected during 3 years of studies and research.

CORPONARIÑO. MoE Colombia. Environmental Management Plan Doña Juana Volcanic

Resume

Complex and Juanoy Area. Nariño - Colombia

Field activities related to environmental base line collection and interpretation, consultation process with the Indigneous communities of Doña Juna Volcanic Complex. Environmental workshops, environmental base line collection and interpretation, land management plan design, report writing and stakeholders liaison (World Bank and Ministry of Environment). During this period desktop and field information were collected and assessed within deadlines proposed. Satellite images and aerial photography were used in a preliminary assessment report involving geology, hydrology, land use and main natural ecosystems of the area of study; the report was submitted to the Ministry of Environment and stakeholders at the area of study.

CAR- MoE Colombia Hydrogeological Assessment and groundwater modelling of the aquifers Fuquene Lagoon. Bogota - Colombia

Hydrogeological understanding of the Fuquene lagoon and its interactions with the Cretaceous and Quaternary units. In order to achieve the project aims, existing information was collected and analysed, a conceptual model was proposed and hypotheses related to recharge zones and flow directions were assessed with aid of groundwater numerical modelling techniques. For this interpretation a numerical model was constructed and calibrated using MODFLOW. The model reproduced the piezometric map with reasonable accuracy and it was used to calculate the groundwater catchment areas, main flow directions and water balance of main aquifers.

CAR- MoE Colombia-Hydrochemistry and Isotopes Assessment of the Rio de Bogota Basin. Bogota - Colombia

Hydrogeological investigation of the Rio de Bogota Basin to provide input for a water management policy design and implementation for the Rio de Bogota Basin. The outcome of this investigation was submitted to the IAEA – Vienna.

1997 – 2000

Hydrogeologist , Institute of Geology and Mining – Colombia. Bogota – Colombia

IAEA & MoE Colombia-Conceptual understanding of the Rio de Bogota Basin. Bogota - Colombia

Identification and assessment of recharge zones, identification of interaction between main aquifers and evaluation of groundwater residence time along selected pathways of the main aquifers of the Rio de Bogota Basin. For this study a sampling network was designed to monitor water levels and water quality. Chemical and isotopic sampling was carried out from rainfall, surface waters, springs and groundwater. The study was focused on the Quaternary lacustrine aquifer and Cretaceous fractured sandstone and mudstone.

GTZ. Corpamag- Conceptual Understanding of Santa Marta Banana Plantation Zone. Santa Marta - Colombia

Regional groundwater investigation, water feature survey, pumping test design, analysis, and interpretation, geophysical survey, water quality sampling, and interpretation, water balance estimation and to design an aquifer management plan.

Groundwater Conceptual Model of San Andres Island. Bogota - Colombia

Conceptual understanding assessment and to propose a water balance of the main aquifers of the San Andres Island on behalf of the regional Environmental Authority.

EDUCATION

M.Sc. Hydrogeology-University of Catalunya, Spain, 2001

Dip.Sc. Hydrogeology-University of Catalunya, Spain, 1995

B.Sc. Geology-University of Caldas, Colombia, 1994

REGISTRATIONS/AFFILIATIONS

P.Geol. Professional Geologist. Association of Professional Engineers Geologists and Geophysicists of Alberta. APEGGA

International Association of Hydrogeologists Canadian Chapter - IAH CNC.

PUBLICATIONS/PRESENTATIONS

2003. Castrillon. F et al. Evaluation of the Origin and Residence Time of the Groundwater in a Regional Aquifer System, Rio de Bogotá Basin, Colombia. International Symposium on Isotope Hydrology and integrated water resources management, 19-23 May 2003, Vienna-Austria. IAEA-CN-104/P149. Poster.

2002. Castrillon F., Aravena R. Algunas evidencias de explotación intensiva de los acuíferos de la cuenca alta del río Bogotá – Colombia, Sur-América. Boletín Geológico y Minero ITGME Madrid-Spain. ISSN:0366-0176. Paper.

2001. Castrillon F., Aplicación de isótopos ambientales y geoquímica en el estudio hidrogeológico de la Cuenca Alta del Río Bogotá – Colombia. Congreso “Las caras del agua”, Barcelona, Septiembre 21-25, Universidad de Cataluña. Paper.

2001. Caracterización hidrogeoquímica de las aguas subterráneas de la Cuenca Alta del Río Bogotá – Colombia. VIII Congreso Colombiano de la Geología. Manizales – 8-10 de Julio de 2001. Paper.

1999. Interpretación preliminar de la isotopía e hidroquímica de la Sabana de Bogotá. X Jornadas de la Ingeniería Colombiana. Bogotá. Colombia. Paper.

1999. Isotopes and groundwater of Sabana de Bogotá Aquifer, Colombia. 3rd International Symposium of Geochemistry in Tropical Countries. Nereroi Brazil. October 23-27. Poster.

1999. Hydrochemical Assessment of Santa Marta Aquifer. Caribbean Coast, Colombia. 3rd International Symposium of Geochemistry in Tropical Countries. Nereroi – Brazil. October 23-27. Poster.

SPECIFIC TECHNICAL EXPERTISE/SPECIALIST COURSES

Technical Expertise:

Water Resources Sustainability
Effects from Presence of Methane Gas in Groundwater
Groundwater Modelling
Water Resources Management
Aquifer Testing
Hydrochemical and Isotopes

Specialist Courses:

Risk Assessment of Contaminated Land- University of Birmingham, UK. 2004
Practical Groundwater Flow and Contaminant Transport Modelling- ESI Shrewsbury, UK. 2004
Landsim 2.5. Training Course, Golder Associates Nottingham, UK. 2004
Monitored Natural Attenuation and In- situ Remediation. Toronto-Canada. 2000
Environmental Hydrogeology. INGEMINAS. Bogotá- Colombia. 1997
Isotopic Limnology-IAEA- Titicaca Lake. Perú. 1998