

ASX / MEDIA ANNOUNCEMENT

Tuesday 21<sup>st</sup> December 2021

# Mid-Stream Project and Calix Testwork Update

## TESTWORK, TECHNICAL INPUTS AND ENGINEERING SUPPORTING THE MID-STREAM PROJECT SCOPING STUDY COMPLETE

### HIGHLIGHTS

- Scoping Study for the Mid-Stream Product Demonstration Plant nearing completion, with technical and engineering work now complete.
- Work to-date supports the Mid-Stream Project objectives for exporting a value-added lithium product from the Pilgangoora Project:
  - calcination test work at Calix's pilot scale BATMn reactor confirms high conversion rates (>95% for Alpha to Beta phase transition), for fine flotation spodumene concentrate<sup>1</sup> produced from Pilgangoora;
  - targeting a materially lower carbon emission footprint through extensive electrification of the calcination process powered by renewable sources, as well as reduced freight quantities; and
  - potential to re-shape the existing spodumene supply chain and present global markets with a cleaner and more efficient supply chain solution.
- Next steps:
  - Economic and commercial evaluations contributing to a completed Scoping Study early in the New Year.
  - Subject to successful completion of the Scoping Study, progress negotiations for the formation of a joint venture.
  - Agree a work program to develop a Demonstration Plant and ultimately commercialise the Mid-Stream Product's process technology.

Pilbara Minerals Limited (ASX: PLS) (**Pilbara Minerals** or **the Company**) and Calix Limited, (ASX:CXL) (**Calix**) are pleased to further report on initiatives to develop value-added lithium products at Pilbara Minerals' 100% owned Pilgangoora Project.

### **MID-STREAM PROJECT SCOPING STUDY UPDATE**

#### **PROJECT BACKGROUND**

Following execution of a Memorandum of Understanding (**MOU**) in May 2021 (refer ASX Announcement dated 11 May 2021) between Pilbara Minerals and Calix, a Scoping Study for a Mid-Stream Product Demonstration Plant ("**Scoping Study**") commenced, which is nearing completion. The Scoping Study aims to support the development of a Demonstration Plant at the Pilgangoora Project ("**Pilgangoora**") to produce lithium salts from fines-flotation spodumene concentrate, supporting a pathway towards potential future commercial production of value-added lithium products at Pilgangoora.

The Scoping Study (undertaken by Lycopodium Minerals in conjunction with the Pilbara Minerals and Calix teams) is assessing the potential development of a new refining process to produce high purity lithium phosphate precipitate from Calix-calcined fines spodumene

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<sup>1</sup> Conversion rates vary as a function of concentrate properties (including particle size) and further testwork is underway.

concentrate supplied from the Pilgangoora Project. This concentrated lithium salt from the Pilgangoora Project ("**Mid-Stream Product**"), could support downstream lithium raw material and cathodes demand.

Technical work contributing to the Scoping Study (including testwork, process design and engineering) is now complete. Completion of the commercial and economic evaluation contributing to the Scoping Study is expected early in the New Year, following which a final review of the results will be undertaken by the boards of Pilbara Minerals and Calix with results released shortly thereafter.

Subject to the results being commercially and technically satisfactory to both Pilbara Minerals and Calix, in accordance with the MOU the parties will then progress negotiations for the formation of a joint venture and agree a work program to develop a Demonstration Plant at the Pilgangoora Project and ultimately seek to commercialise the Mid-Stream Product's process technology in respect of lithium phosphate applications on a worldwide basis.

### ***MID-STREAM PROJECT OBJECTIVE – PURSUING A SUPERIOR LITHIA CARRIER PRODUCT***

The lithium-ion supply chain is rapidly evolving with large scale development occurring through all segments of the supply chain. Several prominent forces are shaping the industry including product cost (per lithia unit), product quality (purity), carbon energy reduction and waste management (particularly for the European market).

Pilbara Minerals Mid-Stream Project objective is to deliver a superior value-added lithia product that exceeds across these metrics of product cost, quality, carbon energy reduction and waste reduction/handling.

The project work to date has comprised exploring alternate solutions to achieve these aims, including reviewing and testing alternate process paths, equipment selection and end-product types.

The project has now been narrowed down to a preferred process route and end-product. The process route under investigation is unique in the use of both the calcination processing technology and chemical concentration process.

Although the project is in its early development phase, the test work and engineering to date which has contributed to the initial Scoping Study provides strong indications that the new mid-stream product (and process path) can be expected to deliver on the desired metrics of an improved value-added lithia product. In particular through a reduction in carbon energy intensity, reduction in shipped volumes (through higher concentration product) and providing a more easily handled product. The metrics of product production cost and quality will however need to be further assessed as the project moves through the subsequent phases of study and further development.

Australian spodumene is a raw material feed to a high-value chemical industry that is largely conducted outside of Australia. Producing a high lithium-content intermediate salt product on site at Pilgangoora, will result in a portion of the value traditionally retained by downstream spodumene converters outside of Australia being retained in-country.

The value-added Mid-Stream product is also expected to be able to access diverse markets worldwide.

### ***PROJECT TESTWORK AND ENGINEERING RESULTS TO-DATE***

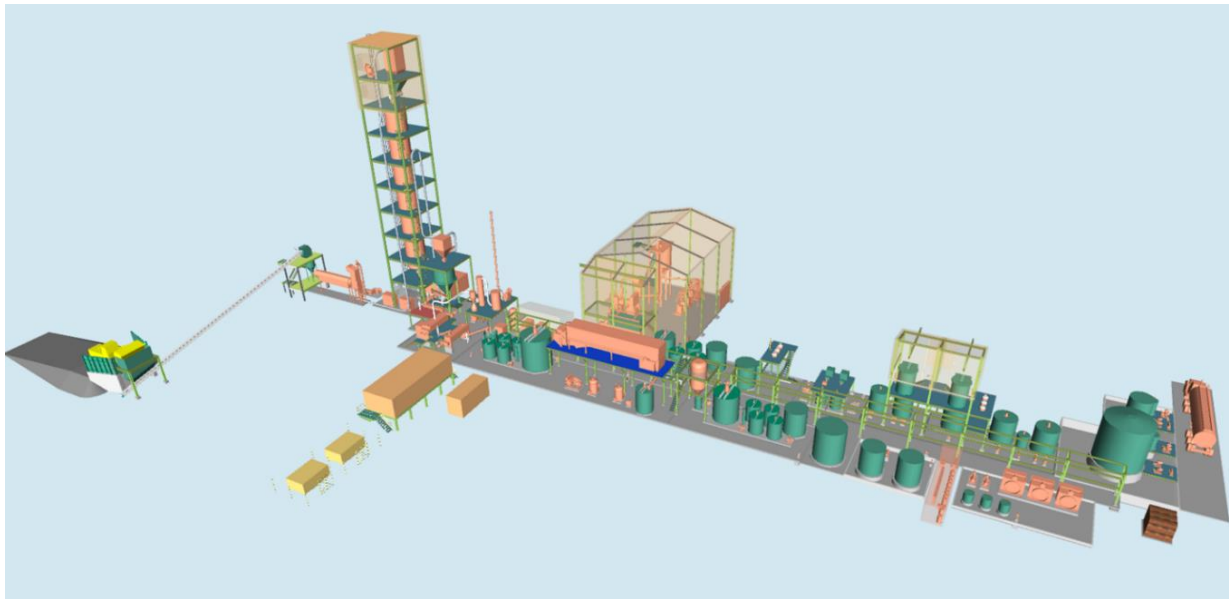
#### ***Process Design***

Pilbara Minerals together with Lycopodium Minerals embarked on a testwork programme to

develop a flowsheet to produce a lithium phosphate salt. The testwork programme was initiated by using a produced synthetic lithium sulphate leach solution to produce small quantities of lithium phosphate precipitate. Subsequent testwork phases further developed the flowsheet to produce high purity lithium phosphate precipitates from Calix-calcined Pilgangoora spodumene concentrate.

Following laboratory scale testwork, lithium phosphate has been selected as the preferred product, having demonstrated superior performance to other alternatives evaluated to date. Other forms of lithium salts will continue to be considered for potential process optimisation in future study works.

Flowsheet test work to-date has demonstrated >90% overall lithium recovery to final high purity lithium phosphate product.



Above: Midstream Demonstration Plant Design Model

Pilbara Minerals' mid-stream project development is expected to be progressed utilising unallocated spodumene concentrate production capacity available from the Pilgangoora Project over time, without disrupting existing customer offtake arrangements, including the POSCO and Pilbara Minerals downstream joint venture.

### **Calcination Testwork**

A series of spodumene flotation concentrate samples from Pilbara Minerals' Pilgangoora Project were sent to Calix's test facility in Bacchus Marsh, Victoria, for processing through their BATMn reactor. These samples were processed under a range of operating conditions to determine whether successful calcination of Pilgangoora spodumene flotation concentrate could be achieved using the Calix Flash Calciner ("**CFC**"); and if so, what the optimal conditions for this calcination would be.

Testing undertaken at the BatMn reactor was considered as a pilot scale initiative, given the scale of the facilities in use.

Calcination test work during the Scoping Study has demonstrated a >95% conversion (Alpha to Beta phase transition) of spodumene concentrate to facilitate subsequent lithium extraction, which is a very competitive result compared to industry norms utilising conventional technology.

Further, the Calix flash calcination technique is particularly well-suited to the finer fraction of the fines flotation concentrate at Pilgangoora (less than 75 $\mu$ m). This is very encouraging as it has the potential to solve for an existing challenge for the industry when dealing with flotation products through conventional calcining technology.



Above: The Calix Flash Calciner and Electric Pilot Scale Plant (BATMn Reactor)

### ***Decarbonising the Hard Rock Lithium Raw Materials Supply Chain***

Conventional hard-rock spodumene processing is relatively carbon-intensive. The conventional processing route involves the export and shipping of low-lithium-content raw material (SC6 spodumene concentrate is only 2.8% lithium metal by mass). In addition, this raw material requires the disposal of the waste material at the customer's site (the 97.2% proportion of the spodumene concentrate that is not lithium). Finally, conventional calcination of the spodumene concentrate is currently done exclusively using fossil fuels.

Producing a more lithium-dense intermediate product on site at Pilgangoora will facilitate a significant reduction in shipped product mass (an 8 to 10-fold shipping mass reduction can be anticipated from the production of a high-purity lithium salt on site), eliminating major waste disposal requirements at a customer's site.

Additionally, an opportunity exists, through the partnership between Calix and Pilbara Minerals, to fundamentally change the method used to calcine fine spodumene

concentrates – eliminating the requirement for fossil-fuelled calcining and enabling a fully renewables-powered operation.

The flowsheet proposed within the Mid-Stream Project adopts complete electrification of all unit processes (including calcination utilising Calix's unique technology solution), which are expected to materially rationalise the carbon footprint across the supply chain through the application of renewable energy in the process, as well as the reduction in freight quantities.

*Release authorised by  
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## MORE INFORMATION

### ABOUT PILBARA MINERALS

Pilbara Minerals is the leading ASX-listed pure-play lithium company, owning 100% of the world's largest, independent hard-rock lithium operation. Located in Western Australia's resource-rich Pilbara region, the Pilgangoora Project produces a spodumene and tantalite concentrate. The significant scale and quality of the operation has attracted a consortium of high quality, global partners including Ganfeng Lithium, General Lithium, Great Wall Motor Company, POSCO, CATL and Yibin Tianyi.

While it continues to deliver a low-cost, quality spodumene to market, Pilbara Minerals is pursuing a growth and diversification strategy to become a sustainable, low-cost lithium producer and fully integrated lithium raw materials and chemicals supplier in the years to come.

Through execution of this strategy, Pilbara Minerals is positioned to become a major player in the rapidly growing lithium supply chain, underpinned by increasing demand for clean energy technologies such as electric vehicles and energy storage as the world pursues a sustainable energy future

## ABOUT CALIX

Calix is a team of dedicated people who are urgently developing great businesses, leveraging our patented technology, that deliver positive global impact.

The core technology is being used to develop more environmentally friendly solutions for water treatment, CO<sub>2</sub> mitigation, biotechnology, advanced batteries, and more sustainable mineral and chemical processing.

Calix develops its technology via a global network of research and development collaborations, including governments, research institutes and universities, some of world's largest companies, and a growing customer base and distributor network for its commercialised products and processes.

Because there's only one Earth – Mars is for Quitters.

Website: <https://www.calix.global/>

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## FORWARD LOOKING STATEMENTS AND IMPORTANT INFORMATION

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All references to dollars (\$) and cents in this announcement are to Australian currency, unless otherwise stated.