



## INTRODUCTION

KLM Consulting Services (KLMCS) is a multi-disciplinary consulting company, specializing in mine dewatering, depressurisation and management of water resources. KLMCS was established in 1989 and is a recognized leader in the field of water supply and mine-dewatering in Southern Africa. It is an expanding, highly specialized company, continually striving to offer clients innovative technology to achieve cost effective, appropriate designs for village, municipal, mine and industry.

Dr Kym Morton is the founder and Managing Director and has over 36 years experience in consulting on ground water projects. The large number of successful projects completed by the company is testimony to her and the staff's technical ability. KLMCS focus on increasing client profitability through accurate water control.

In 2006, KLMCS Botswana was established by KLMCS South Africa, in partnership with Botswana citizens to provide expert groundwater consulting services to the Botswana mining industry. In 2010 a UK office was opened.

## MISSION

KLMCS is committed to providing the most applicable technology for solving ground water problems. Our Clients are assured of complete dedication to accurate collection of relevant data and of performing cost-effective analysis, so as to met their needs and improve their profitability. Training of clients in accurate water management is key.

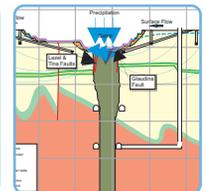
## VISION

Our services include ground water resource assessment; mine dewatering design and application; ground water supply; pollution control and remediation. Emphasis is on using tried and tested techniques developed by KLMCS, so as to reduce costs and improve ground water control and utilisation. Techniques developed on mining projects are transferred to development projects in remote areas.

KLMCS recognises the need to achieve a balance between industrial development and environmental responsibility. Our vision is to continue serving the mining and industrial sector, providing feasible, environmentally sound solutions and expanding our services to include the implementation of remedial techniques as required.

Specifically we provide, expert technical direction in:

- Ground water resource development, management and sustainability
- Mine dewatering design and depressurisation
- Installation and monitoring of groundwater resources
- Input to geotechnical design e.g. slope stability through depressurisation
- Environmental site assessments
- Development of conceptual and numerical models for groundwater flow and contaminant transport
- Remediation design
- Geographical Information Systems (GIS)
- Training courses and seminars.
  - Introduction to Groundwater
  - Groundwater management and monitoring
  - Mine dewatering design



**31**  
**YEARS**  
1989-2020

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## SERVICES

We offer a full range of services related to ground water resource assessment, from mine dewatering to environmental management, mine and aquifer rehabilitation and reporting. These include:

### *Mine dewatering design*

KLM Consulting Services has led the groundwater profession in Southern Africa in providing comprehensive hydrogeological and dewatering consulting services to major Mining Houses. Open pit and underground mines require dewatering and depressurisation to ensure high-wall stability and pit floor workability. It is important to maintain the water table below the mine workings and to lower the pore pressures in the slopes. Background data on water levels and pore pressures are collected to calculate the effectiveness of the dewatering system that will be used. Best practice is to start dewatering before mining. Design and integration of the system are aligned with cashflow projections.

All mines that are excavated below the water table need some form of dewatering. The scale of the dewatering effort is dependent upon the following factors:

- The hydrogeological characteristics of the rock mass in which the excavation takes place.
- The depth of the excavation below the water table.
- The strength of the materials making up the pit slopes or tunnels.

Our areas of mine dewatering design and depressurisation expertise include the following:

- Structural mapping and inflow plotting
- Testing the hydraulic properties of rocks
- Installation of monitoring networks and the data base set up and dashboards
- Numerical modelling of water inflow and dewatering schemes
- Layout of drainage galleries or drainholes
- Design of dewatering and supply boreholes
- Supervision of construction and test pumping of boreholes and drain holes
- Design and operation of groundwater monitoring and remediation systems
- Mine-Waste Impact Assessments and Management
- Modelling of post mining pit chemistry
- Site rehabilitation designs



### *Groundwater resource development and management*

Groundwater is a valuable source of water in arid and remote areas. Due to declining rainfall, demand for groundwater is increasing. Municipalities and all companies need to ensure the most efficient use of existing resources.

Over the past 28 years, KLM Consulting Services has identified, developed and implemented large scale wellfields (6Mm<sup>3</sup>/yr to 12Mm<sup>3</sup>/yr) and designed their management programmes. KLMCS understands it is important that for future generations, these resources are managed sustainably and effectively.

We also have expertise in:

- Groundwater exploration and hydrocensus
- Groundwater exploration programmes using remote sensing and geophysical methods
- Down-hole geophysical logging surveys
- Preparation of terms of references (scope of work) for drilling and pumping test activities
- Supervision of drilling and pump testing of water supply boreholes
- Design of boreholes and supervision of construction
- Design and implementation of aquifer pumping tests
- Analysis of aquifer testing and evaluation
- Groundwater sampling according to internationally acceptable protocols
- Water quality assessment
- Numerical modelling of groundwater flow and solute transport
- Aquifer monitoring and water management strategy
- Licensing with authorities and compliance with stock exchange regulations
- Artificial recharge programs
- Management, development and monitoring of well fields and major aquifers
- Writing and review of Bankable Feasibility studies
- Reducing water costs to business



## ***Environmental impact assessment and environmental management reports.***

Government, lenders and stock exchange regulations impose environmental liability on past, current and future land users. Before inception of any project, an environmental impact assessment study has to be conducted to determine potential effects on the environment and possible mitigation.

Ground water can be contaminated from urban waste, industrial effluent, diffuse source or mine tailings. Prevention and control require effective containment and management techniques.

KLMCS has expertise in:

- Sampling of soil and ground water for contaminants (including volatile organics such as chlorinated hydrocarbons)
- Geophysical surveys to determine preferential groundwater flow paths and tracing of pollution plumes
- Installation of monitoring networks
- Satellite and air photo interpretation to locate seepage and sub surface flow from waste disposal facilities
- Tier 1 and 2 site assessments in accordance with the Risk Based Corrective Action (RBCA) approach
- Health based risk assessment according to the US EPA protocol
- Modelling of contaminants (including hydrocarbon and chlorinated hydrocarbon) transport and degradation
- Writing of Environmental Management Program Reports (EMPRs) and Environmental Impact Assessments (EIAs)
- Expert testimony
- Review of EIA's and EMPR's.

## ***Development of conceptual and numerical models***

Ground water models are valuable tools in determining and simulating ground movement of water and contaminants. The initial step in setting up a mathematical model is the development of a conceptual model, which is then coded using an appropriate software programme such as MODFLOW, FEFLOW, MINEDW (through HClasca USA), PHREEQC, BIOCHLOR, SEQUENCE, RBCA and others, depending on the applicability to the project.

KLMCS areas of expertise include:

- Collection and processing of pump testing, hydrogeological and geochemical data
- Preparation of data plots, cross sections, contour diagrams, geostatistical analysis
- Aquifer simulation to determine drawdown, wellfield design and dewatering requirements
- Solute transport and flow path modelling for environmental studies
- Simulated aquifer clean up, protection and management
- Risk analysis and cost benefit evaluation

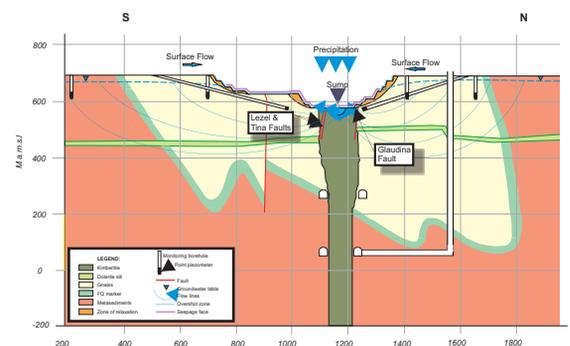


## ***Remediation design***

Cost effective and successful remediation design and technologies are currently being researched in order to offer our clients a solution to groundwater contamination problems. We assist clients not only in the evaluation, but also in the design and implementation of remedial and groundwater control systems.

KLMCS areas of expertise are:

- Conventional excavation and disposal;
- Monitored natural attenuation (MNA);
- Enhanced biodegradation and bioremediation (both in-situ and ex-situ);
- Groundwater pump and treat systems;
- Groundwater hydrodynamic control systems (gradient reversals);
- Scavenger systems and recycling



In addition we utilise a network of qualified contractors to implement the following aspects:

- Soil remediation systems;
- Air sparging;
- Soil vapour extraction;
- Surface/subsurface geotechnical structures;
- Water treatment and disposal systems;
- Underground storage tank removals.

## Training courses

Courses are given each year by the staff of KLM Consulting Services and its associates. The courses are designed for managers, engineers and geologists working in a mine environment, where groundwater, (either too much or too little) needs to be managed. The emphasis is balanced between hard mining issues, such as the prediction, occurrence and removal of groundwater, as well as the environmental considerations and reduction in pollution. Professionals who manage groundwater projects also benefit from the courses.

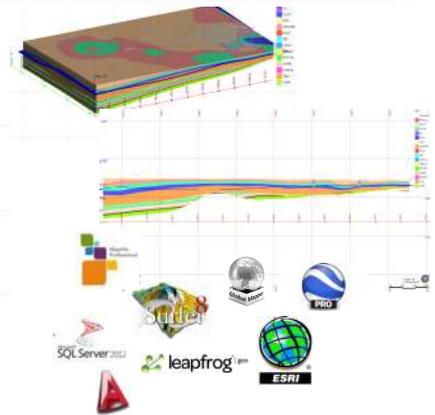
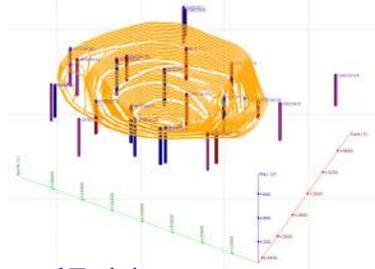
The skills gained from the courses are:

- A thorough understanding of groundwater occurrence and movement;
- An understanding of different mine dewatering techniques;
- The ability to manage groundwater projects and optimise returns;
- The ability to identify potential sources of pollution.

## Geographical Information Systems (GIS)

We offer a wide spectrum of GIS services which include:

- GIS programming, solutions design and implementation
- Spatial Database setup, programming and maintenance
- Web Based GIS programming and configuration
- GIS hosting and virtualised GIS server setup
- Spatial Analysis
- Gap Analysis
- Spatial Data Maintenance and Data Migration
- Cartography and Customised mapping
- Differential GPS Survey and GPS Data Analysis
- Rapid point survey data collection
- Utilities Mapping
- GIS Support, Implemented Systems Documentation and Training



KLMCS has been contracted to work on mines dealing in coal, base metals, gold, kimberlite, platinum, uranium and industrial minerals.

### Our Clients include:

AB Global Mining  
Akanani Mining  
Amplats Ltd  
Anglo American Corporation of South Africa  
Anglogold Free State  
Anglogold Vaal River Operations  
Anglogold West Wits Mines  
Anglovaal Ltd  
Aviva Corporation, Australia  
Aurecon  
Barplats Ltd  
BHP Billiton Ltd. (MAC)  
Boteti Mining Company and Lundin Group (AK6, Karowe)  
Botswana Department of Water Affairs  
CIC Energy  
De Beers Consolidated Mines (Finsch, Premier/Cullinan, Kimberley mines, Koignas, The Oaks, Williamson and Venetia)  
Debswana mines (Orapa, Jwaneng, Damtshaa and Letlhakane)  
Diamondfields  
Discovery Metals Ltd, Australia  
E. Oppenheimer & Sons  
Equinox Minerals Limited Australia  
Gautrain Bombela Consortium  
Gem Diamonds  
Gibb (Arcus Gibb)  
Goldfields Ltd  
Hatch  
Highland Mining Corporation Limited

Impala Platinum Ltd  
Industrial Development Corporation of South Africa  
Ingwe Ltd  
International Mining Consultants (World Bank)  
JCI projects  
Kamoto Mines  
Lumwana Mining Corporation  
Malawi Department of Water Irrigation and Development  
Minergy  
Mocambique Department of Water (DNA)  
Murray and Roberts  
Namzinc  
National Union of Mineworkers  
Noventa Pty Ltd  
Paradigm Project Management  
Parsons Brinckerhof ( PB Power)  
Price Forbes Control Risk Management (Lloyds of London)  
RARECO  
Rio Tinto Ltd  
Rossing UraniumSnowden Consulting  
South African Department of Environmental water  
Southern Era Resources (Klipspringer) Toronto  
SRK Consulting Services  
Sulzer Pumps  
Teal Mining Pty Ltd  
UNESCO (Ramsar Convention)  
Vedanta Resources PLC  
The University of the Witwatersrand