CEEC MINERAL PROCESSING AND INNOVATION WORKSHOP

Session 2

Taking Grade Engineering from Concept to Production Demonstration

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CRC ORE

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CRC ORE ESSENTIAL PARTICIPANTS

MINERS

ANGLO AMERICAN

ANGLOGOLD ASHANTI

BHP

GLENCORE

NEWCREST MINING LIMITED

Teck

Sumitomo Corporation

METS

HATCH

imdeX

JKtech SMI Technology Transfer

ORICA

METS IGNITED

SEDGMAN

SODERN

metso

Researchers

AMIRA INTERNATIONAL

CSIRO

Curtin University

clareo

mining3 TRANSFORMINGMINING

mriwa Minerals Research Institute of Western Australia

NRC·CNRC Canada

QUT

THE UNIVERSITY of ADELAIDE

THE UNIVERSITY OF QUEENSLAND

UTAS

GRADE ENGINEERING

Separate ore from waste much earlier in the mining process

INTEGRATED EXTRACTION SIMULATOR

Linking individual silos for Whole-of-Mine process simulation

TECHNOLOGY DEVELOPMENT & TRANSFER

For benefit of Australia, our Participants and the Mining Industry

MINERA SAN CRISTOBAL CASE STUDY

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MESO-SCALE SAMPLING FROM ROM MUCKPILES

PRODUCTION TRIAL IN ACTION

Metso Lokotrack being shipped to MSC

Screening Trial in Operation at MSC

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PRODUCTION TRIAL RESULTS SUMMARY

- Screened 73,968t of ore
- Mass Splits for Fine/Middling/Coarse are 25%/30%/45% respectively
- Feed NSR was $10.61 vs Fines NSR of $28.30 (Upgrade of 2.67)
- Coarse NSR is $4.99

Attribute	Feed	Upgrade Factor for Fines	Accept Grade / Value of Fines	% Value / Metal Retained
NSR ($)	10.61	2.67	28.30	66
Zn (%)	0.56	1.94	1.08	48
Pb (%)	0.16	2.16	0.35	54
Ag (g/t)	16	2.25	35.71	56

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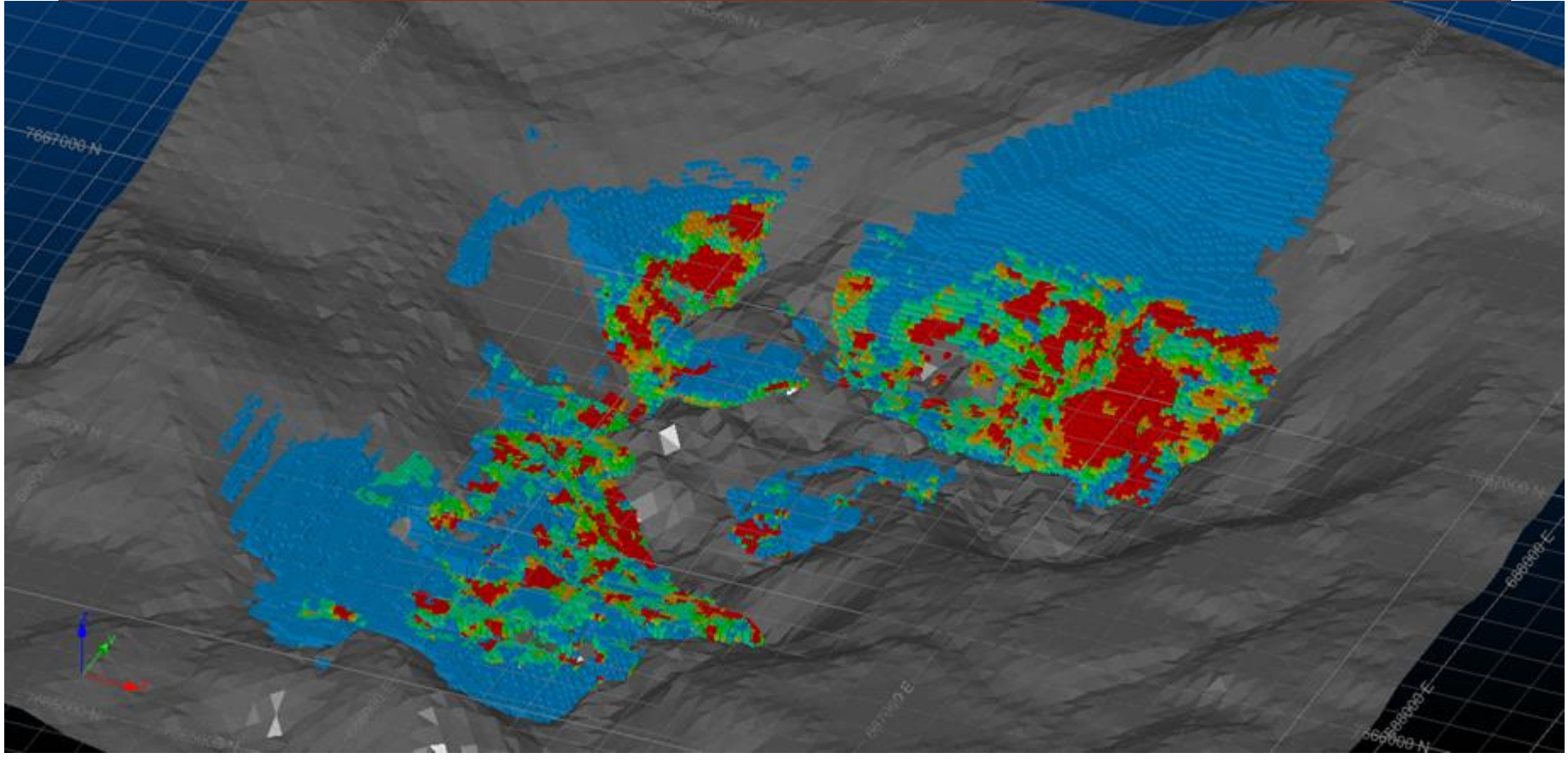
INTRUSIVE ROCK TO BE MINED (GE PIT AND PHASES)

Pit	Δ Profit	Δ NPV	Δ Ore to Plant	Δ LOM
Intrusive Rocks (Grade Engineered)	+$451M	+$257M	+39Mt	+2.0yrs



BULK SENSING PRODUCTION TRIALS

CRCORE with Anglo American to conduct Bulk Ore Sensing and Sorting Trials across multiple commodities

- El Soldado – porphyry copper (Chile)
- Mogalakwena – layered intrusion PGE (Ni/Cu) (South Africa)
- Barro Alto – Ni laterite (Brazil)

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BULK ORE SORTING TRIAL EXPERIMENTAL PROGRAM

- Experimental Phase 0: Preliminary Testwork and Analysis
- Experimental Phase 1a: Calibration of the Sensors
- Experimental Phase 1b: Proving the Technology
- Experimental Phase 1c: Proving Separation
- Experimental Phase 1d: Minimum Separation Capability
- Experimental Phase 1e: Develop Yield-Response Curves
- Experimental Phase 2a: Demonstrate Production Scale
- Experimental Phase 2b: Campaign through Concentrator

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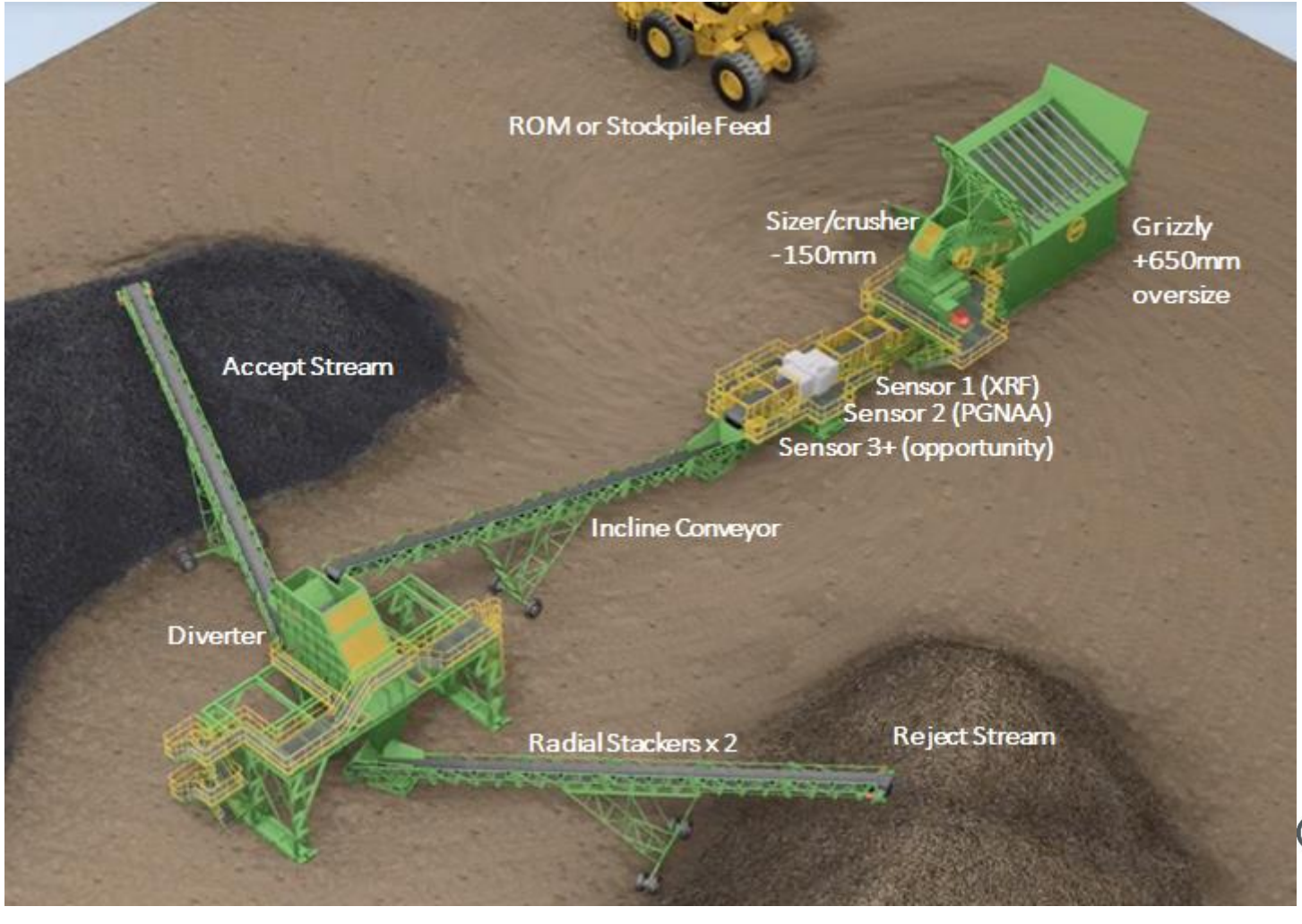
PRODUCTION TRIAL BULK ORE SORTING PLANT LAYOUT



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PRODUCTION TRIAL BULK ORE SORTING PLANT LAYOUT

Sizer, Intermediate Conveyor, Sensors (PGNAA + XRF) and Elevated Conveyor

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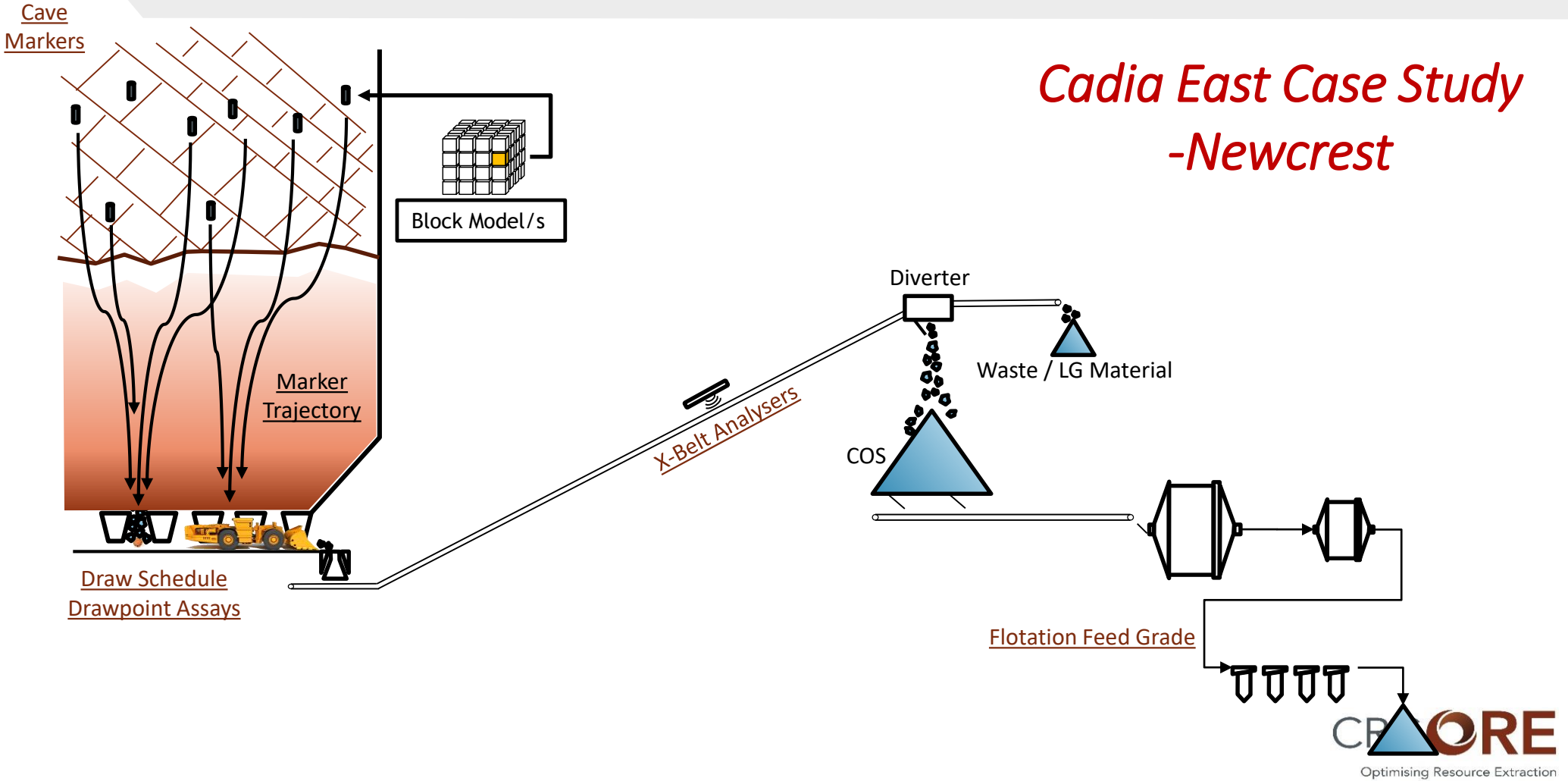
PRODUCTION SCALE IMPLEMENTATION AND DATA FUSION

Cadia East Case Study -Newcrest



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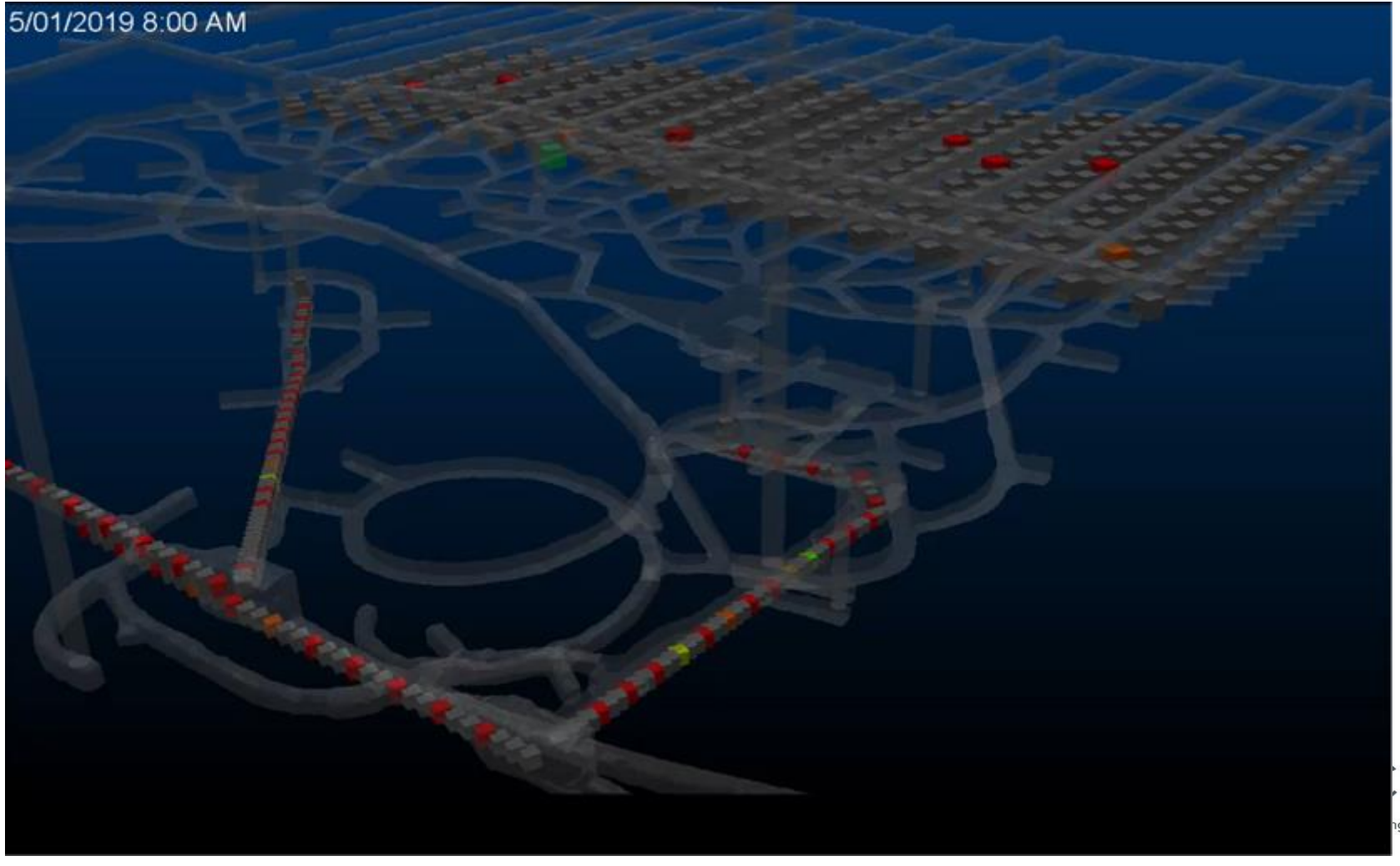
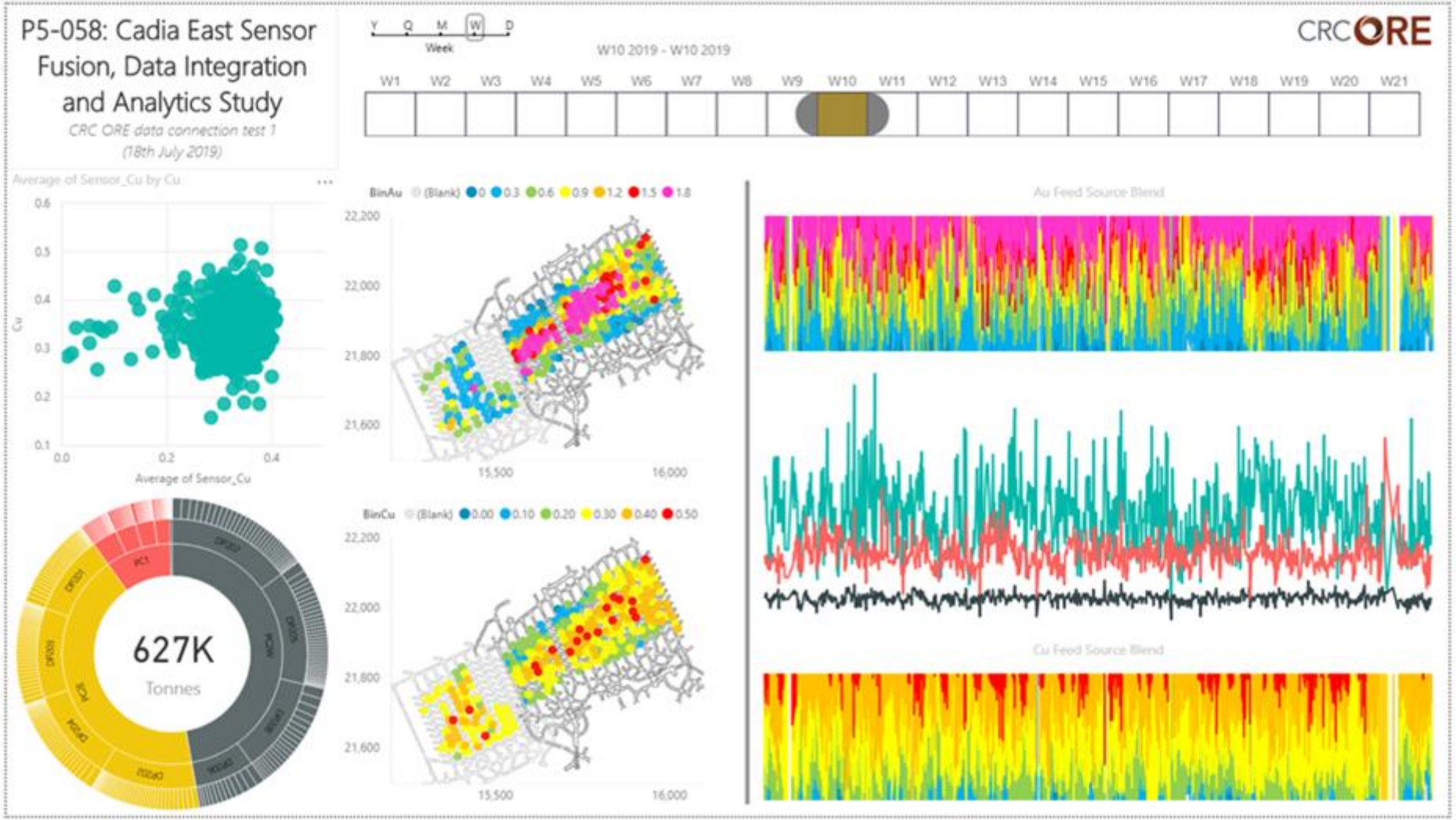
THE GRADE ENGINEERING JOURNEY



DATA INTEGRATION AND ANALYSIS



Extraction

TELFER GE PRODUCTION TRIAL - PROJECT SUMMARY

- *Identify and quantify potentially amenable ores to upgrade via screening & particle sorting*
- Determine production scale responses via pilot plant
- Develop, supervise and undertake wholistic project design, QAQC, procedures, sampling collection, laboratory methods and sample logistics
- Concept level design and valuation of production scale screening plant integrated to Telfer processing plant

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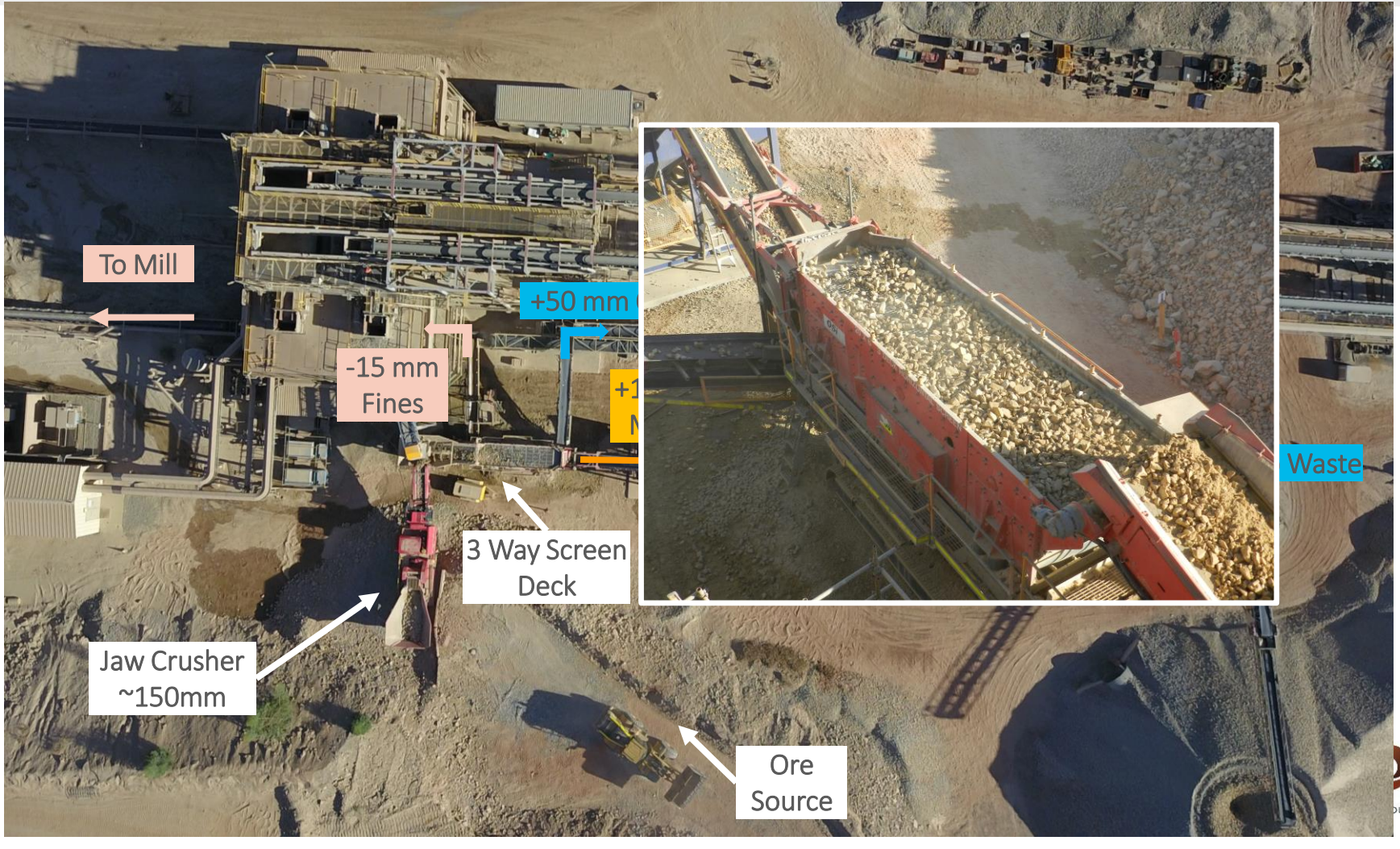
SITE LAYOUT


To Mill
-15 mm Fines
+50 mm
3 Way Screen Deck
Jaw Crusher ~150mm
Ore Source
Waste

Example single sample composite

+50mm OVERSIZE

Sample: Approx 850kg
Mass: Weightometer

→ **Sub Screen**

+90mm
&
+50mm -90mm

Particle Sorter Accept
15-50mm
Sample: Approx 300kg
Mass: Weightometer

→ **Sub Screen**

+32mm - 50mm
&
+15mm -32mm

Particle Sorter Reject
15-50mm
Approx 300kg
Mass: Weightometer

→ **Sub Screen**

+32mm -50mm
&
+15mm -32mm

-15mm FINES

Approx 300kg
Mass: Weightometer

→ **Sub Screen**

+3.35mm -15mm
&
-3.35mm

Crush / Split / Assay
Jaw crush to 3 mm
Rotary split
Weigh and pro rata to Weightometer
Assay: Au (duplicate), Cu, CN soluble Cu and S

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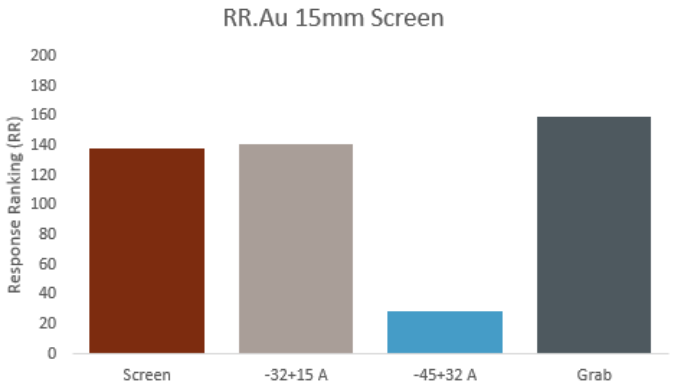
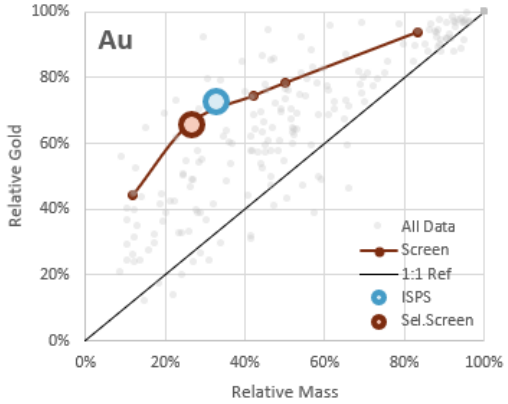
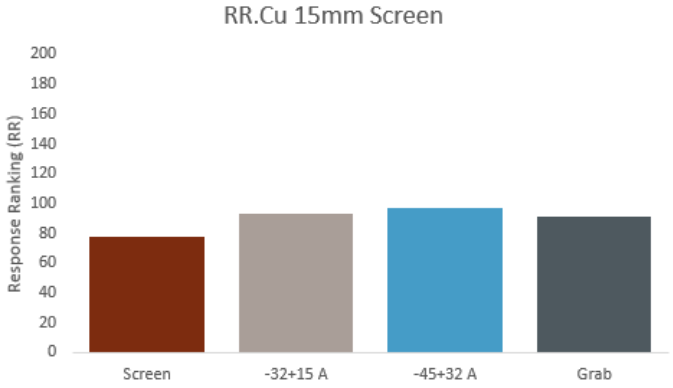
Resource Extraction

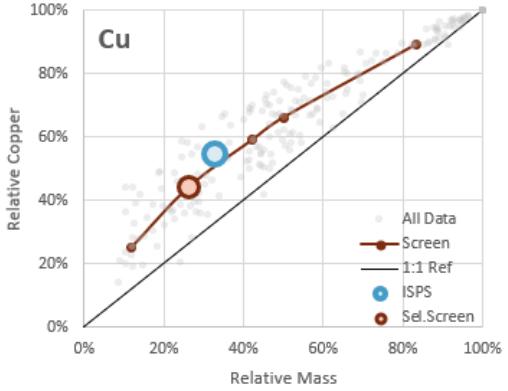
TELFER – INTEGRATED RESULTS

Select	12	Date	Source ID Summary	Ore Source	Bench	Blast	Block	Unit	Material Type	Hardness	Oxidation
		28/05/2019	Desc_0010	West Dome	5420	25420637	5420-432	RSM	CIL	3	2
								Mass	Au ppm	Cu ppm	S %
							Feed	838	0.19	231	0.16









Basic Value Calculation Inputs					Base	Screen	ISPS
Gold Price $/oz	$ 1,300	Screen Cost	$1.00	Value abs	-$ 4.4	-$ 0.1	-$ 0.4
Copper Price $/t	$ 5,600	Sort Cost	$1.00	rel.Mass	100%	26%	32%
Process Cost	$ 12.00	Gold Rec	85%	Value $/t	-$ 4.4	-$ 0.2	-$ 1.3
Rehandle Cost	$ 1.00	Copper Rec	77%	Δ Value $/t		94%	70%

Summary	C.Mass%	C.Au	C.Cu	C.S	RR.Au	RR.Cu	RR.S
Screen 15mm	26%	66%	44%	35%	138	78	42
ISPS (45-15mm)	32%	73%	55%		144	94	

Screen	C.Mass%	C.Au	C.Cu	C.S	RR.Au	RR.Cu	RR.S
-150+90	100%	100%	100%	100%			
-90+45	84%	94%	89%	89%	129	74	68
-45+32	50%	78%	66%	50%	129	81	0
-32+15	42%	74%	59%	44%	131	78	10
-15+3.35	26%	66%	44%	35%	138	78	42
-3.35	12%	44%	25%	18%	124	70	37
				Average RR:	130	76	31

Sorter Feed	24%	12%	22%			
Sorting	C.Mass%	C.Au	C.Cu		RR.Au	RR.Cu
-32+15 A	26%	67%	49%		141	93
-32+15 R	74%	33%	51%			
-45+32 A	26%	32%	50%		29	97
-45+32 R	74%	68%	50%			

Grab	C.Mass%	C.Au	C.Cu	C.S	RR.Au	RR.Cu	RR.S
Oversize	100%	100%	100%	100%			
Sorter Waste	50%	90%	75%	98%	171	117	193
Sorter Product	32%	84%	60%	67%	169	110	128
Fines	26%	76%	49%	50%	159	91	95
				Average RR:	166	106	139

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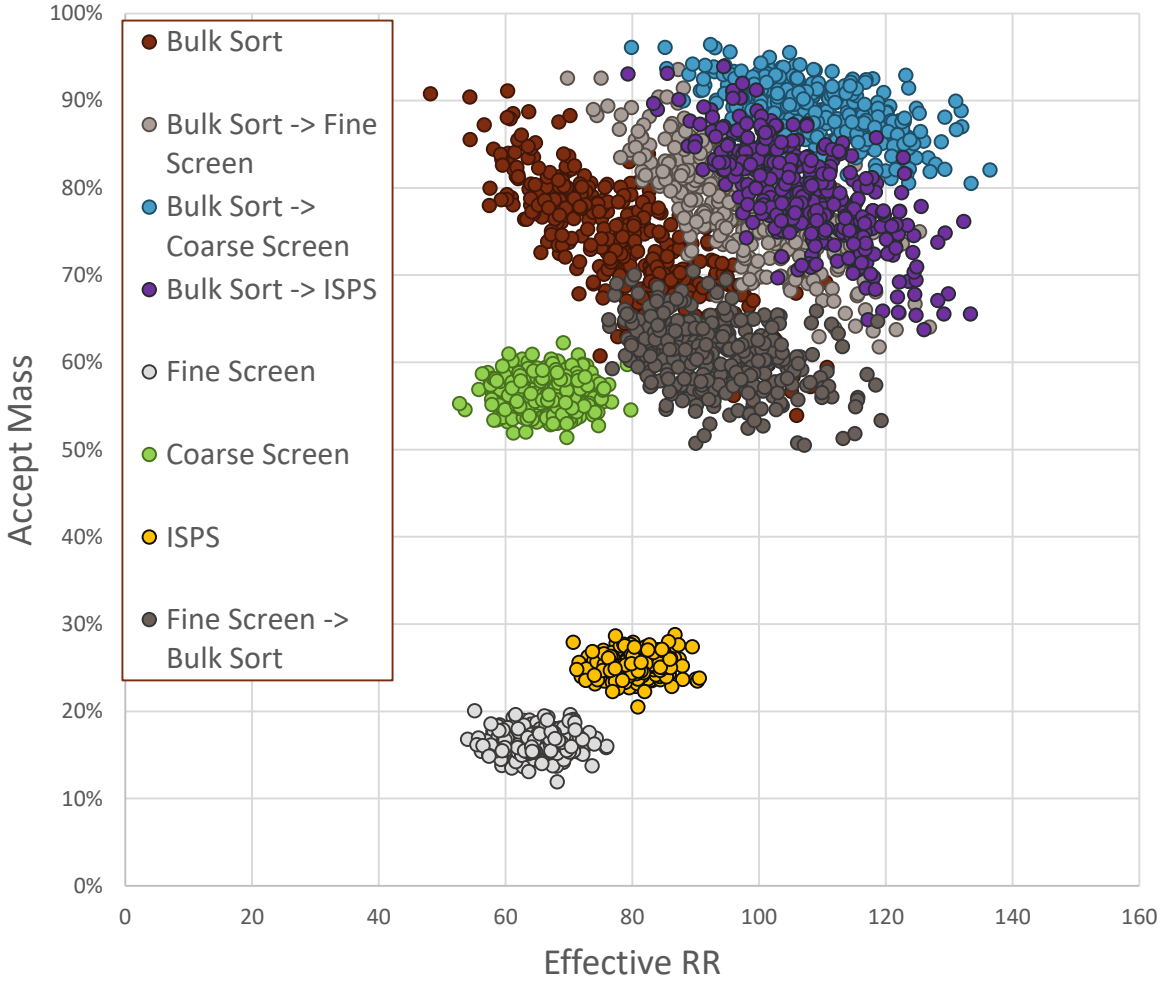
NEXT STEPS: INTEGRATION OF GRADE ENGINEERING LEVERS



Industry is now generating datasets to enable multiple GE levers to be investigated and deployed in multiple configurations

Now have the ability to run what if scenarios based on real Grade Engineering data

Enables early evaluation of what is the best options to investigate

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Integrated Screening and Particle Sorting

Particle sorting trials commonly have two flaws:

- failure to consider the benefit of grade by size assessment before sorting
- bias can exist in particle sorting testing undertaken by a vendor
- currently there is no independent industry framework for assessing an ISPS flowsheet

The ISPS project will provide a new industry framework for independently assessing an ores amenability to an integrated grade by size and particle sorting flowsheet.

$1.3M Project across 5 gold and nickel operations around Kalgoorlie

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