Mississippi State University

E-TECH LAB

Overview – Technologies for the Remediation of Heavy Metals in Soil and Water

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What is Environmental Remediation

The removal of Contaminants form Environmental Media

- **Soil**
- **Sediment**
- **Groundwater**
- **Surface Water**

Rocky Mountain Arsenal

Chemical Weapons Production
GB, VX, Lewisite, Mustard
Shell Pesticide
Aldrin, Dreldrin, Nemagon

Contaminants
- Metals
- Organics (VOCx)
- Pesticides
- Agent Related Compounds

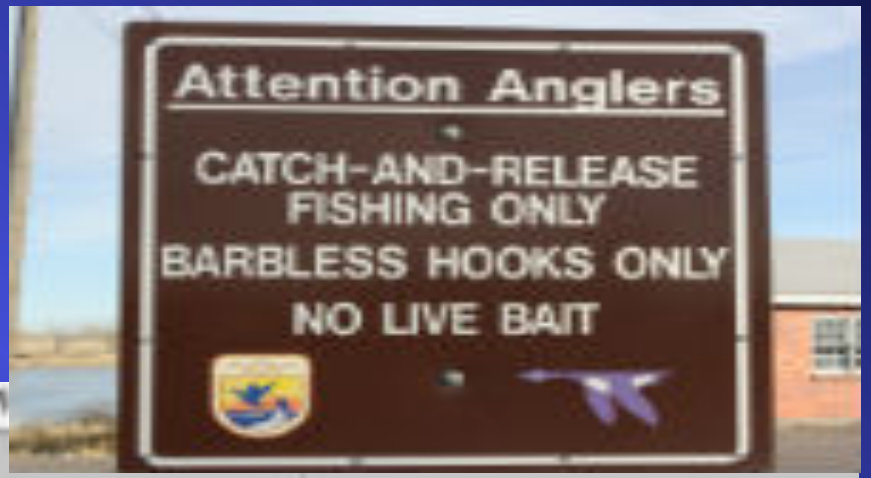
Diisopropyl methylphosphonate (DIMP)

Rocky Mountain Arsenal

Notable Areas of Contamination

- **Basin F**
- **South Plants**
- **Lake system –**

•(Mary, Ladora, Derby)



Rocky Mountain Arsenal Today

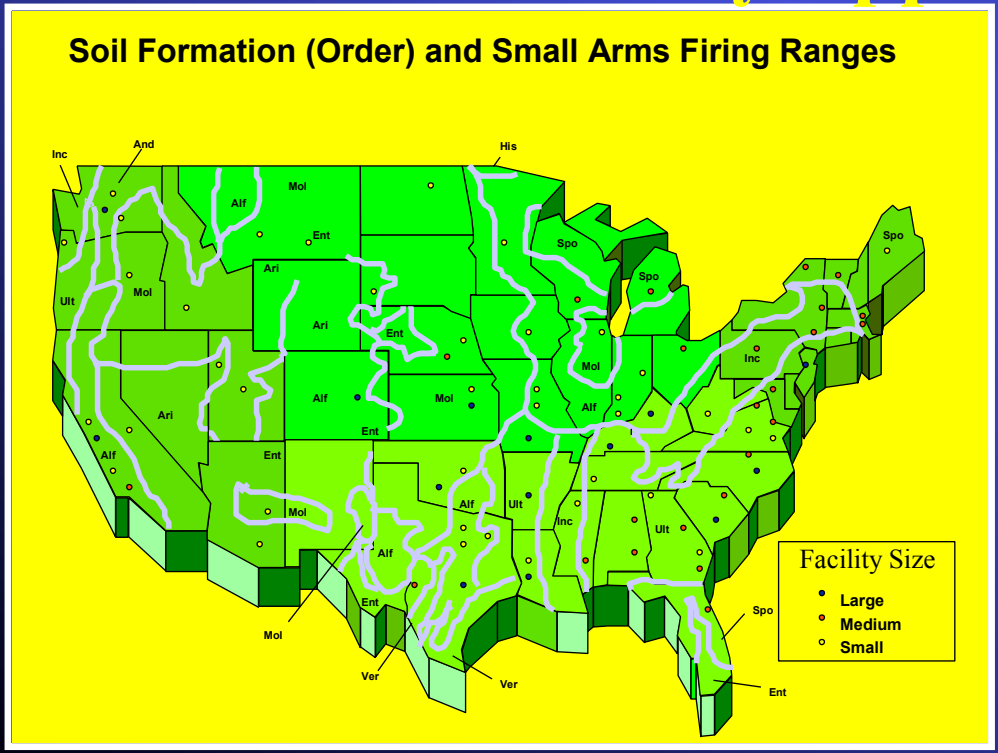
https://kidsindenver.wordpress.com/2011/06/12/rocky-mountain-arsenal-tuesday-tot-time/

http://www.coloradolifemagazine.com/Rocky-Mountain-Arsenal-Denvers-Wildlife-Oasis/

Example Remediation Project: Lead Immobilization at Small Arms Firing Ranges

Objective: To Cost Effectively remove or reduce the toxicity of Lead at SAFR

Many Approaches



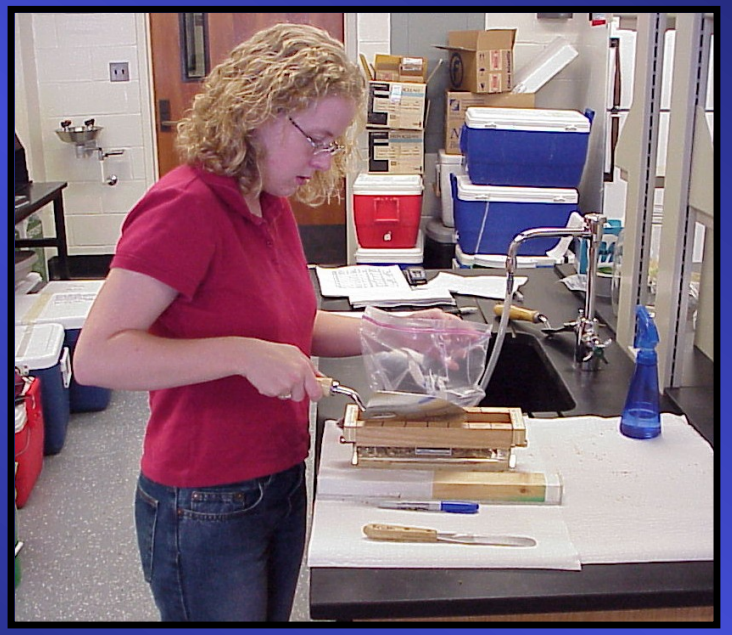
SAFR

Remediation Approaches

- Ex-Situ
- In-Situ

Remediation Approaches

- Dig and Haul
- Containment
- Water Treatment
- Biological Treatment
- Sorption
- Physical Treatment
- Phyto Remediation
- EK
- ETC.



State of Development of Remediation Technologies

- **Existing -** Dig & Haul
- **Immerging -** EK
- **Innovative –** Bio-Refinery

Dig and Haul

Source::
http://www.gatewayparts.com.au/wp-content/uploads/2016/12/EX2600-6_big_img_gallery.jpe

Source: https://www.mining3.com/wp-content/uploads/2016/08/Shovel-and-truck-Almay-stock-image-inverted.jpg

- Most used technique
- Involves
  - Landfill
  - SWMU
- Only Transfer Issue
- Long Term Liability
- Relative Low $
- Depends on Many Factors

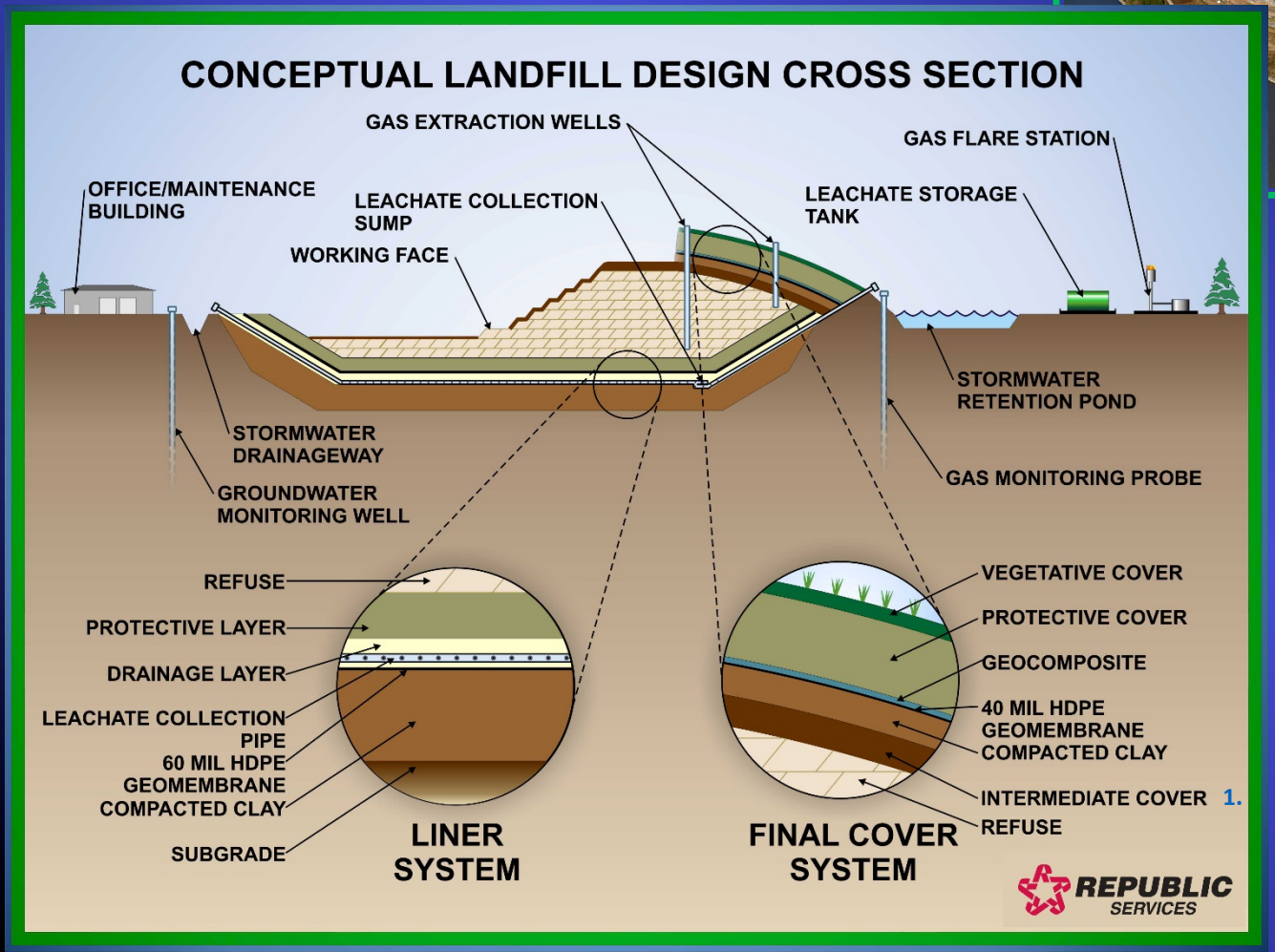
Containment (examples)

- Landfills
- Slurry Walls
- Solidification/Stabilization
- Vitrification
- Calcination

Landfills

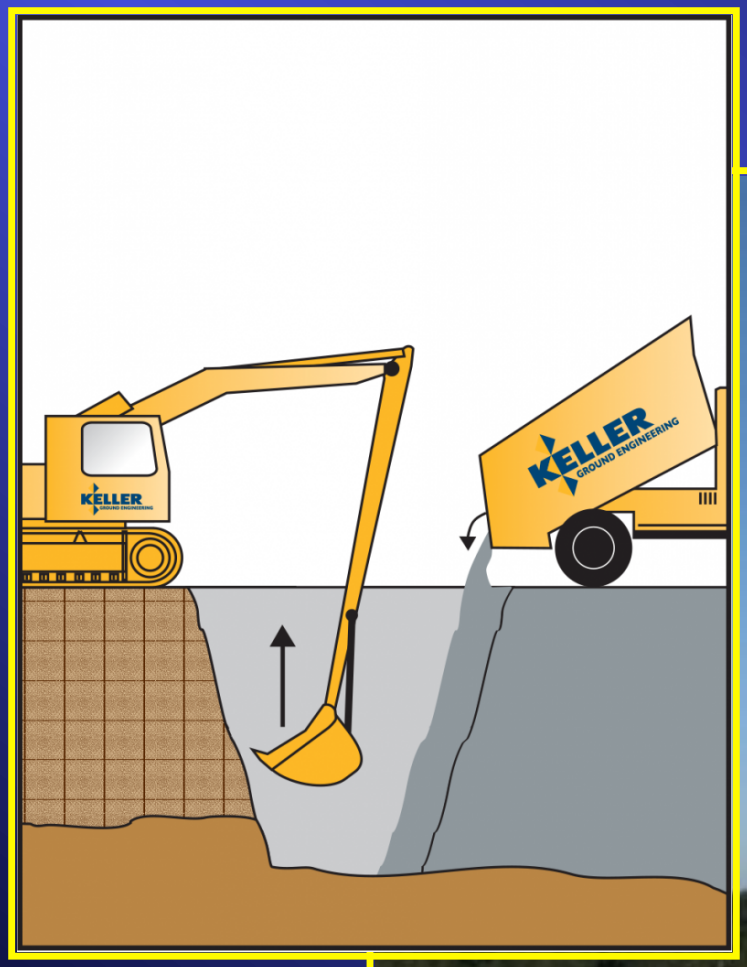
- Types C & D
- Issues

1. Source: http://dswa.com/wp-content/uploads/2015/02/Cherry-Island-Landfill-Expansion.jpg



1. Source: http://site.republicservices.com/publishingimages/7_2_landfill-cross-section.jpg

Slurry Walls



Source:http://www.kellerge.com.au/wp-content/uploads/2014/06/Slurry-Wall-782x1024.png

Source: http://reports.mckinneydrilling.com/Slurry%20Wall%20Dam.jpg.dimg.aspx

Solidification/Stabilization

Sourc ehttps://research.engineering.ucdavis.edu/gpa/wp-content/uploads/sites/43/2015/02/Lime-P2-Labeled.jpg

- Exsitu & Insitu
- Lime, Fly Ash, Portland, Adsorbents
- Mixing Critical

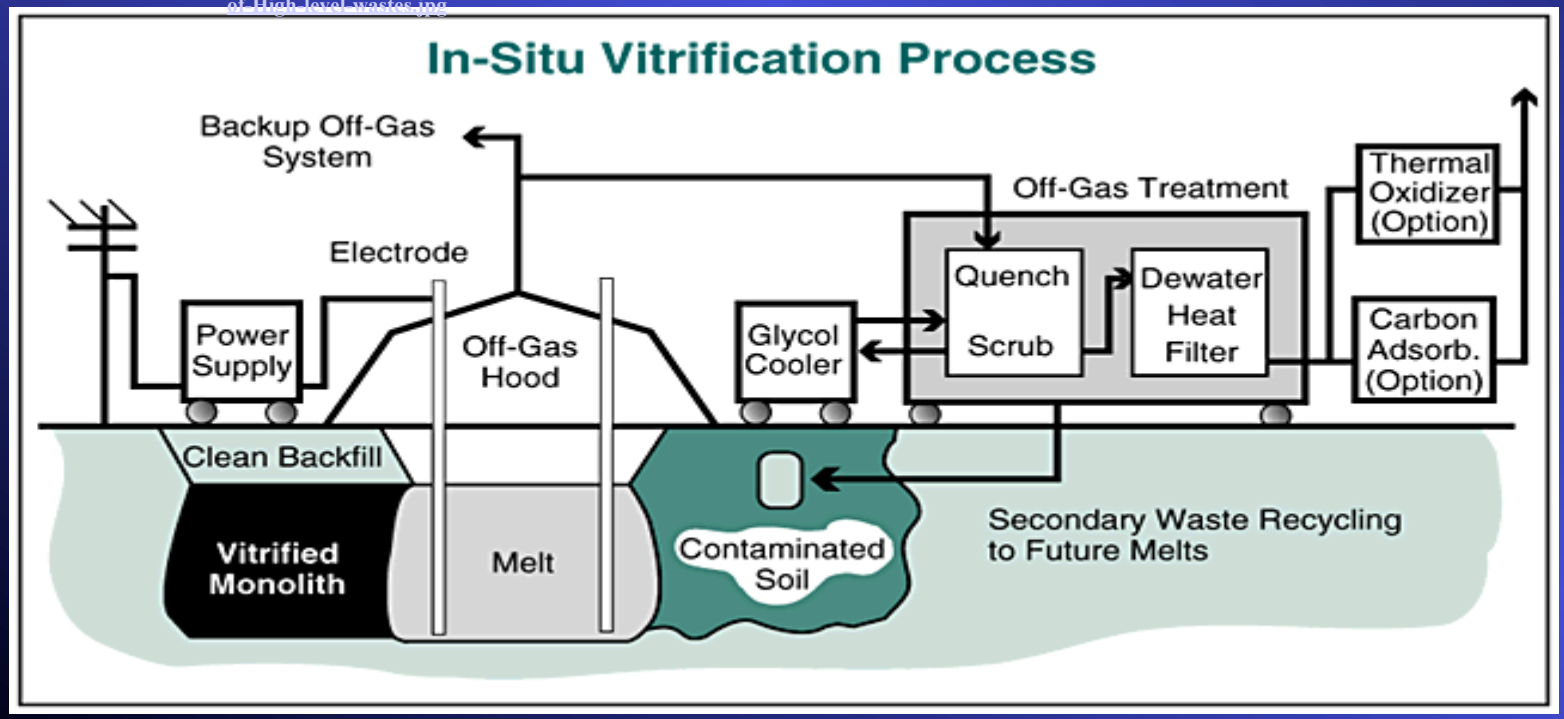
Source: http://cetco.com.au/portals/9/Images/WS2.jpg

Source: http://cetco.com.au/portals/9/Images/WS2.jpg

Vitrification

Source https://civildigital.com/wp-content/uploads/2014/04/Management-of-High-level-wastes.jpg

- Primarily Nuclear Waste
- Energy Intensive
- $$$$$$$$



Sourc http://infohouse.p2ric.org/ref/14/0_initiatives/init/feb95/images/soilmelt/isvfl.gif

Insitu Vitrification

Source: http://i.vimeocdn.com/video/462872563_640.jpg

Calcination

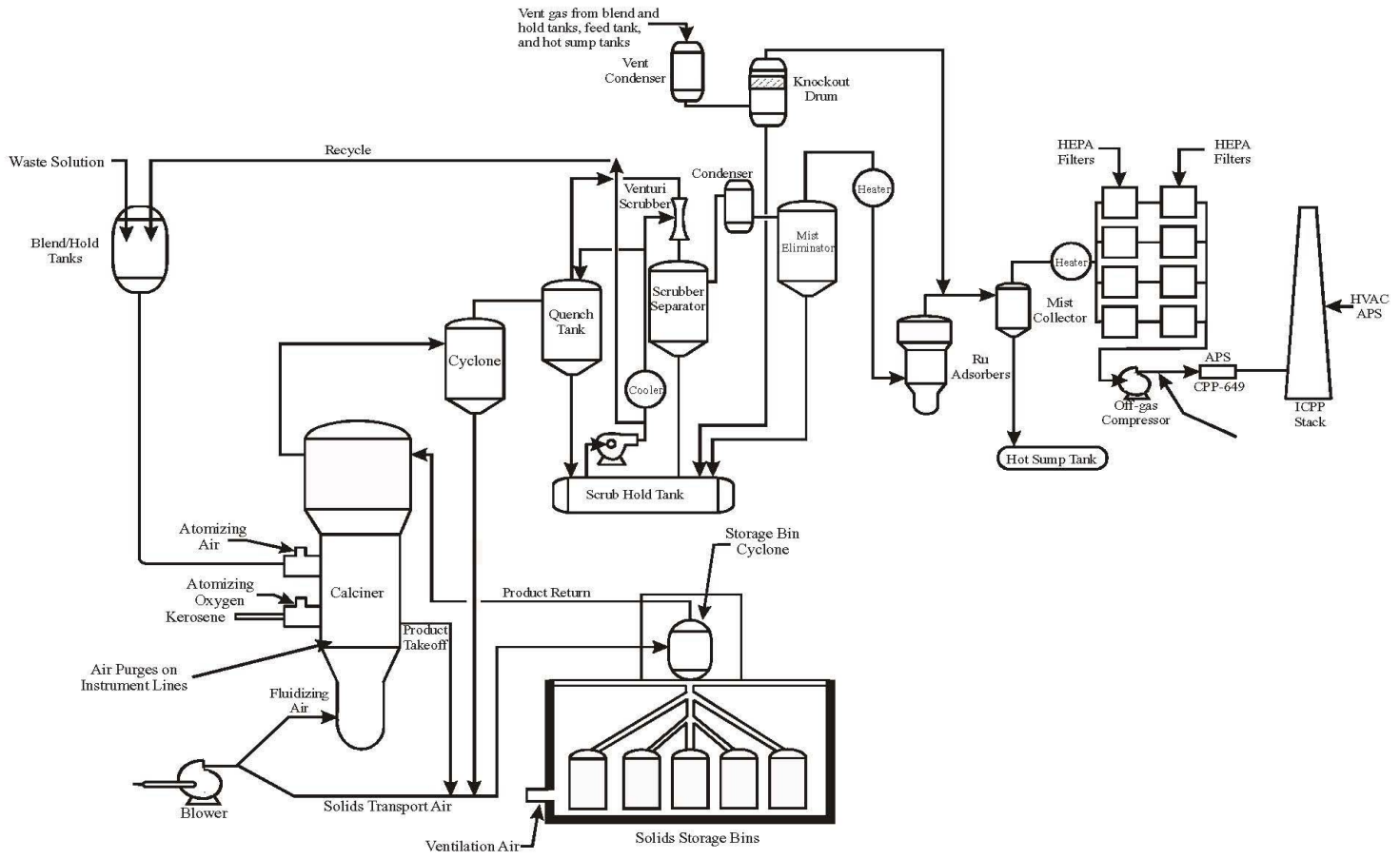
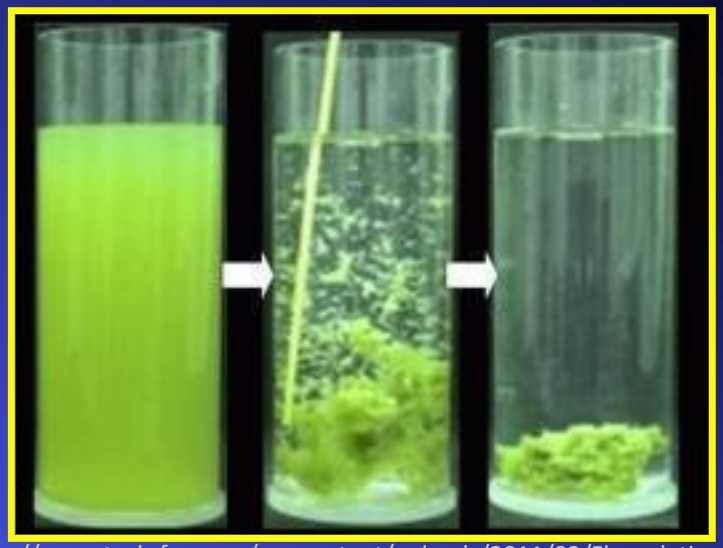


Figure 1. Schematic of the NWCF Calcination process.

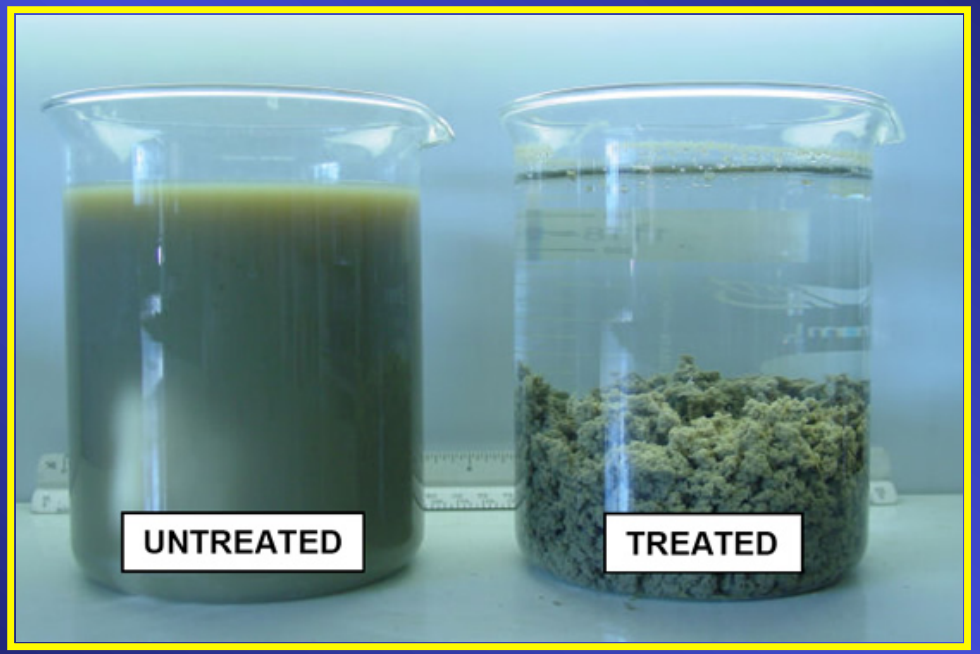
Source: Newby 7 O'Brien "Summary of Waste Calcination at the Idaho Nuclear Technology and Engineering Center, INEEL/ EXT-200-01200, OCT 2000.

Pump and Treat – Water Treatment

- Stripping - VOC
- Neutralization
- Precipitation
- Flocculation
- Sedimentation
- Membrane Treatment
- Ion Exchange
- Electro Techniques
- Flotation
- Electro winning
- Filtration

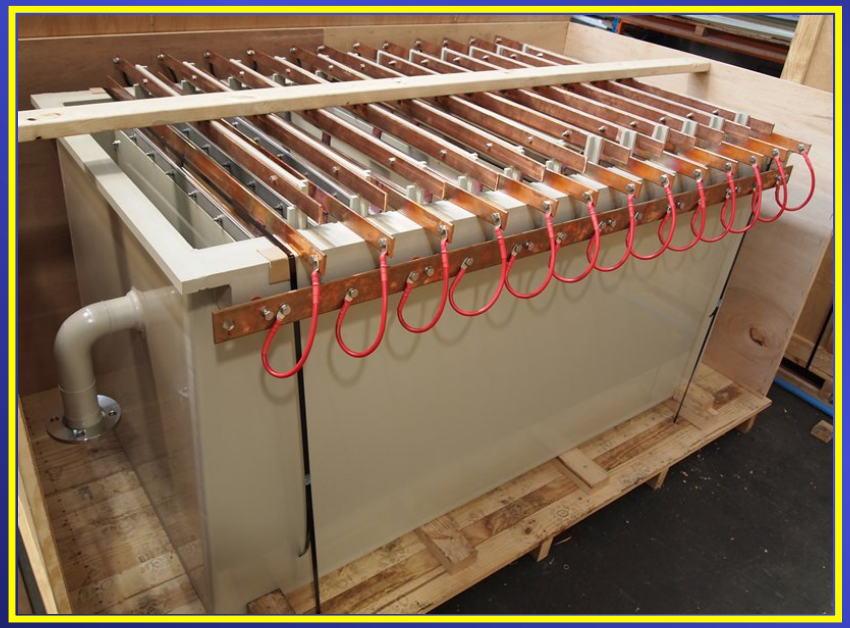


Source: http://www.tech-faq.com/wp-content/uploads/2011/02/Flocculation.jpeg



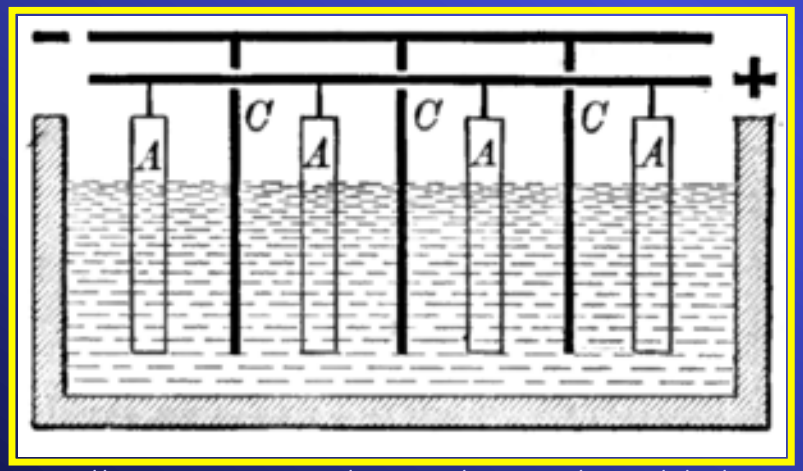
Source: http://aquabluechemical.com/wp-content/uploads/2017/07/Treatment.jpg

Electrowinning



Source: http://www.pfwa.com.au/wp-content/uploads/gallery/electrowinning-cells/Custom-Electrowinning-Cell.jpg

Source: http://www.constructionphotography.com/ImageThumbs/A175-00151/3/A175-00151_Worker_Cleaning_Copper_Cathodes_In_Escondidas_Electro_Winning_Shed_Chile.jpg

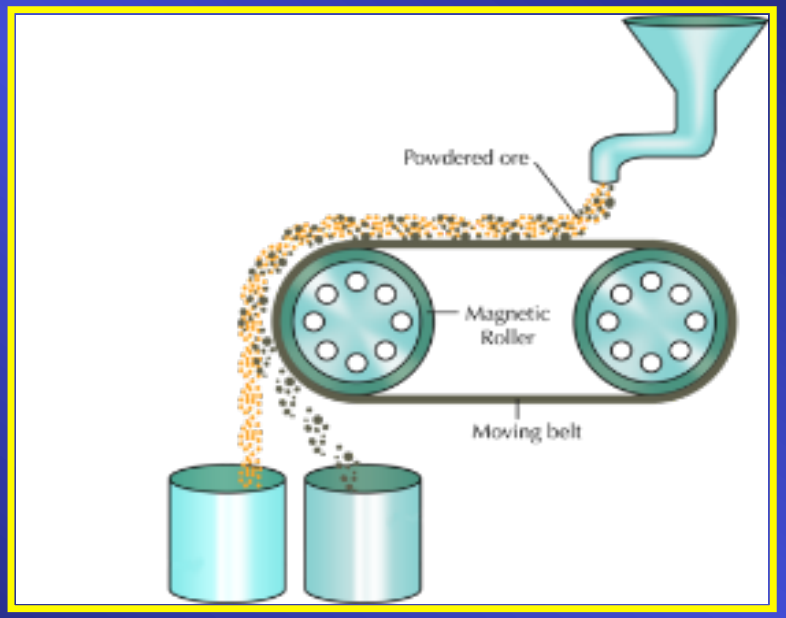


Source:https://upload.wikimedia.org/wikipedia/commons/thumb/6/68/CuElectrolyticRefineApparatus.png/300px-CuElectrolyticRefineApparatus.png

Physical Separation

- Tabling
- Flotation
- Classification
- Trammels
- Magnetic and Electrostatic Separation
- Density segregation
- Soil Flushing/Washing

Source: http://www.suntechgeomet.co.za/images/images/Physical-SeparationL.png



Source: http://www.mstworkbooks.co.za/natural-sciences/gr9/images/gr9eb03-gd-0022.png

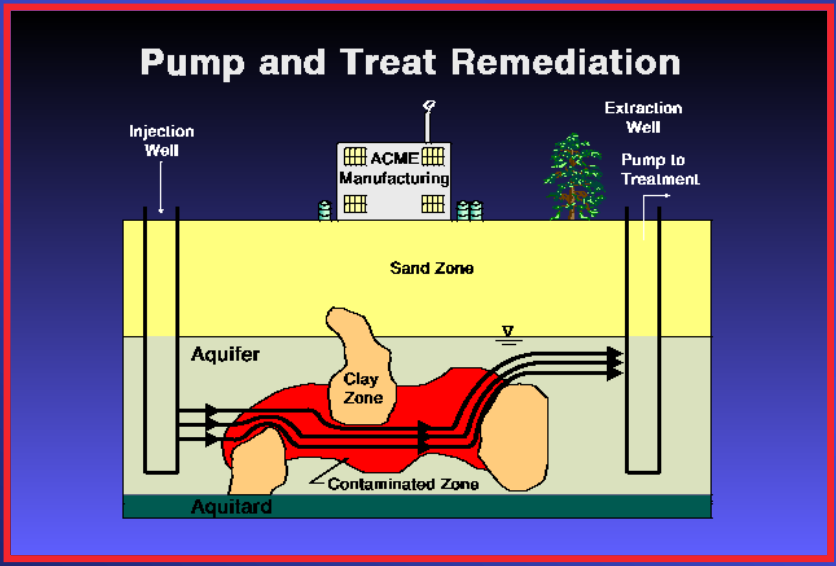
Other Remediation Technologies

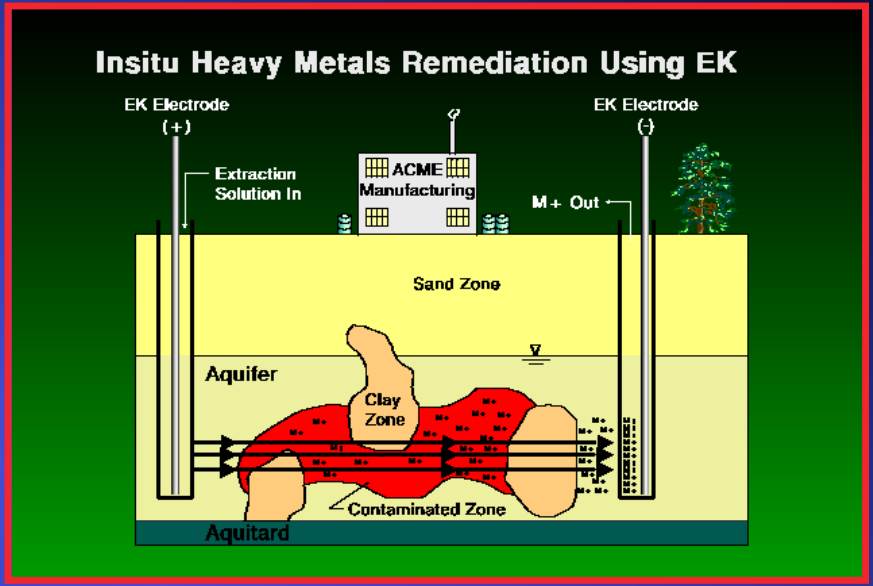
- Heap leaching
- Phyto Remediation
- Chemical and Supercritical Water Oxidation
- Adsorption/Absorption
- Freeze Crystallization
- Electrokinetics

Source: http://3.bp.blogspot.com/-jyD43dAzvVg/ToVWDXjjYEI/AAAAAAAAATU/XslOtVaH-fM/s1600/spraying+sodium+sianide+on+the+system+heap+leaching..jpg

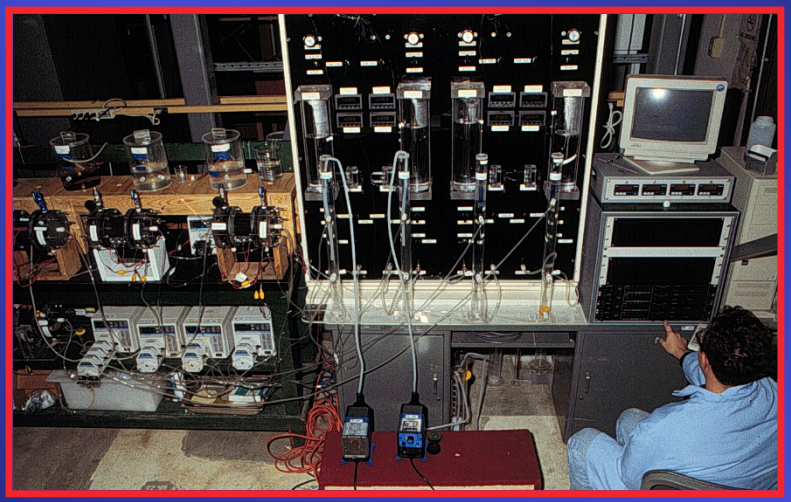
Source: http://2.bp.blogspot.com/-928l4_WdINs/TmlUrbeXKI/AAAAAAAAABA/0NiCOVX0Gx0/s640/Bald%2BMountain%2BMine%2Bheap%2Bleach%2Bin%2Bnortheastern%2BNevad

Application of EK





- Electromigration
- Electroosmosis
- Electrophoresis
- pH



EK
Pt. Mugu NAWS EK Field Project

- DoD 6.4 Dem/Val Project
- EPA SITE Project
- ESTCP

Biological Treatment

Source: http://napier-reid.com/wp-content/uploads/2015/02/DSC04498.jpg

- Aerobic
  - Activated Sludge
  - RBC
  - Aerated Lagoons
  - Trickling Filters
  - Composting

- Anaerobic
  - Anaerobic Digestion
  - Composting
  - Stabilization Ponds
  - Engineered Wet Land

Source: https://3.imimg.com/data3/CA/GV/MY-1555992/windrow-turner-250x250.jpg

Requirement for Application

- Site assessment
  - CoC
  - Soil Characteristics
  - Geology
- Costs
- Regulations
- Public - NIMBY
- PRG
- Clean Closure

Remediation Reclamation Results

Latvia - Flambeau Minerals

Source :https://klimatsrtu.files.wordpress.com/2014/10/zemes-degradacija.png

Remediation Reclamation
Climax Mine

Storke Yard at Climax in 2008 (left) and in 2012 after revegetation activities that included using compost produced at the site's award-winning Biosolids Composting Operation. These activities were part of a larger project to restore the Arkansas River channel and habitat at Storke Yard, both of which had been impacted by historic mining activities.

Source: http://3blaws.s3.amazonaws.com/images/Biosolids_3.jpg

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