What Will be Covered?

- INAP/GARD Guide Introduction
- All 11 Chapters of the Guide
- Focus on Chapter 6, Prevention and Mitigation
- Questions
INAP

An international organization that seeks knowledge expansion and technology transfer for ARD prevention and water management in support of responsible mineral development.
Supported by the Global Alliance

Acid Drainage Technology Initiative

Water Research Commission
GARD Guide
www.gardguide.com

An international guide for facilitating world-wide best practice in prediction, control, and mitigation of acid rock drainage.

The guide will become a reference document for all stakeholders involved in ARD and waste management issues.
Steering & Advisory Committees

- Clive Bell - ACMER (Australia)
- Rich Borden - Kennecott (USA)
- Charles Bucknam - Newmont (USA)
- Rodolfo Camacho - Freeport McMoRan (Chile)
- Dave Chambers - Center for Science in Public Participation (USA)
- Meiring du Plessis - Water Research Commission (S. Africa)
- Linda Figueroa - Colorado School of Mines/ADTI (USA)
- Ross Gallinger - IAMGOLD/INAP (Canada)
- Elizabeth Gardiner - Mining Association of Canada/MEND (Canada)
- Charlene Hogan - NRCan (Canada)
- Zhenqi Hu - China University of Mining and Technology (China)
- Adam Jarvis - U of Newcastle (UK)
- David Jones - Australia Department of Environment and Health (Australia)
- Lars-Ake Lindahl - Swedish Mining Association (Sweden)
- Glenn Miller - University of Nevada (USA)
- Peter Moore - Export Development Canada (Canada)
- Bill Price - Natural Resources Canada/MEND (Canada)
- Dave Salmon - Anglo American (S. Africa)
- Jos Schaekers - Consultant (S. Africa)
- Gilles Tremblay - NRCan (Canada)
- Harvey Van Veldhuizen - World Bank - MIGA (USA)
- David Williams - US Bureau of Land Management/ADTI (USA)
- Christian Wolkersdorfer - PADRE/IMWA/TU Bergakademie Freiberg (Germany)
- Jennifer Yang - International Copper Association (China)
- Paul Ziemkiewicz - University of West Virginia/ADTI (USA)
Scope of GARD Guide

1. **All Mine Phases** – Exploration through Post-Closure

2. **All Mine Facilities** - tailing, waste rock, underground mine, pit walls, pit lakes, spent ore heaps and low-grade stockpiles

3. **All Commodities** - base metals, precious metals, coal, diamonds, iron ore and uranium

4. **Global perspective** -
Chapter 1: GARD Guide

Keith Ferguson (Sustainability Engineering)
Chapter 2: ARD Process
Rens Verburg (Golder)

From Stumm and Morgan, 1986
Chapter 3: Corporate, Regulatory and Community Framework

John Wates (Fraser Alexander) and Frank Wimberley (Golder)
# Chapter 4: Characterization

Devin Castendyk (SUNY) and Cheryl Ross (Golder)

## Mine Phase - Increasing Knowledge of Source Material Characteristics

<table>
<thead>
<tr>
<th>Waste or Facility Type</th>
<th>Potential ARD/SD Sources</th>
<th>Waste Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Laboratory testing of drill core samples - target waste sample</td>
<td>Ongoing laboratory testing of drill core or development rock samples</td>
</tr>
<tr>
<td></td>
<td>Laboratory testing of pilot plant tailings - Analysis of pilot testing supernatant</td>
<td>Ongoing laboratory testing of tailings discharge</td>
</tr>
<tr>
<td></td>
<td>Laboratory testing of drill core samples - sample selection target pit walls</td>
<td>Field scale leach testing (e.g., wall washing)</td>
</tr>
<tr>
<td></td>
<td>Laboratory testing of drill core samples - sample selection target mine walls</td>
<td>Collection and analysis of mine pool water samples</td>
</tr>
</tbody>
</table>

- Typical laboratory testing components: particle size, whole rock analysis, mineralogy, ABA, static and kinetic leach testing

## Post-Closure (Care and Maintenance)

- Collection and analysis of supernatant and seepage samples from TSP (if necessary)

## Operation

- Collection and analysis of runoff and seepage samples from waste rock facility (if necessary)

## Decommissioning

- Collection and analysis of supernatant and seepage samples from waste rock facility (if necessary)

## Decommissioning

- Collection and analysis of supernatant and seepage samples from waste rock facility (if necessary)

## Post-Closure (Care and Maintenance)

- Collection and analysis of supernatant and seepage samples from waste rock facility (if necessary)
Chapter 5: Prediction

Kirk Nordstrom (USGS) and Rens Verburg (Golder)
Chapter 6: Prevention and Mitigation

Ward Wilson (UBC) and Ben Wickland (Golder)
Chapter 7: Treatment

Andre van Niekerk (Golder)
Chapter 8: Monitoring

Peter Chapman and Cheryl Ross (Golder)
Chapter 9: ARD Management and Performance Assessment

Dirk van Zyl (UBC), Andy Robertson (RGC) and William Pulles (Golder)
Chapter 10: ARD
Communication and Consultation
Tisha Greyling (Golder)
Chapter 11: ARD Management in the Future
Keith Ferguson and Beth Beloff (Golder)

- Sustainable development
- Research and development
- Stakeholder roles in advancing ARD science and management
Chapter 6
ARD Prevention and Mitigation

ARD TETRAHEDRON

Pyrite
Bacteria
Air (O₂)
Water
Approach to ARD Prevention and Mitigation

By Disrupting the ARD Tetrahedron relationship in one or more ways Using a Risk-Based Approach

- Minimizing oxygen supply because of diffusion or advection
- Minimizing water infiltration and leaching (water acts as both a reactant and a transport mechanism)
- Minimizing, removing, or isolating sulphide minerals
- Controlling pore water solution pH
- Maximizing availability of acid neutralizing minerals and pore water alkalinity
- Controlling bacteria and biogeochemical processes
Overview
Best Management Practices

- Avoidance
- Re-mining
- Special Handling Methods
- Additions and Amendment Methods
- Water Management Methods
- Reduction of Surface Infiltration
- Liners
- Dry Cover Methods
- Water Cover Methods
Selection and Evaluation of Alternatives
Design and Construction Considerations

- Analytical and numerical modeling
- Phased implementation and testing
- Timing is important
- Use of readily-available and sustainable materials will be important.
Maintenance and Monitoring Considerations

- Walk-away is the Holy Grail
- Most remedies are low-maintenance, not “no maintenance”
- Maintenance supports integrity of the engineering design
- Monitoring documents achievement of objectives, avoids surprises
- Monitoring details in Ch 8 of GARD Guide
Acknowledgements

- Terrence Chatwin
- Rens Verburg
QUESTIONS?

Visit www.gardguide.com