

Company Announcement, July 9<sup>th</sup>, 2019

## **Kvanefjeld Optimised Feasibility Study: Substantial 40% Capital Cost Reduction**

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### **HIGHLIGHTS:**

- **Capital costs reduced by ~40% to US\$505M, inclusive of refinery circuit**
  - **Rare earth production increased by 8%, inclusive of 5,692t NdPr, 270t Dy, 44t Tb oxides**
  - **Initial 37-year mine life based on 108Mt ore reserve estimate**
  - **Industry leading capital intensity complements very low operating costs**
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*Dr John Mair, Managing Director commented:*

“With the completion of an outstanding optimisation program, we have a project with a smaller footprint producing more rare earths at lower operating costs, which requires significantly less capital for development.

The 40% reduction in the capital cost estimate together with the increased projected output over an initial 37-year mine life results in the lowest capital intensity amongst our peers.

The optimised capital costs, when considered with operating costs after credits of below US\$4/kg of rare earth oxide, creates a highly robust project and compelling development opportunity; a strong result for both Company shareholders and project stakeholders.”

**Greenland Minerals Ltd** (‘GML’ or ‘the Company’) is pleased to provide an updated capital cost estimate for the Kvanefjeld Project (the Project). The Project’s capital cost estimate has been **reduced by 40%** from US\$832M (Company Announcement April 6<sup>th</sup>, 2016) to **US\$505M**. The Kvanefjeld Project, 100% owned by GML, is underpinned by the largest code-compliant (JORC or CIM) rare earth resource globally.

The reduction in the capital cost estimate is the result of optimisation studies covering all elements of the Project from the flowsheet to civil construction. The results of individual optimisation studies have been the subject of progressive updates to the market since 2016.

Improvements to the flowsheet include a major enhancement to flotation performance (the production of smaller volumes of higher-grade concentrate) and the development of a simpler, more efficient leaching circuit. These improvements have been developed in close collaboration with the Company's major shareholder, leading rare earth company Shenghe Resources Holding Co Ltd (Shenghe). In combination, these developments significantly reduce the scale of the refinery circuit resulting in substantial cost reductions.

Civil engineering design and construction costs were also a major focus of optimisation studies. A multi-disciplinary team of specialist engineering firms including Nuna Logistics, Tetra Tech, PND Engineers and China Communications Construction Co. has contributed to an updated civil design with constructions costs reduced substantially (Company announcement March 26, 2019).

The updated capital cost of US\$505M is transformational for the Project which now has the lowest capital intensity of emerging ASX-listed rare earth projects.

In August 2018, GML and Shenghe entered a Memorandum of Understanding (MoU) addressing commercialisation of the Kvanefjeld Project. The MoU (non-binding) addressed rare earth separation, off-take and marketing, and project finance. Shenghe is an established producer of high-purity rare earth oxides and metals with an international customer network (Company announcement August 21<sup>st</sup>, 2018).

Kvanefjeld's standing as a world-class rare earth project is bolstered by the new capital cost estimate, the recently announced revised operating costs, the Project's potential multi-decade duration and the globally significant production numbers.

## **Optimised Feasibility Summary**

The Company released its Feasibility Study in 2016 (the Study). The Study was the last major Project study completed by the Company before Shenghe became a major shareholder. Since becoming a major shareholder, Shenghe has worked closely with the Company on the development and execution of the Company's Study optimisation program.

A summary of the results of this optimisation program is set out below.

### **Process Plant**

The Project's main rare earth bearing mineral is steenstrupine which contains 25-30% REO. In the 2016 Study the concentrator produced a mineral concentrate containing 14% rare earth oxide (REO). A key focus of the optimisation programme was to produce a smaller volume of a higher-grade concentrate. With the guidance of Shenghe, metallurgical flotation specialist groups in China were engaged and these groups have developed an optimised flotation circuit producing rare earth mineral concentrates with grades in the range of 22 - 25% REO. For the purposes of engineering design a concentrate grade of 22% was used.

In addition, the method of concentrate refining has been simplified. The refinery now includes a single stage circuit and fewer solid-liquid separation steps. The higher concentrate grade and the simplification of the refinery circuit has resulted in a reduction of the scale of the refinery circuit and the size of processing equipment in the refinery.

Technical developments arising out of the optimisation program have been summarised in a series of Company Announcements, inclusive of JORC Table 1 details (December 20, 2017; January 15, 2018; July 11, 2018; January 10, 2019).

Engineering design work for the optimised concentrator and refinery circuits has been completed and operating and capital costs have been updated.

#### **Contributing Groups:**

- Shenghe Resources Holding Co Ltd
- Baotou Meng Rong Fine Materials Co Ltd (BTMR)
- Institute of Multipurpose Use of Mineral Resources (IMUMR)
- SGS Minerals Metallurgy (Perth)
- ALS Global (Perth)
- ANSTO (Sydney)

#### **Civil Construction**

In the 2016 Study, civil construction costs represented a large proportion of overall capital costs. Another key focus of the Company's optimisation programme was the reduction of construction costs in the civil design and project layout.

Nuna Logistics, cold climate civil construction specialists, have developed an updated estimate of civil construction costs based upon updated designs by Tetra Tech, PND Engineers and China-CCC. Representatives from all four engineering firms visited the Project site in 2018 to gather site specific information to assess the project (Company announcement - September 18<sup>th</sup>, 2018).

Cost reductions were primarily achieved through substantial reductions in civil earth works for site preparation (Company announcement October 22<sup>nd</sup>, 2018) updated port design by specialist groups, and greater use of local materials. The revised civil costs were reduced to US\$175M including indirect costs and contingency. This is a reduction of US\$138M (-44%) of the civil construction cost estimate in the 2016 Feasibility Study (Company announcement March 26<sup>th</sup>, 2019).

The Company elected to use Nuna in the optimisation studies because of their cold climate experience, their excellent track record of involving the local community and their record of creating a positive legacy with all stakeholders.

## Port

Direct shipping access is a key advantage for the Kvanefjeld Project, and efficient port facilities are important for year-round materials handling and transfer. PND Engineers and China-CCC have developed a new capital cost estimate for Project's dedicated port facility. PND Engineers, specialists in cold climate port design, developed the design for the off-shore aspects of the port facility. C-CCC, that bring global port design expertise, provided the on-shore elements of the port design.

## Production Profile

The optimisation programmes in the process plant have increased rare earth production by approximately 8% to approximately 32,000 tpa of REO. The Project will be a major producer of rare earths, particularly the "magnet metals" - **Neodymium, Praseodymium, Terbium, and Dysprosium** – which are critical to clean energy generation and efficient energy use. Of the increased production approximately 6,000t will be "magnet metals".

Table 1 shows details of estimated annual "magnet metal" production after optimisation.

**Table 1**

Rare Earth	Annual Production -t
Praseodymium	~1,400
Neodymium	~4,300
Terbium	~45
Dysprosium	~270

## Capital Cost Estimate

Table 2 summarises the capital cost estimate after the incorporation of the results of the various optimisation studies. The costs are as of Q2 2019.

**Table 2**

Cost Classification	US\$M
Direct Capital Costs	380
Indirect Costs for Construction	61
Contingency (Accuracy Provision)	64
<b>Total Investment Cost</b>	<b>505</b>

Direct capital costs include the costs of equipment, installation labour, mobilisation and demobilisation of construction crews and commissioning. Table 3 presents a breakdown of direct costs by major project area

**Table 3**

<b>Direct Cost Area</b>	<b>US\$M</b>
Mining Area	54.3
Concentrator Process Plant	142.4
Refinery Process Plant	62.7
Tailings Facilities	27.7
Infrastructure	46.3
Utilities	4.2
Miscellaneous	42.2

Indirect costs have been estimated for temporary construction facilities and for engineering, procurement and construction (EPC) management.

A contingency of 15% was applied to both direct and indirect costs.

Using current spot prices for REO's as of July 4<sup>th</sup> 2019, the basket price for project intermediate product is **\$15.32/kg REO**. This basket price has been calculated using REE data from ACREI – the Association of China Rare Earth Industry. ACREI post daily prices in RMB for all REE which have been converted to USD at the daily prevailing exchange rate. The basket price has increased by 16%, since the Company announcement updating the project operating costs, released on May 15<sup>th</sup>, 2019.

Using GML's forecast REE prices, the basket price for project intermediate product is **\$19.55/kg REO**. This basket price has been calculated using REE data from ACREI and independent industry consultant Adamas Intelligence. Forecast prices for the “magnet metals” – Nd, Pr, Tb and Dy – have been taken from the latest industry report prepared by Adamas Intelligence and, for all other REE, the current spot prices have been used in the calculation.

**-ENDS-**

## **ABOUT GREENLAND MINERALS LTD.**

Greenland Minerals Ltd (ASX: GGG) is an exploration and development company focused on developing high-quality mineral projects in Greenland. The Company's flagship project is the Kvanefjeld Rare Earth Project (rare earth elements, uranium, zinc). A pre-feasibility study was finalised in 2012, and a comprehensive feasibility study was completed in 2015 and updated following pilot plant operations in 2016. The studies highlight the potential to develop Kvanefjeld as a long-life, low cost, and large-scale producer of rare earth elements; key enablers to the electrification of transport systems.

GML is working closely with major shareholder and strategic partner Shenghe Resources Holding Co Ltd to develop Kvanefjeld as a cornerstone of future rare earth supply. An exploitation (mining) license application for the initial development strategy was reviewed by the Greenland Government through 2016 -17 and was updated in 2018 following addition supporting studies.

In 2017-19, GML undertook technical work programs with Shenghe Resources Holding Co Ltd that improved the metallurgical performance and simplified the development strategy and infrastructure footprint in Greenland. This will enhance the project cost-structure and ensure that Kvanefjeld is aligned with downstream processing. In addition, the Company continues its focus on working closely with Greenland's regulatory bodies on the processing of the mining license application and maintaining regular stakeholder updates.

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Greenland Minerals Ltd will continue to advance the Kvanefjeld project in a manner that is in accord with both Greenlandic Government and local community expectations and looks forward to being part of continued stakeholder discussions on the social and economic benefits associated with the development of the Kvanefjeld Project.

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## **Competent Person Statement – Mineral Resources Ore Reserves and Metallurgy**

*The information in this report that relates to Mineral Resources is based on information compiled by Mr Robin Simpson, a Competent Person who is a Member of the Australian Institute of Geoscientists. Mr Simpson is employed by SRK Consulting (UK) Ltd ("SRK") and was engaged by Greenland Minerals Ltd on the basis of SRK's normal professional daily rates. SRK has no beneficial interest in the outcome of the technical assessment being capable of affecting its independence. Mr Simpson has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken 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'. Robin Simpson consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.*

*The information in the statement that relates to the Ore Reserves Estimate is based on work completed or accepted by Mr Damien Krebs of Greenland Minerals Ltd and Mr Scott McEwing of SRK Consulting (Australasia) Pty Ltd. The information in this report that relates to metallurgy is based on information compiled by Damien Krebs.*

*Damien Krebs is a Member of The Australasian Institute of Mining and Metallurgy and has sufficient experience that is relevant to the type of metallurgy and scale of project under consideration, and to the activity he is undertaking, to qualify as Competent Persons in terms of The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code, 2012 edition). The Competent Persons consent to the inclusion of such information in this report in the form and context in which it appears.*

*Scott McEwing is a Fellow and Chartered Professional of The Australasian Institute of Mining and Metallurgy and has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration, and to the activity he is undertaking, to qualify as Competent Persons in terms of The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code, 2012 edition). The Competent Persons consent to the inclusion of such information in this report in the form and context in which it appears.*

The mineral resource estimate for the Kvanefjeld Project was updated and released in a Company Announcement on February 12<sup>th</sup>, 2015. The ore reserve estimate was released in a Company Announcement on June 3<sup>rd</sup>, 2015. There have been no material changes to the resource estimate, or ore reserve since the release of these announcements.

Cut-off (U <sub>3</sub> O <sub>8</sub> ppm) <sup>1</sup>	Classification	Multi-Element Resources Classification, Tonnage and Grade								Contained Metal				
		M tonnes Mt	TREO <sup>2</sup> ppm	U <sub>3</sub> O <sub>8</sub> ppm	LREO ppm	HREO ppm	REO ppm	Y <sub>2</sub> O <sub>3</sub> ppm	Zn ppm	TREO Mt	HREO Mt	Y <sub>2</sub> O <sub>3</sub> Mt	U <sub>3</sub> O <sub>8</sub> M lbs	Zn Mt
<b><i>Kvanefjeld - February 2015</i></b>														
150	<b>Measured</b>	143	12,100	303	10,700	432	11,100	978	2,370	<b>1.72</b>	0.06	0.14	<b>95.21</b>	0.34
150	<b>Indicated</b>	308	11,100	253	9,800	411	10,200	899	2,290	<b>3.42</b>	0.13	0.28	<b>171.97</b>	0.71
150	<b>Inferred</b>	222	10,000	205	8,800	365	9,200	793	2,180	<b>2.22</b>	0.08	0.18	<b>100.45</b>	0.48
150	<b>Total</b>	673	10,900	248	9,600	400	10,000	881	2,270	<b>7.34</b>	0.27	0.59	<b>368.02</b>	1.53
200	<b>Measured</b>	111	12,900	341	11,400	454	11,800	1,048	2,460	<b>1.43</b>	0.05	0.12	<b>83.19</b>	0.27
200	<b>Indicated</b>	172	12,300	318	10,900	416	11,300	970	2,510	<b>2.11</b>	0.07	0.17	<b>120.44</b>	0.43
200	<b>Inferred</b>	86	10,900	256	9,700	339	10,000	804	2,500	<b>0.94</b>	0.03	0.07	<b>48.55</b>	0.22
200	<b>Total</b>	368	12,100	310	10,700	409	11,200	955	2,490	<b>4.46</b>	0.15	0.35	<b>251.83</b>	0.92
250	<b>Measured</b>	93	13,300	363	11,800	474	12,200	1,105	2,480	<b>1.24</b>	0.04	0.10	<b>74.56</b>	0.23
250	<b>Indicated</b>	134	12,800	345	11,300	437	11,700	1,027	2,520	<b>1.72</b>	0.06	0.14	<b>101.92</b>	0.34
250	<b>Inferred</b>	34	12,000	306	10,800	356	11,100	869	2,650	<b>0.41</b>	0.01	0.03	<b>22.91</b>	0.09
250	<b>Total</b>	261	12,900	346	11,400	440	11,800	1,034	2,520	<b>3.37</b>	0.11	0.27	<b>199.18</b>	0.66
300	<b>Measured</b>	78	13,700	379	12,000	493	12,500	1,153	2,500	<b>1.07</b>	0.04	0.09	<b>65.39</b>	0.20
300	<b>Indicated</b>	100	13,300	368	11,700	465	12,200	1,095	2,540	<b>1.34</b>	0.05	0.11	<b>81.52</b>	0.26
300	<b>Inferred</b>	15	13,200	353	11,800	391	12,200	955	2,620	<b>0.20</b>	0.01	0.01	<b>11.96</b>	0.04
300	<b>Total</b>	194	13,400	371	11,900	471	12,300	1,107	2,530	<b>2.60</b>	0.09	0.21	<b>158.77</b>	0.49
350	<b>Measured</b>	54	14,100	403	12,400	518	12,900	1,219	2,550	<b>0.76</b>	0.03	0.07	<b>47.59</b>	0.14
350	<b>Indicated</b>	63	13,900	394	12,200	505	12,700	1,191	2,580	<b>0.87</b>	0.03	0.07	<b>54.30</b>	0.16
350	<b>Inferred</b>	6	13,900	392	12,500	424	12,900	1,037	2,650	<b>0.09</b>	0.00	0.01	<b>5.51</b>	0.02
350	<b>Total</b>	122	14,000	398	12,300	506	12,800	1,195	2,570	<b>1.71</b>	0.06	0.15	<b>107.45</b>	0.31

Cut-off (U <sub>3</sub> O <sub>8</sub> ppm) <sup>1</sup>	Classification	Multi-Element Resources Classification, Tonnage and Grade								Contained Metal				
		M tonnes Mt	TREO <sup>2</sup> ppm	U <sub>3</sub> O <sub>8</sub> ppm	LREO ppm	HREO ppm	REO ppm	Y <sub>2</sub> O <sub>3</sub> ppm	Zn ppm	TREO Mt	HREO Mt	Y <sub>2</sub> O <sub>3</sub> Mt	U <sub>3</sub> O <sub>8</sub> M lbs	Zn Mt
<b>Sørensen - March 2012</b>														
150	Inferred	242	11,000	304	9,700	398	10,100	895	2,602	<b>2.67</b>	0.10	0.22	<b>162.18</b>	0.63
200	Inferred	186	11,600	344	10,200	399	10,600	932	2,802	<b>2.15</b>	0.07	0.17	<b>141.28</b>	0.52
250	Inferred	148	11,800	375	10,500	407	10,900	961	2,932	<b>1.75</b>	0.06	0.14	<b>122.55</b>	0.43
300	Inferred	119	12,100	400	10,700	414	11,100	983	3,023	<b>1.44</b>	0.05	0.12	<b>105.23</b>	0.36
350	Inferred	92	12,400	422	11,000	422	11,400	1,004	3,080	<b>1.14</b>	0.04	0.09	<b>85.48</b>	0.28
<b>Zone 3 - May 2012</b>														
150	Inferred	95	11,600	300	10,200	396	10,600	971	2,768	<b>1.11</b>	0.04	0.09	<b>63.00</b>	0.26
200	Inferred	89	11,700	310	10,300	400	10,700	989	2,806	<b>1.03</b>	0.04	0.09	<b>60.00</b>	0.25
250	Inferred	71	11,900	330	10,500	410	10,900	1,026	2,902	<b>0.84</b>	0.03	0.07	<b>51.00</b>	0.20
300	Inferred	47	12,400	358	10,900	433	11,300	1,087	3,008	<b>0.58</b>	0.02	0.05	<b>37.00</b>	0.14
350	Inferred	24	13,000	392	11,400	471	11,900	1,184	3,043	<b>0.31</b>	0.01	0.03	<b>21.00</b>	0.07
<b>All Deposits – Grand Total</b>														
150	Measured	143	12,100	303	10,700	432	11,100	978	2,370	<b>1.72</b>	0.06	0.14	<b>95.21</b>	0.34
150	Indicated	308	11,100	253	9,800	411	10,200	899	2,290	<b>3.42</b>	0.13	0.28	<b>171.97</b>	0.71
150	Inferred	559	10,700	264	9,400	384	9,800	867	2,463	<b>6.00</b>	0.22	0.49	<b>325.66</b>	1.38
150	<b>Grand Total</b>	<b>1010</b>	<b>11,000</b>	<b>266</b>	<b>9,700</b>	<b>399</b>	<b>10,100</b>	<b>893</b>	<b>2,397</b>	<b>11.14</b>	<b>0.40</b>	<b>0.90</b>	<b>592.84</b>	<b>2.42</b>

<sup>1</sup>There is greater coverage of assays for uranium than other elements owing to historic spectral assays. U<sub>3</sub>O<sub>8</sub> has therefore been used to define the cutoff grades to maximise the confidence in the resource calculations.

<sup>2</sup>Total Rare Earth Oxide (TREO) refers to the rare earth elements in the lanthanide series plus yttrium.

Note: Figures quoted may not sum due to rounding.

### Kvanefjeld Ore Reserves Estimate – April 2015

Class	Inventory (Mt)	TREO (ppm)	LREO (ppm)	HREO (ppm)	Y <sub>2</sub> O <sub>3</sub> (ppm)	U <sub>3</sub> O <sub>8</sub> (ppm)	Zn (ppm)
Proven	43	14,700	13,000	500	1,113	352	2,700
Probable	64	14,000	12,500	490	1,122	368	2,500
<b>Total</b>	<b>108</b>	<b>14,300</b>	<b>12,700</b>	<b>495</b>	<b>1,118</b>	<b>362</b>	<b>2,600</b>