Modern Practical Ways to Improve Your Mill Throughput

Tega Industries

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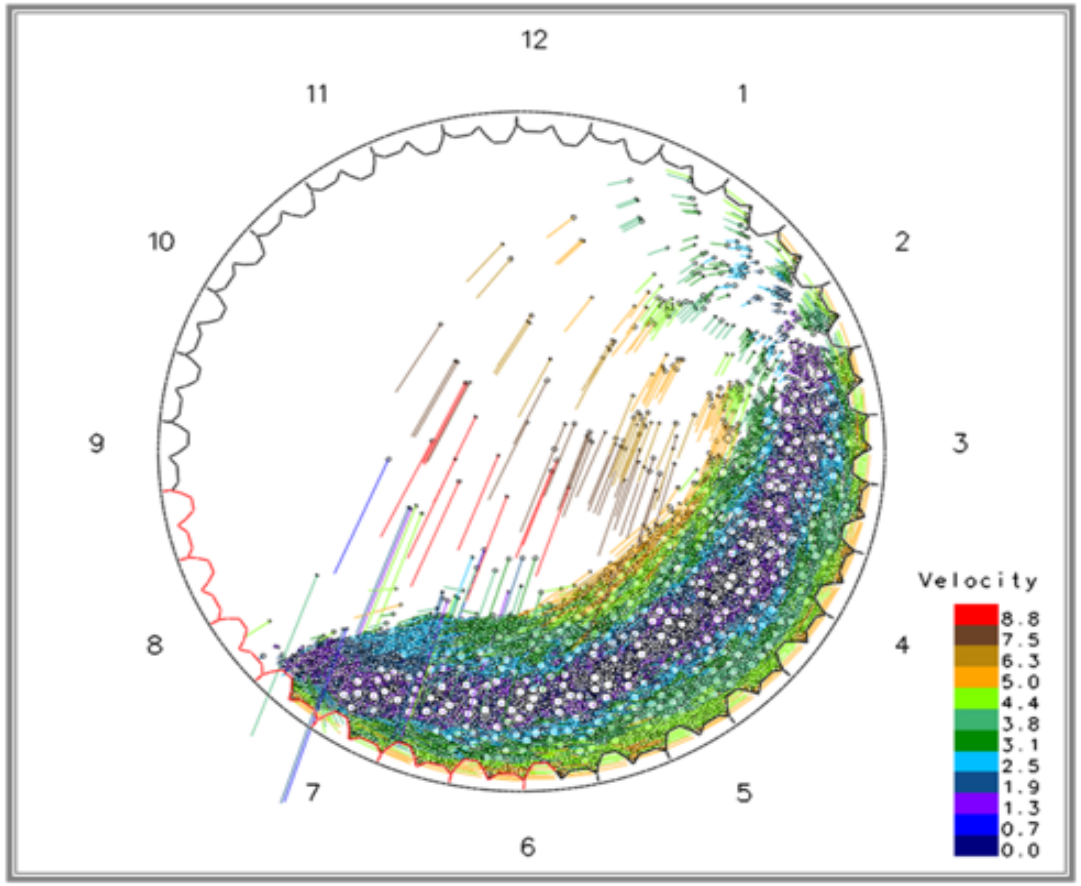
SAG Mill Breakage Mechanisms

Impact breakage:

- Large balls and rocks hitting smaller rocks at high speed. Responsible for 15% to 20% of the breakage.
- Abrasion and Attrition grinding: rocks and balls sliding over other rocks. Its responsible for the rest of the work, i.e. 80% - 85%, which is the majority of the work.



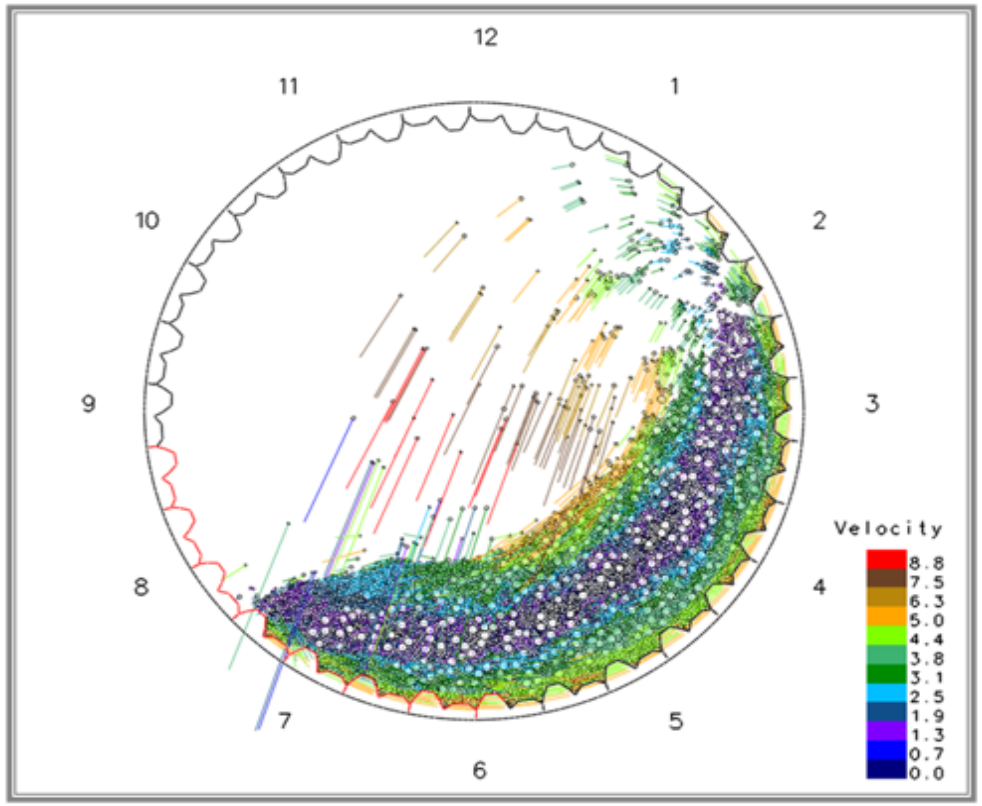
SAG Mill Impact Breakage

Contributing factors are:

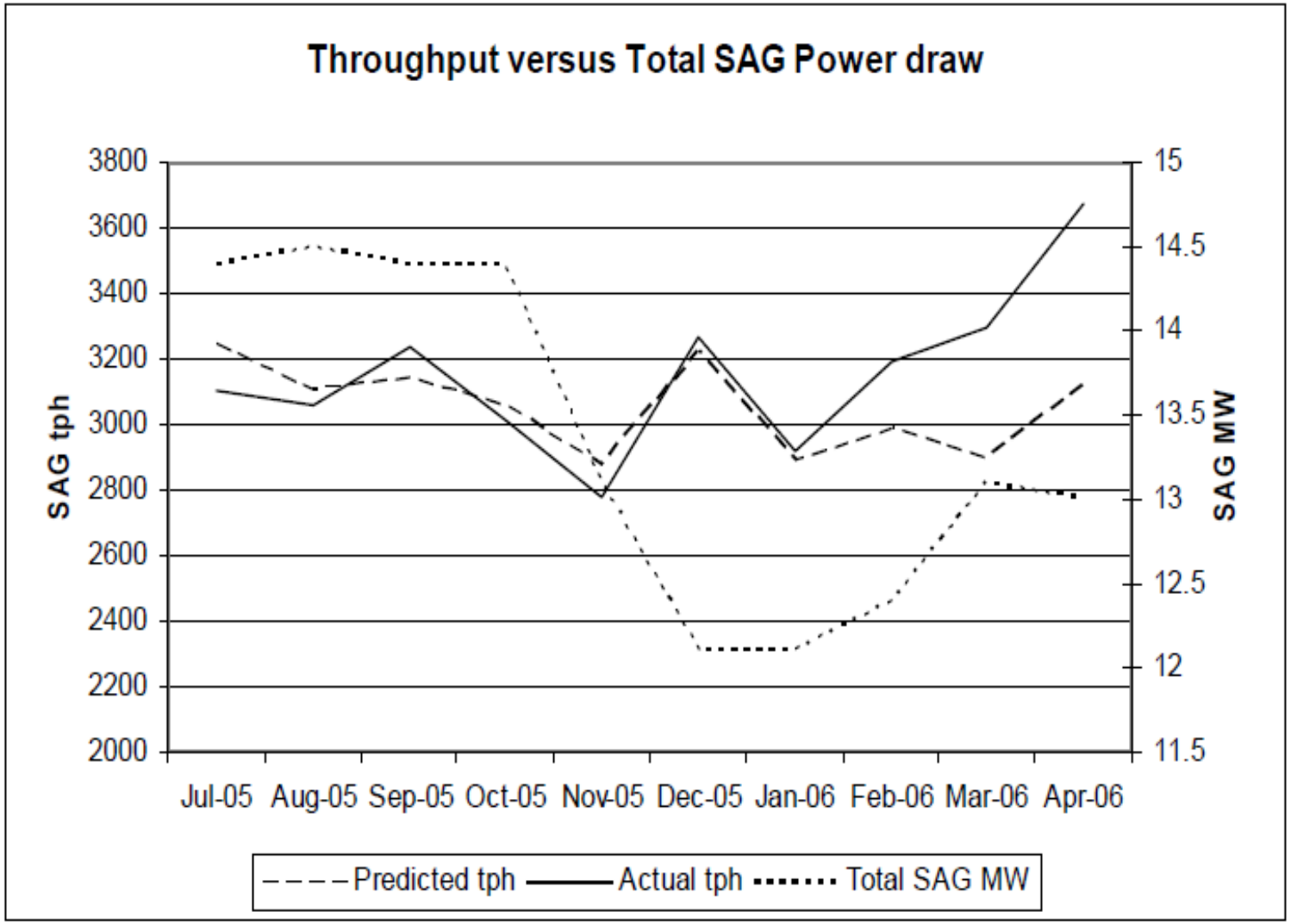
- Mass and velocity of ball
- Frequency of breakage
- Volume of charge is exposed to the impact breakage?
  - Ratio of balls to rocks (1 : 1?)
  - Total volume of mill charge
  - Lifter bucket volume!!

Don’t be surprised that for hard ore, you will get ↑ tph at lower kW!

Max SAG kW ≠ Max hard ore tph!



SAG kW vs tph


Throughput versus Total SAG Power draw
SAG tph
SAG MW
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
15
14.5
14
13.5
13
12.5
12
11.5
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
Predicted tph
Actual tph
Total SAG MW

SAG Mill Abrasion & Attrition

Simple: More speed = More work

VS

High SAG Mill Speed

- Increases abrasion & attrition grinding
- Increases frequency of impact breakage

Combined effect is increased throughput rate

Solution is to use a liner that doesn't fail

- Increases probability of ball mill overthrow. Ball overthrow becomes more damaging if you drop mill charge volume to operate with a 1:1 Ball ratio when the ore is harder and or coarser

Increased risk of premature liner failure

How does finished product leave the mill?

Water! The water pushes the finished product through the grates into the pulp discharge assembly:

- High SAG % Solids: low water volume, increased residence time, finer product
- Low SAG % Solids: higher water volume, lower residence time, coarser product = ↑ tph

Long grate slots close to grate periphery assist hard ore milling by allowing pebbles to easily pass through grates and move on to the pebble crushers

How do we add water to the SAG?

Typically, its ratioed to the feed tonnes:

- When tph ↓, water ↓

Reduce the SAG % Solids to 60%:

- higher water volume to increase flow rate through the mill, reduce residence time and produce a coarser T_{80}

Grate Design Challenges

Typical Grates

Pass through the charge at speeds ranging from 18 k/h (11 mph) to 21 k/h (13 mph):

- Short grate slots?
- Approx. symmetrical Pebble Ports?
- Grate aperture also affects Pebble Crusher performance via top size reporting to the crusher

Pebble Crusher Product

Site	Crushed Pebble P80, mm
Batu Hijau	15
Northparkes Line 2	25
Telfer Gold Mine	20
Rosebel Gold Mine	26
Antapaccay	26
Cowal Operation	21

Crushed Pebble P_{80}

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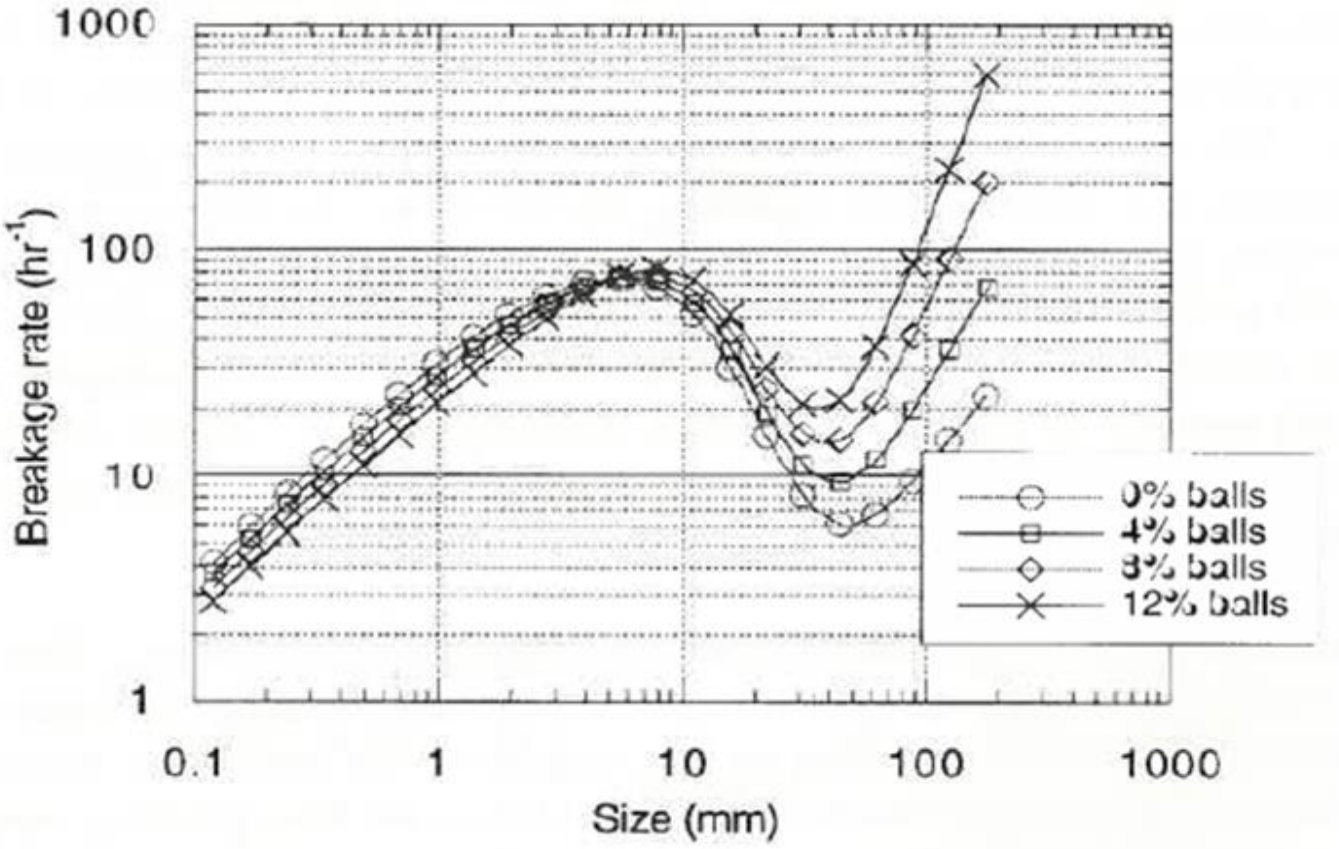


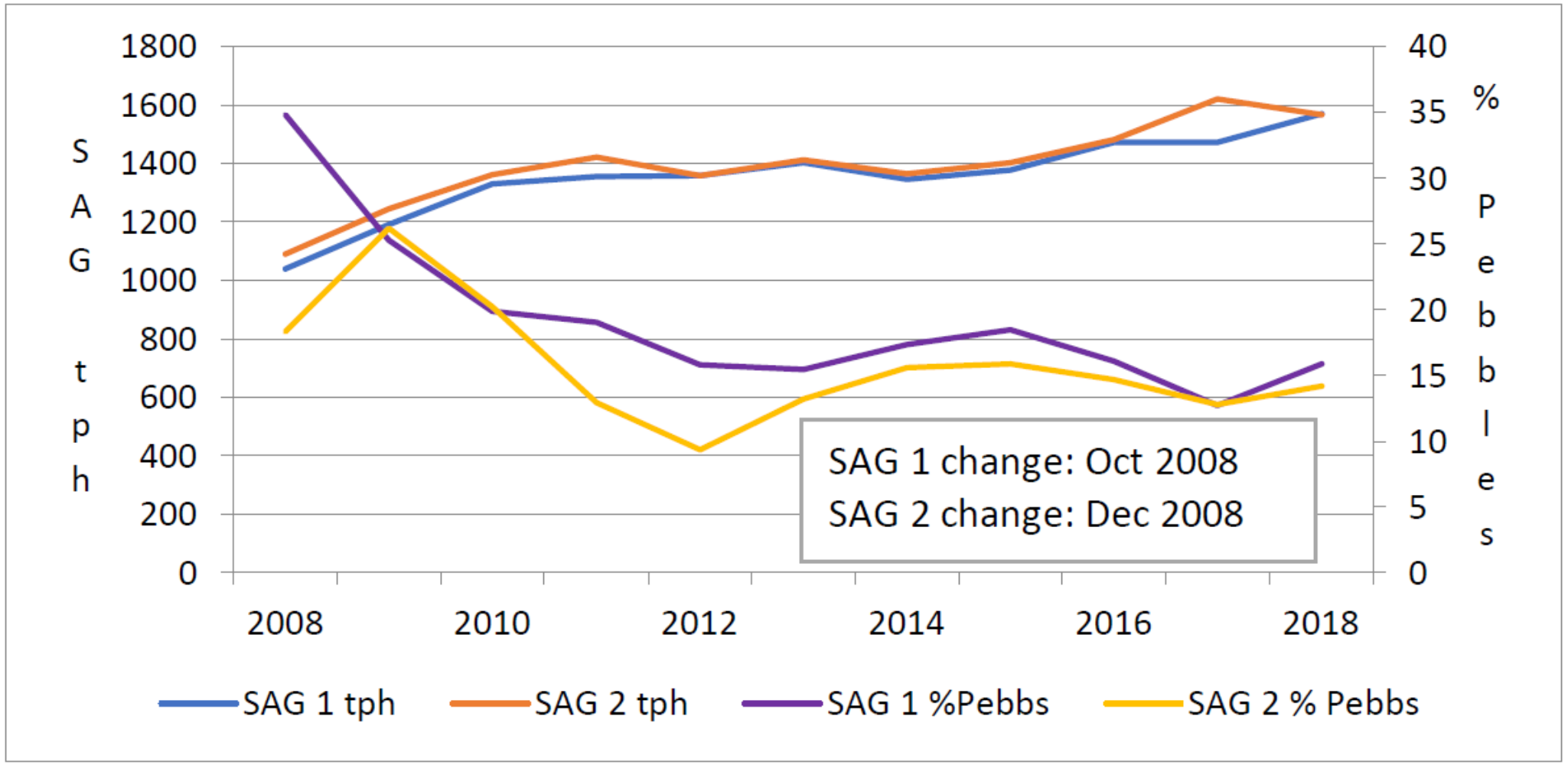
Double Width Grates

Double Width

- longer & narrower slots
- Reduced top size to pebble crusher
- Improved Crusher performance: reduced pebble recirculating load by approximately 30%
- Pebble Crusher maintenance demands halved

Cowal SAG Mill

Double Width Grates at Telfer: 2 x 36’ SAG Mills



Low SAG Mill % Solids

- Increases hydraulic head that pushes material through the grates
- Reduces residence time in the mill
- Produces coarser SAG product

Combined effect is increased throughput rate

- Increases rate of abrasion wear of the shell liners

Reduces service life of SAG liners

Solution is to use a liner that offers wear resistance

Modern Practical Options for increased tph:

Operating Practice:

- Operate SAG at low % Solids, e.g.: 60% - 65% Solids w/w
- Reduce rock volume. For Primary Crushed SAG feed, try operating at 0.9 – 1:1 rock to ball load
- Operate at highest mill speed possible using largest balls possible

Longer term: Liner Optimization

- Choose a liner that is resistant to abrasion wear in high impact environments
- Choose a liner that doesn't fail in a high impact and high abrasion environment

Longer term: Grate Optimization

- Trial double width grates to improve pebble crusher performance
- Half Grate change outs