Co-disposal Practice in Mine Waste Management

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INTRODUCTION

- Most jurisdictions require long-term physical and chemical stability of mine waste disposal facilities
- Despite this requirement:
  - 270 failures of tailings facilities have been recorded since 1960
  - Much fewer failures of waste rock facilities have been recorded
  - Waste rock facilities are typically stable but they are prone to acid rock drainage if they contain sulphide minerals
- Some of the risk-mitigation options available include:
  - Reducing the size of tailings pond
  - Dewatering the tailings to thickened tailings, paste, or filter cake
  - Co-disposal of tailings and waste rock
- Co-disposal refers to the disposal of tailings and waste rock in one integrated facility
FORMS OF CO-DISPOSAL

- Co-disposal can take any of the following forms:
  - Waste rock inclusion within a tailings disposal facility;
  - Tailings disposal facility inclusion within a waste rock dump;
  - Tailings storage in cells constructed of, or encapsulated within waste rock;
  - Waste rock piles encapsulation with tailings;
  - Layered co-disposal of tailings and waste rock;
  - Fully mixed placement ("co-mingling") of tailings and waste rock; and,
  - Pumped co-disposal of coarse and fine tailings.
Co-disposal can be selected to:

- Improve physical stability of the tailings
- Reduce acid rock drainage and metal leaching from the waste rock
- Reduce the footprint area of the waste disposal facilities
- Make closure easy and progressive
- Control freeze-drying, dusting and erosion of tailings
- Accelerate consolidation of tailings
- Reduce life-cycle cost, etc.

Co-disposal is common in coal and diamond mines

Other mines have also used the concept, although the facilities are not typically called co-disposal facilities
LOCATION OF SOME EXISTING AND PROPOSED CO-DISPOSAL FACILITIES

- Throughput of these mines - 1,300 tpd to 16,500 tpd
EXISTING CO-DISPOSAL FACILITIES

1. Snap Lake Mine, Canada

- An underground diamond mine in NWT, operated between 2007-2015
- In care and maintenance since December 4, 2015
- North Pile co-disposal facility was designed to store all waste streams of the mine:
  - 0.9 Mt (0.4 Mm³) of waste rock
  - 14.8 Mt (8.2 Mm³) of coarse tailings and grits
  - 8.0 Mt (6.2 Mm³) of fine tailings
1. Snap Lake Mine, Canada

- Fine tailings, coarse tailings, and grits are NAG
- 50% of waste rock is PAG
- Fine tailings pumped at 43% to 53% solids content
- Coarse tailings and grits are dewatered to 84% solids content and trucked
- The facility covers a total footprint area of 90 ha
- Maximum height of the embankments is 40 m
- The perimeter embankments are free-draining constructed using:
  - Coarse tailings & grits – Chimney drain and/or toe drain may be required
  - Waste rock and quarried rock – Upstream coarse tailings, grits or geotextile may be required to act as a filter
1. Snap Lake Mine, Canada

- The perimeter embankments were raised in the upstream and central constructed methods.

- Snap Lake co-disposal concept can easily be applied to a hard rock mine.
2. The Oaks Mine, South Africa

- An open pit diamond mine in Limpopo, South Africa, operated between 1998-2008
- Mine co-disposed all waste streams: waste rock, fine tailings, coarse tailings and grits
- All mine waste are NAG
- The facility footprint is 49 ha
- Facility developed 3 fine tailings cells and 1 coarse tailings and grits cell
- Waste rock was used as a perimeter embankments for fine tailings cells and for coarse tailings and grits cells
2. The Oaks Mine, South Africa

- The maximum height of the facility is 40m
- Fine tailings were thickened to 50% solids content and pumped
- Conveyor belt was used to transport the coarse tailings and grits
- The facility was progressively developed and closed
- Topsoil from new cell was used to cover the filled cell
- Fine tailings cells were capped with a layer of coarse tailings and grits before the topsoil closure cover placement
3. Co-disposal in South African Coal Mines

- Fine tailings cell is often located within coarse discard
- The fine tailings and coarse discard are intentionally not mixed as they have potential for re-mining
- Coarse discard is compacted in thin layers and progressively rehabilitated
- Fine tailings is discharged as a slurry from perimeter spigot points to maintain a central pond
- Base of the facilities are often covered with low permeability soil
- The facilities are provided with a perimeter drain or ditch to collect the seepage and convey to return water pond
The coal co-disposal concept in South Africa can easily be used in hard rock mine.

- Transition and filter materials will be required between the waste rock and the tailings
4. Serra Azul Mine, Brazil

- An open pit iron mine in Belo Horizonte, Brazil
- Since 2013 the mine operated a co-disposal facility, which consists of:
  - Jig tailings (< 6 mm) blanket drain at the base
  - Rockfill starter embankment with upstream transition and filter
  - Perimeter dykes raised in the upstream method using jig tailings
  - Tailings are cycloned inside external ponds and trucked and placed in shallow alternating layers in the co-disposal facility
  - The co-disposal facility was internally partitioned using cyclone underflow or jig tailings
- A reclaim pond is provided at the downstream toe of the facility
4. Serra Azul Mine, Brazil

- The concept Serra Azul co-disposal facility can easily be used by a hard rock mine, e.g.:
  - The base could be covered with waste rock
  - Perimeter dykes can be constructed using waste rock with upstream transition and filter
  - Internal berms can be constructed using waste rock
  - Alternating layers of waste rock and tailings can be contained inside the internal berms
5. Navachab Gold Mine, Namibia

- An open pit gold mine in Namibia, in operation since 1989
- Tailings and waste rock are NAG
- A tailings facility with a 10Mm³ storage capacity was operated between 2004 and 2012
- 30 m wide embankments were constructed by end-dumping weathered waste rock
- Tailings was delivered as a slurry to the facility
- The slurry was processed using regularly spaced cyclones at the upstream side slopes of the embankments
5. Navachab Gold Mine, Namibia

- The underflow was used as a filter between the overflow tailings and the waste rock embankments.
- The underflow was stacked 20m above the embankment to provide additional storage.
- The mine is located in Namibia desert with annual precipitation of 215mm and annual evaporation of 2,400mm.
- Water supply to the mine is from Swakoppoort dam located about 85km.
- In 2012 the mine installed a belt filter to dewater the tailings to maximize water recovery.
- The filter cake is trucked and disposed inside the active waste rock dumps.
6. Unnamed Mine, South Africa

- An open pit polymetallic mine in South Africa
- Part of the 2006 expansion, the mine required a co-disposal facility to store 18 Mt (9.7 Mm³) of PAG tailings & 136 Mm³ overburden and waste rock
- Facility requires constructing 3 cross-valley embankments using the overburden and weathered waste rock for tailings disposal
6. Unnamed Mine, South Africa

- The embankments are constructed from bottom up in 1.0 m to 1.5 m lifts.
- Each lift was moisture conditioned and compacted using sheepsfoot and smooth drum vibratory rollers.
7. Neves Corvo Mine, Portugal

- An underground copper and zinc mine, in operation since 1988
- PAG waste rock and tailings
- Originally tailings deposited subaqueously
- Since 2012, a co-disposal facility was developed on top of existing facility to store an additional 27 Mt of thickened tailings and 10 Mt of waste rock
- 15 cells were sequentially constructed using waste rock dykes
- Each cell was filled thickened tailings (60% to 70% solids content)
7. Nunavik Nickel Mine, Québec

- An open pit nickel and copper mine, in operation since 2011
- Waste rock and tailings are PAG
- Two tailings cells constructed using waste rock, compacted in 1m lifts
- Upstream transition and liner bedding zones are provided
- Base and slide slopes of the cells are lined
- Tailings dewatered to 65% solids content are deposited in the cells
- The excess waste rock is disposed adjacent to one of the tailings cells
8. Cerro de Maimon Mine, Dominican Republic

- An open pit gold mine, since 2008
- Some waste rock and all tailings are PAG
- Tailings are thickened (55-60% solids content) and disposed in a lined facility
- PAG waste rock is pushed over deposited tailings
- Field trial showed placing a 2 m thick lift of PAG waste rock over a 1 m thick lift of tailings as the ideal co-disposal
- The test also found a minimum of 1.3 m thick waste rock is required to safely operate the co-disposal equipment
9. La Quinua Mine, Peru

- An open pit gold mine
- 45Mt tailings facility is placed inside a heap leach facility
- Maximum height of the tailings facility is 115m
- Leach ore acts as perimeter embankment
- The base of the tailings facility is lined
- Tailings is thickened to 67% solids content
- New tailings cell is being built in the north
10. Greens Creek, USA

- An underground silver mine, in operation since 1989
- Waste rock and tailings are PAG
- The tailings are dewatered to 88% solids content using filter press
- 50% tailings used for underground backfill and the remaining trucked and compacted in a tailings facility
- Tailings facility has capacity to store 9.6 Mt (4.5 Mm³) of tailings and 2.3 Mt (1.2 Mm³) of waste rock
- Waste rock is co-mingled with the filter tailings using dozer and compacted
CONCLUSIONS

- There are a number of mines using or planning to use the concepts of co-disposal
- Existing facilities have minimal mixing between waste streams, but they can still provide long-term physically and chemically stability
- Some of the co-disposal concepts in coal, diamond and iron ore mines can easily be transferred to hard rock mines
- Co-disposal can be used with any tailings (slurry to thickened tailings to filtered tailings)
- Co-disposal deserves its own options study
- There are cheap co-disposal concepts despite the common perception
Thank You!