

**UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549
FORM 10-K**

(Mark One)

ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the fiscal year ended December 31, 2019

OR

TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the transition period from _____ to _____
Commission File Number: 001-38221

PQ Group Holdings Inc.

Delaware

(State or other jurisdiction of
incorporation or organization)

81-3406833

(I.R.S. Employer
Identification No.)

300 Lindenwood Drive

Malvern, Pennsylvania

(Address of principal executive offices)

19355

(Zip Code)

(610) 651-4400

(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Trading symbol	Name of each exchange on which registered
Common stock, par value \$0.01 per share	PQG	New York Stock Exchange

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes No

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes No

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes No

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes No

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Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of “large accelerated filer,” “accelerated filer,” “smaller reporting company,” and “emerging growth company” in Rule 12b-2 of the Exchange Act.

Large accelerated filer	<input checked="" type="checkbox"/>	Accelerated filer	<input type="checkbox"/>
Non-accelerated filer	<input type="checkbox"/>	Smaller reporting company	<input type="checkbox"/>
		Emerging growth company	<input type="checkbox"/>

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act.

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Act). Yes No

The aggregate market value of PQ Group Holdings Inc. voting and non-voting common equity held by non-affiliates as of June 28, 2019 (the last business day of the registrant’s most recently completed second fiscal quarter) based on the closing sale price of \$15.85 per share as reported on the New York Stock Exchange was \$645,970,269.

The number of shares of common stock outstanding as of February 21, 2020 was 136,790,094.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the PQ Group Holdings Inc. Proxy Statement for the 2020 Annual Meeting of Stockholders are incorporated by reference into Part III of this report.

PQ GROUP HOLDINGS INC.

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PART I

Forward-looking Statements

This Annual Report on Form 10-K (“Form 10-K”) includes statements that express our opinions, expectations, beliefs, plans, objectives, assumptions or projections regarding future events or future results and therefore are, or may be deemed to be, “forward-looking statements” within the meaning of the Private Securities Litigation Reform Act of 1995 (the “Act”). The following cautionary statements are being made pursuant to the provisions of the Act and with the intention of obtaining the benefits of the “safe harbor” provisions of the Act. The words “believe,” “may,” “will,” “estimate,” “continue,” “anticipate,” “intend,” “expect,” “should” and similar expressions are intended to identify forward-looking statements. We have based these forward-looking statements largely on our current expectations and projections about future events and financial trends that we believe may affect our financial condition, results of operations, business strategy, short- and long-term business operations and objections, and financial needs. Examples of forward-looking statements include, but are not limited to, statements we make regarding our liquidity, including our belief that our current level of operations, cash and cash equivalents, cash flow from operations and borrowings under our credit facilities and other lines of credit will provide us adequate cash to fund the working capital, capital expenditure, debt service and other requirements for our business for the foreseeable future. These forward-looking statements are subject to a number of risks, uncertainties and assumptions. Moreover, we operate in a very competitive and rapidly changing environment and new risks emerge from time to time. It is not possible for our management to predict all risks, nor can we assess the impact of all factors on our business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements we may make. In light of these risks, uncertainties and assumptions, the forward-looking events and circumstances discussed herein may not occur and actual results could differ materially and adversely from those anticipated or implied in the forward-looking statements. Some of the key factors that could cause actual results to differ from our expectations include risks related to:

- our exposure to local business risks and regulations in different countries;
- general economic conditions;
- exchange rate fluctuations;
- legal and regulatory compliance;
- significant developments relating to the U.S. administration, U.S. courts’ or the United Kingdom’s exit from the European Union;
- technological or other changes in our customers’ products;
- our and our competitors’ research and development;
- fluctuations in prices of raw materials and relationships with our key suppliers;
- substantial competition;
- non-payment or non-performance by our customers;
- reliance on a small number of customers;
- potential early termination or non-renewal of customer contracts in our Refining Services segment;
- reductions in highway safety spending or taxes earmarked for highway safety spending;
- seasonal fluctuations in demand for some of our products;
- retention of certain key personnel;
- realization of our growth projects;
- potential product liability claims;
- existing and potential future government regulation;
- the extensive environmental, health and safety regulations to which we are subject;
- disruption of production and distribution of our products;
- risk of loss beyond our available insurance coverage;
- product quality;
- successful integration of acquisitions;
- our joint venture investments;
- our failure to protect our intellectual property and infringement on the intellectual property rights of third parties;
- information technology risks;
- potential labor disruptions;
- litigation and other administrative and regulatory proceedings; and
- our substantial indebtedness.

The forward-looking statements included herein are made only as of the date hereof. You should not rely upon forward-looking statements as predictions of future events. Although we believe that the expectations reflected in the forward-looking statements are reasonable, we cannot guarantee that the future results, levels of activity, performance or events and circumstances reflected in the forward-looking statements will be achieved or occur. Moreover, neither we nor any other person assumes responsibility for the accuracy and completeness of the forward-looking statements. We undertake no obligation to update publicly any forward-looking statements for any reason after the date of this Form 10-K to conform these statements to actual results or to changes in our expectations.

ITEM 1. BUSINESS.

PQ Group Holdings Inc. (“PQ Group Holdings” or the “Company”) was incorporated in Delaware on August 7, 2015. PQ Holdings Inc. (“PQ Holdings”), a manufacturer of specialty catalysts, materials, chemicals and services, was incorporated in Delaware on June 22, 2007. Founded in 1831, our business has a nearly 200-year history of innovation, enabling environmental improvements in fuel efficiency and emissions, safer highway and airport travel, and healthier personal care products, while improving the sustainability of our planet. On May 4, 2016, we consummated a series of transactions (the “Business Combination”) to reorganize and combine the businesses of PQ Holdings and Eco Services Operations LLC under a new holdings company, PQ Group Holdings. On October 3, 2017, PQ Group Holdings completed its initial public offering (“IPO”). Our common stock is listed on the New York Stock Exchange under the stock ticker “PQG”. Unless the context otherwise indicates, the terms “PQ Group Holdings Inc.,” “we,” “us,” “our,” or the “Company” mean PQ Group Holdings Inc. and our subsidiaries.

Our Company

We are an integrated global provider of specialty catalysts, materials, chemicals and services that enable environmental improvements, enhance consumer and industrial products, and improve personal safety. Our value-added products seek to address global demand trends that are often either the subject of significant environmental and safety regulations or are driven by consumer preferences for environmentally friendlier alternative products, which provides us with high-margin growth opportunities. Specifically, our products and solutions help companies produce vehicles with improved fuel efficiency and cleaner emissions. Our materials are critical ingredients in consumer products that make teeth brighter and skin softer. We produce highly engineered materials that make highways and airports safer for drivers and pilots. Because our products are predominantly inorganic and carbon-free, we believe we contribute to improving the sustainability of our planet.

We believe we are a leader in each of our business segments, holding what we estimate to be a number one or number two supply share position for products that generated more than 90% of our 2019 sales. We believe that our global footprint and efficient network of strategically located manufacturing facilities provide us with a strong competitive advantage in serving our customers both regionally as well as globally.

We believe, with our long history of established partnerships with our customers and our reputation for providing reliable, quality of products and solutions, our products deliver significant value to our customers, as demonstrated by our profit margins. Our products typically constitute a small portion of our customers’ overall end-product costs yet are critical to product performance.

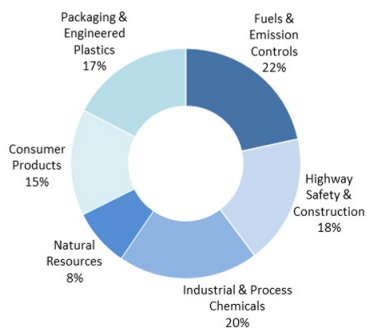
We have a near 200-year track record of innovation that is reflected in our technical and production expertise in silicates, silica, zeolites, glass and catalyst technologies.

We are highly diversified by business, geography and end use. In 2019 the majority of our sales were for applications that have historically had relatively predictable, consistent demand patterns driven by consumption or frequent replacement cycles.

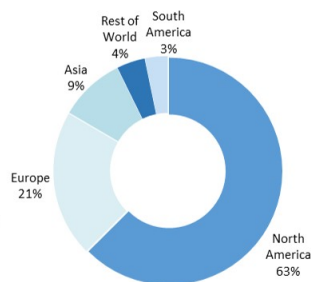
As a result of our competitive strengths, we have generally maintained stable margins through changing macro economic cycles.

In 2019, we served over 4,000 customers globally across many end uses and, as of December 31, 2019, operated 70 manufacturing facilities which are strategically located across six continents.

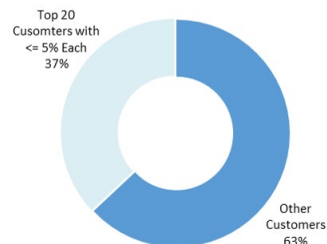
**2019 Sales and Zeolyst Joint Venture
Total Sales by End Use⁽¹⁾**



**2019 Sales and Zeolyst Joint Venture
Total Sales by Destination Geography^(1,2)**



**2019 Sales and Zeolyst Joint Venture
Total Sales by Customer⁽¹⁾**



(1) Percentage calculations include \$170.3 million of total sales attributable to the Zeolyst Joint Venture (“Zeolyst JV”), which represents 50% of its total sales for the year ended December 31, 2019. The Zeolyst JV sales are included in both the Fuels & Emission Controls and Packaging & Engineered Plastics end uses. Refer to “Management’s Discussion and Analysis of Financial Condition and Results of Operations—Basis of Presentation” for a description of the treatment of the Zeolyst Joint Venture in our consolidated financial information.

(2) Based on the delivery destination for products sold in 2019.

Our Strategy

We intend to capitalize on our strong business foundation, market-based approach, and experienced management team to grow sales profitably, maintain high margins, deploy capital efficiently and generate free cash flow in order to create shareholder value. We believe that our long history of operational excellence and proven reliability, technology leadership, strong customer relationships, innovation track record and consistent business execution developed from our almost two centuries of combined industry experience positions us well to execute our business strategy.

Our Industry

Our industry is characterized by constant development of new products and the need to support customers with new product innovation and technical services to meet their needs, coupled with consistent product quality and a reliable source of supply in a safe and environmentally sustainable manner. Products sold to our customers can be high value-add even when they represent a small portion of the overall end product costs, and success can be achieved by helping customers improve their product performance, value, and quality. As a result, operating margins in this sector have historically been high and generally stable through economic cycles. In addition, many products in the specialty chemicals and materials industry benefit from economics that favor incumbent producers because the capital cost to expand existing capacity is typically significantly less than the capital cost necessary to build a new plant. The combination of attractive operating margins and generally predictable maintenance capital expenditure requirements can produce attractive cash flows.

Our End Markets

The table below summarizes our key end use applications and products as well as the significant growth drivers in those applications.

Key End Uses	Sales and Zeolyst JV Total Sales ⁽¹⁾			Significant Growth Drivers	Key PQ Products
	2019	2018	2017		
Fuels & Emission Controls	22%	21%	21%	<ul style="list-style-type: none"> Global regulatory requirements to: <ul style="list-style-type: none"> Remove nitrogen oxides from emissions Remove sulfur from diesel and gasoline Increase gasoline octane in order to improve fuel efficiency while lowering vapor pressure to regulated levels Improve lubricant characteristics to improve fuel efficiencies 	<ul style="list-style-type: none"> Refinery catalysts Emission control catalysts Catalyst recycling services Silicate for catalyst manufacturing
Consumer Products	15%	16%	16%	<ul style="list-style-type: none"> Substitution of silicate materials for less environmentally friendly chemical additives in detergent and cleaning end uses Demand for improved quality and shelf life of beverages Demand for improved oral hygiene and appearance 	<ul style="list-style-type: none"> Silica gels for edible oil and beer clarification Precipitated silicas and zeolites for the surface coating, dentifrice, and dishwasher and laundry detergent applications
Highway Safety & Construction	18%	19%	17%	<ul style="list-style-type: none"> Demand for enhanced "dry and wet" visibility of road and airport markings to improve safety Drive for weight reduction in cements 	<ul style="list-style-type: none"> Reflective markings for roadways and airports Hollow glass beads, or microspheres, for cement additives
Packaging & Engineered Plastics	17%	17%	17%	<ul style="list-style-type: none"> Demand for increased process efficiency and reduction of by-products in production chemicals Demand for high-density polyethylene lightweighting of automotive components Enhanced properties in plastic composites for the automotive and electronics industries 	<ul style="list-style-type: none"> Catalysts for high-density polyethylene and chemicals syntheses Antiblocks for film packaging Solid and hollow microspheres for composite plastics
Industrial & Process Chemicals	20%	20%	21%	<ul style="list-style-type: none"> Demand in the tire industry for reduced rolling resistance Usage of silicate in municipal water treatment to inhibit corrosion in aging pipelines Growth in manufacturing North America driving demand for metal finishing 	<ul style="list-style-type: none"> Silicate precursors for the tire industry Glass beads, or microspheres, for metal finishing end uses
Natural Resources	8%	7%	8%	<ul style="list-style-type: none"> More environmentally friendly drilling fluids for oil and gas production Recovery in global oil drilling/U.S. copper production Growing demand for lighter weight cements in oil and natural gas wells 	<ul style="list-style-type: none"> Silicates for drilling muds Sulfuric acid for mining Microspheres for oil well cements Silicates and alum for water treatment mining Bleaching aids for paper

⁽¹⁾ Percentage calculations include \$170.3 million, \$156.7 million and \$143.8 million of total sales attributable to the Zeolyst JV, which represents 50% of its total sales for each of the years ended December 31, 2019, 2018 and 2017, respectively. The Zeolyst JV sales are included in both the Fuels & Emission Controls and Packaging & Engineered Plastics key end uses. Refer to "Management's Discussion and Analysis of Financial Condition and Results of Operations—Basis of Presentation" for a description of the treatment of the Zeolyst Joint Venture in our consolidated financial information.

Competitive Business Strengths

Favorable Secular Growth Trends Across the Portfolio

We focus on serving end use applications where we believe significant future growth potential exists. Our products address our customers' needs, which are typically driven either by regulatory requirements or consumer preferences, on a global basis. In addition, our product sales and development efforts are driven by regional infrastructure and development trends. In 2019, a majority of our sales were to end uses such as fuels and emission controls, consumer products, and highway safety that generally do not exhibit as much cyclicity as other applications. We believe that our products incorporate innovative environmental and safety solutions to address evolving customer demands, examples of which include the following:

Increased use of plastics as a substitute for heavier and less versatile materials, such as glass and metal, is driving increased global demand for polyethylene capacity expansions and production. Further, we are seeing expansions shift towards silica-based technology, which we believe will drive growth for our Silica Catalysts product group within our Catalysts segment.

Light- and heavy-duty diesel engines are subject to a broad set of regulatory requirements and are subject to increasingly strict standards. We believe these trends present global opportunities for the Zeolyst Joint Venture to support our customers in meeting these standards through our sales of emission control catalysts. While the US Environmental Protection Agency and European Union have led other nations in terms of standards that limit the amount of nitrogen oxides, carbon dioxide and other emissions for diesel engines, other emerging regions are expected to implement similar standards, specifically China, with the China VI (equivalent to Euro VI) emission standard starting in 2020.

Given stringent fuel efficiency standards that are driving the design of new engines and the resulting higher-octane gasoline requirements that can be achieved through alkylate blending, we believe that our Refining Services segment is well positioned to benefit from any related growth in demand for alkylates.

We believe that additional demand and higher visibility standards for retroreflectivity for roadway and aviation markings will continue to benefit our Performance Materials segment. We benefit from increased use and density per mile of road markings that include our products. As an example, some states and municipalities are instituting wider highway striping lines.

We also believe we have opportunities to displace other less environmentally friendly materials for industrial and consumer good applications through our Performance Chemicals segment. Most of our products are manufactured from commonly found materials such as industrial sand and soda ash, which are more environmentally friendly than carbon-based products.

Leading Supply Positions

We believe that we maintain a leading supply position for certain products sold within each of our segments, holding what we estimate to be the number one or two supply share position in 2019 for products that generated more than 90% of our sales. We believe that our global footprint and efficient network of strategically located manufacturing facilities provides us with a strong competitive advantage in serving our customers both globally and regionally, and that it would be costly for our competitors to replicate our network.

In our Catalysts segment, we primarily compete on a global basis. We are a leading supplier of refinery hydrocracking finished and support catalysts used to remove sulfur, and emission control catalysts used in the heavy- and light-duty diesel industries to reduce nitrogen oxide emissions. We are also a global supplier of silica catalysts and supports for polyethylene manufacturers and the exclusive supplier of methyl methacrylate ("MMA") catalysts used in the patented Alpha process practiced by a global MMA leader.

In our Refining Services segment, we hold an estimated number one supply share position in the United States in sulfuric acid regeneration based on 2019 sales volume of greater than 50%.

In both our Performance Materials segment and Performance Chemicals segment, we are a leading supplier in the United States, Europe and Latin America, and largely support customers with regional and local production due to costs of shipping. For the Performance Chemicals segment, we estimate that we had at least two times the sodium silicate supply share of our nearest competitor based on 2019 sales volume.

Innovation Track Record

A key competitive advantage is derived from our depth of expertise in silicates, silica, zeolites, glass and catalysts technologies. Further, we have the ability to tailor and scale specialty grades to meet changing demands and technical support for large scale commercialization. Many of our products require close customer collaboration to address constantly evolving customer application challenges. Given the long lead-time required for product development and commercialization, which can be up to ten years, we work closely and build long-term relationships with our customers. In many cases, our relationships have spanned decades given our ability to meet customized specifications and performance characteristics while also maintaining strict quality standards.

These long-term relationships have allowed us to innovate together with our customers to meet evolving demands. For example, we have developed zeolite-based catalysts that are an effective and efficient method to reduce pollutants from heavy- and light-duty diesel engines and enable our customers to meet increasingly stringent vehicle emission standards worldwide. In personal care applications, we have collaborated with leading consumer products companies over a number of years to develop a family of gentle silica-based dentifrice abrasives that produce more effective cleaning toothpastes. In addition, our proprietary silica catalyst has enabled development of a high strength high-density polyethylene (“HDPE”) resin that is used for making lightweight plastic gasoline tanks for automobiles.

Long-Term, High-Quality Customer Relationships

We collaborate with leading multinational companies that often seek global solutions. Our customers include large industrial companies such as BASF, Honeywell, and 3M, and global catalyst producers such as Albemarle and W.R. Grace. We also supply catalysts to leading chemical and petrochemical producers such as BASF, Dow Chemical, Lucite, LyondellBasell, and Shell. We supply personal care ingredients and additives to leading consumer products companies such as Unilever and Colgate-Palmolive. We have long-term relationships with our top ten customers, based on 2019 sales, that average more than 50 years. In addition, our customer base is diversified, with our top ten customers in 2019 representing approximately 25% of our sales for the year ended December 31, 2019 and no customer representing more than 4% of our sales during this period.

Secured Contractual Pass-through of Raw Material Costs Support Stable Margins

We have been able to mitigate the impact of raw material or energy price volatility using a variety of mechanisms, including hedging and raw material cost pass-through clauses in our sales contracts and other adjustment provisions. For the year ended December 31, 2019, approximately 30% of our Performance Chemicals sales (mostly comprised of sodium silicate sales) were derived from contracts that included raw material pass-through clauses. Most of our Refining Services contracts feature minimum volume protection and/or quarterly price adjustments for items such as commodity inputs, labor, the Chemical Engineering Plant Cost Index and natural gas. In 2019, approximately 90% of our Refining Services segment sales were sold under contracts that included some form of raw material pass-through clause. These price adjustments generally reflect our Refining Services actual cost structure in producing sulfuric acid, and tend to provide us with some protection against volatility in labor, fixed costs and raw material pricing. Freight expenses are generally passed through directly to customers.

Our products are predominantly inorganic and carbon-free, and are produced from readily available raw materials such as industrial sand and soda ash, which prices have historically been less volatile than oil. We also use natural gas in our furnaces where our North American facilities have benefited from the plentiful supplies of shale gas. In addition, we have long-term supply contracts with many of our key raw materials suppliers across all our business segments.

Long Term Customer Contracts Enhance Sales Predictability and Stability

We partner with many of our customers under long-term contract agreements, mutually exclusive product supply arrangements and/or specified products for certain license production processes. In our Refining Services segment, approximately 50% of our production capacity serves customers with staggered five to ten year “take or pay” contracts with potential for value pricing resets and cost pass-through for our regeneration services product line that enhances sales and margin predictability and stability. Excluding contracts with automatic evergreen provisions, approximately 60% of our sulfuric acid volume for the year ended December 31, 2019 was under contracts expiring at the end of 2020 or beyond.

In our Catalysts segment, we are either the sole or dual supplier to key global customers under various term agreements up to 10 years for each of polyolefin catalysts and silica catalysts supports. Further, we are an exclusive multi-year supplier of MMA catalyst to a leading global producer. In our zeolite catalysts product group, we operate with a mix of evergreen

and various term contracts depending on the product customization with value pricing ranging from 1 to 3 years to supply catalysts and zeolite powders for the refining, petrochemical and chemical industries and nitrogen oxide control catalysts for diesel transportation industries. These terms, in line with industry standards, provide us with flexibility in satisfying customers. Our Performance Chemicals segment operates under key customer supply contracts with material cost pass-through ranging from 1 to 5 years, largely depending on terms for customer demand given regional and/or product solution needs.

Strategic and Differentiated Manufacturing Know-how and Supply Chain Global Network

Our manufacturing platform is based on furnace technology and proprietary knowledge developed from almost two centuries of combined experience applying silicates chemistry production and the development of applications across a broadening set of end uses. All of our segments produce materials through our furnace process, other than our silica catalysts and zeolite catalysts product groups, which are derivatives of our Performance Chemicals segment. We believe we have a differentiated capability around furnace operations that enables us to operate more efficiently than most of our competitors.

Stable Margins and Cash Flow Generation Across Changing Macroeconomic Cycles

We have demonstrated the ability to maintain stable margins while continuing to grow in different macroeconomic environments given secular trends supporting many of our business segments. We believe that the stability of our margins and cash flows is also aided by long term sales contracts and material cost pass-through. Our ability to enter into favorable contracts and terms with customers is driven by our long history of collaborative relationships and track record of providing value-added products and services. We believe that our value-added products and services have proven to be critical to the performance of our customers' products, and typically represent only a small portion of our customers' overall end-product costs.

Our cash flow generation has been driven, in part, by our disciplined capital investment as well as tax attributes that provide us with cash flow benefits. As of December 31, 2019, we had \$245.1 million of net operating losses for U.S. federal income tax purposes, along with related net operating losses for state tax purposes, and \$293.6 million of tax deductible intangibles and goodwill with respect to Eco Services Operations LLC, both of which provide us with cash tax savings as we generate taxable income.

Our Business Segments

We are an integrated, global provider of specialty catalysts, materials, chemicals and services that share common end uses, manufacturing techniques, and process technology. We conduct operations through four reporting segments: (1) Refining Services, (2) Catalysts (including our 50% interest in the Zeolyst Joint Venture), (3) Performance Materials and (4) Performance Chemicals.

The table below summarizes certain information regarding our four reporting segments for the year ended December 31, 2019.

Segments and Product Groups	Year ended December 31, 2019						
	Sales	% of Total Sales	Zeolyst Joint Venture Sales ⁽¹⁾	% of Total Sales and Zeolyst Joint Venture Sales ⁽¹⁾⁽²⁾	Net Income	Adjusted EBITDA ⁽¹⁾	% of Total Adjusted EBITDA ⁽¹⁾⁽³⁾
(in millions, except percentages)							
Refining Services	\$ 447.1	28.5 %	\$ —	25.7 %	\$ 175.6	34.1 %	
Catalysts	85.7	5.5 %	—	4.9 %	107.8	21.0 %	
Zeolite Catalyst	—	— %	170.3	9.8 %			
Performance Materials	363.0	23.2 %	—	20.9 %	76.7	14.9 %	
Performance Chemicals	685.1	43.7 %	—	39.4 %	154.3	30.0 %	
Eliminations	(13.8)	(0.9)%	—	(0.8)%			
Subtotal	\$ 1,567.1	100.0 %	\$ 170.3	100.0 %			
Corporate					(40.1)		
Total	\$ 1,567.1	100.0 %	\$ 170.3	100.0 %	\$ 79.5	\$ 474.3	100.0%

(1) Percentage calculations include \$170.3 million of total sales attributable to the Zeolyst JV, which represents 50% of its total sales for the year ended December 31, 2019. The Adjusted EBITDA of our Catalysts segment includes our 50% portion of the Adjusted EBITDA of our Zeolyst JV. Refer to “Management’s Discussion and Analysis of Financial Condition and Results of Operations—Basis of Presentation” for a description of the treatment of the Zeolyst Joint Venture in our consolidated financial information.

(2) Percentage calculations exclude \$13.8 million in intersegment sales eliminations.

(3) Percentage calculations exclude \$40.1 million in corporate expenses.

Refining Services

Our Refining Services segment is a leading provider of sulfuric acid recycling (Regeneration Services) and end-to-end logistics to North American refineries for the production of alkylate, a high value gasoline blending component required for meeting gasoline specifications and producing premium grade fuel. We are also a leading North American producer of on-purpose virgin sulfuric acid for water treatment, mining, and industrial applications. By providing regeneration services, as well as purchasing by-product sulfur from customers as a source of energy and for use in manufacturing virgin sulfuric acid, we believe that we provide our refining customers with a complete solution for their sulfuric acid needs.

Trends for increased alkylate production are being driven by: rising demand for premium gasoline used in smaller, more efficient turbocharged engines, which requires higher octane rated gasoline with an alkylate content of approximately 35%-45%, as compared to the 12% alkylate content in regular gasoline; the need for more alkylate to meet the minimum octane ratings in regular gasoline following the continued significant share growth of shale oil refining in the U.S.; the full implementation of Tier 3 gasoline sulfur standards in the United States anticipated for 2020, which will require the blending of additional low sulfur high octane gasoline components such as alkylate; and rising gasoline exports, which generally contain no ethanol and will generally require more alkylate to replace the ethanol in order to meet the minimum octane requirements for the destination countries.

Our Refining Services segment is highly regionalized due to shipping costs and our customer integration requirements. Our network of facilities is concentrated in the Gulf Coast and the state of California, where approximately 60% of the United States refining capacity is located. The strategic locations of our plants in these key refining regions contribute to our highly efficient supply chain networks with our customers, including in some cases captive pipelines connecting us to our refinery customers. Alternatively, product can be shipped by barge, rail and truck.

Our primary product groups include Regeneration Services and Virgin Sulfuric Acid.

Regeneration Services serves a critical need for refining customers. Sulfuric acid serves as a catalyst in the alkylation process. The resulting spent sulfuric acid needs to be regenerated, which is no longer a core competency of most refiners. Since storage space for fresh and spent acid is typically limited, and the cost to refineries of interruption to their alkylation units would be significant, refineries seek to have a continuous and reliable source of supply for sulfuric acid.

Our end-to-end regeneration service offering takes the spent acid from the refinery, through our network of plants and transportation systems, and regenerates the acid into a high strength fresh acid for reuse in the alkylation process. Because of the number and strategic locations of our plants, and the breadth of our transportation logistics, we believe we bring the highest reliability and flexibility to our refining customers, allowing them to focus on their core competency by optimizing their alkylation capacity.

Virgin sulfuric acid is created either through the burning of sulfur in furnaces, or as a by-product of other industrial processes, primarily the smelting of copper and other base metals. We produce a range of high quality virgin sulfuric acid products by burning sulfur in our plants for supply into a diverse set of end uses. Sulfur-burned acid is generally considered to be of higher purity and quality than smelter-produced acid and, as a result, smelter-produced acid is not suitable for some industrial users including several of our larger customers who require higher quality and differentiated sulfuric acid products, such as super-saturated sulfuric acid (oleum) and other high purity specialty acids. Virgin sulfuric acid is produced at all of our facilities utilizing the same production equipment as our regeneration services.

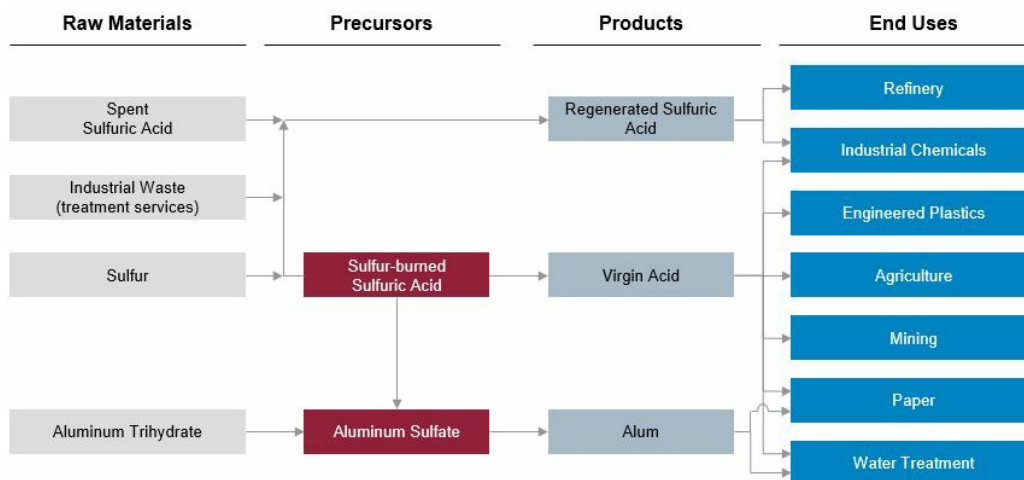
Competition

Given our strategic presence on the Gulf Coast and in California, and our relationships with leading refineries, we estimate that our regenerated sulfuric acid supply share is substantially larger than our closest competitor. We compete in the North American refining services industry with competitors such as Chemtrade and Veolia. We compete on the basis of price, reliability, and responsiveness to changes in customer demand, which is a function of scale, proximity to customer locations and operational expertise. We believe that we benefit from industry economics that favor incumbent producers because the capital cost and regulatory challenges to expand existing capacity are typically significantly less than to build a new plant. In addition, existing robust supply chains, including captive pipeline connections and other transportation logistics add to the competitive advantages available to incumbent producers. As a result, we believe that our integrated and strategically located network of facilities and end-to-end logistics assets in the United States provide us with a significant competitive advantage and would be costly for our competitors to replicate.

Manufacturing

We produce regenerated sulfuric acid and virgin sulfuric acid through our furnace operations. Regenerated sulfuric acid is produced by thermally decomposing the spent acid in our furnace into a clean gas stream which is converted into sulfuric acid. Virgin sulfuric acid is produced by burning sulfur and certain sulfur-rich components at high temperatures within a furnace. The chart below summarizes the manufacturing platform for our Refining Services segment.

Refining Services Manufacturing Platform



Catalysts

We are a leading global provider of customized and innovative catalyst products and process solutions to leading producers and licensors of polyethylene, or PE, and methyl methacrylate, or MMA. Our finished silica-based catalysts and catalyst supports are necessary to produce high strength and high stiffness plastics used in packaging films, bottles, containers, and other molded applications. Global consumer demand for high strength lightweight plastics is expected to continue in the near to medium term driving increased production capacity expansions. Our zeolite-based emission control catalysts enable the removal of nitrogen oxides from diesel engine emissions as well as sulfur dioxide from fuels during the refining process. The continued expansion of stricter global regulations for reducing sulfur in all fuel pools is expected to drive the ongoing demand for our products.

Our product groups include Silica Catalysts and Zeolite Catalysts. Zeolite Catalyst products are sold through the Zeolyst Joint Venture.

Silica Catalysts supplies both the finished catalyst and catalyst supports, which are critical catalyst components for the production of HDPE, a high strength and high stiffness plastic used in bottles, containers, and molded applications and LLDPE used predominately for films. We also produce a catalyst that is used globally for the production of MMA, the monomer for acrylic engineering resins, a clear scratch-resistant plastic used in sheet or molded form to replace glass and as a durable surface coating. Because these catalysts are highly technical and customized for our customers to produce resins with specific properties, they are often covered under long-term supply agreements and, in some cases, we are a customer’s sole source supplier. In addition, we produce silica anti-blocking products that are used to prevent opposite faces of polyolefin and polyester films from adhering to one another during manufacturing and in use.

The Zeolyst Joint Venture, (formed in 1988 specifically as Zeolyst International and Zeolyst C.V., our 50% owned joint venture with Shell Catalysts & Technologies, an affiliate of Royal Dutch Shell plc. or “Shell”), supplies critical high technology specialty zeolite and zeolite-based catalysts to customers in three end-markets: refining (primarily hydrocracking and dewaxing), petrochemicals and emission control systems for both on-road and non-road diesel engines. We also supply custom zeolites to catalyst companies who compete in similar markets. The Zeolyst Joint Venture leverages each partner’s technology and production expertise, including Shell’s expertise in hydrocracking to maximize liquid product yields, especially distillate while at the same time removing sulfur and PQ’s expertise in zeolite technology. We also believe the Zeolyst Joint Venture is a first mover in zeolite fuels and emissions control technology and we expect continued expansion as environmental emissions standards increase globally.

To meet sulfur emission control standards, hydrocracking is the most economic method for refiners while maintaining yields for one of the most profitable product streams. The Zeolyst Joint Venture is the sole supplier of hydrocracking catalysts to Shell, but a majority of sales are to third-party refineries. We also provide precursor supports to many of the hydrocracking catalyst suppliers, positioning us as a leading supplier in the global hydrocracking supply chain.

To meet nitrogen oxides (NOx) emission control regulations that are expanding globally, many of our zeolite powders are used in an advanced emission control technology called selective catalytic reduction, largely focused on heavy duty diesel (HDD) transportation. This process uses ammonia to react with engine exhaust gases via our catalysts in order to convert NOx, a pollutant, into nitrogen and water. We believe that our zeolite catalysts can enable selective catalytic reduction technology to reduce the amount of nitrogen oxides in such exhaust gases by more than 90% and is one of the most cost-effective methods to reduce diesel engine emissions.

Competition

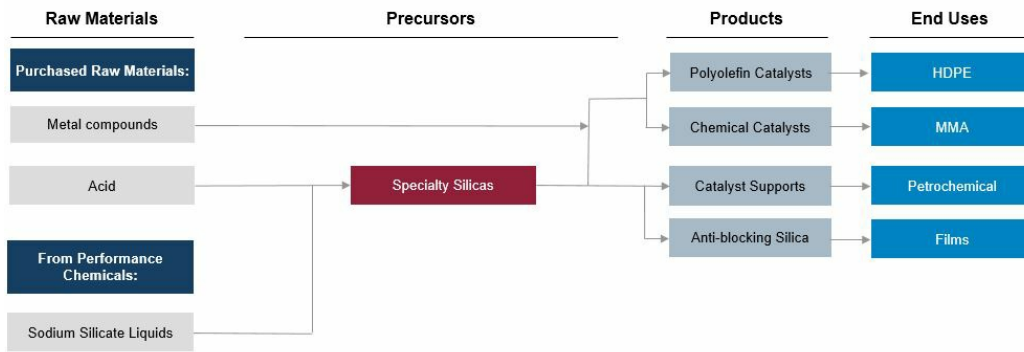
Our Silicia Catalysts product group primarily competes with W.R. Grace. The Zeolyst Joint Venture competes with global catalyst producers such as W.R. Grace, BASF, UOP, Axens, and Haldor Topsoe, while at the same time providing many of them customized zeolite solutions for their product offerings. Some direct competition with niche companies exists, including competitors such as Tosoh and Clariant. We typically compete on the basis of performance, product consistency, reliability, and responsiveness to changes in customer demand.

Manufacturing

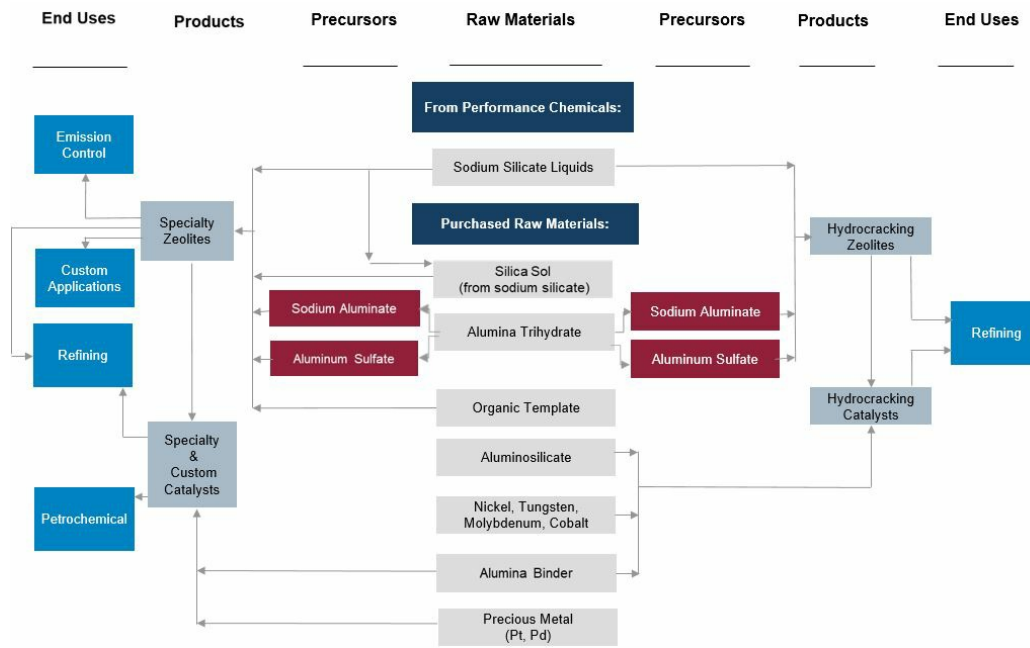
We manufacture our catalyst products using sodium silicate liquids purchased directly from our Performance Chemicals segment or silica sol liquids made by others from Performance Chemicals sodium silicate to make specialty zeolite and silica products. These zeolites and silicas are either used directly to produce catalysts or are sold as precursors to other catalyst manufacturers.

The chart below summarizes the manufacturing platform for our Catalysts segment.

Silica Catalysts Manufacturing Platform



Zeolyst Joint Venture Manufacturing Platform



Performance Materials

Our Performance Materials segment is a global leader in glass microspheres. We are the number one road marking solid bead supplier in North America, Europe and Latin America and number one or two provider of microspheres for a number of highly specialized industrial applications and uses. The segment has innovated for more than 100 years, providing customer solutions for transportation safety and industrial and consumer applications and benefiting from global trends towards increased transportation safety standards and materials substitution.

Our product groups are Transportation Safety and Engineered Glass Materials (EGM).

Transportation safety microspheres are used with a variety of binders, such as paint and epoxy coatings. These microspheres improve retroreflectivity or the visibility of the road markings at night and during inclement weather. Demand growth is driven by routine maintenance and increased spending for both the upgrading of existing roads and the building of new roads around the world. Highway safety budgets in the United States are typically funded by taxes on gasoline and are not typically tied to economic cycles or to state and local government budgeting processes. Microspheres are sold primarily to federal and state government agencies, municipalities, highway contractors, binder manufacturers and airport agencies.

Engineered Glass Materials provide highly specialized solid and hollow microspheres and particles for a variety of uses including strengthening and light-weighting in plastics and polymer additives, environmentally friendly substituting for the cleaning and peening of metal surfaces and for providing conductivity or shielding in electronic applications.

We have a highly efficient global production network to support the reliability of our supply for more than 2,000 customers globally. We have a strong reputation as a supplier of a broad array of differentiated high performance products that meet quality specifications. For transportation safety customers, our strong technical expertise and market knowledge enables us to meet stringent quality and specification requirements by country, state and region. Our supply chain and operational network offers the ability to meet customer demand on short order time frames typically driven by the variability of weather conditions and lack of customer storage. We utilize our engineering expertise to efficiently produce engineered glass materials and highway products on the same manufacturing lines. Our ability to customize to a wide range of specifications allows us to meet stringent performance, size and application requirements while also delivering performance to customers at lower costs than other alternatives.

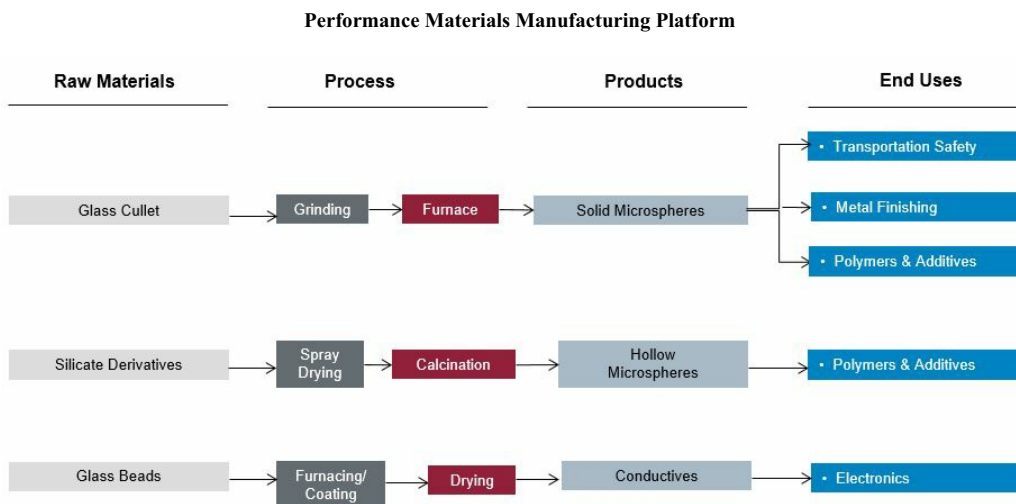
Competition

We primarily compete with regional suppliers including Weissker, Swarco and Allglass and other global producers such as 3M. With our position as a leading global glass producer with operations in North America, Europe, South America and Australia, our network of strategically located manufacturing facilities, and our significant technical expertise, we are able to quickly respond and provide our customers with a broad array of product offerings and solutions at a competitive cost basis. We compete primarily based on performance, product consistency, quality, reliability, and ability to innovate in response to customer demands.

Manufacturing

From either recycled glass, or fresh batch material using our proprietary furnace operations, we produce highly engineered microspheres for highway safety products and industrial and consumer applications. The raw materials are first crushed or mixed. Then they are dried, coated or treated in other ways to meet particular customer and end use specifications. The beads are then bagged and stocked for shipment. The chart below summarizes the manufacturing platform for our Performance Materials segment.

The chart below summarizes the manufacturing platform for our Performance Materials segment.



Performance Chemicals

Our Performance Chemicals segment is a leading global producer of sodium silicates, and downstream specialty silicas as well as other silicate derivative products. These products are used in a wide variety of industrial and consumer applications such as matting agents in surface coatings, clarifying agents for edible oils and beverages, precursors for green tires, additives for dental cleaning and personal care products, and as feedstock for our additives and catalyst platforms. Given our products are derived from quartz sand, which makes them natural and inert materials, we believe they have the environmental and safety profile to address evolving customer demands to replace certain other chemicals. Silicates and silicate derivatives are recognized on the Safer Chemicals Ingredients List of the EPA’s Safer Choice program, which we believe positively impacts our ability to compete in consumer product applications.

Given the breadth of our global infrastructure in terms of scale operations, geographic diversity and production know-how, we are a leading global supplier to key multi-national industrial and consumer product companies. While we are global, our network is highly regionalized in silicate products and strategically located to support customers in a cost effective manner because of the expense of shipping sodium silicates extended distances due to their water content. We believe that we are the only global silicates producer who can supply all of the major regions, excluding China, and we estimate that we hold at least two times the sodium silicates supply share as our nearest competitor based on 2019 sales volume.

Our product groups include Sodium Silicates, Specialty Silicas and Other Silicate Derivatives.

Sodium Silicates have functional attributes that are used as additives and ingredients to enhance product performance as binders, detergent-builders, pH buffers, adhesives or as chemical feedstock and are in extensive diverse customer applications for construction, cleaning, water treatment, pulp & paper, foundry & refractory, green tires, electronics and refining catalysts.

Specialty Silicas are used as ingredients in consumer products such as personal care products, food, edible oils and beer where customers are seeking more environmentally friendly products without loss of effectiveness or performance. In industrial, uses include gloss control in coil, wood, general industrial leather, and other high-performance surface coating applications.

Other Silicate Derivatives include metasilicates, spray dried silicates, and magnesium silicates and potassium silicates which supply diverse uses in cleaning, specialty fertilizer, oil & gas, mining, paints, food, and cosmetics. We also produce zeolites, by reaction with aluminum trihydrate, which are used as builders in detergents and in other applications as stabilizers in the production of polyvinylchloride (PVC) applications.

Competition

In our Performance Chemicals segment, we primarily compete with other global producers such as OxyChem, Grace and Evonik. We believe that we have a leading industry position and technical expertise that provides us with a competitive advantage over competitors who manufacture only in particular end uses. Further, we believe that it would be costly and difficult for a new entrant or existing competitor to replicate our breadth or economies of scale in the production of sodium silicate.

We believe that our network of strategically located manufacturing facilities, with operations in North America, Europe, South America, Africa and Australia, allows us to serve our customers at a lower cost than our competitors and with quicker delivery times for our products. In the industry, we compete primarily on the basis of performance, product consistency, quality, reliability, and ability to innovate in response to customer demands.

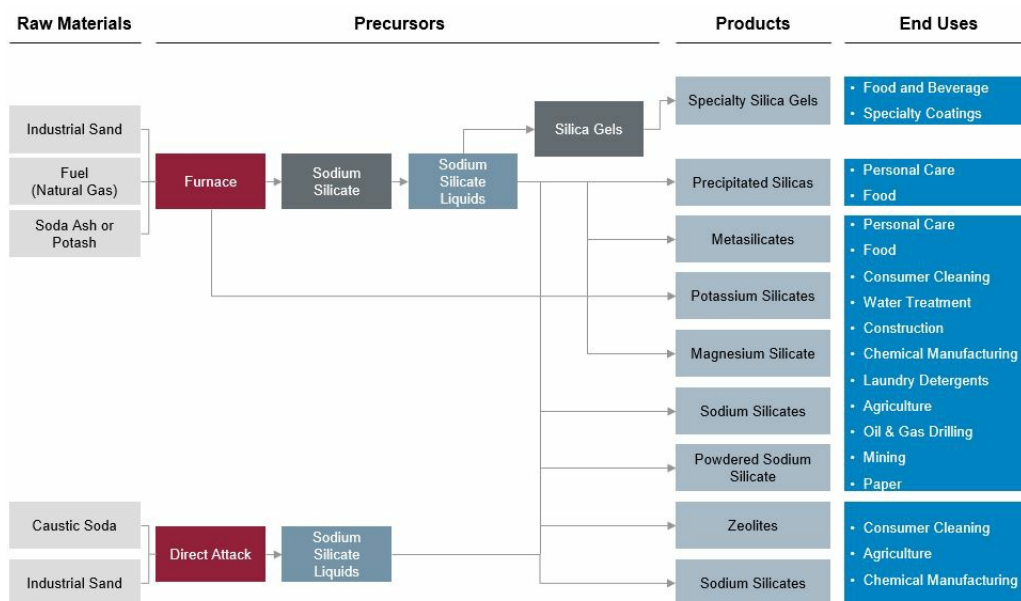
Manufacturing

Performance chemicals are produced through an integrated supply chain beginning with regional and large scale upstream production of sodium silicates and downstream derivatives. Sodium silicates are produced regionally because of the expense of shipping sodium silicates extended distances due to their water content. Our sodium silicates are produced by fusing readily available industrial sand and soda ash in our proprietary furnace operations. We dissolve the molten silicate from the furnace into water and sell these products in liquid form. Downstream derivatives are produced through a variety of chemical operations that create aqueous, solid, and gel forms for our products.

For the year ended December 31, 2019, approximately 50% of our North American silicate sales, which represented a significant portion of our Performance Chemicals segment sales, were derived from contracts that included raw material cost pass-through clauses. Under these contracts, there is usually a time lag of between three and nine months for cost changes to pass-through, depending on the magnitude of the change, industry dynamics and the terms of the particular contract.

The chart below summarizes the manufacturing platform for our Performance Chemicals segment.

Performance Chemicals Manufacturing Platform



Raw Materials

We estimate that our raw material costs represent approximately 40% of total cost of goods sold in the year ended December 31, 2019. Our products are predominantly inorganic and carbon-free, and are produced from readily available raw materials such as industrial sand and soda ash, which prices have historically been less volatile than oil. We also use natural gas in our furnaces, with our North American facilities benefiting from the plentiful supplies of shale gas. In addition, we have long-term supply contracts with many of our key raw materials suppliers across our segments. We have also been able to mitigate the impact of raw material or energy price volatility using a variety of mechanisms, including hedging and raw material cost pass-through clauses in our sales contracts and other adjustment provisions.

We are able to negotiate our supply agreements for our key raw materials based on our leading industry position and global scale in an effort to achieve competitive pricing. We also maintain a raw material quality audit and qualification program designed to ensure that the material we purchase satisfies stringent quality requirements. Key raw materials for our segments include:

Key Raw Materials	Segments
Soda Ash	Refining Services, Performance Materials, Performance Chemicals
Sodium hydroxide ("caustic soda")	Refining Services, Performance Chemicals
Cullet	Performance Materials
Sulfur	Refining Services
Industrial sand	Performance Materials, Performance Chemicals
Aluminum trihydrate	Refining Services, Performance Chemicals

While natural gas is not a direct feedstock for any individual product, we use natural gas powered furnaces to heat raw materials and create the chemical reactions necessary to manufacture our products. We maintain multiple suppliers wherever possible and we seek to hedge our exposure to fluctuations in prices for natural gas through hedging activity in the United States, forward purchases of natural gas in the United States, Canada, and Europe, and the use of pass-through clauses for raw material and natural gas costs in our customer contracts. However, we may not be successful in passing through all increases in raw material costs or maintaining an uninterrupted supply of natural gas for all of our furnaces. See "Risk Factors-Risks Related to Our Business - If we are unable to pass on increases in raw material prices, including natural gas, to our customers or to retain or replace our key suppliers, our results of operations and cash flows may be negatively affected".

Joint Ventures

We have entered into several long-standing joint ventures to supplement our businesses and access other geographic locations, minimize costs and accelerate growth in areas we believe have significant business potential, with the most significant of these joint ventures including the following:

Zeolyst Joint Venture. The Zeolyst Joint Venture is a long-standing partnership with CRI Zeolites Inc., an affiliate of Royal Dutch Shell, that dates back to 1988 and is focused on the development, manufacture and sale of zeolite-containing catalysts through manufacturing facilities located in Kansas and the Netherlands. We combine our expertise in zeolite supply and technology with our partner's expertise in global refinery catalyst sales and technology. We have a 50% ownership stake in the Zeolyst Joint Venture. We supply sodium silicate from our Performance Chemicals segment to the Zeolyst Joint Venture to make specialty zeolites, which are used as precursors in emission control and custom catalysts. We also produce specialty zeolites that are precursors for the production of hydrocracking catalysts and other refinery and petrochemical catalysts that are used by our other segments and sold to third parties. We manage the production of these specialty zeolites due to our expertise in zeolite production. These catalysts include aromatic catalysts that upgrade aromatic by-product streams, dewaxing catalysts that improve lube oil performance and diesel cold flow performance, and paraffin isomerization catalysts that upgrade olefins to high octane gasoline blending components for refinery and petrochemical customers.

PQ Holdings Mexicana S.A. de C.V. PQ Holdings Mexicana was established in 2000 as a joint venture with Solvay Alkalis, Inc. for the manufacture, marketing and sale of various chemicals, including sodium silicate, through manufacturing facilities in Tlalneapantla and Guadalajara, Mexico. We have an 80% ownership stake in PQ Holdings Mexicana.

Research and Development

We benefit from the highly-skilled technical capabilities of our employees dedicated to new product development. We operate six research and development facilities in the United States, Canada, the United Kingdom, the Netherlands, France and Spain. Our research and development activities are directed toward the development of new and improved products, processes, systems and applications for customers. Our research and development team is organized to support each of our operating businesses and staffed with experienced scientists, technical service representatives and process engineers with direct knowledge of our products. This business group and customer-oriented team structure provides strong links between our product development and manufacturing functions and our customer collaboration and specifications. These connections enable us to focus our development on timely and relevant products for our customers while remaining attentive to manufacturing considerations to enable us to produce new products profitably and in a timely manner. Product development activities are organized into research and development projects that are subject to regular reviews by the business teams in order to understand and address our customers' evolving needs and invest in our growth by prioritizing innovation driven by these identified needs. In addition, we hold senior-level project reviews to ensure best practices are shared and consistent metrics are used to determine a project's merit and the size of the potential opportunity.

Intellectual Property

We evaluate on a case-by-case basis how best to use patents, trademarks, copyrights, trade secrets and other available intellectual property protections in order to protect our products and our critical investments in research and development, manufacturing and marketing. We focus on securing and maintaining patents for certain inventions such as composition-of-matter, while maintaining other inventions such as process improvements as trade secrets, derived from our market-based business model, in an effort to maximize the value of our product portfolio and manufacturing capabilities and reinforce our competitive advantage. Our policy is to seek appropriate intellectual property protection for significant product and process developments in the major areas where the relevant products are manufactured or sold. Patents may cover products, processes, intermediate products and product uses. Patents extend for varying periods in accordance with the date of patent application filing and the legal life of patents in the various countries in which the patents are registered. The protection afforded, which may also vary from country to country, depends upon the type of subject matter covered by the patent and the scope of the claims of the patent.

In most industrial countries, patent protection may be available for new substances and formulations, as well as for unique applications and production processes. However, given the geographical scope of our business and our continued growth strategy, there are regions of the world in which we do business or may do business in the future where intellectual property protection may be limited and difficult to enforce. Moreover, we monitor our competitors' products and, if circumstances were to dictate that we do so, we would vigorously challenge the actions of others that conflict with our patents, trademarks and other intellectual property rights. We maintain appropriate information security policies and procedures reasonably designed to ensure the safeguarding of confidential information including, where appropriate, data encryption, access controls and employee awareness training.

We own or have rights to a number of patents relating to our products and processes. As of December 31, 2019, we owned 50 patented inventions in the United States, with approximately 326 patents issued in countries around the world and approximately 100 patent applications pending worldwide covering more than 18 additional inventions. As of December 31, 2019, we also had trademark rights in approximately 619 trademark registrations worldwide, including approximately 73 U.S. trademark registrations. We also have approximately 29 pending trademark applications, which include applications in the United States and worldwide. In addition to our registered and applied-for intellectual property portfolio, we also claim ownership of certain trade secrets and proprietary know-how developed by and used in our business. Including our joint ventures, we are party to certain arrangements whereby we license in the right to use certain intellectual property rights in connection with our business.

Seasonality

Seasonal changes and weather conditions typically affect our Performance Materials segment and our Refining Services segment. In particular, our Performance Materials segment generally experiences lower sales and profit in the first and fourth quarters of the year because highway striping projects typically occur during warmer weather months. Additionally, our Refining Services segment typically experiences similar seasonal fluctuations as a result of higher demand for gasoline products in the summer months. As a result, our working capital requirements tend to be higher in the first and second quarters of the year, which can adversely affect our liquidity and cash flows. Because of this seasonality associated

with certain of our product groups, results for any one quarter are not necessarily indicative of the results that may be achieved for any other quarter or for the full year.

Environmental, Social and Governance

Environmental sustainability is intertwined with our daily business and is reinforced through our strategy and values. Our diverse product technologies enable downstream sustainability. Our Performance Materials segment is one of the world's largest consumers of recycled glass. The segment's products are designed to improve transportation safety through reflective beads in highway and airport traffic lane paint and provide an alternative to petroleum-based industrial cleaning solvents. Our Performance Chemicals segment provides products that are designed to support bio-fuel purification, specialty silicas for low-VOC environmentally preferred coatings, and our sodium silicates are designed to extend the durability of municipal water treatment pipelines by inhibiting corrosion. Our Refining Services segment regenerates sulfuric acid for the refining industry avoiding significant landfill or deep well disposal annually. Certain of our Catalyst segment's products are designed to reduce pollutants, such as nitrous oxides (NOx) in vehicle exhaust and by removing sulfur from fuels.

Our global product technology team formalized its ideation process in 2019 to drive transformational growth through innovation. The team considers product sustainability across the life-cycle in its stage-gate process.

As an American Chemistry Council ("ACC") Responsible Care® member company, we report our health, safety, and environmental metrics annually and have reported our U.S. energy consumption since 2001. Recognizing growing public concern and governmental focus on climate change, we established a sustainability function in 2019 with the hiring of a dedicated sustainability manager. In 2019, we began compiling greenhouse gas ("GHG") emissions data for all manufacturing and technology centers globally. While we will continue to report our carbon emissions to the ACC, CDP, and Ecovadis, with the global baseline completed, we have initiated third-party verification of the GHG data as a precursor to reporting GHG emissions externally on our website. Additionally, the verifier company will assure other sustainability metrics, including hazardous waste and water consumption.

We continued our flagship health, safety and environmental program - PQ Perfect Days ("Perfect Days") - in 2019. The Perfect Days program targets at-risk behaviors and celebrates a positive health, safety and environmental performance across the organization on a daily basis. We concluded 2019 with no material incidents or accidents and continue to work towards our target of ACC top quartile total case incident rate performance in 2020.

Engagement and collaboration is not limited to internal networks. Over the last year, nearly all sites engaged their local communities on initiatives that supported local programs and the needs of the people where we operate. A few examples include participating in Canada Day's New Citizen Day by donating books written by a local author, supporting local schools with student school supplies, painting projects, and a charity bike ride in support of the National Multiple Sclerosis Society.

Diversity, as part of social responsibility, extends internally as we strive to hire candidates from diverse backgrounds, cultures, and ethnicities. By mid-2019, nearly a third of U.S. hired executives, managers and professionals were women. Additional detail on our corporate governance, programs and policies can be found in the Company's Code of Ethics which is routinely updated and communicated annually to all employees. The Code of Ethics is also included in all new hire packets with the Anti-bribery, Anti-harassment, and Cybersecurity policies.

Employees

As of December 31, 2019, we had 3,279 employees worldwide, of which 1,491 were employed in the United States, 527 were employed in Canada, Mexico, Brazil and Argentina, 956 were employed throughout Europe, 38 were employed in South Africa and 97 were employed in Indonesia. Our remaining employees are dispersed throughout Asia and Australia, primarily in Australia, China, Thailand and Japan. As of December 31, 2019, approximately 50% of our employees were represented by a union, works council or other employee representative body. We believe we have good relationships with our employees and their respective works councils, unions or other bargaining representatives. There have been no labor strikes or work stoppages in these locations in recent history.

Environmental Regulations

Obtaining, producing and distributing many of our products involve the use, storage, transportation and disposal of toxic and hazardous materials. We are subject to extensive, evolving and increasingly stringent national and local environmental laws and regulations, which address, among other things, the following:

- emissions to the air;
- discharges to soils and surface and subsurface waters;
- other releases into the environment;
- prevention, remediation or abatement of releases of hazardous materials into the indoor or outdoor environment;
- generation, handling, storage, transportation, treatment and disposal of waste materials;
- maintenance of safe conditions in the workplace;
- registration and evaluation of chemicals;
- production, handling, labeling or use of chemicals used or produced by us; and
- stewardship of products after manufacture.

We apply the principles of the Environmental Management standard of the International Organization for Standardization (ISO 14001) at our facilities throughout the world. For chemical facilities in the United States, we also adhere to the Responsible Care RC14001 Technical Specifications of the American Chemistry Council.

We maintain policies and procedures to monitor and control environmental, health and safety risks, and to monitor compliance with applicable state, national, and international environmental, health and safety requirements. We have a strong environmental, health and safety organization. We have a staff of professionals who are responsible for environmental health, safety and product regulatory compliance. We have implemented a corporate audit program for all of our facilities. However, we cannot provide assurance that we will at all times be in full compliance with all applicable environmental laws and regulations. We expect that stringent environmental regulations will continue to be imposed on us and our industry in general. Evolving chemical regulation programs throughout the world could impose testing requirements or restrictions on our chemical raw materials and products. These programs include the 2016 amendments to the U.S. Toxic Substances Control Act, under which the EPA will prioritize and evaluate chemicals for regulation, the E.U. REACH regulations, which have ongoing registration and evaluation requirements with associated testing costs and potential restrictions, the Korea REACH law, which is requiring registration and potentially testing of chemicals, and similar programs being developed in Taiwan, Turkey, India, and elsewhere. Based on our chemicals and the various regulations promulgated to date, we do not anticipate costly testing requirements or severe restrictions, but cannot guarantee that we will not be subject to requirements for our products or raw materials that could materially affect our operations.

Environmental Remediation. Environmental laws and regulations require mitigation or remediation of the effects of the disposal or release of chemical substances. Under some of these regulations, as the current or former owner or operator of a property, we could be held liable for the costs of removal or remediation of hazardous substances on or under the property, without regard to whether we knew of or caused the contamination, and regardless of whether the practices that resulted in the contamination were permitted at the time they occurred. Many of our current or former production sites have an extended history of industrial use, and it is impossible to predict precisely what effect these laws and regulations will have on us in the future. Soil and groundwater contamination requiring investigation and remediation has been discovered at some of the sites, and might occur or be discovered at other sites. Several active and former facilities currently are undergoing investigation and remediation, including sites in Rahway, NJ; Dominguez, CA; Martinez, CA; and Tacoma, WA.

Environmental Programs. We have comprehensive environmental, health and safety compliance, auditing and management programs in place to assist in our compliance with applicable regulatory requirements and with internal policies and procedures, as appropriate. Each facility has developed and implemented specific critical occupational health, safety, environmental, security and loss control programs.

We also have implemented a Health, Safety and Environmental (“HSE”) organizational structure with executive committee level leadership and dedicated environmental experts. We have Regional HSE Specialists and Managers who are embedded in the field and provide HSE expertise and support to operating sites. Certain, larger sites may have dedicated environmental or safety personnel. We have an established Product Safety/Stewardship management system compliant with

the RC14001 technical specification along with two Product Stewardship Managers, one of which is a REACH Specialist. We conduct Product Stewardship reviews as part of new product development and routinely evaluate product safety risk for raw materials, intermediates and products.

Chemical Product Regulation

As a chemical company, we are subject to extensive and evolving regulations regarding the manufacture, processing, distribution, import, export, and labeling of our products and their raw materials. In the European Union, the REACH regulations came into effect in 2007, with implementation rolling out over time. REACH requires the registration of chemicals, along with a dossier of toxicological and ecotoxicity test results, or a plan to conduct such tests if they are currently unavailable. Registered chemicals then can be subject to further evaluation and potential restrictions. Our high-volume chemicals have been registered under REACH; up to 15 lower-volume chemicals (mainly catalysts) were registered by the applicable 2018 deadline. To date, no further testing has been required. Since the promulgation of REACH, other countries (e.g., China, Korea, Taiwan) have enacted and are in the process of implementing similar comprehensive regulation of chemicals. In the United States, legislation has been enacted that would require the EPA to review and require testing of certain chemicals. Based on our chemicals and the various regulations promulgated to date, we do not anticipate costly testing requirements nor severe restrictions, but cannot guarantee that we will not be subject to requirements for our products or raw materials that could materially affect our operations. In particular, some of our products might be characterized as nanomaterials and then be subject to evolving, new nanomaterial regulations.

Available Information

Our website address is www.pqcorp.com. We make available free of charge through our website our Annual Report on Form 10-K, Quarterly Reports on Form 10-Q, Current Reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Securities and Exchange Act of 1934, as amended (“Exchange Act”), as well as reports on Forms 3, 4 and 5 filed pursuant to Section 16 of the Exchange Act, as soon as reasonably practicable after such documents are electronically filed with, or furnished to, the Securities and Exchange Commission (“SEC”). The SEC maintains an Internet website, <http://www.sec.gov>, which contains reports, proxy and information statements, and other information regarding our Company and other issuers that file electronically with the SEC. The information on our website is not, and shall not be deemed to be, a part of this report or incorporated into any other filings we make with the SEC.

Our Corporate Governance Guidelines, Code of Business Conduct and the charters of the Audit Committee, Compensation Committee, Nominating and Corporate Governance Committee and Health, Safety and Environment Committee of our Board of Directors are also available on our website and are available in print to any shareholder upon request by writing to PQ Investor Relations, 300 Lindenwood Drive, Malvern, PA 19355. In accordance with SEC rules, we intend to disclose any amendment (other than any technical, administrative or other non-substantive) to the Code of Business Conduct, or any waiver of any provision thereof with respect to any of our executive officers, on our website within four business days following such amendment or waiver.

ITEM 1A. RISK FACTORS.

In addition to the other information contained in this Form 10-K, you should carefully consider the following risks that we believe are the material risks that we face. The risks described below could have a material adverse impact on our business, financial condition, cash flows and results of operations, and should be read together and in conjunction with the forward-looking statements and “Management’s Discussion and Analysis of Financial Condition and Results of Operations” included in Item 7 of this Form 10-K, and our consolidated financial statements and the accompanying notes thereto.

Risks Related to Our Business

As a global business, we are exposed to local business risks in different countries, which could have a material adverse effect on our financial condition, results of operations and cash flows.

We have significant operations in many countries, including manufacturing sites, research and development facilities, sales personnel and customer support operations. As of December 31, 2019, we operated 70 manufacturing facilities across six continents. For the year ended December 31, 2019, our foreign subsidiaries accounted for 40% of our sales. Our operations are affected directly and indirectly by global regulatory, economic and political conditions, including:

- new and different legal and regulatory requirements in local jurisdictions;
- export duties or import quotas;
- domestic and foreign customs and tariffs or other trade barriers, including the threat of escalating trade disputes that may result in higher tariffs;
- potential difficulties in staffing and labor disputes;
- potential difficulties in managing and obtaining support and distribution for local operations;
- increased costs of, and availability of, raw materials, energy, transportation or shipping;
- credit risk and financial condition of local customers and distributors;
- potential difficulties in protecting intellectual property rights;
- risk of nationalization of private enterprises by foreign governments;
- potential imposition of restrictions on investments;
- the imposition of withholding taxes or other taxes or royalties on our income, or the adoption of other restrictions on foreign trade or investment, including currency exchange controls;
- capital controls;
- potential difficulties in obtaining and enforcing legal judgments in jurisdictions outside the United States;
- potential difficulties in obtaining and enforcing relief in the United States against parties located outside the United States;
- potential difficulties in enforcing agreements and collecting receivables;
- risks relating to environmental, health and safety matters;
- risks relating to epidemics and pandemics, including effects caused by the spread of COVID-19 (coronavirus); and
- local political, economic and social conditions, including the possibility of hyperinflationary conditions and political instability in certain countries.

We may not be successful in developing and implementing policies and strategies to address the foregoing factors in a timely and effective manner at each location where we do business. Consequently, the occurrence of one or more of the foregoing factors could have a material adverse effect on our international operations or upon our financial condition, results of operations and cash flows.

We are affected by general economic conditions and an economic downturn could adversely affect our operations and financial results.

We sell performance chemicals, performance materials, catalysts and services that are used in manufacturing processes and as components of, or ingredients in, other products and, as a result, our sales are correlated with and affected by fluctuations in the level of industrial production and manufacturing output and by fluctuations in general economic activity. Producers of performance chemicals, in particular, are likely to reduce their output in periods of significant contraction in industrial and consumer demand, while demand for the products we manufacture often depends on trends in demand in the end uses our customers serve. General economic conditions and macroeconomic trends, including economic recessions and inflation, could affect overall demand for our products and any overall decline in such demand could significantly reduce our sales and profitability. In addition, volatility and disruption in financial markets could adversely affect our sales and results of operations by limiting our customers' ability to obtain the financing necessary to maintain or expand their own operations.

Exchange rate fluctuations could adversely affect our financial condition, results of operations and cash flows.

As a result of our international operations, for the year ended December 31, 2019, we generated 40% of our sales and incurred a significant portion of our expenses in currencies other than U.S. dollars. We incur currency transaction risk whenever we enter into either a purchase or sale transaction using a currency other than the local currency of the transacting entity. The main currencies to which we are exposed, besides the U.S. dollar, are the Euro, British pound, Canadian dollar, Mexican peso and the Brazilian real. The exchange rates between these currencies and the U.S. dollar have fluctuated significantly in recent years and may continue to do so in the future. In many cases, we sell exclusively in those jurisdictions and do not have the ability to mitigate our exposure to currency fluctuations through our operations. Accordingly, to the extent that we are unable to match sales made in such foreign currencies with costs paid in the same currency, exchange rate fluctuations could adversely affect our financial condition, results of operations and cash flows. In the past, we have experienced economic loss and a negative impact on earnings as a result of foreign currency exchange rate fluctuations and any future fluctuations may have similar or greater impacts. We expect that the amount of our sales denominated in non-U.S. dollar currencies may increase in future periods. Given the volatility of exchange rates, there can be no assurance that we will be able to effectively manage our currency transaction risks or that any volatility in currency exchange rates will not have a material adverse effect on our financial condition or results of operations. See "Management's Discussion and Analysis of Financial Condition and Results of Operations—Quantitative and Qualitative Disclosures about Market Risk."

Additionally, because our consolidated financial results are reported in U.S. dollars, the translation of sales or earnings generated in other currencies into U.S. dollars can result in a significant increase or decrease in the amount of those sales or earnings in our financial statements, which also affects the comparability of our results of operations and cash flows between financial periods.

Our international operations require us to comply with anti-corruption laws, trade and export controls and regulations of the U.S. government and various international jurisdictions in which we do business.

Doing business on a worldwide basis requires us and our subsidiaries to comply with the laws and regulations of the U.S. government and various international jurisdictions, and our failure to successfully comply with these laws and regulations may restrict our operations, trade practices, investment decisions and partnering activities and may expose us to liabilities. Such laws and regulations apply to companies, individual directors, officers, employees and agents.

In particular, our international operations are subject to U.S. and foreign anti-corruption laws and regulations, such as the Foreign Corrupt Practices Act ("FCPA") and the U.K. Bribery Act ("UKBA"). The FCPA prohibits us from providing anything of value to foreign officials for the purposes of influencing official decisions or obtaining or retaining business or otherwise obtaining favorable treatment, and requires us to maintain adequate record-keeping and internal accounting practices to accurately reflect our transactions. As part of our business, we may deal with state-owned business enterprises, the employees and representatives of which may be considered foreign officials for purposes of the FCPA and UKBA. In addition, some of the international locations in which we operate lack a developed legal system and have elevated levels of corruption. As a result of our international operations, we are exposed to the risk of violating anti-corruption laws.

In addition, we are subject to applicable export controls and economic sanctions laws and regulations imposed by the U.S. government and other countries. Changes in such laws and regulations may restrict our business practices, including cessation of business activities in sanctioned countries or regions or with sanctioned entities or individuals, and may result in modifications to compliance programs. Violations of these legal requirements are punishable by criminal fines and imprisonment, civil penalties, disgorgement of profits, injunctions, debarment from government contracts, loss of export privileges and other remedial measures.

We have established policies and procedures designed to assist us and our personnel in complying with applicable U.S. and international laws and regulations. These policies and procedures are codified in our Code of Conduct and other various policies. However, there can be no assurance that our policies and procedures will effectively prevent us from violating these laws and regulations in every transaction in which we may engage, and such a violation could subject us to governmental investigations and adversely affect our reputation, business, financial condition and results of operations.

Significant developments stemming from the U.S. administration, U.S. courts' or the United Kingdom's exit from the European Union could have an adverse effect on us.

The U.S. administration has called for substantial changes to trade agreements, such as the North American Free Trade Agreement ("NAFTA"), and has imposed tariffs on goods imported from China and certain other countries, which has resulted in retaliatory tariffs by China and other countries. These changes, as well as any other changes in U.S. social, political, regulatory and economic conditions or laws and policies governing foreign trade, manufacturing and development and investment in the territories and countries where we or our customers operate could adversely affect our operating results and our business.

Additionally, in June 2016, the United Kingdom held a referendum and voted in favor of leaving the European Union and, on January 31, 2020, the United Kingdom exited the European Union, although certain implementing agreements relating to such exit have yet to be concluded. This referendum and exit has created political and economic uncertainty, particularly in the United Kingdom and the European Union, and this uncertainty may last for years. Our business could be affected during this period of uncertainty, and perhaps longer, by the impact of the United Kingdom's referendum and exit. In addition, our business could be negatively affected by new trade agreements between the United Kingdom and other countries, including the United States, and by the possible imposition of trade or other regulatory barriers in the United Kingdom. These possible negative impacts, and others resulting from the United Kingdom's withdrawal from the European Union, may adversely affect our customers' businesses and our operating results.

Alternative technology or other changes in our customers' products may reduce or eliminate the need for certain of our products.

Many of the products that we sell are used in manufacturing processes and as components of or ingredients in other products and, as a result, changes in our customers' end products or processes or alternative technology may enable our customers to reduce or eliminate consumption or use of our products. For example, the ongoing shift in customer preferences in the detergent industry from powders to liquid has resulted in lower demand for zeolites. Additionally, shifting consumer preference could result in a significant reduction in the future use of fossil fuels, which would have a negative impact on our zeolite catalysts and refining services. If we are unable to respond appropriately to such new developments, such changes could seriously impair our ability to profitably market certain of our products.

Our new product development and research and development efforts may not succeed and our competitors may develop more effective or successful products.

The industries in which we operate are subject to periodic technological changes and ongoing product improvements. In order to maintain our margins and remain competitive, we must successfully develop, manufacture and market new or improved products. As a result, we must commit substantial resources each year to new product research and development. Ongoing investments in new product research and development could result in higher costs without a proportional increase in revenues. Additionally, for any new product program, there is a risk of technical or market failure, in which case we may need to commit additional resources to the program and may not be able to develop the new products needed to maintain our competitive position. Moreover, new products may have lower margins than the products they replace or may not successfully attract end users.

We also expect competition to increase as our competitors develop and introduce new and enhanced products. As such products are introduced, our products may become obsolete or our competitors' products may be marketed more effectively. If we fail to develop new products, maintain or improve our margins with our new products or keep pace with technological developments, our business, financial condition, results of operations and cash flows will suffer.

Our substantial level of indebtedness could adversely affect our financial condition.

We have substantial indebtedness, which, as of December 31, 2019, totaled approximately \$1,932.1 million. Our substantial indebtedness, combined with our other financial obligations and contractual commitments, could have important consequences, including:

- requiring us to dedicate a substantial portion of our cash flows from operations to payments on our indebtedness, thereby reducing funds available for working capital, capital expenditures, acquisitions, selling and marketing efforts, product development and other purposes;
- increasing our vulnerability to adverse economic and industry conditions, which could place us at a competitive disadvantage compared to our competitors that have relatively less indebtedness;
- limiting our flexibility in planning for, or reacting to, changes in our business and the industries in which we operate;
- increasing our exposure to rising interest rates because certain of our borrowings are at variable interest rates;
- restricting us from making investments, strategic acquisitions or causing us to make non-strategic divestitures; and
- limiting our ability to borrow additional funds, or to dispose of assets to raise funds, if needed, for working capital, capital expenditures, acquisitions, product development and other corporate purposes.

Although the terms of the agreements governing our outstanding indebtedness contain restrictions on the incurrence of additional indebtedness, such restrictions are subject to a number of important exceptions and indebtedness incurred in compliance with such restrictions could be substantial. If we and our restricted subsidiaries incur significant additional indebtedness, the related risks that we face could increase.

If we are unable to pass on increases in raw material prices, including natural gas, to our customers or to retain or replace our key suppliers, our results of operations and cash flows may be negatively affected.

We purchase significant amounts of raw materials, including soda ash, cullet, industrial sand, aluminum trihydrate, sodium hydroxide (commonly known as caustic soda) and sulfur (including hydrogen sulfite), in our Performance Chemicals, Performance Materials and Refining Services segments, and we purchase significant amounts of natural gas to supply the energy required in our production process. The cost of these raw materials represents a substantial portion of our operating expenses and our results of operations have been, and could in the future be, significantly affected by increases in the costs of such raw materials. In addition, we obtain a significant portion of our raw materials from certain key suppliers. If any of those suppliers is unable to meet its obligations under current supply agreements, we may be forced to pay higher prices to obtain the necessary raw materials. Furthermore, if any of the raw materials that we use become unavailable within the geographic area from which we currently source them, we may not be able to obtain suitable and cost-effective substitutes. Any interruption of supply or any price increase of raw materials could adversely affect our profitability.

While we attempt to match raw material price increases with corresponding product price increases, our ability to pass on increases in the cost of raw materials to our customers is, to a large extent, dependent upon our contractual arrangements and market conditions. There may be periods of time during which we are not able to recover increases in the cost of raw materials due to our contractual arrangements or weakness in demand for, or oversupply of, our products. Specifically, timing differences between price adjustments of raw materials, which may occur daily, and adjustments to our product prices, which in many cases are adjusted quarterly or less often, have had and may continue to have a negative effect on our profitability. Even in periods during which raw material prices decline, we may suffer decreasing profits if customers seek relief in the form of lower sales prices or if the raw material price reductions occur at a slower rate than decreases in the selling prices of our products. Furthermore, some of our performance chemicals customers may take advantage of fluctuating prices by building inventories when they expect product prices to increase and reducing inventories when they expect product prices to decrease. Such volatility can result in commercial disputes with customers and suppliers with respect to interpretations of complex contractual arrangements, the adverse resolution of which could reduce our profitability.

In the past, we have entered into long-term supply contracts for certain of our raw materials, including for certain of our North American soda ash purchases. As these contracts expire, we may not be able to renegotiate or enter into new long-term supply contracts that will offer similar protection from price increases and other fluctuations on terms that are satisfactory to us or at all. For example, a contract for the supply of caustic soda expired at the end of 2019 and we will incur increased costs to obtain caustic soda in 2020 because the replacement contract increases the price we will pay for that raw material.

In addition, we have attempted to mitigate our exposure to the significant price volatility of natural gas by implementing a hedging program in the United States and entering into forward purchases in the United States, Canada, Europe and other parts of the world. Our hedging strategy may not be successful and if energy prices rise, our profitability could be adversely affected. With the exception of such natural gas contracts, we typically do not enter into long-term forward contracts to hedge against raw material price volatility.

We face substantial competition in the industries in which we operate.

The industries in which we operate are highly competitive and we face significant competition from large international producers and, particularly in Europe and certain Asia-Pacific regions, smaller regional competitors. Our Catalysts segment primarily competes with other global producers in the petrochemicals and refining industries such as W.R. Grace, BASF, UOP, and Albemarle, as well as other niche competitors such as Tosoh, Axens, and Haldor Topsoe. We compete in the North American refining services industry with competitors such as Chemtrade and Veolia. Additionally, in our Performance Materials segment, we primarily compete with regional suppliers and other global producers such as 3M, and in our Performance Chemicals segment, we primarily compete with other global producers such as OxyChem, Grace and Evonik. We believe that we typically compete on the basis of performance, product consistency, quality, reliability, and ability to innovate in response to customer demands.

Our competitors may improve their competitive position in our core end use applications by successfully introducing new products, improving their manufacturing processes, expanding their capacity or manufacturing facilities or responding more effectively than us to new or emerging technologies and changes in customer requirements. Some of our competitors may be able to lower prices for products that compete with our products if their costs are lower. In addition, consolidation among our competitors or customers may result in reduced demand for our products or make it more difficult for us to compete. Some of our competitors' financial, technological and other resources may be greater than ours or they may have less debt than we do and, as a result, may be better able to withstand changes to industry conditions. The occurrence of any of these events could materially adversely affect our financial condition and results of operations.

We are subject to the risk of loss resulting from non-payment or non-performance by our customers.

Our credit procedures and policies may not be adequate to minimize or mitigate customer credit risk. Our customers may experience financial difficulties, including bankruptcies, restructurings and liquidations. These and other financial problems our customers may experience, as well as potential financial weakness in the industries in which we operate, may increase our risk in extending trade credit to customers. A significant adverse change in a customer's financial position could cause us to limit or discontinue business with such customer, require us to assume more credit risk relating to such customer's receivables or limit our ability to collect accounts receivable from such customer, any of which could have a material adverse effect on our business, results of operations, financial condition and liquidity.

We rely on a limited number of customers for a meaningful portion of our business. A loss of one or more of these customers could adversely impact our profitability.

A loss of any significant customer, including a pipeline customer, or a decrease in the provision of products to any significant customer could have an adverse effect on our business until alternative arrangements are secured. Any alternative arrangement to replace the loss of a customer could result in increased variable costs relating to product shipment. In addition, any new customer agreement entered into by us may not have terms as favorable as those contained in our current customer agreements, which could have a material adverse effect on our business, financial condition and results of operations. For the year ended December 31, 2019 our top 10 customers represented approximately 25% of our sales and no single customer represented more than 4% of our sales.

Refineries, which represent a sizable subset of our Refining Services segment, have undergone significant consolidation and additional consolidation is possible in the future. Such consolidation could further increase our reliance on a small number of customers and further increase our customers' leverage over us, resulting in downward pressure on prices and an adverse effect on our profitability.

Multi-year customer contracts in our Refining Services segment are subject to potential early termination and such contracts may not be renewed at the end of their respective terms.

Many of the customer contracts in our Refining Services segment are multi-year agreements. Sulfuric acid regeneration customer contracts are typically on five- to ten-year terms and virgin sulfuric acid customer contracts are typically on one- to five-year terms, with larger customers typically favoring longer terms. Excluding contracts with automatic evergreen provisions, approximately 60% of our sulfuric acid volume for the year ended December 31, 2019 was under contracts expiring at the end of 2020 or beyond. In addition, our sulfuric acid regeneration contracts with major refinery customers typically allow for termination with advance notice of one to two years. We cannot provide assurance that our existing contracts will not be subjected to early terminations or that our expiring contracts will be renewed at the end of their terms. If we receive a significant number of such contract terminations or experience non-renewals from key customers in our Refining Services segment, our results of operations, financial condition and cash flows may be materially adversely affected.

Reductions in highway safety spending or taxes earmarked for highway safety spending could result in a decline in our sales.

Approximately 19% of our sales for the year ended December 31, 2019 were derived from products sold into highway safety applications. Sales of our performance materials products for highway safety uses are, in part, dependent upon federal, state, local and foreign government budgets. A decrease in, or termination of, governmental budgeting for new highway safety programs or a significant decrease in the use of our performance materials products in any new highway safety projects could have an adverse effect on our business, financial condition, results of operations or cash flows by decreasing the profitability of our Performance Materials segment.

Our quarterly results of operations are subject to fluctuations because the demand for some of our products is seasonal.

Seasonal changes and weather conditions typically affect our Performance Materials and Refining Services segments. In particular, our Performance Materials segment generally experiences lower sales and profit in the first and fourth quarters of the year because highway striping projects typically occur during warmer weather months. Additionally, our Refining Services segment typically experiences similar seasonal fluctuations as a result of higher demand for gasoline products in the summer months. As a result, our working capital requirements tend to be higher in the first and fourth quarters of the year, which can adversely affect our liquidity and cash flows. Because of this seasonality associated with certain of our segments, results for any one quarter are not necessarily indicative of the results that may be achieved for any other quarter or for the full year.

If we lose certain key personnel or are unable to hire additional qualified personnel, we may not be able to execute our business strategy and our business could be adversely affected.

Our success depends, in part, upon the continued services of our highly skilled personnel involved in management, research, production and distribution and, in particular, upon the efforts and abilities of our key officers. Although we believe that we are adequately staffed in key positions, we may not be able to retain such personnel on acceptable terms or at all, and such personnel may seek to compete with us in the future. If we lose the service of any of our key personnel, we may not be able to hire replacements with the same level of industry experience and knowledge necessary to execute our business strategy, which in turn could have a material adverse effect on our business, financial condition, results of operations or cash flows.

Our growth projects may result in significant expenditures before generating revenues, if any, which may materially and adversely affect our ability to implement our business strategy.

We have made and continue to make significant investments in each of our businesses. These projects require us to commit significant capital to, among other things, implement engineering plans and obtain the necessary permits before we generate revenues related to our investments in these businesses. Such projects may take longer to complete or require additional unanticipated expenditures and may never generate profits. If we fail to recover our investment, or these projects never become profitable, our ability to implement our business strategy may be materially and adversely affected.

We may be liable for damages based on product liability claims brought against us or our customers for costs associated with recalls of our or our customers' products.

Even though we are generally a materials and services supplier rather than a manufacturer of finished goods, the sale of our products involves the risk of product liability claims and voluntary or government-ordered product recalls. For example, certain of the products that we manufacture provide critical performance functions to our customers' end products and are used in and around other chemical manufacturing facilities, highways, airports and other locations where personal injury or property damage may occur or are used in certain consumer goods such as beverages, personal care products and medicinal applications. While we attempt to protect ourselves from product liability claims and exposures through our adherence to standards and specifications and through contractual negotiations and provisions, there can be no assurance that our efforts will ultimately protect us from any such claims. A product liability claim or voluntary or government-ordered product recall could result in substantial and unexpected expenditures, affect consumer or customer confidence in our products and divert management's attention from other responsibilities. A product recall or successful product liability claim or series of claims against us in excess of our insurance coverage and for which we are not otherwise indemnified could have a material adverse effect on our business, financial condition, results of operations or cash flows.

We are required to comply with a wide variety of laws and regulations, and are subject to regulation by various federal, state and foreign agencies, and our failure to comply with existing and future regulatory requirements could adversely affect our financial condition, results of operations and cash flows.

We compete in industries in which we and our customers are subject to federal, state, local, international and transnational laws and regulations. Such laws and regulations are numerous and sometimes conflicting, and any future changes to such laws and regulations could adversely affect us. For example, our Performance Materials segment sells products used in highway safety applications, and such products are subject to laws and regulations that vary by state. If we fail to comply with applicable laws and regulations, we may be subject to civil remedies, including fines, injunctions, recalls or seizures, any of which could have an adverse effect on our business, financial condition and results of operations.

In order to obtain regulatory approval for certain of our new products, we must, among other things, demonstrate to the relevant authority that the product is safe and effective for its intended uses and that we are capable of manufacturing the product in accordance with current regulations. The process of seeking approvals can be costly, time-consuming and subject to unanticipated and significant delays. Any delay in obtaining, or any failure to obtain or maintain, these approvals would adversely affect our ability to introduce new products and to generate sales from those products, and could have an adverse effect on our business, financial condition, results of operations or cash flows.

Our products, including the raw materials we handle, are subject to rigorous chemical registration and industrial hygiene regulations and investigation. There is risk that a key raw material, chemical or substance, or one of the end products of which our products are a part, may be recharacterized as having a toxicological or health-related impact on the environment, our customers or our employees. Industrial hygiene regulations are continually strengthened and if such recharacterization occurs, the relevant raw material, chemical or product may be banned or we may incur increased costs in order to comply with new requirements. Changes in industrial hygiene regulations also affect the marketability of certain of our products, and future regulatory changes may have a material adverse effect on our business.

New laws and regulations, and changes in existing laws and regulations, may become effective in the future and could prevent or inhibit the development, distribution and sale of our products, including, but not limited to, the imposition of additional compliance costs, seizures, confiscation, recall or monetary fines. For example, as discussed in more detail in “Business-Environmental Regulations” and “Business-Chemical Product Regulation,” we may be materially impacted by regulatory initiatives worldwide with respect to chemical product safety such as the 2016 amendments to the U.S. Toxic Substances Control Act, the E.U. regulation “Registration, Evaluation, Authorisation and Restriction of Chemicals” (“REACH”), and/or similar regulations being enacted in other countries (e.g., China REACH; Korea REACH). Additionally, the current U.S. administration may seek to tighten current environmental standards and regulations, including, but not limited to, the Corporate Average Fuel Economy standards, which could have a material adverse effect on our sales into the fuels and emission controls industries.

We are subject to extensive environmental, health and safety regulations and face various risks associated with potential non-compliance or releases of hazardous materials.

Like other chemical companies, our operations and properties are subject to extensive and stringent federal, state, local and foreign environmental laws and regulations. U.S. federal environmental laws that affect us include the Resource Conservation and Recovery Act (“RCRA”), the Clean Air Act, the Clean Water Act and the Comprehensive Environmental Response Compensation and Liability Act (“CERCLA”). These laws govern, among other things, emissions to the air, discharges or releases of hazardous substances to land, surface, subsurface strata and water, wastewater discharges and the generation, handling, storage, transportation, treatment, disposal and remediation of hazardous materials and petroleum products. We are also subject to other federal, state, local and foreign laws and regulations regarding chemical and product safety as well as employee health and safety matters, including process safety requirements. These laws and regulations may become more stringent over time and the failure to comply with such laws and regulations can result in significant fines or penalties.

We have in the past been and currently are the subject of investigations and enforcement actions pursuant to environmental laws, including the Clean Air Act. Some of these matters were resolved through the payment of significant monetary penalties and a requirement to implement corrective actions at our facilities. For instance, we remain subject to a 2007 Consent Decree that resolves certain alleged Clean Air Act violations at our seven refining services operating locations involving New Source Review, Prevention of Significant Deterioration and New Source Performance Standard obligations under the U.S. federal rules for the pollutants sulfur dioxide and sulfuric acid mist. The Consent Decree required Solvay (the owner at the time) to pay a \$2 million penalty and spend approximately \$34 million on air pollution controls at our facilities, the majority of which was received from customers in contractual arrangements. Work under the Consent Decree has proceeded since 2007, and we believe that all of the significant capital improvements related to the Consent Decree have been completed. One of our operating locations has been released from the scope of the Consent Decree and we are seeking release of the other locations covered by the Consent Decree.

We are required by these environmental laws and regulations to obtain registrations, licenses, permits and other approvals in order to operate, to make disclosures to public authorities about our chemical handling and usage activities and to install expensive pollution control and spill containment equipment at our facilities, or to incur other capital expenditures aimed at achieving or maintaining compliance with such laws and regulations. We are in the process of implementing a substantial environmentally-driven capital improvement project over the next three years and failure to complete this project or to timely identify and implement other capital projects required to achieve or maintain compliance could expose us to enforcement and penalty.

Under CERCLA and analogous statutes in local and foreign jurisdictions, current and former owners and operators of land impacted by releases of hazardous substances are strictly liable for the investigation and remediation of the contamination resulting from the release. Liability under CERCLA and analogous laws is strict, unlimited, joint, several and retroactive, may be imposed regardless of fault and may relate to historical activities or contamination not caused by the affected property's current owner or operator. We could be held responsible for all cleanup costs at a site, whether currently or formerly owned or operated, regardless of fault, knowledge, timing or cause of the contamination. Further, under CERCLA and analogous laws, we may be jointly and severally liable for contamination at third party sites where we or our predecessors in interest have sent waste for treatment or disposal, even if we complied with applicable laws. In addition, we may face liability for personal injury, property damage and natural resource damage resulting from environmental conditions attributable to hazardous substance releases at or from facilities we currently own or operate or formerly owned or operated or to which we sent waste. As such, a product spill or emission at one of our facilities or otherwise resulting from our operations could have adverse consequences on the environment and surrounding community and could result in significant liabilities with respect to investigation and remediation.

Our facilities have an extended history of industrial use, and soil and groundwater contamination exists at some of our sites. As of December 31, 2019, we had current investigation, remediation or monitoring obligations at several of our current or former sites, including Rahway, New Jersey; Dominguez, California; Martinez, California; and Tacoma, Washington. As of December 31, 2019, we had established reserves of approximately \$3.0 million to cover anticipated expenses at these sites, all of which have reached relatively mature stages of either the investigation, remediation or monitoring process. Actual costs to complete these projects may exceed our current estimates. In addition, we have unresolved liability at several sites to which we or our predecessors allegedly arranged for the disposal or treatment of hazardous wastes. For example, at the Boyertown Sanitary Disposal site in Gilbertsville, Pennsylvania, we are participating in a group of parties who disposed of materials at the site to fund investigatory and remedial work.

As of December 31, 2019, our total reserves associated with environmental remediation and enforcement matters were \$6.6 million. In addition to the ongoing remediation and monitoring activities discussed above, there is risk that the long-term industrial use at our facilities may have resulted in, or may in the future result in, contamination that has yet to be discovered, which could require additional, unplanned investigation and remediation efforts by us for which no reserves have been established, potentially without regard to whether we knew of, or caused, the release of such contaminants. Discovery of additional or unknown conditions at our facilities could have an adverse impact on our business by substantially increasing our capital expenditures, including compliance, investigation and remediation costs. Such environmental liabilities attached to our properties, or for properties that we are otherwise responsible for, could have a material adverse effect on our results of operations or financial condition.

Existing and proposed regulations to address climate change by limiting greenhouse gas emissions may cause us to incur significant additional operating and capital expenses.

Certain of our operations result in emissions of greenhouse gases (“GHGs”), such as carbon dioxide. Growing concern about the sources and impacts of global climate change has led to a number of domestic and foreign legislative and administrative measures, both proposed and enacted, to monitor, regulate and limit carbon dioxide and other GHG emissions. In the European Union, our emissions are regulated under the E.U. Emissions Trading System (the “E.U. ETS”), an E.U.-wide trading scheme for industrial GHG emissions. The E.U. ETS is anticipated to become progressively more stringent over time, including by reducing the number of allowances to emit GHGs that E.U. member states will allocate without charge to industrial facilities. In the United States, the EPA has promulgated federal GHG regulations under the Clean Air Act that affect certain sources. For example, the EPA has issued mandatory GHG reporting requirements, under which our Dominguez, California and Baton Rouge, Louisiana facilities currently report. Moreover, California has enacted the Global Warming Solutions Act of 2006 (“Assembly Bill 32”), a law that establishes a comprehensive program to reduce GHG emissions from all sources throughout the state and contains reporting requirements under which our Dominguez and Martinez facilities currently report. Our Dominguez facility also participates in the emissions trading market established under Assembly Bill 32. Although we believe it is likely that GHG emissions will continue to be regulated in at least some regions of the United States and in other countries (in addition to the European Union) in the future, we cannot yet predict the form such regulation will take (such as a cap-and-trade program, technology mandate, emissions tax or other regulatory mechanism) or, consequently, estimate any costs that we may be required to incur in respect of such requirements, which could, for example, require that we install emission control equipment, purchase emissions allowances, administer and manage our GHG emissions program or address other regulatory obligations. Such requirements could also adversely affect our energy supply or the costs and types of raw materials that we use for fuel. Accordingly, regulations controlling or limiting GHG emissions could have a material adverse effect on our business, financial condition or results of operations, including by reducing demand for our products.

Production and distribution of our products could be disrupted for a variety of reasons, and such disruptions could expose us to significant losses or liabilities.

Certain of the hazards and risks associated with our manufacturing processes and the related storage and transportation of raw materials, products and wastes may disrupt production at our manufacturing facilities and the distribution of products to our customers. These potentially disruptive risks include, but are not limited to, the following:

- pipeline and storage tank leaks and ruptures;
- explosions and fires;
- inclement weather and natural disasters;
- terrorist attacks;
- failure of mechanical, process safety and pollution control equipment;
- chemical spills and other discharges or releases of toxic or hazardous substances or gases;
- epidemics and pandemics, including effects caused by the spread of COVID-19 (coronavirus); and
- exposure to toxic chemicals.

These hazards could expose employees, customers, the community and others to toxic chemicals and other hazards, contaminate the environment, damage property, result in personal injury or death, lead to an interruption or suspension of operations, damage our reputation and adversely affect the productivity and profitability of a particular manufacturing facility or our business as a whole. Such hazards could also result in the need for remediation, governmental enforcement, regulatory shutdowns, the imposition of government fines and penalties and claims brought by governmental entities or third parties. Legal claims and regulatory actions could subject us to both civil and criminal penalties, which could affect our product sales, reputation and profitability.

If disruptions at our manufacturing facilities or in our distribution channels occur, alternative options with sufficient capacity or capabilities may not be available, may cost substantially more or may require significant time to start production or distribution. Any of these scenarios could negatively affect our business and financial performance. If one of our manufacturing facilities or distribution channels is unable to produce or distribute our products for an extended period of time, our sales may be reduced by the shortfall caused by the disruption and we may not be able to meet our customers' needs, which could cause them to seek other suppliers. Furthermore, to the extent a production disruption occurs at a manufacturing facility that has been operating at or near full capacity, the resulting shortage of our product could be particularly harmful because production at the manufacturing facility may not be able to reach levels achieved prior to the disruption. Such risks are heightened in our Refining Services segment, which has operations and customers primarily located in the Gulf Coast, which is susceptible to a heightened risk of hurricanes, and Northern California, which is susceptible to a heightened risk of earthquakes. For example, in August 2017 we shut down our Houston and Baytown refining services facilities in coordination with our refinery partners in anticipation of Hurricane Harvey. The operational interruption at these facilities negatively impacted our sales in 2017 by approximately \$7.7 million.

The insurance that we maintain may not fully cover all potential exposures.

We maintain property, business interruption, casualty and other types of insurance, but such insurance may not cover all risks associated with the operation of our business or our manufacturing process and the related use, storage and transportation of raw materials, products and wastes in or from our manufacturing sites or distribution centers. While we have purchased what we deem to be adequate limits of coverage and broadly worded policies, our coverage is subject to exclusions and limitations, including higher self-insured retentions or deductibles and maximum limits and liabilities covered. Notwithstanding diligent efforts to successfully procure specialty coverage for environmental liability and remediation, we may incur losses beyond the limits or outside the terms of coverage of our insurance policies, including liabilities for environmental remediation. In addition, from time to time, various types of insurance for companies in the industries in which we operate have not been available on commercially acceptable terms or, in some cases, at all. We are potentially at additional risk if one or more of our insurance carriers fail. Additionally, severe disruptions in the domestic and global financial markets could adversely impact the ratings and survival of some insurers. Future downgrades in the ratings of enough insurers could adversely impact both the availability of appropriate insurance coverage and its cost. In the future, we may not be able to obtain coverage at current levels, if at all, and our premiums may increase significantly on coverage that we maintain.

We could be subject to damages based on claims brought against us by our customers or lose customers as a result of the failure of our products to meet certain quality specifications.

Our products provide important performance attributes to our customers' products. If a product fails to perform in a manner consistent with quality specifications, or has a shorter useful life than that which was guaranteed, a customer could seek replacement of the product or damages for costs incurred as a result of the product failing to perform as guaranteed. A successful claim or series of claims against us could cause reputational harm and have a material adverse effect on our financial condition and results of operations and could result in a loss of one or more customers.

We may engage in strategic acquisitions or dispositions of certain assets or businesses that could affect our business, results of operations, financial condition and liquidity.

We may selectively pursue complementary acquisitions, such as the Business Combination, and joint ventures, such as the Zeolyst Joint Venture, each of which inherently involves a number of risks and presents financial, managerial and operational challenges, including:

- potential disruption of our ongoing business and distraction of management;
- difficulty with integration of personnel and financial and other systems;
- hiring additional management and other critical personnel; and
- increasing the scope, geographic diversity and complexity of our operations.

In addition, we may encounter unforeseen obstacles or costs in the integration of acquired businesses. For example, the presence of one or more material liabilities of an acquired company that are unknown to us at the time of acquisition may have a material adverse effect on our business. Our acquisition and joint venture strategy may not be received positively by customers, and we may not realize any anticipated benefits from acquisitions or joint ventures.

We may also opportunistically pursue dispositions of certain assets and businesses, which may involve material amounts of assets or lines of business, which could adversely affect our results of operations, financial condition and liquidity. If any such dispositions were to occur, under the terms of the agreements governing our outstanding indebtedness, we may be required to apply the proceeds of the sale to repay such indebtedness.

The pro forma and non-GAAP financial information included in this Form 10-K is presented for informational purposes only and may not be an indication of our financial condition or results of operations in the future.

The unaudited pro forma combined financial information included in this Form 10-K is presented for informational purposes only and is not necessarily indicative of what our actual financial condition or results of operations would have been had the Business Combination been completed on the date indicated. The assumptions used in preparing the pro forma financial information may not prove to be accurate and other factors may affect our financial condition or results of operations. Accordingly, our financial condition and results of operations in the future may not be consistent with, or evident from, such pro forma financial information. The non-GAAP financial information included in this Form 10-K includes information that we use to evaluate our past performance, but you should not consider such information in isolation or as an alternative to measures of our performance determined under GAAP.

Our joint ventures may not operate according to their business plans if our partners fail to fulfill their obligations or differences in views among our partners results in delayed decisions or failures to agree on major issues, which may adversely affect our results of operations and force us to dedicate additional resources to these joint ventures.

We currently participate in a number of joint ventures and may enter into additional joint ventures in the future. The nature of a joint venture requires us to share control with unaffiliated third parties and we sometimes have joint and several liability with our joint venture partners. If our joint venture partners do not fulfill their obligations, or if differences in views among the joint venture participants results in delayed decisions or failures to agree on major issues, the affected joint venture may not be able to operate according to its business plan. For example, the Zeolyst Joint Venture is structured as a general partnership in which we are equal partners with CRI Zeolites Inc. Accordingly, we do not control the Zeolyst Joint Venture and cannot unilaterally undertake strategies, plans, goals and operations or determine when cash distributions will be made to us. Furthermore, we are liable on a joint and several basis with CRI Zeolites Inc. for all of the partnership's liabilities if it does not have sufficient assets to satisfy such liabilities. Such factors may adversely affect our results of operation and force us to dedicate additional and unexpected resources to our joint ventures.

Our failure to protect our intellectual property rights could adversely affect our future performance and growth.

Protection of our proprietary processes, methods, compounds and other technologies is important to our business. We depend upon our ability to develop and protect our intellectual property rights to distinguish our products from those of our competitors. Failure to protect our existing intellectual property rights may allow our competitors to copy our products and may result in the loss of valuable proprietary technologies or other intellectual property. Failure to protect our innovations and trademarks by securing intellectual property rights could also result in our having to pay other companies for infringing on their intellectual property rights. We rely on a combination of patent, trade secret, trademark and copyright law as well as regulatory and judicial enforcement to protect such technologies and trademarks. In addition, the laws of many foreign countries do not protect our intellectual property rights to the same extent as the laws of the United States. As of December 31, 2019, we owned 50 patented inventions in the United States, with approximately 326 patents issued in countries around the world and approximately 100 patent applications pending worldwide covering more than 18 additional inventions. Some of these patents are licensed to others. In addition, we have acquired certain rights under patents and inventions of others through licenses. Should any of these licenses granted to us by third parties terminate prior to the expiration of the licensed intellectual property, we would need to cease using the licensed intellectual property, and either develop or license alternative technologies. In such a case, there can be no assurance that alternative technologies exist or that we would be able to obtain such a license on favorable terms.

Competitors and third parties may infringe on our patents or violate our intellectual property rights. Defending and enforcing our intellectual property rights can involve litigation and can be expensive and time consuming. Such proceedings could put our patents at risk of being invalidated and confidential information may be disclosed through the discovery process; these costs and diversion of resources could harm our business.

We cannot provide any assurances that any of our pending applications will mature into issued patents, or that any patents that have issued or may issue in the future do or will include claims with a scope sufficient to provide any competitive advantage. Patents involve complex legal and factual questions and, therefore, the issuance, scope, validity and enforceability of any patent claims we have or may obtain cannot be predicted with certainty. Patents may be challenged, deemed unenforceable, invalidated or circumvented. Patents may be challenged in the courts, as well as in various administrative proceedings before the United States Patent and Trademark Office or foreign patent offices. We are currently and may in the future be a party to various adversarial patent office proceedings involving our patents or the patents of third parties. Such challenges can result in some or all of the claims of the challenged patent being invalidated, deemed unenforceable, or interpreted narrowly which, in the case of challenges to our own patents, may be adverse to our interests. Accordingly, the issuance of patents is not conclusive of the validity, scope, or enforceability of such patents. Moreover, even if valid and enforceable, competitors may be able to design around our patents or use pre-existing technologies to compete with us.

We also rely upon unpatented proprietary know-how, continuing technological innovation and other trade secrets to develop and maintain our competitive position, which may not provide us with complete protection against competitors. Misappropriation or unauthorized disclosure of our proprietary know-how could harm our competitive position or have an adverse effect on our business. While it is our policy to enter into confidentiality agreements with our employees and third parties to protect our intellectual property rights and we strive to maintain the physical security of our properties and the security of our IT systems, there can be no assurances that:

- our confidentiality agreements will not be breached;
- our security measures will not be breached;
- such agreements will provide meaningful protection for our trade secrets or proprietary know-how;
or
- adequate remedies will be available in the event of an unauthorized use or disclosure of such trade secrets and know-how.

In addition, there can be no assurances that others will not obtain knowledge of these trade secrets through independent development or other access by legal means.

Measures taken by us to protect these assets and rights may not provide meaningful protection for our trade secrets or proprietary manufacturing expertise and adequate remedies may not be available in the event of an unauthorized use or disclosure of our trade secrets or manufacturing expertise. In addition, as noted above, our patents and other intellectual property rights may be challenged, invalidated, circumvented or rendered unenforceable.

Furthermore, we cannot provide assurance that any pending patent or trademark application filed by us will result in an issued patent or registered trademark or, if patents are issued to us, that those patents will provide meaningful protection against competitors or against competitive technologies. The failure of our patents or other measures to protect our processes, apparatuses, technology, trade secrets and proprietary manufacturing expertise, methods and compounds or trademarks and provide us with freedom to exclude competition could have an adverse effect on our business, financial condition, results of operations and cash flows. See “Business-Intellectual Property.”

Our products may infringe the intellectual property rights of others, which may cause us to incur unexpected costs or prevent us from selling our products.

Our industry is characterized by vigilant pursuit of intellectual property rights, particularly with respect to our silica catalysts and zeolite catalysts product groups. Like us, our competitors rely on intellectual property rights to maintain profitability and competitiveness. As the number of products and competitors has increased, the likelihood of intellectual property disputes has risen. Although it is our policy and intention not to infringe valid patents of which we are aware, our processes, apparatuses, technology, proprietary manufacturing expertise, methods, compounds and products may infringe on issued patents or infringe or misappropriate other intellectual property rights of others. Accordingly, we continually monitor third-party intellectual property to confirm our freedom to operate. Nevertheless, we may be subject to legal proceedings and claims in the ordinary course of our business, including claims of alleged infringement of the patents or trademarks or infringement or misappropriation of other intellectual property rights of third parties by us or our licensees in connection with their use of our products. Intellectual property litigation is expensive and time-consuming, regardless of the merits of any claim, and could divert the attention of our management and technical personnel away from operating our business. If we were to discover that our processes, apparatuses, technology, products or trademarks infringe the valid intellectual property rights of others, we might need to obtain licenses from these parties or substantially reengineer or rebrand our products in order to avoid infringement. We may not be able to obtain the necessary licenses on acceptable terms, or at all, or be able to reengineer our products successfully or at an acceptable cost. Moreover, if we are sued for infringement and lose the suit, we could be required to pay substantial damages and/or be enjoined from using or selling the infringing products or technology or using the infringing trademark. Additionally or alternatively, we may seek to challenge third-party patents in administrative proceedings before the United States patent office or one or more foreign patent offices. Any of the foregoing could cause us to incur significant costs and prevent us from selling our products, which could have an adverse effect on our business, financial condition, results of operations and cash flows. Even if we ultimately prevail, the existence of lawsuits could prompt our customers to switch to alternative products. In addition, we have agreed, and will continue to agree, to indemnify certain customers for certain intellectual property infringement claims related to intellectual property relating to our products and the manufacture thereof. Should there be infringement claims against our licensees, we could be required to indemnify them for losses resulting from such claims or to refund amounts they have paid to us.

Losses and damages in connection with information technology risks could adversely affect our operations.

Our operations materially depend on the reliable performance of a complex, worldwide and highly available information technology infrastructure with integrated processes. The networks and data centers we use are subject to damage by material events such as major disruptions to public infrastructure, including power outages, cyber or terrorist attacks, viruses, malware, physical or electronic break-ins and fires. Despite various disaster recovery plans, there can be no assurance that our systems are appropriately redundant even though we control the operations at the back-up facility we use. Accordingly, such an event could cause material disruptions in our operations.

The broad use of information technology systems has increased the risk of unauthorized access to confidential data, such as customer information, strategic projects, product formulas and other trade secrets, and the risk of destruction or manipulation of material data by employees or third parties. Release of third party confidential information could materially harm our reputation, affect our relationships with such parties and expose us to liability. Although we have introduced many security measures, including firewalls and information technology security policies, these measures may not offer the appropriate level of security. A security breach or other compromise of our information security safeguards could expose our confidential information, including third party confidential information in our possession (such as customer information) to theft and misuse, which could in turn adversely affect our relationships with such third parties and have an adverse effect on our business, financial condition, results of operations and cash flows.

We depend on good relations with our workforce, and any significant disruptions could adversely affect our operations.

As of December 31, 2019, we had 3,279 employees globally, approximately 50% of which were represented by a union, works council or other employee representative body. As of December 31, 2019, approximately 70% of our U.S. unionized employees were covered under collective bargaining agreements that will expire on or before December 31, 2020. Failure to reach agreement with any of our unionized work groups regarding the terms of their collective bargaining agreements or annual pay increases may result in a labor strike, work stoppage or slowdown. In addition, a large number of our employees are employed in countries in which employment laws provide greater bargaining or other rights to employees than the laws of the United States. Such employment rights require us to work collaboratively with the legal representatives of the employees to effect any changes to labor arrangements. For example, many of our employees in Europe are represented by works councils that must approve any changes in conditions of employment, including salaries, benefits and staff changes, and may impede efforts to restructure our workforce. Although we believe that we have a good working relationship with our employees, a strike, work stoppage or slowdown by our employees or a dispute with our employees could result in a significant disruption to our operations or higher ongoing labor costs. In addition, our ability to make adjustments to control compensation and benefit costs, or otherwise adapt to changing business needs, may be limited by the terms and duration of our collective bargaining agreements.

We are subject to certain risks related to litigation filed by or against us, as well as administrative and regulatory proceedings, and adverse results may harm our business.

We cannot predict with certainty the cost of defense, the cost of prosecution or the ultimate outcome of litigation and other administrative and regulatory proceedings filed by or against us, including remedies or damage awards, and adverse results in any litigation or other administrative and regulatory proceedings may materially harm our business. Litigation and other administrative and regulatory proceedings may include, but are not limited to, actions relating to intellectual property, commercial arrangements, environmental, health and safety matters, joint venture agreements, labor and employment matters, domestic and foreign antitrust matters or other harms resulting from the actions of individuals or entities outside of our control. In the case of intellectual property litigation and proceedings, adverse outcomes could include the cancellation, invalidation or other loss of material intellectual property rights used in our business and injunctions prohibiting our use of our processes, apparatuses, technology, trade secrets and proprietary manufacturing expertise, methods and compounds that are subject to third-party patents or other third-party intellectual property rights. Litigation based on environmental matters or exposure to hazardous substances in the workplace or from our products could result in significant liability for us. For example, we are currently subject to various asbestos premises liability claims that relate to employee or contractor exposure to asbestos contained in certain building materials at our sites. Furthermore, our international operations expose us to potential administrative and regulatory proceedings in foreign jurisdictions. Antitrust authorities in Brazil have publicly announced that they are investigating alleged cartel activities by Brazilian silicate manufacturers, including our Brazilian subsidiary (“PQ Brazil”). The authorities allege that the activities occurred over an approximately 10-year period beginning in the late 1990s, which is prior to the time we owned PQ Brazil. PQ Brazil is fully cooperating with the authorities. Adverse outcomes in any of the foregoing could have a material adverse effect on our business.

The terms of our indebtedness restrict our current and future operations, particularly our ability to respond to change or to take certain actions.

The indentures governing our outstanding indebtedness contain a number of restrictive covenants that impose significant operating and financial restrictions on us and may limit our ability to engage in acts that may be in our long-term best interest, including restrictions on our ability to incur additional indebtedness, make investments, acquisitions, loans and advances, sell, transfer or otherwise dispose of our assets or incur liens. See “Management’s Discussion and Analysis of Financial Condition and Results of Operations—Financial Condition, Liquidity and Capital Resources—Debt.” In addition, the restrictive covenants in the agreements governing our senior secured credit facilities require us to maintain specified financial ratios and satisfy other financial condition tests. Our ability to meet these financial ratios and tests can be affected by events beyond our control.

A breach of such covenants could result in an event of default unless we obtain a waiver to avoid such default. If we are unable to obtain a waiver, such a default may allow our creditors to accelerate the related debt and may result in the acceleration of, or default under, any other debt to which a cross-acceleration or cross-default provision applies. In the event our lenders or noteholders accelerate the repayment of our borrowings, we and our subsidiaries may not have sufficient assets to repay that indebtedness.

We may be adversely affected by changes in LIBOR reporting practices or the method in which LIBOR is determined.

LIBOR, the London interbank offered rate, is the basic rate of interest used in lending between banks on the London interbank market and is widely used as a reference for setting the interest rate on loans globally. Our senior secured term loan facility and asset-based revolving credit facility use LIBOR as a reference rate such that the interest due to our creditors under those facilities is calculated using LIBOR. As of December 31, 2019, we had outstanding approximately \$947.5 million of debt that was indexed to LIBOR. In addition, we have entered into a LIBOR-based interest rate cap and cross-currency interest rate swaps to manage our exposure to interest rate movements resulting from changes in the benchmark interest rate of LIBOR. The interest rate cap agreement extends from July 2020 through July 2022 on \$500 million of notional variable-rate debt. As of December 31, 2019, such cross-currency interest rate swap agreements had an aggregate notional amount of approximately \$313.7 million.

On July 27, 2017, the United Kingdom's Financial Conduct Authority, which regulates LIBOR, announced that it intends to phase out LIBOR by the end of 2021. It is unclear if LIBOR will cease to exist at that time or if new methods of calculating LIBOR will be established such that it continues to exist after 2021. The U.S. Federal Reserve, in conjunction with the Alternative Reference Rates Committee, a steering committee comprised of large U.S. financial institutions, is considering replacing U.S. dollar LIBOR with a new index calculated by short-term repurchase agreements, backed by Treasury securities. The future of LIBOR at this time is uncertain and any changes in the methods by which LIBOR is determined or regulatory activity related to LIBOR's phaseout could cause LIBOR to perform differently than in the past or cease to exist. If LIBOR ceases to exist, we may need to renegotiate our credit agreements and/or interest rate cap and cross-currency swap agreements, which may result in interest rates and/or payments that do not correlate over time with the interest rates and/or payments that would have been made on our obligations if LIBOR was available in its current form.

Because our operations are conducted through our subsidiaries and joint ventures, we are dependent on the receipt of distributions and dividends or other payments from our subsidiaries and joint ventures for cash to fund our operations and expenses, including to make future dividend payments, if any.

Our operations are conducted through our subsidiaries and joint ventures. As a result, our ability to make future dividend payments, if any, is dependent on the earnings of our subsidiaries and joint ventures and the payment of those earnings to us in the form of dividends, loans or advances and through repayment of loans or advances from us. Payments to us by our subsidiaries and joint ventures will be contingent upon our subsidiaries' or joint ventures' earnings and other business considerations and may be subject to statutory or contractual restrictions. We do not currently expect to declare or pay dividends on our common stock for the foreseeable future; however, to the extent that we determine in the future to pay dividends on our common stock, the agreements governing our outstanding indebtedness significantly restrict the ability of our subsidiaries to pay dividends or otherwise transfer assets to us.

We may need to recognize impairment charges related to goodwill, identified intangible assets and fixed assets.

We are required to test goodwill and any other intangible asset with an indefinite life for possible impairment on the same date each year and on an interim basis if there are indicators of a possible impairment. We are also required to evaluate indefinite-lived intangible assets and fixed assets for impairment if there are indicators of a possible impairment.

There is significant judgment required in the analysis of a potential impairment of goodwill, identified intangible assets and fixed assets. If, as a result of a general economic slowdown or deterioration in one or more of the industries in which we operate or in our financial performance or future outlook, or if the estimated fair value of our long-lived assets decreases, we may determine that one or more of our long-lived assets is impaired. An impairment charge would be determined based on the estimated fair value of the assets and any such impairment charge could have a material adverse effect on our results of operations and financial position.

Our ability to utilize our net operating losses is uncertain.

As of December 31, 2019, we have \$245.1 million of net operating losses for U.S. federal income tax purposes. Our ability to utilize these net operating losses to offset future income tax liabilities depends on our future financial performance and our future taxable income. In addition, \$105.2 million of these net operating losses are currently subject to limitation under Section 382 of the Internal Revenue Code of 1986, as amended (the "Code"), potentially impacting our ability to realize the benefits of these net operating losses.

Generally, if an ownership change occurs within three years of the closing date of the most recent change in control transaction, any existing net operating losses and certain built-in losses would be subject to an additional limitation pursuant to Section 382 of the Internal Revenue Code (“IRC”). Change in control as defined by Section 382 occurs when there is an ownership change among stockholders owning directly or indirectly 5% or more of our common stock and that results in an aggregate ownership change with respect to such stockholders of more than 50% of our common stock.

We have analyzed our transactional history and determined that the most recent change in control occurred in December of 2014. The Business Combination that occurred in May of 2016 did not result in a change in control as defined by Section 382, and as such, did not further limit the net operating losses available to us.

We believe that it is more likely than not that we will realize the entire \$105.2 million of net operating losses subject to limitation in future years. The remaining \$139.9 million of net operating losses relates to periods subsequent to the most recent change in control and would not be subject to Section 382 limitations.

We may be subject to future changes in tax legislation or exposure to additional tax liabilities that may adversely affect our results of operations.

We are subject to taxes in the U.S. as well as foreign jurisdictions where our subsidiaries are organized. Due to economic and political conditions, tax rates, tax laws and other non-tax legislation, such as economic substance regulations, our business may experience significant impacts as a result of prospective changes. Our future effective tax rates may be affected by changes in the mix of earnings in countries with differing statutory tax rates, changes in the valuation of deferred tax assets and liabilities, changes in available tax credits or tax deductions, as well as changes in tax and other non-tax laws or their interpretation. Additionally, our organization is engaged in a number of cross border intercompany transactions, subject to local transfer pricing regimes currently in place. We believe the economics of these transactions have been clearly reported, and the appropriate local transfer pricing documentation is contemporaneously available, although tax authorities may propose and potentially sustain adjustments that could result in changes to our mix of earnings in countries with differing statutory tax rates. The Organization of Economic Cooperation and Development (“OECD”), which represents a coalition of member countries, is supporting changes to numerous long-standing tax principles through its base erosion and profit shifting (“BEPS”) project. This project focuses on a number of issues, including the shifting of profits cross-border amongst affiliated entities. Given the scope of the Company’s international operations and the fluid and uncertain nature of how the BEPS project might ultimately lead to future legislation, it is difficult to assess how any changes in tax laws would impact the Company’s future income tax expense.

Our tax returns and other tax matters are subject to examination by local tax authorities and governmental bodies. We regularly assess the likelihood of an adverse outcome resulting from these examinations, in order to determine any resulting impact to our provision for taxes. There can be no assurance as to the outcome of these examinations. If our effective tax rates were to increase as a result of a tax examination, or if the ultimate determination of the taxes owed by us is for an amount in excess of amounts previously accrued, our operating results, cash flows and financial condition could be adversely affected.

On December 22, 2017, the Tax Cuts and Jobs Act (“TCJA”) was enacted into law. The TCJA mandated significant changes to U.S. corporate taxation. Notable legislative changes include a reduction of the corporate tax rate from 35% to 21%, new additional limitations on the tax deductibility of interest, extensive changes to the regime governing the taxation of foreign earnings, immediate deductions for certain investments instead of deductions for depreciation expense over time, as well as modification or repeal of certain business deductions and credits. While our current tax accounting is complete based on existing legislative guidance relating to the TCJA, further interpretive guidance of the TCJA’s provisions may result in further adjustments that could have an impact on our future results of operations, cash flows or financial positions.

We have unfunded and underfunded pension plan liabilities. We will require current and future operating cash flow to fund these shortfalls. We have no assurance that we will generate sufficient cash flow to satisfy these obligations.

We maintain defined benefit pension plans covering employees who meet age and service requirements. While some of our plans have been frozen, our net pension liability and cost is materially affected by the discount rate used to measure pension obligations, the longevity and actuarial profile of our workforce, the level of plan assets available to fund those obligations and the actual and expected long-term rate of return on plan assets. Significant changes in investment performance or a change in the portfolio mix of invested assets can result in corresponding increases and decreases in the valuation of plan assets, particularly equity securities, or in a change in the expected rate of return on plan assets. Assets available to fund the pension and other postemployment benefit obligations of our plans as of December 31, 2019 were approximately \$337.6 million, or approximately \$76.4 million less than the measured pension benefit obligation on a GAAP basis. In addition, any changes in the discount rate could result in a significant increase or decrease in the valuation of pension obligations, affecting the reported funded status of our pension plans as well as the net periodic pension cost in the following years. Similarly, changes in the expected return on plan assets can result in significant changes in the net periodic pension cost in the following years.

We also contribute to two multi-employer pension plans on behalf of certain of our employees in the United States pursuant to union agreements that generally provide defined benefits to employees covered by collective bargaining agreements. A total of approximately 18 employees currently participate in such multi-employer pension plans. Funding requirements for benefit obligations of multi-employer pension plans are subject to certain regulatory requirements and we may be required to make cash contributions to one of these plans to satisfy certain underfunded benefit obligations. Absent an applicable exemption, a contributor to a U.S. multi-employer plan is liable upon its withdrawal from, or the termination of, a plan for its proportionate share of the plan's underfunding, if any.

We also provide certain health care and life insurance benefits to certain of our employees and their dependents in the United States upon the retirement of such employee from us pursuant to union agreements. Costs of these other post-employment benefit plans are dependent upon numerous factors, assumptions and estimates.

Risks Related to our Common Stock

CCMP and INEOS continue to have significant influence over us, which could limit your ability to influence the outcome of key transactions, including a change of control.

As of December 31, 2019, investment funds affiliated with CCMP beneficially owned approximately 45% of our outstanding common stock and INEOS beneficially owned approximately 24% of our outstanding common stock. For as long as affiliates of CCMP and INEOS continue to beneficially own a substantial percentage of the voting power of our outstanding common stock, they will continue to have significant influence over us. For example, they will be able to strongly influence or effectively control the election of all of the members of our board of directors and our business and affairs, including any determinations with respect to mergers or other business combinations, the acquisition or disposition of assets, the incurrence of additional indebtedness, the issuance of any additional shares of common stock or other equity securities, the repurchase or redemption of shares of our common stock and the payment of dividends.

Additionally, CCMP and INEOS are in the business of making investments in companies and may acquire and hold interests in businesses that compete directly or indirectly with us. CCMP and INEOS may also pursue acquisition opportunities that may be complementary to our business, and, as a result, those acquisition opportunities may not be available to us.

Our stock price could be extremely volatile and, as a result, you may not be able to resell your shares at or above the price you paid for them.

Since launching our IPO in September 2017, the price of our common stock, as reported on the New York Stock Exchange, has ranged from a low of \$12.88 on March 2, 2018 to a high of \$18.69 on July 10, 2018. In addition, the stock market in general has been highly volatile. As a result, the market price of our common stock is likely to be similarly volatile, and investors in our common stock may experience a decrease, which could be substantial, in the value of their stock, including decreases unrelated to our operating performance or prospects, and could lose part or all of their investment. The price of our common stock could be subject to wide fluctuations in response to a number of factors, including those described elsewhere herein and others such as:

- variations in our operating performance and the performance of our competitors;
- actual or anticipated fluctuations in our quarterly or annual operating results;
- publication of research reports by securities analysts about us, our competitors or our industry;
- our failure or the failure of our competitors to meet analysts' projections or guidance that we or our competitors may give to the market;
- additions or departures of key personnel;
- strategic decisions by us or our competitors, such as acquisitions, divestitures, spin-offs, joint ventures, strategic investments or changes in business strategy;
- the passage of legislation or other regulatory developments affecting us or our industry;
- changes in legislation, regulation and government policy as a result of the U.S. presidential and congressional elections;
- speculation in the press or investment community;
- changes in accounting principles;
- terrorist acts, acts of war or periods of widespread civil unrest;
- natural disasters and other calamities; and
- changes in general market and economic conditions.

In addition, broad market and industry factors may negatively affect the market price of our common stock, regardless of our actual operating performance, and factors beyond our control may cause our stock price to decline rapidly and unexpectedly. We are exposed to the impact of any global or domestic economic disruption, including any potential impact of the United Kingdom's exit from the European Union, commonly referred to as "Brexit."

In the past, securities class action litigation has often been initiated against companies following periods of volatility in their stock price. This type of litigation could result in substantial costs and divert our management's attention and resources, and could also require us to make substantial payments to satisfy judgments or to settle litigation.

If we fail to maintain effective internal control over financial reporting and effective disclosure controls and procedures, we may not be able to accurately report our financial results in a timely manner or prevent fraud, which may adversely affect investor confidence in our company.

Pursuant to Section 404 of the Sarbanes-Oxley Act of 2002, as amended, our management is required to report on, and our independent registered public accounting firm is required to attest to, the effectiveness of our internal control over financial reporting. This assessment includes disclosure of any material weakness identified by our management in our internal control over financial reporting. In addition, we are required to comply with the SEC's rules implementing Section 302 of the Sarbanes-Oxley Act, which requires management to certify financial and other information in our quarterly and annual reports, and we are required to disclose significant changes made in our internal controls and procedures on a quarterly basis.

If we identify a material weakness in our internal control over financial reporting, we may not be able to remediate the material weakness identified in a timely manner or maintain all of the controls necessary to remain in compliance with our reporting obligations. If we are unable to assert that our internal control over financial reporting is effective, or if our independent registered public accounting firm is unable to express an unqualified opinion as to the effectiveness of our internal control over financial reporting in future periods, investors may lose confidence in the accuracy and completeness of our financial reports, the market price of our common stock could be negatively affected, and we could become subject to investigations by the New York Stock Exchange, on which our securities are listed, the SEC or other regulatory authorities, which could require additional financial and management resources.

Your percentage ownership in us may be diluted by future issuances of capital stock, which could reduce your influence over matters on which stockholders vote.

Our board of directors has the authority, without action or vote of our stockholders, to issue all or any part of our authorized but unissued shares of common stock, including shares issuable upon exercise of options, or shares of our authorized but unissued preferred stock. Issuances of common stock or voting preferred stock would reduce your influence over matters on which our stockholders vote and, in the case of issuances of preferred stock, would likely result in your interest in us being subject to the prior rights of holders of that preferred stock.

There may be sales of a substantial amount of our common stock by our current stockholders, and these sales could cause the price of our common stock to fall.

As of December 31, 2019, there were 136,464,961 shares of our common stock outstanding. Approximately 45% and 24% of our outstanding common stock is held by affiliates of CCMP and by INEOS, respectively.

Sales of substantial amounts of our common stock in the public market, or the perception that such sales will occur, could adversely affect the market price of our common stock and make it difficult for us to raise funds through securities offerings in the future.

Investment funds affiliated with CCMP may require us to register shares of our common stock held by them for resale under the federal securities laws, subject to reduction upon the request of the underwriter of the offering, if any. Registration of those shares would allow the investment funds affiliated with CCMP to immediately resell their shares in the public market. Any such sales or anticipation thereof could cause the market price of our common stock to decline.

In addition, we have registered shares of our common stock that are reserved for issuance under our 2016 Stock Incentive Plan and 2017 Omnibus Incentive Plan.

Provisions in our charter documents and Delaware law may deter takeover efforts that may be beneficial to stockholder value.

In addition to investment funds affiliated with CCMP's and INEOS's beneficial ownership of a substantial percentage of our common stock, provisions in our certificate of incorporation and bylaws and Delaware law could make it harder for a third party to acquire us, even if doing so might be beneficial to our stockholders. These provisions include a classified board of directors and the ability of our board of directors to issue preferred stock without stockholder approval that could be used to dilute a potential hostile acquiror. Our certificate of incorporation imposes some restrictions on mergers and other business combinations between us and any holder of 15% or more of our outstanding common stock other than INEOS and investment funds affiliated with CCMP. As a result, you may lose your ability to sell your stock for a price in excess of the prevailing market price due to these protective measures, and efforts by stockholders to change the direction or management of the company may be unsuccessful.

Our certificate of incorporation designates courts in the State of Delaware as the sole and exclusive forum for certain types of actions and proceedings that may be initiated by our stockholders, which could limit our stockholders' ability to obtain a favorable judicial forum for disputes with us or our directors, officers or employees.

Our certificate of incorporation provides that, subject to limited exceptions, the Court of Chancery of the State of Delaware is the sole and exclusive forum for:

- any derivative action or proceeding brought on our behalf;
- any action asserting a claim of breach of a fiduciary duty owed by any of our directors, officers or other employees to us or our stockholders;
- any action asserting a claim against us arising pursuant to any provision of the General Corporation Law of the State of Delaware, our certificate of incorporation or our bylaws;
- any action to interpret, apply, enforce or determine the validity of our certificate of incorporation or bylaws; or
- any other action asserting a claim against us that is governed by the internal affairs doctrine (each, a "Covered Proceeding").

In addition, our certificate of incorporation provides that if any action the subject matter of which is a Covered Proceeding is filed in a court other than the specified Delaware courts without the approval of our board of directors (each, a "Foreign Action"), the claiming party will be deemed to have consented to (i) the personal jurisdiction of the specified Delaware courts in connection with any action brought in any such courts to enforce the exclusive forum provision described above and (ii) having service of process made upon such claiming party in any such enforcement action by service upon such claiming party's counsel in the Foreign Action as agent for such claiming party.

Any person or entity purchasing or otherwise acquiring any interest in shares of our capital stock shall be deemed to have notice of and to have consented to these provisions. These provisions may limit a stockholder's ability to bring a claim in a judicial forum that it finds favorable for disputes with us or our directors, officers or other employees, which may discourage such lawsuits against us and our directors, officers and employees. Alternatively, if a court were to find these provisions of our certificate of incorporation inapplicable to, or unenforceable in respect of, one or more of the specified types of actions or proceedings, we may incur additional costs associated with resolving such matters in other jurisdictions, which could adversely affect our business and financial condition.

Our certificate of incorporation contains a provision renouncing our interest and expectancy in certain corporate opportunities, which could adversely impact our business.

Each of CCMP and INEOS, and the members of our board of directors who are affiliated with CCMP and INEOS, by the terms of our certificate of incorporation, are not required to offer us any corporate opportunity of which they become aware and can take any such corporate opportunity for themselves or offer it to other companies in which they have an investment. We, by the terms of our certificate of incorporation, expressly renounce any interest or expectancy in any such corporate opportunity to the extent permitted under applicable law, even if the opportunity is one that we or our subsidiaries might reasonably have pursued or had the ability or desire to pursue if granted the opportunity to do so. Our certificate of incorporation may not be amended to eliminate our renunciation of any such corporate opportunity arising prior to the date of any such amendment.

CCMP and INEOS are in the business of making investments in companies and may from time to time acquire and hold interests in businesses that compete directly or indirectly with us. These potential conflicts of interest could have a material adverse effect on our business, financial condition, results of operations or prospects if CCMP or INEOS allocate attractive corporate opportunities to themselves or their affiliates instead of to us.

Regulations related to conflict minerals could adversely impact our business.

The Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 contains provisions to improve transparency and accountability concerning the supply of certain minerals, known as conflict minerals, originating from the Democratic Republic of Congo (the “DRC”) and adjoining countries. The SEC requires annual disclosure and reporting requirements for those companies who use conflict minerals mined from the DRC and adjoining countries in their products. There will be costs associated with complying with these disclosure requirements, including for diligence to determine the sources of conflict minerals used in our products and other potential changes to products, processes or sources of supply as a consequence of such verification activities. These rules could adversely affect the sourcing, supply and pricing of materials used in our products. As there may be only a limited number of suppliers offering “conflict free” conflict minerals, we cannot be sure that we will be able to obtain necessary conflict minerals from such suppliers in sufficient quantities or at competitive prices.

Because we have no current plans to pay cash dividends on our common stock for the foreseeable future, you may not receive any return on investment unless you sell your common stock for a price greater than that which you paid for it.

We may retain future earnings, if any, for future operations, expansion and debt repayment and have no current plans to pay any cash dividends for the foreseeable future. Any decision to declare and pay dividends in the future will be made at the discretion of our board of directors and will depend on, among other things, our results of operations, financial condition, cash requirements, contractual restrictions and other factors that our board of directors may deem relevant. In addition, our ability to pay dividends may be limited by covenants of any existing and future outstanding indebtedness we or our subsidiaries incur, including our credit facilities and outstanding notes. See “-Because our operations are conducted through our subsidiaries and joint ventures, we are dependent on the receipt of distributions and dividends or other payments from our subsidiaries and joint ventures for cash to fund our operations and expenses, including to make future dividend payments, if any.” As a result, you may not receive any return on an investment in our common stock unless you sell your common stock for a price greater than that which you paid for it.

**ITEM 1B. UNRESOLVED STAFF
COMMENTS.**

None.

ITEM 2. PROPERTIES.

Our operating headquarters are located in Malvern, Pennsylvania and our primary research and development facility is in Conshohocken, Pennsylvania. As of December 31, 2019, we had 70 manufacturing facilities in 19 countries on six continents. We also had 14 administrative facilities and six research and development facilities located in 13 countries. Our joint ventures operated out of seven facilities located in six countries, including six manufacturing facilities. We also own or lease other properties, including office buildings, warehouses, testing facilities and sales offices.

The table below presents summary information regarding our principal manufacturing facilities as of December 31, 2019.

Location	Owned or leased	Segment ⁽¹⁾
Melbourne-Dandenong, Australia	Owned	PM, PC
Rio Claro, Brazil	Owned	PC, CAT
Pasuruan, Indonesia	Owned	PC, CAT
Tlalnepantla, Mexico	Owned	PM, PC
Eijsden, Netherlands	Owned/Leased ⁽²⁾	PC
Warrington, United Kingdom	Owned	CAT, PC
Augusta, Georgia, United States	Leased	PM
Baton Rouge, Louisiana, United States	Owned	RS
Baytown, Texas, United States	Owned	RS
Dominguez, California, United States	Owned	RS
Hammond, Indiana, United States	Owned	RS
Houston, Texas, United States	Owned	RS
Kansas City, Kansas, United States	Owned ⁽³⁾	CAT
Martinez, California, United States	Owned	RS
Paris, Texas, United States	Owned	PM
Portland, Oregon, United States	Owned	RS

(1) RS: Refining Services; CAT: Catalysts; PM: Performance Materials; PC: Performance Chemicals.

(2) Approximately 89,911 square feet is owned and approximately 75,939 square feet is leased.

(3) We lease a portion of the site to our Zeolyst Joint Venture.

ITEM 3. LEGAL PROCEEDINGS.

From time to time we may be subject to various legal claims and proceedings incidental to the normal conduct of business, relating to such matters as personal injury, product liability and warranty claims, waste disposal practices, release of chemicals into the environment and other matters that may arise in the ordinary course of our business. We currently believe that there is no litigation pending that is likely to have a material adverse effect on our business. Regardless of the outcome, legal proceedings can have an adverse impact on us because of defense and settlement costs, diversion of management resources and other factors.

ITEM 4. MINE SAFETY DISCLOSURES.

Not applicable.

PART II

ITEM 5. MARKET FOR REGISTRANT’S COMMON EQUITY, RELATED STOCKHOLDER MATTERS AND ISSUER PURCHASES OF EQUITY SECURITIES.

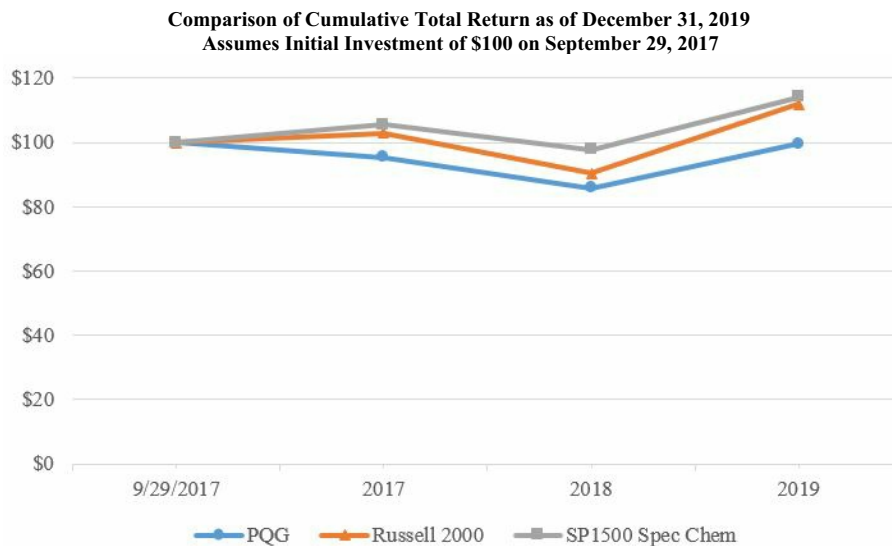
Market Information, Holders and Dividends

Our common stock began trading on the New York Stock Exchange (“NYSE”) under the symbol “PQG” on September 29, 2017. As of February 21, 2020, there were 98 shareholders of record of our common stock. A substantially greater number of holders of our common stock hold their shares in “street name” through banks, brokers and other financial institutions.

We have not and do not currently intend to pay regular dividends on our common stock in the foreseeable future. The declaration and payment of any future dividends by our Board of Directors is subject to compliance with the covenants contained in the agreements governing our credit facilities, the indentures governing our outstanding notes, applicable law and other considerations. See Note 17 to our consolidated financial statements included in this Form 10-K for details regarding covenant restrictions on the payment of dividends under our debt agreements.

Stock Performance Graph

The graph below shows the cumulative total shareholder return of our common stock for the period from September 29, 2017 to December 31, 2019 as compared to the cumulative total return of the Russell 2000 Total Return Index and the S&P 1500 Specialty Chemicals Index, assuming an investment of \$100 made at the respective closing prices on September 29, 2017. The information contained in the graph below is furnished and therefore not to be considered “filed” with the SEC, and is not incorporated by reference into any document that incorporates this Form 10-K by reference.



	9/29/2017	12/31/2017	12/31/2018	12/31/2019
PQG	\$ 100	\$ 95	\$ 86	\$ 100
Russell 2000	100	103	92	112
SP 1500 Spec Chem	100	106	99	114

Issuer Purchases of Equity Securities***Tax Withholdings***

The following table contains information about shares of common stock delivered to the Company by employees to satisfy withholding tax obligations of the employees in connection with the vesting of restricted stock awards and restricted stock units during the fourth quarter of 2019.

	Total Number of Shares of Common Stock Purchased	Average Price Paid per Share of Common Stock	Total Number of Shares of Common Stock Purchased as Part of Publicly Announced Plan or Programs	Maximum Number (or Dollar Value) of Shares of Common Stock that May Yet Be Purchased Under the Plans or Programs
October 2019	78,612	\$ 15.83	N/A	N/A
November 2019	5,132	\$ 16.39	N/A	N/A
December 2019	—	\$ —	N/A	N/A
Total	<u>83,744</u>			

ITEM 6. SELECTED FINANCIAL DATA.

Selected financial data for the Company is presented in the following table and should be read in conjunction with “Management’s Discussion and Analysis of Financial Condition and Results of Operations” included in Item 7 of this Form 10-K and our consolidated financial statements and related notes thereto included in this Form 10-K. Selected financial data has been derived from our audited consolidated financial statements. Historical results are not necessarily indicative of the results to be expected for future periods.

In addition to the analysis of historical results of operations, we have prepared unaudited supplemental pro forma results of operations for the years ended December 31, 2016 and 2015. The unaudited pro forma statements of operations reflect pro forma adjustments to the results of PQ Group Holdings to give effect to the Business Combination and the related financing transactions as if they had occurred on January 1, 2015. The unaudited pro forma adjustments include:

- elimination of intercompany sales between legacy PQ and legacy Eco;
- adjustments to depreciation expense related to the step-up in fair value of property, plant and equipment;
- adjustments to amortization expense related to the step-up in fair value of definite-lived intangible assets;
- removal of non-recurring adjustments related to the step-up in the fair value of inventory;
- adjustments to stock compensation expense to reflect charges as they relate to our new capital structure;
- adjustments related to the amortization of the step-up in fair value of property, plant, equipment and definite-lived intangible assets related to the Zeolyst Joint Venture;
- adjustments to interest expense related to the senior secured term loan facility;
- adjustments related to the write-off of existing deferred financing fees, original issue discounts and prepayment penalties; and
- the tax effect of the aforementioned adjustments, including the effect related to the change in tax status of Eco Services from a limited liability company to a C-corporation.

The unaudited pro forma statements of operations have been prepared in accordance with Article 11 of Regulation S-X by combining the historical results of operations of legacy Eco and legacy PQ for the periods prior to May 4, 2016 and should be read in conjunction with our historical consolidated financial statements and related notes thereto included elsewhere in this Form 10-K.

The unaudited pro forma statements of operations have been prepared for illustrative purposes only and are not necessarily indicative of the combined results of operations that would have been realized had the pro forma transactions been completed as of the dates indicated, nor are they meant to be indicative of any anticipated future results of operations. The unaudited pro forma adjustments are based upon available information and assumptions we believe are factually supportable, directly attributable to the Business Combination and the related financing transactions, and with respect to the statement of operations, expected to have a continuing impact on our business, and that we believe are reasonable under the circumstances. In addition, the unaudited pro forma statements of operations do not include any pro forma adjustments to reflect expected cost savings or restructuring actions which may be achievable or the impact of any non-recurring activity and transaction-related costs.

We believe that the unaudited pro forma statements of operations are a useful presentation of our results of operations as they provide comparative information, period-over-period, on a more comparable basis.

	Historical					Pro Forma		
	Year ended December 31,					Year ended December 31,		
	2019	2018	2017	2016	2015	2016	2015	
(In thousands, except per share data)								
Operating Results:								
Sales	\$ 1,567,072	\$ 1,608,154	\$ 1,472,101	\$ 1,064,177	\$ 388,875	\$ 1,403,041	\$ 1,413,201	
Net (loss) income	80,310	59,621	58,563	(79,158)	11,427	(57,707)	(25,171)	
Net (loss) income attributable to PQ Group Holdings Inc.	\$ 79,539	\$ 58,300	\$ 57,603	\$ (79,746)	\$ 11,427	\$ (58,932)	\$ (26,942)	
Net income (loss) per share:								
Basic income (loss) per share	\$ 0.59	\$ 0.44	\$ 0.52	\$ (1.02)	\$ (3.53)	\$ —	\$ —	
Diluted income (loss) per share	\$ 0.59	\$ 0.43	\$ 0.52	\$ (1.02)	\$ (3.53)	\$ —	\$ —	
Weighted average shares outstanding:								
Basic	134,389,667	133,380,567	111,299,670	78,016,005	22,615,787	—	—	
Diluted	135,548,694	134,684,931	111,669,037	78,016,005	22,615,787	—	—	

	Year ended December 31,				
	2019	2018	2017	2016	2015
(In thousands)					
Financial Position and Other Data:					
Cash and cash equivalents	\$ 72,284	\$ 57,854	\$ 66,195	\$ 70,742	\$ 25,155
Property, plant and equipment, net	1,186,770	1,208,979	1,230,384	1,181,388	481,073
Total assets	4,320,845	4,327,425	4,415,455	4,259,671	1,007,636
Total debt, including current portion	1,906,962	2,113,957	2,230,486	2,562,198	673,101
Total stockholders' equity	1,785,318	1,664,145	1,631,919	1,027,944	235,293
Cash flows data:					
Net cash provided by (used in):					
Operating activities	\$ 267,763	\$ 248,644	\$ 165,173	\$ 122,708	\$ 44,715
Investing activities	(35,359)	(119,290)	(195,982)	(1,915,763)	(38,725)
Financing activities	(216,093)	(137,225)	19,833	1,858,445	(3,462)

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS.

Overview

We are a global provider of specialty catalysts, materials, chemicals and services with leading supply positions across our portfolio. We compete in the global specialty chemicals and materials industry where we seek to focus on attractive, high-growth applications. Our products and services provide critical performance to our customers' products and we are able to offer many of our customers regionally sourced materials to reduce costs and improve delivery logistics. We provide our customers with a combination of product technology and applications knowledge, global supply chain capabilities, and local production and logistical support.

We conduct operations through four reporting segments: (1) Refining Services, (2) Catalysts (including our 50% interest in the Zeolyst Joint Venture), (3) Performance Materials and (4) Performance Chemicals.

Refining Services: We are the leading provider of sulfuric acid recycling services to North American refineries for the production of alkylate, an essential gasoline component for lowering vapor pressure and increasing octane to meet stringent gasoline specifications and fuel efficiency standards. We are also a leading North American producer of on-purpose virgin sulfuric acid for water treatment, mining, and industrial applications.

Catalysts: We are a global supplier of finished silica catalysts and catalyst supports necessary to produce high strength and high stiffness plastics used in packaging films, bottles, containers, and other molded applications. We are also a leading global supplier of zeolites used for catalysts that remove nitric oxide from diesel engine emissions as well as sulfur from fuels during the refining process.

Performance Materials: We are an industry leader in North America, Europe and South America in transportation safety. Our products are used to delineate roads and runways with highly reflective markings, improving safety by enhancing visibility at night and in poor weather. Our microspheres also serve as functional additives in industrial applications, including polymers and plastics, and in abrasive applications for metal surfaces.

Performance Chemicals: We are a leading global supplier of silicate and derivative products which serve as an environmentally friendly substitute for materials used in a variety of applications. These include end uses such as matting agents in surface coatings, clarifying agents for edible oils and beverages, additives for paints and coatings, and in cosmetics to improve feel attributes.

Effective March 1, 2019, we changed the structure of our internal organization to create the four independent businesses described above in order to promote increased visibility to business unit performance, optimize our product portfolio and create efficiencies. Previously, we had two reportable segments, namely the Environmental Catalysts and Services segment and the Performance Materials and Chemicals segment. The segment results and disclosures included in our consolidated financial statements reflect the new segment structure for all periods presented. The changes to our segment structure affect only the manner in which the results of our reportable segments were previously reported; there are no changes to our consolidated balance sheet, statement of income or cash flows for the prior periods.

In 2019, we served over 4,000 customers globally across many end uses and, as of December 31, 2019, operated out of 70 manufacturing facilities, which are strategically located across six continents.

Basis of Presentation

Our zeolite catalysts product group operates through the Zeolyst Joint Venture, which we account for as an equity method investment in accordance with GAAP. We do not record sales by the Zeolyst Joint Venture as revenue and such sales are not consolidated within our results of operations. However, Adjusted EBITDA reflects our share of the earnings of the Zeolyst Joint Venture that have been recorded as equity in net income from affiliated companies in our consolidated statements of income and includes Zeolyst Joint Venture adjustments on a proportionate basis based on our 50% ownership interest.

Key Performance Indicators

Adjusted EBITDA and Adjusted Net Income

Adjusted EBITDA and adjusted net income are financial measures that are not prepared in accordance with GAAP and that we use to evaluate our operating performance, for business planning purposes and to measure our performance relative to that of our competitors. Adjusted EBITDA and adjusted net income are presented as key performance indicators as we believe these financial measures will enhance a prospective investor's understanding of our results of operations and financial condition. EBITDA consists of net income (loss) attributable to PQ Group Holdings before interest, taxes, depreciation and amortization. Adjusted EBITDA consists of EBITDA adjusted for (i) non-operating income or expense, (ii) the impact of certain non-cash, nonrecurring or other items included in net income (loss) and EBITDA that we do not consider indicative of our ongoing operating performance, and (iii) depreciation, amortization and interest of our 50% share of the Zeolyst Joint Venture. Adjusted net income consists of net income (loss) attributable to PQ Group Holdings adjusted for (i) non-operating income or expense and (ii) the impact of certain non-cash, nonrecurring or other items included in net income (loss) that we do not consider indicative of our ongoing operating performance. We believe that these non-GAAP financial measures provide investors with useful financial metrics to assess our operating performance from period-to-period by excluding certain items that we believe are not representative of our core business.

You should not consider adjusted EBITDA or adjusted net income in isolation or as alternatives to the presentation of our financial results in accordance with GAAP. The presentation of adjusted EBITDA and adjusted net income financial measures may differ from similar measures reported by other companies and may not be comparable to other similarly titled measures. In evaluating adjusted EBITDA and adjusted net income, you should be aware that we are likely to incur expenses similar to those eliminated in this presentation in the future and that certain of these items could be considered recurring in nature. Our presentation of adjusted EBITDA and adjusted net income should not be construed as an inference that our future results will be unaffected by unusual or nonrecurring items. Reconciliations of adjusted EBITDA and adjusted net income to GAAP net income (loss) are included in the results of operations discussion that follows for each of the respective periods.

Key Factors and Trends Affecting Operating Results and Financial Condition

Sales

Our Refining Services and Catalysts segments' sales have grown primarily due to expansion into new end applications, including emission control catalysts, polymer catalysts, and refining catalysts, as well as continued supply share gains. Sales in our Refining Services and Catalysts segments are made on both a purchase order basis and pursuant to long-term contracts.

Historically, our Performance Materials and Performance Chemicals segments have experienced relatively stable demand throughout economic cycles, due to the diverse consumer and industrial end uses that our products serve. Expansions into new applications, including personal care and consumer cleaning, as well as share gains in existing end uses, have added to our sales growth. Product sales from our Performance Chemicals segment are made on both a purchase order basis and pursuant to long-term contracts. In the Performance Materials segment, sales have been driven by the growth of spending on repair, maintenance and upgrade of existing highways and the construction of new highways and roads by governments around the world. Product sales in our Performance Materials segment are made principally on a purchase order basis. There may be modest fluctuations in timing of orders, but orders are mainly driven by demand and general economic conditions.

Cost of Goods Sold

Cost of goods sold consists of variable product costs, fixed manufacturing expenses, depreciation expense and freight expenses. Variable product costs include all raw materials, energy and packaging costs that are directly related to the manufacturing process. Fixed manufacturing expenses include all plant employment costs, manufacturing overhead and periodic maintenance costs. The primary raw materials for our Refining Services segment include spent sulfuric acid, sulfur, sodium silicates, acids, bases, and certain metals. The primary raw materials used in the manufacture of products in our Performance Materials, Performance Chemicals and Catalysts segments include soda ash, industrial sand, aluminum trihydrate, sodium hydroxide (also known as "caustic soda"), and cullet.

Most of our Refining Services contracts feature take-or-pay volume protection and/or quarterly price adjustments for commodity inputs, labor, the Chemical Engineering Index (U.S. chemical plant construction cost index) and natural gas. Spent acid for our Refining Services segment is supplied by customers for a nominal charge as part of their contracts. Over 90% of our Refining Services segment sales for the year ended December 31, 2019 were under contracts featuring quarterly price adjustments. The price adjustments generally reflect actual costs for producing acid and tend to protect us from volatility in labor, fixed costs and raw material pricing.

For the year ended December 31, 2019, approximately 50% of our North American silicate sales, which is a significant portion of our Performance Chemicals segment sales, were derived from contracts that included raw material pass-through clauses. Under these contracts, there generally is a time lag of three to nine months for price changes to pass through, depending on the magnitude of the change in cost and other market dynamics. Freight expenses are generally passed through directly to customers.

While natural gas is not a direct feedstock for any product, all businesses use natural gas powered furnaces to heat raw materials and create the chemical reactions necessary to produce end-products. We maintain multiple suppliers wherever possible, hedge exposure to fluctuations in prices for natural gas purchases in the United States, make forward purchases of natural gas in the United States, Canada, and Europe to mitigate our exposure to price volatility, and structure our customer contracts when possible to allow for the pass-through of raw material and natural gas costs.

Joint Ventures

We account for our investments in our equity joint ventures under the equity method. Our largest joint venture, the Zeolyst Joint Venture, manufactures high performance, specialty, zeolite-based catalysts for use in the emission control industry, the petrochemical industry and other areas of the broader chemicals industry. We share proportionally in the management of our joint ventures with the other parties to each such joint venture.

Seasonality

Seasonal changes and weather conditions typically affect our Performance Materials and Refining Services segments. In particular our Performance Materials segment generally experiences lower sales and profit in the first and fourth quarters of the year because highway striping projects typically occur during warmer weather months. Additionally, our Refining Services segment typically experiences similar seasonal fluctuations as a result of higher demand for gasoline products in the summer months. As a result, our working capital requirements tend to be higher in the first and second quarters of the year, which can adversely affect our liquidity and cash flows. Because of this seasonality associated with certain of our segments, results for any one quarter are not necessarily indicative of the results that may be achieved for any other quarter or for the full year.

Foreign Currency

As a global business, we are subject to the impact of gains and losses on currency translations, which occur when the financial statements of foreign operations are translated into U.S. dollars. We operate a geographically diverse business with approximately 40% of our sales for the years ended December 31, 2019 and 2018 in currencies other than the U.S. dollar. Because our consolidated financial results are reported in U.S. dollars, sales or earnings generated in currencies other than the U.S. dollar can result in a significant increase or decrease in the amount of those sales and earnings when translated to U.S. dollars. The foreign currencies to which we have the most significant exchange rate exposure include the Euro, British pound, Canadian dollar, Brazilian real and the Mexican peso.

Results of Operations

Year Ended December 31, 2019 Compared to the Year Ended December 31, 2018

Highlights

The following is a summary of our financial performance for the year ended December 31, 2019 compared with the year ended December 31, 2018.

Sales

- Sales decreased \$41.1 million to \$1,567.1 million. The decrease in sales was primarily due to lower sales volumes and the unfavorable effects of foreign currency translation of \$29.2 million, which was partially offset by higher average customer prices and favorable mix.

Gross Profit

- Gross profit increased \$8.8 million to \$390.5 million. The increase in gross profit was primarily due to favorable customer pricing, which was partially offset by lower sales volumes, unfavorable manufacturing costs and the unfavorable effects of foreign currency translation.

Operating Income

- Operating income increased \$4.2 million to \$187.8 million. The increase in operating income was primarily due to an increase in gross profit for the year ended December 31, 2019.

Equity in Net Income of Affiliated Companies

- Equity in net income of affiliated companies for the year ended December 31, 2019 was \$46.0 million, compared with net income of \$37.6 million for the year ended December 31, 2018. The increase was due to higher earnings of \$8.4 million generated by the Zeolyst Joint Venture during the year ended December 31, 2019 as compared to the year ended December 31, 2018.

The following is our consolidated statement of income and a summary of financial results for the years ended December 31, 2019 and 2018.

	Years ended December 31,		Change	
	2019	2018	\$	%
(in millions, except percentages)				
Sales	\$ 1,567.1	\$ 1,608.2	\$ (41.1)	(2.6)%
Cost of goods sold	1,176.6	1,226.5	(49.9)	(4.1)%
Gross profit	390.5	381.7	8.8	2.3 %
<i>Gross profit margin</i>	24.9%	23.7%		
Selling, general and administrative expenses	166.9	168.6	(1.7)	(1.0)%
Other operating expense, net	35.8	29.5	6.3	21.4 %
Operating income	187.8	183.6	4.2	2.3 %
<i>Operating income margin</i>	12.0%	11.4%		
Equity in net income from affiliated companies	(46.0)	(37.6)	(8.4)	22.3 %
Interest expense, net	111.5	113.7	(2.2)	(1.9)%
Debt extinguishment costs	3.4	7.8	(4.4)	(56.4)%
Other (income) expense, net	(2.1)	11.1	(13.2)	(118.9)%
Income before income taxes and noncontrolling interest	121.0	88.6	32.4	36.6 %
Provision for income taxes	40.7	29.0	11.7	40.3 %
<i>Effective tax rate</i>	33.6%	32.7%		
Net income	80.3	59.6	20.7	34.7 %
Less: Net income attributable to the noncontrolling interest	0.8	1.3	(0.5)	(38.5)%
Net income attributable to PQ Group Holdings Inc.	\$ 79.5	\$ 58.3	\$ 21.2	36.4 %

Sales

	Years ended December 31,		Change	
	2019	2018	\$	%
(in millions, except percentages)				
Sales:				
Refining Services	\$ 447.1	\$ 455.6	\$ (8.5)	(1.9)%
Catalysts	85.7	72.1	13.6	18.9 %
Performance Materials	363.0	378.3	(15.3)	(4.0)%
Performance Chemicals	685.1	717.3	(32.2)	(4.5)%
Eliminations	(13.8)	(15.1)	1.3	
Total sales	\$ 1,567.1	\$ 1,608.2	\$ (41.1)	(2.6)%

Refining Services: Sales in Refining Services for the year ended December 31, 2019 were \$447.1 million, a decrease of \$8.5 million, or 1.9%, compared to sales of \$455.6 million for the year ended December 31, 2018. The decrease in sales was primarily due to lower sales volumes of \$30.4 million which was partially offset by favorable customer mix driving higher average selling prices of \$21.9 million.

The decrease in volumes was due to lower demand for virgin sulfuric acid and unexpected customer plant outages. The favorable customer mix was driven by the roll-off of a below-market contract and other contract renewals in our regenerated sulfuric acid and virgin sulfuric acid product lines.

Catalysts: Sales in Catalysts for the year ended December 31, 2019 were \$85.7 million, an increase of \$13.6 million, or 18.9%, compared to sales of \$72.1 million for the year ended December 31, 2018. The increase in sales was primarily due to higher sales volumes of \$11.6 million and higher average selling price from product mix of \$3.3 million.

The increase in sales was due to the timing of customer orders for methyl methacrylate catalyst and higher customer demand and pricing within our polyolefin catalysts product line.

Performance Materials: Sales in Performance Materials for the year ended December 31, 2019 were \$363.0 million, a decrease of \$15.3 million, or 4.0%, compared to sales of \$378.3 million for the year ended December 31, 2018. The decrease in sales was primarily due to lower sales volumes of \$28.5 million and the unfavorable effects of foreign currency translation of \$9.6 million, which was partially offset by higher average selling price and favorable customer mix of \$22.8 million.

The decrease in sales volumes was a result of unfavorable weather conditions in North America and lower demand in Europe for engineered glass materials. The unfavorable effects of foreign currency translation were due to the stronger U.S. dollar as compared with the Euro. This was partially offset by higher average selling prices within our highway safety product lines.

Performance Chemicals: Sales in Performance Chemicals for the year ended December 31, 2019 were \$685.1 million, a decrease of \$32.2 million, or 4.5%, compared to sales of \$717.3 million for the year ended December 31, 2018. The decrease in sales was primarily due to lower sales volumes of \$32.5 million and the unfavorable effects of foreign currency translation of \$18.7 million, which was partially offset by higher average selling price and favorable mix of \$19.0 million.

The decrease in sales was a result of lower volumes sold to the consumer products and industrial and process chemicals industries and the unfavorable effects of foreign currency translation driven by the stronger U.S. dollar, which was partially offset by higher pricing to cover raw material cost increases.

Gross Profit

Gross profit for the year ended December 31, 2019 was \$390.5 million, an increase of \$8.8 million, or 2.3%, compared with \$381.7 million for the year ended December 31, 2018. The increase in gross profit was due to favorable customer pricing of \$66.9 million which was offset by lower volumes of \$38.7 million, unfavorable manufacturing costs of \$16.5 million and the unfavorable effects of foreign currency translation of \$7.6 million.

Favorable customer pricing was primarily a result of a roll-off of a below-market contract in our virgin sulfuric acid product line and higher average selling prices in North America for our highway safety products. The decrease in volumes was due to a decline in sulfuric acid sales and lower sales to the consumer and industrial products industries. The unfavorable change in manufacturing costs was driven by the higher labor costs, timing of plant maintenance projects and increased transportation costs. The unfavorable effects of foreign currency were driven by the stronger U.S. dollar.

Selling, General and Administrative Expenses

Selling, general and administrative expenses for the year ended December 31, 2019 were \$166.9 million, a decrease of \$1.7 million, or 1.0%, compared with \$168.6 million for the year ended December 31, 2018. The decrease in selling, general and administrative expenses was due to lower research and development expenditures and a decrease in professional fees, which was partially offset by an increase in compensation-related costs.

Other Operating Expense, Net

Other operating expense, net for the year ended December 31, 2019 was \$35.8 million, an increase of \$6.3 million, or 21.4%, compared with \$29.5 million for the year ended December 31, 2018. The increase in other operating expense, net was primarily due to the effects of non-recurring gains in the current year as compared to the prior year. During the year ended December 31, 2019, we realized a gain of \$11.0 million on the disposition of assets related to a non-core product line as well as a gain of \$7.1 million on the sale of property. During the year ended December 31, 2018, we recognized non-recurring gains on the termination of a customer supply contract of \$20.6 million and insurance recoveries totaling \$6.5 million related to losses sustained as a result of Hurricane Harvey in August 2017 (of which \$5.5 million was recorded in other operating expense, net).

Equity in Net Income of Affiliated Companies

Equity in net income of affiliated companies for the year ended December 31, 2019 was \$46.0 million, an increase of \$8.4 million, compared with income of \$37.6 million for the year ended December 31, 2018. The increase was primarily due to \$52.2 million of earnings generated by the Zeolyst Joint Venture during the year ended December 31, 2019 as compared to \$42.9 million for the year ended December 31, 2018, which was a result of higher year-over-year growth in hydrocracking and specialty chemical event-driven sales.

Interest Expense, Net

Interest expense, net for the year ended December 31, 2019 was \$111.5 million, a decrease of \$2.2 million, as compared with \$113.7 million for the year ended December 31, 2018. The decrease in interest expense was due to lower average debt balances.

Debt Extinguishment Costs

Debt extinguishment costs for the years ended December 31, 2019 and 2018 were \$3.4 million and \$7.8 million, respectively.

During the year ended December 31, 2019, we prepaid \$210.0 million of outstanding principal balance on the Term Loan Facility (as defined below). In connection with this prepayment, we wrote off \$1.0 million of previously unamortized deferred financing costs and original issue discount of \$2.4 million as debt extinguishment costs.

During the year ended December 31, 2018, we prepaid \$100.0 million of outstanding principal balance on the Term Loan Facility. In connection with this prepayment, we wrote off \$0.6 million of previously unamortized deferred financing costs and original issue discount of \$1.3 million as debt extinguishment costs.

On February 8, 2018 we refinanced our existing senior secured term loan facility with a new \$1,267.0 million senior secured term loan facility to reduce the applicable interest rates. We recorded \$2.1 million of new creditor and third-party financing fees as debt extinguishment costs. In addition, previously unamortized deferred financing costs of \$1.4 million and original issue discount of \$2.4 million associated with the existing senior secured term loan facility were written off as debt extinguishment costs.

Other (Income) Expense, Net

Other (income) expense, net was income of \$2.1 million for the year ended December 31, 2019, a favorable change of \$13.2 million, compared with expense of \$11.1 million for the year ended December 31, 2018. The change primarily consisted of \$2.3 million in sales and use tax refunds received during the year ended December 31, 2019 and \$11.0 million of lower foreign currency losses primarily related to the non-permanent intercompany debt denominated in local currency and translated to U.S. dollars.

Provision for Income Taxes

The provision for income taxes for the year ended December 31, 2019 was \$40.7 million compared to a \$29.0 million provision for the year ended December 31, 2018. The effective income tax rate for the year ended December 31, 2019 was 33.6% compared to 32.7% for the year ended December 31, 2018. The difference between the U.S. federal statutory income tax rate and our effective income tax rate for the year ended December 31, 2019 was mainly due to the impact of the Global Intangible Low Taxed Income ("GILTI") provisions of U.S. tax reform, foreign withholding taxes and state taxes. The difference between the U.S. federal statutory income tax rate and our effective income tax rate for the year ended December 31, 2018 was mainly due to the impact of the GILTI provisions of U.S. tax reform, the effect of permanent differences related to foreign currency exchange gain or loss, changes in valuation allowances, differing tax rates in foreign jurisdictions as compared to the U.S. statutory tax rate, tax rate changes and state taxes.

Net Income Attributable to PQ Group Holdings

For the foregoing reasons and after the effect of the non-controlling interest in earnings of subsidiaries for each period presented, net income attributable to PQ Group Holdings was \$79.5 million for the year ended December 31, 2019 as compared to net income of \$58.3 million for the year ended December 31, 2018.

Adjusted EBITDA

Summarized Segment Adjusted EBITDA information is shown below in the following table:

	Years ended December 31,		Change	
	2019	2018	\$	%
(in millions, except percentages)				
Segment Adjusted EBITDA ⁽¹⁾ :				
Refining Services	\$ 175.6	\$ 176.5	\$ (0.9)	(0.5)%
Catalysts ⁽²⁾	107.8	81.1	26.7	32.9 %
Performance Materials	76.7	72.5	4.2	5.8 %
Performance Chemicals	154.3	170.9	(16.6)	(9.7)%
Total Segment Adjusted EBITDA ⁽³⁾	514.4	501.0	13.4	2.7 %
Unallocated corporate expenses	(40.1)	(37.0)	(3.1)	8.4 %
Adjusted EBITDA	\$ 474.3	\$ 464.0	\$ 10.3	2.2 %

(1) We define Segment Adjusted EBITDA as EBITDA adjusted for certain items as noted in the reconciliation below. Our management evaluates the performance of our segments and allocates resources based primarily on Segment Adjusted EBITDA. Segment Adjusted EBITDA does not represent cash flow for periods presented and should not be considered as an alternative to net income as an indicator of our operating performance or as an alternative to cash flows as a source of liquidity. Segment Adjusted EBITDA may not be comparable with EBITDA or Adjusted EBITDA as defined by other companies.

(2) The Adjusted EBITDA from the Zeolyst Joint Venture included in the Catalysts segment is \$68.1 million for the year ended December 31, 2019, which includes \$52.2 million of equity in net income, excluding \$7.5 million of amortization of investment in affiliate step-up, plus \$14.7 million of joint venture depreciation, amortization and interest. The Adjusted EBITDA from the Zeolyst Joint Venture included in the Catalysts segment is \$56.7 million for the year ended December 31, 2018, which includes \$42.9 million of equity in net income, excluding \$6.6 million of amortization of investment in affiliate step-up, plus \$12.6 million of joint venture depreciation, amortization and interest.

(3) Our total Segment Adjusted EBITDA differs from our total consolidated Adjusted EBITDA due to unallocated corporate expenses.

Refining Services: Adjusted EBITDA for the year ended December 31, 2019 was \$175.6 million, a decrease of \$0.9 million, or 0.5%, compared with \$176.5 million for the year ended December 31, 2018. Refining Services adjusted EBITDA was consistent with the prior year, and negatively impacted by decreased demand for virgin sulfuric acid, unexpected customer plant outages, timing of plant turnaround costs and the absence of a gain from insurance proceeds related to Hurricane Harvey, which was offset by the roll-off of a below-market contract and other contract renewals in our regenerated sulfuric acid and virgin sulfuric acid product lines.

Catalysts: Adjusted EBITDA for the year ended December 31, 2019 was \$107.8 million, an increase of \$26.7 million, or 32.9%, compared with \$81.1 million for the year ended December 31, 2018. Adjusted EBITDA increased due to favorable costs from building inventories to meet future sales commitments, higher polyolefin catalysts product group sales and increased sales of chemical synthesis catalysts sold to the methyl methacrylate end market.

Performance Materials: Adjusted EBITDA for the year ended December 31, 2019 was \$76.7 million, an increase of \$4.2 million, or 5.8%, compared with \$72.5 million for the year ended December 31, 2018. The increase in Adjusted EBITDA was a result of improved pricing which was offset by lower volumes due to unfavorable weather conditions in North America and lower demand in Europe for engineered glass materials.

Performance Chemicals: Adjusted EBITDA for the year ended December 31, 2019 was \$154.3 million, a decrease of \$16.6 million, or 9.7%, compared with \$170.9 million for the year ended December 31, 2018. The decrease in Adjusted EBITDA was due to lower volumes of product sold to the industrial and consumer products industries and the strengthening of the U.S. dollar, which was partially offset by favorable product mix.

A reconciliation of net income attributable to PQ Group Holdings to Segment Adjusted EBITDA is as follows:

	Years ended December 31,	
	2019	2018
(in millions)		
Reconciliation of net income attributable to PQ Group Holdings Inc. to Segment Adjusted EBITDA		
Net income attributable to PQ Group Holdings Inc.	\$ 79.5	\$ 58.3
Provision for income taxes	40.7	29.0
Interest expense, net	111.5	113.7
Depreciation and amortization	182.1	185.2
EBITDA	413.8	386.2
Joint venture depreciation, amortization and interest ^(a)	14.7	12.6
Amortization of investment in affiliate step-up ^(b)	7.5	6.6
Amortization of inventory step-up ^(c)	—	1.6
Impairment of intangible assets	1.6	—
Debt extinguishment costs	3.4	7.8
Net (gain) loss on asset disposals ^(d)	(13.1)	6.6
Foreign currency exchange loss ^(e)	2.8	13.8
LIFO expense ^(f)	11.1	8.4
Transaction and other related costs ^(g)	3.6	0.9
Equity-based compensation	18.2	19.5
Restructuring, integration and business optimization expenses ^(h)	4.1	14.0
Defined benefit plan pension cost ⁽ⁱ⁾	3.1	(0.8)
Gain on contract termination ^(j)	—	(20.6)
Other ^(k)	3.5	7.4
Adjusted EBITDA	474.3	464.0
Unallocated corporate expenses	40.1	37.0
Segment Adjusted EBITDA	\$ 514.4	\$ 501.0

^(a) We use Adjusted EBITDA as a performance measure to evaluate our financial results. Because our Catalysts segment includes our 50% interest in the Zeolyst Joint Venture, we include an adjustment for our 50% proportionate share of depreciation, amortization and interest expense of the Zeolyst Joint Venture.

^(b) Represents the amortization of the fair value adjustments associated with the equity affiliate investment in the Zeolyst Joint Venture as a result of the Business Combination. We determined the fair value of the equity affiliate investment and the fair value step-up was then attributed to the underlying assets of the Zeolyst Joint Venture. Amortization is primarily related to the fair value adjustments associated with fixed assets and intangible assets, including customer relationships and technical know-how.

^(c) As a result of the Sovitec acquisition, there was a step-up in the fair value of inventory, which is amortized through cost of goods sold in the statement of income.

^(d) When asset disposals occur, we remove the impact of net gain/loss of the disposed asset because such impact primarily reflects the non-cash write-off of long-lived assets no longer in use. During the year ended December 31, 2019, the net gain on asset disposals includes the gains related to the sale of a non-core product line and sale of property.

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- (e) Reflects the exclusion of the foreign currency transaction gains and losses in the statements of income primarily related to the non-permanent intercompany debt denominated in local currency translated to U.S. dollars and, for the year ended December 31, 2018, the Euro-denominated term loan (which was settled as part of the February 2018 term loan refinancing).
- (f) Represents non-cash adjustments to the Company's LIFO reserves for certain inventories in the U.S. that are valued using the LIFO method, which we believe provides a means of comparison to other companies that may not use the same basis of accounting for inventories.
- (g) Represents the costs related to several transactions that are completed, pending or abandoned and that we believe are not representative of our ongoing business operations.
- (h) Includes the impact of restructuring, integration and business optimization expenses which are incremental costs that are not representative of our ongoing business operations.
- (i) Represents adjustments for defined benefit pension plan costs in our statement of income. More than two-thirds of our defined benefit pension plan obligations are under defined benefit pension plans that are frozen, and the remaining obligations primarily relate to plans operated in certain of our non-U.S. locations that, pursuant to jurisdictional requirements, cannot be frozen. As such, we do not view such expenses as core to our ongoing business operations.
- (j) Represents a non-cash gain on the write-off of the remaining liability under a contractual supply arrangement. As part of the acquisition by Eco Services Operations LLC of substantially all of the assets of Solvay USA Inc.'s sulfuric acid refining business unit on December 1, 2014 (the "2014 Acquisition"), we recognized a liability as part of business combination accounting related to our obligation to serve a customer under a pre-existing unfavorable supply agreement. In December 2018, the customer who was party to the agreement closed its facility, and as a result, we were relieved from our obligation to continue to supply the customer on the below market contract. Because the fair value of the unfavorable contract liability was recognized as part of the application of business combination accounting, and since the write-off of the remaining liability was non-cash in nature, we believe this gain is a special item that is not representative of our ongoing business operations.
- (k) Other costs consist of certain expenses that are not core to our ongoing business operations, including environmental remediation-related costs associated with the legacy operations of our business prior to the Business Combination, capital and franchise taxes, non-cash asset retirement obligation accretion and the initial implementation of procedures to comply with Section 404 of the Sarbanes-Oxley Act. Included in this line-item are rounding discrepancies that may arise from rounding from dollars (in thousands) to dollars (in millions).

Adjusted Net Income

Summarized adjusted net income information is shown below in the following table:

	Years ended December 31,					
	2019			2018		
	Pre-tax	Tax expense (benefit)	After-tax	Pre-tax	Tax expense (benefit)	After-tax
	(in millions)					
Reconciliation of net income attributable to PQ Group Holdings Inc. to Adjusted Net Income ⁽¹⁾⁽²⁾						
Net income before non-controlling interest	\$ 121.0	\$ 40.7	\$ 80.3	\$ 88.6	\$ 29.0	\$ 59.6
Less: Net income attributable to non-controlling interest	0.8	—	0.8	1.3	—	1.3
Net income attributable to PQ Group Holdings Inc.	120.2	40.7	79.5	87.3	29.0	58.3
Amortization of investment in affiliate step-up ^(b)	7.5	2.5	5.0	6.6	2.5	4.1
Amortization of inventory step-up ^(c)	—	—	—	1.6	0.6	1.0
Impairment of intangible assets	1.6	0.5	1.1	—	—	—
Debt extinguishment costs	3.4	1.1	2.3	7.8	2.9	4.9
Net (gain) loss on asset disposals ^(d)	(13.1)	(3.4)	(9.7)	6.6	2.4	4.2
Foreign currency exchange (gain) loss ^(e)	2.8	(1.5)	4.3	13.8	5.6	8.2
LIFO expense ^(f)	11.1	3.7	7.4	8.4	3.1	5.3
Transaction and other related costs ^(g)	3.6	1.2	2.4	0.9	0.3	0.6
Equity-based compensation	18.2	6.1	12.1	19.5	4.6	14.9
Restructuring, integration and business optimization expenses ^(h)	4.1	1.4	2.7	14.0	5.2	8.8
Defined benefit plan pension cost ⁽ⁱ⁾	3.1	1.0	2.1	(0.8)	(0.3)	(0.5)
Gain on contract termination ^(j)	—	—	—	(20.6)	(7.6)	(13.0)
Other ^(k)	3.5	1.3	2.2	7.4	2.8	4.6
Adjusted Net Income, including non-cash GILTI tax and tax reform	166.0	54.6	111.4	152.5	51.1	101.4
Impact of non-cash GILTI tax ⁽³⁾	—	(13.8)	13.8	—	(21.2)	21.2
Impact of tax reform ⁽⁴⁾	—	—	—	—	6.0	(6.0)
Adjusted Net Income	<u>\$ 166.0</u>	<u>\$ 40.8</u>	<u>\$ 125.2</u>	<u>\$ 152.5</u>	<u>\$ 35.9</u>	<u>\$ 116.6</u>

(1) We define adjusted net income as net income attributable to PQ Group Holdings adjusted for non-operating income or expense and the impact of certain non-cash or other items that are included in net income that we do not consider indicative of our ongoing operating performance. Adjusted net income is presented as a key performance indicator as we believe it will enhance a prospective investor's understanding of our results of operations and financial condition. Adjusted net income may not be comparable with net income or adjusted net income as defined by other companies.

(2) Refer to the Adjusted EBITDA notes above for more information with respect to each adjustment.

- (3) Amount represents the impact to tax expense in net income before non-controlling interest and the related adjustments to net income associated with the GILTI provisions of the TCJA. Beginning January 1, 2018, GILTI resulted in taxation of “excess of foreign earnings,” which is defined as amounts greater than a 10% rate of return on applicable foreign tangible asset basis. The Company is required to record incremental tax provision impact with respect to GILTI as a result of having historical U.S. net operating loss (“NOL”) amounts to offset the GILTI taxable income inclusion. This NOL utilization precludes us from recognizing foreign tax credits (“FTCs”) which would otherwise help offset the tax impacts of GILTI. No FTCs will be recognized with respect to GILTI until our cumulative NOL balance has been exhausted. Because the GILTI provision does not currently impact our cash taxes (given available U.S. NOLs), and given that we expect to recognize FTCs to offset GILTI impacts once the NOLs are exhausted, we do not view this item as a component of core operations.
- (4) Represents the transition tax adjustment for the impact of the TCJA and the rate change in the Netherlands related to the Dutch Tax Plan 2019 recorded in net income.

The adjustments to net income attributable to PQ Group Holdings Inc. are shown net of applicable statutory tax rates.

Year Ended December 31, 2018 Compared to the Year Ended December 31, 2017

Highlights

The following is a summary of our financial performance for the year ended December 31, 2018 compared with the year ended December 31, 2017.

Sales

- Sales increased \$136.1 million to \$1,608.2 million. The increase in sales was primarily due to increased volumes and higher average customer prices and favorable mix for the year ended December 31, 2018.

Gross Profit

- Gross profit increased \$4.9 million to \$381.7 million. Our increase in gross profit was primarily due to higher pricing, increased volumes and the earnings contributed by the Sovitec acquisition, which were partially offset by higher manufacturing costs and the unfavorable impact on our product mix due to increased sales of lower-margin goods for the year ended December 31, 2018.

Operating Income

- Operating income increased by \$17.7 million to \$183.6 million. Our increase in operating income was primarily due to an increase in gross profit, as noted above, and the favorable impact related to a long-term contract termination, which was partially offset by increased public-company costs for the year ended December 31, 2018.

Equity in Net Income of Affiliated Companies

- Equity in net income of affiliated companies for the year ended December 31, 2018 was \$37.6 million, compared with net income of \$38.8 million for the year ended December 31, 2017. The decrease was due to lower earnings of \$3.4 million generated by the Zeolyst Joint Venture during the year ended December 31, 2018 as compared to the year ended December 31, 2017 and \$2.0 million of lower amortization on the fair value step-up of the underlying assets of the Zeolyst Joint Venture, which was a result of the Business Combination.

The following is our consolidated statement of income and a summary of financial results for the years ended December 31, 2018 and 2017.

	Years ended December 31,		Change	
	2018	2017	\$	%
(in millions, except percentages)				
Sales	\$ 1,608.2	\$ 1,472.1	\$ 136.1	9.2 %
Cost of goods sold	1,226.5	1,095.3	131.2	12.0 %
Gross profit	381.7	376.8	4.9	1.3 %
<i>Gross profit margin</i>	<i>23.7%</i>	<i>25.6%</i>		
Selling, general and administrative expenses	168.6	146.7	21.9	14.9 %
Other operating expense, net	29.5	64.2	(34.7)	(54.0)%
Operating income	183.6	165.9	17.7	10.7 %
<i>Operating income margin</i>	<i>11.4%</i>	<i>11.3%</i>		
Equity in net income from affiliated companies	(37.6)	(38.8)	1.2	(3.1)%
Interest expense, net	113.7	179.0	(65.3)	(36.5)%
Debt extinguishment costs	7.8	61.9	(54.1)	(87.4)%
Other expense, net	11.1	24.4	(13.3)	(54.5)%
Income (loss) before income taxes and noncontrolling interest	88.6	(60.6)	149.2	(246.2)%
Provision (benefit) for income taxes	29.0	(119.2)	148.2	(124.3)%
<i>Effective tax rate</i>	<i>32.7%</i>	<i>196.6%</i>		
Net income	59.6	58.6	1.0	1.7 %
Less: Net income attributable to the noncontrolling interest	1.3	1.0	0.3	30.0 %
Net income attributable to PQ Group Holdings Inc.	\$ 58.3	\$ 57.6	\$ 0.7	1.2 %

Sales

	Years ended December 31,		Change	
	2018	2017	\$	%
(in millions, except percentages)				
Sales:				
Refining Services	\$ 455.6	\$ 398.4	\$ 57.2	14.4 %
Catalysts	72.1	75.3	(3.2)	(4.2)%
Performance Materials	378.3	324.2	54.1	16.7 %
Performance Chemicals	717.3	687.6	29.7	4.3 %
Eliminations	(15.1)	(13.4)	(1.7)	
Total sales	\$ 1,608.2	\$ 1,472.1	\$ 136.1	9.2 %

Refining Services: Sales in Refining Services for the year ended December 31, 2018 were \$455.6 million, an increase of \$57.2 million, or 14.4%, compared to sales of \$398.4 million for the year ended December 31, 2017. The increase in sales was primarily due to favorable customer mix driving higher average selling prices of \$29.6 million and increased volumes of \$27.6 million.

The higher average selling price and customer mix was driven by higher cost pass-through pricing in our virgin sulfuric acid product line and favorable customer pricing in our regeneration services product line. The increase in volumes was driven by higher customer demand within our virgin sulfuric acid and regeneration services product lines.

Catalysts: Sales in Catalysts for the year ended December 31, 2018 were \$72.1 million, a decrease of \$3.2 million, or 4.2%, compared to sales of \$75.3 million for the year ended December 31, 2017. The decrease in sales was primarily due to lower sales volumes of \$2.0 million and unfavorable product mix of \$1.1 million.

The decrease in volumes was due to lower methyl methacrylate sales, which was partially offset by an increase in polyolefin catalyst sales.

Performance Materials: Sales in Performance Materials for the year ended December 31, 2018 were \$378.3 million, an increase of \$54.1 million, or 16.7%, compared to sales of \$324.2 million for the year ended December 31, 2017. The increase in sales was primarily due to increased volumes of \$47.9 million and higher average selling price and favorable customer mix of \$8.5 million, which was partially offset by the unfavorable effects of foreign currency translation of \$2.3 million.

The increase in sales volumes was due to the integration of Sovitec into our existing European operations and increased North American highway safety product sales. Higher average selling prices were principally a result of price increases in certain product lines. The unfavorable effects of foreign currency were primarily driven by a stronger Brazilian Real as compared to the U.S. dollar, which was partially offset by the weaker Euro and British Pound compared to the U.S. dollar.

Performance Chemicals: Sales in Performance Chemicals for the year ended December 31, 2018 were \$717.3 million, an increase of \$29.7 million, or 4.3%, compared to sales of \$687.6 million for the year ended December 31, 2017. The increase in sales was primarily due to higher average selling price and favorable customer mix of \$22.8 million, the favorable effects of foreign currency translation of \$3.8 million and an increase in sales volumes of \$3.1 million.

Higher average selling prices were principally a result of favorable cost pass-through pricing. The increase in sales volumes was a result of higher sodium silicate industrial demand which more than offset a decline in consumer product sales. The favorable effects of foreign currency were primarily driven by the weaker Euro and British Pound compared to the U.S. dollar, which were partially offset by a stronger Brazilian Real as compared to the U.S. dollar.

Gross Profit

Gross profit for the year ended December 31, 2018 was \$381.7 million, an increase of \$4.9 million, or 1.3%, compared with \$376.8 million for the year ended December 31, 2017. The increase in gross profit was due to favorable customer pricing of \$59.9 million, higher volumes of \$36.7 million and favorable foreign currency translation of \$1.1 million, which was offset by unfavorable manufacturing costs of \$78.4 million, unfavorable product mix of \$12.4 million and higher depreciation expense of \$2.0 million.

Increased customer demand within our virgin sulfuric acid and regeneration services product lines, the integration of Sovitec into our existing European operations and higher sodium silicate industrial sales volumes more than offset a decline in sales related to the timing of customer orders in the methyl methacrylate market and slower sales in our consumer products group. The unfavorable change in manufacturing costs was driven by higher raw material costs, some of which are passed through in price, increased shipping and handling costs and the timing of plant maintenance costs incurred during the year ended December 31, 2018. The unfavorable change in manufacturing costs was partially offset by lower highway product line start-up costs, which were incurred during the year ended December 31, 2017. Unfavorable product mix was driven by increased volumes of lower-margin products.

Selling, General and Administrative Expenses

Selling, general and administrative expenses for the year ended December 31, 2018 were \$168.6 million, an increase of \$21.9 million, or 14.9%, compared with \$146.7 million for the year ended December 31, 2017. The increase in selling, general and administrative expenses was due to higher compensation related expenses due to an increase in employee headcount, higher stock compensation expense of \$10.7 million related to awards issued in conjunction with our IPO and increased professional fees.

Other Operating Expense, Net

Other operating expense, net for the year ended December 31, 2018 was \$29.5 million, a decrease of \$34.7 million, or 54.0%, compared with \$64.2 million for the year ended December 31, 2017. The decrease in other operating expense, net was due to gains recognized in the year ended December 31, 2018 on the termination of a customer supply contract of \$20.6 million and insurance recoveries totaling \$6.5 million related to losses sustained as a result of Hurricane Harvey in August 2017 (of which \$5.5 million was recorded in other operating expense, net), and higher expenses in the year ended December 31, 2017 related to severance and restructuring costs for a plant reduction in force, legal and professional fees related to our IPO, management advisory fees for agreements that terminated as a result of our IPO and transaction-related costs for our June 2017 acquisition of Sovitec. Partially offsetting the decrease in other operating expense, net was an increase in amortization expense related to the intangible assets identified as part of the Sovitec acquisition.

Equity in Net Income of Affiliated Companies

Equity in net income of affiliated companies for the year ended December 31, 2018 was \$37.6 million, a decrease of \$1.2 million, compared with income of \$38.8 million for the year ended December 31, 2017. The decrease was primarily due to \$42.9 million of earnings generated by the Zeolyst Joint Venture during the year ended December 31, 2018 as compared to \$46.3 million for the year ended December 31, 2017 which was a result of higher manufacturing costs, offset by increased sales of higher-margin products, and \$2.0 million of lower amortization expense on the fair value step-up of the underlying assets of the Zeolyst Joint Venture, which was a result of the Business Combination.

Interest Expense, Net

Interest expense, net for the year ended December 31, 2018 was \$113.7 million, a decrease of \$65.3 million, as compared with \$179.0 million for the year ended December 31, 2017. The decrease in interest expense was due to lower average debt balances, mainly as a result of the repayment of outstanding debt with the proceeds from our IPO in October 2017, and reduction in interest rates related to our refinancing efforts completed during the year ended December 31, 2017 and first quarter of 2018.

Debt Extinguishment Costs

Debt extinguishment costs for the years ended December 31, 2018 and 2017 were \$7.8 million and \$61.9 million, respectively.

During the year ended December 31, 2018, we prepaid \$100.0 million of outstanding principal balance on the Term Loan Facility (as defined below). In connection with this prepayment, we wrote off \$0.6 million of previously unamortized deferred financing costs and original issue discount of \$1.3 million as debt extinguishment costs.

On February 8, 2018 we refinanced our existing senior secured term loan facility with a new \$1,267.0 million senior secured term loan facility to reduce the applicable interest rates. We recorded \$2.1 million of new creditor and third-party financing fees as debt extinguishment costs. In addition, previously unamortized deferred financing costs of \$1.4 million and original issue discount of \$2.4 million associated with the existing senior secured term loan facility were written off as debt extinguishment costs.

On December 11, 2017, we completed the issuance of \$300.0 million in aggregate principal amount of 5.75% Senior Unsecured Notes due 2025, which were used to repay the remaining outstanding balance on our Floating Rate Senior Unsecured Notes due 2022 and 8.5% Senior Notes due 2022. In conjunction with the issuance of the senior unsecured notes, we paid \$14.0 million in prepayment premiums and recorded \$0.4 million of new creditor and third-party financing fees as debt extinguishment costs. In addition, previous unamortized deferred financing costs of \$5.3 million and original issue discount of \$1.2 million associated with the old debt were written off as debt extinguishment costs.

On October 3, 2017, we completed our IPO whereby we issued 29 million shares of our common stock at an offering price of \$17.50 per share and used the proceeds to repay \$446.2 million of our Floating Rate Senior Unsecured Notes due 2022. In conjunction with the IPO, we paid \$32.3 million in prepayment premiums and wrote off existing unamortized deferred financing costs of \$0.7 million and original issue discount of \$7.6 million as debt extinguishment costs.

On August 7, 2017, we repriced the existing U.S. dollar-denominated tranche and existing Euro-denominated tranche of our term loans to reduce the applicable interest rates. We recorded \$0.2 million of new creditor and third-party financing fees as debt extinguishment costs. In addition, previously unamortized deferred financing costs of \$0.1 million and original issue discount of \$0.2 million associated with the old debt were written off as debt extinguishment costs.

Other Expense, Net

Other expense, net was \$11.1 million for the year ended December 31, 2018, a favorable change of \$13.3 million, compared with other expense, net of \$24.4 million for the year ended December 31, 2017. The change in other expense, net primarily consisted of \$13.8 million of foreign currency losses for the year ended December 31, 2018 as compared to foreign currency losses of \$25.8 million for the year ended December 31, 2017.

Provision (Benefit) for Income Taxes

The provision for income taxes for the year ended December 31, 2018 was \$29.0 million compared to a \$119.2 million benefit for the year ended December 31, 2017. The effective income tax rate for the year ended December 31, 2018 was 32.7% compared to 196.6% for the year ended December 31, 2017. The difference between the U.S. federal statutory income tax rate and our effective income tax rate for the year ended December 31, 2018 was mainly due to the impact of the GILTI provisions of U.S. tax reform, the effect of permanent differences related to foreign currency exchange gain or loss, changes in valuation allowances, differing tax rates in foreign jurisdictions as compared to the U.S. statutory tax rate, tax rate changes and state taxes. The difference between the U.S. federal statutory income tax rate and our effective income tax rate for the year ended December 31, 2017 was mainly due to the tax effects of U.S. tax reform which reduced the corporate tax rate, differing tax rates in foreign jurisdictions as compared to the U.S. federal tax rate, the effect of permanent differences related to foreign currency exchange gain or loss, changes in valuation allowances and state taxes.

Net Income Attributable to PQ Group Holdings

For the foregoing reasons and after the effect of the non-controlling interest in earnings of subsidiaries for each period presented, net income attributable to PQ Group Holdings was \$58.3 million for the year ended December 31, 2018 as compared to a net income of \$57.6 million for the year ended December 31, 2017.

Adjusted EBITDA

Summarized Segment Adjusted EBITDA information is shown below in the following table:

	Years ended December 31,		Change	
	2018	2017	\$	%
	(in millions, except percentages)			
Segment Adjusted EBITDA ⁽¹⁾ :				
Refining Services	\$ 176.5	\$ 154.2	\$ 22.3	14.5 %
Catalysts ⁽²⁾	81.1	89.4	(8.3)	(9.3)%
Performance Materials	72.5	69.7	2.8	4.0 %
Performance Chemicals	170.9	170.5	0.4	0.2 %
Total Segment Adjusted EBITDA ⁽³⁾	501.0	483.8	17.2	3.6 %
Unallocated corporate expenses	(37.0)	(30.5)	(6.5)	21.3 %
Adjusted EBITDA	\$ 464.0	\$ 453.3	\$ 10.7	2.4 %

⁽¹⁾ We define Segment Adjusted EBITDA as EBITDA adjusted for certain items as noted in the reconciliation below. Our management evaluates the performance of our segments and allocates resources based primarily on Segment Adjusted EBITDA. Segment Adjusted EBITDA does not represent cash flow for periods presented and should not be considered as an alternative to net income as an indicator of our operating performance or as an alternative to cash flows as a source of liquidity. Segment Adjusted EBITDA may not be comparable with EBITDA or Adjusted EBITDA as defined by other companies.

- (2) The Adjusted EBITDA from the Zeolyst Joint Venture included in the Catalysts segment is \$56.7 million for the year ended December 31, 2018, which includes \$42.9 million of equity in net income, excluding \$6.6 million of amortization of investment in affiliate step-up plus \$12.6 million of joint venture depreciation, amortization and interest. The Adjusted EBITDA from the Zeolyst Joint Venture included in the Catalysts segment is \$58.2 million for the year ended December 31, 2017, which includes \$46.3 million of equity in net income, excluding \$8.6 million of amortization of investment in affiliate step-up plus \$11.1 million of joint venture depreciation, amortization and interest.
- (3) Our total Segment Adjusted EBITDA differs from our total consolidated Adjusted EBITDA due to unallocated corporate expenses.

Refining Services: Adjusted EBITDA for the year ended December 31, 2018 was \$176.5 million, an increase of \$22.3 million, or 14.5%, compared with \$154.2 million for the year ended December 31, 2017. The increase in Adjusted EBITDA was driven primarily by higher sales volumes within our virgin sulfuric acid and regeneration services product lines and insurance recoveries from Hurricane Harvey, which was partially offset by increased fixed costs and plant maintenance costs incurred at our Refining Services facilities.

Catalysts: Adjusted EBITDA for the year ended December 31, 2018 was \$81.1 million, a decrease of \$8.3 million, or 9.3%, compared with \$89.4 million for the year ended December 31, 2017. The decrease in Adjusted EBITDA was due to lower chemical synthesis catalysts sales due to the timing of customer orders.

Performance Materials: Adjusted EBITDA for the year ended December 31, 2018 was \$72.5 million, an increase of \$2.8 million, or 4.0%, compared with \$69.7 million for the year ended December 31, 2017. The increase in Adjusted EBITDA was due to higher North American highway product line sales and the integration of Sovitec into our European operations, which was partially offset by higher fixed costs.

Performance Chemicals: Adjusted EBITDA for the year ended December 31, 2018 was \$170.9 million, an increase of \$0.4 million, or 0.2%, compared with \$170.5 million for the year ended December 31, 2017. The increase in Adjusted EBITDA was due to higher contribution margin from sodium silicate product line sales, which was partially offset by higher fixed costs and labor-related costs.

A reconciliation of net income attributable to PQ Group Holdings to Segment Adjusted EBITDA is as follows:

	Years ended December 31,	
	2018	2017
(in millions)		
Reconciliation of net income attributable to PQ Group Holdings Inc. to Segment Adjusted EBITDA		
Net income attributable to PQ Group Holdings Inc.	\$ 58.3	\$ 57.6
Provision (benefit) for income taxes	29.0	(119.2)
Interest expense, net	113.7	179.0
Depreciation and amortization	185.2	177.1
EBITDA	386.2	294.5
Joint venture depreciation, amortization and interest ^(a)	12.6	11.1
Amortization of investment in affiliate step-up ^(b)	6.6	8.6
Amortization of inventory step-up ^(c)	1.6	0.9
Debt extinguishment costs	7.8	61.9
Net loss on asset disposals ^(d)	6.6	5.8
Foreign currency exchange (gain) loss ^(e)	13.8	25.8
LIFO expense ^(f)	8.4	3.7
Management advisory fees ^(g)	—	3.8
Transaction and other related costs ^(h)	0.9	7.4
Equity-based compensation	19.5	8.8
Restructuring, integration and business optimization expenses ⁽ⁱ⁾	14.0	13.2
Defined benefit plan pension cost ^(j)	(0.8)	2.9
Gain on contract termination ^(k)	(20.6)	—
Other ^(l)	7.4	4.9
Adjusted EBITDA	464.0	453.3
Unallocated corporate expenses	37.0	30.5
Segment Adjusted EBITDA	\$ 501.0	\$ 483.8

(a) We use Adjusted EBITDA as a performance measure to evaluate our financial results. Because our Catalysts segment includes our 50% interest in the Zeolyst Joint Venture, we include an adjustment for our 50% proportionate share of depreciation, amortization and interest expense of the Zeolyst Joint Venture.

(b) Represents the amortization of the fair value adjustments associated with the equity affiliate investment in the Zeolyst Joint Venture as a result of the Business Combination. We determined the fair value of the equity affiliate investment and the fair value step-up was then attributed to the underlying assets of the Zeolyst Joint Venture. Amortization is primarily related to the fair value adjustments associated with inventory, fixed assets and intangible assets, including customer relationships and technical know-how.

(c) As a result of the Sovitec acquisition and the Business Combination, there was a step-up in the fair value of inventory, which is amortized through cost of goods sold in the statement of income.

(d) When asset disposals occur, we remove the impact of net gain/loss of the disposed asset because such impact primarily reflects the non-cash write-off of long-lived assets no longer in use.

(e) Reflects the exclusion of the foreign currency transaction gains and losses in the statements of income primarily related to the Euro-denominated term loan (which was settled as part of the February 2018 term loan refinancing) and the non-permanent intercompany debt denominated in local currency translated to U.S. dollars.

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- (f) Represents non-cash adjustments to the Company's LIFO reserves for certain inventories in the U.S. that are valued using the LIFO method, which we believe provides a means of comparison to other companies that may not use the same basis of accounting for inventories.
- (g) Reflects consulting fees paid to CCMP and affiliates of INEOS for consulting services that include certain financial advisory and management services. These consulting agreements were terminated upon completion of our IPO on October 3, 2017.
- (h) Relates to certain transaction costs related to our IPO and the Sovitec acquisition, which are described in further detail in our consolidated financial statements, as well as other costs related to several transactions that are completed, pending or abandoned and that we believe are not representative of our ongoing business operations.
- (i) Includes the impact of restructuring, integration and business optimization expenses which are incremental costs that are not representative of our ongoing business operations.
- (j) Represents adjustments for defined benefit pension plan costs in our statement of income. More than two-thirds of our defined benefit pension plan obligations are under defined benefit pension plans that are frozen, and the remaining obligations primarily relate to plans operated in certain of our non-U.S. locations that, pursuant to jurisdictional requirements, cannot be frozen. As such, we do not view such expenses as core to our ongoing business operations.
- (k) Represents a non-cash gain on the write-off of the remaining liability under a contractual supply arrangement. As part of the 2014 Acquisition, we recognized a liability as part of business combination accounting related to our obligation to serve a customer under a pre-existing unfavorable supply agreement. In December 2018, the customer who was party to the agreement closed its facility, and as a result, we were relieved from our obligation to continue to supply the customer on the below market contract. Because the fair value of the unfavorable contract liability was recognized as part of the application of business combination accounting, and since the write-off of the remaining liability was non-cash in nature, we believe this gain is a special item that is not representative of our ongoing business operations.
- (l) Other costs consist of certain expenses that are not core to our ongoing business operations, including environmental remediation-related costs associated with the legacy operations of our business prior to the Business Combination, capital and franchise taxes, non-cash asset retirement obligation accretion and the initial implementation of procedures to comply with Section 404 of the Sarbanes-Oxley Act. Included in this line-item are rounding discrepancies that may arise from rounding from dollars (in thousands) to dollars (in millions).

Adjusted Net Income

Summarized adjusted net income information is shown below in the following table:

	Years ended December 31,					
	2018			2017		
	Pre-tax	Tax expense (benefit)	After-tax	Pre-tax	Tax expense (benefit)	After-tax
	(in millions)					
Reconciliation of net income attributable to PQ Group Holdings Inc. to Adjusted Net Income ⁽¹⁾⁽²⁾						
Net income before non-controlling interest	\$ 88.6	\$ 29.0	\$ 59.6	\$ (60.6)	\$ (119.2)	\$ 58.6
Less: Net income attributable to non-controlling interest	1.3	—	1.3	1.0	—	1.0
Net income attributable to PQ Group Holdings Inc.	87.3	29.0	58.3	(61.6)	(119.2)	57.6
Amortization of investment in affiliate step-up ^(b)	6.6	2.5	4.1	8.6	2.1	6.5
Amortization of inventory step-up ^(c)	1.6	0.6	1.0	0.9	0.3	0.6
Debt extinguishment costs	7.8	2.9	4.9	61.9	15.5	46.4
Net loss on asset disposals ^(d)	6.6	2.4	4.2	5.8	1.9	3.9
Foreign currency exchange loss ^(e)	13.8	5.6	8.2	25.8	9.7	16.1
LIFO expense ^(f)	8.4	3.1	5.3	3.7	0.9	2.8
Management advisory fees ^(g)	—	—	—	3.8	1.0	2.8
Transaction and other related costs ^(h)	0.9	0.3	0.6	7.4	1.8	5.6
Equity-based compensation	19.5	4.6	14.9	8.8	2.2	6.6
Restructuring, integration and business optimization expenses ⁽ⁱ⁾	14.0	5.2	8.8	13.2	5.6	7.6
Defined benefit plan pension cost ^(j)	(0.8)	(0.3)	(0.5)	2.9	0.9	2.0
Gain on contract termination ^(k)	(20.6)	(7.6)	(13.0)	—	—	—
Other ^(l)	7.4	2.8	4.6	4.9	(1.0)	5.9
Adjusted Net Income, including non-cash GILTI tax and tax reform	152.5	51.1	101.4	86.1	(78.3)	164.4
Impact of non-cash GILTI tax ⁽³⁾	—	(21.2)	21.2	—	—	—
Impact of tax reform ⁽⁴⁾	—	6.0	(6.0)	—	106.5	(106.5)
Adjusted Net Income	\$ 152.5	\$ 35.9	\$ 116.6	\$ 86.1	\$ 28.2	\$ 57.9

(1) We define adjusted net income as net income attributable to PQ Group Holdings adjusted for non-operating income or expense and the impact of certain non-cash or other items that are included in net income that we do not consider indicative of our ongoing operating performance. Adjusted net income is presented as a key performance indicator as we believe it will enhance a prospective investor's understanding of our results of operations and financial condition. Adjusted net income may not be comparable with net income or adjusted net income as defined by other companies.

(2) Refer to the Adjusted EBITDA notes above for more information with respect to each adjustment.

- (3) Amount represents the impact to tax expense in net income before non-controlling interest and the related adjustments to net income associated with the GILTI provisions of the TCJA. Beginning January 1, 2018, GILTI results in taxation of “excess of foreign earnings,” which is defined as amounts greater than a 10% rate of return on applicable foreign tangible asset basis. The Company is required to record incremental tax provision impact with respect to GILTI as a result of having historical NOL amounts to offset the GILTI taxable income inclusion. This NOL utilization precludes us from recognizing FTCs which would otherwise help offset the tax impacts of GILTI. No FTCs will be recognized with respect to GILTI until our cumulative NOL balance has been exhausted. Because the GILTI provision does not impact our cash taxes (given available U.S. NOLs), and given that we expect to recognize FTCs to offset GILTI impacts once the NOLs are exhausted, we do not view this item as a component of core operations.
- (4) Represents the transaction tax adjustment for the impact of the TCJA and the rate change in the Netherlands related to the Dutch Tax Plan 2019 recorded in net income.

The adjustments to net income attributable to PQ Group Holdings Inc. are shown net of applicable statutory tax rates.

Financial Condition, Liquidity and Capital Resources

Our primary sources of liquidity consist of cash flow from operations, existing cash balances as well as funds available under our asset based lending revolving credit facility. We expect that ongoing requirements for debt service and capital expenditures will be funded from these sources of funds. Our primary liquidity requirements include funding working capital requirements (primarily inventory and accounts receivable, net of accounts payable and other accrued liabilities), debt service requirements and capital expenditures. Our capital expenditures include both maintenance of business, which includes spending on maintenance and health, safety and environmental initiatives as well as growth, which includes spending to drive organic sales growth and cost savings initiatives.

We believe that our existing cash, cash equivalents and cash flows from operations, combined with availability under our asset based lending revolving credit facility, will be sufficient to meet our presently anticipated future cash needs for at least the next 12 months. We may also pursue strategic acquisition opportunities, which may impact our future cash requirements. We may, from time to time, increase borrowings under our asset based lending revolving credit facility to meet our future cash needs. As of December 31, 2019, we had cash and cash equivalents of \$72.3 million and availability of \$170.2 million under our asset based lending revolving credit facility, after giving effect to \$20.5 million of outstanding letters of credit and no revolving credit facility borrowings, for a total available liquidity of \$242.5 million. As of December 31, 2019, we were in compliance with all covenants under our debt agreements.

Included in our cash and cash equivalents balance as of December 31, 2019 was \$39.1 million of cash and cash equivalents held in foreign jurisdictions. We repatriate cash held outside of the United States from certain foreign subsidiaries in order to meet domestic liquidity needs. Depending on domestic and foreign cash balances, we have certain flexibility to repatriate funds in order to meet domestic liquidity needs. In certain cases, the repatriation of foreign cash under previous U.S. tax law had generally been subject to U.S. income taxes at the time of cash distribution. Due to the enactment of the TCJA in December 2017, our overseas earnings repatriation will generally no longer be subject to U.S. federal income taxes at the time of cash distribution. However, future earnings may still be taxed for foreign and state income tax purposes.

As of December 31, 2019, our total indebtedness was \$1,932.1 million, with up to \$170.2 million of available borrowings under our asset based lending revolving credit facility. Our liquidity requirements are significant, primarily due to debt service requirements. As reported, our cash interest expense for the years ended December 31, 2019, 2018 and 2017 was approximately \$116.9 million, \$105.1 million and \$170.1 million, respectively. Before any impact of hedges, a one percent change in assumed interest rates for our variable interest credit facilities would have an annual impact of approximately \$9.6 million on interest expense.

Cash Flow

	Years ended December 31,		
	2019	2018	2017
	(in millions)		
Net cash provided by (used in)			
Operating activities	\$ 267.7	\$ 248.6	\$ 165.2
Investing activities	(35.3)	(119.3)	(196.0)
Financing activities	(216.1)	(137.2)	19.8
Effect of exchange rate changes on cash, cash equivalents and restricted cash	(2.1)	0.4	(6.9)
Net change in cash, cash equivalents and restricted cash	14.2	(7.5)	(17.9)
Cash, cash equivalents and restricted cash at beginning of period	59.7	67.2	85.1
Cash, cash equivalents and restricted cash at end of period	<u>\$ 73.9</u>	<u>\$ 59.7</u>	<u>\$ 67.2</u>

	Years ended December 31,		
	2019	2018	2017
	(in millions)		
Net income	\$ 80.3	\$ 59.6	\$ 58.6
Non-cash and non-operating activities ⁽¹⁾	198.6	212.4	149.1
Changes in working capital	(4.9)	(21.9)	(38.3)
Other operating activities	(6.3)	(1.5)	(4.2)
Net cash provided by operating activities	<u>\$ 267.7</u>	<u>\$ 248.6</u>	<u>\$ 165.2</u>

⁽¹⁾ Includes depreciation, amortization, changes related to purchase accounting fair value adjustments, amortization of deferred financing costs and original issue discount, debt extinguishment costs, foreign currency exchange gains and losses, pension and postretirement healthcare benefit expense and funding, deferred income tax benefit, net losses on asset disposals, stock compensation expense, equity in net income and dividends received from affiliated companies, and net interest income on swaps designated as net investment hedges.

	Years ended December 31,		
	2019	2018	2017
	(in millions)		
Working capital changes that provided (used) cash:			
Receivables	\$ 14.5	\$ (10.5)	\$ (11.5)
Inventories	(18.9)	(9.0)	(21.2)
Prepays and other current assets	1.3	(6.3)	(3.4)
Accounts payable	(2.3)	(0.1)	4.3
Accrued liabilities	0.5	4.0	(6.5)
	<u>\$ (4.9)</u>	<u>\$ (21.9)</u>	<u>\$ (38.3)</u>

	Years ended December 31,		
	2019	2018	2017
	(in millions)		
Purchases of property, plant and equipment	\$ (127.6)	\$ (131.7)	\$ (140.5)
Investment in affiliated companies	—	(5.0)	(9.0)
Loan receivable under the New Markets Tax Credit Arrangement	—	—	(6.2)
Business combinations, net of cash acquired	—	(1.0)	(41.6)
Proceeds from sale of assets	17.6	12.4	—
Proceeds from sale of product line	27.7	—	—
Proceeds from settlement of swaps designated as net investment hedges	38.1	—	—
Net interest proceeds on swaps designated as net investment hedges	8.5	4.9	—
Other, net	0.4	1.1	1.3
Net cash used in investing activities	<u>\$ (35.3)</u>	<u>\$ (119.3)</u>	<u>\$ (196.0)</u>

	Years ended December 31,		
	2019	2018	2017
	(in millions)		
Net revolver borrowings	\$ 0.7	\$ (25.0)	\$ 23.6
Net cash repayments on debt obligations	(216.7)	(109.1)	(483.6)
Net proceeds from IPO	—	—	480.7
Other financing activities	(0.1)	(3.1)	(0.9)
Net cash (used in) provided by financing activities	<u>\$ (216.1)</u>	<u>\$ (137.2)</u>	<u>\$ 19.8</u>

Year Ended December 31, 2019 Compared to the Year Ended December 31, 2018

Net cash provided by operating activities was \$267.7 million for the year ended December 31, 2019, compared to \$248.6 million provided for the year ended December 31, 2018. Cash generated by net income and non-working capital related activities was higher during the year ended December 31, 2019 by \$2.2 million compared to the prior year. Cash used by working capital during the year ended December 31, 2019 was favorable compared to the year ended December 31, 2018. Working capital for the year ended December 31, 2019 used cash of \$4.9 million, compared to cash used of \$21.9 million for the year ended December 31, 2018.

The increase in cash generated by net income and non-working capital related activities of \$2.2 million as compared to the prior year period was primarily due an increase in gross profit driven by favorable customer pricing and higher average selling prices in North America for our highway safety products, which was partially offset by lower customer volumes and higher compensation related costs due to increased employee headcount and labor inflation.

The \$17.0 million increase in cash from working capital as compared to the prior year was primarily due to favorable changes in accounts receivable and prepaid and other current assets, which were partially offset by unfavorable changes in inventory, accounts payable and accrued liability balances.

The favorable change in accounts receivable was due to lower sales volumes across most business segments during the year ended December 31, 2019 as compared to the year ended December 31, 2018. The favorable change in prepaid and other current assets was due to lower receivable balances with our joint ventures and other related parties as well as the receipt of insurance proceeds during the year ended December 31, 2019. The unfavorable change in inventory was due to higher inventory build to meet future sales commitments. The unfavorable change in accounts payable was due to increased raw material costs. The unfavorable change in accrued liabilities was primarily due to the timing of wage and interest payments.

Net cash used in investing activities was \$35.3 million for the year ended December 31, 2019, compared to net cash used of \$119.3 million during the year ended December 31, 2018. Cash used in investing activities primarily consisted of \$127.6 million and \$131.7 million to fund capital expenditures during the years ended December 31, 2019 and 2018, respectively. During the year ended December 31, 2019, we settled our cross currency swaps and received proceeds of \$38.1 million, sold a product line which resulted in proceeds of \$27.7 million, sold additional assets which generated proceeds of \$17.6 million and received \$8.5 million in interest proceeds related to our cross currency swaps. During the year ended December 31, 2018, we sold assets which generated proceeds of \$12.4 million and received \$4.9 million in interest proceeds related to our cross currency swaps.

Net cash used in financing activities was \$216.1 million for the year ended December 31, 2019, compared to net cash used of \$137.2 million during the year ended December 31, 2018. Net cash used in financing activities was primarily driven by \$216.7 million and \$136.2 million in repayments of our term debt and revolving credit facility made during the years ended December 31, 2019 and 2018, respectively.

Year Ended December 31, 2018 Compared to the Year Ended December 31, 2017

Net cash provided by operating activities was \$248.6 million for the year ended December 31, 2018, compared to \$165.2 million provided for the year ended December 31, 2017. Cash generated by net income plus non-cash and non-working capital related activities was higher during the year ended December 31, 2018 by \$67.1 million compared to the prior year. Cash used by working capital during the year ended December 31, 2018 was favorable compared to the year ended December 31, 2017. Working capital for the year ended December 31, 2018 used cash of \$21.9 million, compared to cash used of \$38.3 million for the year ended December 31, 2017.

The increase in cash generated by net income plus non-cash and non-working capital related activities of \$67.1 million as compared to the prior year period was primarily due to lower interest expense under our new debt structure, the integration of Sovitec into our existing European operations, higher highway safety sales and higher cost pass-through pricing, which was partially offset by higher plant maintenance costs, higher compensation related costs due to increased employee headcount and increased labor inflation costs.

The \$16.4 million increase in cash from working capital as compared to the prior year was primarily due to favorable changes in accounts receivable, inventory and accrued liability balances, which were partially offset by unfavorable changes in prepaid and other current assets and accounts payable.

The favorable change in accounts receivable was due to lower receivable balances in our Performance Chemicals segment, mainly as a result of higher receivable balances at the end of December 31, 2017 as compared to December 31, 2018, which was offset by stronger sales in our North American highway safety and Refining Services segment. The favorable change in inventory was driven by depletion of inventory balances versus our higher inventory build in our North American highway safety product group in the prior year period. The favorable change in accrued liabilities was primarily due to the timing of interest payments. The unfavorable change in prepaid and other current assets is due to our cross currency swap transaction entered into during the year ended December 31, 2018. The unfavorable change in accounts payable was due to increased raw material costs.

Net cash used in investing activities was \$119.3 million for the year ended December 31, 2018, compared to net cash used of \$196.0 million during the year ended December 31, 2017. Cash used in investing activities primarily consisted of utilizing \$131.7 million and \$140.5 million to fund capital expenditures during the years ended December 31, 2018 and 2017, respectively. The acquisitions of a cullet business in May 2018 and Sovitec in June 2017 used cash of approximately \$1.0 million and \$41.6 million during the years ended December 31, 2018 and 2017, respectively. During the year ended December 31, 2018, we received cash proceeds of \$12.4 million related to the sale of assets and \$4.9 million in interest proceeds related to our cross currency swaps.

Net cash used in financing activities was \$137.2 million for the year ended December 31, 2018, compared to net cash provided of \$19.8 million during the year ended December 31, 2017. Net cash used in financing activities was primarily driven by \$136.2 million in repayments of our term debt and revolving credit facility made during the year ended December 31, 2018. This was partially offset by \$8.5 million of new borrowings, less \$6.4 million in financing fees, made under the term loan facility for refinancing costs. Net cash provided by financing activities for the year ended December 31, 2017 was mainly due to our IPO, which generated \$480.7 million of net cash proceeds used to repay a portion of our Floating Rate Senior Unsecured Notes due 2022.

Debt

	December 31,	
	2019	2018
	(in millions)	
Term Loan Facility	\$ 947.5	\$ 1,157.5
6.75% Senior Secured Notes due 2022	625.0	625.0
5.75% Senior Unsecured Notes due 2025	295.0	300.0
ABL Facility	—	—
Other	64.6	65.9
Total debt	1,932.1	2,148.4
Original issue discount	(13.4)	(18.6)
Deferred financing costs	(11.7)	(15.9)
Total debt, net of original issue discount and deferred financing costs	1,907.0	2,113.9
Less: current portion	(7.8)	(7.2)
Total long-term debt, excluding current portion	\$ 1,899.2	\$ 2,106.7

As of December 31, 2019 our total debt was \$1,932.1 million, including \$12.8 million of other foreign debt and \$51.8 million of notes payable for the New Market Tax Credit (“NMTC”) financing and excluding the original issue discount of \$13.4 million and deferred financing fees of \$11.7 million for our senior secured credit facilities and notes. Our net debt was \$1,859.8 million, including cash of \$72.3 million. Our total available liquidity as of December 31, 2019 was \$242.5 million, which represents our cash on hand of \$72.3 million plus our excess availability under our asset based lending revolving credit facility of \$170.2 million, after giving effect to \$20.5 million of outstanding letters of credit and no revolving credit facility borrowings. We may seek, subject to market conditions and other factors, opportunities to repurchase, refinance or otherwise reprice our debt.

Senior Secured Credit Facilities

On May 4, 2016, we entered into senior secured credit facilities (collectively, the “Senior Secured Credit Facilities”) that were comprised of a \$1,200.0 million term loan facility consisting of a \$900.0 million U.S. dollar-denominated tranche and a \$300.0 million Euro-denominated (or €265.0 million) tranche (the “2016 Term Loan Facility”), and a \$200.0 million asset-based revolving credit facility (the “ABL Facility”).

On February 8, 2018, we refinanced the 2016 Term Loan Facility with a new \$1,267.0 million senior secured term loan facility (the “Term Loan Facility”) by entering into the Third Amendment Agreement to the 2016 Term Loan Facility, which amended and restated the 2016 Term Loan Facility. Pursuant to the Third Amendment Agreement, the Term Loan Facility accrued interest at a floating rate of LIBOR (with a zero percent minimum LIBOR floor) plus 2.50% per annum and was scheduled to mature in February 2025. The Term Loan Facility requires scheduled quarterly amortization payments, each equal to 0.25% of the original principal amount of the loans under the Term Loan Facility.

In February 2020, we re-priced the \$947.5 million Term Loan Facility to reduce the applicable interest rate and extend the maturity of the facility to February 2027. The terms of the facility were substantially consistent following the re-pricing, except that borrowings under the term loan will bear interest at a rate equal to a floating rate of LIBOR plus 2.25% per annum.

The ABL Facility provides for up to \$200.0 million in revolving credit borrowings consisting of up to \$150.0 million in U.S. available borrowings, up to \$10.0 million in Canadian available borrowings and up to \$40.0 million of European available borrowings. Borrowings under the ABL Facility bear interest at a rate equal to the LIBOR rate or the base rate elected by us at the time of the borrowing plus a margin of between 1.50%-2.00% or 0.50%-1.00%, respectively, depending on availability under the ABL Facility. In addition, there is an annual commitment fee equal to 0.375%, with a step-down to 0.25% based on the average usage of the revolving credit borrowings available. As of December 31, 2019, there were no revolving credit borrowings under the ABL Facility. Revolving credit borrowings are payable at our option throughout the term of the ABL Facility with the balance due May 4, 2021. We were in compliance with all debt covenants as of December 31, 2019 and 2018, respectively.

The Company has the ability to request letters of credit under the ABL Facility. The Company had \$20.5 million of letters of credit outstanding as of December 31, 2019, which reduce available borrowings under the ABL Facility by such amounts.

6.75% Senior Secured Notes due 2022

Concurrent with the Business Combination, we issued \$625.0 million of 6.750% Senior Secured Notes due November 2022 (the “6.75% Senior Secured Notes”) in transactions exempt from or not subject to registration under the Securities Act pursuant to Rule 144A and Regulation S under the Securities Act of 1933. Interest on the 6.75% Senior Secured Notes is payable on May 15 and November 15 of each year, commencing November 15, 2016. No principal payments are required with respect to the 6.75% Senior Secured Notes prior to their final maturity. The 6.75% Senior Secured Notes mature on November 15, 2022.

5.75% Senior Unsecured Notes due 2025

On December 11, 2017, we issued \$300.0 million aggregate principal amount of 5.75% Senior Unsecured Notes due 2025 (the “5.75% Senior Unsecured Notes”) in a private placement exempt from the registration requirements of the Securities Act. The 5.75% Senior Unsecured Notes mature on December 15, 2025. Interest on the 5.75% Senior Unsecured Notes is to be paid semi-annually on February 15 and August 15, commencing August 15, 2018, at an annual rate of 5.75% per year.

New Markets Tax Credit Financing

The Performance Materials (Potters Industries, LLC (“Potters”)) segment has entered in to various NMTC financing arrangements to fund the expansion of Potter’s manufacturing facilities in Paris, Texas and Augusta, Georgia. The NMTC program, which is administered by the United States Treasury Department, requires certain balance sheet commitments. The NMTC financing arrangements provide us with certain monetary benefits as an offset to specifically identified capital expenditures. The NMTC arrangements require that certain commitments and covenants be maintained over the course of seven years of the closing transaction in order to recognize the benefit.

On October 24, 2013, PQ Holdings’ (and now our) subsidiary Potters entered into a NMTC financing arrangement with JPMorgan Chase Bank N.A. and several of its affiliates (“Chase”) and TX CDE V LLC, an affiliate of Texas LIC Development Company LLC d/b/a Texas Community Development Capital (“TX CDE”), whereby Chase agreed to contribute \$6.6 million and an additional \$15.6 million in funds lent to Chase by Potters Holdings II, L.P. to TX CDE. TX CDE, in turn, lent \$21.0 million in the form of \$5.4 million and \$15.6 million notes to Potters, which used the proceeds to finance the expansion of Potters’ manufacturing facility in Paris, Texas (the “2013 NMTC Agreement”). The capital expenditures associated with the 2013 NMTC Agreement were completed in 2014. The \$21.0 million of debt related to the 2013 NMTC Agreement was assumed as part of the Business Combination and was outstanding as of December 31, 2019.

On May 17, 2016, Potters entered into a NMTC financing arrangement with U.S. Bank N.A. and several of its affiliates (“USB”) and MRC XX LLC, an affiliate of Midwest Renewable Capital, LLC (“MRC”), whereby USB agreed to contribute \$3.7 million and an additional \$7.8 million in funds lent to USB by Potters Holdings II, L.P. to MRC. MRC, in turn, lent \$11.0 million in the form of \$7.8 million, \$1.3 million and \$1.9 million notes to Potters, which used the proceeds to finance the expansion of Potters’ manufacturing facility in Augusta, Georgia (the “May 2016 NMTC Agreement”). The \$11.0 million was outstanding as of December 31, 2019. The capital expenditures associated with the May 2016 NMTC Agreement were completed in 2017.

On December 29, 2016, Potters entered into a second NMTC financing arrangement with USB and MRC whereby USB agreed to contribute \$3.8 million and an additional \$7.8 million in funds lent to USB by Potters Holdings II, L.P. to MRC. MRC, in turn, lent \$11.0 million in the form of \$7.8 million, \$1.4 million and \$1.8 million notes to Potters, which used the proceeds as working capital for another expansion of Potters’ manufacturing facility in Paris, Texas (the “December 2016 NMTC Agreement”). The \$11.0 million was outstanding as of December 31, 2019. The capital expenditures associated with the December 2016 NMTC were completed in 2017.

On June 22, 2017, Potters entered into a NMTC financing arrangement with USB and Business Conduit No. 28, LLC, an affiliate of Community Reinvestment Fund, Inc. (“CRF”). USB contributed \$3.1 million to USB Investment Fund, and Potters Leveraged Lender LLC, our indirect subsidiary, lent USB Investment Fund \$6.2 million. USB Investment Fund then contributed \$9.0 million to CRF, which in turn lent \$8.8 million to Potters pursuant to a credit agreement (the “June 2017 NMTC Agreement”). Potters used the \$8.8 million in proceeds to acquire equipment for the expansion of Potters’ manufacturing facility in Paris, Texas. The \$8.8 million was outstanding as of December 31, 2019. The capital expenditures associated with the June 2017 NMTC Agreement were completed in 2018.

Subsidiary Credit Agreement

On June 12, 2017, we acquired Sovitec and assumed its obligations to Belfius Bank NV (“Belfius”). On June 8, 2017, Sovitec entered into a credit agreement with Belfius governing a €14.5 million credit line which is divided into four tranches. Tranche A was issued in the amount of €7.5 million in the form of a Euro roll-over credit with a maturity date of December 31, 2021. Tranche B was issued in the amount of €3.0 million in the form of a Euro roll-over credit with a full principal payment due on its maturity date of September 30, 2022. A working capital line of credit (“Working Capital”) of €3.0 million was issued under the form of straight loans with a maturity date up to 90 days after borrowings are made on the line. A capital expenditure line of credit (“CAPEX line”) of €1.0 million was issued under the form of straight loans with a maturity date of September 30, 2021. Tranche A is subject to principal payments of €0.8 million made on September 30 and December 31 of each year. Borrowings under the credit agreement bear rates based on Sovitec’s ratio of net debt to Normalized EBITDA. Normalized EBITDA is defined as the Sovitec consolidated operating profit before non-recurring items (i.e. items non-related to normal operations of the last twelve month period and provided an acceptable description of the one-off character of those items is given) and before taxation, depreciation and amortization. Interest rate margins are subject to being reset on June 30 of each year. Interest rates reset based on three net debt to Normalized EBITDA ratio ranges of less than 2, between 2 and 3 or greater than 3. Rates for each tranche of debt reset based on 1 to 9 month EURIBOR rates (not lower than zero) plus a margin that can range between 1.10% to 1.55% for Tranche A, 1.85% to 2.15% for Tranche B, 0.90% and 1.20% for Working Capital and 1.25% and 1.80% for the CAPEX line.

As of December 31, 2019, the interest rate on the credit agreements are as follows: Tranche A, 1.10%, Tranche B, 1.85%, Working Capital, 0.90% and CAPEX 1.25%. As of December 31, 2019, the following principal balances are outstanding on each debt instrument: Tranche A, \$3.4 million, Tranche B, \$3.4 million, Working Capital, \$2.6 million and CAPEX \$1.1 million. We were in compliance with all debt covenants as of December 31, 2019.

Capital Expenditures

Maintenance capital expenditures include spending on maintenance of business, health, safety and environmental initiatives. Growth capital expenditures include spending to drive organic sales growth and cost savings initiatives. These capital expenditures represent our “book” capital expenditures for which the company has recorded, but not necessarily paid for the capital expenditures.

	Years ended December 31,		
	2019	2018	2017
	(in millions)		
Maintenance capital expenditures	\$ 95.0	\$ 95.9	\$ 103.2
Growth capital expenditures	29.8	37.0	37.9
Total capital expenditures	\$ 124.8	\$ 132.9	\$ 141.1

Capital expenditures remained at a level sufficient for required maintenance and certain expansion growth initiatives during these periods. Growth capital expenditures are lower in the year ended December 31, 2019 as compared to December 31, 2018 due to timing of expansion capital within the Refining Services segment. Maintenance capital expenditures are lower in the year ended December 31, 2018 as compared to December 31, 2017 due to lower plant maintenance costs.

Pension Funding

We paid \$9.7 million, \$7.6 million and \$7.9 million in cash contributions into our defined benefit pension plans and other postretirement plans during the years ended December 31, 2019, 2018 and 2017, respectively. The net periodic pension and postretirement expense was \$3.7 million, \$1.1 million, and \$3.3 million for those same periods, respectively.

As of December 31, 2019 and 2018, our pension plans and other post-retirement benefit plans were underfunded by \$61.3 million and \$70.9 million, respectively. In addition, our supplemental retirement plan had a liability balance of \$11.7 million and \$11.9 million as of December 31, 2019 and 2018, respectively, which is funded by our general assets including assets held in a Rabbi trust, or restoration plan assets, of \$4.2 million and \$4.2 million as of December 31, 2019 and 2018, respectively.

Off-Balance Sheet Arrangements

We had \$20.5 million and \$19.8 million of outstanding letters of credit on our revolver facility as of December 31, 2019 and 2018, respectively.

Contractual Obligations and Commitments

The following table reflects our contractual obligations, commercial commitments and long-term debt obligations as of December 31, 2019.

	Payments due by period				
	Total	Less than 1 year	1-3 years	3-5 years	More than 5 years
	(in millions)				
Long-term debt ⁽¹⁾	\$ 1,932.1	\$ 7.8	\$ 630.0	\$ 3.7	\$ 1,290.6
Interest payments ⁽²⁾	454.5	102.6	197.8	120.4	33.7
Letters of credit ⁽³⁾	20.5	20.5	—	—	—
Operating lease obligations	65.5	17.4	25.7	11.8	10.6
Purchase obligations ⁽⁴⁾	25.8	17.6	3.5	2.4	2.2
Other obligations ⁽⁵⁾	35.5	25.3	3.1	2.3	4.8
Total contractual obligations ⁽⁶⁾	\$ 2,533.9	\$ 191.2	\$ 860.2	\$ 140.6	\$ 1,341.9

⁽¹⁾ No prepayment or redemption of any of our long-term debt balances has been assumed. Refer to the “Financial Condition, Liquidity and Capital Resources” section of this Management’s Discussion and Analysis and Note 17, Long-term Debt, in the notes to the consolidated financial statements of PQ Group Holdings included elsewhere in this Form 10-K for information regarding the terms of our long-term debt agreements.

⁽²⁾ Interest on long-term debt excludes the amortization of deferred financing fees and original issue discount. The amounts represent minimum interest payments. All future interest payments on Euro-denominated loans were calculated using a December 31, 2019 Euro to U.S. Dollar spot exchange rate. The actual interest payments may differ materially from those presented above based on actual amounts of long-term debt outstanding and actual interest rates in future periods. As a result of the February 2020 Term Loan Facility re-pricing, we anticipate that the reduction in interest rates will result in a \$2.4 million reduction of interest payments per year. Such anticipated reductions are not reflected in the above table.

⁽³⁾ Letters of credit are used primarily as collateral for various items, including environmental, energy and insurance payments. The letters of credit are supported by the Company’s ABL Facility.

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- (4) Purchase obligations include agreements to purchase goods and services that are enforceable and legally binding and that specify all significant terms, including fixed and minimum quantities to be purchased, fixed, minimum or variable provisions, and the approximate timing of the transaction. Purchase obligations exclude agreements that are cancelable without penalty.
- (5) Other obligations represent payments related to our pension plans, supplemental retirement plans and other post-retirement benefit plans. Included in these amounts are expected benefit plan contributions of \$11.1 million in 2020. Contributions to the benefit plans beyond 2020 cannot be reasonably estimated and are not reflected in this table. Included in other obligations is \$0.5 million of finance lease liabilities. Approximately \$12.4 million of derivative liabilities are included in the less than 1 year category, as we cannot make reasonable estimates with respect to the timing of their ultimate resolution.
- (6) At December 31, 2019, we had \$9.5 million related to unrecognized income tax benefits, including accrued interest and penalties. These liabilities are not included in the above table, as we cannot make reasonable estimates with respect to the timing of their ultimate resolution. See Note 20 in the notes to the consolidated financial statements of PQ Group Holdings included elsewhere in this Form 10-K for further information on our unrecognized income tax benefits.

We expect that we will be able to fund our remaining obligations and commitments with cash flow from operations. To the extent we are unable to fund these obligations and commitments with cash flow from operations, we intend to fund these obligations and commitments with proceeds from available borrowing capacity under our ABL Facility or under future financings.

Critical Accounting Policies

We prepare our consolidated financial statements in conformity with GAAP and our significant accounting policies are described in Note 2 to our consolidated financial statements. The preparation of financial statements in conformity with GAAP requires us to make estimates and assumptions that affect reported amounts and related disclosures. We base our estimates and judgments on historical experience and other relevant factors that we believe to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions. We have identified below the accounting policies and estimates that we believe are most critical in compiling our consolidated statements of financial condition and operating results.

Revenue Recognition

In determining the appropriate amount of revenue to be recognized as we fulfill our obligations under our agreements, we perform the following steps: (i) identify the contract with the customer; (ii) determine whether the promised goods or services are performance obligations, including whether they are distinct in the context of the contract; (iii) measure the transaction price; (iv) allocate the transaction price to the performance obligations based on estimated selling prices; and (v) recognize revenue when (or as) we satisfy each performance obligation.

We identify a contract when an agreement with a customer creates legally enforceable rights and obligations, which occurs when a contract has been approved by both parties, the parties are committed to perform their respective obligations, each party's rights and payment terms are clearly identified, commercial substance exists and it is probable that we will collect the consideration to which we are entitled.

Evidence of a contract with a customer may take the form of a master service agreement ("MSA"), a MSA in combination with an underlying purchase order, a combination of a pricing quote with an underlying purchase order or an individual purchase order received from a customer. Certain of our customers enter into MSAs that establish the terms, including prices, under which orders to purchase goods may be placed. In cases where the MSA contains a distinct order for goods or contains an enforceable minimum quantity to be purchased by the customer, we consider the MSA to be evidence of a contract with a customer as the MSA creates enforceable rights and obligations. In cases where the MSA does not contain a distinct order for goods, evidence of a contract with a customer is the purchase order issued under the MSA. Our customers may also negotiate orders via pricing quotes, which typically detail product pricing, delivery terms and payment information. When a customer procures goods under this method, we consider the combination of the pricing quote and the purchase order to create enforceable rights and obligations. Absent either a MSA or pricing quote, we consider an individual purchase order to create enforceable rights and obligations.

We identify a performance obligation in a contract for each promised good that is separately identifiable from other promises in the contract and for which the customer can benefit from the good. The majority of our contracts have a single performance obligation, which is the promise to transfer individual goods to the customer. Certain of our contracts include multiple performance obligations under which the purchase price for each distinct performance obligation is defined in the contract. These distinct performance obligations may include stand-ready provisions, which are arrangements to provide a customer assurance that they will have access to output from our manufacturing facilities, or monthly reservations of capacity fees. We consider stand-ready provisions and reservation of capacity fees to be performance obligations satisfied over time. Revenues related to stand-ready provisions and reservation of capacity fees are recognized on a ratable basis throughout the contract term and billed to the customer on a monthly basis.

As described above, our MSAs with our customers may outline prices for individual products or contract provisions. MSAs in the our Performance Chemicals and Refining Services segments may contain provisions whereby raw materials costs are passed-through to the customer per the terms of their contract. Our exposure to fluctuations in raw materials prices is limited, as the majority of pass-through contract provisions reset based on fluctuations in the underlying raw material price. MSAs in our Refining Services segment also contain take-or-pay arrangements, whereby the customer would incur a penalty in the form of a shortfall volume fee. Currently there is no history in which customers fail to meet the contractual minimum. Revenue from product sales are recorded at the sales price, which includes estimates of variable consideration for which reserves are established and which result from discounts, returns or other allowances that are offered within contracts with our customers.

We recognize revenues when performance obligations under the terms of a contract with our customer are satisfied, which generally occurs at a point in time by transferring control of a product to the customer. We determine the point in time when a customer obtains control of a product and we satisfy the performance obligation by considering factors including when we have a right to payment for the product, the customer has legal title to the product, we have transferred possession of the product, the customer has assumed the risks and rewards of ownership of the product and the customer has accepted the product. Revenue is measured as the amount of consideration we expect to receive in exchange for transferring goods. We do not have any significant payment terms as payment is received at, or shortly after, the point of sale.

Goodwill and Intangible Assets

Goodwill and intangible assets with indefinite lives are not amortized, but are tested for impairment annually or more frequently if events occur or circumstances change that would more likely than not reduce the fair value of the reporting unit below its carrying amount. We perform our annual impairment tests of goodwill and indefinite-lived intangible assets as of October 1 of each year.

Goodwill is tested for impairment at the reporting unit level. In performing tests for goodwill impairment, we are permitted to first perform a qualitative assessment about the likelihood of the carrying value of a reporting unit exceeding its fair value. If an entity determines that it is more likely than not that the fair value of a reporting unit is less than its carrying amount based on the qualitative assessment, it is required to perform a two-step goodwill impairment test to identify the potential goodwill impairment and measure the amount of the goodwill impairment loss, if any, to be recognized for that reporting unit. However, if an entity concludes otherwise based on the qualitative assessment, the two-step goodwill impairment test is not required. The option to perform the qualitative assessment can be utilized at our discretion, and the qualitative assessment need not be applied to all reporting units in a given goodwill impairment test. For an individual reporting unit, if we elect not to perform the qualitative assessment, or if the qualitative assessment indicates that it is more likely than not that the fair value of a reporting unit is less than its carrying amount, then we must perform the two-step goodwill impairment test for the reporting unit.

In applying the two-step process, the first step used to identify potential impairment involves comparing the reporting unit's estimated fair value to its carrying value, including goodwill. If the estimated fair value of a reporting unit exceeds its carrying value, goodwill is not impaired. If the carrying value exceeds the estimated fair value, there is an indication of potential impairment and the second step is performed to measure the amount of impairment, if any. The second step of the process involves the calculation of an implied fair value of goodwill for each reporting unit for which step one indicated potential impairment. The implied fair value of goodwill is determined in a manner similar to how goodwill is calculated in a former business combination. That is, the estimated fair value of the reporting unit, as calculated in step one, is allocated to the individual assets and liabilities as if the reporting unit was being acquired in a business combination. If the implied fair value of goodwill exceeds the carrying value of goodwill assigned to the reporting unit, there is no impairment. If the carrying value of goodwill assigned to a reporting unit exceeds the implied fair value of the goodwill, an impairment charge is recorded to write down the carrying value. An impairment loss cannot exceed the carrying value of goodwill assigned to a reporting unit and the loss establishes a new basis in the goodwill. Subsequent reversal of an impairment loss is not permitted.

For the purposes of the quantitative goodwill impairment test, we determine the fair value of our reporting units using a combination of a market approach and an income, or discounted cash flow, approach. Estimating the fair value of a reporting unit requires various assumptions including the use of projections of future cash flows and discount rates that reflect the risks associated with achieving those cash flows. The key assumptions used in estimating the fair value are operating margin growth rates, revenue growth rates, the weighted average cost of capital, the perpetual growth rate, and the estimated earnings market multiples of each reporting unit. The market value is estimated using publicly traded comparable company values by applying their most recent annual EBITDA multiples to the reporting unit's EBITDA for the trailing twelve months. The income approach value is estimated using a discounted cash flow approach. The assumptions about future cash flows and growth rates are based on our assessment of a number of factors including the reporting unit's recent performance against budget as well as management's ability to execute on planned future strategic initiatives. Discount rate assumptions are based on an assessment of the risk inherent in those future cash flows.

For intangible assets other than goodwill, definite-lived intangible assets are amortized over their respective estimated useful lives. Intangible assets with indefinite lives are not amortized, but rather are tested for impairment at least annually or more frequently if events occur or circumstances change that would more likely than not reduce the fair value of the intangible asset below its carrying amount. Our indefinite-lived intangible assets include trade names and certain trademarks. Similar to the goodwill impairment test, we may first assess qualitative factors to determine whether it is necessary to perform a quantitative impairment test. If we choose to bypass the qualitative assessment, or if the qualitative assessment indicates that the indefinite-lived intangible asset is more likely than not impaired, a quantitative impairment test must be performed. Unlike the goodwill impairment test, the quantitative test for indefinite-lived intangible assets is a one-step test comparing the fair value of the asset to its carrying amount. If the fair value of the indefinite-lived intangible asset is less than the carrying amount, an impairment loss is recognized in an amount equal to the difference.

The unit of accounting used to test our indefinite-lived intangible assets for impairment is at the reporting unit level. The fair values of our indefinite-lived trade names and trademarks are determined for impairment testing purposes based on an income approach using a discounted cash flow valuation model under a relief from royalty methodology. Significant assumptions under the relief from royalty method include the royalty rate a market participant may assume, projected sales and the discount rate applied to the estimated cash flows.

For definite-lived intangible assets, we amortize technical know-how over periods that range from fourteen to twenty years, customer relationships over periods that range from seven to fifteen years, trademarks over a fifteen year period, contracts over periods that range from two to sixteen years, and permits over five years. We perform an impairment review of definite-lived intangible assets when facts and circumstances indicate that the carrying value of an asset may not be recoverable from its undiscounted future cash flows. The impairment test for definite-lived intangible assets is consistent with the test applied to property, plant and equipment as described in our policy.

Income Taxes

We operate within multiple taxing jurisdictions and are subject to tax filing requirements and potential audits within these jurisdictions. We use the asset and liability method in accounting for income taxes. Deferred tax assets and liabilities are recorded for temporary differences between the tax basis of assets and liabilities and their reported amounts in the financial statements, using statutory tax rates in effect for the year in which the differences are expected to reverse. The effect on deferred tax assets and liabilities of a change in tax rates is recognized in the results of operations in the period that includes the enactment date. We evaluate our deferred tax assets each period to ensure that estimated future taxable income will be sufficient in character (e.g., capital gain versus ordinary income treatment), amount and timing, to result in their realizability. A valuation allowance is recorded to reduce the carrying amounts of deferred tax assets, unless it is more likely than not that those assets will be realized. Considerable judgments are required in establishing deferred tax valuation allowances. The ultimate realization of deferred tax assets is dependent upon the generation of future taxable income during the periods in which those temporary differences and carryforward deferred tax assets become deductible or utilized. We consider the scheduled reversal of taxable temporary differences, projected future taxable income and tax-planning strategies in making this assessment. As events and circumstances change, valuation allowances are adjusted within results from operations when applicable.

Generally, APB 23 of ASC Topic 740, Income Taxes (“ASC 740”), provides guidance with respect to establishing deferred income taxes on earnings from foreign subsidiaries, to the extent that these earnings are considered to be available for repatriation. Further, ASC 740-30 requires that deferred taxes be established with respect to the earnings of a foreign subsidiary, unless existing tax law provides a means by which the investment in a subsidiary can be recovered tax-free. We have determined that we are able to repatriate the non-permanently reinvested earnings of our foreign subsidiaries in a tax-free manner. As such, we are able to assert for purposes of ASC 740-30 that no deferred income taxes are needed with respect to earnings from foreign subsidiaries.

We recognize net tax benefits under the recognition and measurement criteria of ASC 740, which prescribes requirements and other guidance for financial statement recognition and measurement of positions taken or expected to be taken on tax returns. We recognize a financial statement benefit for positions taken for tax return purposes when it will be more likely than not (i.e. greater than 50%) that the positions will be sustained upon tax examination, based solely on the technical merits of the tax positions. Otherwise, no tax benefit is recognized. The tax benefits recognized are measured based on the largest benefit that has a greater than 50% likelihood of being realized upon ultimate settlement. We recognize potential accrued interest and penalties related to unrecognized tax benefits as a component of income tax expense. Tax examinations are often complex as tax authorities may disagree with the treatment of items reported by us and may require several years to resolve. These accrued liabilities represent a provision for taxes that are reasonably expected to be incurred on the basis of available information but which are not certain.

On December 22, 2017, the TCJA was enacted into law. The TCJA provided for several significant tax law changes and modifications, including the reduction of the U.S. federal corporate income tax rate from 35% to 21%, the requirement for companies to pay a one-time transition tax on earnings of certain foreign subsidiaries that were previously tax deferred, as well as the creation of new taxes on certain foreign-sourced earnings. Certain provisions of the TCJA began to impact us in our fourth quarter of 2017, while other provisions began impacting us beginning in 2018.

The corporate tax rate reduction was effective as of January 1, 2018. The TCJA also established other new provisions that became effective in 2018. These include, but are not limited to, (1) a new provision designed to tax low-taxed income of foreign subsidiaries (i.e., "GILTI"), which allows for the possibility of using foreign tax credits ("FTCs") and a deduction of up to 50% to offset any resulting income tax liability (subject to some limitations); (2) limitations on the deductibility of certain executive compensation; (3) limitations on the deductibility of interest expense ("163(j)"); and (4) limitations on the use of FTCs to reduce the U.S. income tax liability. While many of these provisions impact our tax expense and deferred taxes for 2019 and future periods, we expect the GILTI provisions and 163(j) to have the most significant impact under our current structure. While significant guidance regarding U.S. tax reform has been set forth since the law's enactment in 2017, at this time the overall impact of the TCJA on our future income tax provision continues to remain uncertain.

With respect to GILTI, we have once again experienced a significant impact to tax expense in 2019 because of our substantial U.S. NOL balance and being unable to avail ourselves of both U.S. foreign tax credits and the GILTI special deduction ("Section 250 Deduction"). The 2019 U.S. federal impact to tax expense with respect to GILTI is \$8.3 million. Based on FASB guidance, we are permitted to make an accounting policy election to either (1) treat the taxes incurred as a result of the GILTI provision as a current-period expense when incurred or (2) factor such amounts into our measurement of deferred taxes. We have elected to treat any expense incurred as a current-period expense.

With respect to 163(j), we have experienced a significant disallowance with respect to our current year interest expense. Our U.S. federal 163(j) interest disallowance is \$27.6 million for 2019. This disallowance has no impact to overall tax expense, given that any disallowed interest deductions are permitted to be carried forward indefinitely and, as such, are set up as deferred tax assets. Our cumulative U.S. federal 163(j) carry forward is \$72.5 million as of December 31, 2019. Because this disallowance has indefinite carryforward, we believe it is more-likely-than-not that the associated deferred tax asset will be realized.

Stock-Based Compensation

We grant stock-based compensation awards in connection with our stock incentive plans. Under the terms of the incentive plans, we are authorized to issue equity awards to our employees, directors and affiliates. The grants have taken the form of restricted stock awards, restricted stock units, performance stock units and stock options. Restricted stock awards provide the recipient with shares of our stock subject to certain vesting requirements. Restricted stock units and performance stock units provide the recipient with the right to receive shares of our stock at a future date if certain vesting conditions are met. Stock option awards provide the recipient the ability to purchase shares of our stock at a given strike price upon the satisfaction of certain vesting requirements.

The vesting requirements associated with the awards include a mix of both service and/or performance conditions. Depending on the award and recipient, the service condition may reflect a cliff vesting provision (e.g., 100% vested upon four years of service) or a graded vesting provision (e.g., 33.3% vested each year over a period of three years). Restricted stock awards and stock options issued with performance conditions vest based on the occurrence of a defined liquidity event upon which certain investment funds affiliated with CCMP receive proceeds exceeding certain thresholds. Although achievement of the performance condition is subject to continued service with us, the terms of awards issued with performance conditions stipulate that the performance vesting condition can be attained for a period of six months following separation

from service under certain circumstances, depending on the means of separation from the Company and subject to other factors such as individual separation agreements. Performance stock units vest upon the achievement of Company-specific financial performance targets and the provision of service through the vesting date.

We recognize compensation expense related to our equity awards with service conditions on a straight-line basis over the stated vesting period for each award. Expense related to our equity awards with performance conditions is recognized in the period in which it becomes probable that the performance target will be achieved. No compensation expense has been recognized to-date on any of our restricted stock awards and stock options subject to vesting based on performance conditions, since a liquidity event triggering vesting of the awards has not occurred, nor is it considered probable.

The grant date fair value of restricted stock awards, restricted stock units and performance stock units is based on the value of our common stock as traded on the New York Stock Exchange. The grant date fair value of stock option awards is estimated using a Black-Scholes option pricing model. Determining the fair value of stock option awards at the grant date requires judgment, including estimates of the average risk-free interest rate, dividend yield, volatility and expected term. Since we have limited experience with respect to historical exercise and forfeiture rates or patterns, we have estimated certain assumptions using acceptable simplified methods and through benchmarking to our peer group of companies.

Recently Issued Accounting Standards

See Note 3 to our consolidated financial statements for a discussion of recently issued accounting standards and their effect on us.

ITEM 7A. QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK.

Our major market risk exposure is potential losses arising from changing rates and prices regarding foreign currency exchange rate risk, interest rate risk, commodity price risk and credit risk. The audit committee of our board of directors regularly reviews foreign exchange, interest rate and commodity hedging activity and monitors compliance with our hedging policy. We do not use financial instruments for speculative purposes, and we limit our hedging activity to the underlying economic exposure.

Foreign Exchange Risk

Our financial results are subject to the impact of gains and losses on currency translations, which occur when the financial statements of foreign operations are translated into U.S. dollars. We operate a geographically diverse business with approximately 40% of our sales during the years ended December 31, 2019 and 2018 coming from our international operations in currencies other than the U.S. dollar. Because consolidated financial results are reported in U.S. dollars, sales or earnings generated in currencies other than the U.S. dollar can result in a significant increase or decrease in the amount of those sales and earnings when translated to U.S. dollars. The financial statements of our operations outside the United States, where the local currency is considered to be the functional currency, are translated into U.S. dollars using the exchange rate in effect at each balance sheet date for assets and liabilities and the average exchange rate for each period for sales, expenses, gains, losses and cash flows. The exchange rates between these currencies and the U.S. dollar in recent years have fluctuated significantly and may continue to do so in the future. The foreign currencies to which we have the most significant exchange rate exposure include the euro, British pound, Canadian dollar, Brazilian real and the Mexican peso. Sales in these top five currencies represented approximately 31% of our sales during the year ended December 31, 2019. A 10% change in these currencies would have impacted sales by approximately \$48.6 million, or 3% of sales assuming product pricing remained constant. The effect of translating foreign subsidiaries' balance sheets into U.S. dollars is included in other comprehensive income. The impact of gains and losses on transactions denominated in currencies other than the functional currency of the relevant operations are included in other non-operating expense. Income and expense items are translated at average exchange rates during the year. Net foreign exchange included in other expense was a \$2.8 million loss for the year ended December 31, 2019. The foreign currency loss realized in the year ended December 31, 2019 was primarily driven by the Euro-denominated term loan and the non-permanent intercompany debt denominated in local currency and translated to U.S. dollars, and was principally non-cash in nature.

On February 8, 2018, we refinanced our existing senior secured term loan facility whereby the Term Loan Facility was used to repay the then-existing U.S. dollar denominated and Euro denominated Term Loan Facilities, thus reducing our exposure to fluctuations in the euro. Concurrent with the term loan refinancing, we entered into multiple cross currency swap arrangements to hedge foreign currency risk. The swaps are intended to enable us to effectively hedge our exposure on the net investments of certain of our Euro denominated subsidiaries.

As described in Note 3 to the consolidated financial statements included in this Form 10-K, the Financial Accounting Standards Board ("FASB") issued guidance in August 2017 with the objective of improving the financial reporting of hedging relationships to better portray the economic results of an entity's risk management activities in its financial statements. As a result of our early adoption of the FASB guidance, and because the swap agreements are designated as net investment hedges, changes in the fair value of the cross-currency swap agreements will be recognized as a component of "Foreign currency translation, net of tax" within "Other comprehensive income (loss), net of tax" in the consolidated statement of comprehensive income. In this regard, a favorable foreign currency change in the designated investment value of our foreign subsidiaries that use the Euro as their functional currency generally will be offset by an unfavorable foreign currency change in the cross-currency swap agreements, and vice versa. At December 31, 2019, a 10% fluctuation in the U.S. dollar-to-Euro currency exchange rate would have an approximately \$31.1 million impact on the fair value of the notional amount of the cross-currency swap agreements and an offsetting \$31.1 million impact on the designated net investment value of the foreign subsidiaries. In addition, in the event of a significant decline in the U.S. dollar-to-Euro exchange rate, our payment obligations to the counterparties could have a material adverse effect on our cash flows. In this regard, if, at the expiration or earlier termination of the swap agreements, the U.S. dollar-to-Euro currency exchange rate has declined by 10% from the rate in effect at December 31, 2019, we would be required to pay approximately \$31.1 million to the counterparties. The swap agreements entail risk that the counterparties will not fulfill their obligations under the agreements. However, we believe the risk is reduced because we have entered into separate agreements with three different counterparties, all of whom are large, well-established financial institutions.

Interest Rate Risk

We are exposed to fluctuations in interest rates on our Senior Secured Credit Facilities. Changes in interest rates will not affect the market value of such debt but will affect the amount of our interest payments over the term of the loans. Likewise, an increase in interest rates could have a material impact on our cash flow. As of December 31, 2019, a 100 basis point increase in assumed interest rates for our variable interest credit facilities, before impact of any hedges, would have an annual impact of approximately \$9.6 million on interest expense.

We hedge the interest rate fluctuations on debt obligations through interest rate cap agreements. We record the fair value of these hedges as assets or liabilities and the related unrealized gains or losses are deferred in stockholders' equity as a component of other comprehensive income (loss), net of tax. The interest rate caps had a fair value net asset of \$3.2 million and \$0.1 million at December 31, 2019 and 2018, respectively. Fair value is determined based on estimated amounts that would be received or paid to terminate the contracts at the reporting date based on quoted market prices.

In July 2016, we entered into interest rate cap agreements, paying a premium of \$1.6 million to mitigate interest rate volatility from July 2016 through July 2020 by employing varying cap rates ranging from 1.50% to 3.00% on \$1.0 billion of notional variable debt. In November 2018, the Company entered into additional interest rate cap agreements to mitigate interest rate volatility from July 2020 through July 2022, with a cap rate of 3.50% on \$0.5 billion of notional variable-rate debt and a \$3.4 million premium annuitized during the effective period.

Commodity Risk

We purchase significant amounts of natural gas to supply the energy required in our production processes for our products in each of our segments. Since we are a producer of inorganic chemicals, natural gas provides an energy source for us but is not a direct feedstock for our products. Therefore, exposure to the volatility in energy prices is less than that of producers of organic petrochemicals. We purchase approximately 15.6 million MMBtu's of natural gas in a given year. Thus, a \$1 increase in the cost of natural gas would impact our cost of goods sold by approximately \$15.6 million absent hedging. Our purchase agreements with our customers typically provide for the pass through of natural gas price increases; however, there is no guarantee that we will continue to be able to pass through future price increases without loss of existing customers. We have implemented a hedging program in the United States which allows us to mitigate exposure to natural gas volatility with natural gas swap agreements. We also make forward purchases of natural gas related to our production at certain subsidiary locations.

The natural gas swap agreements had a fair value net liability of \$1.0 million and fair value net liability of \$0.2 million at December 31, 2019 and 2018, respectively. Fair value is determined based on estimated amounts that would be received or paid to terminate the contracts at the reporting date based on quoted market prices of comparable contracts. The respective current and non-current assets are recorded in other current assets and other assets. The related unrealized gains or losses are recorded in stockholders' equity as a component of other comprehensive income (loss), net of tax. Realized gains and losses on natural gas hedges are included in production cost and subsequently charged to cost of goods sold in the consolidated statements of income in the period in which inventory is sold.

Credit Risk

We are exposed to credit risk on financial instruments to the extent our counterparty fails to perform certain duties as required under the provisions of an agreement. We only transact with counterparties having an appropriate credit rating for the risk involved. Credit exposure is managed through credit approval and monitoring procedures.

Concentration of credit risk can result primarily from trade receivables, for example, with certain customers operating in the same industry or customer groups located in the same geographic region. Credit risk related to these types of receivables is managed through credit approval and monitoring procedures. In the year ended December 31, 2019, we wrote off a nominal amount of bad debt on total sales of \$1,567.1 million.

ITEM 8. FINANCIAL STATEMENTS AND SUPPLEMENTARY DATA.

The consolidated financial statements, supplementary information and financial statement schedules of the Company are set forth beginning on page F-1 of this report.

ITEM 9. CHANGES IN AND DISAGREEMENTS WITH ACCOUNTANTS ON ACCOUNTING AND FINANCIAL DISCLOSURE.

None.

ITEM 9A. CONTROLS AND PROCEDURES.

Evaluation of Disclosure Controls and Procedures

Our management, with the participation of our Chief Executive Officer and Chief Financial Officer, evaluated the effectiveness of our disclosure controls and procedures as of December 31, 2019. The term “disclosure controls and procedures,” as defined in Rules 13a-15(e) and 15d-15(e) under the Exchange Act, means controls and other procedures of a company that are designed to ensure that information required to be disclosed by a company in the reports that it files or submits under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the SEC’s rules and forms. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by a company in the reports that it files or submits under the Exchange Act is accumulated and communicated to the company’s management, including its principal executive and principal financial officers, as appropriate to allow timely decisions regarding required disclosure. Management recognized that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving their objectives and management necessarily applies its judgment in evaluating the cost-benefit relationship of possible controls and procedures. Based on that evaluation, our Chief Executive Officer and Chief Financial Officer concluded that, as of such date, our disclosure controls and procedures were effective at a reasonable assurance level.

Management’s Annual Report on Internal Control over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting. Internal control over financial reporting is defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act as a process, designed by, or under the supervision of the Company’s principal executive and principal financial officers and effected by the Company’s board of directors, management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. Internal control over financial reporting includes maintaining records that in reasonable detail accurately and fairly reflect our transactions and dispositions of assets; providing reasonable assurance that transactions are recorded as necessary for preparation of our financial statements; providing reasonable assurance that receipts and expenditures are made only in accordance with management and board authorizations; and providing reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of our assets that could have a material effect on our financial statements. Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate. Our management assessed the effectiveness of our internal control over financial reporting as of December 31, 2019. In making this assessment, management used the criteria for effective internal control over financial reporting described in the “Internal Control-Integrated Framework” (2013) set forth by the Committee of Sponsoring Organizations of the Treadway Commission (“COSO”). Based on the assessment, management concluded that, as of December 31, 2019, our internal control over financial reporting was effective based on those criteria.

The effectiveness of our internal control over financial reporting as of December 31, 2019 has been audited by PricewaterhouseCoopers LLP, an independent registered public accounting firm, as stated in their report, which is included in Item 8.

Changes in Internal Control Over Financial Reporting

No changes in our internal control over financial reporting occurred during the quarter ended December 31, 2019 that materially affected, or which are reasonably likely to materially affect, our internal control over financial reporting.

ITEM 9B. OTHER INFORMATION.

None.

PART III

ITEM 10. DIRECTORS, EXECUTIVE OFFICERS AND CORPORATE GOVERNANCE.

The information required by this Item 10 will be included in our 2020 Proxy Statement, which we intend to file with the SEC within 120 days of our December 31, 2019 fiscal year end, and is incorporated herein by reference.

ITEM 11. EXECUTIVE COMPENSATION.

The information required by this Item 11 will be included in our 2020 Proxy Statement, which we intend to file with the SEC within 120 days of our December 31, 2019 fiscal year end, and is incorporated herein by reference.

ITEM 12. SECURITY OWNERSHIP OF CERTAIN BENEFICIAL OWNERS AND MANAGEMENT AND RELATED STOCKHOLDER MATTERS.

The information required by this Item 12 will be included in our 2020 Proxy Statement, which we intend to file with the SEC within 120 days of our December 31, 2019 fiscal year end, and is incorporated herein by reference.

ITEM 13. CERTAIN RELATIONSHIPS AND RELATED TRANSACTIONS, AND DIRECTOR INDEPENDENCE.

The information required by this Item 13 will be included in our 2020 Proxy Statement, which we intend to file with the SEC within 120 days of our December 31, 2019 fiscal year end, and is incorporated herein by reference.

ITEM 14. PRINCIPAL ACCOUNTING FEES AND SERVICES.

The information required by this Item 14 will be included in our 2020 Proxy Statement, which we intend to file with the SEC within 120 days of our December 31, 2019 fiscal year end, and is incorporated herein by reference.

PART IV

ITEM 15. EXHIBITS, FINANCIAL STATEMENT SCHEDULES.

(a) The following documents are filed as part of this report:

- (1) and (2) The response to this portion of Item 15 is submitted as a separate section of this report beginning on page F-1. All other schedules have been omitted as inapplicable or are not required, or because the required information is included in the consolidated financial statements or accompanying notes.
 (3) The exhibits filed as part of this report are listed in the accompanying index.

Exhibit No.	Exhibit Description	Filed Herewith	Incorporated by Reference		
			Form	File No.	Filing Date
3.1	Second Restated Certificate of Incorporation of PQ Group Holdings Inc.		10-Q	001-38221	3.1 11/14/2017
3.2	Amended and Restated Bylaws of PQ Group Holdings Inc.		S-1/A	333-218650	3.2 9/1/2017
4.1	Indenture, dated as of May 4, 2016, among PQ Corporation, as Issuer, the Guarantors from time to time party thereto and Wells Fargo Bank, National Association, as Trustee and Collateral Agent, including the form of Global Note attached as Exhibit A thereto		S-1	333-218650	4.2 6/9/2017
4.2	Indenture, dated as of December 11, 2017, among PQ Corporation, as Issuer, the guarantors party thereto and Wells Fargo Bank, National Association, as trustee		8-K	001-38221	4.1 12/13/2017
4.3	Description of PQ Group Holdings Inc.'s common stock	X			
10.1	Term Loan Credit Agreement, dated as of May 4, 2016, by and among PQ Corporation, CPQ Midco I Corporation, the Lenders from time to time party thereto, and Credit Suisse AG, Cayman Islands Branch, as Administrative Agent and Collateral Agent, with Citigroup Global Markets Inc., Credit Suisse Securities (USA) LLC, JPMorgan Chase Bank, N.A., Morgan Stanley Senior Funding, Inc., Deutsche Bank Securities Inc., Goldman Sachs Lending Partners LLC, Jefferies Finance LLC and KeyBanc Capital Markets Inc., as Joint Lead Arrangers and Joint Bookrunners		S-1	333-218650	10.1 6/9/2017
10.2	First Amendment Agreement, dated as of November 14, 2016, to the Term Loan Credit Agreement dated as of May 4, 2016, among PQ Corporation, CPQ Midco I Corporation, the Guarantors named on the signature pages thereto, JPMorgan Chase Bank, N.A., as an Additional Term Lender, and Credit Suisse AG, Cayman Islands Branch, as Administrative Agent and Collateral Agent		S-1	333-218650	10.2 6/9/2017
10.3	Second Amendment Agreement, dated as of August 7, 2017, to the Term Loan Credit Agreement dated as of May 4, 2016 (as amended by the First Amendment Agreement dated as of November 14, 2016), among PQ Corporation, CPQ Midco I Corporation, the Guarantors named on the signature pages thereto, Citibank, N.A., as an Additional Term Lender, and Credit Suisse AG, Cayman Islands Branch, as Administrative Agent and Collateral Agent		S-1/A	333-218650	10.19 8/14/2017

Exhibit No.	Exhibit Description	Filed Herewith	Incorporated by Reference		
			Form	File No.	Filing Date
10.4	Third Amendment Agreement, dated as of February 8, 2018, to the Term Loan Credit Agreement dated as of May 4, 2016 (as amended by the First Amendment Agreement dated as of November 14, 2016 and the Second Amendment Agreement dated as of August 7, 2017) among PQ Corporation, CPQ Midco I Corporation, the Guarantors named on the signature pages thereto, Citibank, N.A., as an Additional Term Lender, and Credit Suisse AG, Cayman Island Branch, as Administrative Agent and Collateral Agent		8-K	001-38221	10.1 2/9/2018
10.5	Fourth Amendment Agreement, dated as of February 7, 2020, to the Term Loan Credit Agreement dated as of May 4, 2016 (as amended by the First Amendment Agreement dated as of November 14, 2016, the Second Amendment Agreement dated as of August 7, 2017 and the Third Amendment Agreement dated as of February 8, 2018) among PQ Corporation, CPQ Midco I Corporation, the Guarantors named on the signature pages thereto, Citibank, N.A., as the replacement lender, and Credit Suisse AG, Cayman Island Branch, as Administrative Agent and Collateral Agent		8-K	001-38221	10.1 2/13/2020
10.6	ABL Credit Agreement, dated as of May 4, 2016, by and among PQ Corporation, CPQ Midco I Corporation, the Canadian Borrowers from time to time party thereto, the European Borrowers from time to time party thereto, the Lenders from time to time party thereto and Citibank, N.A., as Administrative Agent and Issuing Bank, with Citigroup Global Markets Inc., Credit Suisse Securities (USA) LLC, JPMorgan Chase Bank, N.A., Morgan Stanley Senior Funding, Inc., Deutsche Bank Securities Inc., Goldman Sachs Lending Partners LLC, Jefferies Finance LLC and KeyBanc Capital Markets Inc., as Joint Lead Arrangers and Joint Bookrunners		S-1	333-218650	10.3 6/9/2017
10.7	Partnership Agreement, dated as of February 1, 1988, by and between PQ Corporation and Shell Polymers and Catalysts Enterprises Inc.		S-1/A	333-218650	10.10 8/14/2017
10.8	First Amendment to Partnership Agreement, dated January 1, 1993, by and among PQ Corporation, Shell Catalyst Ventures Inc. and CRI Zeolites Inc.		S-1/A	333-218650	10.11 8/14/2017
10.9	Second Amendment to Partnership Agreement, dated October 18, 2002, by and between PQ Corporation and Shell Catalyst Ventures Inc.		S-1/A	333-218650	10.12 8/14/2017
10.10	Third Amendment to Partnership Agreement, dated January 1, 2005, by and between PQ Corporation and CRI Zeolites Inc.		S-1/A	333-218650	10.13 8/14/2017
10.11	Lease Agreement, dated January 1, 2017, by and between The Realty Associates Fund X, L.P. and PQ Corporation		S-1	333-218650	10.4 6/9/2017
10.12	Form of Amended and Restated Stockholders Agreement between PQ Group Holdings Inc. and certain stockholders of PQ Group Holdings Inc.		S-1/A	333-218650	10.5 9/1/2017
10.13*	PQ Group Holdings Inc. 2017 Omnibus Incentive Plan		S-1/A	333-218650	10.14 9/19/2017
10.14*	Form of Stock Option Award Agreement under the PQ Group Holdings Inc. 2017 Omnibus Incentive Plan		S-1/A	333-218650	10.15 9/1/2017
10.15*	Form of Restricted Stock Award Agreement under the PQ Group Holdings Inc. 2017 Omnibus Incentive Plan		S-1/A	333-218650	10.16 9/1/2017

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Exhibit No.	Exhibit Description	Filed Herewith	Incorporated by Reference			
			Form	File No.	Exhibit	Filing Date
10.16*	Form of Restricted Stock Unit Award Agreement under the PQ Group Holdings Inc. 2017 Omnibus Incentive Plan		S-1/A	333-218650	10.17	9/1/2017
10.17*	Form of Performance Stock Unit Award Agreement under the PQ Group Holdings Inc. 2017 Omnibus Incentive Plan		10-Q	001-38221	10.1	5/10/2019
10.18*	PQ Group Holdings Inc. Stock Incentive Plan		S-1	333-218650	10.6	6/9/2017
10.19*	Form of Nonqualified Stock Option Award Agreement under the PQ Group Holdings Inc. Stock Incentive Plan		S-1	333-218650	10.7	6/9/2017
10.20*	Form of Restricted Stock Agreement under the PQ Group Holdings Inc. Stock Incentive Plan		S-1	333-218650	10.8	6/9/2017
10.21*	Form of Director and Officer Indemnification Agreement		S-1/A	333-218650	10.9	9/1/2017
10.22*	Severance Agreement, dated August 9, 2018, by and between PQ Corporation and Belgacem Chariag		8-K	001-38221	10.2	8/9/2018
10.23*	Severance Agreement, dated August 31, 2017, by and between PQ Corporation and James F. Gentilcore		S-1/A	333-218650	10.18	9/19/2017
10.24*	Letter Agreement, dated August 9, 2018, by and between PQ Corporation, PQ Group Holdings Inc. and James F. Gentilcore		8-K	001-38221	10.1	8/9/2018
10.25*	Separation and General Release Agreement, dated December 21, 2018, by and between PQ Corporation, PQ Group Holdings Inc. and James F. Gentilcore		8-K	001-38221	10.1	12/26/2018
10.26*	Severance Agreement, dated August 31, 2017, by and between PQ Corporation and Michael Crews		S-1/A	333-218650	10.19	9/19/2017
10.27*	Severance Agreement, dated August 31, 2017, by and between PQ Corporation and Scott Randolph		S-1/A	333-218650	10.20	9/19/2017
10.28*	Severance Agreement, dated August 31, 2017, by and between PQ Corporation and Paul Ferrall		S-1/A	333-218650	10.21	9/19/2017
10.29*	Severance Agreement and General Release, dated August 31, 2017, by and between PQ Corporation and Michael R. Boyce		S-1/A	333-218650	10.22	9/19/2017
10.30*	Letter of employment, dated August 30, 2017, by and between PQ Corporation and David Taylor		10-Q	001-38221	10.2	5/10/2019
10.31*	Consent under the August 31, 2017 Severance Agreement, dated March 29, 2019, by and between PQ Corporation and Scott Randolph		10-Q	001-38221	10.3	5/10/2019
10.32*	Transition Agreement and General Release, dated November 15, 2019, between PQ Corporation and David J. Taylor		8-K	001-38221	10.1	11/21/2019
10.33*	Transition Agreement and General Release, dated November 26, 2019, between PQ Corporation and Paul J. Ferrall		8-K	001-38221	10.1	12/03/2019
10.34*	Consulting Agreement, dated November 26, 2019, between PQ Corporation and Paul J. Ferrall		8-K	001-38221	10.2	12/03/2019
10.35*	Amendment to the Severance Agreement, dated August 31, 2017, by and between PQ Corporation and Scott Randolph	X				
10.36*	Letter of employment, dated December 8, 2015, by and between PQ Corporation and Ray Kolberg	X				
10.37*	Severance Agreement, dated September 25, 2017, by and between PQ Corporation and Joseph S. Koscinski	X				

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Exhibit No.	Exhibit Description	Filed Herewith	Incorporated by Reference		
			Form	File No.	Filing Date
21.1	Subsidiaries of PQ Group Holdings Inc.	X			
23.1	Consent of PricewaterhouseCoopers LLP related to the consolidated financial statements and financial statement schedule of PQ Group Holdings Inc. as of December 31, 2019 and 2018 and for each of the three years in the period ended December 31, 2019	X			
23.2	Consent of PricewaterhouseCoopers LLP related to the financial statements of Zeolyst International as of December 31, 2019 and 2018 and for each of the three years in the period ended December 31, 2019	X			
31.1	Certification of Chief Executive Officer of PQ Group Holdings Inc. pursuant to Section 302 of the Sarbanes-Oxley Act of 2002	X			
31.2	Certification of Chief Financial Officer of PQ Group Holdings Inc. pursuant to Section 302 of the Sarbanes-Oxley Act of 2002	X			
32.1	Certification of Chief Executive Officer of PQ Group Holdings Inc. pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002	X			
32.2	Certification of Chief Financial Officer of PQ Group Holdings Inc. pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002	X			
101	The following financial statements from the Annual Report on Form 10-K of PQ Group Holdings Inc. for the year ended December 31, 2019, formatted in Inline XBRL: (i) Consolidated Statements of Income, (ii) Consolidated Statements of Comprehensive Income, (iii) Consolidated Balance Sheets, (iv) Consolidated Statements of Stockholders' Equity, (v) Consolidated Statements of Cash Flows, and (vi) Notes to Consolidated Financial Statements, tagged as blocks of text and including detailed tags	X			
104	The cover page from the Annual Report on Form 10-K of PQ Group Holdings Inc. for the year ended December 31, 2019, formatted in Inline XBRL	X			

* Management contract or compensatory plan

ITEM 16. FORM 10-K SUMMARY.

None.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

PQ GROUP HOLDINGS INC.

Date: February 27, 2020

By: /s/ MICHAEL CREWS

Michael Crews

Executive Vice President and Chief Financial Officer

(Duly Authorized Officer and Principal Financial and Accounting Officer)

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Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the dates indicated.

<u>Signature</u>	<u>Title</u>	<u>Date</u>
<u>/s/ BELGACEM CHARIAG</u> Belgacem Chariag	Chairman of the Board, President and Chief Executive Officer (Principal Executive Officer)	February 27, 2020
<u>/s/ MICHAEL CREWS</u> Michael Crews	Executive Vice President and Chief Financial Officer (Principal Financial and Accounting Officer)	February 27, 2020
<u>/s/ GREG BRENNEMAN</u> Greg Brenneman	Director	February 27, 2020
<u>/s/ TIMOTHY WALSH</u> Timothy Walsh	Director	February 27, 2020
<u>/s/ MARK McFADDEN</u> Mark McFadden	Director	February 27, 2020
<u>/s/ CHRISTOPHER BEHRENS</u> Christopher Behrens	Director	February 27, 2020
<u>/s/ ROBERT COXON</u> Robert Coxon	Director	February 27, 2020
<u>/s/ ANDREW CURRIE</u> Andrew Currie	Director	February 27, 2020
<u>/s/ JONNY GINNS</u> Jonny Ginns	Director	February 27, 2020
<u>/s/ KYLE VANN</u> Kyle Vann	Director	February 27, 2020
<u>/s/ MARTIN S. CRAIGHEAD</u> Martin S. Craighead	Director	February 27, 2020
<u>/s/ KIMBERLY ROSS</u> Kimberly Ross	Director	February 27, 2020

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PQ GROUP HOLDINGS INC. AND SUBSIDIARIES

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Report of Independent Registered Public Accounting Firm

To the Board of Directors and Stockholders of PQ Group Holdings Inc.

Opinions on the Financial Statements and Internal Control over Financial Reporting

We have audited the accompanying consolidated balance sheets of PQ Group Holdings Inc. and its subsidiaries (the “Company”) as of December 31, 2019 and 2018, and the related consolidated statements of income, comprehensive income (loss), stockholders’ equity and cash flows for each of the three years in the period ended December 31, 2019, including the related notes and schedule of condensed parent company information as of December 31, 2019 and 2018 and for each of the three years in the period ended December 31, 2019 listed in the accompanying index (collectively referred to as the “consolidated financial statements”). We also have audited the Company’s internal control over financial reporting as of December 31, 2019, based on criteria established in *Internal Control - Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2019 and 2018, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2019 in conformity with accounting principles generally accepted in the United States of America. Also in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2019, based on criteria established in *Internal Control - Integrated Framework (2013)* issued by the COSO.

Basis for Opinions

The Company’s management is responsible for these consolidated financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in Management’s Annual Report on Internal Control over Financial Reporting appearing under Item 9A. Our responsibility is to express opinions on the Company’s consolidated financial statements and on the Company’s internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the consolidated financial statements included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

Definition and Limitations of Internal Control over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (i) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (ii) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (iii) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Critical Audit Matters

The critical audit matters communicated below are matters arising from the current period audit of the consolidated financial statements that were communicated or required to be communicated to the audit committee and that (i) relate to accounts or disclosures that are material to the consolidated financial statements and (ii) involved our especially challenging, subjective, or complex judgments. The communication of critical audit matters does not alter in any way our opinion on the consolidated financial statements, taken as a whole, and we are not, by communicating the critical audit matters below, providing separate opinions on the critical audit matters or on the accounts or disclosures to which they relate.

Goodwill Impairment Assessment - Performance Chemicals and Performance Materials Reporting Units

As described in Notes 2 and 15 to the consolidated financial statements, the Company's consolidated goodwill balance was \$1,259.8 million at December 31, 2019, and the goodwill associated with the Performance Chemicals and Performance Materials reporting units was \$593.4 million and \$275.9 million, respectively. Management performs its annual goodwill impairment test as of October 1 of each year, or more frequently if events or circumstances indicate that it is more likely than not that goodwill may be impaired. Potential impairment is identified by comparing the reporting unit's estimated fair value to its carrying value, including goodwill. Fair value is estimated by management using a combination of a market approach and an income, or discounted cash flow, approach. Estimating the fair value of a reporting unit requires various assumptions including the use of projections of future cash flows and discount rates. The key assumptions used in estimating the fair value are the operating margin growth rates, revenue growth rates, the weighted average cost of capital, the perpetual growth rate, and the estimated earnings market multiples of each reporting unit.

The principal considerations for our determination that performing procedures relating to the goodwill impairment assessment of the Performance Chemicals and Performance Materials reporting units is a critical audit matter are there was significant judgment by management when developing the fair value measurement of the reporting units. This in turn led to a high degree of auditor judgment, subjectivity, and effort in performing procedures and evaluating audit evidence obtained related to management's projections of future cash flows and significant assumptions, including revenue growth rates, weighted average costs of capital and perpetual growth rates. In addition, the audit effort involved the use of professionals with specialized skill and knowledge to assist in performing these procedures and evaluating the audit evidence obtained.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the consolidated financial statements. These procedures included testing the effectiveness of controls relating to management's goodwill impairment assessment, including controls over the valuation of the Company's reporting units. These procedures also included, among others, testing management's process for developing the fair value estimates; evaluating the appropriateness of the discounted cash flow model and market approach; testing the completeness, accuracy, and relevance of underlying data used in the models; and evaluating the significant assumptions used by management, including the revenue growth rates, weighted average costs of capital, and perpetual growth rates. Evaluating management's assumptions related to revenue growth rates and perpetual growth rates involved evaluating whether the assumptions used by management were reasonable considering (i) the current and past performance of the reporting units, (ii) the consistency with external market and industry data, and (iii) whether these assumptions were consistent with evidence obtained in other areas of the audit. Professionals with specialized skill and knowledge were used to assist in the evaluation of the Company's discounted cash flow model and market approach and certain significant assumptions, including the weighted average costs of capital and perpetual growth rates.

Indefinite-Lived Trade Names and Trademarks Impairment Assessment

As described in Notes 2 and 15 to the consolidated financial statements, the Company's consolidated indefinite-lived trade names balance was \$158.5 million and the consolidated indefinite-lived trademarks balance was \$81.0 million at December 31, 2019. Management performs its annual impairment test as of October 1 of each year, or more frequently if events occur or circumstances change that would more likely than not reduce the fair value of the intangible asset below its carrying value. The fair value of indefinite-lived trade names and trademarks are determined based on an income approach using a discounted cash flow valuation model under a relief from royalty methodology. Significant assumptions under the relief from royalty method include the royalty rate a market participant may assume, projected sales and the discount rate applied to the estimated cash flows.

The principal considerations for our determination that performing procedures relating to the indefinite-lived trade names and trademarks impairment assessment is a critical audit matter are there was significant judgment by management when developing the fair value measurements. This in turn led to a high degree of auditor judgment, subjectivity, and effort in performing procedures and evaluating audit evidence obtained related to management's cash flow projections and significant assumptions, including the royalty rates a market participant may assume, projected sales and the discount rates. In addition, the audit effort involved the use of professionals with specialized skill and knowledge to assist in performing these procedures and evaluating the audit evidence obtained.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the financial statements. These procedures included testing the effectiveness of controls relating to management's indefinite-lived trade names and trademarks impairment assessment, including controls over the valuation of the Company's indefinite-lived trade names and trademarks. These procedures also included, among others, testing management's process for developing the fair value estimates; evaluating the appropriateness of the discounted cash flow model; testing the completeness, accuracy, and relevance of underlying data used in the model; and evaluating the significant assumptions used by management, including the royalty rates a market participant may assume, projected sales and the discount rates. Evaluating management's assumptions related to the royalty rates a market participant may assume, projected sales and the discount rates involved evaluating whether the assumptions used by management were reasonable considering (i) the consistency with external market and industry data, (ii) market recognition and awareness, history, longevity, market size, and control of the trade names and trademarks, including opportunities for extensions and usage in alternative markets and geographic regions, and (iii) whether these assumptions were consistent with evidence obtained in other areas of the audit. Professionals with specialized skill and knowledge were used to assist in the evaluation of the Company's discounted cash flow model and certain significant assumptions, including the royalty rates and discount rates.

/s/ PricewaterhouseCoopers LLP
Philadelphia, Pennsylvania
February 27, 2020

We have served as the Company's auditor since 2015.

PQ GROUP HOLDINGS INC. AND SUBSIDIARIES
CONSOLIDATED STATEMENTS OF INCOME
(in thousands, except share and per share amounts)

	Years ended December 31,		
	2019	2018	2017
Sales	\$ 1,567,072	\$ 1,608,154	\$ 1,472,101
Cost of goods sold	1,176,550	1,226,520	1,095,265
Gross profit	390,522	381,634	376,836
Selling, general and administrative expenses	166,880	168,628	146,723
Other operating expense, net	35,840	29,450	64,225
Operating income	187,802	183,556	165,888
Equity in net income from affiliated companies	(46,034)	(37,611)	(38,772)
Interest expense, net	111,525	113,723	179,044
Debt extinguishment costs	3,400	7,751	61,886
Other (income) expense, net	(2,098)	11,077	24,364
Income (loss) before income taxes and noncontrolling interest	121,009	88,616	(60,634)
Provision (benefit) for income taxes	40,699	28,995	(119,197)
Net income	80,310	59,621	58,563
Less: Net income attributable to the noncontrolling interest	771	1,321	960
Net income attributable to PQ Group Holdings Inc.	\$ 79,539	\$ 58,300	\$ 57,603
Net income per share:			
Basic income per share:	\$ 0.59	\$ 0.44	\$ 0.52
Diluted income per share:	\$ 0.59	\$ 0.43	\$ 0.52
Weighted average shares outstanding:			
Basic	134,389,667	133,380,567	111,299,670
Diluted	135,548,694	134,684,931	111,669,037

See accompanying notes to consolidated financial statements.

PQ GROUP HOLDINGS INC. AND SUBSIDIARIES
CONSOLIDATED STATEMENTS OF COMPREHENSIVE INCOME (LOSS)
(in thousands)

	Years ended December 31,		
	2019	2018	2017
Net income	\$ 80,310	\$ 59,621	\$ 58,563
Other comprehensive income (loss), net of tax:			
Pension and postretirement benefits	2,430	(7,958)	(101)
Net loss from hedging activities	(2,665)	(330)	(3,590)
Foreign currency translation	22,889	(35,056)	60,601
Total other comprehensive income (loss)	22,654	(43,344)	56,910
Comprehensive income	102,964	16,277	115,473
Less: Comprehensive income (loss) attributable to noncontrolling interests	1,543	1,392	(152)
Comprehensive income attributable to PQ Group Holdings Inc.	\$ 101,421	\$ 14,885	\$ 115,625

See accompanying notes to consolidated financial statements.

PQ GROUP HOLDINGS INC. AND SUBSIDIARIES
CONSOLIDATED BALANCE SHEETS
(in thousands, except share and per share amounts)

	December 31, 2019	December 31, 2018
ASSETS		
Cash and cash equivalents	\$ 72,284	\$ 57,854
Accounts receivables, net	179,632	196,770
Inventories, net	280,945	264,748
Prepaid and other current assets	35,730	39,244
Total current assets	568,591	558,616
Investments in affiliated companies	472,929	468,211
Property, plant and equipment, net	1,186,770	1,208,979
Goodwill	1,259,805	1,254,929
Other intangible assets, net	676,385	728,436
Right-of-use lease assets	57,295	—
Other long-term assets	99,070	108,254
Total assets	\$ 4,320,845	\$ 4,327,425
LIABILITIES		
Notes payable and current maturities of long-term debt	\$ 7,766	\$ 7,237
Accounts payable	144,365	148,365
Operating lease liabilities—current	15,183	—
Accrued liabilities	102,154	100,009
Total current liabilities	269,468	255,611
Long-term debt, excluding current portion	1,899,196	2,106,720
Deferred income taxes	218,037	196,124
Operating lease liabilities—noncurrent	40,156	—
Other long-term liabilities	108,670	104,825
Total liabilities	2,535,527	2,663,280
Commitments and contingencies (Note 24)		
EQUITY		
Common stock (\$0.01 par); authorized shares 450,000,000; issued shares 136,861,382 and 135,758,269 on December 31, 2019 and 2018, respectively; outstanding shares 136,464,961 and 135,592,045 on December 31, 2019 and 2018, respectively	1,369	1,358
Preferred stock (\$0.01 par); authorized shares 50,000,000; no shares issued or outstanding on December 31, 2019 and 2018, respectively	—	—
Additional paid-in capital	1,696,899	1,674,703
Retained earnings	103,013	25,523
Treasury stock, at cost; shares 396,421 and 166,224 on December 31, 2019 and 2018, respectively	(6,483)	(2,920)
Accumulated other comprehensive loss	(15,348)	(39,104)
Total PQ Group Holdings Inc. equity	1,779,450	1,659,560
Noncontrolling interest	5,868	4,585
Total equity	1,785,318	1,664,145
Total liabilities and equity	\$ 4,320,845	\$ 4,327,425

See accompanying notes to consolidated financial statements.

PQ GROUP HOLDINGS INC. AND SUBSIDIARIES
CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY
(in thousands, except share data)

	Shares of Common stock	Common stock	Additional paid-in capital	Retained earnings (accum. deficit)	Shares of Treasury stock	Treasury stock, at cost	Accum. other comp. income (loss)	Non- control- ling interest	Total
December 31, 2016	106,452,330	\$ 73	\$ 1,167,137	\$ (90,380)	(21,519)	\$ (239)	\$ (53,711)	\$ 5,064	\$ 1,027,944
Net income				57,603				960	58,563
Stock split and conversion	(232,571)	989	(1,228)		232,534	239			—
Issuance of common stock - IPO	29,000,000	290	480,406						480,696
Other comprehensive income (loss)							58,022	(1,112)	56,910
Distributions to noncontrolling interests								(993)	(993)
Stock compensation expense			8,799						8,799
Shares issued under equity incentive plan, net of forfeitures	24,620	—	—		(211,015)	—			—
December 31, 2017	135,244,379	\$ 1,352	\$ 1,655,114	\$ (32,777)	—	\$ —	\$ 4,311	\$ 3,919	\$ 1,631,919
Net income				58,300				1,321	59,621
Other comprehensive income (loss)							(43,415)	71	(43,344)
Repurchases of common shares					(166,224)	(2,920)			(2,920)
Distributions to noncontrolling interests								(726)	(726)
Stock compensation expense			19,464						19,464
Shares issued under equity incentive plan, net of forfeitures	513,890	6	125		—	—			131
December 31, 2018	135,758,269	\$ 1,358	\$ 1,674,703	\$ 25,523	(166,224)	\$ (2,920)	\$ (39,104)	\$ 4,585	\$ 1,664,145
Cumulative effect adjustment from adoption of new accounting standards	—	—	—	(2,049)	—	—	1,874	—	(175)
December 31, 2018, as adjusted	135,758,269	\$ 1,358	\$ 1,674,703	\$ 23,474	(166,224)	\$ (2,920)	\$ (37,230)	\$ 4,585	\$ 1,663,970
Net income				79,539				771	80,310
Other comprehensive income (loss)							21,882	772	22,654
Repurchases of common shares					(230,197)	(3,563)			(3,563)
Distributions to noncontrolling interests								(260)	(260)
Stock compensation expense			18,225						18,225
Shares issued under equity incentive plan, net of forfeitures	1,103,113	11	3,971		—	—			3,982
December 31, 2019	136,861,382	\$ 1,369	\$ 1,696,899	\$ 103,013	(396,421)	\$ (6,483)	\$ (15,348)	\$ 5,868	\$ 1,785,318

See accompanying notes to consolidated financial statements.

PQ GROUP HOLDINGS INC. AND SUBSIDIARIES
CONSOLIDATED STATEMENTS OF CASH FLOWS
(in thousands)

	Years ended December 31,		
	2019	2018	2017
Cash flows from operating activities:			
Net income	\$ 80,310	\$ 59,621	\$ 58,563
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation	131,646	132,640	124,551
Amortization	50,444	52,594	52,589
Amortization of inventory step-up	—	1,603	871
Intangible asset impairment charge	1,600	—	—
Amortization of deferred financing costs and original issue discount	5,777	6,119	8,733
Debt extinguishment costs	3,400	5,627	61,362
Foreign currency exchange loss	2,787	13,810	25,786
Pension and postretirement healthcare benefit expense	3,702	1,073	3,289
Pension and postretirement healthcare benefit funding	(9,670)	(7,602)	(7,887)
Deferred income tax provision (benefit)	18,308	3,445	(140,212)
Net (gain) loss on asset disposals	(13,068)	6,574	5,793
Stock compensation	18,225	19,464	8,799
Equity in net income from affiliated companies	(46,034)	(37,611)	(38,772)
Dividends received from affiliated companies	40,123	40,195	44,071
Net interest income on swaps designated as net investment hedges	(8,480)	(4,859)	—
Gain on contract termination	—	(20,612)	—
Other, net	(6,330)	(1,517)	(4,061)
Working capital changes that provided (used) cash, excluding the effect of acquisitions and dispositions:			
Receivables	14,538	(10,451)	(11,463)
Inventories	(18,943)	(8,980)	(21,200)
Prepays and other current assets	1,256	(6,348)	(3,434)
Accounts payable	(2,308)	(146)	4,343
Accrued liabilities	480	4,005	(6,548)
Net cash provided by operating activities	<u>267,763</u>	<u>248,644</u>	<u>165,173</u>
Cash flows from investing activities:			
Purchases of property, plant and equipment	(127,642)	(131,688)	(140,482)
Investment in affiliated companies	—	(5,000)	(9,000)
Loan receivable under the New Markets Tax Credit Arrangement	—	—	(6,221)
Business combinations, net of cash acquired	—	(1,006)	(41,572)
Proceeds from sale of assets	17,600	12,380	—
Proceeds from sale of product line	27,658	—	—
Proceeds from settlement of swaps designated as net investment hedges	38,070	—	—
Net interest proceeds on swaps designated as net investment hedges	8,480	4,859	—
Other, net	475	1,165	1,293
Net cash used in investing activities	<u>(35,359)</u>	<u>(119,290)</u>	<u>(195,982)</u>
Cash flows from financing activities:			
Draw down of revolving credit facilities	203,542	141,764	357,773
Repayments of revolving credit facilities	(202,802)	(166,778)	(334,180)
Issuance of long-term debt	—	1,267,000	308,550
Debt issuance costs	—	(6,395)	(4,666)
Repayments of long-term debt	(216,659)	(1,369,690)	(739,472)
Debt prepayment fees	—	—	(47,875)
IPO proceeds	—	—	507,500
IPO costs	—	—	(26,804)
Repurchases of common shares	(3,563)	(2,920)	—
Proceeds from stock options exercised	3,975	131	—
Other, net	(586)	(337)	(993)
Net cash (used in) provided by financing activities	<u>(216,093)</u>	<u>(137,225)</u>	<u>19,833</u>
Effect of exchange rate changes on cash, cash equivalents and restricted cash	(2,120)	354	(6,858)
Net change in cash, cash equivalents and restricted cash	14,191	(7,517)	(17,834)
Cash, cash equivalents and restricted cash at beginning of period	59,726	67,243	85,077
Cash, cash equivalents and restricted cash at end of period	<u>\$ 73,917</u>	<u>\$ 59,726</u>	<u>\$ 67,243</u>

For supplemental cash flow disclosures, see Note 29.
See accompanying notes to consolidated financial statements.

PQ GROUP HOLDINGS INC. AND SUBSIDIARIES
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS
(Dollars in thousands, except share and per share amounts)

1. Background and Basis of Presentation:

Description of Business

PQ Group Holdings Inc. and subsidiaries (the “Company” or “PQ Group Holdings”) is a leading integrated and innovative global provider of specialty catalysts, materials, chemicals and services. The Company supports customers globally through its strategically located network of manufacturing facilities. The Company believes that its products, which are predominantly inorganic, and services contribute to improving the sustainability of the environment.

Basis of Presentation

The Company has four uniquely positioned specialty businesses: Refining Services provides sulfuric acid recycling to the North American refining industry; Catalysts serves the packaging and engineered plastics industry and the global refining, petrochemical and emissions control industries through its Zeolyst joint venture; Performance Materials produces transportation reflective safety markings for roads and airports; and Performance Chemicals supplies diverse product end uses, including personal and industrial cleaning products, fuel-efficient tires, surface coatings, and food and beverage products.

Effective March 1, 2019, the Company changed the structure of its internal organization to create the four independent businesses described above in order to promote increased visibility to business unit performance, optimize the Company’s product portfolio and create efficiencies. Previously, the Company had two reportable segments, namely the Environmental Catalysts and Services segment and the Performance Materials and Chemicals segment. The segment results and disclosures included in the Company’s consolidated financial statements have been retroactively adjusted to reflect the new segment structure for all periods presented. The changes to the Company’s segment structure affect only the manner in which the results of the Company’s reportable segments were previously reported; there are no changes to the Company’s consolidated balance sheet, statement of income or cash flows for the prior periods. For the purposes of the Company’s goodwill impairment testing, the four new operating segments align with the Company’s reporting units at which level goodwill has been assigned and historically tested for impairment.

Seasonal changes and weather conditions typically affect the Company’s Performance Materials and Refining Services segments. In particular, the Company’s Performance Materials segment generally experiences lower sales and profit in the first and fourth quarters of the year because highway striping projects typically occur during warmer weather months. Additionally, the Company’s Refining Services segment typically experiences similar seasonal fluctuations as a result of higher demand for gasoline products in the summer months. As a result, working capital requirements tend to be higher in the first and second quarters of the year, which can adversely affect the Company’s liquidity and cash flows. Because of this seasonality associated with certain of the Company’s segments, results for any one quarter are not necessarily indicative of the results that may be achieved for any other quarter or for the full year.

Stock Split and Initial Public Offering

Prior to September 22, 2017, the Company had two classes of common stock designated as Class A and Class B common stock. On September 22, 2017, the Company reclassified its Class A common stock into common stock and then effected a 8.8275-for-1 split of its common stock. On September 28, 2017, the Company converted each outstanding share of Class B common stock into 8.8275 shares of common stock plus an additional number of shares determined by dividing the unreturned paid-in capital amount of such Class B common stock, or \$113.74 per share, by \$17.50, the price of a share of common stock in the Company’s initial public offering (“IPO”), rounded to the nearest whole share. Holders of Class B common stock did not receive any cash payments from the Company in connection with the conversion of the Class B common stock. As a result of the reclassification of Class A common stock into common stock, and the conversion of Class B common stock into common stock, all references to “Class A common stock” and “Class B common stock” have been changed to “common stock” for all periods presented. All previously reported per share and common share amounts in the accompanying financial statements and related notes have been restated to reflect the stock split.

On October 3, 2017, the Company completed its IPO whereby it issued 29,000,000 shares of its common stock at a price of \$17.50 per share. The shares began trading on the New York Stock Exchange on September 29, 2017. The aggregate proceeds received by the Company from the offering were \$480,696, net of underwriting discounts, commissions and offering expenses. The net proceeds were used to repay existing indebtedness as further described in Note 17.

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2. Summary of Significant Accounting Policies:

Principles of Consolidation. The consolidated financial statements include the accounts of the Company and its controlled subsidiaries. Investments in affiliated companies are recorded at cost plus the Company's equity in their undistributed earnings. All intercompany transactions have been eliminated. Noncontrolling interests represent third-party equity ownership in certain of the Company's consolidated subsidiaries and are presented as a component of equity separate from the equity attributable to the Company's shareholders. The noncontrolling interests' share in the Company's net earnings are included in net income attributable to the noncontrolling interest in the Company's consolidated statements of income, and their portion of the Company's comprehensive income is included in comprehensive income (loss) attributable to noncontrolling interests in the Company's consolidated statements of comprehensive income (loss). The Company's noncontrolling interests relate to third-party minority ownership interests held in certain of the Company's foreign subsidiaries acquired as part of a former business combination.

Foreign Currency Translation. All assets and liabilities of foreign subsidiaries and affiliated companies are translated to U.S. dollars using exchange rates in effect at the balance sheet date. Adjustments resulting from translation of the balance sheets and intercompany loans, which are considered permanent, are included in stockholders' equity as part of accumulated other comprehensive income (loss). Adjustments resulting from translation of certain intercompany loans, which are not considered permanent and are denominated in foreign currencies, are included in other (income) expense, net in the consolidated statements of income. The Company considers intercompany loans to be of a permanent or long-term nature if management expects and intends that the loans will not be repaid. For the years ended December 31, 2019, 2018 and 2017, all intercompany loan arrangements were determined to be non-permanent based on management's intention as well as actual lending and repayment activity. Therefore, the foreign currency transaction gains or losses associated with the intercompany loans were recorded in the consolidated statements of income for the years ended December 31, 2019, 2018 and 2017.

Income and expense items are translated at average exchange rates during the year. Net foreign currency exchange (gains) and losses included in other (income) expense, net were \$2,787, \$13,810 and \$25,786 for the years ended December 31, 2019, 2018 and 2017, respectively. The net foreign currency losses realized in 2019 were driven by the non-permanent intercompany debt denominated in local currency and translated to U.S. dollars. The net foreign currency losses realized in 2018 and in 2017 were primarily driven by the Euro-denominated term loan (which was settled as part of the February 2018 term loan refinancing, see Note 17 to these consolidated financial statements for further information) and the non-permanent intercompany debt denominated in local currency and translated to U.S. dollars.

Cash and Cash Equivalents. Cash and cash equivalents include highly liquid investments with original terms to maturity of 90 days or less from the time of purchase.

Restricted Cash. Restricted cash, which is restricted as to withdrawal or usage, is classified separately from cash and cash equivalents on the Company's consolidated balance sheets. The proceeds from the New Markets Tax Credit ("NMTC") financing arrangements are restricted for use and are classified on the Company's consolidated balance sheets as other current assets. See Note 17 to these consolidated financial statements for further information regarding the NMTC financing arrangements. The Company's total restricted cash balances, including cash related to the NMTC financing arrangements, were \$1,633 and \$1,872 as of December 31, 2019 and 2018, respectively, and are included on the Company's consolidated balance sheets as other current assets.

Accounts Receivable and Allowance for Doubtful Accounts. Trade accounts receivable are recorded at the invoiced amount and do not bear interest. The allowance for doubtful accounts is the Company's best estimate of the amount of probable credit losses in its existing accounts receivable. A specific reserve for bad debt is recorded for known or suspected doubtful accounts receivable. For all other accounts, the Company recognizes a reserve for bad debt based on the length of time receivables are past due and historical write-off experience. Account balances are charged against the allowance when the Company believes it is probable that the associated receivables will not be recovered. If the financial condition of the Company's customers were to deteriorate resulting in an impairment of their ability to make payments, additional allowances may be required. The Company does not have any off-balance sheet credit exposure related to its customers. As of December 31, 2019 and 2018, the Company's allowance for doubtful accounts was not material.

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Inventories. Certain domestic inventories are stated at the lower of cost or market and valued using the last-in, first-out (“LIFO”) method. All other inventories are stated at the lower of cost and net realizable value and valued using the weighted average cost or first-in, first-out (“FIFO”) methods.

Property, Plant and Equipment. Property, plant and equipment are carried at cost and include expenditures for new facilities, major renewals and betterments. The Company capitalizes the cost of furnace rebuilds as part of property, plant and equipment. Maintenance, repairs and minor renewals are charged to expense as incurred. The Company capitalizes certain internal costs associated with the implementation of purchased software. When property, plant and equipment is retired or otherwise disposed of, the net carrying amount is eliminated with any gain or loss on disposition recognized in earnings at that time.

Depreciation is provided on the straight-line method based on the estimated useful lives of the assets, which generally range from 15 to 33 years for buildings and improvements and 3 to 10 years for machinery and equipment. Leasehold improvements are depreciated using the straight-line method based on the shorter of the useful life of the improvement or remaining lease term.

The Company capitalizes the interest cost associated with the development and construction of significant new plant and equipment and depreciates that amount over the lives of the related assets. Capitalized interest recorded during the years ended December 31, 2019, 2018 and 2017 was \$1,941, \$3,542 and \$5,806, respectively.

Leases. The Company has operating and finance lease agreements with remaining lease terms as of December 31, 2019 of up to 30 years, including leases of land, buildings, railcars, vehicles, manufacturing equipment and general office equipment. Some leases include options to terminate or extend for one or more years. These options are incorporated in the Company’s lease term when it is reasonably certain that the option will be exercised. Some leases include options to purchase, which the Company assesses under the guidance to determine if these leases should be classified as finance lease agreements.

When the Company enters into an arrangement, at inception, the Company determines if the arrangement contains a lease and whether that lease meets the classification criteria of a finance or operating lease. Some of the Company’s lease arrangements contain lease components (e.g. minimum rent payments) and non-lease components (e.g. maintenance). The Company accounts for the lease and non-lease components separately based on the estimated standalone price of each component. Certain of the Company’s lease agreements include rental payments that are adjusted periodically for an index or rate and these are initially measured using the index or rate in effect at the commencement date. Variable lease expense is recognized in the period in which the obligation for those payments is incurred. The Company’s lease agreements do not contain any material residual value guarantees or material restrictive covenants.

The Company recognizes a right-of-use lease asset and lease liability at the lease commencement date based on the present value of the remaining lease payments over the lease term. The Company assesses its leasing arrangements to determine the rate implicit in the lease arrangement. Historically, the Company’s leasing arrangements do not contain the information necessary to determine the rate implicit in the lease. As such, the Company utilizes its incremental borrowing rate over the relevant lease term, which is the rate of interest that it would have to pay to borrow on a collateralized basis over a similar term an amount equal to the lease payments in a similar economic environment. The incremental borrowing rate is determined at the lease commencement date and is developed utilizing a readily available market interest rate curve adjusted for the Company’s credit quality. The Company has elected to use a portfolio approach to apply its incremental borrowing rate to individual leases based on lease term and geographic jurisdiction. Short-term leases, which have an initial term of twelve months or less, are not recorded on the Company’s balance sheet.

Lease expense for operating leases is recognized on a straight-line basis over the lease term. Lease expense for financing leases is bifurcated into two components, with the amortization expense component of the right-of-use asset recognized on a straight-line basis and the interest expense component recognized using the effective interest method over the lease term. The amortization expense component of the right-of-use lease asset is included in cost of goods sold and in selling, general and administrative expenses and the interest expense component is included in interest expense, net on the consolidated statements of income.

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Spare Parts. Spare parts are maintained by the Company's facilities to keep machinery and equipment in working order. Spare parts are capitalized and included in other long-term assets. Spare parts are measured at cost and are not depreciated or expensed until utilized; however, reserves may be provided on aged spare parts. When a spare part is utilized as part of an improvement to property, plant and equipment, the carrying value is depreciated over the applicable life once placed in service. Otherwise, the spare part is expensed and charged as a cost of production when utilized.

Investments in Affiliated Companies. Investments in affiliated companies are accounted for using the equity method of accounting if the investment provides the Company with the ability to exercise significant influence, but not control, over the investee. Significant influence is generally deemed to exist if the Company's ownership interest in the voting stock of the investee ranges between 20% and 50%, although other factors, such as representation on the investee's board of directors and the impact of commercial arrangements, are considered in determining whether the equity method of accounting is appropriate. Under the equity method of accounting, the investments in equity-method investees are recorded in the consolidated balance sheets as investments in affiliated companies, and the Company's share of the investees' earnings or losses, together with other than temporary impairments in value, is recorded as equity in net income from affiliated companies in the consolidated statements of income. Any differences between the Company's cost of an equity method investment and the underlying equity in the net assets of the investment, such as fair value step-ups resulting from acquisitions, are accounted for according to their nature and impact the amounts recognized as equity in net income from affiliated companies in the consolidated statements of income.

The Company evaluates all distributions received from its equity method investments using the nature of distribution approach. Under this approach, the Company evaluates the nature of activities of the investee that generated the distribution. The distributions received are either classified as a return on investment, which is presented as a component of operating activities on the Company's consolidated statements of cash flows, or as a return of investment, which is presented as a component of investing activities on the Company's consolidated statements of cash flows.

The Company evaluates its equity method investments for impairment whenever events or changes in circumstances indicate that the carrying amounts of such investments may be impaired. If a decline in the value of an equity method investment is determined to be other than temporary, a loss is recorded in earnings in the current period.

Goodwill and Intangible Assets. Goodwill is an asset representing the future economic benefits arising from other assets acquired in a former business combination that are not individually identified and separately recognized. The Company is required to test goodwill associated with each of its reporting units for impairment at least annually and whenever events or circumstances indicate that it is more likely than not that goodwill may be impaired. The Company performs its annual goodwill impairment test as of October 1 of each year.

Goodwill is tested for impairment at the reporting unit level. In performing tests for goodwill impairment, the Company is permitted to first perform a qualitative assessment about the likelihood of the carrying value of a reporting unit exceeding its fair value. If an entity determines that it is more likely than not that the fair value of a reporting unit is less than its carrying amount based on the qualitative assessment, it is required to perform a two-step goodwill impairment test to identify the potential goodwill impairment and measure the amount of the goodwill impairment loss, if any, to be recognized for that reporting unit. However, if an entity concludes otherwise based on the qualitative assessment, the two-step goodwill impairment test is not required. The option to perform the qualitative assessment can be utilized at the Company's discretion, and the qualitative assessment need not be applied to all reporting units in a given goodwill impairment test. For an individual reporting unit, if the Company elects not to perform the qualitative assessment, or if the qualitative assessment indicates that it is more likely than not that the fair value of a reporting unit is less than its carrying amount, then the Company must perform the two-step goodwill impairment test for the reporting unit.

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In applying the two-step process, the first step used to identify potential impairment involves comparing the reporting unit's estimated fair value to its carrying value, including goodwill. If the estimated fair value of a reporting unit exceeds its carrying value, goodwill is not impaired. If the carrying value exceeds the estimated fair value, there is an indication of potential impairment and the second step is performed to measure the amount of impairment, if any. The second step of the process involves the calculation of an implied fair value of goodwill for each reporting unit for which step one indicated potential impairment. The implied fair value of goodwill is determined in a manner similar to how goodwill is calculated in a former business combination. That is, the estimated fair value of the reporting unit, as calculated in step one, is allocated to the individual assets and liabilities as if the reporting unit was being acquired in a business combination. If the implied fair value of goodwill exceeds the carrying value of goodwill assigned to the reporting unit, there is no impairment. If the carrying value of goodwill assigned to a reporting unit exceeds the implied fair value of the goodwill, an impairment charge is recorded to write down the carrying value. An impairment loss cannot exceed the carrying value of goodwill assigned to a reporting unit and the loss establishes a new basis in the goodwill. Subsequent reversal of an impairment loss is not permitted.

For intangible assets other than goodwill, definite-lived intangible assets are amortized over their respective estimated useful lives. Intangible assets with indefinite lives are not amortized, but rather are tested for impairment at least annually or more frequently if events occur or circumstances change that would more likely than not reduce the fair value of the intangible asset below its carrying amount. The Company tests its indefinite-lived intangible assets as of October 1 of each year in conjunction with its annual goodwill impairment test.

Impairment Assessment of Long-Lived Assets. The Company performs an impairment review of property, plant and equipment and definite-lived intangible assets when facts and circumstances indicate that the carrying value of an asset or asset group may not be recoverable from its undiscounted future cash flows. When evaluating long-lived assets for impairment, if the carrying amount of an asset or asset group is found not to be recoverable, a potential impairment loss may be recognized. An impairment loss is measured by comparing the carrying amount of the asset or asset group to its fair value. Fair value is determined using quoted market prices when available, or other techniques including discounted cash flows. The Company's estimates of future cash flows involve assumptions concerning future operating performance, economic conditions and technological changes that may affect the future useful lives of the assets.

Derivative Financial Instruments. The Company utilizes certain derivative financial instruments to enhance its ability to manage risk, including exposure to interest rate, commodity price and foreign currency fluctuations that exist as part of ongoing business operations. Derivative instruments are entered into for periods consistent with the related underlying exposures and do not constitute positions independent of those exposures.

All derivatives designated as hedges are recognized on the consolidated balance sheets at fair value. The Company may designate a derivative as a hedge of the fair value of a recognized asset or liability or of an unrecognized firm commitment (fair value hedge), a hedge of a forecasted transaction or the variability of cash flows to be received or paid related to a recognized asset or liability (cash flow hedge), a foreign currency fair-value or cash-flow hedge (foreign currency hedge), or a hedge of a net investment in a foreign operation (net investment hedge). The Company's hedging strategies include derivatives designated as cash flow hedges and net investment hedges.

Changes in the fair value of a derivative that is highly effective and that is designated and qualifies as a cash flow hedge are recorded in other comprehensive income and subsequently reclassified into earnings in the same period(s) in which the hedged transaction affects earnings. Changes in the fair value of a derivative that is highly effective and that is designated and qualifies as a hedge of a net investment in a foreign operation are recorded in the foreign currency translation adjustment account within accumulated other comprehensive income, where the associated gains and losses will remain until such time that the hedged net investment (foreign subsidiary) is sold or liquidated.

Changes in the fair value of a derivative that is not designated or does not qualify as a hedge are recorded in the consolidated statements of income. Cash flows from derivative instruments are reported in the same cash flow category as the cash flows from the items being hedged.

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The Company formally documents all relationships between hedging instruments and hedged items, as well as its risk-management objective and strategy for undertaking various hedge transactions. The Company also formally assesses whether each hedging relationship is highly effective in achieving offsetting changes in fair values or cash flows of the hedged item during the period, both at the inception of the hedge and on an ongoing basis. If it is determined that a derivative is not highly effective as a hedge, or if a derivative ceases to be a highly-effective hedge, hedge accounting is discontinued with respect to that derivative prospectively.

Fair Value Measurements. The Company measures fair value using the guidelines under U.S. generally accepted accounting principles (“GAAP”). An asset’s fair value is defined as the price at which the asset could be exchanged in a current transaction between market participants. A liability’s fair value is defined as the amount that would be paid to transfer the liability to a market participant, not the amount that would be paid to settle the liability with the creditor. See Note 5 to these consolidated financial statements regarding the application of fair value measurements.

The carrying values of cash, accounts receivable, accounts payable and accrued liabilities approximate fair value due to the short-term nature of these items. See Note 17 to these consolidated financial statements regarding the fair value of debt.

Revenue Recognition. In determining the appropriate amount of revenue to be recognized as the Company fulfills its obligations under its agreements, the Company performs the following steps: (i) identification of the contract with the customer; (ii) determination of whether the promised goods or services are performance obligations, including whether they are distinct in the context of the contract; (iii) measurement of the transaction price; (iv) allocation of the transaction price to the performance obligations based on estimated selling prices; and (v) recognition of revenue when (or as) the Company satisfies each performance obligation.

The Company identifies a contract when an agreement with a customer creates legally enforceable rights and obligations, which occurs when a contract has been approved by both parties, the parties are committed to perform their respective obligations, each party’s rights and payment terms are clearly identified, commercial substance exists and it is probable that the Company will collect the consideration to which it is entitled.

The Company may offer rebates to customers who have reached a specified volume of optional purchases. The Company recognizes rebates given to customers as a reduction of revenue based on an allocation of the cost of honoring rebates earned and claimed to each of the underlying revenue transactions that result in progress by the customer toward earning the rebate. Rebates are recognized at the time revenue is recorded. The Company measures the rebate obligation based on the estimated amount of sales that will result in a rebate at the adjusted sales price per the respective sales agreement.

Shipping and Handling Costs. Amounts billed to a customer in a sale transaction related to shipping and handling, if any, represent revenues earned for the goods provided and are classified as revenue. Costs related to shipping and handling of products shipped to customers are classified as cost of goods sold. Refer to Note 4 for disclosures regarding the recognition of revenue for shipping and handling costs that are billed to customers.

Research and Development. Research and development costs of \$14,030, \$15,565 and \$13,859 for the years ended December 31, 2019, 2018 and 2017, respectively, were expensed as incurred and reported in selling, general and administrative expenses in the consolidated statements of income.

Income Taxes. The Company operates within multiple taxing jurisdictions and is subject to tax filing requirements and potential audits within these jurisdictions. The Company uses the asset and liability method in accounting for income taxes. Deferred tax assets and liabilities are recorded for temporary differences between the tax basis of assets and liabilities and their reported amounts in the financial statements, using statutory tax rates in effect for the year in which the differences are expected to reverse. The effect on deferred tax assets and liabilities of a change in tax rates is recognized in the results of operations in the period that includes the enactment date. The Company evaluates its deferred tax assets each period to ensure that estimated future taxable income will be sufficient in character (e.g., capital gain versus ordinary income treatment), amount and timing, to result in their realizability. A valuation allowance is recorded to reduce the carrying amounts of deferred tax assets, unless it is more likely than not that those assets will be realized.

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Generally, APB 23 of ASC Topic 740, Income Taxes (“ASC 740”), provides guidance with respect to establishing deferred income taxes on earnings from foreign subsidiaries, to the extent that these earnings are considered to be available for repatriation. Further, ASC 740-30 requires that deferred taxes be established with respect to the earnings of a foreign subsidiary, unless existing tax law provides a means by which the investment in a subsidiary can be recovered tax-free. The Company has determined that it is able to repatriate the non-permanently reinvested earnings of its foreign subsidiaries in a tax-free manner. As such, the Company is able to asset, for purposes of ASC 740-30, that no deferred income taxes are needed with respect to earnings from foreign subsidiaries.

The Company recognizes a financial statement benefit for positions taken for tax return purposes when it will be more likely than not (i.e. greater than 50%) that the positions will be sustained upon tax examination, based solely on the technical merits of the tax positions. Otherwise, no tax benefit is recognized. The tax benefits recognized are measured based on the largest benefit that has a greater than 50% likelihood of being realized upon ultimate settlement. The Company recognizes potential accrued interest and penalties related to unrecognized tax benefits as a component of income tax expense. Tax examinations are often complex as tax authorities may disagree with the treatment of items reported by the Company and may require several years to resolve. These accrued liabilities represent a provision for taxes that are reasonably expected to be incurred on the basis of available information but which are not certain.

Pursuant to the Securities and Exchange Commission (“SEC”) Staff Accounting Bulletin No.118 (“SAB 118”), the Company was allowed a measurement period of up to one year after the enactment date of the Tax Cuts and Jobs Act (“TCJA”) to finalize the recording of any related tax impacts with respect to its transition tax liability. In accordance with SAB 118, the Company finalized the impacts of the transition tax as of December 31, 2018 and recorded a measurement period adjustment of \$2,102 as a benefit to tax expense. There was no cash tax outlay associated with the final transition tax amount, as the Company elected to utilize net operating loss (“NOL”) carryforwards to offset the associated taxable income.

Based on FASB guidance, the Company is permitted to make an accounting policy election to either (1) treat the taxes incurred as a result of the Global Intangible Low Taxed Income (“GILTI”) provision as a current-period expense when incurred or (2) factor such amounts into its measurement of deferred taxes. The Company has elected to treat any expense incurred as a current-period expense.

Asset Retirement Obligations. The Company records a liability when the fair value of any future obligation to retire a long-lived asset as a result of an existing or enacted law, statute, ordinance or contract is reasonably estimable. The Company also records a liability for the fair value of a conditional asset retirement obligation if the fair value can be reasonably estimated. When the liability is initially recorded, the Company capitalizes the cost by increasing the amount of the related long-lived asset. Over time, the Company adjusts the liability to its present value by recognizing accretion expense as an operating expense in the consolidated statements of income each period, and the capitalized cost is depreciated over the useful life of the related asset. Upon settlement of the liability, the Company records a gain or loss if the actual costs differ from the accrued amount.

The Company has recorded asset retirement obligations (“AROs”) in other long-term liabilities in order to recognize legal obligations associated with the retirement of tangible long-lived assets. The Company has assessed whether an ARO is required at each manufacturing facility and has recorded an obligation for those locations for which an obligation exists. The most significant of these are primarily attributable to environmental remediation liabilities associated with current operations that were incurred during the course of normal operations. The Company has AROs that are conditional in nature. The Company identified certain conditional AROs upon which it was able to reasonably estimate their fair value and recorded a liability. These AROs were triggered upon commitments by the Company to comply with local, state and national laws to remove environmentally hazardous materials. The AROs have been recognized on a discounted basis using a credit adjusted risk free rate. Accretion of the AROs is recorded in other operating expense, net in the Company’s consolidated statements of income.

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The following table includes the changes in the Company's ARO liability during the years ended December 31, 2019 and 2018:

	Years ended December 31,	
	2019	2018
Beginning balance	\$ 4,224	\$ 4,094
Accretion expense	311	287
Foreign exchange impact	20	(157)
Ending balance	<u>\$ 4,555</u>	<u>\$ 4,224</u>

Environmental Expenditures. Environmental expenditures that pertain to current operations or to future revenues are expensed or capitalized consistent with the Company's capitalization policy for property, plant and equipment. Expenditures that result from the remediation of an existing condition caused by past operations and that do not contribute to current or future revenues are expensed. Liabilities are recognized for remedial activities when the remediation is probable and the cost can be reasonably estimated. Recoveries of expenditures for environmental remediation are recognized as assets only when recovery is deemed probable. See Note 24 to these consolidated financial statements regarding commitments and contingencies and Note 16 regarding the accrued environmental reserve.

Deferred Financing Costs. Financing costs incurred in connection with the issuance of long-term debt are deferred and presented as a direct reduction from the related debt instruments on the Company's consolidated balance sheets. Deferred financing costs are amortized as interest expense using the effective interest method over the respective terms of the associated debt instruments.

Stock-Based Compensation. The Company applies the fair value based method to account for stock options, restricted stock awards, restricted stock units and performance stock units issued in connection with its equity incentive plans. Stock-based compensation expense is recognized on a straight-line basis over the vesting periods of the respective awards, and the Company accounts for forfeitures of equity incentive awards as they occur. In connection with the vesting of restricted stock awards, restricted stock units and performance stock units, shares of common stock may be delivered to the Company by employees to satisfy withholding tax obligations at the instruction of the employee award holders. These transactions when they occur are accounted for as stock repurchases by the Company, with the shares returned to treasury stock at a cost representing the payment by the Company of the tax obligations on behalf of the employees in lieu of shares for the vesting event. See Note 22 to these consolidated financial statements regarding compensation expense associated with the Company's equity incentive awards.

Pensions and Postretirement Benefits. The Company maintains qualified and non-qualified defined benefit pension plans that cover employees in the United States and Canada, as well as certain employees in other international locations. Benefits for a majority of the plans are based on average final pay and years of service. Our funding policy, consistent with statutory requirements, is based on actuarial computations utilizing the projected unit credit method of calculation. Not all defined benefit pension plans are funded. In the United States and Canada, the pension plans' assets include equity and fixed income securities. In our other international locations, the pension plans' assets include equity and fixed income securities, as well as insurance contracts. Certain assumptions are made regarding the occurrence of future events affecting pension costs, such as mortality, withdrawal, disablement and retirement, changes in compensation and benefits, and discount rates to reflect the time value of money.

The major elements in determining pension income and expense are pension liability discount rates and the expected return on plan assets. The Company references rates of return on high-quality, fixed income investments when estimating the discount rate, and the expected period over which payments will be made based upon historical experience. The long-term rate of return used to calculate the expected return on plan assets is the average rate of return estimated to be earned on invested funds for providing pension benefits.

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In addition to pension benefits, the Company provides certain health care benefits for employees who meet age, participation and length of service requirements at retirement. The Company uses explicit assumptions using the best estimates available of the plan's future experience. Principal actuarial assumptions include: discount rates, present value factors, retirement age, participation rates, mortality rates, cost trend rates, Medicare reimbursement rates and per capita claims cost by age. Current interest rates as of the measurement date are used for discount rates in present value calculations.

The Company also has defined contribution plans covering domestic employees of the Company and certain subsidiaries.

Contingencies. Certain conditions may exist as of the date the financial statements are issued, which may result in a loss to the Company but which will only be resolved when one or more future events occur or fail to occur. The Company's management and its legal counsel assess such contingent liabilities, and such assessment inherently involves an exercise of judgment. In assessing loss contingencies related to legal proceedings that are pending against the Company or unasserted claims that may result in such proceedings, the Company and legal counsel evaluate the perceived merits of any legal proceedings or unasserted claims as well as the perceived merits of the amount of relief sought or expected to be sought therein. If the assessment of a contingency indicates that it is probable that a loss has been incurred and the amount of the liability can be estimated, then the estimated liability is accrued in the Company's financial statements. If the assessment indicates that a loss contingency is not probable, but is reasonably possible, or is probable but cannot be estimated, then the nature of the contingent liability, together with an estimate of the range of possible loss if determinable and material, would be disclosed. Loss contingencies considered remote are generally not disclosed unless they involve guarantees, in which case the nature of the guarantee would be disclosed, including the approximate term, how the guarantee arose, and the events or circumstances that would require the guarantor to perform under the guarantee.

Use of Estimates. The preparation of financial statements in conformity with GAAP requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

Reclassifications. In order to clarify certain differences between the U.S. statutory tax rate and the Company's effective tax rate, reclassifications have been made to the historical footnote disclosures in the reconciliation of income tax expense (benefit) table to conform to the current presentation. Refer to Note 20 for further details.

3. New Accounting Standards:

Recently Adopted Accounting Standards

In February 2016, the Financial Accounting Standards Board ("FASB") issued guidance (with subsequent targeted amendments) that modifies the accounting for leases. Under the new guidance, a lessee recognizes right-of-use lease assets and lease liabilities for most leases (including those classified under existing GAAP as operating leases, which based on previous standards are not reflected on the balance sheet), but recognizes expenses in a manner that is generally consistent with existing practices. The new guidance also requires companies to provide expanded disclosures regarding leasing arrangements. For public companies, the new guidance is effective for fiscal years beginning after December 15, 2018, including interim periods within those years. The new guidance must be adopted using a modified retrospective transition method.

The Company adopted the new lease guidance effective January 1, 2019 as required using the modified retrospective transition method and applied the provisions of the guidance at the effective date with a cumulative-effect adjustment to the opening balance of retained earnings without adjusting the comparative periods presented. The new guidance provides practical expedients and allows for certain policy elections with regard to the Company's lease population. The Company has elected the short term lease accounting policy and will not record right-of-use lease assets or lease liabilities for leases with an initial term of twelve months or less. Additionally, the Company has elected to utilize the portfolio approach to apply incremental borrowing rates to its leases. The Company has elected the package of practical expedients which provides the Company with the ability to bypass reassessment of the following for leases existing at the date of adoption: (1) whether any existing contracts are, or contain, leases; (2) the lease classification for any existing leases; and (3) initial direct costs for any existing leases. The Company also elected the land easement practical expedient to carry forward existing accounting treatment on existing land easements.

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Adoption of the new lease guidance resulted in the recognition of right-of-use lease assets of \$60,726, which included \$57,832 of right-of-use lease assets related to lease commitments and \$2,895 related to the reclassification of favorable lease contracts, and lease liabilities of \$58,929. The new guidance had no impact on the Company's operating results or liquidity upon adoption. Disclosures related to the Company's leases are included in Note 13 to these consolidated financial statements.

In February 2018, the FASB issued guidance which permits entities to make a one-time election to reclassify the residual ("stranded") income tax effects included in accumulated other comprehensive income ("AOCI") to beginning retained earnings as a result of tax reform legislation enacted by the U.S. government on December 22, 2017, namely the TCJA. The standard is effective for fiscal years beginning after December 15, 2018 and interim periods within those fiscal years. Prior to the enactment of the tax reform legislation on December 22, 2017, the Company had amounts recorded in AOCI related to its domestic pension, postretirement and supplementary benefit plans and cash flow hedging relationships that were based on pre-enactment tax rates, which were included in AOCI at the adoption date of the new guidance. The Company adopted the new guidance effective January 1, 2019 as required, and elected to reclassify the income tax effects stranded in AOCI related to the change in the U.S. federal corporate income tax rate from the TCJA of \$1,874 from AOCI to beginning retained earnings. There were no other income tax effects related to the application of the TCJA that were included in this reclassification. The Company's accounting policy for releasing income tax effects from AOCI is based on individual units of account.

In June 2018, the FASB issued guidance which conforms the accounting for the issuance of all share-based payments using the same accounting model. Previously, the accounting for share-based payments to non-employees was covered under a different framework than those made to employees. Under the new guidance, awards to both employees and non-employees essentially follow the same model, with small variations related to determining the term assumption when valuing a non-employee award as well as a different expense attribution model for non-employee awards. The new guidance is effective for fiscal years beginning after December 15, 2018 and interim periods within those fiscal years. The Company adopted the new guidance on January 1, 2019 as required, with no material impact on its consolidated financial statements upon adoption.

In August 2018, the FASB issued guidance which modifies the disclosure requirements for employers that sponsor defined benefit pension or other postretirement plans. The guidance eliminates certain disclosure requirements, including the amounts in accumulated other comprehensive income expected to be recognized as components of net periodic benefit cost over the next fiscal year and the effects of a one-percentage point change in assumed health care cost trend rates. The guidance also requires additional disclosure of the reasons for significant gains and losses related to changes in the benefit obligation for the period. The guidance is effective for fiscal years ending after December 15, 2020 with early adoption permitted, and is required to be applied on a retrospective basis to all periods presented. The Company early adopted the new guidance on December 31, 2019 and modified its benefit plan disclosures, which are further described in Note 21 to these consolidated financial statements. The guidance did not have a material impact on the Company's consolidated financial statements.

Accounting Standards Not Yet Adopted as of December 31, 2019

In December 2019, the FASB issued new guidance to simplify the accounting for income taxes by removing certain exceptions to the general principles and also simplification of areas such as franchise taxes, step-up in tax basis goodwill, separate entity financial statements and interim recognition of enactment of tax laws or rate changes. The new guidance is effective for fiscal years beginning after December 15, 2020 and interim periods within those fiscal years, with early adoption permitted. The Company is currently evaluating the impact of this new guidance on its consolidated financial statements.

In August 2018, the FASB issued guidance which modifies certain disclosure requirements over fair value measurements. The guidance is effective for fiscal years beginning after December 15, 2019, including all interim periods within that fiscal year. The guidance is not expected to have an impact on the fair value measurement disclosures included in the Company's consolidated financial statements.

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In January 2017, the FASB issued guidance which eliminates the second step from the traditional two-step goodwill impairment test. Under current guidance, an entity performed the first step of the goodwill impairment test by comparing the fair value of a reporting unit with its carrying amount; if an impairment loss was indicated, the entity computed the implied fair value of goodwill to determine whether an impairment loss existed, and if so, the amount to recognize. Under the new guidance, an impairment loss is recognized for the amount by which the carrying amount exceeds the reporting unit's fair value (the Step 1 test), with no further testing required. Any impairment loss recognized is limited to the amount of goodwill allocated to the reporting unit. The new guidance is effective for public companies that are Securities and Exchange Commission ("SEC") registrants for fiscal years beginning after December 15, 2019, with early adoption permitted for goodwill impairment tests performed on testing dates after January 1, 2017. The Company adopted the new guidance on January 1, 2020, and will apply the guidance prospectively to its goodwill impairment tests.

In June 2016, the FASB issued guidance that affects loans, trade receivables and any other financial assets that have the contractual right to receive cash. Under the new guidance, an entity is required to recognize expected credit losses rather than incurred losses for financial assets. The new guidance is effective for fiscal years beginning after December 15, 2019 and interim periods within those fiscal years. The Company believes that the new guidance will not have a material impact on its consolidated financial statements.

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4. Revenue from Contracts with Customers:

Revenue Recognition Model

As described in Note 2, the Company applies the five-step revenue recognition model to each contract with its customers.

Evidence of a contract between the Company and its customers may take the form of a master service agreement (“MSA”), a MSA in combination with an underlying purchase order, a combination of a pricing quote with an underlying purchase order or an individual purchase order received from a customer. The Company and certain of its customers enter into MSAs that establish the terms, including prices, under which orders to purchase goods may be placed. In cases where the MSA contains a distinct order for goods or contains an enforceable minimum quantity to be purchased by the customer, the Company considers the MSA to be evidence of a contract between the Company and its customer as the MSA creates enforceable rights and obligations. In cases where the MSA does not contain a distinct order for goods, the Company’s contract with a customer is the purchase order issued under the MSA. Customers of the Company may also negotiate orders via pricing quotes, which typically detail product pricing, delivery terms and payment information. When a customer procures goods under this method, the Company considers the combination of the pricing quote and the purchase order to create enforceable rights and obligations. Absent either a MSA or pricing quote, the Company considers an individual purchase order remitted by a customer to create enforceable rights and obligations.

The Company identifies a performance obligation in a contract for each promised good that is separately identifiable from other promises in the contract and for which the customer can benefit from the good. The majority of the Company’s contracts have a single performance obligation, which is the promise to transfer individual goods to the customer. Single performance obligations are satisfied according to the shipping terms noted within the MSA or purchase order. The Company has certain contracts that include multiple performance obligations under which the purchase price for each distinct performance obligation is defined in the contract. These distinct performance obligations may include stand-ready provisions, which are arrangements to provide a customer assurance that they will have access to output from the Company’s manufacturing facilities, or monthly reservations of capacity fees. The Company considers stand-ready provisions and reservation of capacity fees to be performance obligations satisfied over time. Revenues related to stand-ready provisions and reservation of capacity fees are recognized on a ratable basis throughout the contract term and billed to the customer on a monthly basis.

As described above, the Company’s MSAs with its customers may outline prices for individual products or contract provisions. MSAs in the Company’s Performance Chemicals and Refining Services segments may contain provisions whereby raw material costs are passed-through to the customer per the terms of their contract. The Company’s exposure to fluctuations in raw material prices is limited, as the majority of pass-through contract provisions reset based on fluctuations in the underlying raw material price. MSAs in the Company’s Refining Services segment also contain take-or-pay arrangements, whereby the customer would incur a penalty in the form of a volume shortfall fee. During the years ended December 31, 2019 and 2018, there have been no issues in which Refining Services customers failed to meet their contractual obligations. Revenue from product sales are recorded at the sales price, which includes estimates of variable consideration for which reserves are established and which result from discounts, returns or other allowances that are offered within contracts between the Company and its customers.

The Company recognizes revenues when performance obligations under the terms of a contract with its customer are satisfied, which generally occurs at a point in time by transferring control of a product to the customer. The Company determines the point in time when a customer obtains control of a product and the Company satisfies the performance obligation by considering factors including when the Company has a right to payment for the product, the customer has legal title to the product, the Company has transferred possession of the product, the customer has assumed the risks and rewards of ownership of the product and the customer has accepted the product. Revenue is measured as the amount of consideration the Company expects to receive in exchange for transferring goods. The Company does not have any significant payment terms as payment is received at, or shortly after, the point of sale.

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Refining Services

Contracts between the Company's Refining Services segment and its customers are typically evidenced by entering into a MSA which generally has a term in excess of one year. Though each MSA is unique, the terms may include performance obligations such as stand-ready provisions and minimum purchase requirements. Stand-ready provisions within these contracts are billed on a monthly basis, as the performance obligation resets on a monthly basis and does not carry-over to the following month. Certain of the Company's Refining Services MSAs contain minimum purchase requirements that expire within the calendar year. The Company reviews each contract with minimum purchase requirements to determine if the customer will meet the provisions within the current calendar year. During the years ended December 31, 2019 and 2018, there have been no issues in which Refining Services customers failed to meet their contractual obligations. Contracts within Refining Services may also contain raw material pricing adjustments which are typically based on a commodity index or Refining Services' cost to acquire the commodity. These raw material pass-through provisions reset on a periodic basis and prospectively adjust the raw material cost component of the goods sold to the customer. The Company accounts for the raw material costs on a prospective basis, as the price changes affect the future consideration of the sale of goods.

Catalysts

The Company's Catalysts segment sells customized products to its customers. These customized products are reformulations of existing Catalysts products, tailored to meet individual customer specifications. Prior to entering into an arrangement, the Company will allow a customer to obtain a sample of goods to ensure that it meets their needs. The customer will enter into a long-term supply arrangement that outlines the specification of the products to be sold and contains terms and conditions under which purchase orders are issued. These supply arrangements typically have a duration from one to ten years. Although the duration of these supply arrangements are in excess of one year, a contract is formed between the Company and its customer upon receipt of a purchase order.

Performance Materials

Evidence of a contract between the Company's Performance Materials segment and its customers typically take the form a combination of a pricing quote with an underlying purchase order or an individual purchase order received from a customer, which details the specification of the products to be sold. Revenue is recorded according to the shipping terms noted within the purchase order.

Performance Chemicals

Contracts between the Company's Performance Chemicals segment and its customers are typically evidenced by entering into a supply arrangement that outlines the specification of the products to be sold and contains terms and conditions under which purchase orders are issued. Certain Performance Chemicals supply arrangements may contain raw material pricing adjustments which are typically based on a commodity index. These raw material pass-through provisions reset on a periodic basis and prospectively adjust the raw material cost component of the goods sold to the customer. The Company accounts for the raw material pass-through costs on a prospective basis, as the price changes affect the future consideration of the sale of goods.

Contract Assets and Liabilities

A contract asset is a right to consideration in exchange for goods that the Company has transferred to a customer when that right is conditional on something other than the passage of time. A contract liability exists when the Company receives consideration in advance of the fulfillment of its performance obligations. The Company has no contract assets recorded on its consolidated balance sheets as of December 31, 2019 and 2018, and no contract liabilities existed as of December 31, 2018.

The Company recognized a \$9,000 contract liability associated with the sale of a portion of its sulfate salts product line, of which \$6,450 of deferred revenue remained as of December 31, 2019. The Company recognized revenue of \$2,550 related to this contract liability during the year ended December 31, 2019. Refer to Note 8 of these consolidated financial statements for additional information related to the sale of the product line.

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Practical Expedients and Accounting Policy Elections

The Company has elected to use certain practical expedients and has made certain accounting policy elections as permitted under the new revenue recognition guidance. The majority of the Company’s contracts with customers are based on an individual purchase order; thus, the duration of these contracts are for one year or less. As described above, the Company’s performance obligations reset either monthly or at the end of the calendar year. The Company has made an accounting policy election to omit certain disclosures related to these performance obligations, as the initial term of the Company’s performance obligations are for a term of one year or less.

The Company uses an output method to recognize revenues related to performance obligations satisfied over time. These performance obligations, as described above, are satisfied within a calendar year. As such, the Company has elected to utilize the “as-invoiced” practical expedient, which permits the Company to recognize revenue in the amount to which it has a right to invoice the customer, provided that the amount corresponds directly with the value provided by the performance obligation as completed to date.

When the Company performs shipping and handling activities after the transfer of control to the customer (e.g. when control transfers prior to delivery), they are considered fulfillment activities as opposed to separate performance obligations, and the Company recognizes revenue upon the transfer of control to the customer. Accordingly, the costs associated with these shipping and handling activities are accrued when the related revenue is recognized under the Company’s policy election. The Company does not utilize sales-based commissions plans, and as a result, the Company does not capitalize any costs which could be considered incremental costs of obtaining a contract. Sales, value added and other taxes the Company collects concurrent with revenue producing activities are excluded from revenues.

Disaggregated Revenue

The Company’s primary means of disaggregating revenues is by reportable segment, which can be found in Note 14 to these consolidated financial statements.

The Company’s portfolio of products are integrated into a variety of end uses, which are described in the table below:

Key End Uses	Key Products
Industrial & process chemicals	<ul style="list-style-type: none"> • Silicate precursors for the tire industry • Glass beads, or microspheres, for metal finishing end uses
Fuels & emission control	<ul style="list-style-type: none"> • Refinery catalysts • Emission control catalysts • Catalyst recycling services • Silicate for catalyst manufacturing
Packaging & engineered plastics	<ul style="list-style-type: none"> • Catalysts for high-density polyethylene and chemicals syntheses • Antiblocks for film packaging • Solid and hollow microspheres for composite plastics • Sulfur derivatives for nylon production
Highway safety & construction	<ul style="list-style-type: none"> • Reflective markings for roadways and airports • Silica gels for surface coatings
Consumer products	<ul style="list-style-type: none"> • Silica gels for edible oil and beer clarification • Precipitated silicas, silicates and zeolites for the dentifrice and dishwasher and laundry detergent applications
Natural resources	<ul style="list-style-type: none"> • Silicates for drilling muds • Hollow glass beads, or microspheres, for oil well cements • Silicates and alum for water treatment mining • Bleaching aids for paper

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The following table disaggregates the Company's sales, by segment and end use, for the years ended December 31, 2019 and 2018:

Year ended December 31, 2019					
	Refining Services	Catalysts	Performance Materials	Performance Chemicals	Total
Industrial & process chemicals	\$ 80,661	\$ 109	\$ 50,380	\$ 226,089	\$ 357,239
Fuels & emission control ⁽¹⁾	252,294	—	—	—	252,294
Packaging & engineered plastics	48,056	85,558	68,000	52,836	254,450
Highway safety & construction ⁽¹⁾	—	—	231,081	84,358	315,439
Consumer products	—	—	—	260,868	260,868
Natural resources	66,070	—	13,504	60,986	140,560
Total segment sales	447,081	85,667	362,965	685,137	1,580,850
Inter-segment sales eliminations	(3,398)	(109)	(225)	(10,046)	(13,778)
Total	<u>\$ 443,683</u>	<u>\$ 85,558</u>	<u>\$ 362,740</u>	<u>\$ 675,091</u>	<u>\$ 1,567,072</u>

Year ended December 31, 2018					
	Refining Services	Catalysts	Performance Materials	Performance Chemicals	Total
Industrial & process chemicals	\$ 77,866	\$ 86	\$ 51,262	\$ 240,214	\$ 369,428
Fuels & emission control ⁽¹⁾	246,452	—	—	—	246,452
Packaging & engineered plastics	59,168	72,013	76,489	54,507	262,177
Highway safety & construction ⁽¹⁾	—	—	235,555	84,579	320,134
Consumer products	—	—	—	272,576	272,576
Natural resources	72,076	—	14,973	65,459	152,508
Total segment sales	455,562	72,099	378,279	717,335	1,623,275
Inter-segment sales eliminations	(3,237)	(86)	(300)	(11,498)	(15,121)
Total	<u>\$ 452,325</u>	<u>\$ 72,013</u>	<u>\$ 377,979</u>	<u>\$ 705,837</u>	<u>\$ 1,608,154</u>

⁽¹⁾ As described in Note 1, the Company experiences seasonal sales fluctuations to customers in the fuels & emission control and highway safety & construction end uses.

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5. Fair Value Measurements:

Fair values are based on quoted market prices when available. When market prices are not available, fair values are generally estimated using discounted cash flow analyses, incorporating current market inputs for similar financial instruments with comparable terms and credit quality. In instances where there is little or no market activity for the same or similar instruments, the Company estimates fair values using methods, models and assumptions that management believes a hypothetical market participant would use to determine a current transaction price. These valuation techniques involve some level of management estimation and judgment that becomes significant with increasingly complex instruments or pricing models. Where appropriate, adjustments are included to reflect the risk inherent in a particular methodology, model or input used.

The Company's financial assets and liabilities carried at fair value have been classified based upon a fair value hierarchy. The hierarchy gives the highest ranking to fair values determined using unadjusted quoted prices in active markets for identical assets and liabilities (Level 1) and the lowest ranking to fair values determined using methodologies and models with unobservable inputs (Level 3). The classification of an asset or a liability is based on the lowest level input that is significant to its measurement. For example, a Level 3 fair value measurement may include inputs that are both observable (Levels 1 and 2) and unobservable (Level 3). The levels of the fair value hierarchy are as follows:

- Level 1—Values are unadjusted quoted prices for identical assets and liabilities in active markets accessible at the measurement date. Active markets provide pricing data for trades occurring at least weekly and include exchanges and dealer markets.
- Level 2—Inputs include quoted prices for similar assets or liabilities in active markets, quoted prices from those willing to trade in markets that are not active, or other inputs that are observable or can be corroborated by market data for the term of the instrument. Such inputs include market interest rates and volatilities, spreads and yield curves.
- Level 3—Certain inputs are unobservable (supported by little or no market activity) and significant to the fair value measurement. Unobservable inputs reflect the Company's best estimate of what hypothetical market participants would use to determine a transaction price for the asset or liability at the reporting date.

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The following table presents information about the Company's assets and liabilities that were measured at fair value on a recurring basis as of December 31, 2019 and 2018, and indicates the fair value hierarchy of the valuation techniques the Company utilized to determine such fair value.

	December 31, 2019	Quoted Prices in Active Markets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				
Derivative contracts (Note 19)	\$ 3,928	\$ —	\$ 3,928	\$ —
Restoration plan assets	4,199	4,199	—	—
Total	\$ 8,127	\$ 4,199	\$ 3,928	\$ —
Liabilities:				
Derivative contracts (Note 19)	\$ 12,415	\$ —	\$ 12,415	\$ —

	December 31, 2018	Quoted Prices in Active Markets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				
Derivative contracts (Note 19)	\$ 20,768	\$ —	\$ 20,768	\$ —
Restoration plan assets	4,244	4,244	—	—
Total	\$ 25,012	\$ 4,244	\$ 20,768	\$ —
Liabilities:				
Derivative contracts (Note 19)	\$ 2,026	\$ —	\$ 2,026	\$ —

The following table presents information about the Company's assets and liabilities that were measured at fair value on a non-recurring basis as of December 31, 2019 (there were no such assets or liabilities measured during the year ended December 31, 2018). The Company performed its annual impairment test on its indefinite-lived intangible assets on October 1, 2019, and determined that an impairment existed with respect to one of its in-process research and development intangible assets. Refer to Note 15 to these consolidated financial statements for a description of the valuation techniques the Company utilized to determine such fair value and for the results of the impairment testing procedures performed.

	As of December 31, 2019	Quoted Prices in Active Markets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)	Total Losses
Assets:					
In-process research and development intangible assets ⁽¹⁾	\$ 5,200	\$ —	\$ —	\$ 5,200	\$ (1,600)

⁽¹⁾ In-process research and development with a carrying amount of \$6,800 were written down to their implied fair value of \$5,200 as part of the Company's annual impairment assessment on October 1, 2019. This resulted in an impairment charge of \$1,600, which was recorded to other operating expense, net, on the consolidated statements of income.

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Restoration plan assets

The fair values of the Company's restoration plan assets are determined through quoted prices in active markets. Restoration plan assets are assets held in a Rabbi trust to fund the obligations of the Company's defined benefit supplementary retirement plans and include various stock and fixed income mutual funds. See Note 21 to these consolidated financial statements regarding defined benefit supplementary retirement plans. The Company's restoration plan assets are included in other long-term assets on its consolidated balance sheets. Gains and losses related to these investments are included in other expense, net in the Company's consolidated statements of income. Unrealized gains and losses associated with the underlying stock and fixed income mutual funds were immaterial as of December 31, 2019 and December 31, 2018, respectively.

Derivative contracts

Derivative assets and liabilities can be exchange-traded or traded over-the-counter ("OTC"). The Company generally values exchange-traded derivatives using models that calibrate to market transactions and eliminate timing differences between the closing price of the exchange-traded derivatives and their underlying instruments. OTC derivatives are valued using market transactions and other market evidence whenever possible, including market-based inputs to models, model calibration to market transactions, broker or dealer quotations or alternative pricing sources with reasonable levels of price transparency. When models are used, the selection of a particular model to value an OTC derivative depends on the contractual terms of, and specific risks inherent in, the instrument as well as the availability of pricing information in the market. The Company generally uses similar models to value similar instruments. Valuation models require a variety of inputs, including contractual terms, market prices and rates, forward curves, measures of volatility, and correlations of such inputs. For OTC derivatives that trade in liquid markets, such as forward contracts, swaps and options, model inputs can generally be corroborated by observable market data by correlation or other means, and model selection does not involve significant management judgment.

The Company has interest rate caps, natural gas swaps and cross currency swaps that are fair valued using Level 2 inputs. In addition, the Company applies a credit valuation adjustment to reflect credit risk which is calculated based on credit default swaps. To the extent that the Company's net exposure under a specific master agreement is an asset, the Company utilizes the counterparty's default swap rate. If the net exposure under a specific master agreement is a liability, the Company utilizes a default swap rate comparable to PQ Group Holdings. The credit valuation adjustment is added to the discounted fair value to reflect the exit price that a market participant would be willing to receive to assume the Company's liabilities or that a market participant would be willing to pay for the Company's assets.

6. Accumulated Other Comprehensive Income (Loss):

The following table presents the components of accumulated other comprehensive income (loss), net of tax, as of December 31, 2019 and 2018:

	December 31,	
	2019	2018
Amortization and unrealized gains (losses) on pension and postretirement plans, net of tax of (\$994) and (\$2,362)	\$ 3,568	\$ (546)
Net changes in fair values of derivatives, net of tax of \$604 and (\$474)	(1,838)	637
Foreign currency translation adjustments, net of tax of \$7,474 and \$5,154	(17,078)	(39,195)
Accumulated other comprehensive loss	<u>\$ (15,348)</u>	<u>\$ (39,104)</u>

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The following table presents the tax effects of each component of other comprehensive income (loss) for the years ended December 31, 2019, 2018 and 2017:

	Years ended December 31,								
	2019			2018			2017		
	Pre-tax amount	Tax benefit/ (expense)	After-tax amount	Pre-tax amount	Tax benefit/ (expense)	After-tax amount	Pre-tax amount	Tax benefit/ (expense)	After-tax amount
Defined benefit and other postretirement plans:									
Amortization of net gains and (losses)	\$ 2,970	\$ (423)	\$ 2,547	\$ (10,279)	\$ 2,380	\$ (7,899)	\$ (61)	\$ 19	\$ (42)
Amortization of prior service cost	(156)	39	(117)	(78)	19	(59)	(78)	19	(59)
Benefit plans, net	2,814	(384)	2,430	(10,357)	2,399	(7,958)	(139)	38	(101)
Net loss from hedging activities	(3,553)	888	(2,665)	(441)	110	(331)	(5,799)	2,209	(3,590)
Foreign currency translation ⁽¹⁾	20,539	2,350	22,889	(39,419)	4,364	(35,055)	66,438	(5,837)	60,601
Other comprehensive income (loss)	<u>\$ 19,800</u>	<u>\$ 2,854</u>	<u>\$ 22,654</u>	<u>\$ (50,217)</u>	<u>\$ 6,873</u>	<u>\$ (43,344)</u>	<u>\$ 60,500</u>	<u>\$ (3,590)</u>	<u>\$ 56,910</u>

- (1) The income tax benefit or expense included in other comprehensive income is attributed to the portion of foreign currency translation associated with the Company's cross-currency interest rate swaps, for which the tax effect is based on the applicable U.S. deferred income tax rate. See Note 19 to these consolidated financial statements for information regarding the Company's cross currency interest rate swaps.

The following table presents the change in accumulated other comprehensive income (loss), net of tax, by component for the years ended December 31, 2019 and 2018:

	Defined benefit and other postretirement plans	Net gain (loss) from hedging activities	Foreign currency translation	Total
December 31, 2017	\$ 7,412	\$ 967	\$ (4,068)	\$ 4,311
Other comprehensive income (loss) before reclassifications	(7,874)	(257)	(35,127)	(43,258)
Amounts reclassified from accumulated other comprehensive income ⁽¹⁾	(84)	(73)	—	(157)
Net current period other comprehensive loss	(7,958)	(330)	(35,127)	(43,415)
December 31, 2018	(546)	637	(39,195)	(39,104)
Other comprehensive income (loss) before reclassifications	2,497	(3,388)	22,117	21,226
Amounts reclassified from accumulated other comprehensive income ⁽¹⁾	(67)	723	—	656
Net current period other comprehensive income (loss)	2,430	(2,665)	22,117	21,882
Tax Cuts and Jobs Act, reclassification from AOCI to retained earnings	1,684	190	—	1,874
December 31, 2019	<u>\$ 3,568</u>	<u>\$ (1,838)</u>	<u>\$ (17,078)</u>	<u>\$ (15,348)</u>

- (1) See the following table for details about these reclassifications. Amounts in parentheses indicate debits.

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The following table presents the reclassifications out of accumulated other comprehensive income for the years ended December 31, 2019 and 2018.

Details about Accumulated Other Comprehensive Income Components	Amount Reclassified from Accumulated Other Comprehensive Income ⁽¹⁾		Affected Line Item in the Statements of Income
	Years ended December 31,		
	2019	2018	
Amortization of defined benefit and other postretirement plans:			
Prior service credit (cost)	\$ 133	\$ 112	Other income (expense) ⁽²⁾
Actuarial gains (losses)	(21)	(12)	Other income (expense) ⁽²⁾
	112	100	Total before tax
	(45)	(16)	Tax expense
	<u>\$ 67</u>	<u>\$ 84</u>	Net of tax
Gains and losses on cash flow hedges:			
Interest rate caps	\$ (625)	\$ (256)	Interest expense
Natural gas swaps	(335)	353	Cost of goods sold
	(960)	97	Total before tax
	237	(24)	Tax benefit (expense)
	<u>\$ (723)</u>	<u>\$ 73</u>	Net of tax
Total reclassifications for the period	<u>\$ (656)</u>	<u>\$ 157</u>	Net of tax

⁽¹⁾ Amounts in parentheses indicate debits to profit/loss.

⁽²⁾ These accumulated other comprehensive income (loss) components are components of net periodic pension and other postretirement cost (see Note 21 to these consolidated financial statements for additional details).

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7. Acquisition:

Acquisitions are accounted for using the acquisition method of accounting. Under the acquisition method, the purchase price is allocated to the identifiable net assets acquired based on the fair values of the identifiable assets acquired and liabilities assumed as of the acquisition date. The excess of the purchase price over the fair values of the identifiable net assets acquired is recorded to goodwill.

On June 12, 2017 (the "Acquisition Date"), the Company acquired the facilities of Sovitec Mondial S.A. ("Sovitec") located in Belgium, Spain, Argentina and France as part of a stock transaction (the "Acquisition") for \$41,572 in cash, excluding assumed debt. Based in Fleurus, Belgium, Sovitec is a high quality producer of engineered glass products used in transportation safety, metal finishing and polymer additives. The results of operations of Sovitec have been included in the Company's consolidated financial statements since the Acquisition Date.

The following table sets forth the calculation and allocation of the purchase price to the identifiable net assets acquired with respect to the Acquisition, which was complete as of March 31, 2018:

	Provisional Purchase Price Allocation	Adjustments	Purchase Price Allocation
Total consideration, net of cash acquired	\$ 41,572	\$ —	\$ 41,572
Recognized amounts of identifiable assets acquired and liabilities assumed:			
Receivables	\$ 14,305	\$ —	\$ 14,305
Inventories	7,645	1,603	9,248
Prepaid and other current assets	400	—	400
Property, plant and equipment	9,020	15,960	24,980
Other intangible assets	—	5,753	5,753
Other long-term assets	129	15,921	16,050
Fair value of assets acquired	31,499	39,237	70,736
Current debt	(6,420)	—	(6,420)
Accounts payable	(10,748)	—	(10,748)
Long-term debt	(10,189)	—	(10,189)
Deferred income taxes	—	(4,426)	(4,426)
Other long-term liabilities	(154)	—	(154)
Fair value of net assets acquired	3,988	34,811	38,799
Goodwill	37,584	(34,811)	2,773
	\$ 41,572	\$ —	\$ 41,572

As of the Acquisition Date, the fair value of accounts receivable approximated historical cost. The gross contractual amount of accounts receivable at the Acquisition Date was \$14,607, of which \$302 was deemed uncollectible. The fair value of inventory is defined as estimated selling prices less the sum of (a) costs of disposal and (b) a reasonable profit allowance for the selling effort of the acquiring entity, which was \$1,603 higher than the historical cost.

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The Company's cost of goods sold for the year ended December 31, 2018 includes a pre-tax charge of \$1,603 relating to the step-up on inventory, \$108 of additional amortization expense related to identified intangible assets and \$421 of additional depreciation expense, which would have been recorded during the year ended December 31, 2017 if the adjustments to the provisional amounts had been recognized as of the Acquisition Date. The Company's other expense, net for the year ended December 31, 2018 includes additional amortization expense related to identified intangible assets of \$101 which would have been recorded during the year ended December 31, 2017 if the adjustments to the provisional amounts had been recognized as of the Acquisition Date. The Company's provision for income taxes for the year ended December 31, 2018 includes an additional \$990 tax benefit associated with the year ended December 31, 2017, to reflect impacts as if the adjustments to the provisional amounts had been recognized as of the Acquisition Date. This amount is primarily a result of opening balance sheet adjustments recorded during the year ended December 31, 2018, which needed to be re-measured through the income statement because of income tax rate changes that occurred subsequent to the Acquisition Date.

The Company believes that the Acquisition will enable it to offer a more comprehensive, cost-effective and high-quality portfolio of products and services to its customers worldwide when, combined with anticipated synergies within its existing business, contributed to a total purchase price that resulted in the recognition of goodwill. All of the goodwill was assigned to the Company's Performance Materials segment. The goodwill associated with the Acquisition is not deductible for tax purposes.

The valuation of the intangible assets acquired and the related weighted-average amortization periods are as follows:

	Amount	Weighted-Average Expected Useful Life (in years)
Intangible assets subject to amortization:		
Trademarks	\$ 1,767	11
Technical know-how	1,892	11
Total intangible assets subject to amortization	3,659	
Trade names, not subject to amortization	2,094	Indefinite
Total	<u>\$ 5,753</u>	

The Company's consolidated financial statements include Sovitec's results of operations from June 12, 2017 through December 31, 2017. Sales and net income attributable to Sovitec during this period are included in the Company's consolidated financial statements for the year ended December 31, 2017 and total \$26,257 and \$1,370, respectively.

Acquisition costs were immaterial for the year ended December 31, 2018 and were \$2,515 for the year ended December 31, 2017. Acquisition costs are included in other operating expense, net in the Company's consolidated statements of income.

Pro Forma Financial Information

The unaudited pro forma financial information for the year ended December 31, 2017 has been derived from the Company's historical consolidated financial statements and prepared to give effect to the Acquisition, assuming that the Acquisition occurred on January 1, 2016. The unaudited pro forma consolidated results of operations are provided for illustrative purposes only and are not indicative of the Company's actual consolidated results of operations had the Acquisition been made as of January 1, 2016. The unaudited pro forma results of operations do not reflect any operating efficiencies or potential cost savings which may result from the Acquisition.

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	<u>Year ended</u> <u>December 31, 2017</u>
Pro forma sales	\$ 1,488,528
Pro forma net income	58,774
Pro forma net income attributable to PQ Group Holdings Inc.	57,814
Pro forma basic income per share	\$ 0.52
Pro forma diluted income per share	\$ 0.52

Certain non-recurring charges included in the Company's results of operations for the year ended December 31, 2017 were allocated to the respective prior year periods for pro forma purposes. For the year ended December 31, 2017, non-recurring charges allocated to the prior year period include transaction fee charges of \$2,515 which were excluded from the pro forma net income for the year ended December 31, 2017. Included in pro forma net income for the year ended December 31, 2017 is amortization expense of \$367 and depreciation expense of \$760 associated with the fair value step-up of identifiable intangible assets and property, plant and equipment, respectively.

8. Dispositions:

Sale of Product Line

On June 28, 2019, the Company completed the sale of a portion of its sulfate salts product line within its Performance Chemicals segment for \$28,000, with net cash consideration of \$27,658 and a pre-tax gain on sale of \$11,518. The transaction was recorded as an asset sale, with the gain on disposition included in the other operating expense, net line item in the Company's consolidated statement of income for the year ended December 31, 2019 (see Note 9 to these consolidated financial statements for additional details). At the time of disposition, the carrying value of the Company's net working capital related to this non-core product line was \$4,215. In addition to the net working capital sold as part of the transaction, the Company also derecognized \$3,276 of property, plant and equipment related to the product line and allocated \$9,000 of the consideration received to a liability for deferred revenue.

Concurrent with the product line sale, the Company entered into a tolling arrangement with the buyer in which the Company will use its existing manufacturing facilities for the product line to manufacture the product for the buyer, the majority of which runs until June 2021. The Company deferred \$9,000 of the consideration received as a liability, to be recognized as the Company executes its performance obligations over the term of the contractual agreement with the buyer. Additionally, the Company concluded that an embedded lease arrangement exists as a result of the combination of the sale and tolling agreements. Given the ability of the buyer to control substantially all of the output of the facilities and the existence of bargain purchase options on the manufacturing assets, the Company determined that the buyer is effectively leasing the assets from the Company and derecognized the associated property, plant and equipment under a sales-type leasing arrangement. The gain on the sale of fixed assets is included as part of the Company's overall gain on sale related to the transaction, with the Company's net investment in the leased assets having been settled as part of the consideration received in the transaction with no additional future cash flows to be recognized on the lease.

Sale of Assets

On December 19, 2019, the Company completed the sale of real property for \$19,100, with net cash consideration of \$17,100 and a holdback receivable to be settled by December 2021 of \$1,000, and recorded a pre-tax gain on sale of \$7,150. On December 30, 2019, the Company entered into a leaseback arrangement with the buyer-lessor which expires in December 2021. The Company recorded the asset sale separately from the leaseback, with the gain on disposition included in the other operating expense, net line item in the Company's consolidated statement of income for the year ended December 31, 2019 (see Note 9 to these consolidated financial statements for additional details).

At the time of disposition, the Company derecognized \$10,735 of property, plant and equipment and accounted for the leased asset as an operating lease. A right-of-use lease asset of \$3,588 and lease liability of \$3,524 was recorded at December 31, 2019, based on the present value of the lease payments and future demolition costs associated with the lease.

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9. Other Operating Expense, Net:

A summary of other operating expense, net is as follows:

	Years ended December 31,		
	2019	2018	2017
Amortization expense	\$ 34,553	\$ 35,025	\$ 32,010
Transaction and other related costs ⁽¹⁾	3,541	776	7,415
Restructuring and other related costs (Note 25)	2,692	6,208	8,490
Net (gain) loss on asset disposals ⁽²⁾	(13,068)	6,574	5,793
Intangible asset impairment charge (Note 15)	1,600	—	—
Management advisory fees (Note 27)	—	—	3,777
Insurance recoveries ⁽³⁾	—	(5,480)	—
Write-off of long-term supply contract obligation (Note 26)	—	(20,612)	—
Environmental related costs	2,999	638	395
Other, net	3,523	6,321	6,345
	<u>\$ 35,840</u>	<u>\$ 29,450</u>	<u>\$ 64,225</u>

- ⁽¹⁾ Transaction and other related costs primarily related to several transactions that were completed, pending or abandoned during the year ended December 31, 2019. Transaction and other related costs for the years ended December 31, 2018 and 2017 primarily include transaction costs associated with the Company's IPO, exclusive of the direct costs recorded in stockholders' equity net of the proceeds from the offering (see Note 1 to these consolidated financial statements for further information) and the Acquisition (see Note 7).
- ⁽²⁾ During the year ended December 31, 2019, the Company recognized a gain of \$11,518 related to the sale of a product line and a gain of \$7,150 related to a property sale. Refer to Note 8 of these consolidated financial statements for additional details.
- ⁽³⁾ During the year ended December 31, 2018, the Company recognized \$6,450 of insurance recoveries in its consolidated statement of income related to the Company's claim for losses sustained during Hurricane Harvey in August 2017. For the year ended December 31, 2018, \$5,480 was recorded as a gain in other operating expense, net, as reimbursement of expenses, \$207 was recorded as a gain in net loss on asset disposals within other operating expense, net, for the Company's previously recognized property losses, and \$763 represented recoveries in excess of the Company's property losses which was recorded as a non-operating gain in other expense, net, in the Company's consolidated statement of income.

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10. Inventories, Net:

Inventories, net are classified and valued as follows:

	December 31,	
	2019	2018
Finished products and work in process	\$ 222,940	\$ 206,188
Raw materials	58,005	58,560
	<u>\$ 280,945</u>	<u>\$ 264,748</u>
Valued at lower of cost or market:		
LIFO basis	\$ 168,935	\$ 160,863
Valued at lower of cost and net realizable value:		
FIFO or average cost basis	112,010	103,885
	<u>\$ 280,945</u>	<u>\$ 264,748</u>

The domestic inventory acquired as part of a previous business combination is valued based on the LIFO method. Therefore, the fair value allocated to the acquired LIFO inventory was treated as the new base inventory value. If inventories valued under the LIFO basis had been valued using the FIFO method, inventories would have been \$7,164 and \$18,263 lower than reported as of December 31, 2019 and 2018, respectively, driven primarily by the purchase accounting fair value step-up of the LIFO inventory base value associated with the business combination.

11. Investments in Affiliated Companies:

The Company accounts for investments in affiliated companies under the equity method. Affiliated companies accounted for on the equity method as of December 31, 2019 are as follows:

Company	Country	Percent Ownership
PQ Silicates Ltd.	Taiwan	50%
Zeolyst International	USA	50%
Zeolyst C.V.	Netherlands	50%
Quaker Holdings	South Africa	49%
Asociacion para el Estudio de las Tecnologias de Equipamiento de Carreteras, S.A. ("Aetec")	Spain	20%

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Following is summarized information of the combined investments⁽¹⁾:

	December 31,	
	2019	2018
Current assets	\$ 249,640	\$ 215,416
Noncurrent assets	256,382	248,288
Current liabilities	52,811	40,536
Noncurrent liabilities	5,972	56

	Years ended December 31,		
	2019	2018	2017
Sales	\$ 381,115	\$ 352,599	\$ 317,197
Gross profit	145,157	126,945	132,812
Operating income	106,277	88,508	91,224
Net income	107,192	88,622	94,740

⁽¹⁾ Summarized information of the combined investments is presented at 100%; the Company's share of the net assets and net income of affiliates is calculated based on the percent ownership specified in the table above.

The Company's investments in affiliated companies balance as of December 31, 2019 and 2018 includes net purchase accounting fair value adjustments of \$250,532 and \$258,066, respectively, related a prior business combination, consisting primarily of goodwill and intangible assets such as customer relationships, technical know-how and trade names. Consolidated equity in net income from affiliates is net of \$7,534, \$6,634 and \$8,599 of amortization expense related to purchase accounting fair value adjustments for the years ended December 31, 2019, 2018 and 2017, respectively.

The following table summarizes the activity related to the Company's investments in affiliated companies balance on the consolidated balance sheets:

	Years ended December 31,	
	2019	2018
Balance at beginning of period	\$ 468,211	\$ 469,276
Investments in affiliated companies	—	5,000
Equity in net income of affiliated companies	53,568	44,245
Charges related to purchase accounting fair value adjustments	(7,534)	(6,634)
Dividends received	(40,123)	(40,195)
Return of investment ⁽¹⁾	—	(695)
Foreign currency translation adjustments	(1,193)	(2,786)
Balance at end of period	\$ 472,929	\$ 468,211

⁽¹⁾ Amount is included within cash flows from investing activities in the Company's consolidated statement of cash flows.

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The Company had net receivables due from affiliates of \$3,593 and \$4,775 as of December 31, 2019 and 2018, respectively, which are included in prepaid and other current assets. Net receivables due from affiliates are generally non-trade receivables. Sales to affiliates were \$4,181, \$2,823 and \$2,853 for the years ended December 31, 2019, 2018 and 2017, respectively. The Company purchased goods of \$803, \$645 and \$2,475 from affiliates, which is included in cost of goods sold, during the years ended December 31, 2019, 2018 and 2017, respectively.

On December 18, 2013, PQ Holdings and its joint venture, Zeolyst International, entered into a ten year real estate tax abatement agreement with the Unified Government of Wyandotte County, Kansas. The agreement utilizes an Industrial Revenue Bond ("IRB") financing structure to achieve a 75% real estate tax abatement on the value of the improvements that were constructed during the expansion of PQ Holdings and Zeolyst International's facilities at the jointly-operated Kansas City, Kansas plant. A similar tax abatement agreement has been executed on an annual basis since December 18, 2013 with respect to additional plant expansions during those years.

During the year ended December 31, 2019, the original IRB financing structure from December 2013 was exhausted. In order to fund future plant expansions, the Company entered into an additional IRB financing structure with similar terms and conditions, which also provides for 75% real estate tax abatements on the value of future improvements. The financing obligations and the industrial bonds receivable have been presented net, as the financing obligations and the industrial bonds meet the criteria for right of setoff conditions under GAAP.

12. Property, Plant and Equipment:

A summary of property, plant and equipment, at cost, and related accumulated depreciation is as follows:

	December 31,	
	2019	2018
Land	\$ 183,117	\$ 190,772
Buildings	221,449	212,284
Machinery and equipment	1,236,531	1,125,117
Construction in progress	82,687	102,185
	1,723,784	1,630,358
Less: accumulated depreciation	(537,014)	(421,379)
	<u>\$ 1,186,770</u>	<u>\$ 1,208,979</u>

Depreciation expense was \$131,646, \$132,640 and \$124,551 for the years ended December 31, 2019, 2018 and 2017, respectively.

13. Leases:

Operating lease costs of \$19,148 are included in cost of goods sold and in selling, general and administrative expenses on the consolidated statement of income for the year ended December 31, 2019. Finance lease, short-term lease and variable lease costs for the years ended December 31, 2019 were not material. Lease income is not material to the results of operations for the years ended December 31, 2019.

The Company entered into a sale-leaseback transaction during the year ended December 31, 2019. Disclosures related to this transaction can be found within Note 8 to these consolidated financial statements.

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The table below presents the operating and finance right-of-use lease assets and lease liabilities recognized on the consolidated balance sheet as of December 31, 2019:

	Classification	December 31, 2019
Assets		
Operating lease assets	Right-of-use lease assets	\$ 57,295
Finance lease assets	Property, plant and equipment, net	1,556
Total leased assets		<u>\$ 58,851</u>
Liabilities		
Current:		
Operating lease liabilities	Operating lease liabilities—current	\$ 15,183
Finance lease liabilities	Accrued liabilities	185
Noncurrent:		
Operating lease liabilities	Operating lease liabilities—noncurrent	40,156
Finance lease liabilities	Other long-term liabilities	315
Total lease liabilities		<u>\$ 55,839</u>

The Company's weighted average remaining lease term and weighted average discount rate for operating and financing leases as of December 31, 2019 are as follows:

	December 31, 2019
Weighted average remaining lease term (in years):	
Operating leases	5.54
Finance leases	2.65
Weighted average discount rate:	
Operating leases	5.51 %
Finance leases	4.67 %

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Maturities of lease liabilities as of December 31, 2019 are as follows:

Year	Operating Leases	Finance Leases
2020	17,447	202
2021	15,978	202
2022	9,747	124
2023	7,168	3
2024	4,670	—
Thereafter	10,453	—
Total lease payments	65,463	531
Less: Interest	(10,124)	(31)
Total lease liabilities	55,339	500

⁽¹⁾ Refer to the above table regarding the Company's right-of-use lease assets and lease liabilities for the presentation of the lease liabilities in the Company's consolidated balance sheet at December 31, 2019.

The following table presents other information related to the Company's operating and finance leases and the impact on the Company's consolidated statement of cash flows:

	Year ended December 31, 2019
Cash paid for amounts included in the measurement of lease liabilities:	
Payments on operating leases included in operating cash flows	\$ 18,945
Interest payments under finance lease obligations included in operating cash flows	27
Principal payments under finance lease obligations included in financing cash flows	179
Right-of-use assets obtained in exchange for new lease liabilities (non-cash):	
Operating leases	11,453
Finance leases	—

Under prior lease guidance, total rent expense related to the Company's various leasing arrangements was \$25,082 and \$22,704 for the years ended December 31, 2018 and 2017, respectively. Rent expense for the years ended December 31, 2018 and 2017 included both lease and non-lease costs related to leasing arrangements in place during those years. At December 31, 2018, future minimum payments under non-cancelable operating leases under previous lease guidance were as follows:

Year	Amount
2019	\$ 18,457
2020	14,344
2021	11,432
2022	8,354
2023	6,198
Thereafter	17,477
	\$ 76,262

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14. Reportable Segments:

The Company has organized its business around four operating segments based on the review of discrete financial results for each of the operating segments by the Company's chief operating decision maker (the Company's President and Chief Executive Officer), or CODM, for performance assessment and resource allocation purposes. Each of the Company's operating segments represents a reportable segment under GAAP. The Company's reportable segments are organized based on the nature and economic characteristics of the Company's products. The Company's four reportable segments are as follows: (1) Refining Services provides sulfuric acid recycling to the North American refining industry; (2) Catalysts serves the packaging and engineered plastics and the global refining, petrochemical and emissions control industries; (3) Performance Materials produces transportation reflective safety markings for roads and airports; and (4) Performance Chemicals supplies diverse product end uses, including personal and industrial cleaning products, fuel-efficient tires, surface coatings, and food and beverage products.

The Catalysts segment includes equity in net income from Zeolyst International and Zeolyst C.V. (collectively, the "Zeolyst Joint Venture"), each of which are 50/50 joint ventures with CRI Zeolites Inc. (a wholly-owned subsidiary of Royal Dutch Shell). The Zeolyst Joint Venture is accounted for using the equity method in the Company's consolidated financial statements (see Note 11 to these consolidated financial statements for further information). Company management evaluates the Catalysts segment's performance, including the Zeolyst Joint Venture, on a proportionate consolidation basis. Accordingly, the revenues and expenses used to compute the Catalysts segment's adjusted earnings before interest, income taxes, depreciation and amortization ("Adjusted EBITDA") include the Zeolyst Joint Venture's results of operations on a proportionate basis based on the Company's 50% ownership level. Since the Company uses the equity method of accounting for the Zeolyst Joint Venture, these items are eliminated when reconciling to the Company's consolidated results of operations.

The Company's management evaluates the operating results of each reportable segment based upon Adjusted EBITDA. Adjusted EBITDA consists of EBITDA, which is a measure defined as net income before interest, income taxes, depreciation and amortization (each of which is included in the Company's consolidated statements of income), and adjusted for certain items as discussed below.

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Summarized financial information for the Company's reportable segments is shown in the following table:

	Years ended December 31,		
	2019	2018	2017
Sales:			
Refining Services	\$ 447,081	\$ 455,562	\$ 398,342
Catalysts ⁽¹⁾	85,667	72,099	75,333
Performance Materials	362,965	378,279	324,225
Performance Chemicals	685,137	717,335	687,645
Eliminations ⁽²⁾	(13,778)	(15,121)	(13,444)
Total	\$ 1,567,072	\$ 1,608,154	\$ 1,472,101
Segment Adjusted EBITDA:⁽³⁾			
Refining Services	\$ 175,640	\$ 176,499	\$ 154,191
Catalysts ⁽⁴⁾	107,808	81,067	89,396
Performance Materials	76,712	72,471	69,661
Performance Chemicals	154,264	170,886	170,467
Total Segment Adjusted EBITDA⁽⁵⁾	\$ 514,424	\$ 500,923	\$ 483,715

(1) Excludes the Company's proportionate share of sales from the Zeolyst Joint Venture accounted for using the equity method. The proportionate share of sales is \$170,338, \$156,687 and \$143,774 for the years ended December 31, 2019, 2018 and 2017, respectively.

(2) The Company eliminates intersegment sales when reconciling to the Company's consolidated statements of income.

(3) The Company defines Adjusted EBITDA as EBITDA adjusted for certain items as noted in the reconciliation below. Management evaluates the performance of its segments and allocates resources based on several factors, of which the primary measure is Adjusted EBITDA. Adjusted EBITDA should not be considered as an alternative to net income as an indicator of the Company's operating performance. Adjusted EBITDA as defined by the Company may not be comparable with EBITDA or Adjusted EBITDA as defined by other companies.

(4) The Adjusted EBITDA from the Zeolyst Joint Venture included in the Catalysts segment is \$68,138 for the year ended December 31, 2019, which includes \$45,899 of equity in net income plus \$7,534 of amortization of investment in affiliate step-up plus \$14,705 of joint venture depreciation, amortization and interest.

The Adjusted EBITDA from the Zeolyst Joint Venture included in the Catalysts segment is \$56,663 for the year ended December 31, 2018, which includes \$37,437 of equity in net income plus \$6,634 of amortization of investment in affiliate step-up plus \$12,592 of joint venture depreciation, amortization and interest.

The Adjusted EBITDA from the Zeolyst Joint Venture included in the Catalysts segment is \$58,156 for the year ended December 31, 2017, which includes \$38,486 of equity in net income plus \$8,600 of amortization of investment in affiliate step-up plus \$11,070 of joint venture depreciation, amortization and interest.

(5) Total Segment Adjusted EBITDA differs from the Company's consolidated Adjusted EBITDA due to unallocated corporate expenses.

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A reconciliation of net income attributable to PQ Group Holdings to Segment Adjusted EBITDA is as follows:

	Years ended December 31,		
	2019	2018	2017
Reconciliation of net income attributable to PQ Group Holdings Inc. to Segment Adjusted EBITDA			
Net income attributable to PQ Group Holdings Inc.	\$ 79,539	\$ 58,300	\$ 57,603
Provision for (benefit from) income taxes	40,699	28,995	(119,197)
Interest expense, net	111,525	113,723	179,044
Depreciation and amortization	182,090	185,234	177,140
Segment EBITDA	413,853	386,252	294,590
Unallocated corporate expenses	40,070	36,970	30,422
Joint venture depreciation, amortization and interest	14,705	12,592	11,070
Amortization of investment in affiliate step-up	7,534	6,634	8,600
Amortization of inventory step-up	—	1,603	871
Impairment of fixed assets, intangibles and goodwill	1,600	—	—
Debt extinguishment costs	3,400	7,751	61,886
Net (gain) loss on asset disposals	(13,068)	6,574	5,793
Foreign currency exchange loss	2,787	13,810	25,786
LIFO expense	11,099	8,366	3,708
Management advisory fees	—	—	3,777
Transaction and other related costs	3,642	893	7,425
Equity-based compensation	18,225	19,464	8,799
Restructuring, integration and business optimization expenses	4,076	14,019	13,174
Defined benefit pension plan cost	3,126	(796)	2,940
Gain on contract termination ⁽¹⁾	—	(20,612)	—
Other	3,375	7,403	4,874
Segment Adjusted EBITDA	\$ 514,424	\$ 500,923	\$ 483,715

⁽¹⁾ Includes the non-cash write-off of a long-term supply contract obligation (see Note 26), which was recorded as a reduction in other operating expense, net in the consolidated statement of income for the year ended December 31, 2018.

The Company's consolidated results include equity in net income from affiliated companies of \$46,034, \$37,611 and \$38,772 for the years ended December 31, 2019, 2018, and 2017, respectively. This is primarily comprised of equity in net income of \$45,899, \$37,437 and \$38,486 in the Catalysts segment from the Zeolyst Joint Venture for the years ended December 31, 2019, 2018 and 2017, respectively. The remaining equity in net income for the Company is included in the Performance Chemicals and Performance Materials segments, which was attributed to smaller investments and was not material. The Company's equity in net income from affiliated companies in the consolidated results includes amortization expense related to purchase accounting fair value adjustments associated with the Zeolyst Joint Venture as a result of a prior business combination.

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Capital expenditures for the Company's reportable segments are shown in the following table:

	Years ended December 31,		
	2019	2018	2017
Capital expenditures:			
Refining Services	\$ 42,310	\$ 46,617	\$ 42,876
Catalysts ⁽¹⁾	8,984	8,390	10,269
Performance Materials	16,074	18,001	20,394
Performance Chemicals	54,683	57,475	64,389
Corporate ⁽²⁾	5,591	1,205	2,554
Capital expenditures per the consolidated statements of cash flows	<u>\$ 127,642</u>	<u>\$ 131,688</u>	<u>\$ 140,482</u>

⁽¹⁾ Excludes the Company's proportionate share of capital expenditures from the Zeolyst Joint Venture.

⁽²⁾ Includes corporate capital expenditures, the cash impact from changes in capital expenditures in accounts payable and capitalized interest.

Total assets by segment are not disclosed by the Company because the information is not prepared or used by the CODM to assess performance and to allocate resources.

Sales and long-lived assets by geographic area are presented in the following tables. Sales are attributed to countries based upon location of products shipped.

	Years ended December 31,		
	2019	2018	2017
Sales ⁽¹⁾ :			
United States	\$ 953,511	\$ 963,722	\$ 874,764
Netherlands	117,211	127,803	118,567
United Kingdom	118,626	119,586	116,410
Other foreign countries	377,724	397,043	362,360
Total	<u>\$ 1,567,072</u>	<u>\$ 1,608,154</u>	<u>\$ 1,472,101</u>

⁽¹⁾ Except for the United States, no sales in an individual country exceeded 10% of the Company's total sales.

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	December 31,	
	2019	2018
Long-lived assets ⁽¹⁾ :		
United States	\$ 834,229	\$ 865,799
Netherlands	49,559	52,461
United Kingdom	97,426	90,095
Other foreign countries	205,556	200,624
Total	<u>\$ 1,186,770</u>	<u>\$ 1,208,979</u>

⁽¹⁾ Long-lived assets include property, plant and equipment, net.

15. Goodwill and Other Intangible Assets:

The changes in the carrying amount of goodwill for the years ended December 31, 2019 and 2018 is summarized as follows:

	Refining Services	Catalysts	Performance Materials	Performance Chemicals	Total
Balance as of December 31, 2017	\$ 311,892	\$ 79,441	\$ 313,131	\$ 601,492	\$ 1,305,956
Goodwill recognized	—	—	649	—	649
Goodwill adjustments ⁽¹⁾	—	—	(34,811)	—	(34,811)
Foreign exchange impact and other	—	(1,682)	(4,022)	(11,161)	(16,865)
Balance as of December 31, 2018	<u>\$ 311,892</u>	<u>\$ 77,759</u>	<u>\$ 274,947</u>	<u>\$ 590,331</u>	<u>\$ 1,254,929</u>
Foreign exchange impact	—	852	972	3,052	4,876
Balance as of December 31, 2019	<u>\$ 311,892</u>	<u>\$ 78,611</u>	<u>\$ 275,919</u>	<u>\$ 593,383</u>	<u>\$ 1,259,805</u>

⁽¹⁾ Represents the measurement period adjustments on the net assets acquired as part of the Acquisition (see Note 7 to these consolidated financial statements for further information regarding the Acquisition).

The Company completed its annual goodwill impairment assessments as of October 1, 2019 and 2018. For the annual assessments, the Company bypassed the option to perform the qualitative assessment and proceeded directly to performing the first step of the two-step goodwill impairment test for each of its reporting units. For each of the October 1, 2019 and 2018 assessments, the Company identified four reporting units, which align with the Company's operating segments.

The Company determined the fair value of its reporting units using a split between a market approach and an income, or discounted cash flow, approach. Fair value is defined as the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. Estimating the fair value of a reporting unit requires various assumptions including the use of projections of future cash flows and discount rates that reflect the risks associated with achieving those cash flows. The key assumptions used in estimating the fair value were the operating margin growth rates, revenue growth rates from implementation of strategic plans, the weighted average cost of capital, the perpetual growth rate, and the estimated earnings market multiples of each reporting unit. The market value was estimated using publicly traded comparable company values by applying their most recent annual EBITDA multiples to the reporting unit's trailing twelve months EBITDA. The income approach value was estimated using a discounted cash flow approach. The assumptions about future cash flows and growth rates are based on management's assessment of a number of factors including the reporting unit's recent performance against budget as well as management's ability to execute on planned future strategic initiatives. Discount rate assumptions are based on an assessment of the risk inherent in those future cash flows.

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As of October 1, 2019 and 2018, the fair values of each of the Company's reporting units exceeded their respective carrying values and therefore, the second step of the two-step goodwill impairment test was not required.

In addition to the annual goodwill impairment assessment, the Company also performed the annual impairment test over its other indefinite-lived intangible assets as of October 1, 2019 and 2018. As part of the October 1, 2019 test, the Company recognized an impairment charge of \$1,600 related to one of its Performance Materials segment in-process research and development intangible assets upon the conclusion that the associated project was no longer viable. The fair values of the Company's indefinite-lived trade names and trademarks were in excess of their carrying amounts as of the respective testing dates, and as such, there was no further impairment of the Company's indefinite-lived intangible assets for the years ended December 31, 2019 and 2018.

Gross carrying amounts and accumulated amortization for intangible assets other than goodwill are as follows:

	December 31, 2019				December 31, 2018			
	Gross Carrying Amount	Accumulated Amortization	Impairment Charge	Net Balance	Gross Carrying Amount	Accumulated Amortization	Net Balance	
Technical know-how	\$ 212,067	\$ (43,459)	\$ —	\$ 168,608	\$ 211,067	\$ (32,112)	\$ 178,955	
Customer relationships	362,478	(128,126)	—	234,352	361,150	(95,399)	265,751	
Contracts	16,200	(15,258)	—	942	19,800	(13,139)	6,661	
Trademarks	36,779	(8,972)	—	27,807	36,657	(6,451)	30,206	
Permits	9,100	(9,100)	—	—	9,100	(7,432)	1,668	
Total definite-lived intangible assets	636,624	(204,915)	—	431,709	637,774	(154,533)	483,241	
Indefinite-lived trade names	158,477	—	—	158,477	157,813	—	157,813	
Indefinite-lived trademarks	80,999	—	—	80,999	80,582	—	80,582	
In-process research and development	6,800	—	(1,600)	5,200	6,800	—	6,800	
Total intangible assets	<u>\$ 882,900</u>	<u>\$ (204,915)</u>	<u>\$ (1,600)</u>	<u>\$ 676,385</u>	<u>\$ 882,969</u>	<u>\$ (154,533)</u>	<u>\$ 728,436</u>	

The Company amortizes technical know-how over periods that range from eleven years to twenty years, customer relationships over periods that range from seven years to fifteen years, trademarks over periods that range from eleven years to fifteen years, contracts over periods that range from two years to sixteen years, and permits over five years. In-process research and development intangible assets are considered indefinite-lived until such time as the associated projects are completed, at which time amortization commences on the assets, or abandoned, which results in the impairment of the assets.

Amortization expense related to technical know-how, contracts and permits is included in cost of goods sold in the consolidated statements of income and was \$15,891, \$17,569 and \$20,579 for the years ended December 31, 2019, 2018 and 2017, respectively. Amortization expense related to customer relationships and trademarks is included in other operating expense, net in the consolidated statements of income and was \$34,553, \$35,025 and \$32,010 for the years ended December 31, 2019, 2018 and 2017, respectively.

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Estimated future aggregate amortization expense of intangible assets is as follows:

Year	Amount
2020	\$ 46,809
2021	45,867
2022	45,867
2023	41,963
2024	40,011
Thereafter	211,192
Total estimated future aggregate amortization expense	<u>\$ 431,709</u>

16. Accrued Liabilities:

The following table summarizes the components of accrued liabilities as follows:

	December 31,	
	2019	2018
Compensation and bonus	\$ 49,237	\$ 52,296
Interest	19,176	21,933
Property tax	3,413	3,018
Environmental reserves (Note 24)	4,972	4,693
Income taxes	6,217	2,123
Commissions and rebates	2,061	1,798
Pension, postretirement and supplemental retirement plans (Note 21)	2,229	2,439
Other	14,849	11,709
	<u>\$ 102,154</u>	<u>\$ 100,009</u>

17. Long-term Debt:

The summary of long-term debt is as follows:

	December 31,	
	2019	2018
Term Loan Facility	\$ 947,497	\$ 1,157,498
6.75% Senior Secured Notes due 2022	625,000	625,000
5.75% Senior Unsecured Notes due 2025	295,000	300,000
ABL Facility	—	—
Other	64,629	65,925
Total debt	1,932,126	2,148,423
Original issue discount	(13,434)	(18,584)
Deferred financing costs	(11,730)	(15,882)
Total debt, net of original issue discount and deferred financing costs	1,906,962	2,113,957
Less: current portion	(7,766)	(7,237)
Total long-term debt, excluding current portion	<u>\$ 1,899,196</u>	<u>\$ 2,106,720</u>

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Senior Secured Credit Facilities

On May 4, 2016, the Company entered into senior secured credit facilities (collectively, the “2016 Senior Secured Credit Facilities”) comprised of a \$1,200,000 term loan facility, which consisted of a \$900,000 U.S. dollar-denominated tranche and a \$300,000 Euro-denominated (or €265,000) tranche (the “2016 Term Loan Facility”), and a \$200,000 asset-based revolving credit facility (the “ABL Facility”).

On February 8, 2018 (the “Third Amendment Closing Date”), PQ Corporation (the “Borrower”), an indirect, wholly owned subsidiary of the Company, refinanced its existing U.S. Dollar and Euro denominated senior secured term loan facilities with a new \$1,267,000 senior secured term loan facility (the “Term Loan Facility”) by entering into the Third Amendment Agreement to the 2016 Term Loan Facility (the “Third Amendment”), which amended and restated the Term Loan Credit Agreement dated as of May 4, 2016, among the Borrower, CPQ Midco I Corporation, Credit Suisse AG, Cayman Island Branch, as administrative agent and collateral agent, and the lenders and the other parties party thereto from time to time (as amended prior to the Third Amendment, the “Existing Credit Agreement” and as amended and restated by the Amendment, the “New Credit Agreement”).

As of December 31, 2019, the Term Loan Facility accrued interest at a floating rate of LIBOR plus 2.50% per annum and was scheduled to mature in February 2025. The Term Loan Facility requires scheduled quarterly amortization payments, each equal to 0.25% of the original principal amount of the loans under the Term Loan Facility.

On the Third Amendment Closing Date, the Company also entered into multiple cross currency swap arrangements to hedge foreign currency risk. The swaps were designed to enable the Company to effectively convert a portion of its fixed-rate U.S. dollar denominated debt obligations into approximately €280,000. The swaps were to mature in February 2023. In October 2019, the Company settled all of its cross-currency interest rate swap arrangements (the “February 2018 swaps”) and concurrently entered into new cross-currency interest rate swap arrangements (the “October 2019 swaps”) with the same notional amount of €280,000 equivalent (\$313,656 as of December 31, 2019) and same maturity of February 2023. Consistent with the February 2018 swaps, the October 2019 swaps are designed to enable the Company to effectively convert a portion of its fixed-rate U.S. dollar-denominated debt obligations under the Term Loan Facility into a Euro-denominated equivalent. The October 2019 swaps have been designated and qualify as net investment hedges of the Company’s foreign currency exchange rate exposure on the net investments of certain of its Euro-denominated subsidiaries. The settlement of the February 2018 swaps resulted in cash proceeds to the Company of \$38,070, which the Company used for additional debt repayment on the Company’s Term Loan Facility.

The Company may at any time or from time to time voluntarily prepay loans under the Term Loan Facility in whole or in part without premium or penalty.

The Term Loan Facility requires mandatory prepayments from (i) 50% of “Excess Cash Flow” (as defined in the New Credit Agreement) on an annual basis with step downs to lower percentages based on the Borrower’s leverage ratio, if applicable, (ii) net cash proceeds from the issuance or incurrence of certain indebtedness and (iii) net cash proceeds received from certain non-ordinary course disposition of assets and casualty events to the extent such net cash proceeds were not reinvested in the Company’s business within a certain specified time period. Prepayments are applied to remaining amortization installments in direct order of maturity. The remaining principal balance of the term loans are due upon maturity.

In addition, the New Credit Agreement contains customary affirmative and negative covenants and events of default, all of which are substantially the same as under the Existing Credit Agreement.

The Borrower and certain Canadian and European subsidiaries of the Borrower also have a \$200,000 asset-based revolving credit facility (the “ABL Facility”) which provides for \$150,000 in U.S. available borrowings, up to \$10,000 in Canadian available borrowings and up to \$40,000 of European available borrowings. Borrowings under the ABL Facility bear interest at a rate equal to the LIBOR rate or the base rate elected by the Company at the time of the borrowing plus a margin of between 1.50%-2.00% or 0.50%-1.00%, respectively, depending on availability under the ABL Facility. In addition, there is an annual commitment fee equal to 0.375%, with a step-down to 0.25% based on the average usage of the revolving credit borrowings available. As of December 31, 2019, there were no revolving credit borrowings under the ABL Facility. Revolving credit borrowings are payable at the option of the Company throughout the term of the ABL Facility with the balance due May 4, 2021.

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The Company has the ability to request letters of credit under the ABL Facility. The Company had \$20,506 of letters of credit outstanding as of December 31, 2019, which reduce available borrowings under the ABL Facility by such amounts.

The Term Loan Facility is guaranteed by CPQ Midco I Corporation, a subsidiary of the Company and the direct parent of the Borrower (“Holdings”) and substantially all of the Borrower’s wholly owned U.S. subsidiaries. The obligations under the Term Facility are secured (i) by a first-priority security interest in, among other things, a pledge substantially all of the Borrower’s and the guarantors’ assets (other than collateral securing the ABL Facility on a first-priority basis) and (ii) by a second-priority security interest in receivables, inventory, deposit accounts and other collateral of the Borrower and the U.S. subsidiary guarantors securing the ABL Facility. The liens securing the Term Loan Facility and the guarantees are pari passu with the liens securing the Senior Secured Notes subject to the pari passu intercreditor agreement.

The obligations of the Borrower under the ABL Facility are guaranteed by Holdings and the same U.S. subsidiary guarantors that guarantee the Term Loan Facility, the obligations of the Canadian Borrowers under the ABL Facility are guaranteed by certain other Canadian subsidiaries of the Borrower and the obligations of the European Borrowers under the ABL Facility are guaranteed by certain other European subsidiaries of the Borrower. The obligations of the borrowers and guarantors under the ABL Facility are secured (i) by a first-priority security interest in, among other things, substantially all of their receivables, inventory, deposit accounts and other collateral securing the ABL Facility on a first-priority basis and (ii) by a second-priority security interest in the property and assets of Holdings, the Borrower and the U.S. subsidiary guarantors that secure the Term Loan Facility. In addition, the ABL Facility is secured by the equity interests in, and substantially all of the assets of, certain foreign guarantors in connection with the Canadian dollar-denominated and Euro-denominated availability.

The Term Loan Facility and the ABL Facility contain various non-financial restrictive covenants. Each limits the ability of PQ Corporation and its restricted subsidiaries to incur certain indebtedness or liens, merge, consolidate or liquidate, dispose of certain property, make investments or declare or pay dividends, make optional payments, modify certain debt instruments, enter into certain transactions with affiliates, enter into certain sales and leasebacks, and certain other non-financial restrictive covenants. The ABL Facility also contains one financial covenant which applies when minimum availability under the ABL Facility exceeds a certain threshold. During such time, the Company is required to maintain a fixed-charge coverage ratio of at least 1.0 to 1.0. The Company is in compliance with all debt covenants as of December 31, 2019 and 2018, respectively.

During the year ended December 31, 2018, the Company prepaid \$100,000 of outstanding principal balance on the Term Loan Facility. The Company wrote off \$559 of previously unamortized deferred financing costs and original issue discount of \$1,313 as debt extinguishment costs. The prepayments were applied against the remaining scheduled installments of principal due in respect of the loans under the Term Loan Facility in direct order of maturity.

During the year ended December 31, 2019, the Company prepaid \$210,000 of outstanding principal balance on the Term Loan Facility. The Company wrote off \$1,027 of previously unamortized deferred financing costs and original issue discount of \$2,414 as debt extinguishment costs. The prepayments were applied against the remaining scheduled installments of principal due in respect of the loans under the Term Loan Facility in direct order of maturity.

Debt extinguishment costs resulting from Term Loan amendments

As a result of amending the Term Loan facility during the year ended December 31, 2018, the Company recorded \$2,124 of new creditor and third-party financing costs as debt extinguishment costs. In addition, previous unamortized deferred financing costs of \$1,403 and original issue discount of \$2,352 associated with the previously outstanding debt were written off as debt extinguishment costs.

As a result of amending the Term Loan facility during the year ended December 31, 2017, the Company recorded \$199 of new creditor and third-party financing costs as debt extinguishment costs. In addition, previous unamortized deferred financing costs of \$105 and original issue discount of \$162 associated with the previously outstanding debt were written off as debt extinguishment costs.

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6.75% Senior Secured Notes due 2022

On May 4, 2016, the Borrower issued \$625,000 of 6.750% Senior Secured Notes due November 2022 (the “6.75% Senior Secured Notes”) in transactions exempt from or not subject to registration under the Securities Act pursuant to Rule 144A and Regulation S under the Securities Act of 1933. The 6.75% Senior Secured Notes are guaranteed by PQ Holdings Inc. and by the U.S. subsidiary guarantors that guarantee the Term Loan Facility and are secured by liens on the assets of the Borrower and the U.S. subsidiary guarantors on a *pari passu* with the liens securing the Term Loan Facility subject to the *pari passu* intercreditor agreement. The guarantee by PQ Holdings Inc. is unsecured. The indenture relating to the 6.75% Senior Secured Notes contains various limitations on the Company’s and its restricted subsidiaries’ ability to incur additional indebtedness, pay dividends or repay certain debt, make loans and investments, sell assets, create liens, enter into transactions with affiliates, enter into agreements restricting the Borrower’s subsidiaries ability to pay dividends, and merge and consolidate with other companies, among other things. Interest on the 6.75% Senior Secured Notes is payable on May 15 and November 15 of each year, commencing November 15, 2016. No principal payments are required with respect to the 6.75% Senior Secured Notes prior to their final maturity. The 6.75% Senior Secured Notes mature on November 15, 2022.

If any Event of Default (other than a default relating to certain events of bankruptcy or insolvency of PQ Corporation or certain of its subsidiaries) occurs and is continuing under the Indenture, the Trustee or the Holders of at least 30% in principal amount of the then total outstanding notes by notice to the Company may declare the principal, premium, if any, interest and any other monetary obligations on all the then outstanding notes to be due and payable immediately. If an event of default arising from certain events of bankruptcy or insolvency of the Company occurs, the principal of, premium, if any, and interest on all the 6.75% Senior Secured Notes shall become immediately due and payable without any declaration or other act on the part of the trustee or any holders.

The 6.75% Senior Secured Notes are redeemable, in whole or in part, at the redemption prices (expressed as percentages of principal amount of the 6.75% Senior Secured Notes to be redeemed) set forth below, plus accrued and unpaid interest, if any, to, but not including, the redemption date, if redeemed on or after any of the dates below until the subsequent date below:

Year	Percentage
May 15, 2019	103.375%
May 15, 2020	101.688%
May 15, 2021 and thereafter	100.000%

Upon the occurrence of a change of control, as defined, each holder will have the right to require the Company to purchase all or any part of such holder’s 6.75% Senior Secured Notes at a purchase price in cash equal to 101% of the principal amount, plus accrued and unpaid interest.

Senior Unsecured Notes - Redeemed in 2017

On May 4, 2016, the Borrower issued \$525,000 aggregate principal amount of floating rate Senior Unsecured Notes due 2022 (the “Senior Unsecured Notes”) in a concurrent private placement exempt from the registration requirements of the Securities Act. The notes were issued at 98.0% of the principal amount. The Senior Unsecured Notes were to mature on May 1, 2022.

In conjunction with the Company’s IPO, on October 3, 2017, the Borrower redeemed \$446,208 in aggregate principal of the \$525,000 of its Senior Unsecured Notes using the proceeds from the IPO. Following the redemption, \$78,792 aggregate principal amount of the Senior Unsecured Notes remained outstanding. The Borrower paid a redemption premium of \$32,284, which was recorded as debt extinguishment costs. In addition, previous unamortized deferred financing costs of \$696 and original issue discount of \$7,555 associated with the previously outstanding debt were written off as debt extinguishment costs.

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On December 11, 2017, the Borrower redeemed the remaining \$78,792 aggregate principal amount of the Senior Unsecured Notes with the proceeds from its issuance of the 5.75% Senior Unsecured Notes due 2025. The Borrower paid a redemption premium of \$7,091, of which \$6,043 was recorded as debt extinguishment costs. In addition, unamortized deferred financing costs of \$108 and original issue discount of \$1,176 associated with the previously outstanding debt were written off as debt extinguishment costs. Refer to the 5.75% Senior Unsecured Notes due 2025 section of this note for further information.

8.50% Senior Notes due 2022 - Redeemed in 2017

In December 2014, Eco Services issued \$200,000 aggregate principal amount of 8.50% senior notes due 2022 (the “2022 Notes”) under an indenture dated October 24, 2014. The 2022 Notes were issued in a private transaction exempt from the registration requirements of the Securities Act. Pursuant to the indenture governing the 2022 Notes, PQ Group Holdings assumed the obligations of Eco Services under the 2022 Notes following the former business combination. The 2022 Notes were to mature on November 1, 2022 and were issued at 100% of the principal amount. On December 11, 2017, the Borrower redeemed the \$200,000 aggregate principal amount of the 2022 Notes with the proceeds from its issuance of the 5.75% Senior Unsecured Notes due 2025. The Borrower paid a redemption premium of \$8,500, of which \$7,996 was recorded as debt extinguishment costs. In addition, unamortized deferred financing costs of \$5,207 associated with the previously outstanding debt were written off as debt extinguishment costs. Refer to the 5.75% Senior Unsecured Notes due 2025 section of this note for further information.

5.75% Senior Unsecured Notes due 2025

On December 11, 2017, the Borrower issued \$300,000 aggregate principal amount of 5.75% Senior Unsecured Notes due 2025 (the “5.75% Senior Unsecured Notes”) in a private placement exempt from the registration requirements of the Securities Act. The 5.75% Senior Unsecured Notes mature on December 15, 2025. Interest on the 5.75% Senior Unsecured Notes is to be paid semi-annually on February 15 and August 15, commencing August 15, 2018, at an annual rate of 5.75%. The indenture relating to the 5.75% Senior Unsecured Notes contained various limitations on the Borrower’s and its restricted subsidiaries’ ability to incur additional indebtedness, pay dividends or repay certain debt, make loans and investments, sell assets, create liens, enter into transactions with affiliates, enter into agreements restricting the Borrower’s subsidiaries ability to pay dividends, and merge and consolidate with other companies, among other things. No principal payments are required with respect to the Senior Secured Notes prior to their final maturity.

The obligations of the Borrower under the 5.75% Senior Unsecured Notes and the related indenture are guaranteed by its U.S. subsidiary guarantors that guarantee the Term Loan Facility. The obligations of the Company under the 5.75% Senior Unsecured Notes and the indenture are unsecured.

If any Event of Default (other than a default relating to certain events of bankruptcy or insolvency of PQ Corporation or certain of its subsidiaries) occurs and is continuing under the Indenture, the Trustee or the Holders of at least 30% in principal amount of the then total outstanding notes by notice to the Company may declare the principal, premium, if any, interest and any other monetary obligations on all the then outstanding notes to be due and payable immediately. If an event of default arising from certain events of bankruptcy or insolvency of the Company occurs, the principal of, premium, if any, and interest on all the Senior Secured Notes shall become immediately due and payable without any declaration or other act on the part of the trustee or any holders.

At any time prior to December 15, 2020, the Borrower may, at its option and on one more occasions, redeem (a) up to 40% of the aggregate principal amount of the 5.75% Senior Unsecured Notes with the cash proceeds from certain equity offerings at a redemption price equal to the sum of 105.75% of the aggregate principal amount thereof plus accrued and unpaid interest thereon, and (b) all or part of the 5.75% Senior Unsecured Notes at 100.00% of the aggregate principal amount redeemed plus accrued and unpaid interest thereon and a make-whole premium (the “Applicable Premium”). The Applicable Premium is equal to the greater of: (a) 1% of the principal amount of notes redeemed, or (b) the excess, if any, of:

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(1) the present value at the redemption date of (i) the redemption price of such notes at December 15, 2020 (as set forth in the table below), plus (ii) all required remaining scheduled interest payments due on such notes through December 15, 2020 (excluding accrued but unpaid interest to, but excluding, the redemption date), computed using a discount rate equal to the applicable United States Treasury rate as of such redemption date plus 50 basis points; over

(2) the outstanding principal amount of such notes on the redemption date.

On or after December 15, 2020, the 5.75% Senior Unsecured Notes are redeemable, in whole or in part, at the redemption prices (expressed as percentages of principal amount of the 5.75% Senior Unsecured Notes to be redeemed) set forth below, plus accrued and unpaid interest, if any, to, but not including, the redemption date, if redeemed on or after any of the dates below until the subsequent date below:

Year	Percentage
December 15, 2020	102.875%
December 15, 2021	101.438%
December 15, 2022 and thereafter	100.000%

Upon the occurrence of a change of control, as defined, each holder will have the right to require the Company to purchase all or any part of such holder's Senior Secured Notes at a purchase price in cash equal to 101% of the principal amount, plus accrued and unpaid interest.

In March 2019, the Company repurchased \$5,000 of the 5.75% Senior Unsecured Notes at 97.75%. The Company wrote off \$55 of previously unamortized deferred financing costs and original issue discount of \$29 as debt extinguishment costs.

Other Debt

New Markets Tax Credit Financing

On October 24, 2013, PQ Holdings' (and now the Company's) subsidiary Potters Industries, LLC ("Potters") entered into a NMTC financing arrangement with JPMorgan Chase Bank N.A. and several of its affiliates ("Chase") and TX CDE V LLC, an affiliate of Texas LIC Development Company LLC d/b/a Texas Community Development Capital ("TX CDE") to fund the expansion of Potters' manufacturing facility in Paris, Texas (the "2013 NMTC Agreement"). The NMTC program, which is administered by the United States Treasury Department, requires certain balance sheet commitments. The 2013 NMTC Agreement will provide the Company with certain monetary benefits as an offset to specifically identified capital expenditures. The 2013 NMTC Agreement requires that certain commitments and covenants be maintained over a period of seven years in order to legally recognize the benefit. Chase agreed to contribute \$6,634 and an additional \$15,632 in funds lent to Chase by Potters Holdings II, L.P. to TX CDE. TX CDE, in turn, lent \$21,000 in the form of \$5,368 and \$15,632 of notes to Potters, which used the proceeds to finance the expansion of Potters' manufacturing facility in Paris, Texas. The capital expenditures associated with the 2013 NMTC Agreement were completed in 2014. The \$21,000 of debt related to the 2013 NMTC was assumed as part of the former business combination and was outstanding as of December 31, 2019 and 2018.

On May 17, 2016, Potters entered into a NMTC financing arrangement with U.S. Bank N.A. and several of its affiliates ("USB") and MRC XX LLC, an affiliate of Midwest Renewable Capital, LLC ("MRC"), to fund the expansion of Potters' manufacturing facility in Augusta, Georgia (the "May 2016 NMTC Agreement"). The May 2016 NMTC Agreement provides the Company with certain monetary benefits as an offset to specifically identified capital expenditures. The May 2016 NMTC Agreement requires that certain commitments and covenants be maintained over a period of seven years in order to legally recognize the benefit. USB agreed to contribute \$3,732 and an additional \$7,822 in funds lent to USB by Potters Holdings II, L.P. to MRC. MRC, in turn, lent \$11,000 in the form of \$7,823, \$1,311 and \$1,866 of notes to Potters, which used the proceeds to finance the expansion of Potters' manufacturing facility in Augusta, Georgia. The \$11,000 was outstanding as of December 31, 2019. The capital expenditures associated with the May 2016 NMTC Agreement were completed in 2017.

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On December 29, 2016, Potters entered into a second NMTC financing arrangement with USB and MRC whereby USB agreed to contribute \$3,815 and an additional \$7,775 in funds lent to USB by Potters Holdings II, L.P. to MRC. MRC, in turn, lent \$11,000 in the form of \$7,775, \$1,402 and \$1,823 of notes to Potters, which will use the proceeds as working capital for another expansion of Potters' manufacturing facility in Paris, Texas (the "December 2016 NMTC Agreement"). The \$11,000 was outstanding as of December 31, 2019 and 2018. Potters expended the proceeds of the notes as working capital in 2017.

On June 22, 2017, Potters, entered into a NMTC financing arrangement with U.S. Bank N.A. ("USB"), one of USB's affiliates ("USB Investment Fund") and Business Conduit No. 28, LLC, an affiliate of Community Reinvestment Fund, Inc. ("CRF"). USB contributed \$3,054 to USB Investment Fund, and Potters Leveraged Lender LLC, an indirect subsidiary of the Company, lent USB Investment Fund \$6,221. USB Investment Fund then contributed \$9,000 to CRF, which in turn lent \$8,820 to Potters pursuant to a credit agreement (the "June 2017 NMTC Agreement"). Potters used the \$8,820 in proceeds to acquire equipment for the expansion of Potters' manufacturing facility in Paris, Texas. The June 2017 NMTC Agreement provides the Company with certain monetary benefits as an offset to specifically identified capital expenditures. The June 2017 NMTC Agreement requires that certain commitments and covenants are maintained over a period of seven years in order to legally recognize the benefit. The \$8,820 was outstanding as of December 31, 2019 and 2018. The capital expenditures associated with the June 2017 NMTC Agreement were completed in 2018.

In connection with the aforementioned NMTC financing arrangements, the Company provided indemnifications related to its actions or inactions which cause either a NMTC disallowance or recapture event. In the event that the Company causes either a recapture or disallowance of the tax credits expected to be generated under this program, then the Company will be required to repay the disallowed or recaptured tax credits plus an amount sufficient to pay the taxes on such repayment to the counterparty of the agreement. This indemnification covers the Company's actions and inactions prior the end of the seven-year term of each agreement. The maximum potential amount of future payments under this indemnification is approximately \$24,649. The Company currently believes that the likelihood of a required payment under this indemnification is remote.

Subsidiary Credit Agreement

On June 12, 2017, the Company acquired Sovitec and assumed its obligations to Belfius Bank NV ("Belfius"). On June 8, 2017, Sovitec entered into a credit agreement with Belfius governing a €14,500 credit line which is divided into four tranches. Tranche A was issued in the amount of €7,500 in the form of a Euro roll-over credit with a maturity date of December 31, 2021. Tranche B was issued in the amount of €3,000 in the form of a Euro roll-over credit with a full principal payment due on its maturity date of September 30, 2022. A working capital line of credit ("Working Capital") of €3,000 was issued under the form of straight loans with a maturity date up to 90 days after borrowings are made on the line. A capital expenditure line of credit ("CAPEX line") of €1,000 was issued under the form of straight loans with a maturity date of September 30, 2021. Tranche A is subject to principal payments of €750 made on September 30 and December 31 of each year. Borrowings under the credit agreement bear rates based on Sovitec's ratio of net debt to Normalized EBITDA. Normalized EBITDA is defined as the Sovitec consolidated operating profit before non-recurring items (i.e. items non-related to normal operations of the last twelve month period and provided an acceptable description of the one-off character of those items is given) and before taxation, depreciation and amortization. Interest rate margins are subject to being reset on June 30 of each year. Interest rates reset based on three net debt to Normalized EBITDA ratio ranges of less than 2, between 2 and 3 or greater than 3. Rates for each tranche of debt reset based on 1 to 9 month EURIBOR rates (not lower than zero) plus a margin that can range between 1.10% to 1.55% for Tranche A, 1.85% to 2.15% for Tranche B, 0.90% and 1.20% for Working Capital and 1.25% and 1.80% for the CAPEX line.

As of December 31, 2019, the interest rate on the credit agreements are as follows: Tranche A, 1.10%, Tranche B, 1.85%, Working Capital, 0.90% and CAPEX 1.25%. As of December 31, 2019, the following principal balances are outstanding on each debt instrument: Tranche A, \$3,361, Tranche B, \$3,361, Working Capital, \$2,576 and CAPEX \$1,120.

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Loans and guarantees under the credit agreement are secured by (1) a first priority security interest on the Sovitec properties located Fleurus, Belgium and Florange, France and (2) 100% of the nominative shares in Sovitec's wholly owned parent company, Sovitec International B.V. The credit agreement contains various non-financial and financial covenants. Each limits the ability of Sovitec and its restricted subsidiaries to incur certain indebtedness or liens, merge, consolidated or liquidate, dispose of certain property, make investments or declare or pay dividends. The credit agreement also contains one financial covenant which requires maintaining a maximum net debt/EBITDA ratio of 3:1 during the first three years of the agreement and afterwards a maximum 2.5:1 ratio. The Company is in compliance with all debt covenants as of December 31, 2019.

Notes Payable

The Company also has several note payable agreements denominated in Japanese Yen which enables the Company to borrow up to a total of 260,000 Japanese Yen, or \$2,358. Borrowings bear interest at either TIBOR ("Tokyo Interbank Offered Rate") plus a margin or the short-term prime rate. The terms of the agreements vary and are renewable upon expiration of the term with the balances due in 2020. Borrowings under the agreement are payable at the option of the Company throughout the term of the agreements. Borrowings outstanding under these agreements were \$2,387 and \$2,358 as of December 31, 2019 and 2018, respectively.

Certain of the Company's foreign subsidiaries maintain other note payable agreements. These agreements are not further described as they are not significant to the consolidated financial statements.

Fair Value of Debt

The fair value of a financial instrument is defined as the exchange price that would be received for an asset or paid to transfer a liability (an exit price) in the principal or most advantageous market for the asset or liability in an orderly transaction between market participants. As of December 31, 2019 and 2018, the fair value of the senior secured term loans and senior secured and unsecured notes was \$1,905,822 and \$2,010,023, respectively. The fair value is classified as Level 2 based upon the fair value hierarchy (see Note 5 to these consolidated financial statements for further information on fair value measurements).

Aggregate Long-term Debt Maturities

The aggregate long-term debt maturities are:

Year	Amount
2020	\$ 7,766
2021	1,683
2022	628,361
2023	3,689
2024	—
Thereafter	1,290,627
	<u>\$ 1,932,126</u>

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18. Other Long-term Liabilities:

The following table summarizes the components of other long-term liabilities as follows:

	December 31,	
	2019	2018
Pension benefits	\$ 66,544	\$ 75,430
Other postretirement benefits	3,680	3,233
Supplemental retirement plans	10,632	10,763
Derivative liabilities	11,182	—
Deferred revenue	6,450	—
Reserve for uncertain tax positions	1,355	3,176
Asset retirement obligation	4,555	4,224
Other	4,272	7,999
	<u>\$ 108,670</u>	<u>\$ 104,825</u>

19. Financial Instruments:

The Company uses (1) interest rate related derivative instruments to manage its exposure related to changes in interest rates on its variable-rate debt instruments, (2) commodity derivatives to manage its exposure to commodity price fluctuations, and (3) foreign currency related derivative instruments to manage its foreign currency exposure to its net investments in certain foreign operations. The Company does not speculate using derivative instruments.

By using derivative financial instruments to hedge exposures to changes in interest rates, commodity prices and foreign currency, the Company exposes itself to credit risk and market risk. Credit risk is the failure of the counterparty to perform under the terms of the derivative contract. When the fair value of a derivative contract is an asset, the counterparty owes the Company, which creates credit risk for the Company. When the fair value of a derivative contract is a liability, the Company owes the counterparty and, therefore, the Company is not exposed to the counterparty's credit risk in those circumstances. The Company minimizes counterparty credit risk in derivative instruments by entering into transactions with high quality counterparties. The derivative instruments entered into by the Company do not contain credit-risk-related contingent features.

Market risk is the adverse effect on the value of a derivative instrument that results from a change in interest rates, currency exchange rates or commodity prices. The market risk associated with interest rate and commodity price contracts is managed by establishing and monitoring parameters that limit the types and degree of market risk that may be undertaken.

Use of Derivative Financial Instruments to Manage Commodity Price Risk. The Company is exposed to risks in energy costs due to fluctuations in energy prices, particularly natural gas. The Company has a hedging program in the United States which allows the Company to mitigate exposure to natural gas volatility with natural gas swap agreements. Fair value is determined based on estimated amounts that would be received or paid to terminate the contracts at the reporting date based on quoted market prices of comparable contracts. The respective current and non-current liabilities are recorded in accrued liabilities and other long-term liabilities and the respective current and non-current assets are recorded in prepaid and other current assets and other long-term assets, as applicable, in the Company's consolidated balance sheet. As the derivatives are designated and qualify as cash flow hedges, the gains or losses on the natural gas swaps are recorded in stockholders' equity as a component of other comprehensive income (loss) ("OCI"), net of tax. Reclassifications of the gains and losses on natural gas hedges into earnings are included in production costs and subsequently charged to cost of goods sold in the consolidated statements of income in the period in which the associated inventory is sold. As of December 31, 2019, the Company's natural gas swaps had a remaining notional quantity of 3.6 million MMBTU to mitigate commodity price volatility through December 2021.

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Use of Derivative Financial Instruments to Manage Interest Rate Risk. The Company is exposed to fluctuations in interest rates on its senior secured credit facilities. Changes in interest rates will not affect the market value of such debt but will affect the amount of the Company's interest payments over the term of the loans. Likewise, an increase in interest rates could have a material impact on the Company's cash flow. The Company hedges the interest rate fluctuations on debt obligations through interest rate cap agreements. The Company records these agreements at fair value as assets or liabilities in its consolidated balance sheet. As the derivatives are designated and qualify as cash flow hedges, the gains or losses on the interest rate cap agreements are recorded in stockholders' equity as a component of OCI, net of tax. Reclassifications of the gains and losses on the interest rate cap agreements into earnings are recorded as part of interest expense in the consolidated statements of income as the Company makes its interest payments on the hedged portion of its senior secured credit facilities. Fair value is determined based on estimated amounts that would be received or paid to terminate the contracts at the reporting date based on quoted market prices.

In July 2016, the Company entered into interest rate cap agreements, paying a premium of \$1,551 to mitigate interest rate volatility from July 2016 through July 2020 by employing varying cap rates, ranging from 1.50% to 3.00% on \$1,000,000 of notional variable-rate debt. The cap rate in effect at December 31, 2019 was 3.00%. In November 2018, the Company entered into additional interest rate cap agreements to mitigate interest rate volatility from July 2020 through July 2022, with a cap rate of 3.50% on \$500,000 of notional variable-rate debt. During the quarter ended December 31, 2019, the Company discontinued cash flow hedging on \$53,000 of its \$1,000,000 notional on its remaining July 2016 interest rate cap agreement. With the Company's prepayments on its Term Loan Facility during 2019 (see Note 17 to these consolidated financial statements for additional information), the original forecasted interest rate payments associated with the dedesignated portion of the interest rate cap agreement are no longer probable of occurring. As a result of the discontinuance of cash flow hedge accounting on this portion of the interest rate cap agreement, the Company immediately reclassified into earnings the loss deferred in AOCI related to the dedesignated portion of the hedge, which was not material. Any future gains and losses associated with the dedesignated portion of the interest rate cap agreement through its maturity in July 2020 will be recognized in earnings.

Use of Derivative Financial Instruments to Manage Foreign Currency Risk. The Company is exposed to risks related to its net investments in foreign operations due to fluctuations in foreign currency exchange rates, particularly between the United States dollar and the Euro. In connection with the February 2018 term loan refinancing (see Note 17 to these consolidated financial statements), the Company entered into multiple cross currency interest rate swap arrangements with an aggregate notional amount of €280,000 to hedge this exposure on the net investments of certain of its Euro-denominated subsidiaries. The Company records these swap agreements at fair value as assets or liabilities in its consolidated balance sheet.

In October 2019, the Company settled all of its February 2018 swaps and concurrently entered into the October 2019 swaps with the same notional amount of €280,000 (\$313,656 as of December 31, 2019) and same maturity date of February 2023, which resulted in cash proceeds to the Company of \$38,070. Consistent with the February 2018 swaps, the October 2019 swaps are designed to enable the Company to effectively convert a portion of its fixed-rate U.S. dollar-denominated debt obligations under the Term Loan Facility into a Euro-denominated equivalent. The October 2019 swaps have been designated and qualify as net investment hedges of the Company's foreign currency exchange rate exposure on the net investments of certain of its Euro-denominated subsidiaries.

As the derivatives are designated and qualify as net investment hedges, changes in the fair value of the swaps attributable to changes in the spot exchange rates are recognized in cumulative translation adjustment ("CTA") within OCI and are held there until the hedged net investments are sold or substantially liquidated. Changes in the fair value of the swaps attributable to the cross currency basis spread are excluded from the assessment of hedge effectiveness and are recorded in current period earnings. Upon such sale or liquidation, the amount recognized in CTA is reclassified to earnings and reported in the same line item as the gain or loss on the liquidation of the net investments.

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The fair values of derivative instruments held as of December 31, 2019 and 2018 are shown below:

	Balance sheet location	December 31,	
		2019	2018
Derivative assets:			
Derivatives designated as cash flow hedges:			
Natural gas swaps	Prepaid and other current assets	\$ —	\$ 21
Interest rate caps	Prepaid and other current assets	—	1,358
Interest rate caps	Other long-term assets	—	546
		—	1,925
Derivatives designated as net investment hedges:			
Cross currency swaps	Prepaid and other current assets	3,928	5,499
Cross currency swaps	Other long-term assets	—	13,344
		3,928	18,843
Total derivative assets		\$ 3,928	\$ 20,768
Derivative liabilities:			
Derivatives designated as cash flow hedges:			
Natural gas swaps	Accrued liabilities	\$ 813	\$ 36
Interest rate caps	Accrued liabilities	420	—
Natural gas swaps	Other long-term liabilities	226	148
Interest rate caps	Other long-term liabilities	2,822	1,842
		4,281	2,026
Derivatives designated as net investment hedges:			
Cross currency swaps	Other long-term liabilities	8,134	—
Total derivative liabilities		\$ 12,415	\$ 2,026

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The following table shows the effect of the Company's derivative instruments designated as hedges on accumulated other comprehensive income (loss) ("AOCI") and the statements of income for the years ended December 31, 2019, 2018 and 2017:

Location of gain (loss) reclassified from AOCI into income		Years ended December 31,					
		2019		2018		2017	
		Amount of gain (loss) recognized in OCI on derivatives	Amount of gain (loss) reclassified from AOCI into income	Amount of gain (loss) recognized in OCI on derivatives	Amount of gain (loss) reclassified from AOCI into income	Amount of gain (loss) recognized in OCI on derivatives	Amount of gain (loss) reclassified from AOCI into income
Interest rate caps	Interest (expense) income	\$ (3,304)	\$ (625)	\$ (981)	\$ (256)	\$ (4,760)	\$ (40)
Natural gas swaps	Cost of goods sold	(1,210)	(335)	637	353	(1,300)	(222)
		<u>\$ (4,514)</u>	<u>\$ (960)</u>	<u>\$ (344)</u>	<u>\$ 97</u>	<u>\$ (6,060)</u>	<u>\$ (262)</u>

The following table shows the effect of the Company's cash flow hedge accounting on the consolidated statements of income for the years ended December 31, 2019, 2018 and 2017:

	Location and amount of gain (loss) recognized in income on cash flow hedging relationships					
	Years ended December 31,					
	2019		2018		2017	
	Cost of goods sold	Interest (expense) income	Cost of goods sold	Interest (expense) income	Cost of goods sold	Interest (expense) income
Total amounts of income and expense line items presented in the statement of income in which the effects of cash flow hedges are recorded	\$ (1,176,550)	\$ (111,525)	\$ (1,226,520)	\$ (113,723)	\$ (1,095,265)	\$ (179,044)
The effects of cash flow hedging:						
Gain (loss) on cash flow hedging relationships:						
Interest contracts:						
Amount of gain (loss) reclassified from AOCI into income	—	(625)	—	(256)	—	(40)
Commodity contracts:						
Amount of gain (loss) reclassified from AOCI into income	(335)	—	353	—	(222)	—

The following table shows the effect of the Company's net investment hedges on AOCI and the consolidated statements of income for the years ended December 31, 2019, 2018 and 2017:

	Amount of gain (loss) recognized in OCI on derivative			Location of gain (loss) reclassified from AOCI into income	Amount of gain (loss) reclassified from AOCI into income			Location of gain (loss) recognized in income on derivative (amount excluded from effectiveness testing)	Amount of gain (loss) recognized in income on derivative (amount excluded from effectiveness testing)		
	Years ended December 31,				Years ended December 31,				Years ended December 31,		
	2019	2018	2017		2019	2018	2017		2019	2018	2017
Cross currency swaps	\$ 17,077	\$ 18,843	\$ —	Gain (loss) on sale of subsidiary	\$ —	\$ —	\$ —	Interest (expense) income	\$ 8,035	\$ 7,898	\$ —

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Amounts of unrealized losses in AOCI that are expected to be reclassified to the consolidated statement of income over the next twelve months are \$,442 as of December 31, 2019.

20. Income Taxes:

Income (loss) before income taxes and noncontrolling interest within or outside the United States are shown below:

	Years ended December 31,		
	2019	2018	2017
Domestic	\$ 53,169	\$ 3,935	\$ (137,147)
Foreign	67,840	84,681	76,513
Total	<u>\$ 121,009</u>	<u>\$ 88,616</u>	<u>\$ (60,634)</u>

The provision (benefit) for income taxes as shown in the accompanying consolidated statements of income consists of the following:

	Years ended December 31,		
	2019	2018	2017
Current:			
Federal	\$ (3)	\$ —	\$ —
State	1,422	2,470	806
Foreign	20,972	23,080	20,209
	<u>22,391</u>	<u>25,550</u>	<u>21,015</u>
Deferred:			
Federal	14,179	12,854	(135,970)
State	3,165	(784)	(1,817)
Foreign	964	(8,625)	(2,425)
	<u>18,308</u>	<u>3,445</u>	<u>(140,212)</u>
Provision (benefit) for income taxes	<u>\$ 40,699</u>	<u>\$ 28,995</u>	<u>\$ (119,197)</u>

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A reconciliation of income tax expense (benefit) at the U.S. federal statutory income tax rate to actual income tax expense is as follows:

	Years ended December 31,		
	2019	2018	2017
Tax at statutory rate	\$ 25,412	\$ 18,610	\$ (21,222)
State income taxes, net of federal income tax benefit	4,779	1,203	(7,754)
Tax on global intangible low-taxed income	8,517	15,445	—
Impact of US Tax Reform	—	—	(132,158)
Non-US earnings transition tax	—	—	42,903
Changes in uncertain tax positions	(1,288)	(996)	974
Change in valuation allowances	2,032	5,075	6,771
Rate changes	2,322	(3,325)	(151)
Foreign withholding taxes	(5,869)	570	978
Foreign tax rate differential	217	3,329	(12,798)
Non-deductible transaction costs	22	84	1,679
Permanent difference created by foreign exchange gain or loss	1,880	(7,550)	3,502
Research and development tax credits	(32)	(1,173)	—
Other, net	2,707	(2,277)	(1,921)
Provision (benefit) for income taxes	<u>\$ 40,699</u>	<u>\$ 28,995</u>	<u>\$ (119,197)</u>

The total tax provision of \$40,699 and \$28,995 for the years ended December 31, 2019 and 2018, respectively, and tax benefit of \$119,197 for the year ended December 31, 2017 on the Company's consolidated pre-tax income (loss) for the period differs from the U.S. statutory tax rate of 21%. This difference is principally due to the GILTI impacts of U.S. tax reform, foreign withholding taxes, changes in valuation allowances, statutory tax rate changes and state taxes.

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Deferred tax assets (liabilities) are comprised of the following:

	December 31,	
	2019	2018
Deferred tax assets:		
Net operating loss carryforwards	\$ 106,763	\$ 116,607
Section 163(j) interest disallowance carryforward	16,535	13,387
Pension	15,946	16,397
Post retirement health	859	1,385
Transaction costs	1,272	708
Natural gas contracts and interest rate swaps	1,216	335
Unrealized translation losses	1,865	3,737
US research and development credits	1,205	1,173
Operating lease liability	14,480	—
Other	41,670	38,855
Valuation allowance	(51,296)	(48,711)
	\$ 150,515	\$ 143,873
Deferred tax liabilities:		
Depreciation	\$ (108,242)	\$ (92,911)
Undistributed earnings of non-US subsidiaries	—	(6,648)
Inventory	(11,481)	(10,432)
Intangible assets	(159,765)	(174,327)
Cross currency swaps	(7,354)	(4,654)
Operating lease right-of-use assets	(14,324)	—
Other	(48,333)	(32,230)
	\$ (349,499)	\$ (321,202)
Net deferred tax liabilities	\$ (198,984)	\$ (177,329)

Included in the 2019 and 2018 deferred tax asset and liability amounts for depreciation, intangible assets, inventory, natural gas contracts, unrealized translation losses, and other above is \$42,621 and \$45,251, respectively, of a net deferred tax liability related to the Company's investment in Potters, which is a partnership for federal income tax purposes. The Company and one of its subsidiaries own in aggregate 100% of Potters and the assets and liabilities of Potters are included in the consolidated financial statements of the Company.

The change in net deferred tax liabilities for the years ended December 31, 2019 and 2018 was primarily related to the usage of U.S. federal and state net operating losses reducing those deferred tax assets, activity related to book amortization of intangible assets with no corresponding tax basis reducing those deferred tax liabilities, activity with respect to tax deductible goodwill at Eco Services LLC, as well as the election for full expensing on certain assets creating additional deferred tax liabilities for depreciable property.

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The following are changes in the deferred tax valuation allowance during the years ended December 31, 2019 and 2018:

	Years ended December 31,	
	2019	2018
Beginning balance	\$ 48,711	\$ 64,945
Additions	3,343	5,314
Reductions	(758)	(21,548)
Ending balance	<u>\$ 51,296</u>	<u>\$ 48,711</u>

Included in the reductions line above is \$20,038 related to fair value adjustments recorded to goodwill as part of the finalization of the Acquisition purchase accounting for the year ended December 31, 2018.

The net change in the total valuation allowance was a decrease of \$2,585 in 2019. The valuation allowance at December 31, 2019 was primarily related to foreign net operating losses as well as state net operating loss carryforwards and tax credits that, in the judgment of management, are not more likely than not to be realized. In assessing the ability to realize deferred tax assets, management considered whether it is more likely than not that some portion or all of the deferred tax assets will not be realized. The ultimate realization of deferred tax assets is dependent upon the generation of future taxable income during the periods in which those temporary differences become deductible. Management considered the scheduled reversal of deferred tax liabilities (including the impact of available carryback and carryforward periods), projected future taxable income, and tax-planning strategies that are prudent in making this assessment. In order to fully realize deferred tax assets, the Company will need to generate future taxable income prior to the expiration of the net operating loss and credit carryforwards. The amount of the deferred tax assets considered realizable, however, could be reduced in the near term if estimates of future taxable income during the carryforward period are reduced.

Management considered certain earnings in non-U.S. subsidiaries to be available for repatriation in the future. The tax cost associated with non-U.S. subsidiary earnings and distributions for the year ended December 31, 2019 has been recorded as a deferred tax benefit for the period. The unremitted earnings of non-U.S. subsidiaries and affiliates that have not been permanently reinvested amount to \$255,000 and \$168,304 as of December 31, 2019 and 2018, respectively. The deferred foreign withholding tax liability on these undistributed earnings is estimated to be \$0 and \$6,648 as of December 31, 2019 and 2018, respectively.

The cumulative unremitted earnings of foreign subsidiaries outside the United States in excess of the \$255,000 are considered permanently reinvested, for which no withholding taxes have been provided. Such earnings are expected to be reinvested indefinitely and, as a result, no deferred tax liability has been recognized with regard to such earnings. Determination of the deferred withholding tax liability on these unremitted earnings is not practicable.

The following table summarizes the activity related to the Company's gross unrecognized tax benefits:

	Years ended December 31,	
	2019	2018
Balance at beginning of period	\$ 10,175	\$ 11,431
Increases related to prior year tax positions	46	—
Decreases related to prior year tax positions	(1,046)	(1,538)
Increases related to current year tax positions	—	282
Decreases related to settlements with taxing authorities	(100)	—
Balance at end of period	<u>\$ 9,075</u>	<u>\$ 10,175</u>

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The total unrecognized tax benefits of \$9,075 and \$10,175 as of December 31, 2019 and 2018, respectively. If these amounts are recognized in future periods, it would affect the effective tax rate on income from continuing operations for the years in which they are recognized.

Interest and penalties released related to uncertain tax positions amounted to \$701 and \$42 for the years ended December 31, 2019 and 2018, respectively. To the extent interest and penalties are not assessed with respect to uncertain tax positions, amounts accrued will be reduced and reflected as a reduction of the overall income tax provision in the period for which the event occurs requiring the adjustment. The \$381 and \$1,088 in accrued interest and penalties as of December 31, 2019 and 2018, respectively, is recorded in other long-term liabilities on the consolidated balance sheets.

The Company files numerous consolidated and separate income tax returns in the U.S. federal jurisdiction and in many state and foreign jurisdictions. The following describes the open tax years, by significant tax jurisdiction, as of December 31, 2019:

Jurisdiction	Period
United States-Federal	2007-Present
United States-State	2007-Present
Canada ⁽¹⁾	2011-Present
Germany	2015-Present
Netherlands	2013-Present
Mexico	2015-Present
United Kingdom	2013-Present
Brazil	2015-Present

⁽¹⁾ Includes federal as well as local jurisdictions

Given that certain subsidiaries have U.S. and state net operating loss carryforwards, the statute for examination by the U.S. and state taxing authorities will typically remain open for a period following the use of such net operating loss carryforwards, extending the period for examination beyond the years indicated above.

The Company has subsidiaries in various states, provinces and countries that are currently under audit for years ranging from 2014 through 2018. To date, no material adjustments have been proposed as a result of these audits. As of December 31, 2019, the Company does not believe that there are any positions for which it is reasonably possible that the total amount of unrecognized tax benefits will significantly increase or decrease within the next 12 months.

The Company has an NOL available of \$245,138 to reduce future U.S. federal taxes payable. The current federal carry-forward period for those NOL's is 20 years because they were generated prior to U.S. tax reform being enacted. In light of tax reform, any net operating losses incurred after December 31, 2017 will be allowed to carry forward indefinitely. As a result of the 2014 change in control, \$105,158 of the \$245,138 are subject to the limitations of Section 382 of the Internal Revenue Code ("IRC"). Although subject to the limitations of IRC §382, management believes it is more likely than not that the Company will realize the entire \$105,158 in pre-transaction NOLs in future years. The remaining \$139,880 relates to periods after the 2014 change in control and would not be subject to limitation under IRC §382.

For state income tax purposes, the Company incurred net operating losses of \$8,077 for 2019 that may be carried forward at a minimum period of 5 years, and in certain circumstances indefinitely, among the states in which the Company is subject to tax to reduce future state income taxes payable. The Company also utilized net operating losses of \$42,163 for 2019. Cumulative state net operating losses carrying forward into 2020 are \$627,221. A valuation allowance of \$15,553 has been applied against the total \$30,170 of state net operating loss deferred tax assets, leaving losses of \$14,617 that have been recognized for financial accounting purposes for the portion of those losses that the Company believes, on a more likely than not basis, will be realized.

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Foreign net operating losses of \$137,134, of which \$644 will begin to expire in 2019, \$1,588 will begin to expire in 2026, \$154 will begin to expire in 2028, \$11,292 will begin to expire in 2029 with the remaining \$123,456 carrying forward indefinitely, are available to reduce future foreign income taxes payable. A valuation allowance of \$13,954 has been applied to \$32,827 of deferred tax assets related to foreign net operating loss carry-forwards, leaving a net deferred tax asset relating to foreign net operating losses of \$18,873 that has been recognized for financial accounting purposes.

Cash payments for income taxes, net of refunds, are as follows:

	Years ended December 31,		
	2019	2018	2017
Domestic	\$ 1,917	\$ 2,160	\$ 1,647
Foreign	15,489	21,682	27,552
	<u>\$ 17,406</u>	<u>\$ 23,842</u>	<u>\$ 29,199</u>

21. Benefit Plans:

The Company sponsors defined benefit pension plans covering employees in the United States and certain employees at its foreign subsidiaries. Benefits for a majority of the plans are based on average final pay and years of service. The Company's funding policy is to fund the minimum required contribution under local statutory requirements.

The Company sponsors unfunded plans to provide certain health care benefits to retired employees in the United States and Canada. The plans pay a stated percentage of medical expenses reduced by deductibles and other coverage. The plans are unfunded and obligations are paid out of the Company's operations.

The Company also has defined benefit supplementary retirement plans which provide benefits for certain U.S. employees in excess of qualified plan limitations. The obligations are paid out of the Company's general assets, including assets held in a Rabbi trust, or restoration plan assets.

The Company uses a December 31 measurement date for all of its defined benefit pension, postretirement medical and supplementary retirement plans. The following discussion includes information for the Eco Services benefit plans for all periods presented, and the acquired PQ Holdings benefit plans beginning on the date of a former business combination.

The Eco Services benefit plans include two defined benefit pension plans and one retiree health plan, all based in the U.S. The PQ Holdings benefit plans include a U.S. defined benefit pension plan as well as the defined benefit pension plans for all of the Company's foreign subsidiaries, two retiree health plans (one each in the U.S and Canada), and the Company's defined benefit supplementary retirement plans.

Of the Company's three defined benefit pension plans covering employees in the U.S., only the Eco Services Hourly Pension Plan continues to accrue benefits for certain participants; however, this plan will be frozen to future accruals as of December 31, 2020. All future accruals were frozen for the PQ Corporation Retirement Plan as of December 31, 2006 and for the Eco Services Pension Equity Plan as of December 31, 2016. With respect to the Company's three retiree health plans, the PQ Holdings plans in the U.S. and Canada were closed to new retirees as of December 31, 2006. The Eco Services Postretirement Life and Dental Plan was closed to new retirees effective July 1, 2017. The Company's defined benefit supplementary retirement plans were frozen to future accruals as of December 31, 2006.

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Defined Benefit Pension Plans

The following tables summarize changes in the benefit obligation, plan assets and funded status of the Company's significant defined benefit pension plans as well as the components of net periodic benefit cost, including key assumptions:

	U.S.		Foreign	
	December 31,		December 31,	
	2019	2018	2019	2018
Change in benefit obligation:				
Benefit obligation at beginning of period	\$ 246,311	\$ 261,102	\$ 112,103	\$ 119,710
Service cost	978	1,019	3,382	3,566
Interest cost	10,281	9,599	3,290	3,340
Participant contributions	—	—	555	570
Plan amendments	—	—	—	179
Plan curtailments	(2,795)	(952)	—	(340)
Plan settlements	(1,669)	—	(642)	(1,071)
Benefits paid	(10,862)	(11,453)	(2,478)	(2,569)
Expenses paid	—	—	(328)	(363)
Net transfer in	—	—	—	1,535
Actuarial (gains) losses	25,148	(13,004)	16,186	(5,432)
Translation adjustment	—	—	(589)	(7,022)
Benefit obligation at end of the period	\$ 267,392	\$ 246,311	\$ 131,479	\$ 112,103
Change in plan assets:				
Fair value of plan assets at beginning of period	\$ 195,755	\$ 218,374	\$ 91,787	\$ 96,518
Actual return on plan assets	43,116	(12,854)	13,421	(540)
Employer contributions	5,073	1,688	3,941	4,249
Employee contributions	—	—	555	570
Plan settlements	(1,669)	—	(642)	(1,071)
Benefits paid	(10,862)	(11,453)	(2,478)	(2,569)
Expenses paid	—	—	(328)	(363)
Acquisitions	—	—	—	1,013
Translation adjustment	—	—	(70)	(6,020)
Fair value of plan assets at end of the period	\$ 231,413	\$ 195,755	\$ 106,186	\$ 91,787
Funded status of the plans (underfunded)	\$ (35,979)	\$ (50,556)	\$ (25,293)	\$ (20,316)

The total actuarial losses for the year ended December 31, 2019 across the Company's U.S. plans was \$25,148, which was driven by declines in the discount rates of \$26,604 and declines in general demographic experience of \$2,953, which was offset by favorable changes in mortality assumptions of \$4,409. The total actuarial losses for the year ended December 31, 2019 across the Company's foreign plans was \$16,186, which was driven by declines in the discount rates of \$17,998, which was offset by favorable changes in general demographic experience of \$1,263 and favorable changes in mortality assumptions of \$549. Total actuarial gains for the year ended December 31, 2018 across the Company's U.S. and foreign plans was \$18,436, which was primarily driven by movements in the discount rates of \$17,085.

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Amounts recognized in the consolidated balance sheets consist of:

	U.S.		Foreign	
	December 31,		December 31,	
	2019	2018	2019	2018
Noncurrent asset	\$ —	\$ —	\$ 4,877	\$ 4,670
Current liability	—	—	(397)	(748)
Noncurrent liability	(35,979)	(50,556)	(29,773)	(24,238)
Accumulated other comprehensive income (loss)	8,687	1,218	(5,895)	(1,829)
Net amount recognized	<u>\$ (27,292)</u>	<u>\$ (49,338)</u>	<u>\$ (31,188)</u>	<u>\$ (22,145)</u>

Amounts recognized in accumulated other comprehensive income (loss) consist of:

	U.S.		Foreign	
	December 31,		December 31,	
	2019	2018	2019	2018
Prior service cost	\$ —	\$ —	\$ (151)	\$ (170)
Net gain (loss)	10,922	1,618	(7,981)	(2,133)
Gross amount recognized	10,922	1,618	(8,132)	(2,303)
Deferred income taxes	(2,235)	(400)	2,237	474
Net amount recognized	<u>\$ 8,687</u>	<u>\$ 1,218</u>	<u>\$ (5,895)</u>	<u>\$ (1,829)</u>

Components of net periodic benefit cost consist of:

	U.S.			Foreign		
	Years ended December 31,			Years ended December 31,		
	2019	2018	2017	2019	2018	2017
Service cost	\$ 978	\$ 1,019	\$ 1,219	\$ 3,382	\$ 3,566	\$ 3,686
Interest cost	10,281	9,599	10,115	3,290	3,340	3,271
Expected return on plan assets	(11,508)	(12,851)	(12,277)	(3,153)	(3,311)	(3,208)
Amortization of prior service cost	—	—	—	24	—	—
Amortization of net (gain) loss	—	—	—	(5)	49	(9)
Curtailed gain recognized	—	(576)	—	—	(340)	—
Settlement (gain) loss recognized	49	—	(48)	20	(11)	—
Net periodic expense (benefit)	<u>\$ (200)</u>	<u>\$ (2,809)</u>	<u>\$ (991)</u>	<u>\$ 3,558</u>	<u>\$ 3,293</u>	<u>\$ 3,740</u>

All components of net periodic benefit cost other than service cost are presented within other expense (income), net in the Company's consolidated statements of income.

The net amount of projected benefit obligation and plan assets for all underfunded and unfunded plans was \$77,801 and \$87,410 as of December 31, 2019 and 2018, respectively, and was classified as noncurrent liabilities. The total accumulated benefit obligation as of December 31, 2019 and 2018 for the Company's U.S. pension plans was \$266,992 and \$244,580, respectively. The total accumulated benefit obligation as of December 31, 2019 and 2018 for the Company's foreign pension plans was \$126,518 and \$107,910, respectively.

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The following table presents selected information about the Company's pension plans with accumulated benefit obligations in excess of plan assets:

	U.S.		Foreign	
	December 31,		December 31,	
	2019	2018	2019	2018
Projected benefit obligation	\$ 267,392	\$ 246,311	\$ 97,635	82,656
Accumulated benefit obligation	266,992	244,580	94,334	78,862
Fair value of plan assets	231,413	195,755	68,790	57,670

The following table presents selected information about the Company's pension plans with projected benefit obligations in excess of plan assets:

	U.S.		Foreign	
	December 31,		December 31,	
	2019	2018	2019	2018
Projected benefit obligation	\$ 267,392	\$ 246,311	\$ 116,165	82,656
Fair value of plan assets	231,413	195,755	85,994	57,670

Significant weighted average assumptions used in determining the pension obligations include the following:

	U.S.		Foreign	
	December 31,		December 31,	
	2019	2018	2019	2018
Discount rate	3.32%	4.32%	2.18%	3.01%
Rate of compensation increase ⁽¹⁾	3.00%	3.00%	2.35%	2.44%

Significant weighted average assumptions used in determining net periodic benefit cost include the following:

	U.S.			Foreign		
	Years ended December 31,			Years ended December 31,		
	2019	2018	2017	2019	2018	2017
Discount rate	4.32%	3.74%	4.24%	3.01%	2.91%	2.99%
Rate of compensation increase ⁽¹⁾	3.00%	3.00%	3.00%	2.44%	2.57%	2.97%
Expected return on assets	6.00%	6.00%	6.37%	3.44%	3.52%	3.58%

⁽¹⁾ Includes only plans not frozen to benefit accruals for the respective periods.

The discount rate for each of the U.S. plans was determined by utilizing a yield curve model. The model develops a spot rate curve based on the yields available from a broad-based universe of high quality corporate bonds. The discount rate is then set as the weighted average spot rate, using the respective plan's expected benefit cash flows as the weights.

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The investment objective for the U.S. plans is to generate returns sufficient to meet future obligations. The strategy to meet the objective includes generating attractive returns using higher returning assets such as equity securities and balancing risk using less volatile assets such as fixed income securities. The U.S. plans invest in an allocation of assets across the two broadly-defined financial asset categories of equity and fixed income securities. The target allocations for the plan assets across the three U.S. plans are as follows: 45% equity securities and 55% fixed income investments for the PQ Corporation Retirement Plan; 40% equity securities and 60% fixed income investments for the Eco Services Pension Equity Plan; and 60% equity securities and 40% fixed income investments for the Eco Services Hourly Pension Plan.

Similar considerations are applied to the investment objectives of the non-U.S. plans as well as the asset classes available in each location and any legal restrictions on plan investments.

The Company classifies plan assets based upon a fair value hierarchy (see Note 5 to these consolidated financial statements for further information). The classification of each asset within the hierarchy is based on the lowest level input that is significant to its measurement. The fair value hierarchy consists of three levels as follows:

- Level 1—Values are unadjusted quoted prices for identical assets and liabilities in active markets accessible at the measurement date. Active markets provide pricing data for trades occurring at least weekly and include exchanges and dealer markets. Level 1 assets primarily include investments in publicly traded equity securities and mutual funds. These securities (or the underlying investments of the funds) are actively traded and valued using quoted prices for identical securities from the market exchanges.
- Level 2—Inputs include quoted prices for similar assets or liabilities in active markets, quoted prices from those willing to trade in markets that are not active, or other inputs that are observable or can be corroborated by market data for the term of the instrument. Such inputs include market interest rates and volatilities, spreads and yield curves. Level 2 assets primarily consist of fixed-income securities and commingled funds that are not actively traded or whose underlying investments are valued using observable marketplace inputs. The fair value of plan assets invested in fixed-income securities is generally determined using valuation models that use observable inputs such as interest rates, bond yields, low-volume market quotes and quoted prices for similar assets. Plan assets that are invested in commingled funds are valued using a unit price or net asset value (“NAV”) that is based on the underlying investments of the fund.
- Level 3—Certain inputs are unobservable (supported by little or no market activity) and significant to the fair value measurement. Unobservable inputs reflect the Company’s best estimate of what hypothetical market participants would use to determine a transaction price for the asset or liability at the reporting date. Level 3 assets include investments covered by insurance contracts and real estate funds valued using significant unobservable inputs.

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The following tables set forth by level, within the fair value hierarchy, plan assets at fair value:

	December 31, 2019			
	Total	Level 1	Level 2	Level 3
Cash and cash equivalents	\$ 991	\$ 991	\$ —	\$ —
Equity securities:				
U.S. investment funds	67,374	67,374	—	—
International investment funds	65,136	44,905	20,231	—
Fixed income securities:				
Government securities	31,040	23,500	7,540	—
Corporate bonds	14,900	14,782	118	—
Investment fund bonds	116,121	1,170	114,951	—
Other:				
Insurance contracts	42,037	—	36,637	5,400
Total	\$ 337,599	\$ 152,722	\$ 179,477	\$ 5,400

	December 31, 2018			
	Total	Level 1	Level 2	Level 3
Cash and cash equivalents ⁽¹⁾	\$ 57,000	\$ 56,925	\$ 75	\$ —
Equity securities:				
U.S. investment funds	35,103	35,103	—	—
International investment funds	44,508	24,040	20,468	—
Fixed income securities:				
Government securities	10,121	—	10,121	—
Corporate bonds	77,229	72,216	5,013	—
Investment fund bonds	25,152	7,665	17,487	—
Other:				
Insurance contracts	38,429	—	33,408	5,021
Total	\$ 287,542	\$ 195,949	\$ 86,572	\$ 5,021

⁽¹⁾ Level 1 balance includes \$55,905 of cash and cash equivalents held by the Eco Services Pension Equity and Hourly Pension Plans. The investments in equity securities and fixed income securities previously held by these plans were liquidated into cash and cash equivalents in December 2018 in preparation for a transfer of plan assets to a new custodian. This transfer was completed in January 2019.

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The changes in the Level 3 pension plan assets are as follows for the years ended December 31:

	Insurance Contracts	
	2019	2018
Beginning balance	\$ 5,021	\$ 4,150
Actual return on plan assets	185	10
Benefits paid	(76)	(385)
Contributions	479	461
Exchange rate changes and other	(209)	785
Ending balance	<u>\$ 5,400</u>	<u>\$ 5,021</u>

The Company expects to contribute \$7,280 to the U.S. pension plans and \$3,837 to the foreign pension plans in 2020.

The following benefit payments, which reflect expected future service, as appropriate, are expected to be paid:

Year	U.S.	Foreign
2020	\$ 16,372	\$ 2,759
2021	17,327	2,908
2022	16,048	3,289
2023	15,963	3,544
2024	15,943	4,023
Years 2025-2029	77,891	24,028

Certain of the Company's foreign subsidiaries maintain other defined benefit plans that are consistent with statutory practices. These plans are not included in the disclosures above as they are not significant to the Company's consolidated financial statements.

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Supplemental Retirement Plans

The following tables summarize changes in the benefit obligation, plan assets and funded status of the Company's defined benefit supplementary retirement plans, as well as the components of net periodic benefit cost, including key assumptions:

	December 31,	
	2019	2018
Change in benefit obligation:		
Benefit obligation at beginning of period	\$ 11,868	\$ 12,781
Interest cost	465	450
Benefits paid	(1,045)	(1,070)
Actuarial (gains) losses	364	(293)
Benefit obligation at end of period	\$ 11,652	\$ 11,868
Change in plan assets:		
Fair value of plan assets at beginning of period	\$ —	\$ —
Employer contributions	1,045	1,070
Benefits paid	(1,045)	(1,070)
Fair value of plan assets at end of period	\$ —	\$ —
Funded status of the plans (underfunded)	\$ (11,652)	\$ (11,868)

The total actuarial losses for the year ended December 31, 2019 across the Company's supplemental retirement plans was \$364, which was driven by declines in the discount rates of \$971, which was offset by favorable changes in general demographic experience of \$281 and favorable changes in mortality assumptions of \$326.

Amounts recognized in the consolidated balance sheets consist of:

	December 31,	
	2019	2018
Current liability	\$ (1,019)	\$ (1,105)
Noncurrent liability	(10,633)	(10,763)
Accumulated other comprehensive income	253	795
Net amount recognized	\$ (11,399)	\$ (11,073)

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Amounts recognized in accumulated other comprehensive income consist of:

	December 31,	
	2019	2018
Net gain	\$ 681	\$ 1,055
Gross amount recognized	681	1,055
Deferred income taxes	(428)	(260)
Net amount recognized	\$ 253	\$ 795

Components of net periodic benefit cost consist of:

	Years ended December 31,		
	2019	2018	2017
Interest cost	\$ 465	\$ 450	\$ 489
Amortization of net (gain) loss	(10)	—	—
Net periodic expense	\$ 455	\$ 450	\$ 489

Interest cost is presented within other expense (income), net in the Company's consolidated statements of income.

The accumulated benefit obligation of the Company's defined benefit supplemental retirement plans as of December 31, 2019 and 2018 was \$11,652 and \$11,868, respectively. The discount rate used in determining the defined benefit supplemental retirement plan obligation was 3.10% and 4.20% as of December 31, 2019 and 2018, respectively. The discount rate used in determining net periodic benefit cost was 4.20%, 3.60% and 3.90% for the years ended December 31, 2019, 2018 and 2017, respectively. There was no rate of compensation increase for any of the periods presented, as all future accruals were frozen for the defined benefit supplementary retirement plans as of December 31, 2006. There was no rate of interest crediting rate, as there are no cash balance accounts associated with these plans.

The Company expects to contribute \$1,019 to the defined benefit supplementary retirement plans in 2020.

The following benefit payments, which reflect expected future service, as appropriate, are expected to be paid:

Year	Amount
2020	\$ 1,019
2021	996
2022	966
2023	933
2024	898
Years 2025-2029	3,966

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Other Postretirement Benefit Plans

The following tables summarize changes in the benefit obligation, plan assets and funded status of the Company's other postretirement benefit plans as well as the components of net periodic benefit cost, including key assumptions:

	December 31,	
	2019	2018
Change in benefit obligation:		
Benefit obligation at beginning of period	\$ 3,814	\$ 4,612
Service cost	10	16
Interest cost	152	150
Employee contributions	253	251
Plan amendments	(460)	(271)
Benefits paid	(751)	(1,061)
Medical subsidies received	—	74
Premiums paid	(7)	(66)
Actuarial (gains) losses	412	172
Translation adjustment	29	(63)
Benefit obligation at end of period	<u>\$ 3,452</u>	<u>\$ 3,814</u>
Change in plan assets:		
Fair value of plan assets at beginning of period	—	—
Employer contributions	505	802
Employee contributions	253	251
Benefits paid	(751)	(1,061)
Medical subsidies received	—	74
Premiums paid	(7)	(66)
Fair value of plan assets at end of period	<u>\$ —</u>	<u>\$ —</u>
Funded status of the plans (underfunded)	<u>\$ (3,452)</u>	<u>\$ (3,814)</u>

The total actuarial losses for the year ended December 31, 2019 across the Company's U.S. plans was \$412, which was driven by declines in the discount rates of \$334 and declines in general demographic experience of \$172, which was offset by favorable changes in mortality assumptions of \$94.

Amounts recognized in the consolidated balance sheets consist of:

	December 31,	
	2019	2018
Current liability	\$ (537)	\$ (581)
Noncurrent liability	(2,915)	(3,233)
Accumulated other comprehensive income	524	830
Net amount recognized	<u>\$ (2,928)</u>	<u>\$ (2,984)</u>

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Amounts recognized in accumulated other comprehensive income consist of:

	December 31,	
	2019	2018
Prior service credit	\$ 828	\$ 525
Net gain	67	500
Gross amount recognized	895	1,025
Deferred income taxes	(371)	(195)
Net amount recognized	<u>\$ 524</u>	<u>\$ 830</u>

Components of net periodic benefit cost consist of:

	Years ended December 31,		
	2019	2018	2017
Service cost	\$ 10	\$ 16	\$ 21
Interest cost	152	150	174
Amortization of prior service credit	(157)	(112)	(78)
Amortization of net gain	(33)	(26)	(45)
Net periodic expense (benefit)	<u>\$ (28)</u>	<u>\$ 28</u>	<u>\$ 72</u>

All components of net periodic benefit cost other than service cost are presented within other expense (income), net in the Company's consolidated statements of income.

The discount rate used in determining the other postretirement benefit plan obligation was 3.06% and 4.09% as of December 31, 2019 and 2018, respectively. The discount rate used in determining net periodic benefit cost was 4.09%, 3.53% and 3.74% for the years ended December 31, 2019, 2018 and 2017, respectively. There was no rate of interest crediting rate, as there are no cash balance accounts associated with these plans.

Assumed health care cost trend rates were as follows:

	December 31,	
	2019	2018
Immediate trend rate	5.91%	6.59%
Ultimate trend rate	4.39%	4.50%
Year that the rate reaches ultimate trend rate	2038	2035

The Company expects to contribute \$537 to the retiree health plans in 2020.

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The following benefit payments, which reflect expected future service, as appropriate, are expected to be paid:

Year	Amount
2020	\$ 537
2021	473
2022	343
2023	318
2024	185
Years 2025-2029	820

There are no expected Medicare subsidy receipts expected in future periods.

Certain of the Company's foreign subsidiaries maintain other postretirement benefit plans that are consistent with statutory practices. These plans are not included in the disclosures above as they are not significant to the Company's consolidated financial statements.

Defined Contribution Plans

The Company also has defined contribution plans covering domestic employees of the Company and certain subsidiaries. The Company recorded expenses of \$12,702, \$12,585 and \$13,103 related to these plans for the years ended December 31, 2019, 2018 and 2017, respectively.

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22. Stock-Based Compensation:

PQ Group Holdings Awards

In May 2016, the Company adopted an equity incentive plan, namely the PQ Group Holdings Inc. Stock Incentive Plan (“2016 Plan”). Under the terms of the 2016 Plan, the Company was authorized to issue a total of 8,017,038 shares for common stock awards to employees, directors and affiliates of the Company. Immediately preceding the IPO as of September 30, 2017, awards with respect to 7,644,518 shares of common stock had been issued under the 2016 Plan.

In connection with the IPO, the Company’s board of directors adopted the PQ Group Holdings Inc. 2017 Omnibus Incentive Plan (the “2017 Plan”). Subsequent to the IPO, all equity incentive awards have been granted under the 2017 Plan. The number of shares of common stock reserved for issuance under the 2017 Plan is 7,344,000 shares, which amount was increased by the 372,520 shares remaining available for grant under the 2016 Plan as of the 2017 Plan adoption. Shares that become available for issuance pursuant to the 2016 Plan as a result of forfeiture, cancellation or termination for no consideration will be available for future awards under the 2017 Plan. Shares underlying awards granted under the 2017 Plan that are forfeited, canceled, terminated for no consideration, settled in cash or are withheld for exercise, taxes, etc. will not be deemed as delivered and will also be available for future issuance under the 2017 Plan. At December 31, 2019, 3,980,449 shares of common stock were available for issuance under the 2017 Plan.

Stock Options

Under both the 2016 and 2017 Plans, the Company has issued options to purchase PQ Group Holdings Inc. common stock as part of its equity incentive compensation program. There are various vesting conditions associated with the awards issued under the 2016 Plan, including satisfaction of certain service and/or performance based conditions. Under the 2017 Plan, the Company’s stock option grants have been subject to graded vesting conditions based on service. The maximum contractual term of the Company’s stock options is ten years.

The following table summarizes the activity of common stock options for the period from December 31, 2016 through the year ended December 31, 2019:

	Number of Options	Weighted Average Exercise Price	Weighted Average Remaining Contractual Term (in years)	Aggregate Intrinsic Value (in thousands)
Outstanding at December 31, 2016	1,798,438	\$ 7.96		
Granted	1,051,496	\$ 13.70		
Exercised	(32,366)	\$ 8.04		
Forfeited	(102,398)	\$ 7.98		
Outstanding at December 31, 2017	2,715,170	\$ 10.18		
Granted	241,316	\$ 17.50		
Exercised	(15,332)	\$ 8.51		
Outstanding at December 31, 2018	2,941,154	\$ 10.79		
Exercised	(492,498)	\$ 8.07		
Forfeited	(74,299)	\$ 8.16		
Outstanding at December 31, 2019	2,374,357	\$ 11.44	6.77	\$ 13,355
Exercisable at December 31, 2019	1,533,650	\$ 11.84	7.02	\$ 7,993

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The aggregate intrinsic value per the above table represents the difference between the fair value the Company's common stock on the last trading day of the reporting period (determined in accordance with the plan terms) and the exercise price of in-the-money stock options multiplied by the respective number of stock options as of that date. The total intrinsic value of stock options exercised during the year ended December 31, 2019 and the resulting tax benefits recognized by the Company were \$3,615; the total intrinsic value of stock options exercised during the years ended December 31, 2018 and 2017 was not material for either year. Additionally, cash proceeds received by the Company from the exercise of stock options were \$3,975 during the year ended December 31, 2019 and were not material for the year ended December 31, 2018. The Company did not receive any cash proceeds from the exercise of stock options during the year ended December 31, 2017, as the Company withheld shares in satisfaction of the exercise price and taxes due.

The fair values of PQ Group Holdings common stock options granted during the years ended December 31, 2018 and 2017 were determined on the respective grant dates using a Black-Scholes option pricing model with the following weighted-average assumptions:

	2018	2017
Expected term (in years)	5.75	5.85
Expected volatility	26.38%	34.85%
Risk-free interest rate	2.86%	2.00%
Expected dividend yield	0.00%	0.00%
Weighted average grant date fair value of options granted	\$ 5.47	\$ 4.71

There were no stock option awards granted during the year ended December 31, 2019.

With respect to the stock option awards granted during the years ended December 31, 2018 and 2017, the Company used the simplified method for plain vanilla stock options to estimate the expected term assumption, since the Company lacked sufficient historical exercise data to provide a reasonable basis upon which to estimate the expected term due to the limited period of time its common stock has been publicly traded. The application of the simplified method involves calculating the average of the time-to-vesting period and the total contractual life of the options. The expected volatility assumption was compared to a range of the actual stock price volatility of a peer group of companies. The risk-free interest rate was based on U.S. Treasury rates in effect at the time of the grant commensurate with the expected term. There was no dividend yield assumption since the Company has not paid dividends nor does it have an expectation of future dividend payouts.

Restricted Stock Awards, Restricted Stock Units and Performance Stock Units

The Company has granted restricted stock awards subject to vesting conditions based on (1) service only, (2) performance only, or (3) a combination of service and performance conditions, dependent on which event occurs first. The vesting requirements for the majority of these awards were based upon the achievement of a performance condition. As defined in the award agreements, each award subject to the performance condition fully vests upon the occurrence of a defined liquidity event upon which certain investment funds affiliated with CCMP receive proceeds exceeding certain thresholds. Although achievement of the performance condition is subject to continued service with the Company, the terms of awards issued with performance conditions stipulate that the performance vesting condition can be attained for a period of six months following separation from service under certain circumstances, depending on the means of separation from the Company and subject to other factors such as individual separation agreements. The same performance vesting condition for the Company's restricted stock awards also governs the achievement of the performance vesting condition for the Company's stock options. With the exception of 14,498 and 21,067 of restricted stock awards granted on December 27, 2018 and October 2, 2017, respectively, both of which immediately vested and were valued using the average of the high and low trading prices of the Company's common stock on the NYSE on the preceding trading day, based on the Company's policy for valuing such awards, all of the Company's restricted stock awards were granted prior to the IPO. As a result, the Company valued the pre-IPO restricted stock awards at grant using multiples of EBITDA and the income approach, based on a discounted free cash flow model.

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In addition to restricted stock awards, the Company has granted restricted stock units and performance stock units as part of its equity incentive compensation program. Each restricted stock unit provides the recipient with the right to receive a share of common stock subject to graded vesting terms based on service, which generally requires one year of service for members of the Company's board of directors and three years of service for employees.

The Company also granted performance stock units during the year ended December 31, 2019, which provide the recipients with the right to receive shares of common stock dependent on the achievement of two Company-specific financial performance targets and the provision of service through the vesting date. Attainment of the metrics is measured based on the average levels of achievement across the three-year period from January 1, 2019 through December 31, 2021. Depending on the Company's performance against the pre-determined thresholds for achievement, each performance stock unit award holder is eligible to earn a percentage of the target number of shares granted to the holder, ranging from zero to 200%. The performance stock units, to the extent earned, will vest on the date the Company's compensation and governance committee certifies the achievement of the performance metrics for the three-year period ending December 31, 2021, which will occur no later than March 1, 2022.

The value of the restricted stock units granted by the Company is based on the average of the high and low trading prices of the Company's common stock on the NYSE on the preceding trading day, in accordance with the Company's policy for valuing such awards. Compensation expense related to the restricted stock units is recognized on a straight-line basis over the respective vesting period. The value of the performance stock units granted during the year ended December 31, 2019 was measured on the same basis as that of the restricted stock units, and based on the target number of shares granted; because the performance vesting conditions affect the ability of the recipients to vest in the awards, they are not factored into the fair value measure of the award. Compensation expense related to the performance stock units is recognized ratably over the requisite service period, and the Company must assess the probability that the performance conditions will be met each reporting period and the level at which they are estimated to be attained. Should the probability assessment change during a given reporting period, the total compensation cost (both recognized and unrecognized) will be adjusted to reflect the revised assessment.

The following table summarizes the activity of restricted stock awards, restricted stock units and performance stock units for the period from December 31, 2016 through the year ended December 31, 2019:

	Restricted Stock Awards		Restricted Stock Units		Performance Stock Units	
	Number of Shares	Weighted Average Grant Date Fair Value (per share)	Number of Units	Weighted Average Grant Date Fair Value (per share)	Number of Units	Weighted Average Grant Date Fair Value (per share)
Nonvested as of December 31, 2016	2,482,932	\$ 9.34	—	\$ —	—	\$ —
Granted	51,907	\$ 16.11	1,654,690	\$ 16.97	—	\$ —
Vested	(187,837)	\$ 12.84	—	\$ —	—	\$ —
Forfeited	(250,365)	\$ 12.03	—	\$ —	—	\$ —
Nonvested as of December 31, 2017	2,096,637	\$ 8.87	1,654,690	\$ 16.97	—	\$ —
Granted	14,498	\$ 13.80	161,598	\$ 16.12	—	\$ —
Vested	(223,298)	\$ 12.18	(797,859)	\$ 16.97	—	\$ —
Forfeited	(117,177)	\$ 8.04	(19,643)	\$ 16.97	—	\$ —
Nonvested as of December 31, 2018	1,770,660	\$ 8.39	998,786	\$ 16.83	—	\$ —
Granted	—	\$ —	1,245,628	\$ 15.42	550,676	\$ 15.41
Vested	(97,140)	\$ 12.32	(541,383)	\$ 16.68	—	\$ —
Forfeited	(127,390)	\$ 8.04	(74,595)	\$ 16.09	—	\$ —
Nonvested as of December 31, 2019	<u>1,546,130</u>	\$ 8.17	<u>1,628,436</u>	\$ 15.83	<u>550,676</u>	\$ 15.41

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The total fair value of restricted stock awards that vested during the years ended December 31, 2019, 2018 and 2017 was \$1,543, \$3,493 and \$2,608, respectively. The total fair value of restricted stock units that vested during the years ended December 31, 2019, 2018 and 2017 was \$8,493, \$13,628 and \$0, respectively. None of the Company's performance stock units vested during the years ended December 31, 2019, 2018 and 2017.

Equity Restructuring

The Company's equity restructuring which occurred prior the IPO (see Note 1 to these consolidated financial statements for further information) constituted an event subject to modification accounting for stock-based compensation awards. However, the change to the equity incentive awards of the Company was designed to preserve the fair value of the awards before and after the reclassification and stock split (based on the existing antidilution provisions of the 2016 Plan), and included the same terms and were classified in the same manner as the equity awards preceding the modification. As a result, no incremental compensation cost was recognized by the Company.

Total Stock-Based Compensation Expense

For the years ended December 31, 2019, 2018 and 2017, total stock-based compensation expense for the Company was \$18,225, \$19,464 and \$8,799, respectively. The income tax benefit recognized in the statements of income for the years ended December 31, 2019, 2018 and 2017 was \$3,943, \$4,809 and \$3,350.

As of December 31, 2019, there was \$813 of total unrecognized compensation cost related to nonvested stock options subject to service vesting conditions, with a weighted-average period over which these costs are expected to be recognized of 0.67 years. Unrecognized compensation cost related to nonvested restricted stock awards subject to service vesting conditions was not material. As of December 31, 2019, there was \$18,045 of total unrecognized compensation cost related to nonvested restricted stock units and \$6,186 of total unrecognized compensation cost related to nonvested performance stock units considered probable of vesting. The weighted-average period over which these costs are expected to be recognized at December 31, 2019 is 1.63 years for the restricted stock units and 2.16 years for the performance stock units. No expense has been recognized for any stock-based compensation awards subject to the performance condition for the years ended December 31, 2019, 2018 and 2017, as the performance-based criteria was not achieved nor considered probable of achievement.

Restricted stock awards and stock options issued with performance conditions vest based on the occurrence of a defined liquidity event upon which certain investment funds affiliated with CCMP receive proceeds exceeding certain thresholds. All of the Company's equity incentive awards with performance-based vesting, whether in the form of stock options or restricted stock awards, are subject to achievement of the same performance condition. If an exit event occurs that exceeds the defined threshold, then all performance-based awards of the Company vest 100%, with no potential for partial vesting or excess achievement. If an exit event or events occur with no further possibility of meeting the defined threshold, then all of the Company's awards subject to the performance vesting condition will be forfeited. In addition to the defined liquidity event, subsequent to the Company's IPO, the performance vesting condition can also be achieved if the average closing trading price of the Company's common stock on the NYSE over any consecutive ten-day trading period equals or exceeds a price that would be equivalent to the achievement of the threshold proceeds to CCMP. See Note 23 to these consolidated financial statements for further information on the number of awards outstanding subject to performance-based vesting.

23. Earnings per Share:

Basic earnings per share is calculated as income (loss) available to common stockholders, divided by the weighted average number of common shares outstanding during the period. The weighted average number of common shares outstanding during the period for the computation of basic earnings per share excludes restricted stock awards that have legally been issued but are nonvested during the period, as the sale of these shares is prohibited pending satisfaction of certain vesting conditions by the award recipients in order to earn the rights to the shares (see Note 22 to these consolidated financial statements for further information regarding outstanding nonvested restricted stock awards).

Diluted earnings per share is calculated as income (loss) available to common stockholders, divided by the weighted average number of common and potential common shares outstanding during the period, if dilutive. Potential common shares reflect (1) unvested restricted stock awards and restricted stock units with service vesting conditions, (2) performance stock units with vesting conditions considered probable of achievement and (3) options to purchase common stock, all of which have been included in the diluted earnings per share calculation using the treasury stock method.

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The reconciliation from basic to diluted weighted average shares outstanding is as follows:

	Years ended December 31,		
	2019	2018	2017
Weighted average shares outstanding – Basic	134,389,667	133,380,567	111,299,670
Dilutive effect of invested common shares and restricted stock units with service conditions, performance stock units considered probable of vesting and assumed stock option exercises and conversions	1,159,027	1,304,364	369,367
Weighted average shares outstanding – Diluted	<u>135,548,694</u>	<u>134,684,931</u>	<u>111,669,037</u>

Basic and diluted earnings per share are calculated as follows:

	Years ended December 31,		
	2019	2018	2017
Numerator:			
Net income attributable to PQ Group Holdings Inc.	\$ 79,539	\$ 58,300	\$ 57,603
Denominator:			
Weighted average shares outstanding – Basic	134,389,667	133,380,567	111,299,670
Weighted average shares outstanding – Diluted	135,548,694	134,684,931	111,669,037
Net income per share:			
Basic income per share:	<u>\$ 0.59</u>	<u>\$ 0.44</u>	<u>\$ 0.52</u>
Diluted income per share:	<u>\$ 0.59</u>	<u>\$ 0.43</u>	<u>\$ 0.52</u>

The table below presents the details of the Company's weighted average equity-based awards outstanding during each respective year that were excluded from the calculation of diluted earnings per share:

	Years ended December 31,		
	2019	2018	2017
Restricted stock awards with performance only targets not yet achieved	1,584,980	1,643,760	1,769,447
Stock options with performance only targets not yet achieved	558,283	586,253	586,523
Anti-dilutive restricted stock awards, restricted stock units and performance stock units	—	5,162	—
Anti-dilutive stock options	863,063	717,612	155,011

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Restricted stock awards and stock options with performance only vesting conditions are not included in the dilution calculation, as the performance targets have not been achieved nor were probable of achievement as of the end of the respective periods. Options to purchase 621,747 shares of common stock at \$16.97 per share that were outstanding during the years ended December 31, 2019 and 2018, and for part of the year ended December 31, 2017, were excluded from the computation of diluted earnings per share for the respective periods, because the combination of the options' exercise price and remaining unamortized stock-based compensation expense was greater than the average market price of the common shares. Options to purchase 241,316 shares of common stock at \$17.50 per share that were outstanding during the year ended December 31, 2019 and for part of the year ended December 31, 2018, were also considered anti-dilutive and excluded from the computation of diluted earnings per share. The 621,747 stock options expire on October 2, 2027, while the 241,316 stock options expire on August 9, 2028. All of the options were outstanding as of December 31, 2019. Anti-dilutive awards are not included in the dilution calculation, as their inclusion would have the effect of increasing diluted income per share.

24. Commitments and Contingent Liabilities:

Environmental Contingencies

There is a risk of environmental impact in chemical manufacturing operations. The Company's environmental policies and practices are designed to comply with existing laws and regulations and to minimize the possibility of significant environmental impact. The Company is also subject to various other lawsuits and claims with respect to matters such as governmental regulations, labor and other actions arising out of the normal course of business. While management believes that the liabilities resulting from such lawsuits and claims are not probable or reasonably estimable, certain accruals have been reflected in the Company's consolidated financial statements, some of which are described in detail within this note.

In 2008, the Company sold property located in Tacoma, Washington to the local port authority. In 2009, the port authority commissioned an environmental investigation of portions of the property. In 2010, the port authority advised the Company of alleged soil and groundwater contamination on the property and alleged the Company liable for certain conditions. The Company received and reviewed the environmental investigation documentation and determined it may have liability with respect to some, but not all, of the alleged contamination. At this time, remedial plans are in the feasibility study stage and have not been agreed upon or presented to Washington State for consideration. As of December 31, 2019 and 2018, the Company has recorded reserves of \$1,045 and \$740, respectively, for costs related to this potential liability.

The Company has recorded a reserve of \$770 and \$873 as of December 31, 2019 and 2018, respectively, to address remaining subsurface remedial and wetlands/marsh management activities at the Company's Martinez, CA site. Although currently a sulfuric acid regeneration plant, the site originally was operated by Mountain Copper Company ("Mococo") as a copper smelter. Also, the site sold iron pyrite to various customers and allowed their customers to deposit waste iron pyrite cinder and slag on the site. The property is adjacent to Peyton Slough, where Mococo had a permitted discharge point from its process. In 1997, the San Francisco Bay Regional Water Quality Control Board ("RWQCB") required characterization and remediation of Peyton Slough for Copper, Zinc and Acidic Soils. Various remediation activities were undertaken and completed, and the site has received final concurrence from the Army Corps with respect to the completed work. The RWQCB has agreed that Eco Services has achieved the goals for vegetative cover. The current marsh condition is being sustained by the opening and subsequent closing of the tide gates on a once per year basis. The Company is continuing to indicate to the RWQCB a plan to involve Contra Costa County and work towards development of an alliance for operating, maintaining and funding the tide gates is appropriate. The Company is currently in the process of obtaining permits for the long-term maintenance of Peyton Slough.

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As of December 31, 2019 and 2018, the Company has recorded a reserve of \$709 and \$984, respectively, for subsurface remediation and the Soil Vapor Extraction Project at the Company's Dominguez, CA site. In the 1980s and 1990s, the EPA and the Los Angeles Regional Water Quality Control Board conducted investigations of the site due to historic chlorinated pesticide and chlorinated solvent use. Soil and groundwater beneath the site were impacted by chlorinated solvents and associated breakdown products, petroleum hydrocarbons, chlorinated pesticides and metals. A Corrective Measures Plan approved in October 2011 requires (1) soil vapor extraction ("SVE") in affected areas, (2) covering of unpaved areas containing pesticide impacted soil, and (3) annual groundwater monitoring of the perched water-bearing zone. Annual groundwater sampling and soil vapor monitoring indicates that the SVE system has been effective in reducing subsurface contaminant levels. The Company is moving in the direction of rendering the SVE system dormant and potentially closing this matter within the next few years following rebound testing, including the preparation of an updated long-term Operations and Maintenance Plan as requested by the California Department of Toxic Substances Control.

Purchase Commitments

The Company has entered into short and long-term purchase commitments for various key raw materials and energy requirements. The purchase obligations include agreements with various suppliers to purchase goods that are enforceable and legally binding, and that specify all significant terms. Purchases under these agreements are expected to be as follows:

Year	Amount
2020	\$ 17,649
2021	2,116
2022	1,396
2023	1,245
2024	1,197
Thereafter	2,187
	<u>\$ 25,790</u>

Letters of Credit

At December 31, 2019, the Company had outstanding letters of credit of \$20,506. Letters of credit are guarantees of payment to third parties. The Company's letters of credit are used primarily as collateral for various items, including environmental, energy and insurance payments. The letters of credit are supported by the Company's ABL facility.

25. Restructuring and Other Related Costs:

The following table presents the components of restructuring and other related costs for the years ended December 31, 2019, 2018 and 2017 included in other operating expense, net, in the accompanying consolidated statements of income:

	Years ended December 31,		
	2019	2018	2017
Severance and other employee costs related to Eco Services restructuring plan	\$ —	\$ —	\$ 830
Severance and other employee costs related to Performance Materials plant closure	—	885	4,711
Other related costs	2,692	5,323	2,949
	<u>\$ 2,692</u>	<u>\$ 6,208</u>	<u>\$ 8,490</u>

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Eco Services Restructuring Plan

On July 30, 2014, Eco Services, a newly formed Delaware limited liability company and indirect subsidiary of certain investment funds affiliated with CCMP, entered into an Asset Purchase Agreement with Solvay USA, Inc. (“Solvay”), a Delaware corporation, which provided for the sale, transfer and assignment by Solvay and the acquisition, acceptance and assumption by Eco Services, of substantially all of the assets of Solvay’s Eco Services business unit of Solvay’s regeneration and virgin sulfuric acid production business operations in the United States (the “2014 Acquisition”). Prior to the Asset Purchase Agreement with Solvay, Eco Services operated as a business unit within Solvay, which is an indirect, wholly owned subsidiary of Solvay SA.

Subsequent to the 2014 Acquisition, the Company initiated a restructuring plan designed to improve organizational efficiency and streamline the operations of Eco Services as a stand-alone company. The primary impact of the plan to the Company’s consolidated results of operations was the recognition of severance costs related to a reduction-in-force. These costs included benefits payable under ongoing Company severance plan arrangements, whereby payments are attributable to employee services rendered with benefits that accumulate over time. The liabilities and associated charges related to these severance costs are recognized by the Company when payment of the benefits becomes probable and estimable. The restructuring plan was substantially complete in early 2017.

Costs related to the restructuring plan affected employees in the Company’s Refining Services segment, although these costs are excluded from the segment’s measure of profitability of Adjusted EBITDA (see Note 14 to these consolidated financial statements for further information).

Performance Materials Plant Closure

In September 2017, the Company approved and announced a plan to consolidate its manufacturing operations in Europe for the Performance Materials segment and close its facility in Kirchheimbolanden, Germany, and subsequently reduced production. The plan was part of the Company’s overall strategy with respect to the Acquisition (see Note 7 to these consolidated financial statements) and the realization of cost and other synergies in connection with the transaction.

As a result of a change in the market and increased customer demand for the products produced at this facility, the Company intends to keep the facility open and expanded production at this facility during the third quarter of 2018 from the previously reduced levels. However, the Company continued to pay its obligations to the individuals originally separated from service as part of the reorganization, with additional payments anticipated through 2020, primarily for individuals who extended their separation dates as a result of the decision to continue operations at the facility. Costs related to the restructuring plan affected employees in the Company’s Performance Materials segment, although these costs are excluded from the segment’s measure of profitability of Adjusted EBITDA (see Note 14 to these consolidated financial statements for further information). The Company considers the restructuring plan related to the original decision to close the facility substantially complete, with no additional restructuring charges anticipated as of December 31, 2019.

Other Related Costs

The Company incurred severance and other costs of \$2,692, \$5,323 and \$2,949 for the years ended December 31, 2019, 2018 and 2017, respectively. These costs were not associated with formal restructuring plans and primarily related to severance charges for certain executives and employees, transition/duplicate staffing, professional fees and other expenses related to the Company’s organizational changes.

26. Long-term Supply Contract:

As part of Solvay’s 2004 sale of its Specialty Phosphates business, Solvay agreed to continue to supply sulfuric acid to a customer in support of the phosphoric acid production for its specialty phosphates business under a preexisting supply agreement. This non-cancelable agreement extends to 2031, and was assumed by the Company in connection with the 2014 Acquisition.

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The liability associated with this unfavorable supply agreement was recorded at a fair value of \$27,300 in connection with the 2014 Acquisition. The fair value was determined using the income method based on the differential of the estimated margin over the cost of the sulfuric acid per the market as compared to the below market margin included in the supply agreement, and the application of this excess differential to the anticipated volumes over the term of the agreement using a commensurate discount rate. In December 2018, the customer to the supply agreement ceased production and closed the facility which utilized the Company's sulfuric acid under the agreement. As such, all orders for sulfuric acid under the agreement were discontinued in December 2018. Although the agreement is not cancelable, the likelihood is remote that the Company will be further obligated to supply the customer under the agreement since this is the only facility subject to the agreement, and there are no transfer or substitution rights under the agreement to another facility. As a result, the Company wrote-off the remaining supply contract liability of \$20,612 at December 31, 2018 and recorded a corresponding gain to other operating expense, net for the year ended December 31, 2018.

27. Related Party Transactions:

The Company maintains certain policies and procedures for the review, approval and ratification of related party transactions to ensure that all transactions with selected parties are fair, reasonable and in the Company's best interests. All significant relationships and transactions are separately identified by management if they meet the definition of a related party or a related party transaction. Related party transactions include transactions that occurred during the year, or are currently proposed, in which the Company was or will be a participant, and for which any related person had or will have a direct or indirect material interest. All related party transactions are reviewed, approved and documented by the appropriate level of the Company's management in accordance with these policies and procedures.

On December 29, 2014, PQ Holdings, CCMP and PQ Corporation entered into a consulting agreement relating to the provision of certain financial and strategic advisory services and consulting services. At the same time, the existing consulting agreement between PQ Holdings, INEOS Capital Partners and PQ Corporation was amended and restated. Under these consulting agreements, the Company paid an annual management fee of \$5,000 distributed to CCMP and INEOS AG equal to the Pro Rata Percentage, as defined, between CCMP and INEOS AG. These consulting agreements were terminated upon completion of the Company's IPO on October 3, 2017. The Company recorded \$3,777 of management advisory fees in other operating expense, net in the consolidated statements of income for the year ended December 31, 2017.

Transactions with Board of Directors

In connection with the offering by PQ Corporation of the Senior Unsecured Notes issued in May 2016 (see Note 17 to these consolidated financial statements for further information), a member of the Company's board of directors purchased \$4,000 in principal amount of such notes. The director received interest payments in respect of the notes totaling \$362 during the year ended December 31, 2017. The notes were partially redeemed in October 2017 in connection with the Company's IPO, and redeemed in full in December 2017 in connection with the Company's issuance and sale of the 5.75% Senior Unsecured Notes due 2025 (see Note 17). The director received \$4,000 of principal amount of such notes as well as \$338 related to the prepayment penalties in connection with these two transactions.

Joint Venture Agreement

The Company entered into a joint venture agreement (the "ZI Partnership Agreement") in 1988 with CRI Zeolites Inc., a Royal Dutch Shell plc affiliate, to form Zeolyst International, a 50/50 joint venture partnership (the "Partnership"). Under the terms of the ZI Partnership Agreement, the Partnership leases certain land used in its Kansas City production facilities from PQ Corporation. This lease, which has been recorded as an operating lease, provided for rental payments to the Company of \$305, \$295 and \$295 during the years ended December 31, 2019, 2018 and 2017, respectively. The terms of this lease are evergreen as long as the ZI Partnership Agreement is in place. The Partnership recognized sales to the Company of \$803, \$645 and \$2,475 during the years ended December 31, 2019, 2018 and 2017, respectively.

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The Partnership purchases certain of its raw materials from the Company and is charged for various manufacturing costs incurred at the Company's Kansas City production facility. The amount of these costs charged to the Partnership were \$19,976, \$16,869 and \$17,470 for the years ended December 31, 2019, 2018 and 2017, respectively. Certain administrative, marketing, engineering, management-related, and research and development services are provided to the Partnership by the Company. During the years ended December 31, 2019, 2018 and 2017, the Partnership was charged \$12,871, \$12,727 and \$12,248, respectively, for these services. In addition, the Partnership was charged certain product demonstration costs of \$2,204, \$1,768 and \$2,175 during the years ended December 31, 2019, 2018 and 2017, respectively. These charges to the Partnership are recorded as reductions in either cost of goods sold or selling, general and administrative expenses in the consolidated statements of income, depending on the nature of the expenditures.

Other

From time to time, the Company makes sales to and purchases raw materials from portfolio companies of funds that are affiliated with CCMP and companies that are affiliated with INEOS Capital Partners. The Company had sales of \$4,841, \$5,587 and \$8,396 to companies affiliated with INEOS Capital Partners during the years ended December 31, 2019, 2018, and 2017 respectively. The Company purchased raw materials of \$1,203, \$1,495 and \$1,096 to companies affiliated with INEOS Capital Partners during the years ended December 31, 2019, 2018, and 2017 respectively.

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28. Quarterly Financial Summary (Unaudited):

The following tables summarize the Company's quarterly financial results during the years ended December 31, 2019 and 2018:

	2019			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Sales	\$ 359,221	\$ 431,675	\$ 423,801	\$ 352,375
Gross profit	80,910	115,495	112,897	81,220
Operating income	29,463	70,301	57,574	30,464
Net income	3,441	30,719	26,819	19,331
Net income attributable to PQ Group Holdings Inc.	3,151	30,574	26,713	19,101
Net income per share:				
Basic income per share	\$ 0.02	\$ 0.23	\$ 0.20	\$ 0.14
Diluted income per share	\$ 0.02	\$ 0.23	\$ 0.20	\$ 0.14
Weighted average shares outstanding:				
Basic	133,946,308	134,142,552	134,511,819	134,912,212
Diluted	134,894,354	135,323,024	135,649,710	136,151,739

	2018			
	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
Sales	\$ 366,197	\$ 434,713	\$ 427,203	\$ 380,041
Gross profit	78,121	108,404	107,500	87,609
Operating income	28,189	49,054	48,854	57,459
Net income	556	16,159	14,436	28,470
Net income attributable to PQ Group Holdings Inc.	214	15,782	14,185	28,119
Net income per share:				
Basic income per share	\$ —	\$ 0.12	\$ 0.11	\$ 0.21
Diluted income per share	\$ —	\$ 0.12	\$ 0.11	\$ 0.21
Weighted average shares outstanding:				
Basic	133,154,144	133,222,463	133,336,352	133,765,294
Diluted	133,884,983	134,209,740	134,576,162	134,987,604

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29. Supplemental Cash Flow Information:

The following table presents supplemental cash flow information for the Company:

	Years ended December 31,		
	2019	2018	2017
Cash paid during the year for:			
Income taxes, net of refunds	\$ 17,406	\$ 23,842	\$ 29,199
Interest ⁽¹⁾	116,892	105,057	170,131
Non-cash investing activity ⁽²⁾ :			
Capital expenditures acquired on account but unpaid as of the year end	22,562	23,498	18,762
Non-cash financing activities:			
Debt assumed in the Acquisition (Note 7)	—	—	16,609

⁽¹⁾ Cash paid for interest is shown net of capitalized interest for the periods presented and excludes \$8,480 and \$4,859 of net interest proceeds on swaps designated as net investment hedges for the years ended December 31, 2019 and 2018, respectively, which are included within cash flows from investing activities in the Company's consolidated statements of cash flows.

⁽²⁾ For the supplemental non-cash information on lease liabilities arising from obtaining right-of-use lease assets, see Note 13 to these consolidated financial statements for additional details.

The following table provides a reconciliation of cash, cash equivalents and restricted cash reported within the consolidated balance sheets as of December 31, 2019, 2018 and 2017 to the total of the same amounts shown in the consolidated statements of cash flows for the years then ended:

	December 31,		
	2019	2018	2017
Cash and cash equivalents	\$ 72,284	\$ 57,854	\$ 66,195
Restricted cash included in prepaid and other current assets	1,633	1,872	1,048
Total cash, cash equivalents and restricted cash shown in the consolidated statements of cash flows	<u>\$ 73,917</u>	<u>\$ 59,726</u>	<u>\$ 67,243</u>

30. Subsequent Events:

In February 2020, the Company re-priced its Term Loan Facility to reduce the applicable interest rate and extend the maturity of the facility to February 2027. The terms of the facility were substantially consistent following the re-pricing, except that borrowings under the term loan will bear interest at a rate equal to a floating rate of LIBOR plus 2.25% per annum.

Also in February 2020, the Company entered into a long-term agreement with a leading global thermoplastic producer to supply glass beads, and to meet that supply, exchanged the Company's ThermoDrop® product line for their glass bead production facilities in the U.S.

Other than the items described above, the Company has evaluated subsequent events since the balance sheet date and determined that there are no additional items to disclose.

SCHEDULE I
PQ GROUP HOLDINGS INC. AND SUBSIDIARIES (PARENT)
CONDENSED FINANCIAL INFORMATION
CONDENSED STATEMENTS OF INCOME
(in thousands)

	Years ended December 31,		
	2019	2018	2017
Stock compensation expense	\$ 18,225	\$ 19,464	\$ 8,799
Equity in net income from subsidiaries	(97,764)	(77,764)	(66,402)
Net income	79,539	58,300	57,603
Other comprehensive income (loss), net of tax:			
Pension and postretirement benefits	2,430	(7,958)	(101)
Net loss from hedging activities	(2,665)	(330)	(3,590)
Foreign currency translation	22,117	(35,127)	61,713
Total other comprehensive income (loss)	21,882	(43,415)	58,022
Comprehensive income	\$ 101,421	\$ 14,885	\$ 115,625

See accompanying notes to condensed financial statements.

SCHEDULE I
PQ GROUP HOLDINGS INC. AND SUBSIDIARIES (PARENT)
CONDENSED FINANCIAL INFORMATION
CONDENSED BALANCE SHEETS
(in thousands, except share and per share amounts)

	December 31, 2019	December 31, 2018
ASSETS		
Investment in subsidiaries	\$ 1,779,450	\$ 1,659,560
Total assets	<u>\$ 1,779,450</u>	<u>\$ 1,659,560</u>
LIABILITIES		
Total liabilities	<u>\$ —</u>	<u>\$ —</u>
STOCKHOLDERS' EQUITY		
Common stock (\$0.01 par); authorized shares 450,000,000; issued shares 136,861,382 and 135,758,269 on December 31, 2019 and 2018, respectively; outstanding shares 136,464,961 and 135,592,045 on December 31, 2019 and 2018, respectively	1,369	1,358
Preferred stock (\$0.01 par); authorized shares 50,000,000; no shares issued or outstanding on December 31, 2019 and 2018, respectively	—	—
Additional paid-in capital	1,696,899	1,674,703
Retained earnings	103,013	25,523
Treasury stock, at cost; shares 396,421 and 166,224 on December 31, 2019 and 2018, respectively	(6,483)	(2,920)
Accumulated other comprehensive loss	(15,348)	(39,104)
Total PQ Group Holdings Inc. equity	<u>1,779,450</u>	<u>1,659,560</u>
Total liabilities and equity	<u>\$ 1,779,450</u>	<u>\$ 1,659,560</u>

See accompanying notes to condensed financial statements.

SCHEDULE I
PQ GROUP HOLDINGS INC. AND SUBSIDIARIES (PARENT)
CONDENSED FINANCIAL INFORMATION
CONDENSED STATEMENTS OF CASH FLOWS
(in thousands)

	Years ended December 31,		
	2019	2018	2017
Cash flows from operating activities:			
Net income	\$ 79,539	\$ 58,300	\$ 57,603
Adjustments to reconcile net income to net cash provided by operating activities:			
Equity in net income from subsidiaries	(97,764)	(77,764)	(66,402)
Stock compensation expense	18,225	19,464	8,799
Net cash (used in) provided by operating activities	—	—	—
Cash flows from investing activities:			
Investment in subsidiaries	—	—	(480,696)
Net cash (used in) provided by investing activities	—	—	(480,696)
Cash flows from financing activities:			
IPO proceeds	—	—	507,500
IPO costs	—	—	(26,804)
Net cash (used in) provided by financing activities	—	—	480,696
Effect of exchange rate changes on cash, cash equivalents and restricted cash	—	—	—
Net change in cash, cash equivalents and restricted cash	—	—	—
Cash, cash equivalents and restricted cash at beginning of period	—	—	—
Cash, cash equivalents and restricted cash at end of period	\$ —	\$ —	\$ —

See accompanying notes to condensed financial statements.

SCHEDULE I
PQ GROUP HOLDINGS INC. AND SUBSIDIARIES (PARENT)
CONDENSED FINANCIAL INFORMATION
NOTES TO CONDENSED SCHEDULE I

1. Description of PQ Group Holdings Inc. and Subsidiaries

PQ Group Holdings Inc. (“PQ Group Holdings” or the “Parent Company”) is a holding company that conducts substantially all of its business operations through its wholly owned subsidiary, PQ Corporation. As specified in certain of PQ Corporation’s debt agreements entered into concurrently with a series of transactions to reorganize and combine the businesses of PQ Holdings Inc. and Eco Services Operations LLC in May 2016 (the “Business Combination”), as subsequently amended and restated, there are restrictions on the ability of PQ Corporation to make payments to its stockholder, PQ Group Holdings, on behalf of its equity interests (refer to Note 17 to the PQ Group Holdings consolidated financial statements for further information regarding PQ Corporation debt).

2. Basis of Presentation

The accompanying condensed Parent Company financial statements are required in accordance with Rule 4-08(e)(3) of Regulation S-X. These condensed financial statements have been presented on a “parent-only” basis. Under a parent-only presentation, the Parent Company’s investment in its consolidated subsidiary is presented under the equity method of accounting. Under the equity method, the investment in subsidiary is stated at cost plus contributions and equity in undistributed income (loss) of the subsidiary, less distributions received since the date of acquisition. For purposes of presenting net income, this presentation assumes that the Parent Company was in existence for the full year ended December 31, 2016, the year of the Business Combination. These parent-only financial statements should be read in conjunction with PQ Group Holdings’ audited consolidated financial statements.

3. Stock-Based Compensation

Refer to Note 22 of the notes to the PQ Group Holdings consolidated financial statements for a description of stock-based compensation.

4. Common Stock

Refer to Note 23 of the notes to the PQ Group Holdings consolidated financial statements for a description of common stock.

Report of Independent Auditors

To the Management Committee of Zeolyst International:

We have audited the accompanying financial statements of Zeolyst International (the “Partnership”), which comprise the balance sheets as of December 31, 2019 and 2018, and the related statements of operations and accumulated earnings, changes in partners’ capital, and cash flows for the three years in the period ended December 31, 2019.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of the financial statements in accordance with accounting principles generally accepted in the United States of America; this includes the design, implementation, and maintenance of internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error.

Auditors' Responsibility

Our responsibility is to express an opinion on the financial statements based on our audits. We conducted our audits in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on our judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, we consider internal control relevant to the Partnership’s preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Partnership’s internal control. Accordingly, we express no such opinion. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of significant accounting estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of Zeolyst International as of December 31, 2019 and 2018, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2019 in accordance with accounting principles generally accepted in the United States of America.

Emphasis of Matter

As discussed within Footnote 15 to the financial statements, the Partnership has significant related party transactions. Our opinion is not modified with respect to this matter.

/s/ PricewaterhouseCoopers LLP
Philadelphia, Pennsylvania
February 27, 2020

ZEOLYST INTERNATIONAL
BALANCE SHEETS
(in thousands)

	December 31, 2019	December 31, 2018
ASSETS		
Cash	\$ 10,522	\$ 39,629
Trade receivables, net:		
Receivables from third parties	29,525	26,994
Receivables from affiliates	50,373	27,267
Non-trade receivables from affiliates	—	1,895
Inventories	127,864	92,889
Other current assets	573	749
Total current assets	218,857	189,423
Property, plant and equipment, net	144,615	133,810
Intangible assets	8,100	9,150
Right-of-use lease asset	6,077	—
Other long-term assets	694	906
Total assets	<u>\$ 378,343</u>	<u>\$ 333,289</u>
LIABILITIES		
Revolver	\$ 15,000	\$ —
Trade accounts payable	13,231	11,939
Accounts payable to affiliates	12,519	11,921
Other current liabilities	3,885	6,051
Total current liabilities	44,635	29,911
Operating lease liability—noncurrent	5,968	—
Total liabilities	50,603	29,911
Commitments and contingencies (Note 14)		
PARTNERS' CAPITAL		
Contributed capital	54,930	54,930
Accumulated earnings	272,810	248,448
Net partners' capital	327,740	303,378
Total liabilities and partners' capital	<u>\$ 378,343</u>	<u>\$ 333,289</u>

See accompanying notes to financial statements.

ZEOLYST INTERNATIONAL
STATEMENTS OF OPERATIONS AND ACCUMULATED EARNINGS
(in thousands)

	Years ended December 31,		
	2019	2018	2017
Sales	\$ 161,725	\$ 209,083	\$ 178,751
Related party sales	178,950	104,291	108,798
Total sales	340,675	313,374	287,549
Cost of goods sold	84,566	88,551	75,597
Related party cost of goods sold	112,441	99,653	80,992
Total cost of goods sold	197,007	188,204	156,589
Gross profit	143,668	125,170	130,960
Selling, general and administrative expenses (SG&A)	3,857	1,476	5,777
Related party SG&A	37,085	35,635	31,744
Operating income	102,726	88,059	93,439
Interest expense, net	76	100	105
Other (income) expense, net	(1,712)	2,251	830
Net income	104,362	85,708	92,504
Accumulated earnings at beginning of year	248,448	242,740	238,236
Dividends paid	(80,000)	(80,000)	(88,000)
Accumulated earnings at end of year	<u>\$ 272,810</u>	<u>\$ 248,448</u>	<u>\$ 242,740</u>

See accompanying notes to financial statements.

ZEOLYST INTERNATIONAL
STATEMENTS OF CHANGES IN PARTNERS' CAPITAL
(in thousands)

	Contributed capital	Accumulated earnings	Net partners' capital
<u>PQ Corporation:</u>			
Balance, December 31, 2016	\$ 27,465	\$ 119,118	\$ 146,583
Dividends paid		(44,000)	(44,000)
Net income		46,252	46,252
Balance, December 31, 2017	\$ 27,465	\$ 121,370	\$ 148,835
Dividends paid		(40,000)	(40,000)
Net income		42,854	42,854
Balance, December 31, 2018	\$ 27,465	\$ 124,224	\$ 151,689
Dividends paid		(40,000)	(40,000)
Net income		52,181	52,181
Balance, December 31, 2019	\$ 27,465	\$ 136,405	\$ 163,870
<u>CRI Zeolites Inc.:</u>			
Balance, December 31, 2016	\$ 27,465	\$ 119,118	\$ 146,583
Dividends paid		(44,000)	(44,000)
Net income		46,252	46,252
Balance, December 31, 2017	\$ 27,465	\$ 121,370	\$ 148,835
Dividends paid		(40,000)	(40,000)
Net income		42,854	42,854
Balance, December 31, 2018	\$ 27,465	\$ 124,224	\$ 151,689
Dividends paid		(40,000)	(40,000)
Net income		52,181	52,181
Balance, December 31, 2019	\$ 27,465	\$ 136,405	\$ 163,870
Total partners' capital at December 31, 2016	\$ 54,930	\$ 238,236	\$ 293,166
Total partners' capital at December 31, 2017	\$ 54,930	\$ 242,740	\$ 297,670
Total partners' capital at December 31, 2018	\$ 54,930	\$ 248,448	\$ 303,378
Total partners' capital at December 31, 2019	\$ 54,930	\$ 272,810	\$ 327,740

See accompanying notes to financial statements.

ZEOLYST INTERNATIONAL
STATEMENTS OF CASH FLOWS
(in thousands)

	Years ended December 31,		
	2019	2018	2017
Cash flows from operating activities:			
Net income	\$ 104,362	\$ 85,708	\$ 92,504
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation and amortization	17,845	15,954	14,260
Loss on sale or disposal of capital assets	47	101	178
Impairment of cost investment	—	—	3,000
Gain on sale of investment	(3,062)	—	—
Net change in returns allowance	856	(205)	88
Net change in inventory reserve	—	—	867
Working capital changes that provided (used) cash:			
Receivables, including affiliates	(24,598)	15,663	14,275
Inventories	(34,975)	5,549	(1,119)
Other current assets	175	(459)	1,038
Accounts payable, including affiliates	(4,616)	(718)	(7,377)
Other current liabilities	(2,275)	1,178	(3,795)
Other long-term assets	—	6	(230)
Net cash provided by operating activities	<u>53,759</u>	<u>122,777</u>	<u>113,689</u>
Cash flows from investing activities:			
Purchases of property, plant and equipment	(20,928)	(12,452)	(9,465)
Purchase of license	—	(4,000)	(6,500)
Proceeds from sale of investment	3,062	—	—
Net cash used in investing activities	<u>(17,866)</u>	<u>(16,452)</u>	<u>(15,965)</u>
Cash flows from financing activities:			
Proceeds from line of credit	25,000	7,000	5,000
Payments on line of credit	(10,000)	(7,000)	(5,000)
Payments of cash dividends	(80,000)	(80,000)	(88,000)
Net cash used in financing activities	<u>(65,000)</u>	<u>(80,000)</u>	<u>(88,000)</u>
Net change in cash	(29,107)	26,325	9,724
Cash at beginning of period	39,629	13,304	3,580
Cash at end of period	<u>\$ 10,522</u>	<u>\$ 39,629</u>	<u>\$ 13,304</u>
Non-cash investing activity:			
Capital expenditures acquired on account but unpaid	<u>\$ 6,506</u>	<u>\$ 5,461</u>	<u>\$ 3,904</u>

See accompanying notes to financial statements.

ZEOLYST INTERNATIONAL
NOTES TO FINANCIAL STATEMENTS
(in thousands)

1. Organization:

Zeolyst International, a General Partnership (“Partnership”) was formed in 1988 pursuant to a Joint Venture Agreement (“the Agreement”) between PQ Corporation (“PQ”) and CRI Zeolites Inc. (“CRI”), a Royal Dutch Shell affiliate (collectively, the “Partners”). The percentage interests as of December 31, 2019 and 2018 are as follows:

PQ	50%
CRI	50%

The Partnership was formed pursuant to the Kansas Uniform Partnership Act. The Agreement specifies that the partners share equally in capital contributions. The Agreement states that the profits and losses of the Partnership will be allocated in accordance with the partners’ interests in the Partnership. The intent of the Partnership is to develop, manufacture, and sell zeolites and zeolite-containing catalysts.

The Partnership has significant transactions with its partners and related affiliates. Refer to the Related Party Transactions footnote for further disclosure.

2. Partnership Business:

The Partnership manufactures zeolites and zeolytic catalysts that are used by refiners to capture impurities in the processing of petroleum and other chemicals. The filtration ability of zeolites placed into a customer’s chemical process generally extends two to three years. As a result, a significant portion of the Partnership’s customer base tends to change on an annual basis. A significant percentage of the base materials purchased for the Partnership’s manufacturing process is acquired from related parties. In addition, a significant portion of the Partnership’s sales is transacted through Criterion Catalyst Company (“Criterion”) which is a subsidiary of CRI. The Partnership compensates Criterion with a 2% sales commission on specific sales transactions.

3. Summary of Significant Accounting Policies:

These financial statements have been prepared in accordance with generally accepted accounting principles. These financial statements are accounted for on a historical cost basis and do not reflect the results of any purchase accounting adjustments recorded in the Partners’ respective consolidated financial statements.

Cash and Cash Equivalents. Cash and cash equivalents include investments with original terms to maturity of 90 days or less from the time of purchase.

Trade Accounts Receivables and Allowance for Doubtful Accounts: Trade accounts receivables are recorded at the invoiced amount and do not bear interest. The Partnership maintains allowances for doubtful accounts for estimated losses resulting from the inability of its customers to make required payments. Allowances for doubtful accounts are based on historical experience and known factors regarding specific customers. If the financial condition of the Partnership’s customers were to deteriorate, resulting in an impairment of their ability to make payments, additional allowances would be required. Account balances are charged off against the allowance when it is probable the receivable will not be recovered.

Inventories: Inventories are stated at the lower of cost or net realizable value, valued on the first-in, first-out (“FIFO”) method. The Partnership establishes reserves for slow-moving and obsolete inventory.

Property, Plant and Equipment: Property, plant, and equipment are carried at cost and include expenditures for new facilities and major renewals and betterments. Interest is capitalized on capital projects as applicable. Maintenance, repairs and minor renewals are charged to expense as incurred. When assets are sold or otherwise disposed of, the related cost and accumulated depreciation are removed from the accounts, and any resulting gain or loss is included in the results of operations.

Depreciation is generally provided on the straight-line method based on estimated useful lives of the assets, ranging up to 33 years for buildings and improvements and 10 years for machinery and equipment.

We perform an impairment review of property, plant and equipment and other long-lived assets when events and circumstances indicate that those assets may be impaired by comparing the carrying amount of the assets to their fair value.

ZEOLYST INTERNATIONAL
NOTES TO FINANCIAL STATEMENTS
(in thousands)

Fair value is determined using quoted market prices where available, or other techniques including discounted cash flows. The Partnership's estimates of future cash flows involve assumptions concerning future operating performance, economic conditions, and technological changes that may affect the future useful lives of the assets.

Leases. The Partnership has an evergreen land lease agreement with a remaining lease term of 32 years as of December 31, 2019. Accounting Standards Codification Topic 842, Leases ("ASC 842"), does not provide definitive guidance as to determining the length of evergreen leasing arrangements. As such, the Partnership estimated the term of the lease agreement to be commensurate with the estimated useful life of the buildings located on the land that is being leased. Upon adoption of ASC 842 on January 1, 2019, the Partnership assigned a 33 year life to the land lease agreement.

When the Company enters into an arrangement, at inception, the Partnership determines if the arrangement contains a lease and whether that lease meets the classification criteria of a finance or operating lease. The Partnership's lease arrangement only contains lease components. The Partnership's lease agreement does not contain any material residual value guarantees or material restrictive covenants.

The Partnership recognizes a right-of-use lease asset and lease liability at the lease commencement date based on the present value of the remaining lease payments over the lease term. The Partnership was unable to readily determine the discount rate implicit in the lease agreement. As such, the Partnership utilized its incremental borrowing rate over the relevant lease term, which is the rate of interest that it would have to pay to borrow on a collateralized basis over a similar term an amount equal to the lease payments in a similar economic environment. Short-term leases, which have an initial term of twelve months or less, are not recorded on the Partnership's balance sheet.

Lease expense for the operating lease is recognized on a straight-line basis over the lease term. The amortization expense component of the right-of-use lease asset is included in cost of goods sold and in selling, general and administrative expenses on the consolidated statements of income.

Intangibles and Other Long-term Assets: Other long-term assets primarily include investments, at cost and spare parts. In April 2018, the Partnership made a \$4,000 strategic investment to buy down royalty obligations related to certain license agreements. On May 10, 2017, the Partnership made a \$6,500 strategic investment for license of materials-based solutions for catalytic and separations processes. The Partnership amortizes these intangible assets over a ten-year period and includes the expense in selling, general and administrative expenses on its statements of operations. These investments are accounted for under the cost method of accounting.

In December 2017, the Partnership wrote down a \$3,000 investment in a technology developer and licensor of materials-based solutions for catalytic and separations processes. During the year ended December 31, 2019, the Partnership sold its investment in the common stock of the technology developer and received \$3,062 in proceeds, which was recorded in other (income) expense, net on the Partnership's statements of operations and accumulated earnings.

Revenue Recognition: In determining the appropriate amount of revenue to be recognized as the Partnership fulfills its obligations under its agreements, the Partnership performs the following steps: (i) identification of the contract with the customer; (ii) determination of whether the promised goods or services are performance obligations, including whether they are distinct in the context of the contract; (iii) measurement of the transaction price; (iv) allocation of the transaction price to the performance obligations based on estimated selling prices; and (v) recognition of revenue when (or as) the Partnership satisfies each performance obligation.

The Partnership identifies a contract when an agreement with a customer creates legally enforceable rights and obligations, which occurs when a contract has been approved by both parties, the parties are committed to perform their respective obligations, each party's rights and payment terms are clearly identified, commercial substance exists and it is probable that the Partnership will collect the consideration to which it is entitled.

The Partnership may offer rebates to customers who have reached a specified volume of optional purchases. The Partnership recognizes rebates given to customers as a reduction of revenue based on an allocation of the cost of honoring rebates earned and claimed to each of the underlying revenue transactions that result in progress by the customer toward earning the rebate. Rebates are recognized at the time revenue is recorded. The Partnership measures the rebate obligation based on the estimated amount of sales that will result in a rebate at the adjusted sales price per the respective sales agreement.

ZEOLYST INTERNATIONAL
NOTES TO FINANCIAL STATEMENTS
(in thousands)

The Partnership recognizes revenue when all essential elements of the sales order have shipped and both title and risk of loss has passed to the customer. Hydrocracking and specialty catalyst orders are typically filled by a number of individual shipments, and those shipments may span the end of a fiscal quarter or year. If a portion of the order has not shipped and it is essential to the functionality of the customer's end use, revenue is recognized when the order is completed. A shipment is considered essential if each individual shipment has no value to the customer on a stand-alone basis and if the remaining shipment is not considered inconsequential and perfunctory.

The Partnership reserves 3% of the Hydrocracking sales due to a clause in the contract that allows customers to return up to 5% of the unused products they purchase within 90 days, and based on historical experience. The total sales returns reserve as of December 31, 2019 and 2018 amounted to \$1,389 and \$534, respectively.

Shipping and Handling Costs: The Partnership classifies costs related to shipping and handling of products shipped to customers as cost of goods sold.

Research and Development: Research and development costs of \$17,468, \$17,566 and \$16,011 for the years ended December 31, 2019, 2018 and 2017, respectively, were expensed as incurred and reported in selling, general and administrative expenses in the accompanying statements of operations.

Foreign Exchange Transactions: The functional currency of the Partnership is the U.S. Dollar. The Partnership enters into transactions that are denominated in other currencies. Gains and losses on foreign currency transactions are included in other (income) / expense, net on the statements of operations. Foreign exchange losses of \$967, \$1,726 and gain of \$2,569 were recognized for the years ended December 31, 2019, 2018 and 2017, respectively.

Fair Value Measurements: The Partnership's financial assets and liabilities are reflected in the financial statements at fair value. Fair value is defined as the price at which an asset could be exchanged in a current transaction between willing market participants. A liability's fair value is defined as the amount that would be paid to transfer the liability to a market participant, not the amount that would be paid to settle the liability with a creditor. The Partnership's cash balances approximate fair value due to their short-term maturity.

Use of Estimates: The preparation of the Partnership's financial statements in conformity with generally accepted accounting principles requires management to make estimates that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenue and expenses during the reporting period. Actual results could differ from those estimates.

4. Recently Issued Accounting Standards:

In February 2016, the FASB issued guidance (with subsequent targeted amendments) that modifies the accounting for leases. Under the new guidance, a lessee will recognize assets and liabilities for most leases (including those classified under existing GAAP as operating leases, which based on current standards are not reflected on the balance sheet), but will recognize expenses similar to current lease accounting. The new guidance also requires companies to provide expanded disclosures regarding leasing arrangements. The guidance is effective for fiscal years beginning after December 15, 2018, with early adoption permitted. The new guidance must be adopted using a modified retrospective transition method. The Partnership can choose to apply the new guidance at the beginning of the earliest period presented in the financial statements, or at the date of adoption, with a cumulative-effect adjustment to the opening balance of retained earnings and no recast of prior period results presented within the Partnership's financial statements. The Partnership has elected to apply the new guidance as of the date of adoption and has included all relevant disclosures within Note 3 and Note 9 to these financial statements.

ZEOLYST INTERNATIONAL
NOTES TO FINANCIAL STATEMENTS
(in thousands)

5. Revenue from Contracts with Customers:

The Partnership applies the five-step revenue recognition model to each contract with its customers. Evidence of a contract between the Partnership and its customers may take the form of a master service agreement (“MSA”), a MSA in combination with an underlying purchase order, a combination of a pricing quote with an underlying purchase order or an individual purchase order received from a customer. The Partnership and certain of its customers enter into MSAs that establish the terms, including prices, under which orders to purchase goods may be placed. In cases where the MSA contains a distinct order for goods or contains an enforceable minimum quantity to be purchased by the customer, the Partnership considers the MSA to be evidence of a contract between the Partnership and its customer as the MSA creates enforceable rights and obligations. In cases where the MSA does not contain a distinct order for goods, the Partnership’s contract with a customer is the purchase order issued under the MSA. Customers of the Partnership may also negotiate orders via pricing quotes, which typically detail product pricing, delivery terms and payment information. When a customer procures goods under this method, the Partnership considers the combination of the pricing quote and the purchase order to create enforceable rights and obligations. Absent either a MSA or pricing quote, the Partnership considers an individual purchase order to create enforceable rights and obligations.

The Partnership identifies a performance obligation in a contract for each promised good that is separately identifiable from other promises in the contract and for which the customer can benefit from the good. The Partnership’s contracts have a single performance obligation, which is the promise to transfer individual goods to the customer. Single performance obligations are satisfied according to the shipping terms noted within the MSA or purchase order.

As described above, the Partnership’s MSAs with its customers may outline prices for individual products or contract provisions. Revenue from product sales are recorded at the sales price, which includes estimates of variable consideration for which reserves are established and which result from discounts, returns or other allowances that are offered within contracts between the Partnership and its customers.

The Partnership recognizes revenues when performance obligations under the terms of a contract with its customer are satisfied, which generally occurs at a point in time by transferring control of a product to the customer. The Partnership determines the point in time when a customer obtains control of a product and the Partnership satisfies the performance obligation by considering factors including when the Partnership has a right to payment for the product, the customer has legal title to the product, the Partnership has transferred possession of the product, the customer has assumed the risks and rewards of ownership of the product and the customer has accepted the product. Revenue is measured as the amount of consideration the Partnership expects to receive in exchange for transferring goods. The Partnership does not have any significant payment terms as payment is received at, or shortly after, the point of sale.

Contract Assets and Liabilities

A contract asset is a right to consideration in exchange for goods that the Partnership has transferred to a customer when that right is conditional on something other than the passage of time. A contract liability exists when the Partnership receives consideration in advance of performance obligations. The Partnership has not recorded any contract assets or contract liabilities on its balance sheet as of December 31, 2019.

Practical Expedients and Accounting Policy Elections

The Partnership has elected to use certain practical expedients and has made certain accounting policy elections as permitted under the new revenue recognition guidance. Certain of the Partnership’s contracts with customers are based on an individual purchase order; thus, the duration of these contracts are for one year or less. The Partnership has made an accounting policy election to omit certain disclosures related to remaining performance obligations for contracts which have an initial term of one year or less.

The Partnership uses an output method to recognize revenues related to performance obligations. These performance obligations, as described above, are satisfied within a calendar year. As such, the Partnership has elected to utilize the “as-invoiced” practical expedient, which permits the Partnership to recognize revenue in the amount to which it has a right to invoice the customer, provided that the amount corresponds directly with the value provided by the performance obligation as completed to date.

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(in thousands)

When the Partnership performs shipping and handling activities after the transfer of control to the customer (e.g. when control transfers prior to delivery), they are considered fulfillment activities as opposed to separate performance obligations, and the Partnership recognizes revenue upon the transfer of control to the customer. Accordingly, the costs associated with these shipping and handling activities are accrued when the related revenue is recognized under the Partnership's policy election. The Partnership expenses incremental costs of obtaining a contract as incurred if the expected amortization period of the asset that the Partnership would have recognized is one year or less. Sales, value added and other taxes the Partnership collects concurrent with revenue producing activities are excluded from revenues.

Disaggregated Revenue

The following table disaggregates the Partnership's sales by end use for the year ended December 31, 2019 and 2018:

	Years ended December 31,	
	2019	2018
Fuels and Emission Controls	\$ 245,926	\$ 219,249
Packaging & Engineered Plastics	94,749	94,125
Total	<u>\$ 340,675</u>	<u>\$ 313,374</u>

6. Accounts Receivable and Allowance for Doubtful Accounts:

The components of accounts receivable are as follows:

	December 31,	
	2019	2018
Trade accounts receivable	\$ 81,287	\$ 54,795
Allowance	(1,389)	(534)
	<u>\$ 79,898</u>	<u>\$ 54,261</u>

7. Inventories:

Inventories were classified and valued as follows:

	December 31,	
	2019	2018
Finished products and work in process	\$ 119,271	\$ 84,794
Raw materials and containers	8,593	8,095
	<u>\$ 127,864</u>	<u>\$ 92,889</u>

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8. Property, Plant and Equipment:

A summary of property, plant and equipment, at cost, and related accumulated depreciation is as follows:

	December 31,	
	2019	2018
Land and buildings	\$ 49,382	\$ 49,609
Machinery and equipment	177,804	180,415
Construction in progress	40,579	18,632
	267,765	248,656
Less: accumulated depreciation	(123,150)	(114,846)
	\$ 144,615	\$ 133,810

Depreciation expense was \$16,582, \$16,260 and \$13,580 for the years ended December 31, 2019, 2018, and 2017, respectively. Disposal of assets reduced PP&E and accumulated depreciation by \$8,356, \$5,166, and \$7,299, respectively with a \$47, \$101, and \$178 reduction to earnings for the years ended December 31, 2019, 2018, and 2017, respectively.

9. Leases:

Operating lease costs of \$305 are included in cost of goods sold on the consolidated statements of income for the year ended December 31, 2019. The weighted average lease term is 32 years with a weighted average discount rate of 3.25%. Cash payments on operating leases included in operating cash flows was \$305 for the year ended December 31, 2019. The current portion of the lease liability is included on the Partnership's balance sheet in other current liabilities.

Maturities of lease liabilities as of December 31, 2019 are as follows:

	Operating Lease
2020	\$ 305
2021	305
2022	305
2023	305
2024	305
Thereafter	8,235
Total lease payments	9,760
Less: Interest	(3,683)
Total lease liabilities	\$ 6,077

10. Other Current Liabilities:

A summary of other current liabilities is as follows:

	December 31,	
	2019	2018
Accrued royalties and license fees	\$ 1,968	\$ 4,419
Accrued commissions	1,228	1,225
Accrued other	689	407
	\$ 3,885	\$ 6,051

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11. Revolver:

On March 2, 2016, the Partnership entered into a five-year revolving line of credit facility of \$60,000, which carries an initial interest rate of LIBOR. The agreement expires on March 1, 2021. The interest rate on the facility is LIBOR plus an interest margin ranging from 0.75% to 1.00% per annum based on the Partnership's debt to EBITDA ratio. A commitment fee is paid to the bank for this agreement. As of December 31, 2019, availability under this agreement was \$45,000.

The revolving credit agreement contains certain restrictions and covenants that require the Partnership to maintain a minimum partners' equity, as defined, of \$100,000 plus 10% of net income, and a minimum EBITDA of \$40,000 on a last twelve month basis measured quarterly. The Partnership was in compliance with all covenants during 2019.

Cash payments for interest were approximately \$134, \$101 and \$108 for the years ended December 31, 2019, 2018 and 2017, respectively.

The fair value of a financial instrument is the amount at which the instrument could be exchanged in a current transaction. The carrying amount of the revolving line of credit approximates fair value because it is a short-term liquidity tool to fund operations, which is drawn down and paid back with cash generated from operations.

12. Partners' Contributions:

In accordance with the Agreement, in the event that cash flow from operations is insufficient to meet the Partnership's requirements, following a majority vote by the Management Committee of the Partnership to request capital from the partners, the partners will provide additional capital to enable the Partnership to meet its obligations. No such contributions were made during the years ended December 31, 2019, 2018, or 2017 as the Partnership had the ability to finance operations through cash flow from operations and borrowings under the Partnership's revolving line of credit facility.

13. Income Taxes:

As a partnership, Zeolyst International is not liable for the payment of taxes on income in the U.S. Net income and losses are allocated to the respective partners on an annual basis, and it is the partners' responsibility to pay income taxes, if any, thereon according to their respective tax positions.

14. Commitments and Contingent Liabilities:

In 1998, the Partnership entered into a ten year tolling agreement ("the Tolling Agreement") with CRI Belgium, a related party, for the manufacture of specialty extruded products. Effective January 2004, the 1998 Tolling Agreement was replaced by a new evergreen ten-year tolling agreement with CRI Belgium. Both parties can terminate this agreement without cause with twenty-four months' notice. The Partnership pays CRI Belgium a daily charge rate based on the actual days of production. This charge is included in related party cost of goods sold and totaled \$27,811, \$23,381 and \$19,241 for the years ended December 31, 2019, 2018 and 2017, respectively. In addition, for certain capital expenditures, that are beneficial to the Partnership, the parties will mutually agree on future adjustments to the daily charge rates or propose an alternative method of the Partnership's contribution to those costs.

During 2007, the Partnership entered into a License Agreement with a third party to obtain exclusive licensing rights to use the technology in the manufacturing, using and selling of Powder catalyst and Shaped catalyst. The consideration for the licensing rights includes (1) a down payment of \$3,200 payable in six annual installments to acquire the product license, and (2) royalty payments at a rate of 10% of the Powder and Shaped Net Sale price during the royalty period. The \$3,200 is payable as follows: \$500 was paid at the date of the agreement, \$500 at first, second, and third anniversaries of the agreement, and \$600 at the fourth and fifth anniversary of the agreement. The product license intangible is being amortized

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over the life of the agreement on a straight-line basis, which is estimated to be 15 years. Amortization expense of \$213 was recognized in 2019, 2018 and 2017. The royalty period of 10 years began in 2013, immediately after the date on which the Partnership had cumulatively produced the first 250 metric tons of Powder and Shaped catalyst. If at the end of the Royalty Period, the cumulative of running royalties actually paid by the Partnership is less than \$3,000, the Partnership will be obligated to pay the difference between the \$3,000 and the actual cumulative running royalty amount. As of December 31, 2019 and 2018 there were \$240 and \$2,153, respectively, liabilities recorded related to this agreement.

During 2013 the Partnership entered into a Sublicense Agreement with a third party to obtain patent and know-how licensing rights to make, use, import, and sell the Licensed Process and Products in the Licensed field. The consideration for the licensing rights includes a payment of \$1,500 payable in three installments. The \$1,500 is payable as follows: \$500 will be paid at the date of the first successful sale of commercialized product, or 36 months from execution of the license agreement, \$500 after sale of 0.5 million pounds of product, or 48 months from execution of the license agreement, and \$500 after sale of 1.0 million pounds of product, or 60 months from execution of the license agreement. In October 2016, the agreement was amended to extend payment terms. The payment of \$1,500 is payable as follows: \$500 will be paid at the date of the first successful sale of commercialized product, or 69 months from execution of the license agreement, \$500 after sale of 0.5 million pounds of product, or 81 months from execution of the license agreement, and \$500 after sale of 1.0 million pounds of product, or 93 months from execution of the license agreement. The product license intangible will be amortized prospectively with this change in estimated life. Amortization expense of \$0, \$12 and \$36 was recognized in the years ending December 31, 2019, 2018 and 2017, respectively. This agreement was terminated in 2018 with no payments due to third party. Amortization credit of \$1,448 was recognized in the year ending December 31, 2018.

15. Related Party Transactions:

Policies and Procedures

The Partnership maintains certain policies and procedures for the review, approval, and ratification of related party transactions. All significant relationships and transactions are separately identified by management if they meet the definition of a related party or a related party transaction. Related party transactions include transactions that occurred during the year, in which the Partnership was or will be a participant and which any related person had or will have a direct or indirect material interest. Due to the nature of the Partnership, material related party transactions are identified on a transaction-based approach. The types of transactions identified and reviewed include, but are not limited to, sales of products, purchases of inventory, tolling costs, sales and marketing costs, research and development, and management-related fees. All related party transactions are reviewed, approved and documented by the appropriate level of the Partnership's management in accordance with these policies and procedures.

PQ

Under the terms of the Agreement, the Partnership leases certain land used in its Kansas City production facilities from PQ. This lease, which has been recorded as an operating lease, provided for rental payments of \$305, \$295, and \$295 for the years ended December 31, 2019, 2018 and 2017, respectively. The rent expense is included in the related party cost of goods sold line item in the accompanying statements of operations. The terms of this lease are evergreen as long as the Partnership agreement is in place. The Partnership recognized sales to PQ of \$803, \$645, and \$2,475 in the years ended December 31, 2019, 2018, and 2017, respectively. The Partnership purchases certain of its raw materials from PQ and is charged for various manufacturing costs incurred at the PQ Kansas City production facility. The amount of these costs charged to the Partnership during the years ended December 31, 2019, 2018 and 2017 were \$19,976, \$16,869 and \$17,470, respectively. These costs are a component of production costs and are included in the related party cost of goods sold line item in the accompanying statements of operations when the inventory is sold. Certain administrative, marketing, engineering, management-related, and research and development services are provided to the Partnership by PQ. During the years ended December 31, 2019, 2018 and 2017, the Partnership was charged \$12,871, \$12,727 and \$12,248, respectively, for these services. These amounts are included in the related party selling, general and administrative line item in the accompanying statements of operations. In addition, certain product demonstration costs of \$2,204, \$1,768 and \$2,175 during the years ended December 31, 2019, 2018 and 2017, respectively, were recorded in the related party cost of goods sold line of the accompanying statements of operations.

At December 31, 2019 and 2018, the accounts payable to affiliates consisted of \$3,020 and \$3,047 due to PQ. Included in trade accounts receivable at December 31, 2019 and 2018 was \$320 and \$360, respectively due from PQ.

On December 18, 2013, PQ and ZI, entered into a real estate tax abatement agreement with the Unified Government of Wyandotte County and Kansas City, Kansas that will utilize an Industrial Revenue Bond financing structure to achieve a 75% real estate tax abatement on the value of the improvements that will be constructed during the expansion of PQ's and ZI's facilities at the jointly-operated Kansas City, Kansas plant.

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During the year ended December 31, 2019, the original IRB financing structure from December 2013 was exhausted. In order to fund future plant expansions, the Company entered into an additional IRB financing structure with similar terms and conditions, which also provides for 75% real estate tax abatements on the value of future improvements. The financing obligations and the industrial bonds receivable have been presented net, as the financing obligations and the industrial bonds meet the criteria for right of setoff conditions under GAAP.

CRI and Royal Dutch Shell Affiliates

Royal Dutch Shell affiliates include CRI, Criterion, Shell Development Company, Shell Research and Technology Center-Amsterdam, CRI Center Marketing Asia Pacific, Shell International Oil Products, CRI Belgium and CRI Technology Services. As described in Note 2, a significant portion of the Partnership's sales are transacted through Criterion. During the years ended December 31, 2019, 2018 and 2017 the Partnership recognized sales transacted through Criterion of \$178,148, \$103,646 and \$106,325, respectively. The Partnership purchases certain of its raw materials and is charged for tolling, customer distribution and packaging costs incurred by Criterion. The amount of these costs charged to the Partnership during the years ended December 31, 2019, 2018 and 2017 were \$38,988, \$31,383 and \$23,965, respectively. These costs are a component of production costs and are included in the related party cost of goods sold line item in the accompanying statements of operations when the inventory is sold. Certain engineering, management-related, broker-related, and research and development services are provided to the Partnership by CRI and Royal Dutch Shell affiliates. During the years ended December 31, 2019, 2018 and 2017, the Partnership was charged \$24,214, \$22,908 and \$19,496, respectively, for these services. These amounts are included in the related party selling, general and administrative line item in the accompanying statements of operations.

At December 31, 2019 and 2018, the accounts payable to affiliates balance consisted of \$8,026 and \$8,873, respectively, due to CRI and Shell affiliates. Included in trade accounts receivable at December 31, 2019 and 2018 was \$50,053 and \$26,907, respectively, of receivables related to sales transacted through Criterion, as described above.

Zeolyst C.V.

Zeolyst C.V. is a limited partnership formed in 1993 pursuant to a joint venture agreement between PQ Zeolites B.V. and CRI for the purpose of the production of Zeolite powders. The Partnership entered into an agreement with Zeolyst C.V. to purchase Zeolite powders manufactured by Zeolyst C.V. Under the terms of the agreement, products manufactured by Zeolyst C.V. are supplied solely to the Partnership. The Partnership has performed a qualitative and quantitative analysis and concluded that for Zeolyst C.V. for which it holds a variable interest but will not absorb a majority of the expected losses or residual returns, the Partnership is not the primary beneficiary and therefore, this VIE was not consolidated in the Partnership's consolidated financial statements. The Partnership has no unfunded commitments or guarantees as a result of its involvement with Zeolyst C.V. The total carrying value of assets and liabilities for Zeolyst C.V. was \$122,726 and \$7,068 as of December 31, 2019 and was \$125,412 and \$9,636 as of December 31, 2018, respectively. The Partnership currently does not have any exposure to any losses by Zeolyst C.V. The Partnership has purchased \$50,968, \$49,338 and \$37,087 through the sales agreement during the years ended December 31, 2019, 2018 and 2017, respectively. These costs are a component of production costs and are included in the related party cost of goods sold line item in the accompanying statements of operations when the inventory is sold.

At December 31, 2019 and 2018, the accounts receivable from affiliates balance consisted of \$1,473 and \$1,895, respectively, due from Zeolyst C.V.

16. Subsequent Events:

The Partnership has evaluated subsequent events from the balance sheet date through February 27, 2020 and determined there are no further items to disclose.

**DESCRIPTION OF THE REGISTRANT'S SECURITIES
REGISTERED PURSUANT TO SECTION 12 OF THE
SECURITIES EXCHANGE ACT OF 1934**

The following summary describes all material provisions of the common stock, par value \$0.01 per share, of PQ Group Holdings Inc. The description of our common stock is qualified by reference to our certificate of incorporation and bylaws, which are included as exhibits to the Annual Report on Form 10-K of which this Exhibit 4.3 is a part.

Common Stock

Shares Authorized. Our certificate of incorporation authorizes us to issue 450,000,000 shares of common stock, par value \$0.01 per share.

Dividend Rights. Subject to preferences that may apply to shares of preferred stock outstanding at the time, holders of outstanding shares of our common stock will be entitled to receive dividends out of assets legally available at the times and in the amounts as the board of directors may from time to time determine.

Voting Rights. Each outstanding share of our common stock is entitled to one vote on all matters submitted to a vote of stockholders. Holders of shares of our common stock have no cumulative voting rights.

Except as otherwise required under the Delaware General Corporation Law or provided for in our certificate of incorporation, all matters other than the election of directors are determined by a majority of the votes cast on the matter and all elections of directors are determined by a plurality of the votes cast. However, we have implemented a Majority Voting Policy for uncontested director elections (elections in which the number of nominees for election does not exceed the number of directors to be elected). In the event that the votes "withheld" from a nominee's election exceed the votes cast "for" that nominee's election, such nominee shall be required to submit his or her resignation to the board of directors for consideration. The board of directors will then have the opportunity to determine whether to accept or reject such tendered resignation. The board of directors, in making its decision, may consider any factors or other information that it considers appropriate or relevant.

The board of directors will act within 120 days following certification of the shareholder vote. Thereafter, the board of directors will promptly publicly disclose, in a report furnished to the Securities and Exchange Commission, its decision regarding the tendered resignation, including its rationale for accepting or rejecting the tendered resignation. The board of directors may accept a director's resignation or reject the resignation. If the board of directors accepts a director's resignation, or if a nominee for director is not elected and the nominee is not an incumbent director, then the board of directors, in its sole discretion, may fill any resulting vacancy or may decrease the size of the board of directors, in each case pursuant to our bylaws. If a director's resignation is not accepted by the board of directors, such director will continue to serve until the next annual meeting of shareholders when such director's class is up for re-election and until his or her successor is duly elected, or his or her earlier resignation or removal.

Preemptive Rights. Our common stock is not entitled to preemptive or other similar subscription rights to purchase any of our securities.

Conversion or Redemption Rights. Our common stock does not have any conversion rights and there are no redemption or sinking fund provisions applicable to our common stock.

Liquidation Rights. Upon our liquidation, the holders of our common stock will be entitled to receive pro rata our assets that are legally available for distribution, after payment of all debts and other liabilities and subject to the prior rights of any holders of preferred stock then outstanding.

Stock Exchange Listing. Our common stock is listed on the New York Stock Exchange under the symbol "PQG."

Transfer Agent and Registrar. The transfer agent and registrar for our common stock is American Stock Transfer and Trust Company, LLC.

Anti-Takeover Effects of our Certificate of Incorporation and Bylaws

Our certificate of incorporation and bylaws contain provisions that are intended to enhance the likelihood of continuity and stability in the composition of our board of directors and which may have the effect of delaying, deferring or preventing a future takeover or change in control of our company unless such takeover or change in control is approved by our board of directors. These provisions include:

Classified Board. Our certificate of incorporation provides that our board of directors be divided into three classes of directors, with the classes as nearly equal in number as possible. As a result, approximately one-third of our board of directors is elected each year. The classification of directors has the effect of making it more difficult for stockholders to change the composition of our board. Our certificate of incorporation also provides that, subject to any rights of holders of preferred stock to elect additional directors under specified circumstances, the number of directors is fixed exclusively pursuant to a resolution adopted by our board of directors.

Special Meetings of Stockholders. Our certificate of incorporation and bylaws provide that, except as otherwise required by law, special meetings of the stockholders can only be called by the chairman of the board or pursuant to a resolution adopted by a majority of the board of directors. Except as otherwise required by law, stockholders are not permitted to call a special meeting or to require the board of directors to call a special meeting.

Removal of Directors. Our certificate of incorporation provides that our directors may be removed only for cause by the affirmative vote of at least a majority of the voting power of our outstanding shares of capital stock entitled to vote generally in the election of directors, voting together as a single class.

Advance Notice Procedures. Our bylaws have established an advance notice procedure for stockholder proposals to be brought before an annual meeting of our stockholders, including proposed nominations of persons for election to the board of directors. Stockholders at an annual meeting will only be able to consider proposals or nominations specified in the notice of meeting or brought before the meeting by or at the direction of the board of directors or by a stockholder who was a stockholder of record on the record date for the meeting, who is entitled to vote at the meeting and who has given our Secretary timely written notice, in proper form, of the stockholder's intention to bring that business before the meeting. Although our bylaws do not give the board of directors the power to approve or disapprove stockholder nominations of candidates or proposals regarding other business to be conducted at a special or annual meeting, our bylaws may have the effect of precluding the conduct of certain business at a meeting if the proper procedures are not followed or may discourage or deter a potential acquiror from conducting a solicitation of proxies to elect its own slate of directors or otherwise attempting to obtain control of the company.

Authorized but Unissued Shares. Our authorized but unissued shares of common stock and preferred stock are available for future issuance without stockholder approval. These additional shares may be utilized for a variety of corporate purposes, including future public offerings to raise additional capital, corporate acquisitions and employee benefit plans. The existence of authorized but unissued shares of common stock and preferred stock could render more difficult or discourage an attempt to obtain control of a majority of our common stock by means of a proxy contest, tender offer, merger or otherwise.

Business Combinations with Interested Stockholders. We have elected in our certificate of incorporation not to be subject to Section 203 of the Delaware General Corporation Law, an antitakeover law. In general, Section 203 prohibits a publicly held Delaware corporation from engaging in a business combination, such as a merger, with a person or group owning 15% or more of the corporation's voting stock for a period of three years following the date the person became an interested stockholder, unless (with certain exceptions) the business combination or the transaction in which the person became an interested stockholder is approved in a prescribed manner. Accordingly, we are not subject to any anti-takeover effects of Section 203. However, our certificate of incorporation contains provisions that have the same effect as Section 203, except that they provide that INEOS Investments Partnership and investment funds affiliated with CCMP Capital Advisors, LP, and certain of their respective transferees and affiliates will not be deemed to be "interested stockholders," regardless of the percentage of our voting stock owned by them, and accordingly will not be subject to such restrictions.

Exclusive Forum. Our certificate of incorporation provides that, subject to limited exceptions, the Court of Chancery of the State of Delaware will be the sole and exclusive forum for (i) any derivative action or proceeding brought on our behalf, (ii) any action asserting a claim of breach of a fiduciary duty owed by any of our directors, officers or other employees to us or our stockholders, (iii) any action asserting a claim against us arising pursuant to any provision of

the Delaware General Corporation Law, our certificate of incorporation or our bylaws, or (iv) any other action asserting a claim against us that is governed by the internal affairs doctrine. Any person or entity purchasing or otherwise acquiring any interest in shares of our capital stock shall be deemed to have notice of and to have consented to the provisions of our certificate of incorporation described above. Although we believe these provisions benefit us by providing increased consistency in the application of Delaware law for the specified types of actions and proceedings, the provisions may have the effect of discouraging lawsuits against our directors and officers. The enforceability of similar choice of forum provisions in other companies' certificates of incorporation has been challenged in legal proceedings, and it is possible that, in connection with one or more actions or proceedings described above, a court could find the choice of forum provisions contained in our certificate of incorporation to be inapplicable or unenforceable.

**AMENDMENT TO
CONSENT UNDER THE AUGUST 31, 2017 SEVERANCE AGREEMENT**

This AMENDMENT TO CONSENT UNDER THE AUGUST 31, 2017 SEVERANCE AGREEMENT (this “*Amendment*”) is made and entered into as of the 30th day of January, 2020 with reference to the Consent Under The August 31, 2017 Severance Agreement (the “*Consent*”) dated as of March 29, 2019, by and between PQ Corporation, a Pennsylvania corporation (the “*Company*”) and Scott Randolph (the “*Executive*”). Any capitalized term not otherwise defined herein shall have the meaning ascribed to it in the Consent.

WHEREAS, the Executive and the Company desire to amend the Consent on the terms and conditions set forth in this Amendment.

NOW, THEREFORE, in consideration of the covenants contained herein and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, and intending to be legally bound hereby, the parties hereto agree and acknowledge as follows:

1. The “Window Period”, as defined in Section 2 of the Amendment, shall begin on September 1, 2020 and end on September 15, 2020.
2. If the Executive exercises his right under Section 2 of the Consent to make a claim for a Good Reason termination, the Executive’s separation of employment from the Company will be (unless otherwise agreed by the Company in writing) no sooner than December 31, 2020.
3. Other than as set forth in this Amendment, the Consent is unchanged and unamended, and remains in full force and effect.

IN WITNESS WHEREOF, the parties hereto have executed this Consent as of the date first written above.

EXECUTIVE

/s/ Scott Randolph
Scott Randolph

PQ CORPORATION

By: /s/ William J. Sichko Jr.
Name: William J. Sichko Jr.
Title: Chief Administrator Officer

December 8, 2015

Ray Kolberg
47555 Bellagio Dr.
Northville, MI 48167

Re: Offer of Employment

Dear Mr. Kolberg:

We are pleased to offer you (hereinafter referred to as "you," "your" or "Executive") the position of President, Catalyst Business of PQ Corporation (the "Company"). In accordance with our discussions, set forth below are the basic terms and conditions of your employment.

1. Start Date. We look forward to a start date of January 1, 2016 (the "Start Date"). Your place of employment will be Conshohocken, Pennsylvania. You understand and agree that you shall frequently travel on behalf of the Company, including but not limited to its business locations.

2. Base Salary. Your annual Base Salary shall be at the rate of \$425,000 per year, and payable pursuant to the Company's normal payroll practices. Your Base Salary may be adjusted from time to time on review by the Compensation Committee of the Board of Directors.

3. Annual Performance Bonus. For each calendar year of your employment, you shall have the opportunity to earn an annual bonus (the "Annual Performance Bonus") with a target bonus equal to 75% of Base Salary, based on achievement of annual target performance goals (based on EBITDA metrics or other financial metrics) established by the Board of Directors of the Company ("Board") or the Compensation Committee of the Board, and as further described in and governed by the 2016 PQ Corporation Incentive Plan ("PQIP"), as it may be amended from time to time.

4. Benefits. You shall be entitled to participate in all employee benefit plans, practices and programs maintained by the Company, as in effect from time to time (collectively, "Employee Benefit Plans"), to the extent consistent with applicable law and the terms of the applicable Employee Benefit Plans. The Company reserves the right to amend or cancel any Employee Benefit Plans at any time in its sole discretion, subject to the terms of such Employee Benefit Plan and applicable law.

5. Business Expenses. You shall be entitled to reimbursement for all reasonable and necessary out-of-pocket business expenses incurred by you in connection with the performance of your duties in accordance with the Company's expense reimbursement policies and procedures.

6. Vacation. You shall be entitled to twenty-five (25) days of paid vacation per year, accruing in accordance with the Company's vacation policy.

7. Equity Participation.

(a) You will be eligible to participate in the PQ Holdings Inc. Stock Incentive Plan (as amended and restated) or such equity incentive plan as may be adopted by the Company to provide for the equity grants described herein and future equity grants to key executives and management (the "Equity Plan"). You will be subject to the terms and conditions of the Equity Plan and any documents required to be executed in conjunction with the Equity Plan.

(b) You will be provided an opportunity to purchase at least one hundred thousand dollars

(\$100,000) in restricted Class D stock, or an equivalent class of stock, upon the terms and conditions set forth in applicable plan documents.

(c) On your Start Date, PQ Holdings Inc., or another indirect parent of the Company ("Holdings"), will grant you the following equity awards, subject to the terms and conditions of the applicable plan documents:

(i) 6,178 Class C options, or an equal number of options for an equivalent class of stock, with a strike price of \$60.71 (CCMP Cost Basis). Fifty percent (50%) of these options will be time vested with 1544 options vesting on January 1, 2018, and 1545 options vesting on January 1, 2020. The remaining 3089 options will be performance and time vested and will vest on the earlier of January 1, 2020 or achievement by CCMP of pre-tax returns on its capital of at least two times its investment. The vesting provisions are further described and are subject to the terms set forth in the Stock Option Award Agreement which you will be required to sign.

(ii) 2,645 shares of restricted Class D common stock, or an equivalent class of stock, with a share price of \$160.71 (CCMP's cost basis). Fifty percent (50%) of these restricted non-voting shares will be time vested with 661 shares vesting on January 1, 2018, and 661 shares vesting on January 1, 2020. The remaining 1323 restricted shares will be performance and time vested and will vest on the earlier of January 1, 2020 or achievement by CCMP of pre-tax returns on its capital of at least two times its investment. The vesting provisions are further described and are subject to the terms set forth in the Restricted Stock Award Agreement which you will be required to sign.

8. Termination of Employment

(a) *Termination of Employment.* Your employment hereunder will be terminated immediately by your death or disability, and may be terminated by either the Company or by you at any time and for any reason, provided that, you shall be required to give the Company at least thirty (30) days advance written notice of any termination of your employment. Upon termination of your employment for any of the foregoing reasons, the Company will pay you, in a lump sum, within thirty (30) days after such termination of employment, (1) any Base Salary earned but not yet paid, (2) any accrued but unused vacation days, and (3) the amount of any business expenses incurred by you prior to such termination that were incurred in accordance with the Company's policies and which have not yet been reimbursed (collectively, the "Unpaid Amounts").

(b) For purposes of the foregoing Section 8(a), "disability" shall mean the physical or mental illness, disease or incapacity of the Executive (i) that renders him substantially unable to perform all of his duties under this Agreement for a period of 90 consecutive days or longer, or for 90 or more days in any period of 365 consecutive days, or (ii) that, in the opinion of a physician selected by the Company, but reasonably acceptable to the Executive, is likely to prevent the Executive from substantially performing all of his duties under this Agreement for more than 90 days in any period of 365 consecutive days; provided that, with respect to any payment that is subject to Section 409A of the Code.

(c) *Severance Upon Termination Without Cause.* If your employment is terminated by the Company without Cause, then in addition to the Unpaid Amounts and subject to your compliance with any restrictive covenant, your execution of the release of claims substantially in the form set forth as Exhibit A (the "Release") and such Release becoming effective and irrevocable in accordance with its terms within forty five (45) days following the date of termination, you shall be entitled to receive (i) continued Base Salary, Annual Performance Bonus at target and health benefits at the active employee contribution rates for the 12 month period following the date of termination; and (ii) a pro-rata amount of the Annual Performance Bonus, if any, which would have been payable to you for the calendar year in which such termination occurs and equal to the amount which would have been payable to you if your employment had not been terminated during such calendar year, based on

achievement of annual target performance goals (based on EBITDA metrics or other financial metrics) established by the Board or the Compensation Committee, multiplied by a fraction, the numerator of which is the number of days you were employed by the Company during such calendar year and the denominator of which is 365. Base Salary and Annual Performance Bonus ("Severance Payments") is payable in equal installments in accordance with the Company's normal payroll practices, which shall commence on the date that is forty-five (45) days following such termination of employment, provided that prior to that date the Release has become effective and irrevocable. Health benefits at the active employee rates are subject to plan eligibility requirements including but not limited to current enrollment in the plan. Health benefits end if you have access to substantially equivalent health benefits as a result of commencing new employment. The Severance Payments described in this Section 8 shall supersede in their entirety any severance payment provisions in any severance plan, policy, program or arrangement maintained by the Company.

(d) For purposes of the foregoing Section 8(c), "cause" shall mean (i) the failure by the Executive to observe any provision of this Agreement, Company policy, policies of its parent ("Holding") generally applicable to executives of Holding, the Company and/or their Subsidiaries of which the Executive has notice and which failure has not been cured within thirty (30) days of receipt by the Executive of written notice from the Board describing the failure; (ii) misconduct by the Executive in the performance of his duties or the Executive's disregard of his duties; (iii) the commission by the Executive of any act which results in his conviction, or plea of guilty or no contest to, a felony, or his commission of any act involving moral turpitude, fraud or theft; (iv) Executive's breach of fiduciary duty with respect to Holding, the Company or any of their Subsidiaries and which failure has not been cured within ten (10) days of receipt by the Executive of written notice from the Board describing the breach; (v) the material breach by the Executive of the restrictive covenants he is to sign, or (vi) any acts of dishonesty undertaken by the Executive and intended to result in substantial enrichment, at the Company's expense, of the Executive or any other Person.

9. Confidentiality; Covenant Not to Compete. As a condition subsequent to the execution of this Agreement and a condition to the receipt of the equity awards set forth in Section 7, and any severance set forth in Section 8, Executive must sign at the start of his employment a Confidentiality, Non Competition, Non-Solicitation and Intellectual Property Agreement to be provided by the Company, which among other provisions, will contain a 24 month non compete/non-solicitation provision.

10. Assignment and Binding Effect. This Agreement shall be binding upon and inure to the benefit of you and your heirs, executors, administrators, estate, beneficiaries, and legal representatives. Neither this Agreement nor any rights or obligations under this Agreement shall be assignable by Executive. The Company may assign this Agreement without Executive's consent.

11. Choice of Law and Venue. Except for the terms and conditions of any Equity Participation set forth in Section 7, which will be controlled by the language in any applicable plan documents relating to that Equity Participation, this Agreement shall be construed and interpreted in accordance with the laws of Pennsylvania. Each of the parties hereto agrees to the exclusive jurisdiction of the state and federal courts located in the Commonwealth of Pennsylvania for any and all actions between the parties. Any controversy or claim arising out of or relating to this Agreement or the breach thereof, whether involving remedies at law or in equity, shall be adjudicated in Pennsylvania.

12. Counterparts. This Agreement may be executed in any number of counterparts, each of which when so executed and delivered shall together constitute an original hereof.

13. Sections 280G and 409A of the Code. Notwithstanding anything to the contrary in this Agreement, the parties agree that this Agreement, and the employment agreement which Executive will sign upon starting work, shall be interpreted to comply with or be exempt from Sections 280(g) and 409A of the Internal Revenue Code of 1986, as amended, as interpreted and applied by the Board.

14. Relocation. The Company shall pay Executive's expenses reasonably incurred to relocate from

Northville, Michigan to Conshohocken, Pennsylvania in accordance with applicable Company plans and policies. For the avoidance of doubt, such expenses shall not include the purchase by the Company of Executive's current residence in Michigan or purchase of a new residence in the Conshohocken, Pennsylvania area. You shall be required to repay the Company the full amount of the expenses for which you are reimbursed within ninety (90) days of your separation date, if you resign from the Company within twelve (12) months of your start date or if you are terminated for cause, as that term is defined in Section 8(d) above, within twelve (12) months of your start date

15. Sign On Bonus. You will also receive a one-time sign-on bonus in the amount of two hundred thousand dollars (\$200,000.00), less applicable deductions and withholdings required by law, payable on or before March 15, 2016. You shall be required to repay the Company the full amount of the signing bonus within ninety (90) days of your separation date, if you resign from the Company within twelve (12) months of your start date or if you are terminated for cause, as that term is defined in Section 8(d) above, within twelve (12) months of your start date.

We are pleased to offer you this opportunity and look forward to a positive response. Let me know if you have any questions.

Very truly yours.

PQ CORPORATION

By: /s/ William J. Sichko Jr.

Name: William J. Sichko Jr.

Title: Chief Administrator Officer

ACCEPTED AND AGREED:

By: /s/ Ray Kolberg

Name: Ray Kolberg

Date: 12/8/2015

EXHIBIT A
FORM SEVERANCE AGREEMENT AND GENERAL RELEASE

This General Release and Waiver of Claims (hereafter "Agreement") is entered into by and between PQ Corporation, a Pennsylvania corporation (the "Company") and _____ (the "Executive") on ____ 20____.

In consideration of the mutual promises and covenants contained herein and in the employment offer dated December 8, 2015 (the "Employment Offer"), and other good and valuable consideration, the receipt of which hereby is acknowledged, the parties agree as follows:

Section 1. Release and Waiver of Claims. As of the Effective Date set forth below, in consideration of the payments, benefits, and other considerations provided to the Executive under the Employment Agreement and as set forth below, the Executive, for the Executive and the Executive's family, heirs, executors, administrators, legal representatives, and their respective successors and assigns (the "Related Parties"), hereby releases and forever discharges the Company, and all of its parents, affiliates, subsidiaries, divisions and joint ventures, and their respective officers, directors, Executives, agents, parents, stockholders, representatives, benefit plans and their successors and assigns (collectively, "Company Entities"), from all rights, claims, demands, suits, causes of action of any kind or nature whatsoever, known or unknown, foreseen or unforeseen, in law or in equity the Executive ever had, has or may have or which the Related Parties may have, arising at any time on or before the date hereof, based on or arising out of the Executive's dealings with any Company Entity, with respect to any claims relating to or arising out of the Executive's employment with any Company Entity or the termination of that employment, including without limitation any claims under the Employment Agreement, or based on any services provided to any Company Entity by the Executive pursuant to an employment relationship with any Company Entity. This includes a release of any and all rights, claims or demands the Executive may have, whether known or unknown, under the Age Discrimination in Employment Act ("ADEA" which prohibits age discrimination in employment; Title VII of the Civil Rights Act of 1964, which prohibits discrimination in employment based on race, color, national origin, religion or sex; the Equal Pay Act, which prohibits paying men and women unequal pay for equal work; or under any other federal, state or local laws or regulations regarding employment discrimination or termination of employment. This also includes a release by the Executive of any claims for wrongful discharge or discrimination under any statute, rule, regulation or under the common law, including, without limitation, the Sarbanes-Oxley Act.

This release is intended to be a general release and excludes only those claims under any statute or common law that Executive is legally barred from releasing. Executive understands that the release does not include and the parties hereto expressly reserve: any claim that cannot be released or waived as a matter of law; any claim for or right to vested benefits under Company's plans, including but not limited to any pension or retirement account benefits; any right to enforce any term of this Agreement and any surviving provisions of the Employment Agreement; any claims based on acts or events occurring after Executive signs this Agreement, except for claims arising from Executive's employment or termination of employment with Company, up to and through the date Executive signs this Agreement; any challenge to the validity of the Agreement; or any prohibition on the filing of a charge or complaint with, or testimony, assistance or participation in, any investigation, proceeding or hearing conducted by any federal, state or local governmental agency, including but not limited to the EEOC.

Section 2. Termination of Employment. Executive's last regular day of work will be _____, 20__, and his last official date of employment, if different, will be _____, 20____. On or before _____, 20____, Executive will comply with normal Company policies regarding separation from employment, including returning Company Confidential Information and equipment

Section 3. Consideration. The Company agrees to pay Executive the amounts and benefits set forth in Section 8(c) of the Employment Offer, and subject to the limitations and conditions set forth in Employment Offer.

Section 4. Affirmations. (a) Executive represents and agrees by signing the Agreement that he has not been denied any leave or benefit requested, has received the appropriate pay for all hours worked for Company and has

no known workplace injuries or occupational diseases. Other than the consideration set forth in Section 3 , Executive is not entitled to receive any other compensation or benefits under Section 8 of the Employment Offer or under any other severance plan or policy maintained by the Company. Executive further affirms that he has been paid and/or has received all leave (paid or unpaid), compensation, wages, bonuses and/or commissions to which Executive may be entitled and that no other leave (paid or unpaid), compensation, wages, bonuses and/or commissions are due to Executive, except as provided in this Agreement.

(b) Executive affirms he has neither filed, nor caused or permitted to be filed , on his behalf any charge, complaint, proceeding or action before any administrative agency or court against Company, and that no such charge, complaint, proceeding or action exists to his knowledge. If any administrative agency or court assumes jurisdiction of any charge, complaint, proceeding or action including a claim or course of action released in Section 1, Executive agrees not to accept, recover or receive any monetary damages or other relief from or in connection with such claim or cause of action.

Section 5. Rights Not Released or Waived. Section 1 hereof notwithstanding, by signing this Agreement Executive shall not have relinquished any right to enforce the provisions of this Agreement.

Section 6. Release and Waiver of Claims under the Age Discrimination in Employment Act. Executive acknowledges that the Company has encouraged Executive to consult with an attorney of Executive's choosing and, through this Agreement, encourages Executive to consult with an attorney with respect to any possible claims Executive may have, including claims under the ADEA, as well as under the other federal, state and local laws described in Section 1 hereof. Executive understands that by signing this Agreement Executive is in fact waiving, releasing and forever giving up any claim under the ADEA, as well as all other federal, state and local laws described in Section 1 hereof that may have existed on or prior to the date hereof.

Section 7. Waiting Period and Revocation Period. Executive hereby acknowledges that the Company has informed Executive that Executive has up to forty-five (45) days to consider this Agreement and Executive may knowingly and voluntarily waive that forty-five (45) day period by signing this Agreement earlier. Executive also understands that Executive shall have seven (7) days following the date on which Executive signs this Agreement within which to revoke it by providing a written notice of revocation to the Company by hand delivering or mailing it to _____, post-marked within the seven day period.

Section 8. Acceptance. To accept this Agreement, Executive shall execute and date this Agreement on the spaces provided and return a copy to the Company at any time during the forty-five (45) day period commencing on the date hereof, without extension of any kind (including by mutual agreement of the parties). Failure to accept within this time period will result in forfeiture of any rights conditioned upon delivery of this Agreement. This Agreement shall take effect on the eighth day following Executive's execution of this Agreement unless Executive's written revocation is delivered to the Company within seven (7) days after such execution, provided that date occurs within the 45 day period (the "Effective Date").

Section 9. Entire Agreement. This Agreement represents the entire agreement of the parties with respect to Executive's employment and termination thereof, except for _____.

THIS AGREEMENT SHALL BE GOVERNED BY AND CONSTRUED AND ENFORCED IN ACCORDANCE WITH THE LAWS OF THE STATE OF DELAWARE APPLICABLE TO CONTRACTS MADE AND TO BE PERFORMED ENTIRELY WITHIN SUCH STATE.

IN WITNESS WHEREOF, and with the intention of being legally bound hereby, the Executive has executed this General Release and Waiver of Claims.

PQ CORPORATION

RAY KOLBERG

By:

Execution Copy

SEVERANCE AGREEMENT

SEVERANCE AGREEMENT (the “*Agreement*”) dated as of September 25, 2017, by and between PQ Corporation, a Pennsylvania corporation (the “*Company*”), a wholly-owned subsidiary of PQ Group Holdings Inc., a Delaware corporation (“*Holdings*”), and Joseph S. Koscinski (the “*Executive*”).

WHEREAS, the Executive currently serves as Vice President, Secretary and General Counsel of the Company;

WHEREAS, the Executive is party to that certain Offer of Employment between the Executive and the Company dated September 18, 2015 (the “*Offer Letter*”); and

WHEREAS, the Agreement is intended to help retain the Executive and provide financial security to the Executive under circumstances entitling him to separation pay as provided herein; and

NOW, THEREFORE, in consideration of the covenants contained herein and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties hereto agree as follows:

ARTICLE I

DEFINITIONS AND INTERPRETATIONS

Section 1.01 Definitions. Capitalized terms used in the Agreement shall have the following respective meanings, except as otherwise provided or as the context shall otherwise require:

“*Accrued Obligations*” shall have the meaning set forth in Section 3.01(a).

“*Affiliate*” shall mean any company or other entity controlled by, controlling or under common control with Holdings.

“*Annual Bonus*” shall mean an annual bonus paid to the Executive under the Company’s (or Holdings’) annual incentive bonus plans or programs based upon the achievement of performance objectives established by the Board or Compensation Committee each year.

“*Base Salary*” shall mean the base salary (inclusive of any amounts deferred on a pre-tax basis pursuant to Code Sections 125, 132 or 401(k)) paid to the Executive immediately prior to the Termination Date on an annual basis (or, in the case of a termination for Good Reason due to prong (i) of section (B) of such definition, as in effect immediately prior to the reduction of the such Base Salary), exclusive of any Annual Bonus or other bonus payments or additional payments under any Benefit Plan.

“*Beneficial Owner*” shall have the meaning ascribed to such term in Rule 13d-3 under the Exchange Act.

“*Benefit Plan*” shall mean any “employee benefit plan” (including any employee benefit plan within the meaning of Section 3(3) of ERISA), program, arrangement or practice maintained, sponsored or provided

by the Company or Holdings, including but not limited to those relating to compensation, bonuses, profit-sharing, stock option, or other stock related rights or other forms of incentive or deferred compensation, paid time off benefits, insurance coverage (including any self-insured arrangements), health or medical benefits, disability benefits, life insurance benefits, workers' compensation, supplemental unemployment benefits, travel reimbursements, car allowances, moving expenses, taxable fringe benefits, gross-up payments to neutralize tax effects, separation pay and post-employment or retirement benefits (including compensation, pension, health, medical or life insurance or other benefits).

“**Benefits**” shall mean benefits the Executive may be entitled to due to his coverage or participation in the Benefit Plans.

“**Board**” shall mean the Board of Directors of Holdings.

“**Cause**” shall mean:

(A) the Executive's failure to perform such lawful duties reasonably requested by the CEO or Board, which failure, if susceptible of cure, remains uncured or continues or recurs thirty (30) days after the Executive's receipt of written notice from the Board specifying in reasonable detail the nature of such failure, *provided, however*, that it is understood that this clause (A) shall not permit the Company to terminate the Executive's employment for Cause because of dissatisfaction with the quality of services provided by or disagreement with the actions taken by the Executive in the good faith performance of the Executive's duties to the Company;

(B) the Executive's failure to observe any material written policies of Holdings, the Company or their Affiliates of which the Executive has notice;

(C) the Executive's gross negligence, willful disregard or willful misconduct in the performance of Executive's duties;

(D) the Executive's conviction, guilty plea or plea of nolo contendere of a felony or his commission of any act that the Board determines is involving moral turpitude, fraud or theft;

(E) the Executive materially breaching a fiduciary duty with respect to Holdings, the Company or their Affiliates;

(F) a material breach of this Agreement by the Executive; or

(G) any acts of dishonesty undertaken by the Executive with respect to the Company, Holdings or their Affiliates and intended to result in substantial enrichment, at the Company's, Holdings' or their Affiliates' expense.

“**Change in Control**” shall mean the first to occur of any of the following events:

(A) Any Person, becomes the Beneficial Owner, directly or indirectly, of more than fifty percent (50%) of the combined voting power, excluding any Person who holds fifty percent (50%) or more of the voting power on the Effective Date (the “**Initial Owners**”), of the then outstanding voting securities of Holdings entitled to vote generally in the election of its directors (the “**Outstanding Holdings Voting Securities**”) including by way of merger, consolidation or otherwise; *provided*,

however, that for purposes of this definition, the following acquisitions shall not constitute a Change in Control: (i) any acquisition of voting securities of Holdings directly from Holdings, including without limitation, a Public Offering of securities; (ii) any acquisition by Holdings or any of its Subsidiaries of Outstanding Holdings Voting Securities, including an acquisition by any employee benefit plan or related trust sponsored or maintained by Holdings or any of its Subsidiaries; or (iii) any acquisition after which the Initial Owners and their Affiliates remain the Beneficial Owners of more Outstanding Holdings Voting Securities than any other Person.

(B) Consummation of a reorganization, merger, or consolidation to which Holdings is a party or a sale or other disposition of all or substantially all of the assets of Holdings (a “**Business Combination**”), unless, following such Business Combination: (i) any individuals and entities that were the Beneficial Owners of Outstanding Holdings Voting Securities immediately prior to such Business Combination are the Beneficial Owners, directly or indirectly, of more than fifty percent (50%) of the combined voting power of the outstanding voting securities entitled to vote generally in the election of directors (or election of members of a comparable governing body) of the entity resulting from the Business Combination (including, without limitation, an entity which as a result of such transaction owns all or substantially all of Holdings or all or substantially all of Holdings’ assets either directly or through one or more Subsidiaries) (the “**Successor Entity**”) in substantially the same proportions as their ownership immediately prior to such Business Combination; (ii) no Person (excluding any Successor Entity or any employee benefit plan or related trust of Holdings, such Successor Entity, or any of their Subsidiaries) is the Beneficial Owner, directly or indirectly, of more than fifty percent (50%) of the combined voting power of the then outstanding voting securities entitled to vote generally in the election of directors (or comparable governing body) of the Successor Entity, except to the extent that such ownership existed prior to the Business Combination; and (iii) at least a majority of the members of the board of directors (or comparable governing body) of the Successor Entity were incumbent directors (including persons deemed to be incumbent directors) at the time of the execution of the initial agreement or of the action of the Board providing for such Business Combination.

Notwithstanding the foregoing, to the extent necessary to comply with Section 409A with respect to the payment of “nonqualified deferred compensation,” “Change in Control” shall be limited to a “change in control event” as defined under Section 409A. For the avoidance of doubt, neither a Public Offering nor any changes to the size or members of the Board in connection with or as a result of a Public Offering shall constitute or be deemed to result in a Change in Control.

For purposes of this definition of “Change in Control” the terms “Person” shall have the meaning ascribed to such term in Section 3(a)(9) of the Exchange Act and used in Sections 13(d) and 14(d) thereof, including a “group” as defined in Section 13(d) thereof.

“**COBRA**” shall mean the Consolidated Omnibus Budget Reconciliation Act of 1985, as amended.

“**Code**” shall mean the Internal Revenue Code of 1986, as amended, and the rules and regulations promulgated thereunder.

“**Code Section 409A**” shall mean Section 409A of the Code and the Treasury regulations and other interpretive rulings and guidance issued thereunder.

“**Common Stock**” means Holdings’ common stock, par value \$0.01 per share, as the same may be reclassified, exchanged or recapitalized.

“**Compensation Committee**” shall mean the Compensation Committee of the Board.

“**Confidential Information**” shall mean information that is not generally known to the public and that is or was used, developed or obtained by Holdings, the Company, or any of their Affiliates, including, but not limited to the following: (i) information, observations, procedures and data known by the Executive as a consequence of his employment with, or direct or indirect services as agent, employee or consultant, to or on behalf of, the Company or Holdings or any Affiliates of either of them concerning the business or affairs of Holdings, the Company or any of their Affiliates; (ii) products or services; (iii) costs and pricing structures; (iv) analyses; (v) drawings, photographs and reports; (vi) computer software, including operating systems, applications and program listings; (vii) flow charts, manuals and documentation; (viii) data bases; (ix) accounting and business methods; (x) inventions, devices, new developments, methods and processes, whether patentable or unpatentable and whether or not reduced to practice; (xi) customers, vendors, suppliers and customer, vendor and supplier lists; (xii) other copyrightable works; (xiii) all production methods, processes, technology and trade secrets and (xiv) all similar and related information in whatever form. Confidential Information will not include any information that has been published in a form generally available to the public prior to the date the Executive proposes to disclose or use such information. Confidential Information will not be deemed to have been published merely because individual portions of the information have been separately published, but only if all material features comprising such information have been published in combination.

“**Disability**” shall mean the inability to engage in substantial gainful activity by reason of any medically determinable physical or mental impairment that can be expected to result in death or can be expected to last for a continuous period of no less than 12 months as within the scope of the Company’s long term disability plan, as in effect from time to time, or if no such plan is in effect, “Disability” means “permanent and total disability” as defined in Code Section 22(e)(3).

“**Effective Date**” shall mean August 31, 2017.

“**ERISA**” shall mean the Employee Retirement Income Security Act of 1974, as amended, and the rules and regulations promulgated thereunder.

“**Exchange Act**” means the Securities Exchange Act of 1934, as amended, and the rules and regulations promulgated thereunder from time to time.

“**Good Reason**” shall mean, when used with reference to the Executive, any of the following actions or failures to act, but in each case only if it occurs while the Executive is employed by the Company and then only if it is not consented to by the Executive in writing:

(A) a material reduction in Executive’s title, authority, duties or responsibilities, excluding isolated or immaterial actions;

(B) a material reduction in: (i) the Executive’s Base Salary or (ii) the target bonus opportunity with respect to his Annual Bonus, other than an across-the-board reduction in Base Salary or bonus opportunity for all of the members of the Company’s management team;

(C) a demand by the Company that the Executive must relocate from his primary residence unless the Executive and the Company are in mutual agreement regarding such relocation; or

(D) a material breach by the Company of this Agreement.

The foregoing notwithstanding, for purposes of this definition, none of the actions described in clauses (A) through (D) above shall constitute “Good Reason” with respect to the Executive if it was an isolated and inadvertent action not taken in bad faith by the Company and if it is remedied by the Company within 30 days after receipt of written notice thereof given by the Executive as provided in the paragraph below. In the case of a demand from the Company that the Executive must relocate from his primary residence, as described in clause (C), the Executive must give the Company written notice within 30 days of the time the Company makes such relocation request. In the case of the actions described in clauses (A) through (D), if the matter is not capable of being remedied within 30 days, then such remedy needs to occur within a reasonable period of time following such 30-day period, provided that the Company has commenced such remedy within said 30-day period.

If the Executive believes that an event constituting Good Reason has occurred, the Executive must notify the Company in writing of that belief within 30 days of the occurrence of the Good Reason event, which notice will set forth the basis for that belief. The Company will have 30 days after receipt of such notice (or, if the matter is not capable of remedy within 30 days, then within a reasonable period of time following such 30-day period, provided that the Company has commenced such remedy within said 30-day period) (the “**Determination Period**”) in which to rectify such event, determine that an event constituting Good Reason does not exist, or determine that an event constituting Good Reason exists. If the Company does not take any of such actions within the Determination Period, the Executive may terminate his employment with the Company for Good Reason within the 30 day period following the end of the Determination Period by giving written notice to the Company in accordance with the provisions of Section 2.01, which termination will be effective on the Termination Date; if the Executive does not so terminate his employment within such time period his ability to terminate employment for Good Reason shall cease to exist upon the end of such period. If the Company determines that Good Reason does not exist, then (A) the Executive will not be entitled to rely on or assert such event as constituting Good Reason, and (B) the Executive may pursue his remedies under this Agreement within 30 days after the Executive’s receipt of written notice of the Company’s determination.

“**Person**,” except as otherwise provided in this Agreement, shall be construed broadly and shall include, without limitation, an individual, a partnership, an investment fund, a limited liability company, a corporation, an association, a joint stock company, a trust, a joint venture, an unincorporated organization and a governmental entity or any department, agency or political subdivision thereof.

“**Public Offering**” means the sale of shares of the Common Stock to the public pursuant to an effective registration statement (other than a registration statement on Form S-4 or S-8 or any similar or successor form) filed under the Securities Act in connection with an underwritten offering.

“**Severance Continuation Period**” shall mean the 24-month period following the Termination Date.

“**Subsidiary**” means any corporation, partnership, limited liability company or other entity, a majority of whose outstanding voting securities are owned, directly or indirectly, by Holdings.

“Target Bonus Payment” shall mean, for any given year, an amount equal to the Executive’s target bonus opportunity (expressed as a percentage of Base Salary) with respect to his Annual Bonus (without proration).

“Termination Date” shall mean the date on which the Executive is no longer employed by, and has a “separation from service” (within the meaning of Code Section 409A) from, the Company and its Affiliates.

“Termination Notice” shall mean, as appropriate, written notice from (a) the Executive to the Company purporting to terminate the Executive’s employment for or without Good Reason in accordance with Section 2.01 or (b) the Company to the Executive purporting to terminate the Executive’s employment for Cause or Disability in accordance with Section 2.02.

“Termination Year” shall mean the calendar year during which the Termination Date occurs.

“Work Product” shall mean all inventions, innovations, improvements, technical information, systems, software developments, methods, designs, analyses, drawings, reports, service marks, trademarks, tradenames, logos and all similar or related information (whether patentable or unpatentable) which relates to the Company’s, Holdings’ or any of its or their Subsidiaries’ actual or anticipated business, research and development or existing or future products or services and which are conceived, developed or made by the Executive (whether or not during usual business hours and whether or not alone or in conjunction with any other Person) while employed by the Company together with all patent applications, letters patent, trademark, tradename and service mark applications or registrations, copyrights and reissues thereof that may be granted for or upon any of the foregoing.

Section 1.02 Interpretation. In the Agreement (a) the words “herein,” “hereof” and “hereunder” refer to the Agreement as a whole and not to any particular Article, Section or other subdivision, (b) reference to any Article or Section, means such Article or Section hereof and (c) the words “including” (and with correlative meaning “include”) means including, without limiting the generality of any description preceding such term. The Article and Section headings herein are for convenience only and shall not affect the construction hereof.

ARTICLE II

ELIGIBILITY AND BENEFITS

Section 2.01 Termination Notices from Executive for Good Reason. For purposes of the Agreement, in order for the Executive to terminate his employment for Good Reason, the Executive must give a Termination Notice to the Company in accordance with the requirements specified under the definition of Good Reason in Section 1.01, which notice shall be signed by the Executive, shall be dated the date it is given to the Company, shall specify the Termination Date and shall state that the termination is for Good Reason and shall set forth in reasonable detail the facts and circumstances claimed to provide a basis for such Good Reason. In the event that the Executive voluntarily terminates his employment without Good Reason, the Executive must give a Termination Notice to the Company, which shall specify the Termination Date, which date shall not be less than 30 days from the date the Termination Notice is given. In such cases, the Board may, in its discretion, accelerate the effective date of such termination of employment and pay the Executive Base Salary in lieu of such notice.

Section 2.02 Termination Notices from Company for Cause or Disability. For purposes of the Agreement, in order for the Company to terminate the Executive’s employment for Cause, the Company must give a Termination Notice to the Executive, which notice shall be in writing and dated the date it is

given to the Executive, shall specify the Termination Date and shall state that the termination is for Cause and shall set forth in reasonable detail the particulars thereof. For purposes of the Agreement, in order for the Company to terminate the Executive's employment for Disability, the Company must give a Termination Notice to the Executive, which notice shall be dated the date it is given to the Executive, shall specify the Termination Date and shall state that the termination is for Disability and shall set forth in reasonable detail the particulars thereof. Any Termination Notice given by the Company that does not comply, in all material respects, with the foregoing requirements shall be invalid and ineffective for purposes of the Agreement. Any Termination Notice purported to be given by the Company to the Executive after the death or retirement of such Executive shall be invalid and ineffective. Executive and his/her representative(s) will cooperate fully in providing all evidence that the Board needs to determine Disability.

ARTICLE III

SEVERANCE AND RELATED TERMINATION BENEFITS

Section 3.01 Termination of Employment.

(a) *Voluntary Termination by Executive.* In the event that the Executive's employment is terminated by the Executive other than for Good Reason, then the Executive shall be paid, within 30 days following the Termination Date (unless applicable state law requires sooner payment), the following (with the benefits set forth in (1) and (2) collectively referred to as the "*Accrued Obligations*"):

- (1) the Base Salary through the Termination Date, to the extent not already paid, and any amounts due for paid time off or vacation bank through the Termination Date; and
- (2) reimbursement for any unreimbursed business expenses properly incurred by the Executive, in accordance with the Company's applicable policy, prior to the Termination Date, to the extent such reimbursements are submitted to the Company within 30 days following the Termination Date.

Following the Executive's termination of employment other than for Good Reason, except as set forth in this Section 3.01(a), the Executive shall have no further rights to any compensation or any other benefits in the nature of severance or termination pay or in connection with the termination of his employment.

(b) *For Cause.* In the event that the Executive's employment is terminated by the Company for Cause, then the Executive shall be paid, within 30 days following the Termination Date (unless applicable state law requires sooner payment), the Accrued Obligations through the Termination Date.

Following the Executive's termination of employment by the Company for Cause, except as set forth in this Section 3.01(b), the Executive shall have no further rights to any compensation or any other benefits in the nature of severance or termination pay or in connection with the termination of his employment.

(c) *Disability or Death.* In the event that the Executive's employment is terminated (i) by the Company by reason of the Executive's Disability or (ii) as a result of the Executive's death, then in either case, the following benefits shall be paid to the Executive or the Executive's estate, as applicable:

- (1) the Accrued Obligations (at the time set forth in Section 3.01(a));
and

- (2) within 60 days following the Termination Date, a lump-sum cash payment equal to the product of (i) the Target Bonus Payment and (ii) a fraction, the numerator of which is the number of days during which the Executive was employed by the Company in the Termination Year and the denominator of which is 365.

Following the Executive's termination of employment due to death or Disability, except as set forth in this Section 3.01(c), the Executive shall have no further rights to any compensation or any other benefits in the nature of severance or termination pay or in connection with the termination of his employment.

(d) *Without Cause or for Good Reason Before a Change in Control.* In the event that the Executive's employment is terminated before a Change in Control (i) by the Company without Cause (other than due to Disability or death) or (ii) by the Executive for Good Reason, then, subject to the provisions of Section 3.02 and Section 5.02(a) and (b) (under certain circumstances requiring a six month suspension of payments) hereof, in either case, the following benefits shall be paid to the Executive:

- (1) the Accrued Obligations (at the time set forth in Section 3.01(a));
- (2) a continuation of the Executive's Base Salary during the Severance Continuation Period, which shall be paid at the same time and in the same manner as if the Executive had remained employed by the Company during such period; *provided, however,* that the payments normally payable during the 60-day period following the Termination Date shall be accrued and paid in a lump sum within five days following the end of such 60-day period;
- (3) a pro rata amount of the Annual Bonus, if any, which would have been payable for the calendar year in which such termination occurs, determined at the same time and in the same manner as would have occurred if the Executive's employment had not been terminated during such calendar year and equal to the amount which would have been payable to the Executive if the Executive's employment had not been terminated during such calendar year multiplied by a fraction, the numerator of which is the number of days the Executive was employed by the Company during such calendar year and the denominator of which is 365. Any pro rata Annual Bonus payable under this subsection shall be paid in a lump sum at the same time the Annual Bonus amounts would have been paid if the Executive's employment had continued until the normal Annual Bonus payment date;
- (4) a cash payment equal to two (2) times the Target Bonus Payment for the year in which the Termination Date occurs (or, in the case of a termination for Good Reason due to prong (ii) of section (B) of such definition, based on the target bonus opportunity immediately prior to any reduction of it), payable in as nearly equal installments as possible over the Severance Continuation Period, *provided, however,* that the payments normally payable during the 60-day period following the Termination Date shall be accrued and paid in a lump sum within five days following the end of such 60-day period; and
- (5) during the Severance Continuation Period, the Executive and his eligible dependents as of the Termination Date shall continue to be covered by all medical, vision and dental Benefit Plans (excluding disability and life

insurance) maintained by the Company, and at the same single / family / spouse only / other option, under which the Executive was covered immediately prior to the Termination Date (collectively, the “**Continued Health Benefits**”) at the same active Executive premium cost as a similarly situated active executive; *provided, however*, in any case such Benefits shall cease if the Executive becomes entitled to medical benefits, dental and vision benefits from a new employer as provided in Section 3.03(a). The Company may provide such medical, vision and dental benefits by reimbursing Executive for his cost for COBRA (or, if the Company determines it is possible, by making other arrangements to relieve Executive of such cost) in an amount equal to what the Company was previously paying on behalf of Executive for such benefits through such Severance Continuation Period and comparable amounts if the COBRA continuation period expires prior to the expiration of the Severance Continuation Period.

Following the Executive’s termination of employment by the Company without Cause or by the Executive for Good Reason, except as set forth in this Section 3.01(d), the Executive shall have no further rights to any compensation or any other benefits in the nature of severance or termination pay or in connection with the termination of his employment.

(e) *Without Cause or For Good Reason Following a Change in Control.* In the event that the Executive’s employment is terminated within one year following a Change in Control either (i) by the Executive for Good Reason or (ii) by the Company without Cause (other than due to Disability or death), then, subject to provisions of Section 3.02 and Section 5.02(a) and (b) (under certain circumstances requiring a six month suspension of payments) hereof, in either case, the following benefits shall be paid to the Executive:

- (1) the Accrued Obligations (at the time set forth in Section 3.01(a));
- (2) a continuation of the Executive’s Base Salary during the Severance Continuation Period, which shall be paid at the same time and in the same manner as if the Executive had remained employed by the Company during such period; *provided, however*, that the payments normally payable during the 60-day period following the Termination Date shall be accrued and paid in a lump sum within five days following the end of such 60-day period;
- (3) a pro rata amount of the Annual Bonus, if any, which would have been payable for the calendar year in which such termination occurs, determined at the same time and in the same manner as would have occurred if the Executive’s employment had not been terminated during such calendar year and equal to the amount which would have been payable to the Executive if the Executive’s employment had not been terminated during such calendar year multiplied by a fraction, the numerator of which is the number of days the Executive was employed by the Company during such calendar year and the denominator of which is 365. Any pro rata Annual Bonus payable under this subsection shall be paid in a lump-sum at the same time the Annual Bonus amounts would have been paid if the Executive’s employment had continued until the normal Annual Bonus payment date;

- (4) a cash payment equal to two (2) times the Target Bonus Payment for the year in which the Termination Date occurs (or, in the case of a termination for Good Reason due to prong (ii) of section (B) of such definition, based on the target bonus opportunity immediately prior to any reduction of it), payable in as nearly equal installments as possible over the Severance Continuation Period, *provided, however*; that the payments normally payable during the 60-day period following the Termination Date shall be accrued and paid in a lump sum within five days following the end of such 60-day period; and
- (5) during the Severance Continuation Period, the Executive and his eligible dependents as of the Termination Date shall continue to receive the Continued Health Benefits at the same active Executive premium cost as a similarly situated active executive; *provided, however*; in any case such Continued Health Benefits shall cease if the Executive becomes entitled to medical benefits, dental and vision benefits from a new employer as provided in Section 3.03(a). The Company may provide such medical, vision and dental benefits by reimbursing Executive for his cost for COBRA (or, if the Company determines it is possible, by making other arrangements to relieve Executive of such cost) in an amount equal to what the Company was previously paying on behalf of Executive for such benefits through such Severance Continuation Period and comparable amounts if the COBRA continuation period expires prior to the expiration of the Severance Continuation Period.

Following the Executive's termination of employment within one year following a Change in Control either (i) by the Executive for Good Reason or (ii) by the Company without Cause, except as set forth in this Section 3.01(e), the Executive shall have no further rights to any compensation or any other benefits in the nature of severance or termination pay or in connection with the termination of his employment.

(f) *Vested Benefits.* Following the Executive's termination of employment under Section 3.01(a), (b), (c), (d), or (e) he shall be entitled to payment or distribution of such vested Benefits, if any, as to which the Executive may be entitled under the Benefit Plans pursuant to the terms of the applicable plans then in effect. Notwithstanding the foregoing, nothing in this Agreement shall provide accelerated or enhanced vesting beyond the terms, conditions and provisions set forth in the Benefit Plans. With respect to entitlement to vested Benefits, in the event of conflict between this Agreement and the Benefit Plans, the Benefit Plans shall control.

(g) *Treatment of Continued Health Benefits.* The premium cost to the Company of providing any Continued Health Benefits which are medical, dental or vision benefits on a self-insured basis, will be timely reported to the Executive as taxable income, unless the Company determines that applicable law permits some other treatment. Any continued medical, dental or vision benefits provided to Executive and his dependents pursuant to Section 3.01(d) or (e) are provided concurrently with any rights the Executive and such dependents may have to continue such coverages under COBRA. The provisions of this Section 3.01 will not prohibit the Company from changing the terms of such Continued Health Benefits provided that any such changes apply to all similarly situated executives of the Company and its Affiliates (e.g., the Company may switch insurance carriers or preferred provider organizations).

Section 3.02 Condition to Receipt of Separation Pay. As a condition to receipt (or retention, as applicable) of any payment or amounts under Section 3.01(d) and (e), the Executive must (a) enter into a General Release and Waiver of Claims ("**Release Agreement**") with the Company and its Affiliates in substantially the form attached as **Exhibit A** and (b) continue to comply with his obligations under Article

IV of this Agreement. The Executive must execute and return the Release Agreement to the Company no later than the time period established by the Company which shall be no longer than 45 days from the date Executive receives the Release Agreement, followed by a seven (7)-day revocation period following the date the Release Agreement is executed (“**Revocation Period**”). The Executive’s failure to timely execute and return the Release Agreement in accordance with the previous sentence, or the Executive’s revocation of the Release Agreement during the Revocation Period, will result in a forfeiture of all benefits payable to the Executive under the terms of the Agreement other than the Accrued Obligations and any vested Benefits described under Section 3.01(f).

Section 3.03 Limitation of Benefits.

(a) Anything in the Agreement to the contrary notwithstanding, the Company’s obligation to provide the Continued Health Benefits shall cease if and when the Executive becomes employed by a third party that provides such Executive with substantially comparable health and welfare benefits, subject to the Executive’s right to elect to continue coverage under COBRA at his own cost.

(b) Any amounts payable under the Agreement shall be in lieu of and not in addition to any other severance or termination payment under any other plan or agreement with the Company. As a condition to receipt of any payment under the Agreement, the Executive shall waive any entitlement to any other severance or termination payment by the Company, including any severance or termination payment set forth in an individual employment agreement with the Company. Notwithstanding the foregoing and subject to Section 3.01(f), nothing in this Section 3.03(b) shall abridge the Executive’s rights with respect to vested benefits under any Benefit Plan.

Section 3.04 Certain Excise Taxes. Notwithstanding anything to the contrary in this Agreement, if the Executive is a “**disqualified individual**” (as defined in Code Section 280G(c)), and the payments and benefits provided for in this Agreement, together with any other payments and benefits which the Executive has the right to receive from the Company or any of its Affiliates, would constitute a “**parachute payment**” (as defined in Code Section 280G(b)(2)), then the payments and benefits provided for in this Agreement shall be either (a) reduced (but not below zero) so that the present value of such total amounts and benefits received by the Executive from the Company and its Affiliates will be one dollar (\$1.00) less than three (3) times Executive’s “**base amount**” (as defined in Code Section 280G(b)(3)) and so that no portion of such amounts and benefits received by the Executive shall be subject to the excise tax imposed by Code Section 4999 or (b) paid in full, whichever produces the better net after tax position to the Executive (taking into account any applicable excise tax under Code Section 4999 and any other applicable taxes). The reduction of payments and benefits mentioned hereunder, as applicable, shall be made by reducing such payments and benefits first, to the extent of any severance payments due pursuant to Article 3 paid in cash, with later payments being reduced first. Thereafter, the reduction shall be made by: (A) the waiver of accelerated vesting of equity awards, with awards having a later vesting date being reduced first; (B) next, cutting back on the benefit continuation pursuant to Section 3; and (C) lastly, reducing all other payments or benefits, with later payments being reduced first. The determination as to whether any such reduction in the amount of the payments and benefits provided hereunder is necessary shall be made by Holdings in good faith. If a reduced payment or benefit is made or provided and through error or otherwise that payment or benefit, when aggregated with other payments and benefits from the Company (or its Affiliates) used in determining if a parachute payment exists, exceeds one dollar (\$1.00) less than three (3) times the Executive’s base amount, then the Executive shall immediately repay such excess to the Company upon notification that an overpayment has been made. In the event any reduction under this Agreement is disputed by the Executive, then determinations required to be made under this Section 3.04, including the assumptions to be utilized in arriving at such determination, shall be made by an outside nationally recognized accounting or consulting firm selected by Holdings or the Board, in its reasonable discretion (the “**Accounting Firm**”), which shall provide detailed supporting

calculations both to Holdings and the Executive within 15 business days of the receipt of notice from the Executive that there has been a payment hereunder, or such earlier time as is requested by Holdings. In no event shall the Accounting Firm be an accounting firm that was, or is, serving as accountant or auditor for the individual, entity or group affecting the change of ownership or effective control of Holdings. Nothing in this Section 3.04 shall require the Company or Holdings (or any of their respective Affiliates) to be responsible for, or have any liability or obligation with respect to, the Executive's excise tax liabilities under Code Section 4999.

Section 3.05 Unfunded; Executive's Rights Unsecured. The Company shall not be required to establish any special or separate fund or make any other segregation of funds or assets to assure the payment of any benefit hereunder. The right of the Executive to receive the benefits provided for herein shall be an unsecured obligation against the general assets of the Company.

ARTICLE IV

CERTAIN AGREEMENTS

Section 4.01 Nondisclosure and Nonuse of Confidential Information. The Executive will not disclose or use at any time, either during his employment with the Company or its Affiliates or thereafter, any Confidential Information of which the Executive is or becomes aware, except to the extent that (i) such disclosure or use is directly related to and required by the Executive's performance of duties assigned to the Executive by the Company; (ii) to the extent that such disclosure is required in connection with any action by the Executive to enforce rights under this Agreement or (iii) such disclosure is required by a court of law, governmental agency, or by any administrative or legislative body with jurisdiction to order the Executive to divulge or disclose such Confidential Information; provided, that, the Executive shall provide ten (10) days prior written notice to the Company of any such requirement or order to disclose Confidential Information so that the Company may seek a protective order or similar remedy; and, provided, further, that, in each case set forth above, the Executive informs the recipients that such information or communication is confidential in nature. In addition, nothing in this Agreement limits, restricts or in any other way affects the Executive's communicating with any governmental agency or entity, or communicating with any official or staff person of a governmental agency or entity, concerning matters relevant to the governmental agency or entity. The Executive cannot be held criminally or civilly liable under any federal or state trade secret law for disclosing a trade secret (a) in confidence to a federal, state, or local government official, either directly or indirectly, or to an attorney, solely for the purpose of reporting or investigating a suspected violation of law, or (b) in a complaint or other document filed under seal in a lawsuit or other proceeding. Notwithstanding this immunity from liability, the Executive may be held liable if Executive unlawfully accesses trade secrets by unauthorized means.

Section 4.02 Inventions and Patents. The Executive agrees that all Work Product belongs to the Company. The Executive will promptly disclose such Work Product to the Board and perform all actions reasonably requested by the Board (whether during or after the Employment Period) to establish and confirm such ownership (including, without limitation, the execution and delivery of assignments, consents, powers of attorney and other instruments) and to provide reasonable assistance to the Company in connection with the prosecution of any applications for patents, trademarks, trade names, service marks or reissues thereof or in the prosecution or defense of interferences relating to any Work Product.

Section 4.03 Non-Compete and Non-Solicitation. The Executive acknowledges and agrees with the Company that during the course of the Executive's employment with the Company, the Executive will have the opportunity to develop relationships with existing employees, customers and other business associates of Holdings, the Company and their Subsidiaries (collectively, "**PQ**") which relationships

constitute goodwill of PQ, and PQ would be irreparably damaged if the Executive were to take actions that would damage or misappropriate such goodwill. Accordingly, the Executive agrees as follows:

(a) The Executive acknowledges that PQ currently conducts its business throughout the world (the “*Territory*”). Accordingly, during the Executive’s employment with the Company and during the 24-month period following the Termination Date (the “*Non-Compete Period*”), the Executive shall not, directly or indirectly, enter into, engage in, assist, give or lend funds to or otherwise finance, be employed by or consult with, or have a financial or other interest in, any Person that offers one or more products or services or engages in a business, in each case, that is directly competitive with a product or service or the business of PQ, as conducted or in active planning (a “*Competitor*”), whether for or by himself or in any other capacity. To the extent that the covenant provided for in this Section 4.03(a) may later be deemed by a court to be too broad to be enforced with respect to its duration or with respect to any particular activity or geographic area, the court making such determination shall have the power to reduce the duration or scope of the provision, and to add or delete specific words or phrases to or from the provision. The provision as modified shall then be enforced. Notwithstanding the foregoing restriction, it shall not be a violation of this Section 4.03(a) for the Executive to work for a Competitor if: (i) the Executive works in a separate legal subsidiary or Affiliate that offers products or services or conducts a business, in each case, that is not directly competitive with PQ, (ii) the Executive informs Holdings in writing prior to accepting the position how such position complies with the terms of this subsection, and (iii) Holdings consents to Executive’s employment with such entity, which consent shall not be unreasonably withheld.

(b) Notwithstanding the foregoing, the aggregate ownership by the Executive of no more than two percent (on a fully-diluted basis) of the outstanding equity securities of any Person, which securities are traded on a national or foreign securities exchange, quoted on the NASDAQ stock market or other automated quotation system, and which Person competes with PQ (or any part thereof) within the Territory, shall not be deemed to be a violation of Section 4.03(a). In the event that any Person in which the Executive has any financial or other interest directly or indirectly enters into a line of business during the Non-Compete Period that competes with PQ or engages in the business of PQ within the Territory, the Executive shall divest all of his interest (other than as permitted to be held pursuant to the first sentence of this Section 4.03(b)) in such Person within 15 days after such Person enters into such line of business that competes with PQ or engages in such business within the Territory; provided that, in the event that such equity interest is not publicly traded, the Executive will divest such interest as promptly as practicable and, pending such divestiture, will recuse himself from any and all activities that would be in competition, whether directly or indirectly, with PQ or that would otherwise be precluded under Section 4.03(a). For the avoidance of doubt, the immediately preceding sentence shall not be construed as an amendment, waiver or modification to any other term or provision of this Agreement, or to any restrictive covenant or other provision contained in any agreement between the Executive, Holdings, the Company or any Affiliate of any of them and in the event that the Executive does not promptly divest such interest and recuse himself from competitive activities with such non-public entity while attempting to divest his interest in such entity or engages in any activity that would otherwise be precluded under Section 4.03(a), the Executive’s termination shall be immediately deemed a termination of employment for Cause pursuant to the terms of this Agreement.

(c) The Executive covenants and agrees that during the Executive’s employment with the Company and during the 24-month period following the Termination Date, except as expressly provided herein, the Executive will not, directly or indirectly, either for himself or for any other Person (i) solicit or attempt to induce any employee or consultant of PQ to terminate his employment; (ii) employ any employee or consultant of PQ during the period of his employment or consulting relationship with PQ; (iii) solicit any customer of PQ to purchase or distribute information, products or services of or on behalf of the Executive or such other Person that are competitive with the information, products or services provided by PQ or

(iv) take any action that may cause injury to or interfere with the relationships between PQ or any of their employees and any lessor, lessee, vendor, supplier, customer, distributor, employee, consultant or other business associate of PQ or any of its Subsidiaries as such relationship relates to PQ's conduct of its business.

(d) The Executive understands that the foregoing restrictions may limit his ability to earn a livelihood in a business similar to the business of the Company and any of its Affiliates, but he nevertheless believes that he has received and will receive sufficient consideration and other benefits as an employee of PQ and as otherwise provided hereunder or as described in the recitals hereto to clearly justify such restrictions which, in any event (given his education, skills and ability), the Executive does not believe would prevent him from otherwise earning a living.

ARTICLE V

MISCELLANEOUS PROVISIONS

Section 5.01 Cumulative Benefits. Except as provided in Section 3.03(b), the rights and benefits provided to the Executive under the Agreement are in addition to and shall not be a replacement of, all of the other rights and benefits provided to such Executive under any Benefit Plan or any agreement between such Executive and the Company.

Section 5.02 Code Section 409A.

(a) It is intended that the payments and benefits provided under the Agreement shall be exempt from or comply with the application of the requirements of Code Section 409A.

(b) This Agreement shall be construed, administered and governed in a manner that affects such intent. For purposes of Code Section 409A, each payment made under this Agreement is intended to be a separate payment. Any taxable benefits or payments provided under the Agreement are intended to qualify for the "short-term deferral" exception to Code Section 409A to the maximum extent possible, and to the extent they do not so qualify, are intended to qualify for the separation (severance) pay exceptions to Code Section 409A, to the maximum extent possible. To the extent that none of these exceptions (or any other available exception) applies, then notwithstanding anything contained herein to the contrary, and to the extent required to comply with Code Section 409A, if the Executive is a "specified employee," as determined by the Company in accordance with Code Section 409A, as of the Termination Date, then all amounts due under the Agreement that constitute a "deferral of compensation" within the meaning of Code Section 409A, that are provided as a result of a "separation from service" within the meaning of Code Section 409A, and that would otherwise be paid or provided during the first six months following the Termination Date, shall be accumulated through and paid or provided on the first business day that is more than six months after the date of the Termination Date (or, if the Executive dies during such six -month period, within 90 days after the Executive's death). In no event shall the Executive be permitted, directly or indirectly, to designate the taxable year of payment.

(c) With regard to any provision herein that provides for reimbursement of costs and expenses or in-kind benefits, except as permitted by Code Section 409A: (i) the right to reimbursement or in-kind benefits shall not be subject to liquidation or exchange for another benefit; (ii) the amount of expenses eligible for reimbursement, or in-kind benefits, provided during any calendar year shall not affect the expenses eligible for reimbursement, or in-kind benefits to be provided, in any other calendar year; and (iii) such payments shall be made on or before the last day of the Executive's calendar year following the calendar year in which the expense occurred, or such earlier date as required hereunder. The payments and benefits provided under the Agreement may not be deferred, accelerated, extended, paid out or modified in a manner

that would result in the imposition of an additional tax, interest, penalties or other monetary amounts under Code Section 409A upon the Executive. Although the Company will use its best efforts to avoid the imposition of taxation, interest, penalties or other monetary amounts under Section 409A of the Code, the tax treatment of the benefits provided under the Agreement is not warranted or guaranteed. None of the Company, Holdings or their Affiliates, or their respective directors, officers, executives or advisers shall be held liable for any taxes, interest, penalties or other monetary amounts owed by the Executive (or any other individual claiming a benefit through the Executive) as a result of the Agreement.

Section 5.03 No Mitigation. The Executive shall not be required to mitigate the amount of any payment provided for in the Agreement by seeking or accepting other employment following a termination of his employment with the Company or otherwise. Except as otherwise provided in Section 3.03, the amount of any payment provided for in the Agreement shall not be reduced by any compensation or benefit earned by the Executive as the result of employment by another employer or by retirement benefits. Except as set forth in Section 5.18 or as otherwise set forth herein, the Company's obligations to make payments to the Executive required under the Agreement shall not be affected by any set off, counterclaim, recoupment, defense or other claim, right or action that the Company may have against such Executive.

Section 5.04 No Employment Rights Conferred. This Agreement shall not be deemed to create a contract of employment between the Executive and the Company and/or its Affiliates. Nothing contained in the Agreement shall (a) confer upon the Executive any right with respect to continuation of employment with the Company or (b) subject to the rights and benefits of the Executive hereunder, interfere in any way with the right of the Company to terminate the Executive's employment at any time and for any reason.

Section 5.05 Severability. It is the desire and intent of the parties hereto that the provisions of this Agreement be enforced to the fullest extent permissible under the laws and public policies applied in each jurisdiction in which enforcement is sought. Accordingly, if any particular provision of this Agreement shall be adjudicated by a court of competent jurisdiction to be invalid, prohibited or unenforceable for any reason, such provision, as to such jurisdiction, shall be ineffective, without invalidating the remaining provisions of this Agreement or affecting the validity or enforceability of this Agreement or affecting the validity or enforceability of such provision in any other jurisdiction. Notwithstanding the foregoing, if such provision could be more narrowly drawn so as not to be invalid, prohibited or unenforceable in such jurisdiction, it shall, as to such jurisdiction, be so narrowly drawn, without invalidating the remaining provisions of this Agreement or affecting the validity or enforceability of such provision in any other jurisdiction.

Section 5.06 Notices. All notices, requests, demands, claims and other communications hereunder shall be in writing and sufficient if (i) delivered personally, (ii) delivered by certified United States Post Office mail, return receipt requested, (iii) telecopied or (iv) sent to the recipient by a nationally-recognized overnight courier service (charges prepaid) and addressed to the intended recipient as set forth below:

if to the Executive, to him at his most recent address in the Company's records,

if to Holdings or the Company:

PQ Corporation
300 Lindenwood Drive
Valleybrooke Corporate Center
Malvern, PA 19355-1740
Attention: William J. Sichko, Jr.,
Chief Administrative Office
Facsimile: 610-651-4273;

or such other address as the recipient party to whom notice is to be given may have furnished to the other party in writing in accordance herewith. Any such communication shall be deemed to have been delivered and received (a) in the case of personal delivery, on the date of such delivery, (b) in the case of delivery by mail, on the third business day following such mailing, (c) if telecopied, on the date telecopied, and (d) in the case of delivery by nationally-recognized, overnight courier, on the business day following dispatch.

Section 5.07 Enforcement. Because the Executive's services are unique and because the Executive has access to Confidential Information and Work Product, the parties hereto agree that money damages would be an inadequate remedy for any breach of this Agreement. Therefore, in the event of a breach or threatened breach of this Agreement, the Company or its successors or assigns may, in addition to other rights and remedies existing in their favor, apply to any court of competent jurisdiction for specific performance and/or injunctive or other relief in order to enforce, or prevent any violations of, the provisions hereof (without posting a bond or other security).

Section 5.08 Entire Agreement. This Agreement, the agreements and documents referenced herein, including but not limited to the Benefit Plans, and the General Release and Waiver of Claims embody the complete agreement and understanding among the parties and supersede and preempt any prior or contemporaneous understandings, agreements or representations by or among the parties, written or oral, which may have related to the subject matter hereof in any way, including but not limited to, the Offer Letter and any other employment agreement or offer letter. As of the Effective Date, the Offer Letter shall terminate and be of no further force or effect.

Section 5.09 Counterparts. This Agreement may be executed in two or more counterparts, each of which shall be deemed an original and all of which together shall constitute one and the same instrument. The parties hereto agree to accept a signed facsimile copy of this Agreement as a fully binding original.

Section 5.10 Successors and Assigns. Except as otherwise provided herein, this Agreement shall bind and inure to the benefit of and be enforceable by the Executive and the Company and their respective successors, assigns, heirs, executors, administrators, legal representatives and estate, as the case may be, provided, however, that the obligations of the Executive under this Agreement shall not be assigned without the prior written consent of the Company.

Section 5.11 Amendment and Waiver. The provisions of this Agreement may be amended and waived only with the prior written consent of the Company and the Executive, and no course of conduct or failure or delay in enforcing the provisions of this Agreement shall affect the validity, binding effect or enforceability of this Agreement or any provision hereof.

Section 5.12 Governing Law. This Agreement shall be governed by and construed in accordance with the domestic laws of the Commonwealth of Pennsylvania without giving effect to any choice or conflict of law provision or rule that would cause the application of the laws of any jurisdiction other than the Commonwealth of Pennsylvania.

Section 5.13 Descriptive Headings: Nouns and Pronouns. Descriptive headings are for convenience only and shall not control or affect the meaning or construction of any provision of this Agreement. Whenever the context may require, any pronouns used herein shall include the corresponding masculine, feminine or neuter forms, and the singular form of nouns and pronouns shall include the plural and vice-versa.

Section 5.14 Taxes. The Company shall have the power to withhold, or require the Executive to remit to the Company, as the case may be, promptly upon notification of the amount due, an amount sufficient to satisfy the amount of all Federal, state, local and foreign withholding tax requirements with respect to any

payment of cash, or issuance or delivery of any other property hereunder to the Executive or any third party, and the Company may defer any such payment of cash or issuance or delivery of such other property until such requirements are satisfied.

Section 5.15 Waiver of Jury Trial. EACH OF THE PARTIES HERETO HEREBY IRREVOCABLY AND UNCONDITIONALLY WAIVES ALL RIGHT TO TRIAL BY JURY IN ANY ACTION, PROCEEDING OR COUNTERCLAIM ARISING OUT OF OR RELATING TO THIS AGREEMENT. Each party certifies and acknowledges that (i) no representative, agent or attorney of any other party has represented, expressly or otherwise, that such other party would not, in the event of litigation, seek to enforce the foregoing waiver, (ii) each such party understands and has considered the implications of this waiver, (iii) each such party makes this waiver voluntarily, and (iv) each such party has been induced to enter into this Agreement by, among other things, the mutual waivers and certifications in this Section 5.15.

Section 5.16 Arbitration. The parties agree that any dispute, controversy, or claim arising out of or related in any way to this Agreement or any breach of this Agreement, or to any matter relating to Executive's employment with the Company and his separation therefrom, including but not limited to any disputes between Executive and employees and/or agents of Holdings, the Company and their affiliates, shall be submitted to and decided by binding arbitration in (i) at the election of Holdings, Philadelphia, PA or the county in which Holdings' or the Company's headquarters are then located or (ii) if the Executive and Holdings mutually agree in writing, any other location. Arbitration shall be administered under the laws of the American Arbitration Association in accordance with Commercial Arbitration Rules ("AAA") in effect at the time the arbitration is commenced. The arbitration will be held before a panel of three arbitrators, unless the parties agree to have a single arbitrator hear the case. To the extent not provided for in the AAA, the Arbitrator has the power to order discovery upon a showing that discovery is necessary for a party to have a fair opportunity to present a claim or defense. This Agreement to arbitrate covers all grievances, disputes, claims, or causes of action that otherwise could be brought in a federal, state, or local court or agency under applicable federal, state, or local laws, arising out of or relating to Executive's severance with, including claims Executive may have against Holdings, the Company, their Affiliates or against their officers, directors, supervisors, managers, employees, or agents in their capacity as such or otherwise, or that Holdings or the Company may have against Executive, *provided however*, that nothing in this Section 5.16 or otherwise shall prohibit Holdings, the Company or its Affiliates from enforcing any matter set forth in Article IV in a court of competent jurisdiction. Except as related to matters set forth in Article IV hereof, any arbitral award determination shall be final and binding upon the parties. Judgment on the award rendered by the arbitrator may be entered in any court having jurisdiction thereof. All proceedings and communications will be kept confidential by the parties, their counsel and other agents, as well as by the arbitrator. If any provision of this agreement to arbitrate is adjudged to be void or otherwise unenforceable, in whole or in part, the void or unenforceable provision shall be severed and such adjudication shall not affect the validity of the remainder of this agreement to arbitrate. This agreement to arbitrate shall survive the termination of Executive's employment. It can only be revoked or modified in writing signed by both parties that specifically states an intent to revoke or modify this agreement to arbitrate.

Section 5.17 Further Assurances. Each party hereto agrees with the other party hereto that it will cooperate with such other party and will execute and deliver, or cause to be executed and delivered, all such other instruments and documents, and will take such other actions, as such other parties may reasonably request from time to time to effectuate the provisions and purposes of this Agreement.

Section 5.18 Clawback. If Holdings is required to prepare an accounting restatement due to the material noncompliance of Holdings, as a result of misconduct, with any financial reporting requirement under the securities laws, then, if the Executive is one of the individuals subject to automatic forfeiture under Section 304 of the Sarbanes-Oxley Act of 2002, Executive will reimburse Holdings or the Company for the

amount required to be reimbursed under the Sarbanes-Oxley Act of 2002. Holdings also may seek to recover by the provisions of the Dodd-Frank Wall Street Reform and Consumer Protection Act or any other clawback, forfeiture or recoupment provision required by applicable law. In addition, this Agreement and the payments and benefits hereunder are subject to forfeiture or other penalties pursuant to any clawback or forfeiture policy of Holdings or the Company, as in effect from time to time.

Section 5.19 Legal Review. The Executive hereby represents that the Executive has had the opportunity to review this Agreement carefully and to consult with counsel prior to the execution of this Agreement and that the Executive does fully understand all the terms of this Agreement.

IN WITNESS WHEREOF, the parties hereto have executed this Severance Agreement as of the date first written above.

PQ CORPORATION

By: /s/ William J. Sichko, Jr.
Name: William J. Sichko, Jr.
Title: Chief Administrative Officer

EXECUTIVE

/s/ Joseph S. Koscinski

EXHIBIT A

FORM OF GENERAL RELEASE AND WAIVER OF CLAIMS

This General Release and Waiver of Claims (hereafter "Agreement") is entered into by and between PQ Corporation, a Pennsylvania corporation (the "Company"), and _____ (the "Executive") on _____.

In consideration of the mutual promises and covenants contained herein and the Severance Agreement dated August __, 2017 (the "Severance Agreement"), and other good and valuable consideration, the receipt of which hereby is acknowledged, the parties agree as follows:

Section 1. Release and Waiver of Claims. Effective as of _____, in consideration of the payments, benefits, and other considerations provided to the Executive under the Severance Agreement, the Executive, for the Executive and the Executive's family, heirs, executors, administrators, legal representatives, and their respective successors and assigns (the "Related Parties"), hereby releases and forever discharges the Company, and all of its parents, affiliates, subsidiaries, divisions and joint ventures, and their respective officers, directors, Executives, agents, parents, stockholders, representatives, employee benefit plans and their successors and assigns (collectively, "Company Entities"), from all rights, claims, demands, suits, causes of action of any kind or nature whatsoever, known or unknown, in law or in equity the Executive ever had, has or may have or which the Related Parties may have, arising at any time on or before the date hereof, based on or arising out of the Executive's dealings with any Company Entity, including but not limited to any claims arising out of the Executive's employment with any Company Entity or the termination of that employment, including without limitation any claims under the Severance Agreement, or based on any services provided to any Company Entity by the Executive other than pursuant to an employment relationship with any Company Entity. This includes a release of any and all rights, claims or demands the Executive may have, whether known or unknown, under the Age Discrimination in Employment Act ("ADEA"), which prohibits age discrimination in employment; Title VII of the Civil Rights Act of 1964, which prohibits discrimination in employment based on race, color, national origin, religion or sex; the Equal Pay Act, which prohibits paying men and women unequal pay for equal work; or under any other federal, state or local laws or regulations regarding employment discrimination or termination of employment. This also includes a release by the Executive of any claims for wrongful discharge or discrimination under any statute, rule, regulation or under the common law, including, without limitation, the Sarbanes-Oxley Act.

Section 2. Rights Not Released or Waived. This release is intended to be a general release and excludes only those claims under any statute or common law that Executive is legally barred from releasing. Executive understands that the release does not include and the parties hereto expressly reserve: (i) any claim that cannot be released or waived as a matter of law; (ii) any claim for or right to vested benefits in accordance with the Company's employee benefit plans and equity arrangements, including but not limited to any pension or retirement account benefits, but specifically excluding, among other plans, any other severance plan or policy; (iii) any right to enforce any term of this Agreement and any surviving provisions of the Severance Agreement; (iv) any claims based on acts or events occurring after Executive signs this Agreement, except for claims arising from Executive's employment or termination of employment with Company, up to and through the date Executive signs this Agreement; (v) any claims with respect to indemnification or coverage under directors' and officers' liability insurance or any challenge to the validity of the Agreement; (vi) any prohibition on the filing of a charge or complaint with, or testimony, assistance or participation in, any investigation, proceeding or hearing conducted by any federal, state or local governmental agency, including but not limited to the Equal Employment Opportunity Commission ("EEOC") and to report violations of any law administered by the Occupational

Safety and Health Administration (“OSHA”), or make other disclosures protected under the whistleblower provisions of state or federal law or regulation; or (vii) receive any financial awards from OSHA or the SEC for reporting possible violations of federal law or regulation in cases where the law prohibits employees from waiving their rights to receive such payments.

Section 3. Affirmations. (a) Executive represents and agrees by signing this Agreement that he has not been denied any leave or benefit requested, has received the appropriate pay for all hours worked for Company and has no known workplace injuries or occupational diseases.

(b) Executive further affirms that he has been paid and/or has received all leave (paid or unpaid), compensation, wages, bonuses and/or commissions to which Executive may be entitled and that no other leave (paid or unpaid), compensation, wages, bonuses and/or commissions are due to Executive, except as provided under Article III of the Severance Agreement.

(c) If any administrative agency or court assumes jurisdiction of any charge, complaint, proceeding or action including a claim or course of action released in Section 1 of this Agreement, Executive agrees not to accept, recover or receive any monetary damages or other relief from or in connection with such claim or cause of action, including but not limited to from charges filed with the EEOC.

(d) The separation pay being received by Executive is compensation that Executive is not entitled to receive in the absence of this Agreement.

(e) Executive has returned to the Company all property and information belonging to the Company, including, but not limited to the following (where applicable): computers (desktop and laptop); phone; tablet; iPad; devices (including usb, external hard drives, etc.); handheld devices; keys, access cards, passwords, and/or ID cards; all electronically stored and paper copies of all financial data, customer information, business plans and reports, and Company files; and all records, customer lists, written information, forms, plans, and other documents, including electronically stored information. Executive shall search Executive's electronic devices, device back-ups, residence, and automobile and agrees that by signing below, Executive represents that Executive has returned all such property in his possession or control.

(f) Executive acknowledges and agrees that he remains bound by the restrictions contained in Article IV of the Severance Agreement.

Section 4. Release and Waiver of Claims Under the Age Discrimination in Employment Act. Executive acknowledges that the Company has encouraged the Executive to consult with an attorney of the Executive's choosing, at Executive's expense, and, through this Agreement, encourages the Executive to consult with an attorney with respect to any possible claims the Executive may have, including claims under the ADEA, as well as under the other federal, state and local laws described in Section 1 hereof. Executive understands that by signing this Agreement Executive is in fact waiving, releasing and forever giving up any claim under the ADEA, as well as all other federal, state and local laws described in Section 1 hereof that may have existed on or prior to the date hereof.

Section 5. Waiting Period and Revocation Period. The Executive hereby acknowledges that the Company has informed the Executive that the Executive has up to “x” days to consider this Agreement and the Executive may knowingly and voluntarily waive that “x” day period by signing this Agreement earlier. Executive also understands that Executive shall have seven (7) days following the date on which Executive signs this Agreement within which to revoke it by providing a written notice of revocation to

the Company by hand delivering or mailing it to _____, 300 Lindenwood Drive, Valleybrooke Corporate Center, Malvern, PA, 19355-1740, post-marked within the seven day period.

Section 6. Acceptance. To accept this Agreement, the Executive shall execute and date this Agreement on the spaces provided and return a copy to the Company at any time during the "x" day period commencing on the date hereof, without extension of any kind (including by mutual agreement of the parties). This Agreement shall take effect on the eighth day following the Executive's execution of this Agreement unless the Executive's written revocation is delivered to the Company within seven (7) days after such execution.

Section 7. Confidentiality. To the extent this Agreement and its terms are not otherwise subject to public disclosure, Executive will keep this Agreement and its terms (other than the fact that Executive was terminated on the Termination Date) confidential and will not disclose such information to anyone other than Executive's immediate family and professional advisors, each of whom must, as a condition to the disclosure, agree to keep the information confidential. Executive will be responsible for any breach of this Section by Executive's immediate family members and professional advisors. Notwithstanding the foregoing, this Agreement does not prohibit Executive from (a) providing truthful testimony in response to compulsory legal process, (b) participating or assisting in any investigation or inquiry by a governmental agency acting within the scope of its statutory or regulatory jurisdiction, or (c) making truthful statements in connection with any claim permitted to be brought by Executive under Section 1. In addition, nothing in this Agreement limits, restricts or in any other way affects the Executive's communicating with any governmental agency or entity, or communicating with any official or staff person of a governmental agency or entity, concerning matters relevant to the governmental agency or entity.

Section 8. No Disparagement. Executive has not from the date Executive was given this Agreement and will not in the future make any defamatory or disparaging statements to any third parties regarding the Company Entities, or any of their employees, officers, or board members, as well as the Company's products, services and methods of operations. Notwithstanding the foregoing, this Agreement does not prohibit Executive from (a) providing truthful testimony in response to compulsory legal process, (b) participating or assisting in any investigation or inquiry by a governmental agency acting within the scope of its statutory or regulatory jurisdiction, or (c) making truthful statements in connection with any claim permitted to be brought by Executive under Section 1. In addition, nothing in this Agreement limits, restricts or in any other way affects the Executive's communicating with any governmental agency or entity, or communicating with any official or staff person of a governmental agency or entity, concerning matters relevant to the governmental agency or entity.

Section 9. No Admissions. Neither the execution of this Agreement nor the performance of its terms and conditions shall be construed or considered by any party or by any other person as an admission of liability or wrongdoing by either party.

Section 10. Counterparts. This Agreement may be executed in one or more counterparts, each of which will be considered an original instrument and all of which together will be considered one and the same agreement and will become effective when all executed counterparts have been delivered to the respective parties. Delivery of executed pages by facsimile transmission or e-mail will constitute binding execution of this Agreement.

Section 11. Assignment. This Agreement shall be binding upon and shall inure to the benefit of the Company and its respective successors and assigns, and any such successors and assigns shall be

considered third-party beneficiaries of this Agreement. Executive may not assign or transfer any payment obligations under this Agreement.

Section 12. Severability. If any term, provision or paragraph of this Agreement is determined by a court of competent jurisdiction to be invalid or unenforceable for any reason, such determination shall be limited to the narrowest possible scope in order to preserve the enforceability of the remaining portions of the term, provision or paragraph, and such determination shall not affect the remaining terms, provisions or paragraphs of this Agreement, which shall continue to be given full force and effect.

Section 13. Further Assurances. Executive agrees to execute and deliver, after the date hereof, without additional consideration, any additional documents, and to take any further actions, as may be necessary to fulfill the intent of this Agreement and the transactions contemplated hereby.

Section 14. Cooperation. Executive will (i) cooperate with the Company in all reasonable respects concerning any transitional matters which require Executive's assistance, cooperation or knowledge, including communicating with persons inside or outside the Company as directed by the Company, and (ii) in the event that the Company (or any of its affiliates or other related entities) becomes involved in any legal action relating to events which occurred during Executive's employment with the Company, cooperate to the fullest extent possible in the preparation, prosecution or defense of their case, including, but not limited to, the execution of affidavits or documents, testifying or providing information requested by the Company. To the extent that Executive incurs (i) travel-related expenses, (ii) out-of-pocket expenses, and/or (iii) loss of wages as a result of Executive's cooperation with the Company as contemplated by this Section, the Company will reimburse Executive for such expenses, provided they are reasonable and were approved by the Company in advance.

Section 15. Entire Agreement. This Agreement constitutes the complete and final agreement between the parties and supersedes and replaces all prior or contemporaneous agreements, negotiations, or discussions relating to the subject matter of this Agreement. All provisions and portions of this Agreement are severable. If any provision or portion of this Agreement or the application of any provision or portion of this Agreement shall be determined to be invalid or unenforceable to any extent or for any reason, all other provisions and portions of this Agreement shall remain in full force and shall continue to be enforceable to the fullest and greatest extent permitted by law.

Section 16. Governing Law. THIS AGREEMENT SHALL BE GOVERNED BY AND CONSTRUED AND ENFORCED IN ACCORDANCE WITH THE LAWS OF THE STATE OF DELAWARE APPLICABLE TO CONTRACTS MADE AND TO BE PERFORMED ENTIRELY WITHIN SUCH STATE.

IN WITNESS WHEREOF, and with the intention of being legally bound hereby, the Executive has executed this General Release and Waiver of Claims.

_____ Date: _____

SUBSIDIARIES OF PQ GROUP HOLDINGS INC.

ENTITY	JURISDICTION
PQ Group Holdings Inc.	Delaware
PQ Holdings Inc.	Delaware
CPQ Midco I Corporation	Delaware
PQ Corporation	Pennsylvania
PQ Holdings I Limited	United Kingdom
PQ Intermediate Limited	United Kingdom
PQ Germany GmbH	Germany
PT PQ Silicas Indonesia	Indonesia
PQ Sweden A.B.	Sweden
PQ Finland Oy	Finland
PQ Silicas Holdings South Africa Pty Ltd.	South Africa
PQ Silicas South Africa Pty Ltd.	South Africa
Quaker Chemicals South Africa Pty Ltd. 1	South Africa
PQ International Holdings Inc.	Delaware
PQ Netherlands Holding LLC	Delaware
Potters International Holdings S.à.r.l.	Luxembourg
Potters Leveraged Lender LLC	Delaware
PQ Silicas Asia Pacific Pte Ltd.	Singapore
PQ Silicates Ltd. 2	Taiwan
PQ International C.V.	Netherlands
PQ Netherlands Cooperative LLC	Delaware
PQ International Coöperatie U.A.	Netherlands
PQ Silicas Brazil Ltda.	Brazil
PQ Acquisition B.V.	Netherlands
PQ Canada Company	Canada
PQ Australia LLC	Delaware
NSL Australia Company	Canada
NSL Canada Company	Canada
National Silicates Partnership	Canada
PQ Europe Coöperatie U.A.	Netherlands
PQ Europe ApS	Denmark
PQ Silicas B.V.	Netherlands
PQ Zeolites B.V.	Netherlands
Zeolyst C.V. 3	Netherlands
PQ Italy S.r.l.	Italy
PQ France S.A.S.	France
PQ Silicas UK Limited	United Kingdom
PQ Chemicals (Thailand) Limited	Thailand
PQ Holdings Mexicana, S.A. de C.V. 4	Mexico
Silicatos y Derivados, S.A. de C.V.	Mexico
PQ China (Hong Kong) Limited	Hong Kong
PQ Holdings Australia Pty Limited	Australia

1 Represents a joint venture company of which the registrant indirectly owns 49% of the voting equity.

2 Represents a joint venture company of which the registrant indirectly owns 50% of the voting equity.

3 Represents a joint venture company of which the registrant indirectly owns 50% of the voting equity.

4 Represents a joint venture company of which the registrant indirectly owns 80% of the voting equity.

PQ Australia Pty. Limited	Australia
PQ Mexico Holdings B.V.	Netherlands
PQ Mexico S. de R.L. de C.V.	Mexico
Zeolyst International 5	Kansas
Eco Services Operations Corp.	Delaware
PQ Asia Inc.	Delaware
Potters Netherlands Holding LLC	Delaware
Potters Netherlands Holdings I C.V.	Netherlands
Potters Netherlands Holdings II B.V.	Netherlands
Sovitec Mondial S.A.	Belgium
Sovitec International B.V.	Netherlands
Sovitec Belgium S.A.	Belgium
Beads Belgium S.A.	Belgium
Sovitec Iberica, S.A.	Spain
Asociación para el Estudio de las Tecnologías de Equipamiento de Carreteras, S.A. 8	Spain
Sovitec France S.A.S.	France
Glass Beads S.A.	Argentina
KILT, LLC 6	Delaware
Delpen Corporation	Delaware
Commercial Research Associates, Inc.	Pennsylvania
PQ Systems Incorporated	Pennsylvania
PQ Export Company	Delaware
PQ International, Inc.	Pennsylvania
Philadelphia Quartz Company	Pennsylvania
Potters Holdings GP, Ltd.	Cayman Islands
Potters Holdings, LP	Cayman Islands
Potters Holdings II GP, LLC	Delaware
Potters Holdings II, LP	Delaware
Potters Industries Holding, Inc.	Delaware
Potters Industries, LLC	Delaware
SAJB Holding Company, LLC	Delaware
Potters Ballotini S.A.S.	France
Societe Recyclage Produit Verrier Industriels SAS	France
Interminglass Sp. Z.o.o.	Poland
Interminglass Holding Sp. z.o.o.	Poland
Potters (Thailand) Limited 7	Thailand
Potters Industries Acquisition Pty. Ltd.	Australia
Potters Industries Pty. Ltd.	Australia
Potters Industrial Limitada	Brazil
Potters Canada Holding Company	Canada
Potters Canada Holding II Company	Canada
PNA Partnership	Canada
Potters-Ballotini Co., Ltd.	Japan
Potters Nederland B.V.	Netherlands
Ballotini Panamericana S. de R.L. de C.V.	Mexico
Potters Ballotini Acquisition GmbH	Germany
Potters Ballotini GmbH	Germany
Potters Ballotini Ltd.	United Kingdom
Northern Cullet Ltd.	United Kingdom

5 Represents a joint venture company of which the registrant indirectly owns 50% of the voting equity.

6 Represents a joint venture company of which the registrant indirectly owns 72.5% of the voting equity.

7 Represents a joint venture company of which the registrant indirectly owns approximately 75% of the voting equity.

8 Represents a joint venture company of which the registrant indirectly owns approximately 22% of the voting equity.

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statements on Form S-8 (Nos. 333-220774 and 333-227643) of PQ Group Holdings Inc. of our report dated February 27, 2020 relating to the financial statements, financial statement schedule and effectiveness of internal control over financial reporting, which appears in this Form 10-K.

/s/ PricewaterhouseCoopers LLP
Philadelphia, Pennsylvania
February 27, 2020

CONSENT OF INDEPENDENT ACCOUNTANTS

We hereby consent to the incorporation by reference in the Registration Statements on Form S-8 (Nos. 333-220774 and 333-227643) of PQ Group Holdings Inc. of our report dated February 27, 2020 relating to the financial statements of Zeolyst International, which appears in PQ Group Holdings Inc.'s Form 10-K.

/s/ PricewaterhouseCoopers LLP
Philadelphia, Pennsylvania
February 27, 2020

**CERTIFICATION OF CHIEF EXECUTIVE OFFICER
PURSUANT TO SECTION 302 OF THE
SARBANES-OXLEY ACT OF 2002**

I, Belgacem Chariag, certify that:

1. I have reviewed this annual report on Form 10-K of PQ Group Holdings Inc.;
2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - (a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - (b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - (c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - (d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - (a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - (b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: February 27, 2020

/s/ BELGACEM CHARIAG

Belgacem Chariag
Chairman of the Board, President and Chief Executive Officer
(Principal Executive Officer)

**CERTIFICATION OF CHIEF FINANCIAL OFFICER
PURSUANT TO SECTION 302 OF THE
SARBANES-OXLEY ACT OF 2002**

I, Michael Crews, certify that:

1. I have reviewed this annual report on Form 10-K of PQ Group Holdings Inc.;
2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - (a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - (b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - (c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - (d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - (a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - (b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: February 27, 2020

/s/ MICHAEL CREWS

Michael Crews

Executive Vice President and Chief Financial Officer

(Principal Financial Officer)

**CERTIFICATION OF CHIEF EXECUTIVE OFFICER
PURSUANT TO 18 U.S.C. SECTION 1350, AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002**

In connection with the annual report of PQ Group Holdings Inc. (the "Company") on Form 10-K for the period ended December 31, 2019 as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I, Belgacem Chariag, Chairman of the Board, President and Chief Executive Officer of the Company, certify, pursuant to 18 U.S.C. § 1350, as adopted pursuant to § 906 of the Sarbanes-Oxley Act of 2002, that to my knowledge:

1. The Report fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934;
and
2. The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: February 27, 2020

/s/ BELGACEM CHARIAG

Belgacem Chariag

Chairman of the Board, President and Chief Executive Officer

(Principal Executive Officer)

**CERTIFICATION OF CHIEF FINANCIAL OFFICER
PURSUANT TO 18 U.S.C. SECTION 1350, AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002**

In connection with the annual report of PQ Group Holdings Inc. (the "Company") on Form 10-K for the period ended December 31, 2019 as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I, Michael Crews, Executive Vice President and Chief Financial Officer of the Company, certify, pursuant to 18 U.S.C. § 1350, as adopted pursuant to § 906 of the Sarbanes-Oxley Act of 2002, that to my knowledge:

1. The Report fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934;
and
2. The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: February 27, 2020

/s/ MICHAEL CREWS

Michael Crews

Executive Vice President and Chief Financial Officer

(Principal Financial Officer)