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Caso de Esudio:
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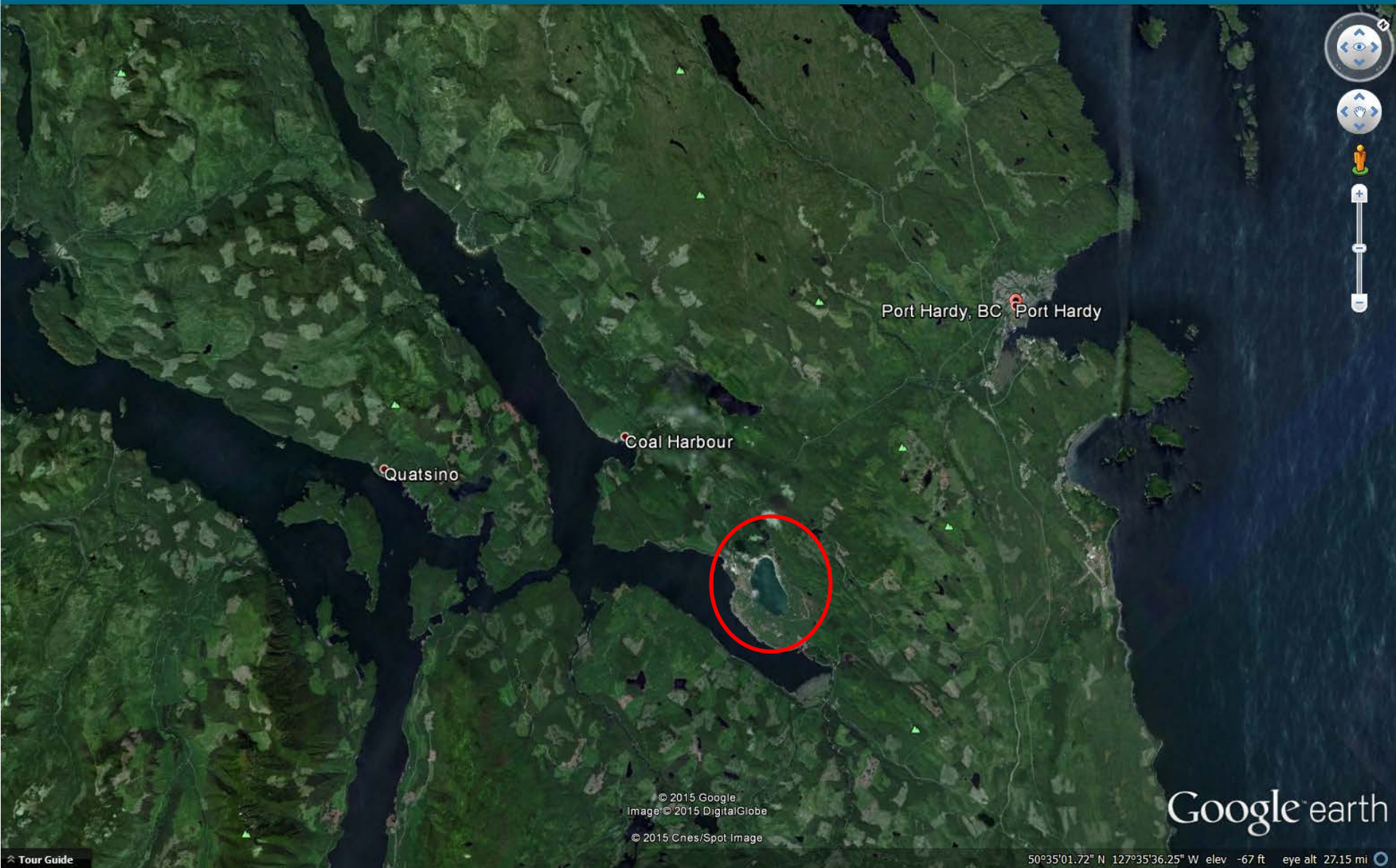
MWH®

BUILDING A BETTER WORLD

Pit Lake Closure Case Studies

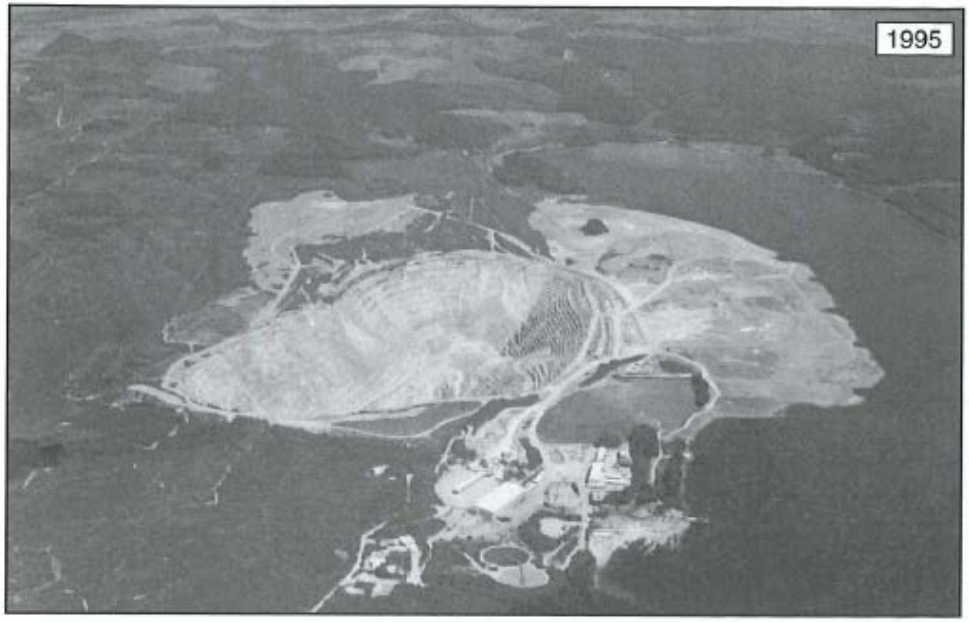
- Island Copper, British Columbia, Canada
- Sleeper Mine, Nevada USA
- Berkeley Pit, Montana USA

Island Copper



Island Copper

- Physical properties
  - 2 km long, 1 km wide
  - Maximum depth is 353 m
  - Pit wall rock types
    - Andesitic pyroclastics, quartz feldspar porphyry, Bonanza volcanics, minor sulfides
  - Pit volume is 241,000,000 m^3
  - Pit area is 1,735,000 m^2



Island Copper

- Closure plan
  - Create a meromictic lake
    - Anaerobic (no oxygen) bottom layer will cause precipitation of metal sulfides to meet water quality standards
    - Upper layer is freshwater from catchment
  - Diverted seawater into pit, filled in ~30 days
  - Inject ARD at depth of 220 m

Island Copper

- Developed three layer system
  - Bottom is anoxic, dense, sea water
  - Middle layer circulates due to injection of ARD at a depth of 220 m
  - Upper layer brackish water, about 5 m thick
- Biological cycling controls oxygen levels
- Lessons learned for other pit lakes
  - Understand the physical structure and stability of the water column
  - Understand the chemistry of ARD and how it will be managed
  - Know the chemistry of the pit water
  - Understand the effect of ice cover conditions
  - Careful consideration of the pit outflow system if flow-through

Reference: Pelletier, C.A., M.E. Wen, and G.W. Poling, 2009, Flooding Pit Lakes with Surface Water, Chpt. 17 in D.N. Castendyk and L.E. Eary, eds. Mine Pit Lakes: Characteristics, Predictive Modeling, and Sustainability, Vol. 3, pp. 187-202.

Sleeper Mine Pit Lake

- Physical properties
  - Five pits combined into one large pit
  - Sulfide rich bedrock, high sulfide content in waste rock and in pit wall rock
  - Final pit dimensions are 1,675 m long, 760 m wide and 177 m deep

Sleeper Pit

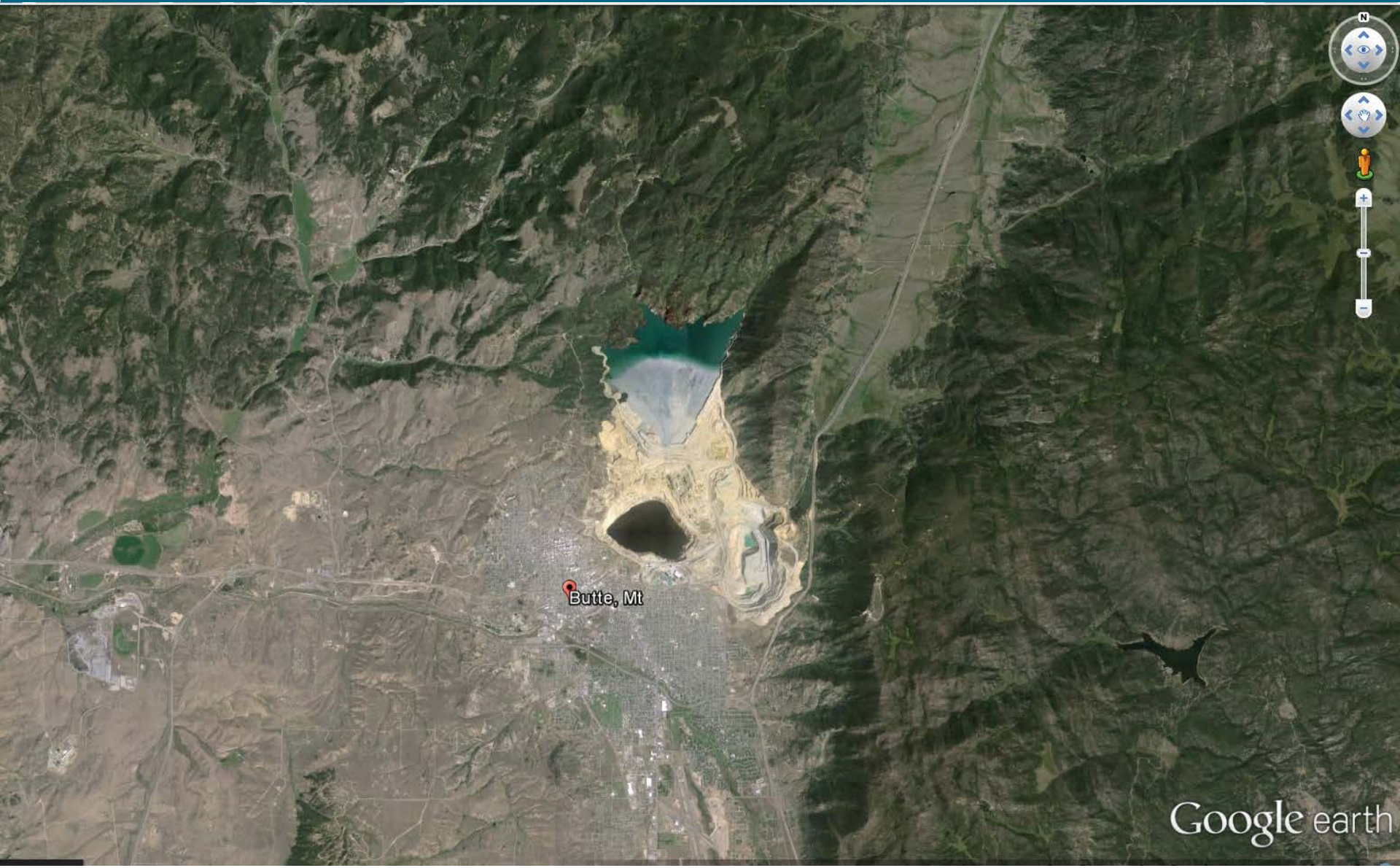
- Closure plan
  - Water balance indicated pit lake will be a hydraulic sink
  - Partial backfill with unoxidized, high sulfide waste rock that was capped with oxide waste rock
  - Rapid fill by pumping groundwater from adjacent alluvial aquifer to a depth sufficient to cover high-sulfide rock units in the pit wall
  - Add lime
    - To enhance carbonate alkalinity added by pumped groundwater
    - To offset effects of oxidized, high sulfide pit wall rinsing and pit wall failures
  - Added nutrients (manure) to stimulate lake biological system

Sleeper Pit

- Final pit lake holomictic with seasonal turn over causing mixing throughout the pit water column
- Sub-aqueous deposition of the high-sulfide waste rock effectively limited oxidation of sulfide minerals with minimal effect on pit water chemistry
- Lime addition during filling critical to achieving final water chemistry standards
- Pit supports viable aquatic ecosystem and is used for sport fishing

Reference: Dowling, J., S. Atkin, G. Beale, and G. Alexander, 2004, Development of the Sleeper Pit Lake, Mine Water and the Environment, 23:2-11.

Berkeley Pit



Berkeley Pit

- Physical properties
  - About 2.4 km long, 1 km wide and about 540 m deep
  - As of 2013, pit contains about 160,000,000 m^3 of low pH (<3.0) water
  - Began in the 1800s as underground operation, transitioned to open pit in 1955
    - Almost 80 km of vertical shafts
    - Almost 9,000 km of horizontal workings
  - Groundwater pumping ended in 1982
  - Site under regulatory authority of CERCLA or Superfund by 1994

Berkeley Pit

Berkeley Pit

- Closure plan
  - Initially there was no formal closure plan
    - Pit water chemistry strongly influenced by leaching of metals and acidity from the near pit zone
  - Regulatory action under CERCLA created a water management plan
    - Established critical water level above which the pit water level can not rise
    - Pumping from the pit will be required to maintain the pit water level below the critical water level
    - Pumped water is treated using lime neutralization and solids separation by a high-density sludge (HDS) process

Reference: www.pitwatch.org

Thank you