



# AMD in the Bolivian Altiplano: Unique Problems and Solutions

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# Overview



Mining In Bolivia



Kumurana Valley



Phase I



Phase II

# Overview



Mining In Bolivia



Kumurana Valley



Phase I



Phase II



# Mining In Bolivia



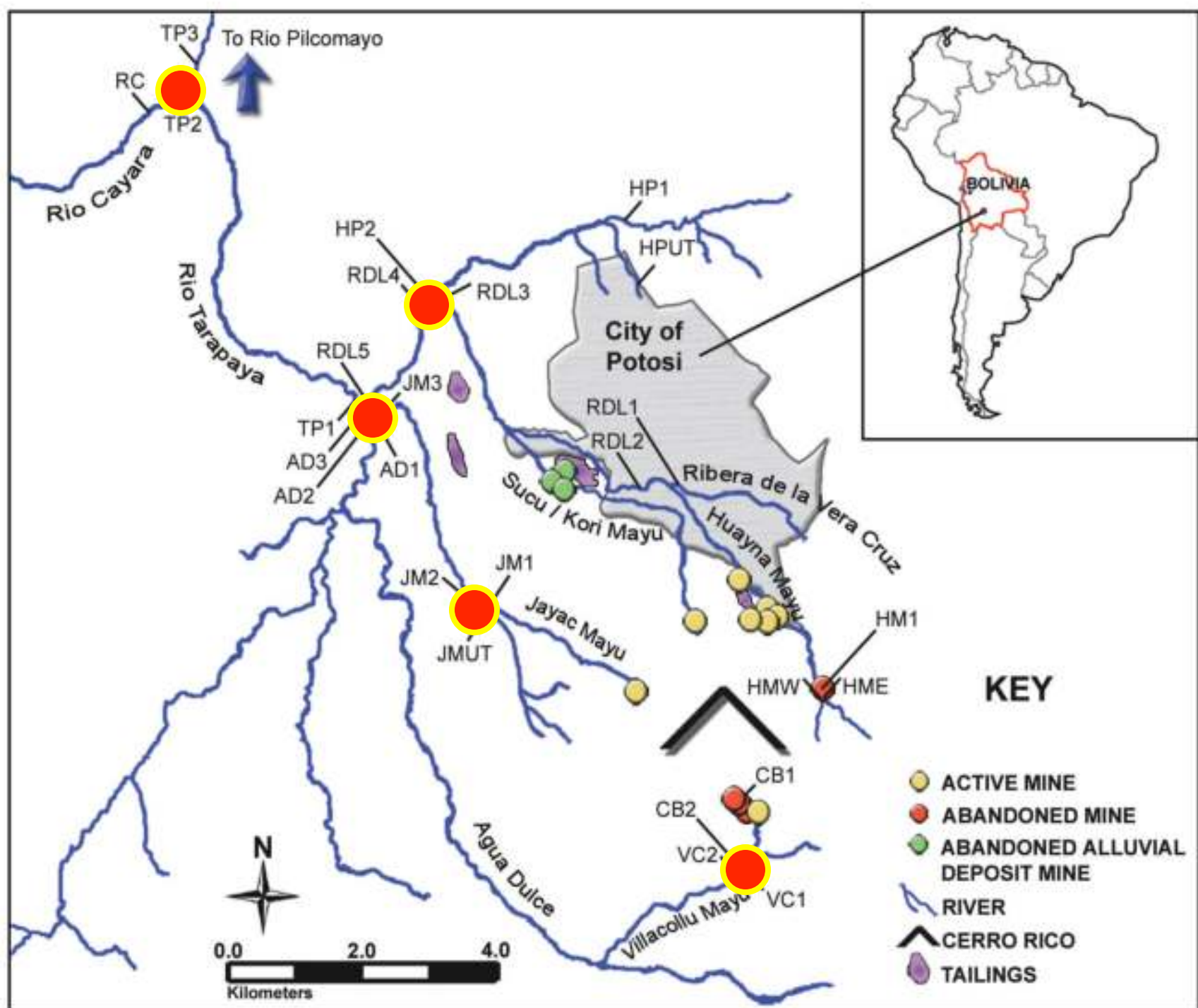
# Cerro Rico

- 1532 Pizarro
- 1545 Potosí
- “Envy of Kings”
  - “Silver Train”
  - ~40,000 tonnes of Ag
- “Mountain that Eats Men”
  - 7-8 million deaths

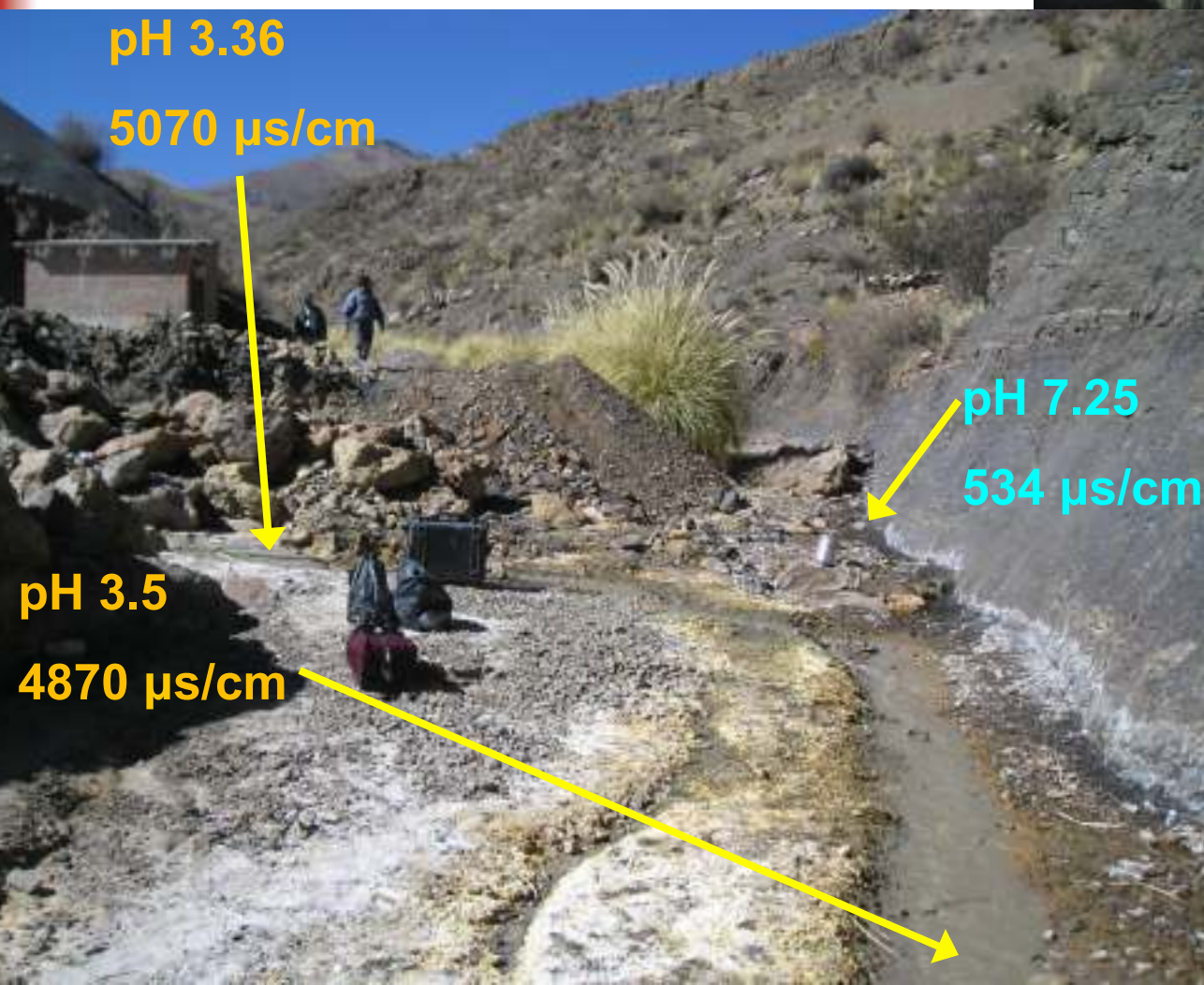
The SILVER - MINE of POTOSI.







# Typical Situation



pH 3.36

5070  $\mu\text{s/cm}$

pH 7.25

534  $\mu\text{s/cm}$

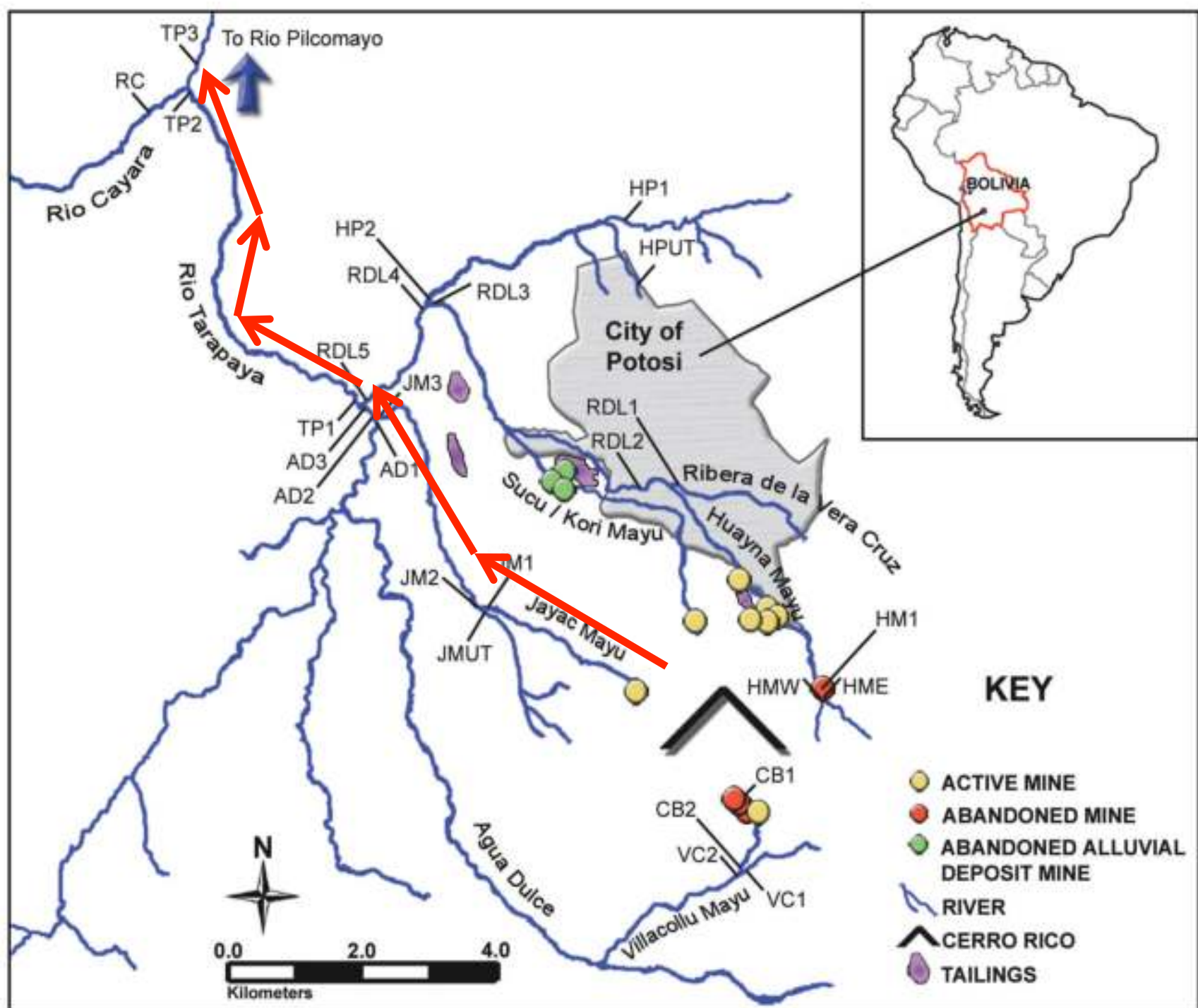
pH 3.5

4870  $\mu\text{s/cm}$

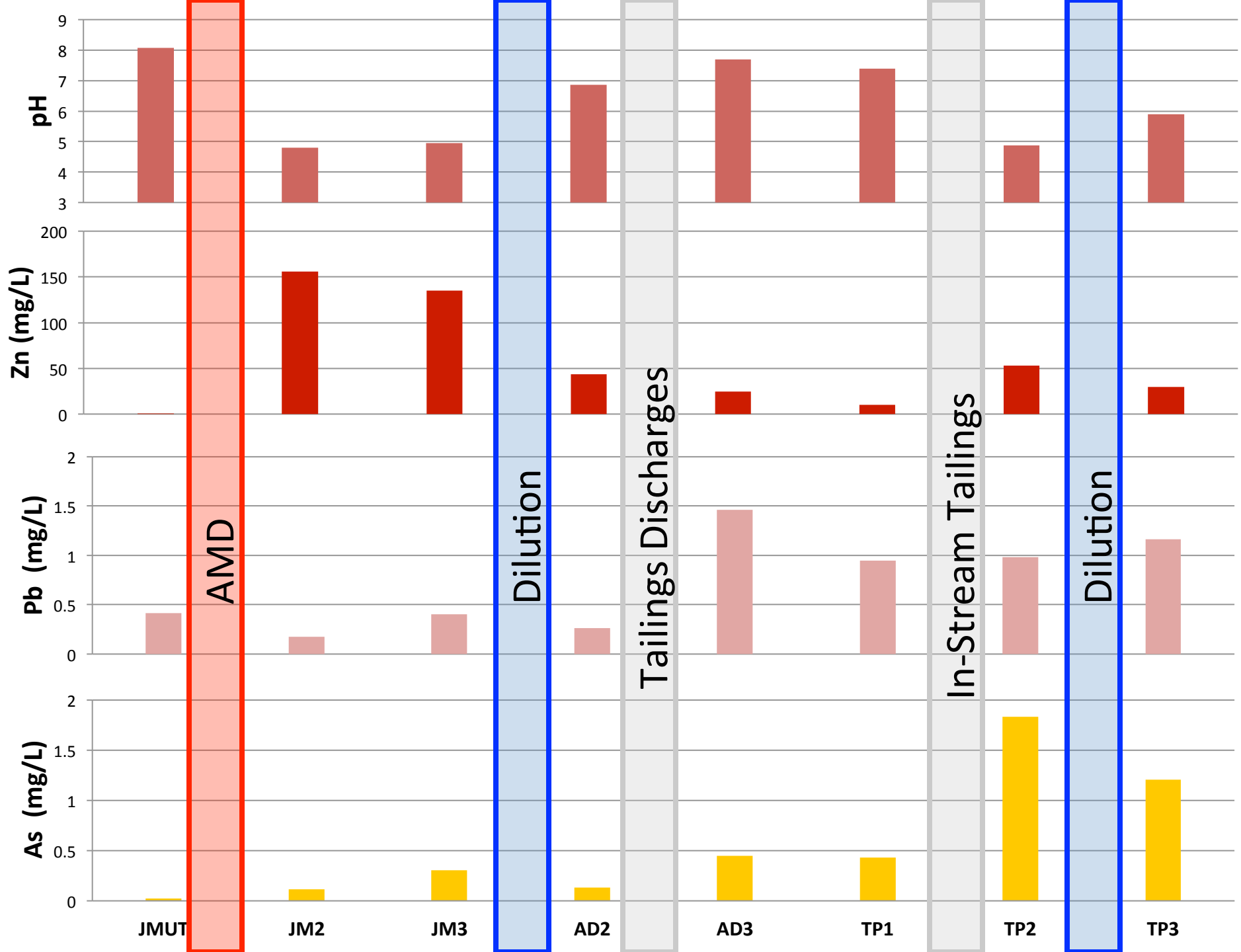
## Jayacmayu (mg/L)

As	14
Cd	5
Fe	1100
Mn	85
Ni	0.8
Pb	3.3
Zn	1500
SO <sub>4</sub>	4000-8000









# Overview



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Phase I



Phase II



# The Problem: Muyu Khocha





# Khomer Khocha









EMPRESA MINERA VERTEDLA  
MINA "KUMURAY"  
INTERCOMUNICACION  
TEL: 054-445-123456789





# Laguna Santa Catalina



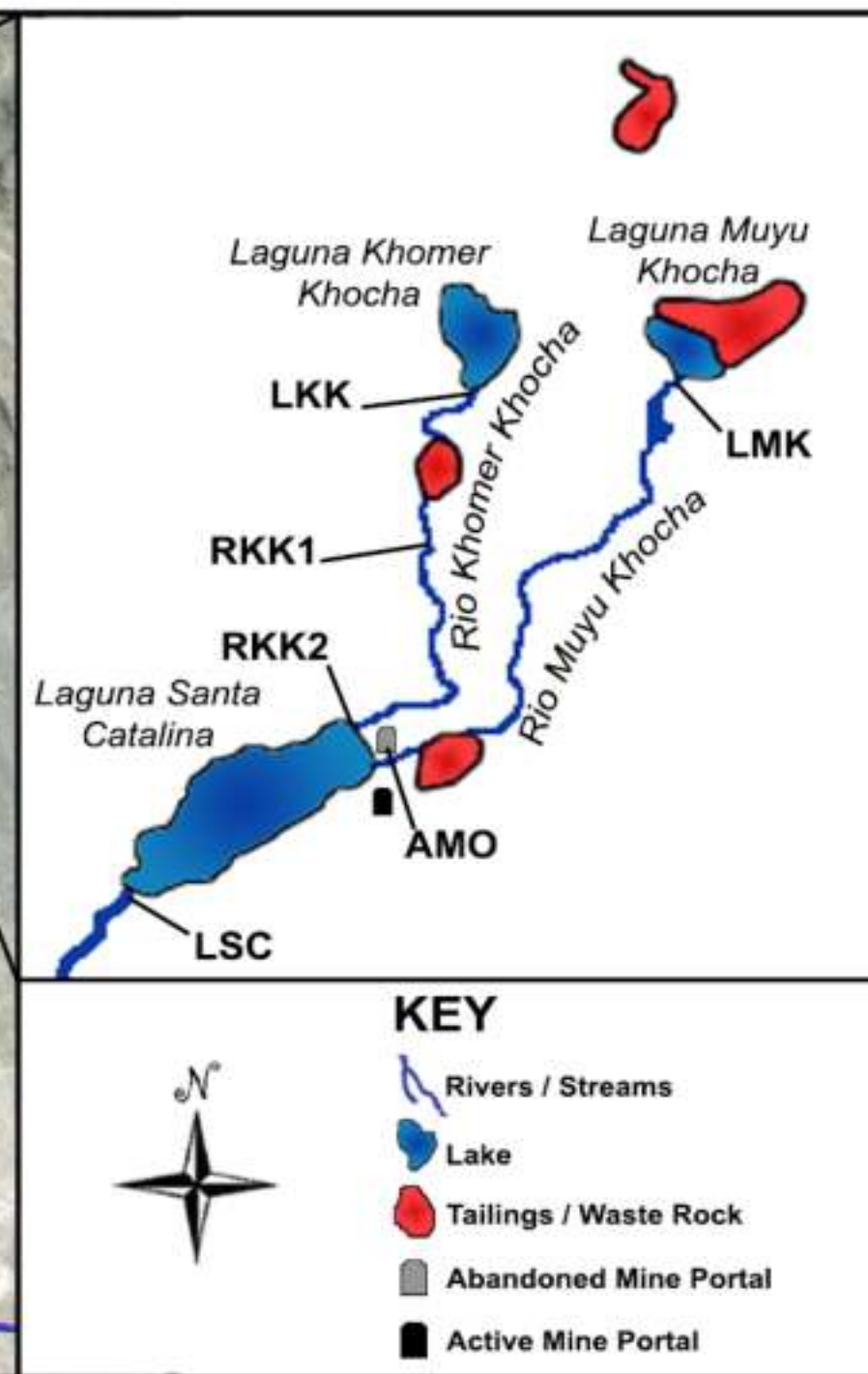
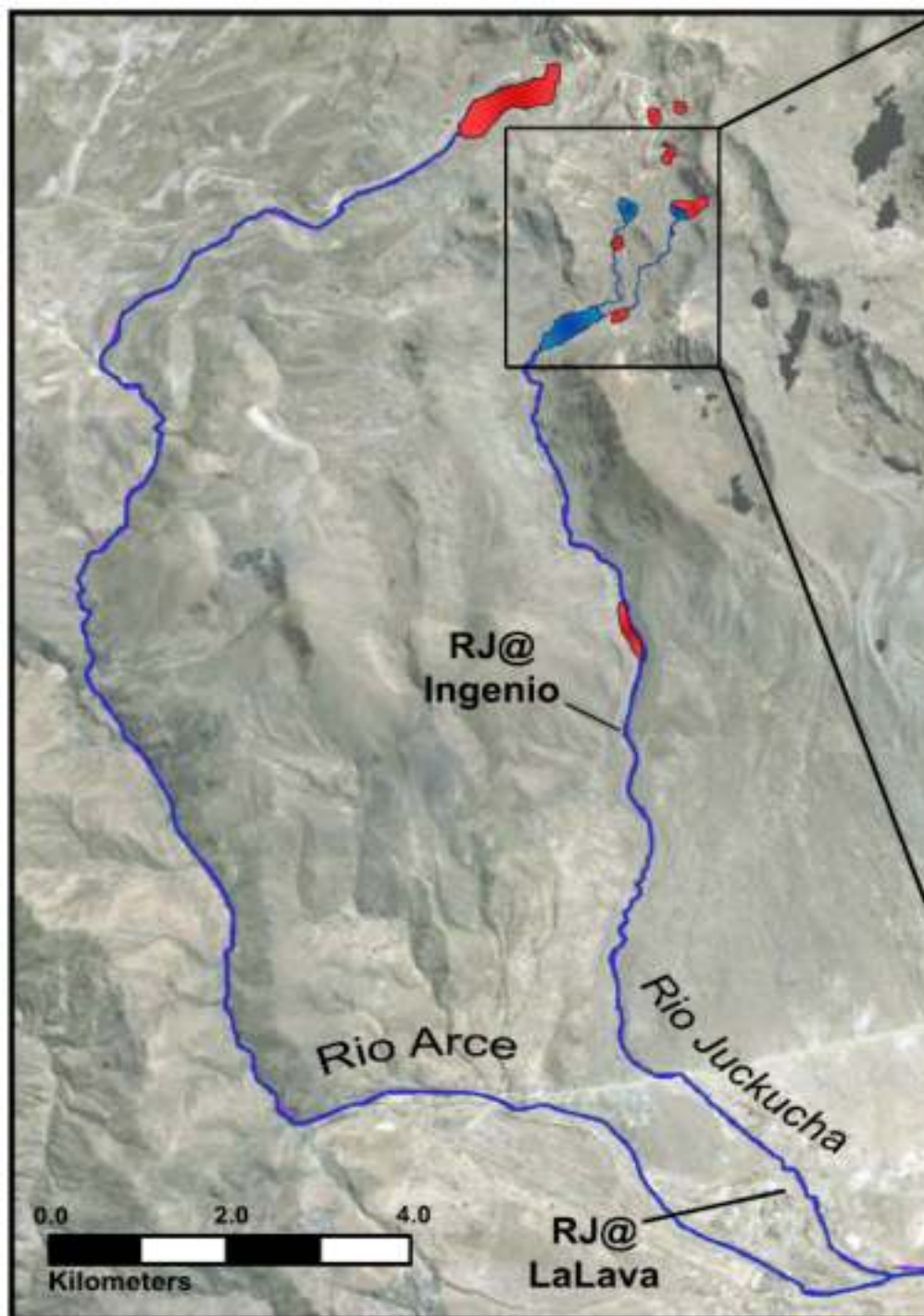
# Rio Juckucha





# Rio Juckucha Valley







# Overview



Mining In Bolivia



Kumurana Valley

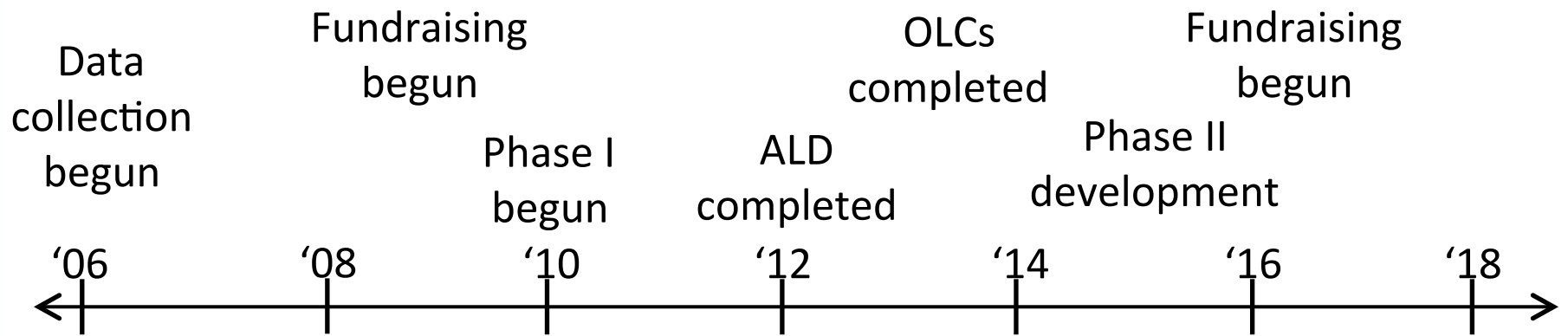


Phase I



Phase II





Survey

Final designs

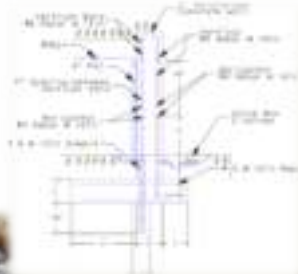


Control structure completed



Final design

Concept shopped



# Construction





# OLCs





Abandoned mine pH =5.4



# ALD



ALD  
(pH= 7.3, 47 mg/L alkalinity)





# Currently

- ALD
  - 135 tonnes
  - Oxidation pond dug
    - Looking for clay
- OLCs
  - Quebrada Muyu Khocha
    - 880 m
    - 1080 tonnes
  - Quebrada Khomer Khocha
    - 720 m
    - 854 tonnes
    - Flow control structure complete
- Post-construction water quality monitoring begun



# Obstacles Overcome

- Distance from limestone & manpower





# Obstacles Overcome

- Road blockades/strikes



# Obstacles Overcome

- Government Control/Tolls





# Paving the Way...



# Obstacles Overcome







# Fresh Mining!?





# Despite of the above... cont'd

- All limestone delivered
  - Government then private transport



# Despite of the above... cont'd

- Channels installed
  - Government, community, gringo-labor, private labor
  - Collaborative effort





# Despite of the above... cont'd

- ALD completed



# Overview



Mining In Bolivia



Kumurana Valley



Phase I



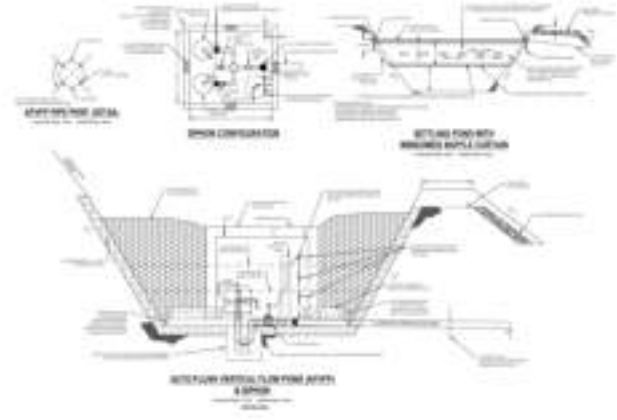
Phase II



# Phase II: Passive Treatment



Site Assessment



Survey/Design



Materials



Construction

# Site Assessment



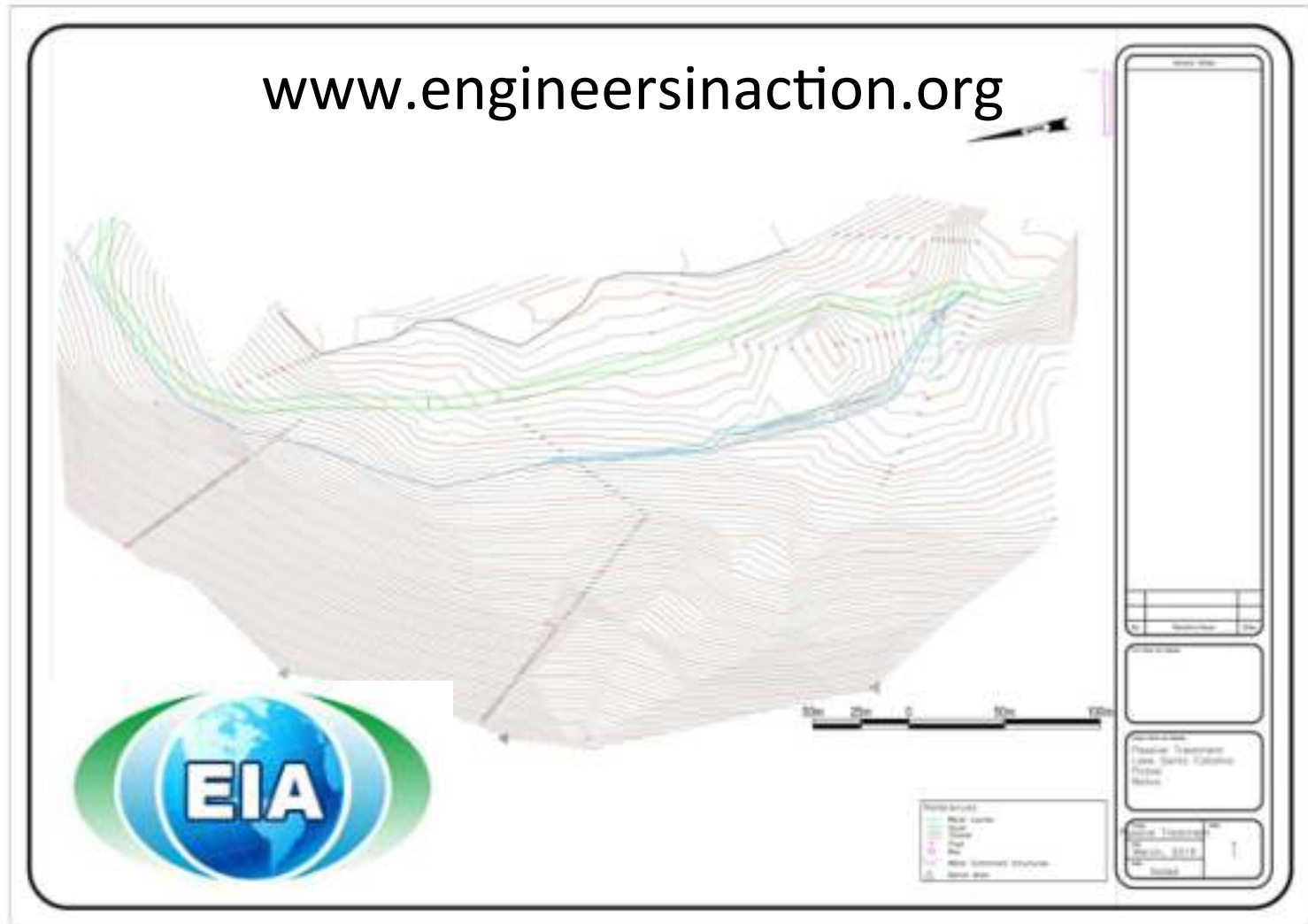


# Site Assessment



# Survey (by EIA)

[www.engineersinaction.org](http://www.engineersinaction.org)

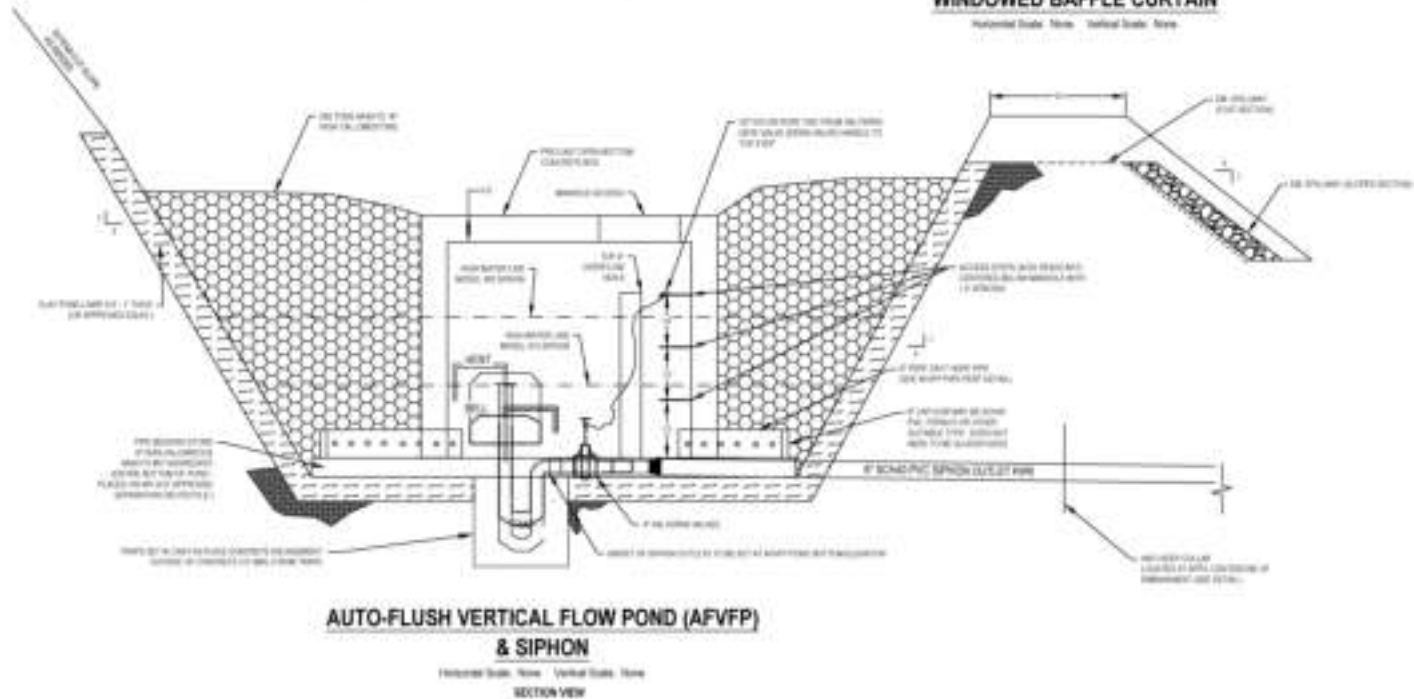
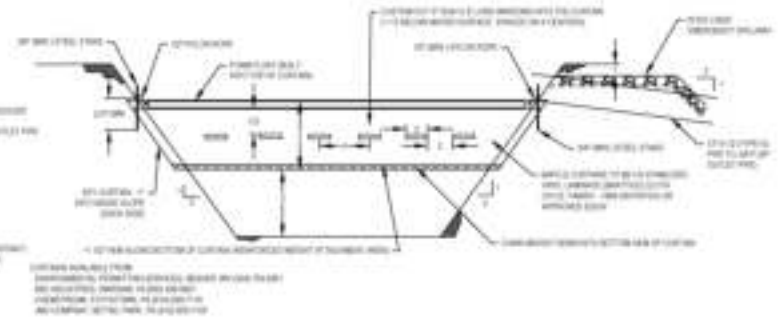
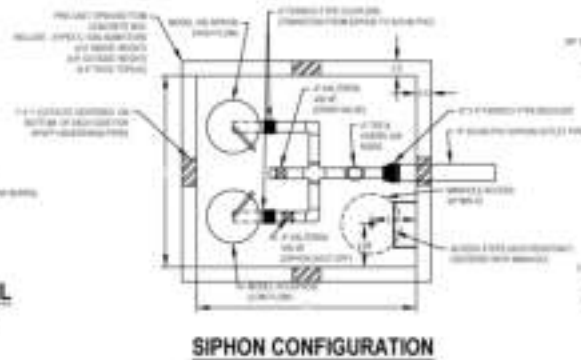




# Survey (by EIA)



# Survey/Design





# Materials



# Materials





# Limestone Quarry



# Limestone Quarry





# Limestone Specifications



# Construction





# Construction



# Construction







# Thanks to the Coalition!

OU Center for Restoration of Ecosystems and Watersheds

SFU Center for Watershed Research & Service

- Norman Rotary Club
- Universidad Autonoma de Tomas Frías
- Empresa Minera Agricola Kumurana
- Engineers in Action
- Centro Investigacion Minero Ambiental
- Japan International Cooperation Agency
- Potosí Rotary Club
- OU Sooners Without Borders
- OU WaTER Center
- Other Rotary Clubs
  - Norman CrossTimbers, Norman Sooner, Pauls Valley, Purcell, Houston Space Center, Ardmore, Altus, Elk City
- Rotary Foundation
- Cardinal Engineering
- Penn State University College of Medicine
- BioMost Inc.



# Questions?

*(and shameless plug)*



Rev. David  
Stephenson

[www.engineersinaction.org](http://www.engineersinaction.org)