Pure Minerals Limited

05 September 2018

ASX Announcement

OUTSTANDING MANGANESE AND COBALT LEACH KINETICS IDENTIFIED AT BATTERY HUB PROJECT

- **Results exceed expectations, with 95%-99% manganese recovery and 85%-90% cobalt recovery**
- **Exceptionally fast leach kinetics, with leaching equilibrium met in less than 30 minutes**
- **Weak leach kinetics of contaminant iron indicates a higher-purity solution can be produced**
- **Confirms potential to produce high-purity manganese products and cobalt across the major types of mineralisation at Battery Hub**
- **Pure Minerals to assess refining metallurgical testwork and calculating a maiden resource**

Pure Minerals Limited (ASX: PM1) ("Pure Minerals", "the Company") is pleased to announce the results of preliminary leaching testwork for the Battery Hub manganese-cobalt project, located in Western Australia's Gascoyne region.

The objectives of the testwork were to confirm that the two primary forms of manganese-cobalt mineralisation at Battery Hub (stratiform mineralisation from the Pools prospect, and detrital mineralisation from the Julia prospect) are amenable to atmospheric leaching and the production of high-purity manganese sulphate, electrolytic manganese dioxide (EMD), electrolytic manganese metal (EMM) and cobalt.

The results of the testwork were very encouraging:

- Manganese extractions were very high for both the Pools and Julia, with final leach extractions of between 95% and 99%.
- Final cobalt recoveries were also very good, with results of between 85% and 90%.
- The leaching kinetics of manganese and cobalt were fast, approaching equilibrium in 15 to 30 minutes under the test conditions.

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- Significantly, contaminant iron has slow leach kinetics, suggesting simpler downstream processing to produce a high-purity product. Results were enhanced with tests using lower acid concentrations. For example:
  - For the detrital (Julia) sample, after 20 minutes 91.6% of the manganese and 81.2% of the cobalt were leached, whereas only 3.8% of iron leached
  - For the stratiform (Pools) sample, after 20 minutes 97.6% of the manganese and 84.7% of the cobalt were leached, whereas only 7.6% of iron leached

Testwork was conducted by the CSIRO, located in Western Australia, and supervised by METS Engineering (“METS”).

Sample Sources

The samples leached were from the same composite RC drilling samples utilized in the preliminary metallurgical testwork, the results of which were announced on 12th June, 2018. Two types of manganese-cobalt mineralisation were tested: detrital/lateritic mineralisation from the Julia prospect and primary stratiform mineralisation from the Pools prospect. The samples were aimed to be representative of a potentially mineable block of each type of mineralisation, with each sample a composite of multiple drill hole intercepts. The average assay grade of each composite sample is outlined in Table 1, below.

Composite	Mn (%)	Fe_2O_3 (%)	SiO_2	Al_2O_3	Co
Julia (Detrital)	10.8	43.2	13.3	11.7	0.030%
Pools (Stratiform)	11.1	29.2	37.7	6.3	0.020%

Table 1: Composite head grades of samples utilised

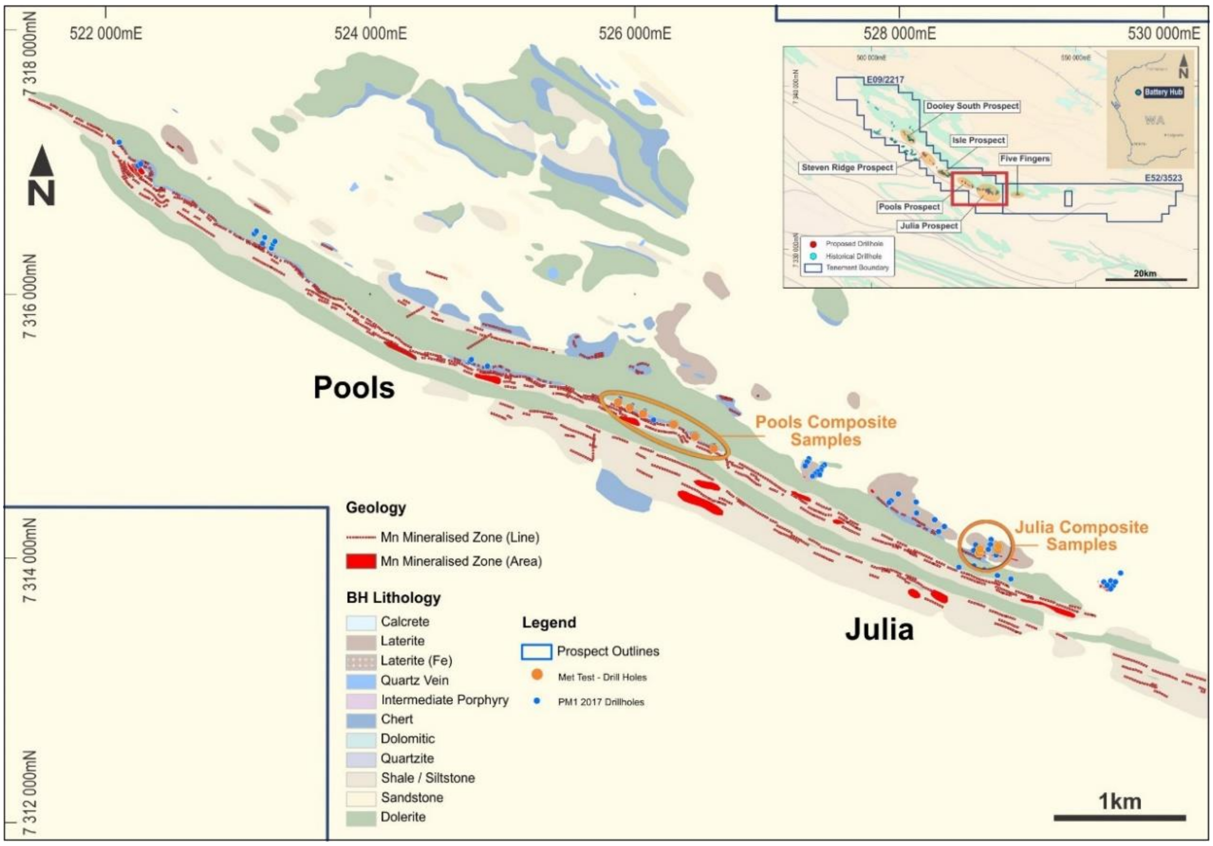

Figure 1: Location of metallurgical samples from Julia prospect (five holes) and Pools (six holes)

The sample locations, and the Pools and Julia prospects in their entirety, represent only a small portion of the 70km-long strike length of manganese-cobalt mineralisation identified at Battery Hub.

Further Testwork

The results confirm and exceed Pure Minerals' expectations, first outlined in June 2018, of attractive leach recoveries at Battery Hub.

Most significantly, Pure Minerals has de-risked a key component of the Battery Hub project prior to engaging in the more expensive aspects of mineral development, such as resource drilling and bulk sampling – potentially significant given the 70km-long strike length of mineralisation. The successful leaching testwork provides Pure Minerals with greater confidence to advance the project further.

METS and the CSIRO have recommended Pure Minerals develop next stage of scope of work for further investigation and optimisation of the leaching conditions, separation / purification options and the recovery of individual high purity Mn and Co products.

High-Purity Manganese Products

Hydrometallurgical leaching, such as that used in the proof-of-concept testwork conducted by METS and the CSIRO, has the potential to produce high-purity/high-value manganese products that are used in the electric vehicle (EV) battery sector. These products include manganese sulphate, electrolytic manganese metal (EMM) and electrolytic manganese dioxide (EMD).

Manganese sulphate, or more specifically manganese sulphate monohydrate, is used as a fertilizer but also EV batteries and as a precursor to the production of EMM and EMD, both of which are also key products for batteries and other applications. Manganese sulphate prices tend to vary between US$500/mt and US$1,200/mt, depending on purity.

Electrolytic manganese dioxide (EMD) is traditionally used in zinc–carbon batteries and in zinc manganese dioxide rechargeable alkaline (Zn RAM) batteries.

More recently, there is considerable interest in using manganese as a possible cathode for lithium ion batteries, such as Nickel Manganese Cobalt (NMC) batteries, or Lithiated Manganese Dioxide (LMD) and Lithiated Manganese Oxide (LMO) batteries. According to Avicenne Energy (2017), NMC battery formulations are expected to be the largest section of the market by 2025, while the LMO batteries are expected to show the greatest growth in percentage terms (4x growth) over the same period.

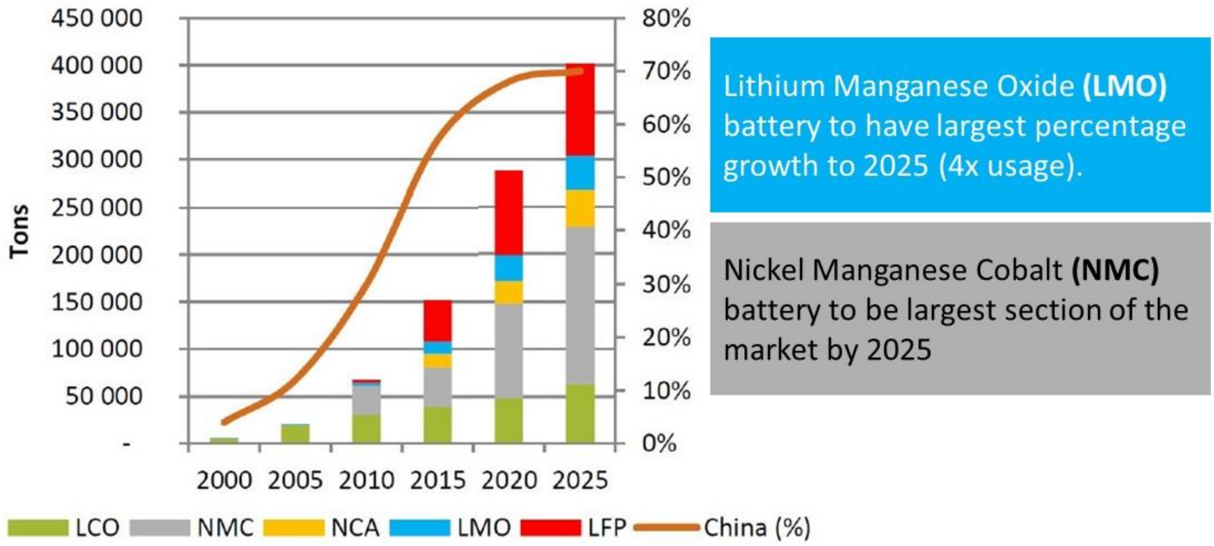

Figure 2: Growth projections for various battery types. Source: Avicenne Energy, 2017

The standard mix of used in LMD/LMO batteries contains 4% lithium, 61% manganese and 35% oxygen by atomic weight. The LMD/LMO battery has high power output, thermal stability and enhanced safety when compared to other lithium ion battery types and therefore it is currently being used by Nissan, BMW and Chevrolet.

Traditionally, high-purity manganese products are produced from manganese ore typically imported into China. The U.S. is the largest consumer of high-purity manganese products. However, given the attractive leach kinetics, Pure Minerals sees the opportunity to produce such products within Australia and on site and export directly to the end user.

On 24 August 2018, the S&P Global Platts weekly 99.7% electrolytic manganese metal assessment was between US$2,580/mt and US$2,630/mt FOB China. Chinese export EMM prices have seen a 36% increase since on 18 May this year when the price was US$1,915/mt.

Cobalt

Cobalt represents a significant by-product of hydrometallurgical leaching of manganese at Battery Hub. It is associated with manganese mineralisation at all assayed prospects and was identified in every drill hole containing manganese mineralisation from the December 2017 drill program. It's grade typically correlates with the grade of manganese and some prospects, such as Isle, exhibit a larger cobalt-to-manganese ratio than others. At the Isle prospect, cobalt grades in drilling exceeded 0.10% Co.

Cobalt's primary use is in lithium ion batteries, where it stabilizes the chemistry of the battery. Given the increased demand, car makers are scrambling to find new raw materials in more stable areas of the world, free of child and slave labour, and from cobalt concentrates with low arsenic content. Accordingly, prices have driven up from US$25,000/tonne in 2016 to up to US$95,000/tonne in March 2018. The current cobalt price is approximately US$64,500/tonne.

For and on behalf of the Board,

Mauro Piccini
Company Secretary

Competent Persons Statements

The information in this report that relates to the Processing and Metallurgy for the Battery Hub project is based on and fairly represents information and supporting documentation compiled by Damian Connelly who is a Fellow of The Australasian Institute of Mining and Metallurgy and a full time employee of METS Engineering (METS). Damian Connelly has sufficient experience relevant to the style of mineralisation and type of deposit under consideration and to the activity which he is undertaking to qualify as a Competent Person as defined in the 2012 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves'. Damian Connelly consents to the inclusion in the report of the matters based on his information in the form and context in which it appears

Appendix A

JORC Code, 2012 Edition – Table 1 report template

Section 1 Sampling Techniques and Data

(Criteria in this section apply to all succeeding sections.)

Criteria	JORC Code explanation	Commentary
Sampling techniques	• *Nature and quality of sampling (eg cut channels, random chips, or specific specialised industry standard measurement tools appropriate to the minerals under investigation, such as down hole gamma sondes, or handheld XRF instruments, etc). These examples should not be taken as limiting the broad meaning of sampling.* • *Include reference to measures taken to ensure sample representivity and the appropriate calibration of any measurement tools or systems used.* • *Aspects of the determination of mineralisation that are Material to the Public Report.* • *In cases where 'industry standard' work has been done this would be relatively simple (eg 'reverse circulation drilling was used to obtain 1 m samples from which 3 kg was pulverised to produce a 30 g charge for fire assay'). In other cases more explanation may be required, such as where there is coarse gold that has inherent sampling problems. Unusual commodities or mineralisation types (eg submarine nodules) may warrant disclosure of detailed information.*	This ASX Release dated 5 September 2018 reports on metallurgical test work on the Battery Hub manganese-cobalt project. Two composite reverse circulation drilling samples were sourced from the Julia prospect and the Pools prospect. Metallurgical test work samples were selected from RC holes BH0005, BH0006, BH0007, BH0009 and BH0010 for the Julia composite and RC holes BH0050, BH0053, BH0055, BH0057, BH0058 and BH0059 for the Pools composite. These composites were prepared at ALS Metallurgy, Balcatta (refer PM1 ASX announcement 12 June 2018).
Drilling techniques	• *Drill type (eg core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc) and details (eg core diameter, triple or standard tube, depth of diamond tails, face-sampling bit or other type, whether core is oriented and if so, by what method, etc).*	No drilling was undertaken.
Drill sample recovery	• *Method of recording and assessing core and chip sample recoveries and results assessed.*	No drilling was undertaken.

Criteria	JORC Code explanation	Commentary
	• *Measures taken to maximise sample recovery and ensure representative nature of the samples.* • *Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.*	
Logging	• *Whether core and chip samples have been geologically and geotechnically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies.* • *Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc) photography.* • *The total length and percentage of the relevant intersections logged.*	No drilling or logging was undertaken.
Sub-sampling techniques and sample preparation	• *If core, whether cut or sawn and whether quarter, half or all core taken.* • *If non-core, whether riffled, tube sampled, rotary split, etc and whether sampled wet or dry.* • *For all sample types, the nature, quality and appropriateness of the sample preparation technique.* • *Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.* • *Measures taken to ensure that the sampling is representative of the in situ material collected, including for instance results for field duplicate/second-half sampling.* • *Whether sample sizes are appropriate to the grain size of the material being sampled.*	No drilling or logging was undertaken.
Quality of assay data and laboratory tests	• *The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.* • *For geophysical tools,*	For the metallurgical testwork outlined in this announcement, the composite samples underwent a head assay at ALS Metallurgy via XRF-BM and ICP D4Z and D3 scans. The leach liquors underwent ICP-OES (AES) at CSIRO Analytical Laboratory. The leach residues were

Criteria	JORC Code explanation	Commentary
	spectrometers, handheld XRF instruments, etc, the parameters used in determining the analysis including instrument make and model, reading times, calibrations factors applied and their derivation, etc. • *Nature of quality control procedures adopted (eg standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (ie lack of bias) and precision have been established.*	digested and then assayed via ICP-OES (AES) at CSIRO Analytical Laboratory.
Verification of sampling and assaying	• *The verification of significant intersections by either independent or alternative company personnel.* • *The use of twinned holes.* • *Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic) protocols.* • *Discuss any adjustment to assay data.*	No drilling or sampling was undertaken.
Location of data points	• *Accuracy and quality of surveys used to locate drill holes (collar and down-hole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.* • *Specification of the grid system used.* • *Quality and adequacy of topographic control.*	No drilling or sampling was undertaken.
Data spacing and distribution	• *Data spacing for reporting of Exploration Results.* • *Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied.* • *Whether sample compositing has been applied.*	No drilling or sampling was undertaken.
Orientation of data in relation to geological structure	• *Whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which this is known, considering the deposit*	No drilling or sampling was undertaken.

Criteria	JORC Code explanation	Commentary
	type. • *If the relationship between the drilling orientation and the orientation of key mineralised structures is considered to have introduced a sampling bias, this should be assessed and reported if material.*	
Sample security	• *The measures taken to ensure sample security.*	Samples were collected, secured and sent in closed polyweave sacks via either a registered transport company, or were hand delivered directly to the laboratory.
Audits or reviews	• *The results of any audits or reviews of sampling techniques and data.*	No external audits have been completed.

Section 2 Reporting of Exploration Results

(Criteria listed in the preceding section also apply to this section.)

Criteria	JORC Code explanation	Commentary
Mineral tenement and land tenure status	• *Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings.* • *The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.*	Results reported are from the Julia andPools Prospects which are wholly located with E09/2217 The Battery Hub Project is comprised of two exploration licences E09/2217 and E52/3523 that are wholly owned by Pure Manganese Pty Ltd, a wholly owned subsidiary of Pure Minerals Limited with a total combined area of 724.43 km^2. There are no joint ventures or other agreements in place. Exploration licences 09/2217 and 52/3523 fall wholly within the Wajarri Yamatji (WC2004/010) Native Title Claimant (NTC) group. The Yamatji Marlpa Aboriginal Corporation (YMAC) is the Native Title Representative Body (NTRB) for the NTC..
Exploration done by other parties	• *Acknowledgment and appraisal of exploration by other parties.*	The Battery Hub Project has had previous exploration completed by Aztec Mining Company, Rio Tinto Exploration, BHP and Aurora Minerals. The majority of exploration was completed by Aurora Minerals which included soil and rock chip assays and 509 holes of reverse circulation drilling.
Geology	• *Deposit type, geological setting and style of mineralisation.*	The primary exploration target at the Battery Hub Project is manganese mineralisation associated with specific stratigraphic units and laterites with other targeted minerals including cobalt, graphite, copper, zinc and other base metals.

Criteria	JORC Code explanation	Commentary
		Geological information is included in the attachment.
Drill hole Information	• *A summary of all information material to the understanding of the exploration results including a tabulation of the following information for all Material drill holes:* ○ *easting and northing of the drill hole collar* ○ *elevation or RL (Reduced Level – elevation above sea level in metres) of the drill hole collar* ○ *dip and azimuth of the hole* ○ *down hole length and interception depth* ○ *hole length.* • *If the exclusion of this information is justified on the basis that the information is not Material and this exclusion does not detract from the understanding of the report, the Competent Person should clearly explain why this is the case.*	No drilling or sampling was undertaken.
Data aggregation methods	• *In reporting Exploration Results, weighting averaging techniques, maximum and/or minimum grade truncations (eg cutting of high grades) and cut-off grades are usually Material and should be stated.* • *Where aggregate intercepts incorporate short lengths of high grade results and longer lengths of low grade results, the procedure used for such aggregation should be stated and some typical examples of such aggregations should be shown in detail.* • *The assumptions used for any reporting of metal equivalent values should be clearly stated.*	No drilling or sampling was undertaken. No metal equivalents have been used
Relationship between mineralisation widths and intercept lengths	• *These relationships are particularly important in the reporting of Exploration Results.* • *If the geometry of the mineralisation with respect to the drill hole angle is known, its nature should be reported.*	No drill results reported.

Criteria	JORC Code explanation	Commentary
	• *If it is not known and only the down hole lengths are reported, there should be a clear statement to this effect (eg 'down hole length, true width not known').*	
Diagrams	• *Appropriate maps and sections (with scales) and tabulations of intercepts should be included for any significant discovery being reported These should include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views.*	No drill results reported.
Balanced reporting	• *Where comprehensive reporting of all Exploration Results is not practicable, representative reporting of both low and high grades and/or widths should be practiced to avoid misleading reporting of Exploration Results.*	Reports on previous metallurgical results can be found in ASX Releases that are available on Pure Minerals website (or Aurora Minerals), including announcements 12 June 2018.
Other substantive exploration data	• *Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations; geophysical survey results; geochemical survey results; bulk samples – size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances.*	Substantive historical data is summarised in previous announcements by Pure Minerals (and Aurora Minerals) and is being reviewed as part of the exploration of the Battery Hub Project. These include historical drilling results, an XTEM survey and preliminary metallurgical test results of samples.
Further work	• *The nature and scale of planned further work (eg tests for lateral extensions or depth extensions or large-scale step-out drilling).* • *Diagrams clearly highlighting the areas of possible extensions, including the main geological interpretations and future drilling areas, provided this information is not commercially sensitive.*	As detailed in the Report.