



SMART AUTOMATION PRODUCT SUITE
SMART STOCKYARD MANAGEMENT SYSTEM

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PIONEERING HIGH-TECH STOCKYARD & STOCKPILE MANAGEMENT SOLUTION

Stockpiles are part of the critical path in the mined materials handling supply chain. Any efficiency gains related to stacking and reclaiming directly impact on throughput and profitability.

Our Smart Stockyard Management System is world class and represents a significant advancement in the management of a modern mined material stockyard, its stockpiles and its machines, including job and task management.

The combination of laser technology, advanced data modelling and a deep understanding of the automation process is the key strength of our System, aided by our long collaboration with The University of Newcastle.

Our credentials are well established – we work with over 30 machines across four eastern seaboard coal terminals processing a combined 250MTPA.

KEY BENEFITS

Enhanced management

- Highly accurate, volumetric modelling.
- Material and its key properties can be tracked down to 100kg blocks through the stockyard lifecycle.

- Visualise the entire stockyard, individual stockpiles and mobile machines showing actual and projected performance.
- 30-day playback feature.
- Optimise stockyard capacity.
- Schedule job and task management.

Increased performance

- Maximise time-in-material with optimised machine performance based on advanced stockpile-machine modelling.
- Help machines to reach and exceed their nameplate capacity.
- Help to provide even material flow.
- Reduce transient machine stress.

KEY FEATURES

- Works with any materials handling site including iron ore, bauxite and coal.
- Suitable for brownfield retrofit and greenfield sites.
- Open PLC solution gives site maintainability and control.
- Ideal for a multi-site network solution.
- Australian owned and operated with skilled integration and PLC and SCADA engineers.
- Simple monthly software service fee.

The MRA Smart Automation Product Suite inclusions

The MRA Smart Stockyard Management System is part of our Smart Automation Product Suite that also includes:

Smart Wagon Products form part of a full train load-out or dump station automation solution that can replace an onsite operator or an aged photo-electric (PE) cell solution.

Machine-to-Machine Anti-collision works seamlessly with our Stockyard Management System to provide a SIL-rated functional safety anti-collision solution.

Ship Loader-Vessel Anti-collision uses our scanning technology to accurately locate the ship loader relative to the vessel.

DEPLOYED IN KEY COAL-HANDLING FACILITIES

The System is deployed in four major coal-handling facilities which together manage over 250MTPA of coal being loaded onto vessels:

Port Kembla Coal Terminal

- Manages four machines and a site throughput of 17MTPA.
- Automated complete stockyard operations.
- Helping facility to achieve nameplate throughput.
- Helping to maximise limited stockyard capacity.

Port Waratah Coal Services, Kooragang Terminal

- Manages 10 machines and a site throughput of 120MTPA.
- Reduced turnaround times by 90% (time out of material).
- Increased average reclaim rate by 4.8% (long travel reclaim).
- Increased throughput capacity by over 5MTPA
- Reduced transient machine stress and variance on material flow.
- Port Waratah is the largest coal export terminal in the world.

Abbot Point Coal Terminal

- Manages six machines and a site throughput of 50MTPA.
- Increased average reclaim rate by 13.7% on a manually optimised automated machine (slew reclaim).
- Automated complete stockyard operations.

THE FOUR OPTIONS FOR SMART STOCKYARD MANAGEMENT

The Smart Stockyard Management System is available in four stepped levels and is composed of these core components: a Stockpile Modelling Module, Visualisation Module, Machine Optimisation Module, Task Execution Manager, Job Execution Manager and Reporting Manager.

The stepped levels are:

Level 1 – Live Machine Monitoring shows your complete stockyard operations in real time.

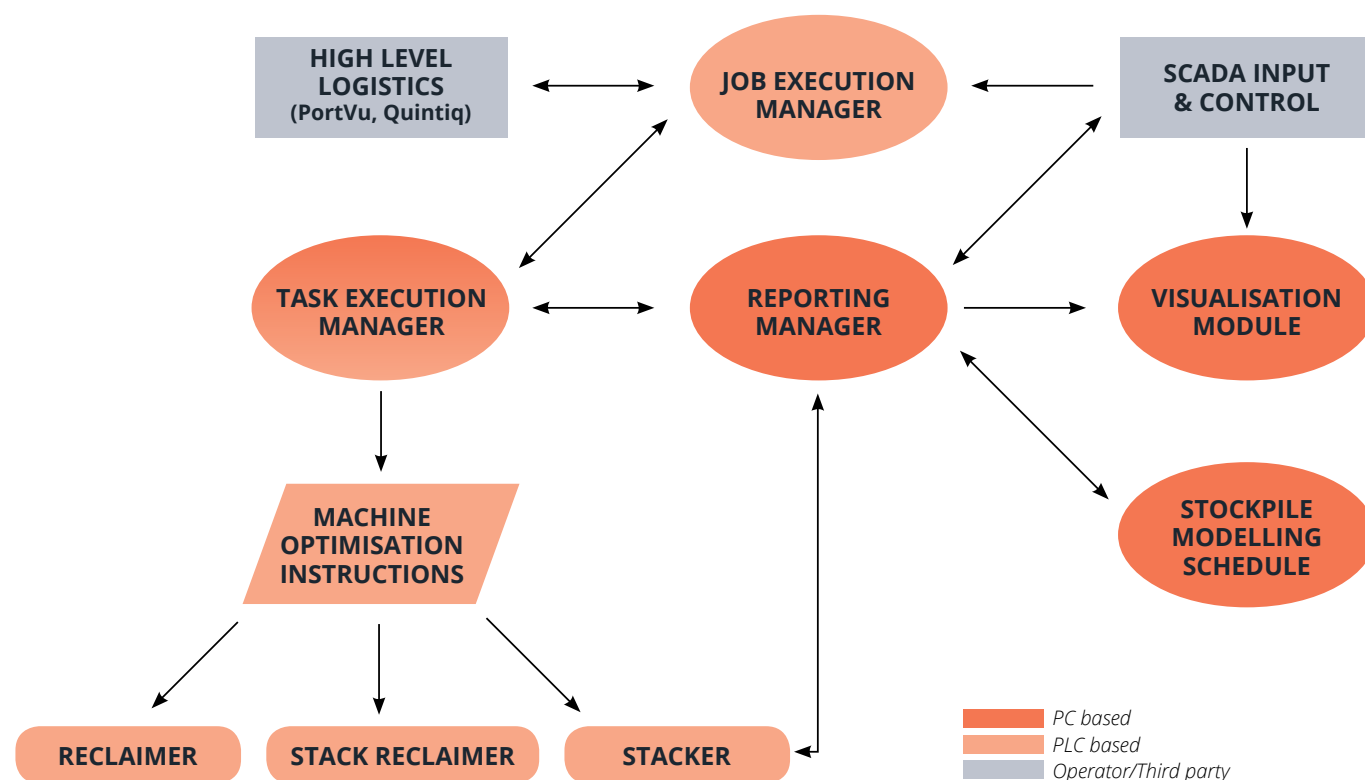
Level 2 – Stockpile Modelling uses real-time machine metrics to create a highly accurate volumetric model of the stockpiles. Integrates a comprehensive range of reclaim and stacking methods. Accurately tracks the material life cycle down to 100kg blocks through the site regardless of whether the

machines are manually or automatically operated.

Level 3 – 3D Visualisation shows a real-time, life-like 3D visualisation of the stockyard, stockpiles and individual machines with key metrics and features a 30-day playback.

Level 4 – Machine Optimisation enhances the stockpile modelling to include data collected from lasers to deliver machine-level optimisation instructions.

Level 4 represents a fully functional Stockyard Management System as outlined in the following diagram. The Job Execution Manager is either integrated with a high-level logistics system like PortVu or manually driven by an operator. Each stockyard job becomes a series of machine actionable tasks that are set by the Task Execution Manager.



MRA is experienced in custom integration, PLC and SCADA programming

MRA has an experienced team of control system engineers and PLC and SCADA programmers to help integrate and support our range of Smart Automation Products. Our team is experienced in:

- All major PLC and SCADA platforms.
- A wide range of train load-out, dump station, conveyor systems and mobile machines.
- Functional safety experience delivering several

machine-to-machine anti-collision SIL systems.

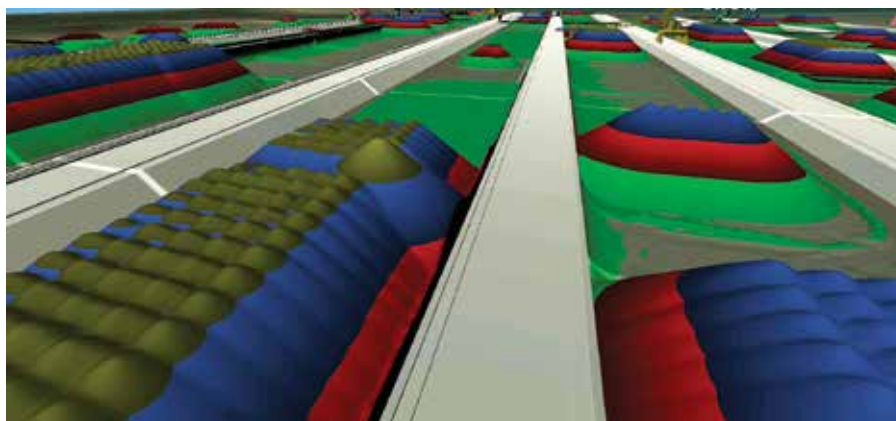
- Developing and commissioning PLC software for more than 35 mobile machines.
- The tuning of machine performance leveraging our optimisation toolkit.
- Developing and integrating job management systems for several major coal terminals.
- Custom reports.

THE CORE COMPONENTS OF THE STOCKYARD MANAGEMENT SYSTEM

STOCKPILE MODELLING MODULE

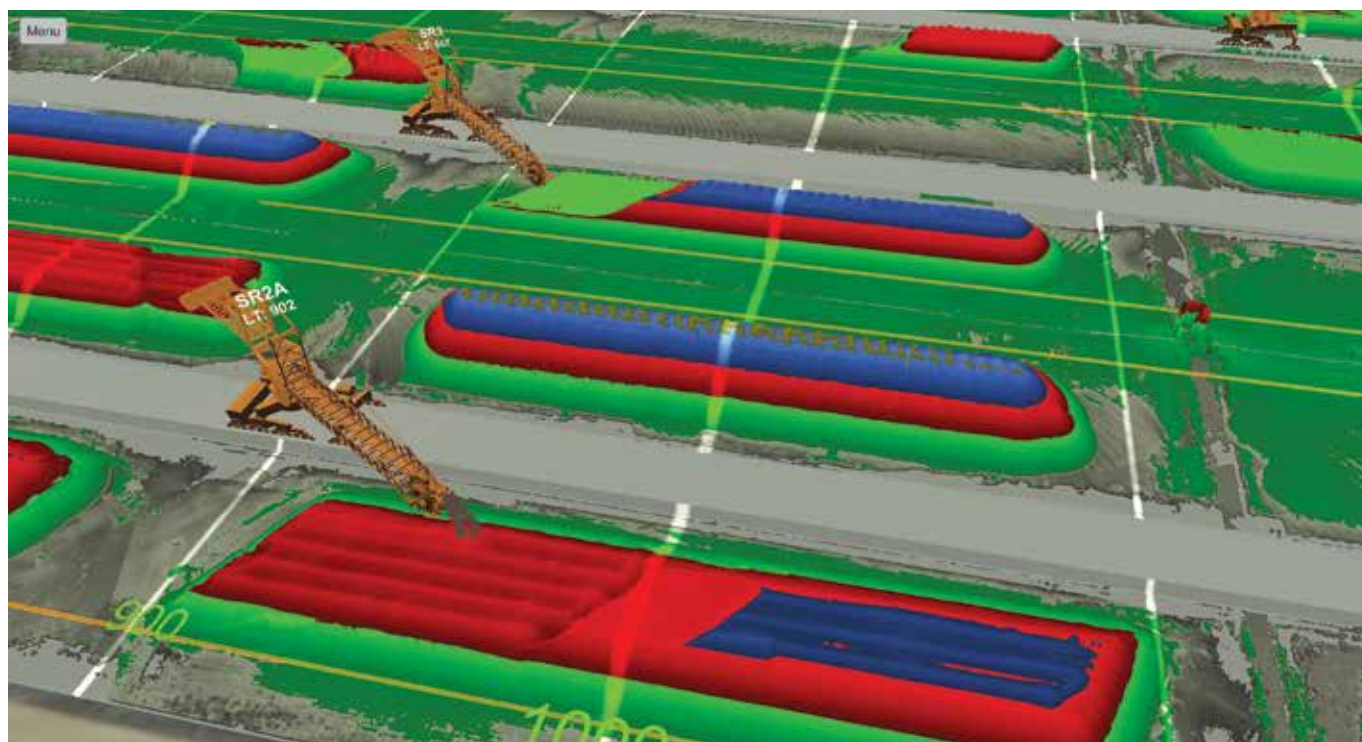
The high accuracy of our volumetric stockyard and stockpile model is the cornerstone of the Smart Stockyard Management System. Our base model uses real-time machine metrics that can be further enhanced with the integration of laser data collected in the machine optimisation process:

- Stockpile modelling shows utilised and available capacity for stockpiles across the stockyard.
- Stockpile material position and quality information can be track-and-traced to 100kg blocks within the stockpile profile. This includes real-time information through an online analyser and integrating retrospective test results.
- Machine activity and performance capabilities are mapped over the profile to provide optimised automation instructions to adjust for irregular stockpile profiles and to standardise material flow.
- Reclaim modelling methods supported include single bench reclaim, whole of stockpile bench reclaim, pilgrim drop and pilgrim step reclaim, and square up functionality and square up with pilgrim step functionality.
- Stacking modelling methods supported include cone, cone slew and windrow stacking.



Above: These images show visual correlation between the stockpile model created using machine trend data (without laser enhancement) and the physical stockpile. The images highlight a stacking process issue that can be addressed without physical site inspection.

Below: Abbot Point Shows highly accurate modelling of different stacking methods within the same stockyard – windrow stacked with partial reclaim and rebuild and cone slew.

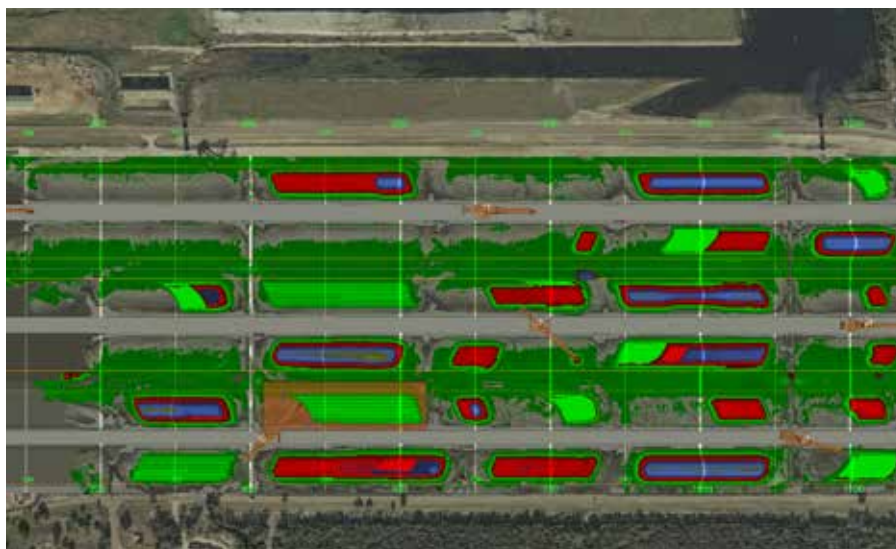


VISUALISATION MODULE

Enables the stockyard, stockpiles and individual machines to be seen in a rich, real-time 3D visualisation, which includes a 30-day playback feature. Operators can access a suite of reporting tools that provide a comprehensive understanding of actual and projected stockyard performance, including:

- Ability to navigate to any part of the facility with pan, tilt and zoom.

- Visual aids including coloured stockpile benches, grade information, stockpile information, stockpile zones and yard chainage markers.
- Machine-to-stockpile and machine-to-machine separation distances.
- Machine and stockpile visualisation playback enables the operator to review site and machine activity over the previous 30 days.

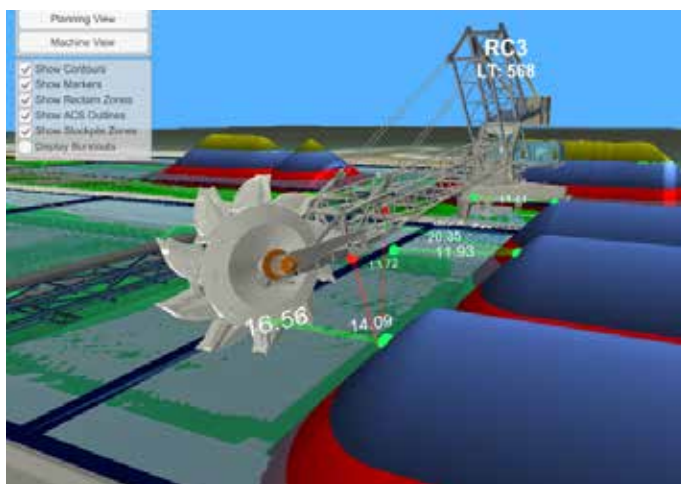
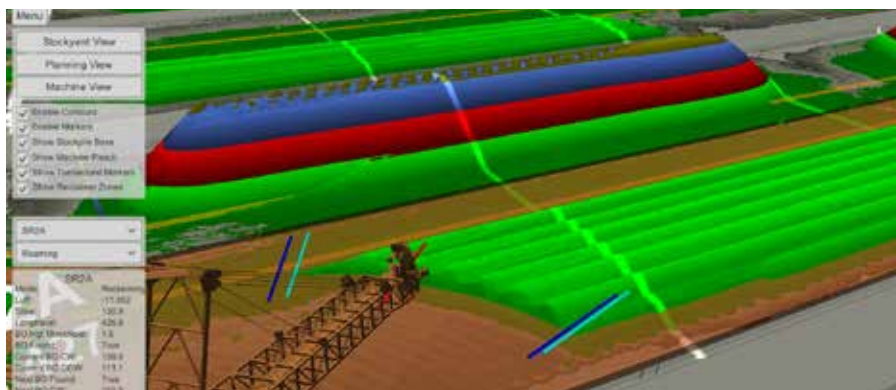


Left: Abbot Point
Whole of site overview, including machine positions, planned stockpile zones and quarantined areas.

Below: Abbot Point
Visualisation shows a zoomed-in site view with stockpile information pop-up.

Bottom left: Port Kembla
Shows calculated machine to stockpile separation distances.

Bottom right: Port Waratah
Visualisation playback feature includes both machine positions and stockpile profiles (15 minutes of operations per second).

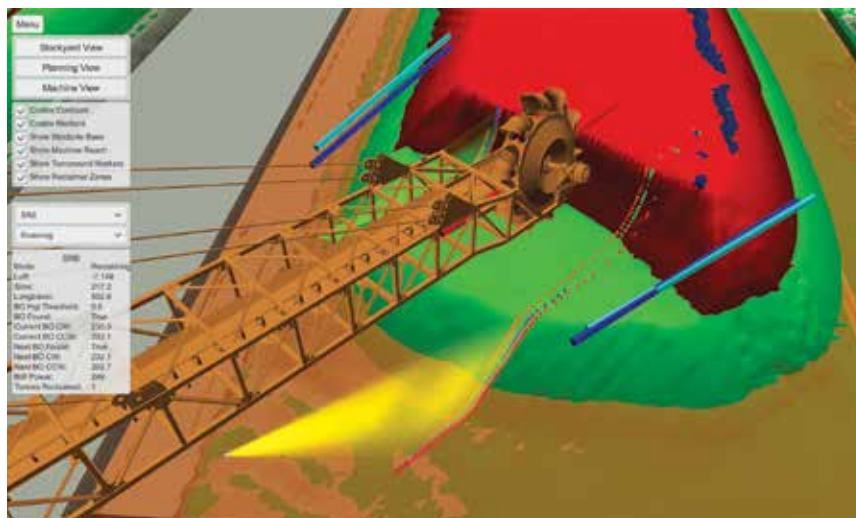


MACHINE OPTIMISATION MODULE

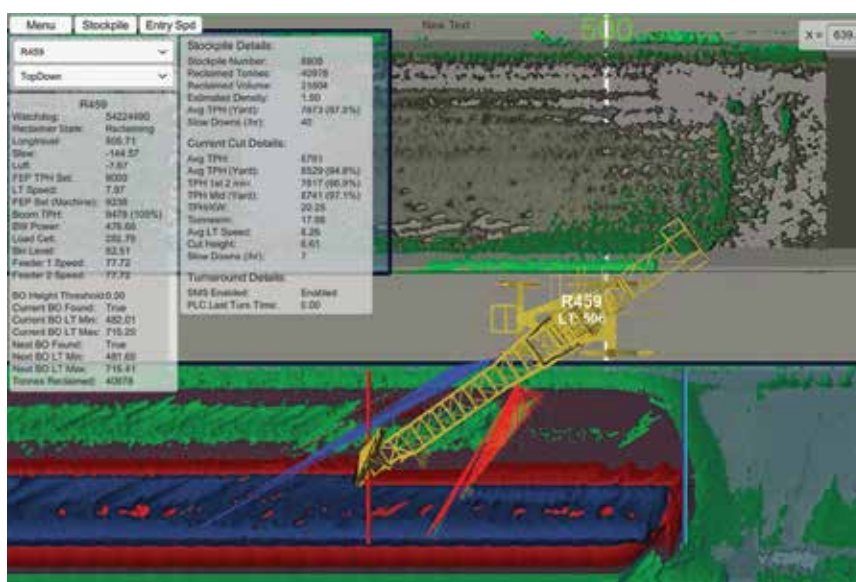
With this module, machine data is collected from two lasers per reclaimer to enhance stockpile modelling and calculate machine-level optimisation instructions.

The accuracy of the stockpile modelling enables the enhancement of several reclaimer processes to maximise time-in-material:

- Optimal turnaround (slew angle) calculated for existing and next cut.
- Step size optimally set for each cut.
- Volumetric look-ahead to help set cut speed.
- Calculates remaining material for end-of-bench signalling.
- Calculates optimal slew angle for outer edge remnant clean-up on bench change.
- Can set optimal reclaimer start position for fresh bench, partially reclaimed bench, partially completed square up and partially completed pilgrim step.



Top: Abbot Point Reclaim optimisation showing laser scanner data points and calculated turnaround slew position for the current and next slew swings.



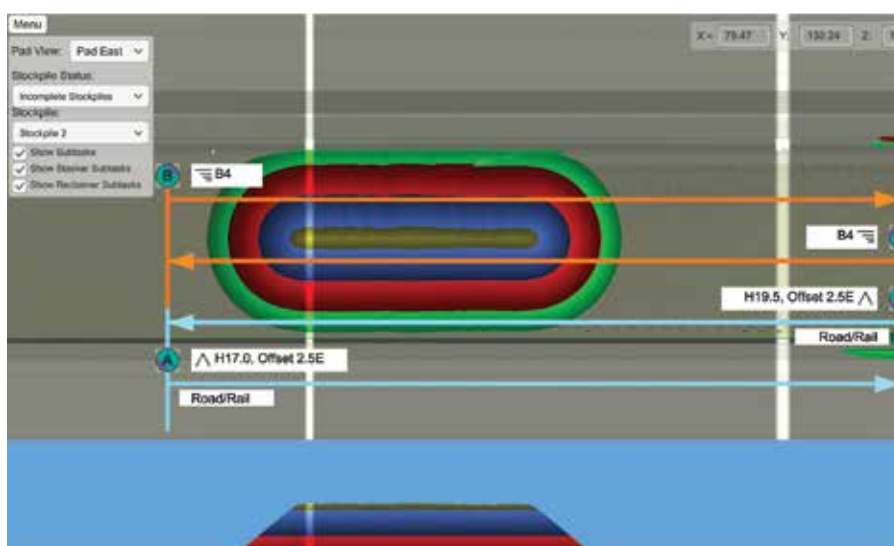
Right: Port Waratah Live machine process information, whole of stockpile reclaim metrics and specific cut metrics, including turnaround time.

TASK EXECUTION MANAGER

The Task Execution Manager produces optimised PLC level instructions for machine tasks and monitors and reports on their status. It enables:

- Creation and editing of tasks.
- Supports a comprehensive range of stacking – cone, cone slew, windrow, chevron, strata – and reclaiming (slew) – full stockpile bench, single bench, pilgrim drop, square-up (for space optimisation) – methods.
- Calculation of optimal stacker and reclaim start positions for initiation or to resume.
- Resetting of smart machine relocation.

As it is PLC-based, process control and maintenance personnel can modify the software as required.



Port Kembla Shows the tasks that have been set up for the selected stockpile.

JOB EXECUTION MANAGER

The Job Execution Manager functionality includes:

- Ability to load jobs from planning DB and then execute in PLC.
- Route planning for current and next jobs with live modifications to reallocate source/destination.

- Ability to start, stop, suspend and cancel tasks.
- Material tracking.
- Material contamination checks.
- Reporting of job details back to DB.
- Monitoring machine to stockpile collision avoidance.



Left: Port Waratah Shipping work list detailing the reclaim jobs allocated to the vessel with live reporting and showing varied coal types in a multi cargo vessel.

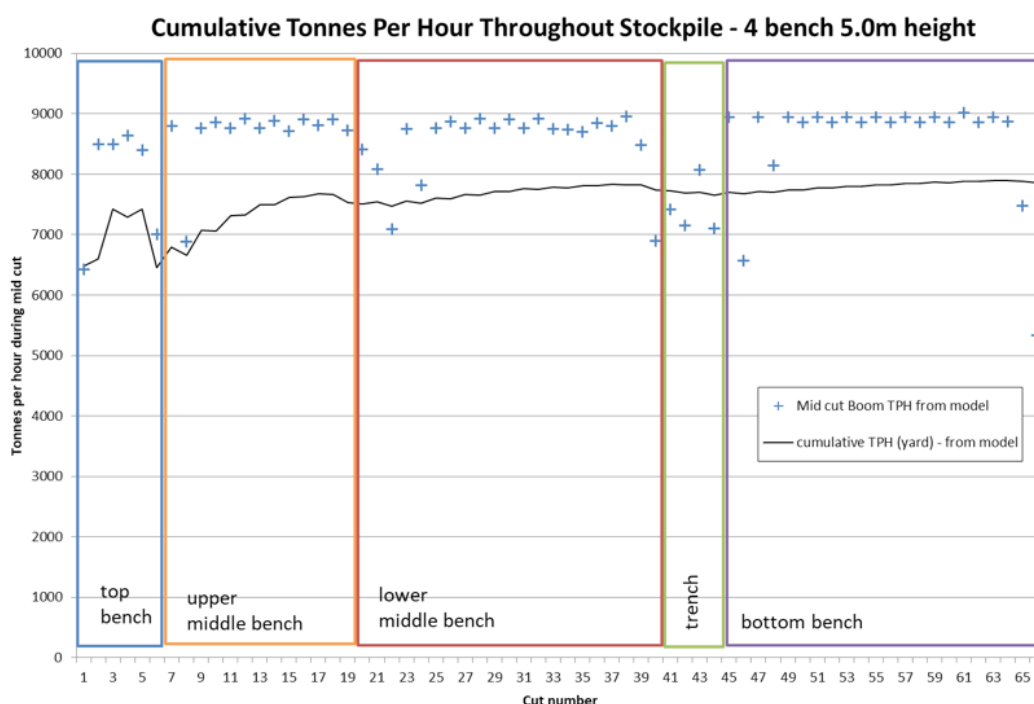
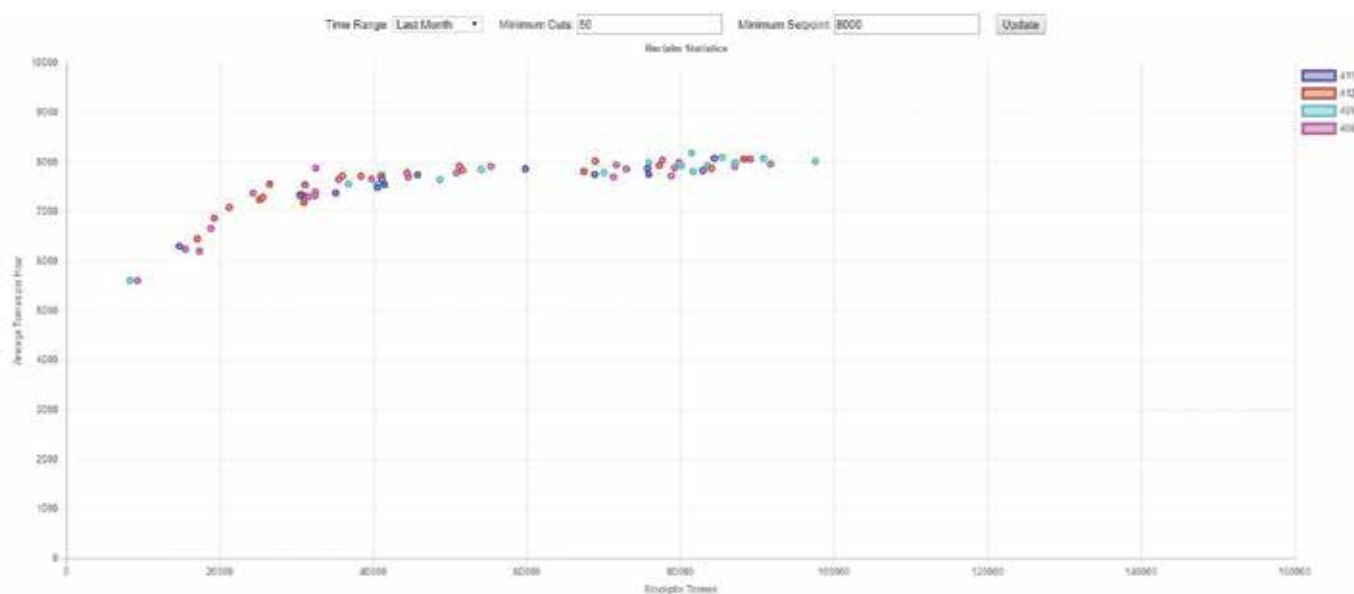
Below: Port Waratah
Port Waratah train job
schedule showing in real-
time each active train and
scheduled arrival.

					OLDI ● CITEC ● COMMS ● BATT'S ●				WorkTrain		09:41:34		04/04/2019				
U	ID	ETA	Vessel	Component	Export	Sch	Act	Source	Route	Dstn	MC	Status	DS1 Current Next				
4	CW372	Thu 09:15	DECLAN DUFF	INTEGRA	GIAG TH	8600	510	DS1	DS1>358	B1280-1475	1358	Running					
U	ID	ETA	Vessel	Component	Export	Sch	Act	Source	Route	Dstn	MC	Status	DS2 Current Next				
2	ND382	Thu 08:25	NORTH FORTUNE	NDTH	GLENCORE	9100	7850	DS2	DS2>359	C2380-2570	2515	Completing					
100	BC374	Thu 09:40	NAVIOS SYMPHONY	BULGA	BULGA	9150	0	DS2	DS2>359	C2110-2185	2135	Promoted					
U	ID	ETA	Vessel	Component	Export	Sch	Act	Source	Route	Dstn	MC	Status	DS3 Current Next				
U	ID	ETA	Vessel	Component	Export	Sch	Act	Source	Route	Dstn	MC	Status	DS4 Current Next				
92	UL246	Thu 10:00	SKYTHIA	ULAN	GLENCORE	9150	0	DS4	DS4>322	D2015-2290	2230	Running					
U	ID	ETA	Vessel	Component	Export	Sch	Act	Source	Route	Dstn	MC	Status	TX/RB				
U	ID	ETA	Vessel	Component	Export	Sch	Act	Source	Route	Dstn	MC	Status					
96	UL284	Thu 11:50	SKYTHIA	ULAN	GLENCORE	9150		DS4	DS4>322	D2015-2290	2231	Scheduled					
	TX730		MG KRONOS	ASHTN CO	YSSC	99999		A2520-2625	460>416>359	B2400-2490	2421	Scheduled					
11	WK160	Thu 13:05	CORONA JOYFUL	WKTH	YLAT	9100		DS1	DS1>356	A450-630	562	Scheduled					
97	BC162	Thu 13:27	NAVIOS SYMPHONY	BULGA	NS SEMI	9150		DS4	DS4>322	D2300-2405	2355	Scheduled					
9	HV172	Thu 14:12	NORTH FORTUNE	HVTH	GLENCORE	9100		DS2	DS2>359	C2380-2570	2516	Scheduled					
68	WG316	Thu 14:30	EHIME QUEEN	WILPSTD	PBDYSTM1	8601		DS3	DS3>357	A1675-1855	1805	Scheduled					
99	MN142	Thu 15:39	SKYTHIA	MANGOOOLA	GLENCORE	9150		DS3	DS3>322	D2015-2290	2231	Scheduled					
17	UL352	Thu 15:45	SKYTHIA	ULAN	GLENCORE	9100		DS4	DS4>322	D2015-2290	2231	Scheduled					
90	MO184	Thu 16:35	CORONA ACE	MTOWEN	GLENCORE	9150		DS2	DS2>359	C1645-1830	1683	Scheduled					
2	WK212	Thu 17:08	CORONA JOYFUL	WKTH	YLAT	9100		DS1	DS1>356	A450-630	562	Scheduled					
6	BG182	Thu 17:52	KAGUYA	BNGALA_P	JPBLEN	8600		DS4	DS4>321	D1645-1835	1785	Scheduled					
4	ND220	Thu 18:58	NORTH FORTUNE	NDTH	GLENCORE	8600		DS2	DS2>359	C2380-2570	2516	Scheduled					
98	UL112	Thu 19:20	SKYTHIA	ULAN	GLENCORE	9150		DS4	DS4>322	D2015-2290	2231	Scheduled					
91	MN214	Thu 20:59	GIOVANNI BOTTIGLIERI	MANGOOOLA	HVTH	9150		DS2	DS2>359	B2200-2385	2227	Scheduled					
68	JW262	Thu 21:21	FPMC B GUARD	WAM STM	GIAG TH	8601		DS4	DS4>321	D385-680	422	Scheduled					
Citect User: Operator					Last Download: 04/04/2019 09:41			Version: 2.5.0.30180		I/O Server: KCIOTCL1 (prop)		Database: KOP:WORLD (ReadOnly)					
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REPORTING MANAGER

The Reporting Manager shows real-time reports and charts for site, stockpile and machine performance metrics including throughput, turnaround times and areas of projected performance gains. Historical data can be reviewed and custom dashboards provided.

This includes efficiency reports for stacking, reclaiming and machine utilisation. Data export capabilities and web-based access to all reports is incorporated.



*Above: **Port Waratah** Whole of stockpile reclaim performance history graph for comparison of relative performance between machines. The chart shows the achieved tonnes per hour for each reclaimer across a range of stockpile sizes (each point is a whole stockpile). It is automatically generated and viewable to site staff via an internally accessible web page.*

*Left: **Port Waratah** Detailed reporting of cut statistics on a per stockpile basis. Example chart shows achieved tonnes per hour throughout the reclaim, including bench changes.*

Keen to find out more?

You're welcome to contact our Engineering Manager Peter McPherson **m** 0403 453 250 **e** peter.mcpherson@mra.com.au **w** mra.com.au