

## Due Diligence and Valuation Report

Arrowhead Code:	41-01-04
Coverage initiated:	28 03 2017
This document:	05 04 2018
Fair share value bracket:	CAD4.17 to CAD4.59 <sup>i</sup>
Share price on date:	CAD2.93 <sup>ii</sup>

### Analyst Team

Natasha Agarwal	Sumit Wadhwa
<a href="mailto:natasha.agarwal@arrowheadbid.com">natasha.agarwal@arrowheadbid.com</a>	<a href="mailto:sumit.wadhwa@arrowheadbid.com">sumit.wadhwa@arrowheadbid.com</a>



Company:	5N Plus Incorporation
Ticker:	TSX:VNP
Headquarters:	Quebec, Canada
Chairman:	Luc Bertrand
Website:	<a href="http://www.5nplus.com/">http://www.5nplus.com/</a>

### Market Data

52-Week Range:	CAD 1.75 – CAD 3.71 <sup>iii</sup>
Average Daily Volume:	237,231 <sup>iv</sup>
Market Cap. on date:	CAD 245.4MM <sup>v</sup>

**Fiscal Year (FY)** 1<sup>st</sup> January – 31<sup>st</sup> December

### Summary

5N Plus is the leading producer of specialty metal and chemical products. Fully integrated with closed-loop recycling facilities. They are headquartered in Montreal, Quebec, Canada and operate in manufacturing facilities and sales offices in several locations in Europe, North as well as South America and Asia. 5N Plus installs a range of proprietary and proven technologies to produce products which are put into use in a number of advanced pharmaceutical, electronic and re applications. Their product palette includes purified metals such as bismuth, gallium, germanium, indium, selenium and tellurium, inorganic chemicals based on such metals and compound semiconductor wafers. Many of these are critical precursors and key enablers in various high profile markets.

The company has two reportable segments, namely Electronic Materials and Eco-Friendly Materials. Important to mention, the revenue line for both segments includes an important metal price component, which is a flow through for the company, sourcing its commercial grade metals externally and via its recycling facilities. For this reason, the revenue line varies to a very large extent with the metal market prices while the premiums charged on the products made from the various metals is not directly related to the metal market price level.

The Electronic Materials segment operates in North America, Europe and Asia. This segment manufactures and sells refined metals, compounds and alloys, primarily used in a number of electronic applications. Typical end-markets include photovoltaics (terrestrial and spatial solar energy), light emitting diodes (LED), displays, high-frequency electronics, medical imaging and thermoelectrics. Main products are related to the following metals: cadmium, gallium, germanium, indium and tellurium. These are sold either in elemental or alloyed form as well as in the form of chemicals, compounds and wafers.

This segment is tagged as Eco-Friendly Materials segment because of its association with bismuth, one of the very few heavy metals which have no detrimental effect on either human health or in the environment. This has resulted into increased usage of Bismuth in a number of applications as a replacement for more harmful metals and chemicals. The Eco-Friendly Materials segment operates in North America, Europe and Asia. It manufactures and sells refined bismuth and bismuth chemicals, low melting point alloys as well as refined selenium and selenium chemicals. The finished products are used in the pharmaceutical and animal-feed industry as well as in a number of industrial applications including coatings, pigments, metallurgical alloys and electronics.

During FY17, 5N Plus continued its strides towards reducing the earning volatility, increasing operating efficiency and improving return on capital employed (ROCE) across its business segments, while focusing on the value-added products. In October 2017, the company

secured a multi-year contract from the US government to supply engineered semiconductor materials essential for space and aeronautical missions. The contract demonstrates the company's strategy to invest and focus its commercial efforts towards value-add products.

In FY17, the company reported an EPS of \$0.14 per share compared to a loss of \$0.07 per share during FY16.

Revenues in FY17 declined by 5% YoY to USD 219.9MM primarily due to lower sales of pass-through metal component, consistent with the company's plan to reduce its earnings volatility. The company continued to improve its gross margin reaching 26.1% in FY17 compared to 22.4% in FY16.

The company divulged its Strategic Plan 5N21 ("5N21") designed to amplify profitability while lowering earnings volatility on 12 September, 2016. The principal thrust of 5N21 is to selectively extract value along the current value-chain while also addressing emerging opportunities based on existing and non-organic competencies compatible with the corporate DNA. 5N21 focuses on three major pillars:

- Optimizing balance of contribution from upstream and downstream activities;
- Extracting more value from core businesses and global asset; and
- Delivering quality growth from both existing and future M&A opportunities.

5N21 is built on the company's strengths and aims to grow earnings while reducing risk and volatility associated with its business.

Along this path, the business is viewed in two distinct parts; Upstream and Downstream activities. The Upstream part starts with procurement of feeds, by-products, concentrates, wastes which contain metals essential to the product business (Downstream business). The company extracts these metals using metallurgical technologies. The Upstream part does not include mining - they are not engaged in mining. Going forward they expect their investments in this area will enable them to valorize more metals from secondary streams

which should grow their bottom line performance. In the Downstream portion of their business, they utilize upstream valorized metal as a consumable to produce various material for a whole host of industries. Their aim is to grow their value-added activities and move further Downstream. They embrace technologically complex sectors which enable pricing power - they believe complexity can serve as an entry barrier. In this bimodal approach, upstream business benefits from higher metal prices and downstream business benefits from lower metal prices; together they will enable to grow earnings while reducing earnings volatility. With this model the company should be able to generate market competitive returns independent of metal prices.

During 2016, the company exhibited improved profitability and a solid balance sheet, in spite of competitive operating environment. It reduced its inventory substantially, its operating expenses, and net debt as well, signifying a growing recognition, in turn changing the dynamics, creating a new model for 5N Plus. This one is focused on providing sustainable value without the impact of metal prices, investing to improve product mix and quality of earnings over time.

The company also initiated and achieved a number of key milestones making progress towards its renewed Vision and Strategy Plan 5N21.

5N Plus made a number of investments at its Laos facility in 2014-15 to improve plant capacity. In Q216, the company announced the closure of a jointly owned facility in Europe. In November 2017, the company completed its 'footprint optimization initiatives', within a year of its commencement in 2016. 5N Plus has reallocated all the key product lines produced at its Wellingborough, UK plant to the group's other plants in Canada, Germany and China.

In the longer run, these initiatives will improve the company's ability to extract more value from its existing businesses and assets.

5N Plus continued to make progress towards its strategic initiatives to position its business segments with emphasis on higher value added downstream markets and further expansion into upstream activities.

5N Plus will continue to focus on improving capacity utilization, increasing production yields, and managing working capital, while also selectively growing its existing portfolio of core businesses.

**Valuation**

5N Plus operates in a high-potential market and manufactures a diversified range of products. The company is an industrial leader in specialty metals and chemical products.

Arrowhead believe that the increased focus on higher-margin products along with additional investments to increase the plant capacity will lead to margin expansion.

Given due diligence and valuation estimations based on discounted cash flow (DCF), we believe that the fair share value of 5N Plus lies between CAD 4.17 and CAD 4.59.

**Table of Contents**

**Company Presentation.....4**

**Listing Information.....13**

**Contacts .....13**

**Major Shareholders .....14**

**Management and Governance.....15**

**Assets and Projects .....16**

**Technologies and Market.....20**

**Value .....25**

**Analyst Certifications .....28**

**Valuation .....29**

**Notes and References.....30**

## Company Presentation

Listed on the Canadian Stock Exchange (TSE:VNP), the specialty metals and chemicals 5N Plus supplies are key components in countless consumer and industrial products. They go into making the digital devices we carry in our pockets, and into satellites circling the earth. Customers use its products to make thin-film solar panels, pharmaceuticals, LEDs (light emitting diodes) and a multitude of other items that are essential to our way of life.

Headquartered in Montreal, Canada, and with strategically located facilities around the world, 5N Plus is among the leading suppliers of specialty metals, alloys and related chemicals. Beyond being a trusted supplier, they strive to be a business partner. This means:

- Deploying proprietary and proven technologies to meet the specifications customers demand
- Securing long-term sourcing contracts with primary producers so that customers can depend on them
- And offering value-added services such as cradle-to-cradle recycling and R&D partnerships

With multiple facilities on three continents, 5N Plus is strategically situated close to resources, suppliers and customers. Their growing Asian presence includes minor metal recovery facilities in Laos and Malaysia, a bismuth chemicals manufacturing facility and an ultra-high purity gallium processing facility in China, and a partnership in South Korea for gallium chemicals production.

5N Plus has undertaken some strategic initiatives to overcome and offset the impact from global volatility and commodity price fluctuations. On 12 September 2016, the company released its Strategic Plan 5N21 with the aim to improve profitability and reduce volatility in its earnings. The footprint optimization initiatives announced in Sep-2016, was completed in Nov-2017. All the key product lines which were formerly produced at its Wellingborough, UK are now produced at the other plants within the group, explicitly plants in Canada, Germany and China. The company expects to realize the benefits from the above initiatives by FY18.

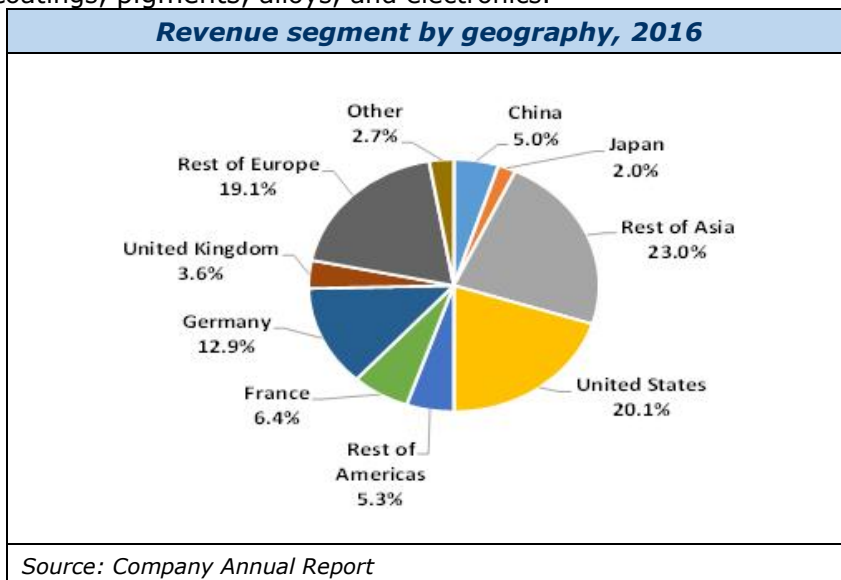
### Premiums

*Leading supplier of metals having multiple applications:* 5N Plus is a leading manufacturer and supplier of metals like bismuth, tellurium, gallium, indium among others. Bismuth, having multiple uses in the pharmaceutical and electronic industry, is being widely substituted for lead, and germanium and tellurium are highly demanded in the satellite and solar power generation. 5N Plus has acquired certifications to supply bismuth products to FDA and GMP standards. It also has a significant position in the supply of germanium, tellurium, gallium and indium.

*Specialized in manufacture of high quality micro powders:* The company has made significant investments in developing high performance atomizing technology over the past years. This has helped the company to efficiently manufacture fine metallic powders, known as micro powders. The demand for these powders has grown significantly in the electronics industry where its main application is in the production of solder pastes and conductive adhesives in mobile device and automotive applications. The micro powders technology of 5N Plus has distinct properties for preparing powders with consistent shape, uniform size distribution and controlled purity, ideally suited to meet the challenges of these demanding markets.

*International market leader in the production of LMPA:* Low melting point Alloys (LMPA) are fusible alloys which are made with bismuth, lead, tin, cadmium and indium. LMPA-type alloys have a melting point below 450°F (233°C). Major applications of these alloys is seen in optics, radiation screening, fusible core technologies, and in architecture and construction. 5N Plus has expertise in the production of such alloys. The company also sells customized LMPA's which meet customer specifications and needs.

*Diversification in terms of product mix and geography:* The Electronic Materials and Eco-Friendly Materials segments operate in the United States, China, Japan, Germany, France, United Kingdom, and others, with none of the countries contributing more than 20% to the total revenues. 5N Plus also manufactures a wide variety of products for the solar, pigment, medical sectors and some others that find usage in chemical applications such as coatings, pigments, alloys, and electronics.



*Promoting sustainable development through recycling initiatives:* 5N Plus has formulated sustainable development policies to reduce the adverse impact on the environment. One of the initiatives to reduce environmental impact is the adoption of recycling its by-products. 5N Plus’ extensive know-how of the industry processes has enabled it to help smelting operations across the world, to utilize the full potential of their mining sites and its by-products. 5N Plus has developed unique technologies which recover and treat the by-products and scrap generated in the metallurgical process. The company promotes recycling of industrial waste generated by its manufacturing process and has set targets that will ensure minimal environmental impact. The company has set up recycling plants in three continents namely, Eisenhüttenstadt (Germany), Kulim (Malaysia), Montreal (Canada), and Vientiane (Laos).

*Experienced management team:* The company’s management personnel have relevant experience and a wealth of knowledge and expertise, which helps them achieve strategic objectives such as improving bottom-line performance and extracting appropriate value from existing assets. On an average, each senior management member has an industry experience of about 20 years.

## Risks associated

5N Plus is subject to a number of risk factors which may limit the company’s ability to execute its strategy and achieve its long-term growth objectives. The management analyses these risks and implements strategies in order to minimize their impact on the company's performance.

*Risks associated with growth strategy:* 5N Plus’ strategic plan is designed to enhance profitability while reducing earnings volatility and is found on three pillars of growth: first, optimizing balance of contribution from upstream and downstream activities; second, extracting more value from core businesses and global asset; and third, delivering quality growth from both existing and future M&A opportunities. There is a risk that some of the expected benefits will fail to materialize, or may not occur within the time periods anticipated by management. The realization of such benefits may be affected by a number of factors, many of which are beyond our control.

*International operations:* Commodity prices may fluctuate owing to various reasons that are beyond the control of the company, including economic conditions, currency exchange rates, global demand for metal

products, trade sanctions, tariffs, labor costs, competition, overcapacity of producers and price surcharges, in turn affecting the results of its operations and cash flows. Although the company operates primarily in countries with relatively stable economic and political climates, there can be no assurance that its business will not be adversely affected by the risks inherent in international operations.

*International trade regulations:* The company does business in a number of countries from various locations due to which it faces risks associated with changes to International trade regulations and policies. Some of these risks include barriers to or restrictions on free trade, changes in taxes, tariffs and other regulatory costs. Although the company operates primarily in countries, with proximity to its clients and suppliers, and with relatively stable economic and political climates, it is not sure that its business will not be adversely affected by the risks inherent to the changing international political landscape and its impact on global trade.

*Environmental regulations:* The operations of the company involve use, handling, generation, processing, storage, transportation, recycling and disposal of hazardous materials due to which it is subjected to extensive environmental laws and regulations at the national, provincial, local and international level. These environmental laws and regulations relate the discharge of pollutants into the air and water, the use, management and disposal of hazardous materials and wastes, the clean-up of contaminated sites and occupational health and safety. The company has incurred and will continue to incur capital expenditures in order to comply with these laws and regulations. Additionally, violations of, or liabilities under, environmental laws or permits may result in imposition of restrictions on the company's operating activities or may subject the company to substantial fines, penalties, criminal proceedings, third party property damage or personal injury claims, clean-up costs or other costs. Though the company believes that currently it complies with applicable environmental requirements, future developments like more aggressive enforcement policies, the implementation of new, more stringent laws and regulations, or the discovery of currently unknown environmental conditions may require additional expenditures having materially adverse effect on its business, results of operations and financial condition.

*Competition risk:* 5N Plus is a leading producer of specialty metal and chemical products and has a limited number of competitors. Few of its competitors are as fully integrated as the company is and offer similar range of products. As a result, they have limitation to provide differentiated products. However, it cannot be assumed that this situation will continue in the future and competition could arise from new low-cost metal refiners or from certain customers who could decide to backward integrate. Greater competition could have an adverse effect on the revenues and operating margins if the competitors gain market share and the company is unable to compensate for the volume lost to its competition.

*Commodity price risk:* The purchase price and availability of various inputs fluctuates due to numerous factors beyond the control of the company, including economic conditions, currency exchange rates, global demand for metal products, trade sanctions, tariffs, labor costs, competition, over capacity of producers and price surcharges. Fluctuations in availability and cost of inputs may materially affect the business, financial condition, results of operations and cash flows of the company. The company's inability to pass on any increases, its business, financial condition, results of operations and cash flows may be materially adversely affected.

*Sources of supply:* The company is unsure whether it will be able to secure the critical raw material feedstock on which it depends for its operations. Currently, the company procures its raw materials from a number of suppliers with whom it has had long-term commercial relationships. The loss of any one of these suppliers or a reduction in the level of deliveries to the company may reduce the production capacity and impact deliveries to its customers. As a result, the sales and net margins will be negatively impacted resulting in additional liabilities with respect to some of the supply contracts.

*Protection of intellectual property:* Protection of the proprietary processes, methods and other technologies is important to the business of the company. To safeguard its intellectual property, the company relies almost exclusively on a combination of trade secrets and employee confidentiality agreements. The company has deliberately chosen to limit its patent position to avoid disclosing valuable information. If

the company fails to protect and monitor the use of its existing intellectual property rights it might lose out on its valuable technologies and processes.

*Inventory price risk:* The company monitors the risks associated with the value of its inventories in relation to the market price of such inventories. The highly illiquid nature of many of its inventories forces the company to rely on a combination of standard risk measurement techniques, such as value at risk as well as a more empirical assessment of the market conditions. Decisions on appropriate physical stock levels depend on both the value at risk calculations and the market conditions.

*Business interruptions:* Business interruptions might result in losses for the company. In many instances, especially those related to long-term contracts, the company has contractual obligations to deliver product in a timely manner. Any disruption in activities leading to a business interruption could harm the customers' confidence level and lead to the cancellation of contracts and legal recourse against the company. Although the company believes that it has taken the necessary precautions to avoid business interruptions and carry business interruption insurance, there is still probability of experiencing interruptions which would adversely impact its financial results.

*Dependence on key personnel:* The smooth functioning of company's operations are dependent on the expertise and know-how of its personnel. The loss of any member of the senior management team could have a material adverse effect on the company. The future success also depends on the company's ability to retain and attract key employees, train, retain and successfully integrate new talent into the management and technical teams. Recruiting and retaining talented personnel, particularly those with expertise in the specialty metals industry and refining technology is crucial for the success of the company and may prove difficult. The company cannot provide assurance that it will be able to attract and retain qualified personnel when needed.

*Collective agreements:* A portion of 5N Plus' workforce is unionized and the company is party to collective agreements that are due to expire at various times in the future. The inability of the company to renew these collective agreements on similar terms as they become subject to renegotiation from time to time, could result in work stoppages or other labor disturbances, such as strikes, walkouts or lock-outs, potentially affecting the performance of the company.

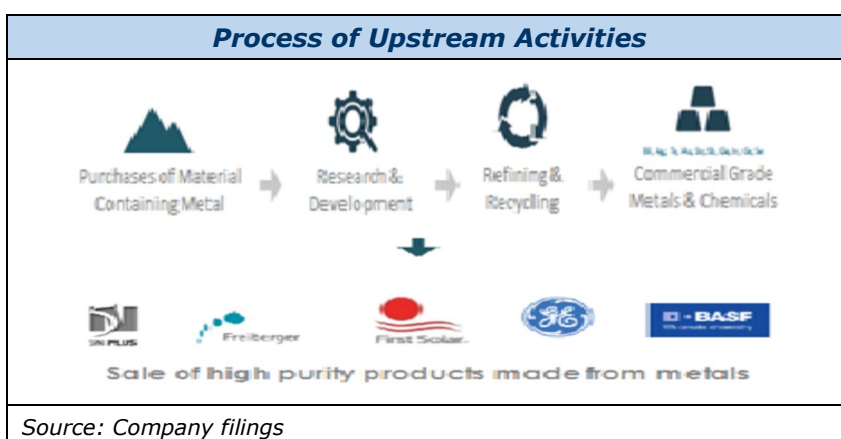
*Risks associated with public issuer status:* The shares of 5N Plus are publicly traded and, as such, the company is subject to all of the obligations imposed on "reporting issuers" under applicable securities laws in Canada and all of the obligations applicable to a listed company under stock exchange rules. Compared to privately owned competitors, the company faces the risk associated with a public issuer status regarding disclosure of key company information.

## 5N21 Strategic Plan:

On 12 September 2016, management unveiled its strategic plan aimed at improving profitability, addressing earnings volatility and delivering quality growth. 5N21 utilizes three main pillars to achieve this goal:

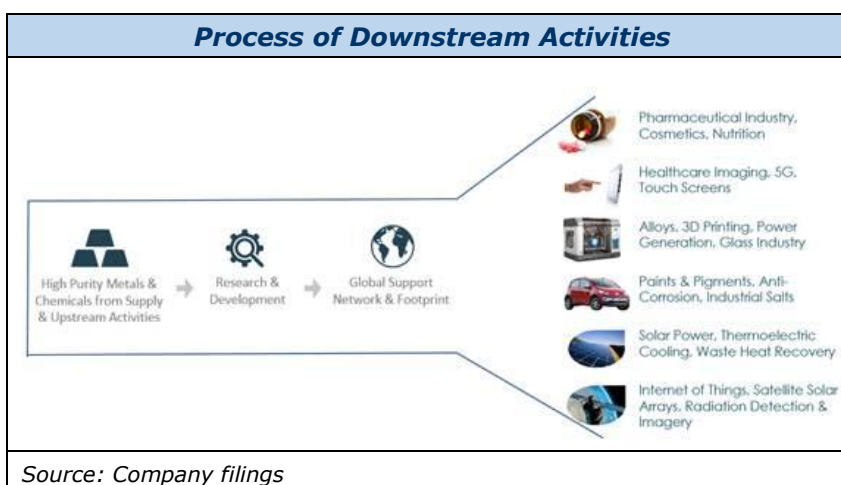
### 1<sup>st</sup> Pillar: *optimizing balance of contribution from upstream & downstream activities*

The upstream activities of the company are referred to as the acquisition of specialty metals used in their products & services. However, this can be the purchase of required metals from the market; or the acquisition of complex feeds, by-products, industrial waste, etc. Once these streams are procured, the next step is to process technology along with recycling & refining assets which are used to extract necessary metals utilized in the downstream businesses. The Company does not have any plans to migrate to mining related activities and it will continue to work closely with current and future suppliers to develop their upstream goals.



Source: Company filings

On the other hand, the downstream activities include product businesses where specialty chemicals, compounds, engineered material, substrates and alike are sold to a diverse set of industries and customers, based on metals which have largely been procured from the upstream activities.



Source: Company filings

Against this backdrop, 5N21 aims at utilization of process technologies to enable higher effectiveness in procurement of various metals from complex residues at reasonable terms. In the long term, the company expects to record higher contribution from its Recycling and Refinery assets. The company has made a number of investments at its Laos facility with the aim of improving capability and capacity. Going forward, the company expects this site to play a vital role in efficient valorization of key metals for the



Group. Additionally, 5N21 calls for further migration downstream and use product technology as an enabler and a differentiator to take care of more value-added market requirements which usually promise better margins. Over time, 5N Plus expects metal to account for a smaller percentage of the COGS.

As per the trend, the climate of high metal prices benefit upstream activities while low metal prices benefit downstream activities. One inherent benefit of this integrated model is a quasi-hedge in the group's P&L when the right balance between the two streams have been struck.

<b>Downstream Opportunities</b>			
	Market growth Prospect	Current Capital Requirements	5N's Position
Pharma, Health & Nutrition	High	High	Market Leader
Electronics & Electro-Optics	Average	Low	Top 3
Industrial Chemicals	Average	Low	Top 3
Coating & Pigments	Average	Low	Top 3
Alternative Energy	High	Low	Market Leader
Aerospace, Security & Defence	High	Low	Top 3

Source: Company filings

## **2<sup>nd</sup> Pillar:** *Extracting more value from core businesses and global assets*

**Higher contribution from core business:** Over the past years, 5N Plus has been successful in increasing its penetration across a number of downstream related products, platforms and market sectors through both M&A and organic investments. With the current portfolio, it is time to consider all activities through a view of selectivity in order to optimize value across their various platforms. To do this, the company has divided the businesses in three distinct pillars.

- Those which create appropriate value and remain critical for the company's future growth,
- Those which are no longer seen as viable and must address, and
- Those which need to be moved either to the former or accept the consequences of the latter.

**Optimize the assets and operations:** On November 6, 2017, 5N Plus announced the completion of its footprint optimization initiatives – to consolidate the operations at Wellingborough, UK. All the key products lines are now relocated to other sites in the group, mainly Canada, Germany and China. Over the next quarters the company will continue to focus on improving capacity utilization, increasing production yields, managing working capital while selectively growing the existing portfolio of core businesses.

## **3<sup>rd</sup> Pillar:** *Delivering quality growth from both existing and future M&A opportunities*

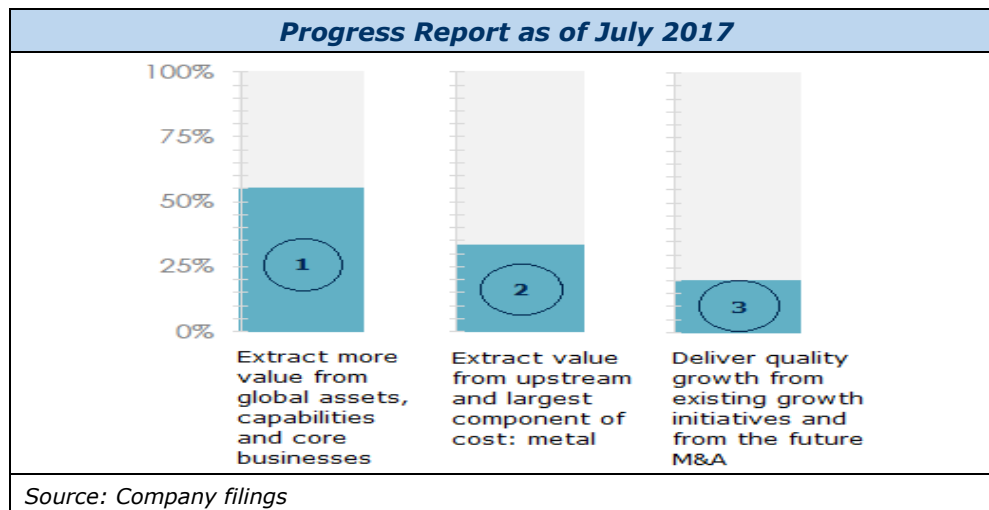
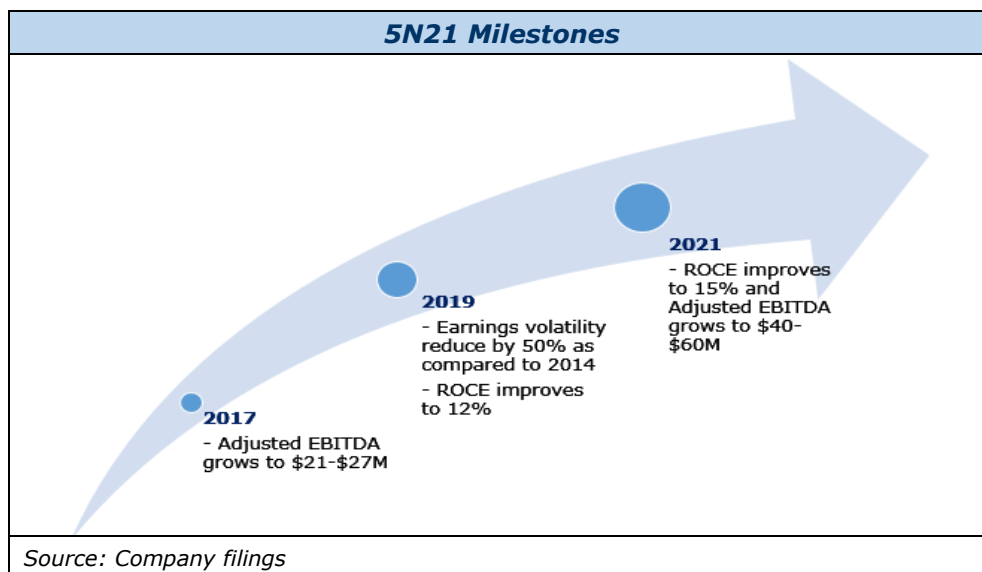
**Monetizing existing growth initiatives:** There are a number of organic growth opportunities which the Group is considering amongst which the two cases are Semiconductors and Micro-Powders. The first activity will focus around specialty semiconductor material and engineered substrates utilized in a whole number of industries. Regarding Micro-Powders, recalibrated, the company is making progress to a point where they have proven the viability of the technology, on the basis of feedbacks attained from a number of potential customers, declaring it to be unique and of interest. The next milestone will be industrialization of the technology where the company will consider different options to propagate.

**M&A Opportunities:** The company sees M&A activities as an important part of 5N21 and believes that proper discipline and due diligence is essential, to focus on quality targets with obvious synergies and growth potential.

As a general rule of thumb, 5N21 estimates a minimum of 12% Return on Capital Employed and this is expected to increase to 15% by the end of the plan.+

### Key Milestones:

As per 5N21 Strategic plan, following are the key Milestones of the company:



## News

- **5N Plus announced FY17 results:** The company witnessed a fall in the topline by 5% in FY17 to \$219.9MM from \$231.5MM in FY16, primarily due to lower sales of pass-through metal component, consistent with the Company's plan to reduce its earnings volatility. In FY17, Adjusted EBITDA and EBITDA reached \$25.1MM and \$26.9MM, compared to \$20.1MM and \$15.1MM in FY16. The Adjusted EBITDA demonstrates improved profitability which was largely supported by growth in value-added activities and services within an environment of stable commodity prices and sustainable demand. The net profit in FY17 reached \$12MM compared to \$5.9MM loss in FY16.
- **5N Plus Inc. announced entry into specialized materials for Feed Additives Industry:** The company entered into the animal feed minerals market, 5N Plus will manufacture a range of products to address the specific needs associated with this sector, focusing initially on the production and development of animal feed containing trace elements essential for good health and nutrition of animals, a sub-segment of the feed minerals market worth in excess of \$100MM annually.
- **5N Plus Inc. announced Q317 results:** Revenue for Q317 decreased by 9.4% to \$50.3MM from \$55.5MM; however, the gross margin slightly improved in Q317 to 26.5% compared to 26.2% in Q316. This reflects a change in the quality of revenue with the value-added component of revenue growing and the pass-through component declining. The company's net earnings for Q317 was \$2.2MM compared to a net loss of \$4.2MM for Q316.
- **5N Plus Inc. Announces Completion of Footprint Optimization Initiatives:** On November 6, 2017, 5N Plus announced successful completion of the footprint optimization initiatives which was introduced on September 2016, along with its Strategic Plan 5N21. The company has strategically relocated all the key product lines which were earlier produced at its Wellingborough, UK plant to other plants within the group, mainly to plants in Canada, Germany and China.
- **5N Plus awarded Multi-Year, US Government Contract:** On October 11, 2017, the company announced that it entered into a multi-year agreement with the US government, wherein the company will supply engineered semiconductor materials essential for space and aeronautical missions. The contract was awarded after a broad process with the competitors, and was decided on the total value creation based on products and services offered. This contract demonstrates the company's focus towards achieving its 5N21 strategic plan to deliver quality growth driven by technology enhancement. The company anticipates to commence the services from the second half of 2018.
- **Amendment of the Normal Course Issuer Bid:** On February 21, 2017, 5N Plus announced that the approval given by the Toronto Stock Exchange ("TSX") to amend its normal course issuer bid ("NCIB") implemented on October 11, 2016. Under the NCIB, 5N Plus now has the right to purchase for cancellation, from October 11, 2016 to October 10, 2017, a maximum of 2,100,000 (previously 600,000) common shares, representing 4.73% of the 44,416,731 shares forming 5N Plus' public float as at October 3, 2016. As of October 3, 2016, 5N Plus had 83,979,657 common shares issued and outstanding. During the NCIB period, subject to TSX and other regulatory authorities' approval, the company may consider purchasing for cancellation more than 2,100,000 common shares up to a maximum of 4,441,673 common shares, representing 10% of the company's public float.
- **Appointment of Executive Vice President, Eco-Friendly Materials:** On February 20, 2017, 5N Plus Inc. announced that Mr. Paul Tancell has been appointed Executive Vice President, Eco-Friendly Materials, and effective February 20, 2017. Mr. Tancell has over 20 years of experience across several international regions and industries, including automotive, chemical, and minor and precious metals. He previously held senior commercial and business development roles within the Umicore Automotive Catalysts Division, responsible for markets in Asia Pacific while living in China. Mr. Tancell holds a BSc in Environmental Chemistry and a PhD in Chemistry from the University of Plymouth, United Kingdom.
- **Approval of normal course Issuer bid:** On 5 October 2016, 5N Plus announced that the Toronto Stock Exchange (TSX) has approved its normal course issuer bid (NCIB), under which the company

has the right to purchase for cancellation, from 11 October 2016 to 10 October 2017, a maximum of 600,000 common shares, representing 1.35% of the 44,416,731 shares forming 5N Plus' public float as at October 3, 2016. As of October 3, 2016, 5N Plus had 83,979,657 common shares issued and outstanding. Any shares purchased by 5N Plus under the NCIB will be effected through the facilities of TSX as well as on alternative Canadian trading platforms at prevailing market rates and any common shares purchased by the company will be cancelled. During the NCIB period, subject to TSX and other regulatory authorities' approval, the corporation may consider purchasing for cancellation more than 600,000 common shares up to a maximum of 4,441,673 common shares, representing 10% of the corporation's public float.

- **5N Plus Inc. announces footprint optimization initiatives:** On 29 September 2016, 5N Plus announced the consolidation of its Wellingborough operations with those of other sites within the group. During the first half of 2017, the operations of DeForest-Wisconsin, U.S.A. and Fairfield-Connecticut, U.S.A. will be consolidated into a newly updated and scaled facility located in the state of Connecticut. Over the next few quarters, the corporation will transfer a number of product lines from Wellingborough to other manufacturing facilities within the Group. During this time, the corporation expects a seamless transition while serving its client base. The primary drivers to determine the future locations of the affected product lines will be operational synergy, cost competitiveness and client proximity. The expected restructuring cost associated with these initiatives will be around \$3.5 million with an expected payback of less than two years. The positive impact from these initiatives will be progressive reaching full potential starting in 2018.
- **Release of 5-Year Strategic Plan:** On September 12, 2016, 5N Plus released the highlights of a five-year strategic plan (5N21 Plan) which aims at improving the corporation's profitability along with reducing the volatility exposure. The 5N21 Plan is based on three main pillars, namely: a) Optimizing balance of contribution between upstream and downstream activities b) Extracting more value from core businesses, existing assets and capabilities c) Delivering quality growth from existing growth initiatives including future M&A activities.
- **Appointment of Chairman of the Board:** On January 11, 2016, 5N Plus announced the appointment of Mr. Luc Bertrand as the company's new Chairman of the Board effective immediately. He succeeded Mr. Jean-Marie Bourassa, who continues to serve on the board and as Chair of the Audit & Risk Management Committee, a position he already held. Since February 2011, Mr. Bertrand is Vice-Chairman of National Bank of Canada, responsible for developing and maintaining relations with corporate, institutional and government clients in Canada. During his illustrious career, Mr. Bertrand has held various management positions in the financial services industry. Aside from his professional duties, Mr. Bertrand is an active member of boards of directors and industry committees. He currently serves on the Board of the International Finance Centre of Montréal, is also Chairman of the Board of the Montreal Canadiens/CH Group Inc.
- **Appointment of new president and chief executive officer:** On 10 December 2015, the company announced the appointment of Mr. Arjang J. (AJ) Roshan as its new President and Chief Executive Officer (CEO) effective 15 February 2016. The position was previously held by Mr. Jacques L'Écuyer who decided to step aside from 03 November 2015. Mr. Roshan has 25 years of international and executive experience, closely related to 5N Plus' line of businesses. He has worked for Umicore, a global materials technology and recycling group for 18 years, holding a number of senior executive positions, including leading the Automotive Catalysts business in Asia Pacific as Senior Vice President for the division and later, as Senior Vice President of Umicore's Electro-Optic Materials Business Unit, widely recognized as the global leader in development, production, recycling and refining of semiconductor and electro-optic materials along with high purity chemicals and metals.
- **Fifth consecutive win at the 2014 Deloitte Technology Fast 50 awards:** On 13 November 2014, 5N Plus announced that it has been ranked in the Deloitte Technology Fast 50 and Technology Fast 500 for the fifth year in a row. The company ranked 179 on Deloitte's Technology Fast 500, a listing

of the 500 fastest growing technology, media, telecommunications, life sciences, and clean technology companies in North America based on percentage growth over a five-year period.

- **Closing of new USD 125MM syndicated credit facility:** On 07 August 2014, 5N Plus secured a USD 125MM senior secured multi-currency revolving syndicated credit facility, replacing the existing USD 100MM facility. This facility is expected to be used for refinancing existing debt liabilities, capital expenditures, and funding other growth opportunities. The new credit facility is on a revolving basis, has a four-year term and carries interest at either prime rate, U.S. base rate, HK base rate or Libor plus a margin based on 5N Plus' senior consolidated debt to EBITDA ratio.
- **Closure of allotment of convertible unsecured subordinated debentures:** On 26 June 2014, 5N Plus announced the closure of its offering of USD 60MM convertible unsecured subordinated debentures, with an additional purchase of USD 6MM aggregate principal amount of debentures at a price of \$1,000 per debenture, by the underwriters.
- **Completion of Bought-Deal Offering of Convertible Unsecured Subordinated Debentures:** On June 18, 2014, 5N Plus announced the completion of its previously-announced bought-deal offering, under a short form prospectus, of convertible unsecured subordinated debentures in an aggregate principal amount of CAD60 million. The debentures were offered at a price of CAD1,000 per debenture in each of the provinces of Canada. For the short term, 5N Plus used the net proceeds of the offering to reduce indebtedness under its senior revolving credit facility. The debentures bear interest at a rate of 5.75% per annum, payable semi-annually on June 30 and December 31 each year, commencing on December 31, 2014. The debentures are convertible at the holder's option into 5N Plus common shares at a conversion price of CAD6.75 per share, representing a conversion rate of 148.1481 5N Plus shares per CAD1,000 principal amount of debentures. The debentures will mature on June 30, 2019 and may be redeemed by 5N Plus, in certain circumstances, after June 30, 2017. 5N Plus has granted an over-allotment option to the underwriters of the Offering, entitling them to purchase, for a period of 30 days from June 18, 2014, up to CAD6.0 million principal amount of additional debentures at the offering price of CAD1,000 per debenture, to cover over-allotments, if any.
- **Renewal of exclusive agreements with First Solar Inc.:** On 27 May 2014, 5N Plus announced that it has entered into new supply agreements with the world's leading thin-film solar module manufacturer, First Solar Inc. As per the agreement, 5N Plus will supply First Solar's compound semiconductor requirements till 31 March 2019. The company also renewed its existing cadmium telluride (CdTe) supply agreement and byproducts recycling agreement with First Solar along with the new agreement, under which First Solar has agreed to exclusively purchase, from 5N Plus, all the CdTe required, on a worldwide basis, for the manufacture of solar photovoltaic modules.
- **Completion of the acquisition of Advanced Machine and Materials Inc.:** On 05 May 2014, 5N Plus completed the acquisition of all issued and outstanding shares of Advanced Machine and Materials Inc. (AM&M), which is a specialized manufacturer of micron-sized metallic powders based in Ontario.

## Listing Information

5N Plus is listed on the Toronto Stock Exchange (TSX) in Canada and started trading on 20 December 2007.

## Contacts

<b>Head office</b>	4385 Garand Street, Montreal, Quebec, H4R 2B4, Canada
<b>Telephone</b>	+1 514-856-0644
<b>Facsimile</b>	+1 514-856-9611
<b>E-mail (General inquiries)</b>	<a href="mailto:info@5nplus.com">info@5nplus.com</a>

<b>E-mail (Investors)</b>	<a href="mailto:invest@5nplus.com">invest@5nplus.com</a>
---------------------------	----------------------------------------------------------

### Major Shareholders

<b>Equity Holder</b>	<b>No. of ordinary shares held (Million)</b>	<b>Percentage shareholding</b>
Caisse De Depot Et Placeme	15.87	18.90%
Letko Brosseau & Associates	15.70	18.69%
FMR LLC	5.06	6.02%
IG Investment Management LTD	1.86	2.21%
Dimensional Fund Advisors LP	1.39	1.65%

*Source: Bloomberg*

## Management and Governance

Personnel	Designation	Current and Total Experience
<b>Luc Bertrand</b>	<b>Chairman</b>	Mr. Luc Bertrand has been the Vice-Chairman of National Bank of Canada since February 2011, and is responsible for developing and maintaining relations with corporate, institutional, and government clients in Canada. He serves on the Board of the International Finance Centre of Montréal, is also Chairman of the Board of the Montreal Canadiens/CH Group Inc. He also serves on the Board of TMX Group.
<b>Arjang Roshan</b>	<b>President and Chief Executive Officer</b>	Mr. Roshan has nearly 25 years of business experience in various industries including Automotive, Chemical, Electro-Optics, and Metals & Material Technology. Previously, he was Senior Vice President of Electro-Optic Materials at Umicore (2012-15). Mr. Roshan has also worked with Ford Motor Company and Robert Bosch Corporation. He holds a degree in Electrical Engineering from Michigan Technological University, an Executive Management Degree from the University of Michigan Ross School of Business, and an Executive MBA from Michigan State University Broad School of Business.
<b>Richard Perron</b>	<b>Chief Financial Officer</b>	Mr. Richard Perron is a Certified Public Accountant (CPA) having 20 years of international experience in the manufacturing and technology sectors. He has served as the Chief Financial Officer and Strategy Manager of Long Carbon Americas, at ArcelorMittal, and also as the Director of Finance and Control and Chief Information Officer at Danfoss Turbocor Compressors of Danfoss Group. Mr. Perron holds a B.Com degree (Accounting), a M.Sc. in Administration, Management and Accounting, and a M.B.A. from the University of Sherbrooke.
<b>Nicholas Audet</b>	<b>Executive Vice President, Electronic Materials</b>	Mr. Nicholas Audet has served various positions in 5N Plus including those of Chief Commercial Officer, Director of Research & Development, and Manager, Research & Development. Formerly, Mr. Audet acted as a lead engineer for EMS Technologies Inc. Mr. Audet is a certified mechanical engineer, and graduated from the Université Laval in Québec City. He also holds a Master's degree in Engineering from the University of Victoria, British Columbia.
<b>Paul Tancell</b>	<b>Executive Vice President, Eco-Friendly Materials</b>	Mr. Paul Tancell has over 20 years of experience across several international regions and industries, including automotive, chemical, and minor and precious metals. He has held senior roles in companies such as Umicore, Ford Motor Company, and Johnson Matthey. He has an excellent track record of developing high-performing organizations and delivering competitive results across industries, environments, and geographies. Mr. Tancell holds a BSc in Environmental Chemistry and a PhD in Chemistry from the University of Plymouth, United Kingdom.

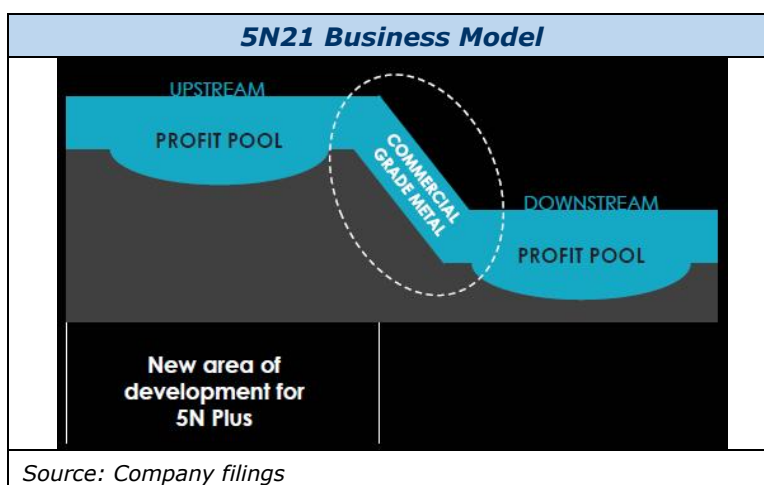
## Assets and Projects

5N Plus is a leader in the production of specialty metal and chemical products which are used in a number of advanced chemical, pharmaceutical, industrial, electronic and electro-optics applications. 5N Plus has put into use a range of proprietary and proven technologies to manufacture its products. Their main products include purified metals such as bismuth, gallium, germanium, indium, selenium and tellurium, inorganic chemicals based on such metals and compound semiconductor wafers. The company is headquartered in Montreal, Quebec, Canada and has manufacturing facilities and sales offices in several locations in Europe, the Americas, and Asia. Its products are niche and many of these are critical precursors and key enablers in markets such as solar, light-emitting diodes and eco-friendly materials.

An integrated supplier having both primary and secondary refining capabilities. Their forte in primary refining allows them to treat very low-grade metal concentrates, and extract and refine the required metals so as to be fed to their secondary refining operations, to attain the highest level of purity. Once purified, metals can be sold to customers in the form of pure metals, alloys or chemicals. As the company excels in extensive refining functions, leading them to go from one end of the purity spectrum to the other, and manufacture chemicals and alloys, and this drives them to consider themselves a supplier with integrated refining capabilities. Furthermore, their primary refining proficiencies enable them to treat complex feeds and very low-grade concentrates containing minor amounts of the metals of interest, playing a vital role in the recycling of the specialty metals that they produce.

Purification and manufacturing activities are carried out using a variety of metallurgical and chemical processes. Their raw materials or “feedstock” are generally in the form of concentrates or recyclable materials containing the metals of interest. Given the nature of their activities and the metals that we purify, they operate under, and comply with, stringent environmental, health and safety conditions. Several of our operations are either certified (ISO 9001, ISO 14001, ISO 50001 and OHSAS 18001) or have approval from the United States Food and Drug Administration (“FDA”) or have Good Manufacturing Practices (GMP) requirements, reinforcing our commitment to best practices in terms of operations, quality and health and safety.

**Business Model:** Upstream activities utilizes technology to extract critical metals from complex streams at attractive terms. At the same time, downstream deals with manufacturing and sale of industrial product and material technology with high degree of value-added activity and transformation. For upstream activities, high metal prices reaps maximum benefit, whereas in case of downstream activities, maximum value addition results from low metal prices.





## Electronic Materials

**Summary:** The Electronic Materials segment manufactures and sells refined metals, compounds, and alloys. The segment operates in North America, Europe, and Asia. The products are sold to top firms for their electronic applications. Depending on the requirements, these products are manufactured in elemental, alloyed, chemical, or compound forms.

**End Markets:** Photovoltaic (terrestrial and spatial solar energy), LED, displays, high-frequency electronics, medical imaging, and thermo-electrics.

**Target Commodities:** Cadmium, Gallium, Germanium, Indium, and Tellurium.

The list of products manufactured under the Electronic Materials segment is given below.

	Cadmium	Gallium & Gallium Chemicals	Germanium	Indium & Indium Chemical and alloys	Tellurium & Tellurium Chemicals
Applications	Battery Industry CdTe solar cells Alloys and Metallurgical additives	LED Lights Flat-panel displays Integrated Circuits Optoelectronic devices Specialty alloys Energy storage Biomedical CIGS solar cells	Infrared optics Optical fibers Catalysts Solar cell substrates	Flat panel displays (ITO) Solders Thin-film coating CIGS solar cells Battery manufacturing & Catalysts Ceramics Fuel cells	CdTe solar cells Medical Imaging Thermoelectric devices Infrared detectors Optical storage
Annual Worldwide Production*	>20,000 MT	300 MT	120 MT	800 MT	550-600 MT

\* Based on management estimates and units in metric tons (MT)

### Supply of Raw Materials

**Specialty metal concentrates** - Procured from a number of non-ferrous metal suppliers. 5N Plus has long-term commercial relationships with suppliers.

**Cadmium and Indium** - These products are generally the by-products of zinc refining. The company purchases these from zinc producers in various forms.

**Gallium** - Purchased in various forms from other sources of operations.

**Tellurium** - By-product of copper, zinc, or gold refining. It is procured from several sources worldwide.

## Financial Summary:

**FY17 vs. FY16 Performance:** In FY17, revenues of the Electronic Materials segment declined by 7.1% YoY to USD 73.4MM. However, the company witnessed strong growth in adjusted EBITDA of USD 24.8MM in FY17 compared to USD 19.8MM in FY16. This reflects strong growth in the EBITDA margin from 25.1% in FY17 to 33.8% in FY16.

in USD '000	FY17	FY16	Δ
Sales	73,448	79,038	(7.1%)
Adjusted EBITDA	24,835	19,824	25.3%
Adjusted EBITDA Margin %	33.8%	25.1%	NA

Note: Also includes revenues from recycling services provided to clients of the Electronic Materials segment

## Eco-Friendly Materials

**Asset Summary:** This segment manufactures and sells bismuth and bismuth chemicals, LMPA, refined selenium, and selenium chemicals. Bismuth has no adverse effect on either human health or the environment and hence is replacing other harmful metals and chemicals in a number of applications. The segment operates in North America, Europe, and Asia.

**End Markets:** Pharmaceutical and animal-feed industries, other industrial applications including coatings, pigments, metallurgical alloys, and electronics.

**Target Commodities:** Bismuth and Selenium.

The table below lists the products manufactured under the Eco-Friendly Materials segment.

	Bismuth & Bismuth chemicals and alloys	Selenium & Selenium chemicals
Applications	Pharmaceutical Industry Electronics Cosmetics Magnets Non-toxic substitute for lead Alloys for soldering Lubricating greases Pigments Alloys and metallurgical additives	Glass Industry Animal feeds Additive for production of electrolytic manganese Metallurgical additive CIGS solar cells Infrared optics Thermoelectric devices
Annual Worldwide Production*	12,000 MT	4,000 MT

\* Based on management estimates and units in metric tons (MT)

### Supply of Raw Materials

**Bismuth** – Recovered as a byproduct of lead, tin, and tungsten refining. 5N Plus has been dealing with most producers of primary bismuth worldwide.

**Selenium** – A by-product of copper refining. 5N Plus purchases suitable feedstock from several copper suppliers.

### Financial Summary:

**FY17 vs. FY16 Performance:** In FY17, revenues declined by 3.9% YoY to USD 146.5MM. However, adjusted EBITDA increased to USD 14.9MM in FY17, 11.2% growth YoY, signifying the company's selective approach on better margin products. Adjusted EBITDA margins increased to 10.2% in FY17 from 8.8% in FY16.

in USD '000	FY17	FY16	Δ
Sales	146,468	152,460	(3.9%)
Adjusted EBITDA	14,976	13,467	11.2%
Adjusted EBITDA Margin %	10.2%	8.8%	NA

### Recent Developments

The operations at the Wellingborough, UK plant were successfully consolidated with the rest of the group plants. With this, the company accomplished its initially announced footprint optimization initiatives within a year of its commencement. All the key product lines have been reallocated to other plants in Canada, Germany and China. With these restructuring initiatives and increased focus on value-added products, the company's EBITDA margins are expected to expand further.

On Oct-2017, the company secured a long-term multi-year contract with the US government to supply engineered semiconductor materials utilized for space and aeronautical missions. The agreement further exhibits the company's focus to achieve 5N21 strategic objective of delivering quality organic growth and reducing earning volatility.

5N Plus is renegotiating contracts with some of its customer, wherein the company is commercially hedging its exposure towards commodity prices.

## Specialty Chemicals & Metals

**Bismuth:** Various commercial applications using Bismuth are in cosmetics, pigments, and medicines. Combination of Bismuth with other metals is used to make LMPA for safety devices in fire extinguishers and detection systems. Bi also acts as a replacement for lead in shots and bullets as well. The U.S. Naval Surface Weapons Center uses Bismuth, a permanent magnet of high coercive force. After the European Union's Restriction of Hazardous Substances Directive for reduction of lead in electronics, as well as for food processing equipment and copper water pipes, the use of Bismuth has significantly grown.

Bismuth is also used in the pharmaceutical industry and is the active ingredient in a number of drugs for treating stomach ulcers and other discomforts associated with the gastrointestinal tract. Bismuth Oxide is also used in the manufacture of mobile phone and digital camera lenses having high refractive index. Having acquired certifications to supply bismuth products to FDA and GMP standards, 5N Plus sells bismuth in various forms, including chemicals and pure metals.

**Gallium:** Gallium is extensively used in electronic applications with an extensive use in the LED industry value chain. Gallium arsenide (GaAs), for example, is the semiconductor of choice for wireless devices and high-frequency electronics, whereas gallium nitride (GaN) is preferred for light-emitting diodes (LED) and display applications.

5N Plus generally sell gallium as a high purity metal or as a gallium chemical.

**Germanium:** Germanium has unique properties for infrared optical applications and is also being used as a substrate for solar cells. Other applications for germanium in the form of oxide or chloride include catalysts and optical fibers.

5N Plus is a reliable supplier of high quality germanium wafers for the production of ultra-high efficiency solar cells which serve as key components of solar power generation and concentrated photovoltaic systems. Along with this, the company is also engaged in growing

germanium crystals for satellite power generation.

**Indium:** Due to its low melting and boiling point characteristics, Indium is used to make LMPA and bearing alloys. An important part of touch screen, flat screen TV, and solar panel production uses Indium tin oxide (ITO), which is made using Indium. The Indium metal can be evaporated to glass to form mirrors which are more corrosion resistant when compared to those made with silver. The main end-use markets include Electronics, Energy, Optics, and Petrochemicals.

5N Plus generally sell indium in the form of pure metal or as a chemical. Also, the company sell engineered substrates and semiconductor material containing Indium as a critical component of high-end sensing and imaging applications.

**Selenium:** The most extensive use of selenium is as an additive to glass. It is used to make pigments for ceramics, paint, and plastics and as an additive to make stainless steel. It further finds use in photocells, solar cells, and photocopiers. It is used extensively in electronics applications, such as in photocells, light meters, and solar cells.

5N Plus sell selenium in various forms, including powder, high-purity metal and chemicals. The company mainly supplies selenium to Zinc Selenide manufacturers wherein it is used to make lenses for CO lasers

**Tellurium:** Tellurium is used in the solar industry, electronics, imaging and metallurgical applications. Tellurium also finds application as a key ingredient in thermoelectric components used of solid state cooling and heating. Typical applications include power generation, waste heat recovery, and climate-controlled car seats. Some of its other uses are to color glass and ceramics, and as an alloying agent. Small amounts of tellurium are added to copper and stainless steel to make them easier to machine and mill.

5N Plus is active in all market segments selling CdTe to solar cell manufacturers, engineered material for imaging and sensing applications, metals to bismuth telluride producers and tellurium alloys for metallurgical applications.

## Technologies and Market

### Bismuth<sup>vi</sup>

**Chemistry and Properties:** Bismuth (Bi) is considered to be the most diamagnetic of all metals. It has thermal conductivity lower than any metal except mercury.

**Sources:** Native Bi is rare and is available in mineral form with other elements such as bismuthinite and bismite. These and other bismuth minerals also occur within ores of other metals, such as gold, silver, lead, zinc, and tungsten, but in minute quantities. Most bismuth is produced from mines in China, Mexico, Peru, and Bolivia.

**Supply and Production:** As per the US Geological Survey (USGS), the world reserves of bismuth containing ore stands at 320,000 tons and the reserve base is estimated to be 680,000 tons, with the majority located in China, Bolivia and Mexico.

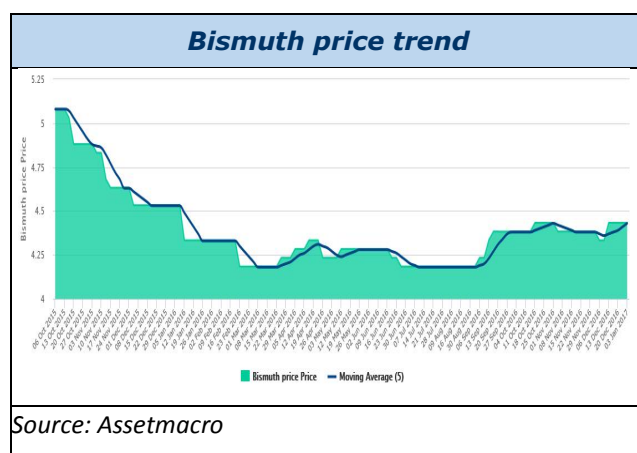
<b>World Bismuth Reserves(USGS)</b>	
<i>(Data in metric tons of bismuth content unless otherwise noted)</i>	
<b>Country</b>	<b>Reserves</b>
United States	5,000
Bolivia	10,000
Canada	5,000
China	240,000
Mexico	10,000
Other countries	50,000
<b>World total</b>	<b>320,000</b>

China has a reserve base of around 470,000 tons, taking a 69% worldwide share. The total worldwide bismuth mining production was 7,600 tons in 2013. China was the biggest bismuth producer, with a total production of 6,500 tons. Mexico produced 940 tons of bismuth in the same year.

**Demand:** Inclusion of stringent environmental regulations regarding lead usage would push the market of bismuth and bismuth derived compounds. Major paints & coatings manufacturers such as BASF SE and PPG Inc. are actively offering bismuth-based products. The global bismuth market is expected to reach US\$ 400.0 Million expanding at a CAGR of 6.7% during the forecast period (2016–2024). Asia

Pacific is anticipated to be the largest market for bismuth, with a share of 46% in overall sales by the end of 2024.

**Market Trends - Commodity Prices:** In 2008–09, the worldwide financial crisis and recession had a marked effect on global Bi consumption and prices. But in the due course, Bismuth gained momentum and reached peaks by 2011. Though prices again dropped and displayed a flattish trend for two years. The price movement showed some improvement and reached the same 2011 levels by mid of 2014, but to the dismay drastically fell below 5 US\$/lb.



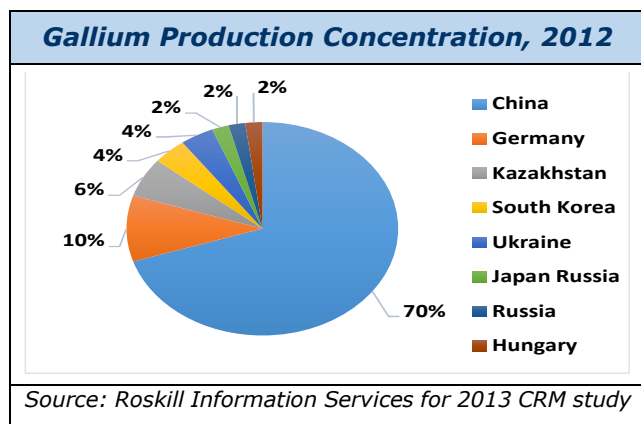
### Gallium<sup>vii</sup>

**Chemistry and Properties:** Gallium (Ga) is silvery white and soft enough to be cut with a knife. Because of superficial oxidation, it takes on a bluish tinge. Known for its unusually low melting point (about 30°C [86°F]), gallium also expands upon solidification and supercools readily.

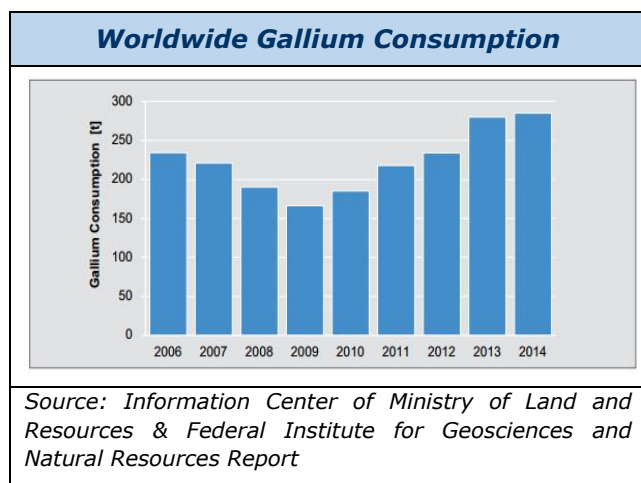
**Sources:** Gallium is more abundant than lead but much less accessible because it has not been selectively concentrated into minerals and tends to be widely dispersed. Several ores, such as the aluminum ore bauxite, contain a small amount of gallium, and Coal may also have a relatively high gallium content.

**Supply and Production:** As per USGS estimates, the worldwide low-grade primary gallium production was 435 metric tons in 2015. China, Germany, Japan, and Ukraine were the

leading producers; countries with lesser output were Hungary, the Republic of Korea, and Russia. China, Japan, the United Kingdom, the United States, and possibly Slovakia were the principal producers of high-purity refined gallium. Gallium was recycled from new scrap in Canada, Germany, Japan, the United Kingdom, and the United States.



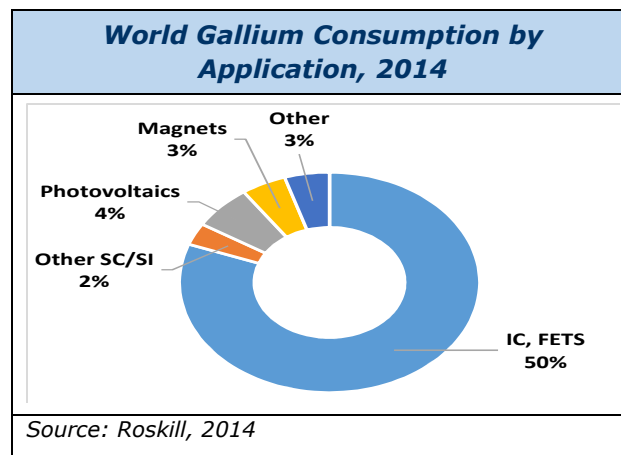
**Demand:** Global gallium consumption is estimated at 285 t in 2014 (RLJ 2014), which means a rise of merely 1% compared to 2013, but an increase of more than 70% compared to 2009.



The largest market for gallium is still in Japan, which consumed 97 t in 2013. However, the country's share of the global market has fallen from about 80% in the mid-2000s to about 35% in 2013, while China's demand increased rapidly to 67.5 t in 2013, or a share of 24% of the global market. The United States ranks third with a consumption of 37.8 t (13.5%), similar to the

European market which is estimated to consume 30–40 t.

Around 90% of the worldwide gallium demand is utilized in semi-conducting or semi-insulating (SC/SI) substrates and epitaxial layers. Of this figure, integrated circuits and discrete field effect transistors (FETs) accounted for 50% and LEDs (for general lighting and backlighting applications) 38%.



5N Plus generally sell gallium as a high purity metal or as a gallium chemical.

**Market Trends - Commodity Prices:** Prices are negotiated bilaterally usually on a long-term basis among suppliers and customers. Between 1960 and 2013, prices for 6N gallium in the US metal market declined at a CAGR of 3.1%.

## Germanium<sup>viii</sup>

**Chemistry and Properties:** Germanium (Ge) is a shiny and silvery, yet very brittle metalloid. It has a diamond-like crystalline structure and has similarities with Silicon in terms of chemical and physical properties. Germanium is stable in air and water, and is unaffected by alkalis and acids, except nitric acid.

**Sources:** Germanium like gallium, is rarely found in minerals except in trace amounts. Further, similar to gallium, germanium is obtained as a byproduct of mining and processing zinc and copper.

**Production:** The available resources of germanium are associated with certain zinc and lead-zinc-copper sulfide ores. Most of the US reserves of recoverable germanium are contained in zinc deposits in Alaska and Tennessee. After analysis of zinc concentrates, the US reserves of zinc should contain as much as 2,500 tons of germanium.

**Supply and Demand:** In 2015, China remained the leading global producer of germanium and consumed about 26 tons. The use of Ge in fiber optics increased substantially in China from 2012 to 2015, making the country the leading germanium consuming area. Earlier, China's Ministry of Commerce issued a preliminary antidumping ruling against imports of fiber-optic preforms from Japan and the United States. In early-2015, scientists from the United States developed a multi-junction solar cell that used germanium quantum dots on a standard silicon wafer. This might increase the demand of germanium in the long run.

**Market Trends - Commodity Prices:** Germanium dioxide prices were relatively stable during the first half of 2015, remaining close to the 2014 levels, and nearly double as compared to 2010. However, prices began to drop in the second half of the year and reached \$1,170 per kilogram in October 2015.

### Indium<sup>ix</sup>

**Chemistry and Properties:** Indium (In) is a soft, silvery-white metal with very low melting and boiling points, which makes it ideal for soldering activity. It is stable in air and water but dissolves in acids.

**Sources:** Indium has a rare existence on earth, and as such is prevalently found in zinc, copper and iron ores. The world's top producers of In are Canada, China, and Russia. Indium Corporation, headquartered in New York, US, is one of the largest producers of Indium metal.

**Production:** According to the USGS 2014 Minerals Yearbook, the world's total production of primary indium was estimated to be 881 tonnes in 2014, or 8% more than the 2013 level. China

was the leading producer, followed by the Republic of Korea, Japan, and Canada. Primary indium was recovered from residues generated during the smelting of zinc concentrates. According to market reports, indium production in China declined by 15-30% in the first half of 2015 compared with the year-ago period.

**Supply:** The global ITO market was valued at USD 2.59 billion in 2015 and is expected to reach USD 3.46 billion by 2020, growing at a CAGR of almost 6%. Several indium-containing exploration or development projects are advancing in Canada and South America. It is however uncertain as to when or whether these projects will come on stream.

### Selenium<sup>x</sup>

**Chemistry and Properties:** Selenium (Se) is a non-metallic chemical element which can exist in two forms, as a silvery metal and as a red powder. Being a metalloid, it has some characteristics of metals and some of non-metals. Selenium burns in air and is unaffected by water, but dissolves in concentrated nitric acid and alkalis.

**Sources:** Selenium is a very rare element with no ore from which it can be profitably mined. It is obtained as a byproduct of mining other metals. It is produced primarily from copper, iron, and lead ores. The major producers of selenium in the world are Japan, Canada, Belgium, the United States, and Germany.

**Demand:** Approximately 40% of the Selenium demand is from the glass manufacturing and paint industries. Other areas of demand are metallurgy (approximately 30%), where it is used as an additive in manganese production; agriculture, where it is used as a supplement for animal feedstock; and electronics photovoltaic technology (10%), with pigments further accounting for a similar 10% share.

**Production and Supply:** The average world production of selenium is estimated at 3,000-3,500 tonnes per year. In 2011, the production of selenium metal in respect of 11 countries for which data is available was estimated at 1,911 tonnes. The chief producers were Japan,

Germany, Belgium, Russia, Kazakhstan, Sweden, Poland, and Finland.

**Market Trends - Commodity Prices:** According to USGS, the Selenium price was \$37.83 per lb in 2010.

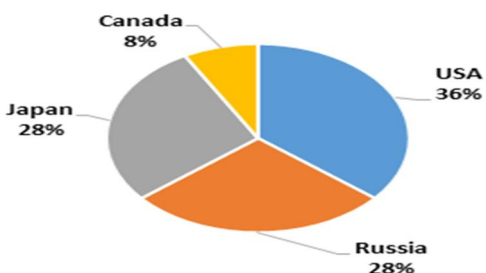
## Tellurium<sup>xi</sup>

**Chemistry and Properties:** Tellurium (Te) is a silvery-white metalloid. Its pure version has a metallic luster. Crystalline tellurium is easily pulverized.

**Source:** Currently, most tellurium is obtained as a byproduct of mining and refining copper. The metalloid is found commercially in the electrolytic refining of blister copper from anode muds.

**Demand:** World consumption of tellurium was estimated to have decreased in 2014 owing to a continued decreasing demand for thermoelectrics in China. The usage of Tellurium in solar cells was estimated to have decreased because of the falling cost of conventional silicon-based cells.

**Global Tellurium Production, 2012**



Source: USGS

**Supply:** The supply of tellurium is directly linked to the production of copper. With decreasing metal prices throughout 2014, production rates from copper refineries are expected to fall. The recovery of tellurium from copper drums continues to fall, owing to reduced supplies.

**Natural Graphite Statistics**

Country	Reserves*
World: Total (rounded)	24,000
Canada	800
Peru	3,600
USA	3,500
Other Countries	26,000

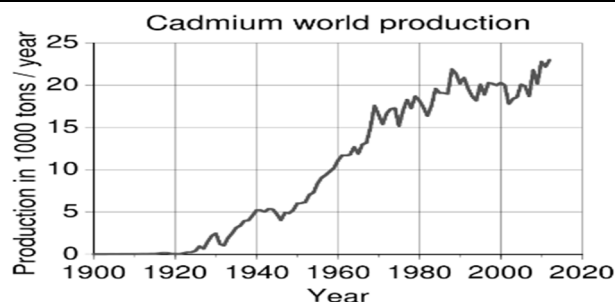
\*Estimates include tellurium contained in copper resources only  
Source: Mineral Commodities Summaries, 2013

## Cadmium<sup>xii</sup>

**Chemistry and Properties:** Cadmium (Cd) is a lustrous, silvery white, ductile, and highly malleable metal having a bluish tinge. It is soluble in acids but not in alkalis.

**Supply and Production:** The main mining areas for cadmium are those associated with zinc. The world production of Cd is around 14,000 tons per year. Canada is the main producing country, with the United States, Australia, Mexico, Japan, and Peru also being major suppliers.

**Cadmium World Production**



Source: Wikipedia

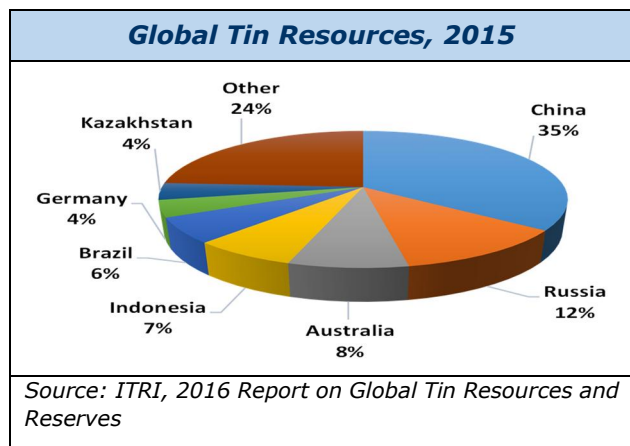
**Applications:** Cadmium is primarily used in rechargeable batteries and in low melting-point alloys. It is also extensively used in association with tellurium and sold by us in the form of CdTe for solar module, infrared imaging and medical imaging applications.

Around three-fourths of cadmium is used in Ni-Cd batteries, while most of the remaining one-fourth is used mainly in pigments, coatings and plating, and as stabilizers for plastics.

## Tin<sup>xiii</sup>

**Chemistry and Properties:** Tin (Sn) is a soft, pliable, and a silvery-white metal.

**Production:** The graph below shows the leading tin producing companies worldwide in 2014, based on production output (in 1,000 metric tons). As per the graph, Yunnan Tin in China is the leading producer with 75.92 metric tons.

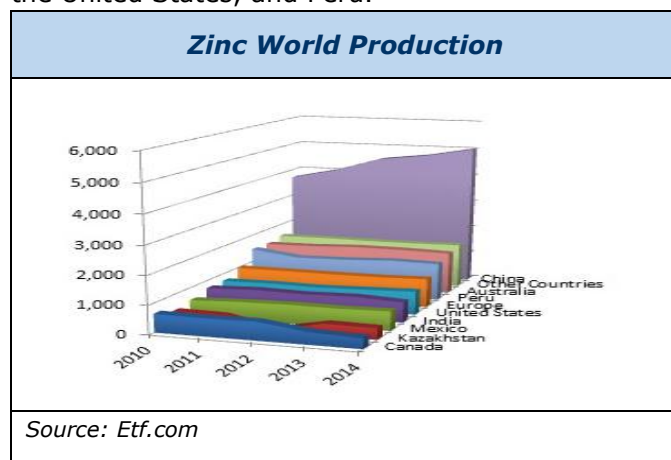


**Applications:** Tin is widely used for plating steel cans used as cooking vessels, food containers, metals used for bearings, and in solder. It is also used to form many useful alloys such as bronze and Pewter.

## Zinc<sup>xiv</sup>

**Chemistry and Properties:** Zinc (Zn) is a lustrous bluish-white metal. It combines with oxygen and other non-metals and is fairly reactive.

**Production:** China remains the world's largest zinc producer in terms of mine production. It is also the world's largest consumer and the largest refiner of Zinc. The other main zinc mining areas are in Canada, Russia, Australia, the United States, and Peru.





## Value

The Fair Market Value for 5N Plus Inc. shares stands between CAD 348.9MM and CAD 383.8MM.

The Fair Market Value for one of 5N Plus Inc. publicly traded shares stands between CAD 4.17 and CAD 4.59

## 5N Plus Inc. Balance Sheet Forecast

<b>CONSOLIDATED BALANCE SHEET</b>	<i>all figures in '000 USD, unless stated differently</i>		<i>Low bracket estimates</i>			
<i>year ending Dec 31</i>	<b>2018E</b>	<b>2019E</b>	<b>2020E</b>	<b>2021E</b>	<b>2022E</b>	<b>2023E</b>
Total Current Assets	176,355	131,688	155,739	201,544	232,915	264,083
Total Non-Current Assets	81,763	81,894	82,886	77,880	80,739	84,693
<b>TOTAL ASSETS</b>	<b>258,118</b>	<b>213,582</b>	<b>238,625</b>	<b>279,424</b>	<b>313,654</b>	<b>348,777</b>
Total Current Liabilities	68,897	69,349	72,473	75,063	77,811	80,727
Total Non-current Liabilities	75,682	22,083	22,083	22,083	22,083	22,083
<b>TOTAL LIABILITIES</b>	<b>144,579</b>	<b>91,432</b>	<b>94,556</b>	<b>97,146</b>	<b>99,894</b>	<b>102,810</b>
Total Shareholders' Equity	113,539	122,150	144,069	182,278	213,760	245,967
<b>TOTAL LIABILITIES and EQUITY</b>	<b>258,118</b>	<b>213,582</b>	<b>238,625</b>	<b>279,424</b>	<b>313,654</b>	<b>348,777</b>

## Important Information on Arrowhead Methodology

The principles of the valuation methodology employed by Arrowhead BID are variable to a certain extent, depending on the sub-sectors in which the research is conducted. But all Arrowhead valuation researches possess an underlying set of common principles and a generally common quantitative process.

With Arrowhead commercial and technical due diligence, the company researches the fundamentals, assets and liabilities of a company, and builds estimates for revenue and expenditure over a coherently determined forecast period.

Elements of past performance such as price/earnings ratios, indicated as applicable, are mainly for reference. Still, elements of real-world past performance enter the valuation through their impact on the commercial and technical due diligence.

## Arrowhead BID Fair Market Value Bracket

The Arrowhead Fair Market Value is given as a bracket. This is based on quantitative key variable analyses such as key price analysis for revenue and cost drivers or analysis and discounts on revenue estimates for projects, especially relevant to projects estimated to provide revenue near the end of the chosen forecast period. Low and high estimates for key variables are produced as a valuation tool.

In principle, an investor comfortable with the high brackets of our key variable analysis will align with the high bracket in the Arrowhead Fair Value Bracket, and, likewise, in terms of low estimates. The investor will also note the company's intangibles to analyze the strengths and weaknesses, and other essential company information. These intangibles serve as supplementary decision factors for adding or subtracting a premium in the investor's own analysis.

The bracket should be taken as a tool by Arrowhead BID for the reader of this report and the reader should not solely rely on this information to make his decision on any particular security. The reader must also further understand that while on the one hand global capital markets contain inefficiencies, especially in terms of information, on the other, corporations and their commercial and technical positions evolve rapidly. This present edition of the Arrowhead valuation is for a short to medium-term alignment analysis (one to twelve months). The reader should also refer to important disclosures on page 27 of this report.

## Information on the 5N Plus Inc. Valuation

**5N Plus Inc. Valuation Methodology:** The Arrowhead fair valuation for 5N Plus is based on the discounted cash flow (DCF) method. We have calculated the NPV of the project based on estimated cash flows, which we have subsequently discounted by a discount rate. We have also accounted for the operational risk through an implied P/NPV multiple, which is applied to the NPV of the project to arrive at an implied equity value.

**Time Horizon:** The Arrowhead fair valuation for 5N Plus Inc. is based on a DCF method. We have assumed a longer time horizon. The later years are heavily discounted and have a marginal effect on valuation, which are included primarily to present a full project cycle situation.

**Underlying Business Plan:** 5N Plus engages in the manufacturing and sales of specialty metals and chemicals. The company produces a range of products used as an input in industries such as solar photovoltaics, LEDs, and ecofriendly materials.

**Terminal Value:** Terminal value is estimated to depend on a terminal growth rate of 0%, representing the maturity, technology change, and prospective competitiveness in the business.

**Prudential Nature of Valuation:** This Arrowhead Fair Value Bracket estimate is a relatively prudential estimate as it is based upon the company's business model.

## Key Variables in Revenue Estimations for 5N Plus Inc.

### Variable 1 –Revenue Growth Rate

We have estimated the growth rate based on the estimates of commodity prices and the demand for the company’s products.

Eco-Friendly Materials Revenue Growth Rate	2018-2020	2021-2025
Low	8%	6%
High	9%	7%

Electronic Materials Revenue Growth Rate	2018-2020	2021-2025
Low	7%	5%
High	8%	6%

### Variable 2 – EBITDA Margin

We have estimated the EBITDA margin in line with the company outlook and 5N plus increased focus on value-added products.

Eco-Friendly Materials EBITDA Margin	2018-2020	2021-2025
Low	11%	13%
High	12%	14%

Electronic Materials EBITDA Margin	2018-2020	2021-2025
Low	30%	35%
High	31%	36%

## **Analyst Certifications**

I, Natasha Agarwal, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security and the subject company.

I, Sumit Wadhwa, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security and the subject company.

## **Important disclosures**

Arrowhead Business and Investment Decisions, LLC received fees in 2017 and will receive fees in 2017 and 2018 from 5N Plus Inc. for researching and drafting this report and for a series of other services to 5N Plus Inc., including distribution of this report, investor relations and networking services.

Aside from certain reports published on a periodic basis, the large majority of reports are published by Arrowhead BID at irregular intervals as appropriate in the analyst's judgment. Any opinions expressed in this report are statements of our judgment to this date and are subject to change without notice.

This report was prepared for general circulation and does not provide investment recommendations specific to individual investors. As such, any of the financial or other money-management instruments linked to the company and company valuation described in this report, hereafter referred to as "the securities", may not be suitable for all investors.

Investors must make their own investment decisions based upon their specific investment objectives and financial situation utilizing their own financial advisors as they deem necessary.

Investors are advised to gather and consult multiple information sources before making investment decisions. Recipients of this report are strongly advised to read the information on Arrowhead Methodology section of this report to understand if and how the Arrowhead Due Diligence and Arrowhead Fair Value Bracket integrate alongside the rest of their stream of information and within their decision taking process.

Past performance of securities described directly or indirectly in this report should not be taken as an indication or guarantee of future results. The price, value of, and income from any of the financial securities described in this report may rise as well as fall, and may be affected by simple and complex changes in economic, financial and political factors.

Should a security described in this report be denominated in a currency other than the investor's home currency, a change in exchange rates may adversely affect the price of, value of, or income derived from the security.

This report is published solely for information purposes, and is not to be considered as an offer to buy any security, in any state.

Other than disclosures relating to Arrowhead Business and Investment Decisions, LLC, the information herein is based on sources we believe to be reliable but is not guaranteed by us and does not purport to be a complete statement or summary of the available data.

Arrowhead Business and Investment Decisions, LLC is not responsible for any loss, financial or other, directly or indirectly linked to any price movement or absence of price movement of the securities described in this report.

## Valuation

### WACC

Risk-free rate	2.2%	xv
Beta	0.9	xvi
Risk premium	7.8%	xvii
Additional Risk Premium	0.0%	xviii
Cost of Equity	8.9%	
Terminal Growth Rate	0.0%	

	Revenue Growth	EBITDA Margins
Max value	<i>Please refer to the Key Variable Section</i>	
Min value		

### FCFE (High) Time Period

	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E
EBITDA	27,781	30,088	32,588	48,669	51,772	55,074	58,588	62,327	66,306
Tax	(7,473)	(8,094)	(8,766)	(13,092)	(13,927)	(14,815)	(15,760)	(16,766)	(17,836)
Capital Expenditure	(7,181)	(6,879)	(6,649)	(6,442)	(6,258)	(6,097)	(5,957)	(5,840)	(5,744)
<b>Free Cash Flow</b>	<b>13,127</b>	<b>15,116</b>	<b>17,173</b>	<b>29,135</b>	<b>31,587</b>	<b>34,162</b>	<b>36,870</b>	<b>39,721</b>	<b>42,725</b>
<b>Present Value of FCF</b>	<b>12,322</b>	<b>13,025</b>	<b>13,584</b>	<b>21,155</b>	<b>21,054</b>	<b>20,903</b>	<b>20,710</b>	<b>20,481</b>	<b>20,223</b>

### FCFE (Low) Time Period

	2018E	2019E	2020E	2021E	2022E	2023E	2024E	2025E	2026E
EBITDA	25,695	27,636	29,723	45,656	48,287	51,071	54,016	57,133	60,431
Tax	(6,912)	(7,434)	(7,995)	(12,281)	(12,989)	(13,738)	(14,530)	(15,369)	(16,256)
Capital Expenditure	(7,181)	(6,879)	(6,649)	(6,442)	(6,258)	(6,097)	(5,957)	(5,840)	(5,744)
<b>Free Cash Flow</b>	<b>11,602</b>	<b>13,323</b>	<b>15,078</b>	<b>26,932</b>	<b>29,039</b>	<b>31,236</b>	<b>33,529</b>	<b>35,924</b>	<b>38,430</b>
<b>Present Value of FCF</b>	<b>10,891</b>	<b>11,480</b>	<b>11,927</b>	<b>19,556</b>	<b>19,356</b>	<b>19,113</b>	<b>18,833</b>	<b>18,523</b>	<b>18,190</b>

In the model, the valuation is continued to the year 2028, from which point the terminal value is established. For all data see reference table below:

### Arrowhead Fair Value Bracket

<i>in USD '000, unless otherwise stated</i>	High	Low
<b>Implied Enterprise value</b>	<b>263,550</b>	<b>236,501</b>
+ Cash <sup>xix</sup>	34,024	34,024
<b>Equity Value Bracket (USD' 000)</b>	<b>297,574</b>	<b>270,525</b>
USD/CAD <sup>xx</sup>	1.29	1.29
<b>Equity Value Bracket (CAD' 000)</b>	<b>383,870</b>	<b>348,978</b>
Shares Outstanding (in millions) <sup>xxi</sup>	83.7	83.7
<b>Fair Value Bracket (CAD)</b>	<b>4.59</b>	<b>4.17</b>
Current Market Price (CAD)	2.93	2.93

## Notes and References

- i Arrowhead Business and Investment Decisions (ABID) Fair Value Bracket. See information on valuation on pages 24-28 of this report and important disclosures on page 27 of this report
- ii Bloomberg as on 05-April-2018
- iii Bloomberg as on 05-April-2018
- iv 30-day average volume from Bloomberg as on 05-April-2018
- v Bloomberg as on 05-April-2018
- vi <http://www.lenntech.com/periodic/elements/bi.htm#ixzz4XLRwe7dJ>  
<http://scienceviews.com/geology/bismuth.html>  
<http://www.persistencemarketresearch.com/mediarelease/bismuth-market.asp>
- vii <http://www.lenntech.com/periodic/elements/ga.htm>  
<https://minerals.usgs.gov/minerals/pubs/commodity/gallium/mcs-2016-galli.pdf>  
[http://www.bgr.bund.de/EN/Themen/Min\\_rohstoffe/Downloads/studie\\_Li\\_Ga\\_en.pdf?\\_\\_blob=publicationFile&v=4](http://www.bgr.bund.de/EN/Themen/Min_rohstoffe/Downloads/studie_Li_Ga_en.pdf?__blob=publicationFile&v=4)
- viii <http://www.livescience.com/29520-germanium.html>  
<https://minerals.usgs.gov/minerals/pubs/commodity/germanium/mcs-2016-germa.pdf>
- ix <https://minerals.usgs.gov/minerals/pubs/commodity/indium/myb1-2014-indiu.pdf>  
<http://www.businesswire.com/news/home/20160826005015/en/Top-5-Vendors-Indium-Tin-Oxide-Market>
- x <https://minerals.usgs.gov/minerals/pubs/commodity/selenium/myb1-2014-selen.pdf>  
<http://ibm.gov.in/writereaddata/files/07092014130755IMYB-2012-Selenium%20and%20Tellurium.pdf>
- xi <http://www.rsc.org/periodic-table/element/52/tellurium>  
<http://ibm.gov.in/writereaddata/files/07092014130755IMYB-2012-Selenium%20and%20Tellurium.pdf>
- xii <http://www.lenntech.com/periodic/elements/cd.htm>  
<https://en.wikipedia.org/wiki/Cadmium>
- xiii <https://minerals.usgs.gov/minerals/pubs/commodity/tin/mis-201601-tin.pdf>  
[https://www.itri.co.uk/index.php?option=com\\_mtree&task=att\\_download&link\\_id=55516&cf\\_id=24](https://www.itri.co.uk/index.php?option=com_mtree&task=att_download&link_id=55516&cf_id=24)
- xiv <http://www.lenntech.com/periodic/elements/zn.htm>  
<http://www.chemistryexplained.com/elements/T-Z/Zinc.html>
- xv Bloomberg as on 05-April-2018
- xvi Bloomberg as on 05-April-2018
- xvii Bloomberg as on 05-April-2018
- xviii Arrowhead estimates
- xix Company's cash and cash equivalents (incl. Research and development tax incentive receivable) as at 30<sup>th</sup> September 2017
- xx Bloomberg as on 05-April-2018
- xxi Bloomberg as on 05-April-2018