BEYOND BANKRUPTCY

THE OUTLOOK FOR PHILADELPHIA'S NEIGHBORHOOD REFINERY

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CONTENTS

REPORT UPDATE

At the time of original publication in November 2018, the report author had made regulators aware of perceived shortcomings in the public participation process conducted by Sunoco affiliate, Evergreen, with respect to environmental remediation at the Philadelphia refinery under Pennsylvania's Land Recycling Act. These shortcomings were presented in the original release of the report. This included deficiencies in the public participation plan, absence of public notice, absence of documentation available at designated public libraries, and lack of public comment and response submission. In June 2019, Evergreen launched a public website (*phillyrefinerycleanup.info*) that proposed a new public involvement plan and public comment period, provided proof of public notice, and made relevant documents available online (and in designated public libraries). As of July 2019, these actions by Evergreen are acknowledged with this update.

EXECUTIVE SUMMARY

SOME MAY BELIEVE THAT AFTER EMERGING FROM BANKRUPTCY REORGANIZATION IN AUGUST 2018, THERE IS NO LONGER A NEED TO PAY ATTENTION TO WHAT'S HAPPENING AT PHILADELPHIA'S NEIGHBORHOOD REFINERY, PHILADELPHIA ENERGY SOLUTIONS (PES). But, the exact opposite is true. Now, more than ever, involvement from municipal leaders and the public is pivotal.

LEGACY OF POLLUTION

The sprawling 1,300-acre footprint of land located just a few miles southwest of Center City, Philadelphia has been home to petroleum storage and refining activities since 1866. PES is the current owner of the facility, the oldest and largest refinery on the East Coast.

The history of pollution contamination at the refinery site is profound, given it has been home to hydrocarbon processing for over 150 years. The soil and groundwater at the site are heavily contaminated with hydrocarbons. Light non-aqueous phase liquids (e.g., refinery products like gasoline) are present on the groundwater in many areas of the facility. Specific chemicals of widespread concern include benzene (a known human carcinogen), lead, MTBE, toluene, benzo(a)pyrene, and many other toxic compounds. In some areas, contaminants have migrated offsite, and a drinking water aquifer used by the state of New Jersey could potentially be impacted. *(Appendix C provides a detailed explanation of site contamination.)*

Sunoco (owned by Energy Transfer Partners) is a part owner of PES and maintains legal liability for historic contamination at the site. Sunoco entered the facility into Pennsylvania's voluntary Land Recycling Program (Act 2 of 1995) and has been taking steps for years to characterize pollution at the site, stabilize migrating pollution plumes, develop site-specific risk-based pollution concentration standards to achieve (i.e. standards less stringent than statewide health standards) and complete other required tasks. These activities—along with performing remediation and demonstrating to the satisfaction of the Pennsylvania Department of Environmental Protection (PA DEP) and the U.S. Environmental Protection Agency (U.S. EPA) that site-specific standards have been achieved—will provide Sunoco with relief from further federal and state liability for legacy contamination at the site.

LACK OF PUBLIC INVOLVEMENT

The City of Philadelphia, local communities, and other interested stakeholders have not been afforded an adequate opportunity to be informed or involved in remediation planning for the refinery. This is inconsistent with the legal requirements of Pennsylvania's Act 2.

In 2006, the City of Philadelphia timely submitted a request to Sunoco to develop a public involvement plan. However, the plan subsequently developed by Sunoco does not meet the minimum requirements of Act 2 related to community involvement and public notice and review. For example, the plan does not include measures to notify or involve the public in the development and review of key reports and plans—e.g. remedial investigation reports, risk assessment reports, cleanup plans, or final reports. As a result, remedial investigation reports for eight of the eleven "areas of concern" at the refinery—as well as approval of a soil lead cleanup standard that is more than twice the statewide health-based maximum—have been approved without the benefit of municipal or public input.

Sunoco's failure to fully comply with the relevant community involvement and public notice and review requirements of Act 2—for example, soliciting and submitting public comments and responses to those comments to PA DEP for the agency's consideration prior to approval of relevant plans and reports—raises serious legal questions about the validity of the approvals thus far awarded.

Two of the three remaining areas of concern for which site characterization reports have yet to be approved involve pollution that has migrated off site, and one area of concern involves the New Jersey drinking water aquifer. Separate from PA DEP, the U.S. EPA is expected to open a public comment period on the proposed site cleanup plan, which is estimated to be available by 2020.

The omission of public involvement in the remediation planning for the refinery is a meaningful grievance. Given the magnitude, severity, and toxicity of the site's contamination, coupled with its proximity to highly populated environmental justice neighborhoods, population centers, and drinking water resources, public involvement is critical to informing the municipality and community about existing risks, appropriateness of site-specific standards, and remediation options. In turn, this input could inform, improve, and garner public support for the project approach and goals. *(See Section 5 for more information.)*

PES LIKELY TO FACE BANKRUPTCY AGAIN IN 2022

To add another wrinkle, although PES successfully navigated bankruptcy reorganization in August 2018, it is likely the facility will again face bankruptcy on or before 2022, when its debts mature. This is crucial to site remediation activities because it impacts the future use of the site, and therefore the appropriateness of the site-specific remediation standards Sunoco is pursuing.

WHY PES WENT BANKRUPT

Sunoco had lost money on the refinery for years, before entering into the PES joint venture with the Carlyle Group in 2012. The effort initially looked like it might pay off, and plans for an initial public offering were launched in 2014. However, by January 2018, PES had declared bankruptcy, citing burdensome compliance costs associated with the federal Renewable Fuels Standard (RFS), loss of economic rail access to cheap domestic crude, and compressed refinery crack spreads. *(See Section 1 for more information.)*

Petroleum refineries generally object to the RFS because it reduces the amount of fuel they can sell (i.e. by displacing it with non-petroleum fuel like ethanol) and creates compliance costs. In spite of this, many merchant refineries (PES is a merchant refinery), have remained profitable while complying with the RFS. More meaningful to PES' bankruptcy is the refinery's uncompetitive technology, loss of economic rail access to cheap domestic feedstock, and inability to process even cheaper Canadian heavy crudes.

Although PES is a large facility, it is not state of the art. Rather, it is below average in all of the technical measures examined in the report. PES is a rather simple refinery compared to the rest of the U.S. fleet. It has below-average conversion capacity (limited to fluidized catalytic cracking) that is reliant on higher quality, higher cost feedstocks. On top of this, the facility falls short on reliability, operating with a lot of costly down time.

Absent additional and significant disruption (e.g. changes to the Jones Act, oil production increases from the nearby Utica shale), and unlike many of its peers, PES may not be able to benefit from changes in North American crude oil production patterns. Policy changes or strategic investments that reduce RFS compliance costs—such as the RIN-generating biodigester partnership with RNG Energy—could benefit the facility. *(See Sections 2 & 3 for more information.)*

PES IS FACING MANY FUTURE CHALLENGES

The bankruptcy reorganization allowed PES to postpone debt maturity, raise capital, and shed some costly obligations. However, post-bankruptcy, the company is more highly leveraged than it was before. Bankruptcy did nothing to change the fundamental structural challenges facing the refinery, nor did it address new challenges on the horizon. These new challenges include:

- Costly capital needs for refinery turnarounds,
- Required investments to meet domestic and international rules to limit sulfur in motor and marine fuels,
- Increased competition from Midwestern refineries,
- Proposed interstate flow adjustments to a key offtake pipeline,
- Significant unresolved back tax liabilities,
- Loss of competitive advantage in supplying summer gas to the Pittsburgh market, and
- Several other obstacles.

(See Section 4 for more information.)

It is possible that PES could navigate these challenges and maintain viable refinery operations. It is also conceivable the facility could function as a fuel-storage terminal and logistics facility, even if refining operations cease. Post-bankruptcy, PES is now majority owned by creditors (e.g. financial institutions) with Sunoco and the Carlyle Group relegated to minority interests. PES's January 2018 bankruptcy filings estimate the company could recover about $700 million upon liquidation (i.e. converting assets to cash to pay down debts), at best.

EXPLORING REDEVELOPMENT OPPORTUNITIES

In 2013, Philadelphia released and began to implement a "Master Plan" for redevelopment of the 3,700 acre industrial Lower Schuylkill corridor, of which 1,300 acres includes the PES property. This plan was comprehensive in nature, but chiefly explored economic development opportunities outside of the refinery's footprint. The plan assumed ongoing operations at the refinery and did not consider the opportunity for industrial redevelopment of all or parts of the refinery complex.

It is not often that 1,300 acres of contaminated land gets remediated near the center of a major metropolitan area. Remediation activities should consider potential alternative future uses for the site, informed by a redevelopment planning exercise based on highest and best use, and assuming cessation of refinery operations. To minimize worker hardship, early planning to prepare for displacement of workers and supply chain businesses should take place in the event that the refinery closes.

THE NEED FOR ENGAGEMENT

The City of Philadelphia, neighboring residents, community leaders, local businesses, and other stakeholders should prepare for engagement.

- Achieving Compliance with Public Involvement Requirements. Sunoco, PA DEP, the City of Philadelphia, communities surrounding the refinery, and other stakeholders need to determine how to correct Sunoco's omission of community involvement and public notice and review requirements in a manner consistent with Act 2. This includes 1) reviewing the entire remediation project to determine public involvement deficiencies, 2) developing an approach to ensure PA DEP has the opportunity to meaningfully consider public input for all regulatory milestones already approved (e.g. eight remedial investigation reports (RIRs), risk assessments, site-specific standards), and 3) revising Sunoco's public involvement plan to ensure compliance for the remaining three RIRs, risk assessments, cleanup plan, and final report. Ameliorating some of these grievances may be complicated given the law envisions public comment and remediator responses being inputs into PA DEP's review prior to approval or rejection of the relevant plans and reports.
- Exploring Redevelopment Opportunities. Given the near-term potential for closure of refinery operations, stakeholders should begin exploring redevelopment options for the site. This could include consideration of a wide range of potential industrial and recreational uses for site parcels that would add value to the City. The opportunity to reclaim such a large footprint of land so close to Center City deserves thorough and

creative exploration and analysis for the highest and best use. These potential future site uses should also inform the appropriateness of site-specific remediation standards being pursued by Sunoco.

- Preparing for Worker Dislocation. Closure of PES will create hardships for many employees and businesses dependent on the refinery. Relevant stakeholders should acknowledge the potential for the refinery's near-term closure, understand the magnitude of related worker displacement, and plan for the associated needs of refinery workers and those employed in the refinery's business supply chain. Evaluation and planning should take place for the potential need to deploy re-employment services (e.g. retraining, trade adjustment assistance), including assessing local, state, and federal funding resources.

PHILADELPHIA'S FUTURE

PES is the largest single source of toxic, criteria, and greenhouse gas emissions pollution in Philadelphia County. Closure of the refinery will result in significant reduction of air pollution that is harmful to human health and the environment. In addition, reduced local air pollution emissions may ease permitting requirements for new or existing industrial entities—with the potential for job creation and economic development—given the regulatory air quality attainment status of the region.

There is only one chance to inform and influence Sunoco and Energy Transfer Partner's legal obligation to fund the cleanup of Philadelphia's neighborhood refinery. This remediation project is important to the future of the City and its residents, and the project will benefit from active public involvement and support.

SECTION 1: HISTORY OF PHILADELPHIA ENERGY SOLUTIONS AND REFINERY OPERATIONS

This section explores the history of the Philadelphia Refinery Complex in southwest Philadelphia from its initial 1866 establishment as a petroleum storage facility through the January 2018 bankruptcy petition of its current owner, Philadelphia Energy Solutions (PES).

BACKGROUND ON THE PHILADELPHIA REFINING COMPLEX

The refining complex located at the edge of Center City, Philadelphia was originally established in 1866 as a bulk petroleum storage facility called the Atlantic Petroleum Storage Company. Refinery operations began in 1870 (Philadelphia Energy Solutions 2018). The original refinery, located in Point Breeze, was called the Atlantic Refining Company, which Standard Oil purchased in 1874 and subsequently rebuilt after an 1879 fire destroyed the original facility (Hein 2016). By 1891, 50% of the world's lighting fuel and 35% of U.S. petroleum exports came from the 360-acre Atlantic Refining Company (Hein 2016). In 1920, Gulf Oil built a terminal just south of the Atlantic refinery at Girard Point, and by 1926 a new refinery was operating on that site (Philadelphia Energy Solutions 2018). The two refineries were bought and sold over the years. The Sun Company (Sunoco) purchased the Point Breeze refinery in 1988 and the Girard Point refinery in 1994 (F. L. Quivik 2015).

Sunoco subsequently constructed the northeast refining complex along a 20-mile stretch of the Delaware River that included the Eagle Point refinery in New Jersey; Sunoco's original Marcus Hook refinery (est. 1902) near the Pennsylvania–Delaware border; and the Philadelphia Refining Complex at the adjoining Point Breeze and Girard Point refineries. Sunoco converted Point Breeze from a heavy–sour facility into a light–sweet facility[1] to match the configuration of Marcus Hook and Girard Point. Sunoco then built a 15-mile pipeline system between the plants with interconnection to the Philadelphia airport (Norman 2004).

FIGURE 1: 1866 ADVERTISEMENT DEPICTING ATLANTIC PETROLEUM STORAGE COMPANY FACILITIES AT POINT BREEZE ON THE SCHUYLKILL RIVER

(The Library Company of Philadelphia 2017)

FIGURE 2: 1926 AERIAL VIEW OF THE ATLANTIC REFINING COMPANY AT POINT BREEZE

(The Library Company of Philadelphia 2017)

1 More information on refinery technology and crude oil feedstock quality is included in Section 2.

SUNOCO EXITS UNPROFITABLE REFINING BUSINESS

In 2009, Sunoco announced it would idle the Eagle Point refinery to increase utilization at Marcus Hook and the Philadelphia Refining Complex (Oil and Gas Journal 2009). In early 2010, Eagle Point permanently closed. By 2011, Sunoco announced it was exiting the refinery business to focus on its more profitable operations, like retail. After reducing its refining capacity by 43% since 2009, Sunoco intended to shut down its last two remaining refinery locations at the Philadelphia Refining Complex and Marcus Hook by July 2012, if a new buyer could not be found (Gilbert 2011). Management claimed the company's northeast refinery operations lost $772 million between 2009 and 2011, and the company could not justify new capital investments needed to make the two refineries sustainable (Wolfe 2011). Analysts attributed the Philadelphia Refinery Complex' failure on a difficult business environment marked by reliance on expensive imports of light sweet crudes, inability to process cheaper crudes, and falling East Coast demand for refined products (GlobalData Deal Analysis 2012). In April 2012, Energy Transfer Partners (ETP) acquired Sunoco.

PES CREATION AND OPERATIONS

In July 2012, a combination of political will, public subsidies, private capital from the Carlyle Group, and continued participation from Sunoco, coalesced to save the Philadelphia Refining Complex by creating PES (Heath 2012). Sunoco intended to sell 100% of the Philadelphia refinery, but moved towards a joint venture relationship after complete sale efforts were unsuccessful (Fair Disclosure Wire 2012). The joint venture deal created PES with Sunoco (now an affiliate of ETP) contributing the Philadelphia Refinery Complex assets and the Carlyle Group contributing $175 million in capital (Renshaw, February 2018). The Commonwealth of Pennsylvania provided: $15 million over three years through the Pennsylvania Economic Growth Initiative for refinery equipment upgrades; a $10 million grant for a high-speed rail unloader from the Pennsylvania Department of Transportation; a Keystone Opportunity Zone designation; the opportunity for tax-exempt bonds through the Pennsylvania Economic Development Finance Agency; and a consent decree with the Pennsylvania Department of Environmental Protection to deal with air pollution violations (Fair Disclosure Wire 2012). In addition, a "prospective purchaser agreement" between Sunoco, the U.S. EPA, and PES protected PES from potential liability stemming from historical environmental contamination at the site, such as soil and groundwater contaminants, including hydrocarbons and heavy metals[2] (U.S. Environmental Protection Agency 2012).

As of January 2018, the Carlyle Group owned 65.04% of PES; Sunoco/ETP (called PES Equity Holdings) owned 32.5%; and current and former PES senior management owned 2.44% (Kirkland and Ellis LLP 2018, 22). A diagram of the pre-bankruptcy corporate organizational structure is included in Appendix A.

The PES refining complex includes two separate refineries, Point Breeze and Girard Point, with a total of 350,000 barrels per stream day of crude oil distillation capacity, which represents about 28% of the East Coast's refining capacity.[3] The refinery complex is situated on 1,300 acres of land about 2.5 miles southwest of Center City, Philadelphia. The two refineries produce approximately 45% gasoline, 40% distillate, and 3% high-value petrochemicals, with the remaining 12% as low-value products (9% residual fuel, 2% liquefied petroleum gas, and 1% other) (Philadelphia Energy Solutions Inc 2015, 77). As of January 2018, PES employed about 1,100 people, 650 of whom were unionized members of the United Steelworkers (Kirkland and Ellis LLP 2018, 14).

PES primarily markets its refined products in the northeast U.S. via pipeline to Pittsburgh, New York City, and Buffalo. However, PES can also send out refined product by barge or truck. PES's Schuylkill River Tank Farm connects to the Harbor pipeline, enabling product to move north to the New York Harbor, the largest refined product market in the world. The Schuylkill River Tank Farm also connects to the Laurel pipeline, allowing product to move west towards Pittsburgh. PES has

2 More information about the Prospective Purchaser Agreement with PES can be found at: https://www.epa.gov/enforcement/case-summary-prospective-purchaser-agreement-philadelphia-energy-solutions-llc-and

3 "Stream day capacity" is a measure of the refinery's designed processing capacity. "Calendar day capacity" incorporates operational factors that can lower effective capacity.

the ability to connect to other pipelines and can also move product via barge (e.g. via Eagle Point), truck (via Belmont Rack), or ship (Kirkland and Ellis LLP 2018, 19).

The PES refineries primarily rely on light–sweet crude oil feedstocks from West Africa, Canada, North Dakota, Texas, and other areas (Kirkland and Ellis LLP 2018, 15). PES has the ability to receive up to 75% of its total crude supply needs by rail from domestic sources enabled by its affiliated rail terminal, North Yard Logistics. It can receive up to 100% of crude supply needs by ship via the Delaware River, enabled by the Fort Mifflin tanker offloading and Darby Creek crude storage tank facilities owned by Sunoco. (Kirkland and Ellis LLP 2018, 18). However, to receive rail delivered feedstocks (mostly domestic-sourced), PES must pay per barrel fees to North Yard Logistics (NYL) ($1.95 per barrel) for rail receiving, which includes a minimum volume commitment of 170,000 barrels per day (quarterly average) (Kirkland and Ellis LLP 2018, 21). Documents from 2015 indicate that in order to receive marine delivered feedstocks (mostly imports), PES must pay per barrel fees to Sunoco Logistics for receipt and storage of supply from the Fort Mifflin terminal and Darby Creek storage facilities with a minimum volume commitment of 300,000 barrels per day (bpd) (on an annual average basis) (Philadelphia Energy Solutions Inc 2015). The agreement with Sunoco Logistics expires in January 2022 but provides that PES could purchase the Fort Mifflin/Darby Creek facilities for $200 million (Philadelphia Energy Solutions Inc 2015, 160). PES also has a ten-year agreement with Sunoco Logistics to provide a minimum of 609,374 barrels of storage capacity at the Eagle Point tank farm (Philadelphia Energy Solutions Inc 2015, F-9). If the minimum volume commitments are not met, PES must remit deficiency payments on any shortfalls. Appendix B provides a map of the refinery complex and supporting infrastructure mentioned above.

PES ATTEMPTS PUBLIC OFFERING

Initially, PES's financial performance looked positive. The refinery facility's 2011 net income indicated over a $1 billion loss. By 2013, the facility's net income was negative $103 million. During the first three quarters of 2014, net income was positive at $156 million (Philadelphia Energy Solutions Inc 2015, 16). The positive performance was generally attributed to improvements made to plant equipment and operations and to increased rail receiving capacity that enabled access to domestic feedstocks priced at discounts to the West-Texas Intermediate (WTI) exchange.[4]

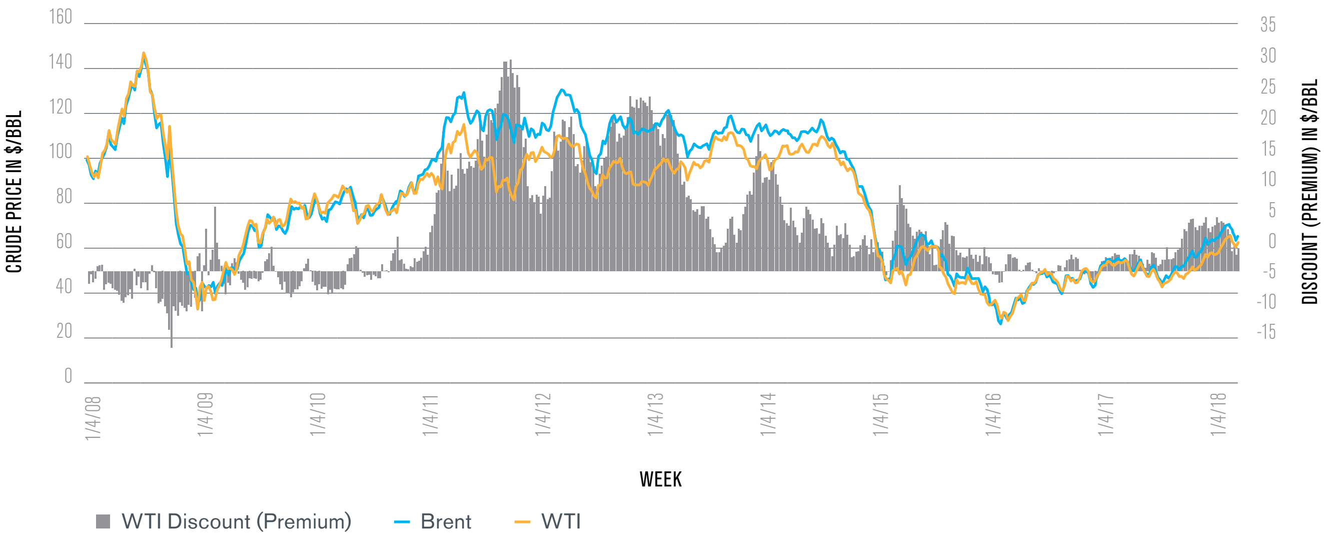
In September 2014, PES filed initial public offering (IPO) paperwork with the U.S. Securities and Exchange Commission (SEC) for sale of a percentage ownership of PES Logistics Partners, a Master Limited Partnership comprised of the North Yard Logistics (NYL) rail receiving terminal. At the time, NYL had unloading capacity of two unit trains (104-cars each) per day, which was equivalent to 140,000 bpd. There was also a project underway to expand from two to three unit trains per day, increasing capacity to 210,000 bpd, and the opportunity for further capacity expansion (PES Logistics Partners, L.P. 2014). The IPO of common stock sought to raise $250 million and valued PES Logistics at about $105 million (PES Logistics Partners, L.P. 2014, F-5). Initially, the PES Logistics business model was solely dependent on revenues from a 10-year, per barrel fee-based contract with the parent-owned PES Refinery business, though growth and diversification opportunities were envisioned (PES Logistics Partners, L.P. 2014).

In February 2015, PES filed IPO paperwork with the SEC for percentage ownership in Philadelphia Energy Solutions, Inc. a holding company with two subsidiaries, including the refinery complex and related marketing activities, and PES Logistics. The IPO for PES Inc. valued the company at over $1 billion (Philadelphia Energy Solutions Inc 2015, F-3).

In August 2015, PES postponed its IPO efforts as a result of market conditions and pressure on energy investors and funds (Street Insider 2015). Unfortunately for PES, the IPO offerings were timed a little late. The 2013 and 2014

4 The West-Texas Intermediate (WTI) is an oil pricing benchmark associated with the Cushing, Oklahoma oil trading hub and traded on the New York Mercantile Exchange. The crude traded on the WTI is light, sweet oil and therefore is often compared to pricing of Brent crude from the North Sea, which is also light and sweet and trades on the Intercontinental Exchange (ICE).

FIGURE 3: WEEKLY SPOT PRICE OF BRENT AND WTI CRUDES AND WTI DISCOUNT (PREMIUM) IN $/BARREL



(U.S. Energy Information Administration 2018)

PES financial improvement occurred when crude prices were high and WTI crude was trading at a substantial discount to imported Brent crude. As shown in **Figure 3** and **Table 1**, crude's average price dropped by about half from 2014 to 2015 and the WTI discount also narrowed. The drop in crude price related partly to OPEC's decision in November 2014 not to cut oil production in the face of plentiful supplies and low prices. As a result of the price drop and spread erosion, the premium associated with shipping crude by rail made accessing domestic supplies less viable for PES.

In June 2016, reports surfaced that PES was looking for a private buyer, but entities reviewing the company's prospectus (which included the potential to separate the Girard Point and Point Breeze refineries) believed the value of the assets were much lower than PES's target (Resnick-Ault and Renshaw 2016). In July 2016, PES cut production by 10% due to low profit margins. (Renshaw, July 2016). In September 2016, PES cut employee benefits, offered buyouts to salaried employees, and laid off some non-union workers a month later (Simeone 2016). In November 2016, Moody's rating agency successively downgraded PES corporate family rating and debt from B1 down to B3, and down again to Ca in November 2017 (Moody's 2018). In April 2018, PES has a $523 million term loan set to mature, which Moody's believed was a high default risk (Moody's 2017).

TABLE 1: ANNUAL AVERAGE OF WEEKLY SPOT CRUDE OIL PRICES

	WTI	Brent
2013	$97.92	$108.62
2014	$93.64	$99.47
2015	$48.90	$52.56
2016	$43.15	$43.55
2017	$50.83	$54.23

(U.S. Energy Information Administration 2018)

PES DECLARES BANKRUPTCY

On January 21, 2018, PES filed for Chapter 11 bankruptcy protection. The bankruptcy plan would allow PES to continue uninterrupted operations while shedding some debt, converting other debt to equity, and gaining new investment. At the time of its bankruptcy petition, PES was $581.2 million in debt secured by its refinery business, and $97.5 million in debt secured by its rail logistics business at North Yard (Kirkland and Ellis LLP 2018, 23).

In its filing with the U.S. Bankruptcy Court for the District of Delaware, PES primarily blamed its economic woes on regulatory compliance costs associated with the federal Renewable Fuels Standard (RFS) policy, followed by loss of access to cheap domestic crude, eroding gross refining margins, and other factors.

Renewable Fuel Standard Compliance

The federal RFS program was established by the Energy Policy Act of 2005 and expanded by the Energy Independence and Security Act of 2007, both of which amended the Clean Air Act. The U.S. Environmental Protection Agency (EPA) implements the RFS program that requires renewable fuel (e.g. ethanol) to be blended into transportation fuel in increasing amounts. The EPA establishes renewable fuel volume compliance requirements based on the volume standards in the enabling legislation and renewable fuel availability. Crude oil refiners and gasoline and diesel importers are required to comply with the RFS, which can be achieved by blending/selling biofuels or by purchasing renewable identification number (RIN) credits.[5]

PES asserts it cannot blend biofuels onsite because the pipeline owners that distribute its product will not accept ethanol-blended gasoline. It also notes its RFS compliance disadvantage when compared to its integrated oil company competitors that comply with the RFS through their fuel blending operations. Given its merchant status[6] and lack of blending operations, PES has largely relied on buying RINs at market price to meet its obligations. PES cites the following annual RIN expenses in **Table 2**, for a grand total of $832 million between 2012–2017. PES asserts its 2017 RIN expenses were twice its annual payroll and represented its largest expense after crude oil (Kirkland and Ellis LLP 2018, 17). At the time of its bankruptcy filing, PES needed to purchase an additional $350 million in RINs before March 31, 2018 to meet outstanding RFS compliance obligations (Kirkland and Ellis LLP 2018, 26).

Loss of Access to Cheap Domestic Crude

After RFS compliance costs, PES blamed the elimination of affordable access to domestic crude (namely, the Bakken formation in North Dakota) as the second reason pushing it into bankruptcy. Once dependent on imported crude priced on the ICE–Brent exchange, the refinery invested $130 million to expand rail-based crude receiving capacity to take advantage of cheaper domestic feedstock priced on the NYMEX–WTI exchange. However, the combination of curtailed domestic production (due to falling prices caused by OPEC), lifting of the oil export ban, and opening of new pipeline takeaway capacity made moving Bakken crude to the Gulf Coast more financially attractive than towards the East Coast.

TABLE 2: PES ANNUAL RIN EXPENSES (MILLIONS)

2012	2013	2014	2015	2016	2017
$13	$116	$130	$124	$231	$218

(Kirkland and Ellis LLP 2018)

Declining Gross Refining Margins

PES also cited industry-wide reduced gross refining margins, which is a measure of the profitability of converting crude oil to refined products, as another critical factor driving bankruptcy. Specifically, they note the 2-1-1 Brent crack spread, which uses New York Harbor market values for refined product, where the bulk of their product is sold, dropped from $14.52 per barrel (average September 2012 to September 2015) to $13.37 per barrel (average October 2015 to December 2017). PES asserts that each $1 drop in the crack spread represents about $110 million in reduced revenues to the company (Kirkland and Ellis LLP 2018, 28).

In response to these and other unfavorable circumstances, PES instituted layoffs, cost-cutting measures, and operational process improvements to achieve $50 million in annual savings. However, these cost-cutting actions were insufficient to address the firm's deteriorating financial condition. In 2017, the company began refinancing and debt restructuring efforts, which were unsuccessful in light of deteriorating market conditions (Kirkland and Ellis LLP 2018, 29).

The bankruptcy plan sought to infuse $260 million in new capital, reduce annual debt obligations by $35 million,

5 More information on the RFS program can be found at https://www.epa.gov/renewable-fuel-standard-program

6 PES operates through intermediation agreements with financial institutions that function like tolling agreements. This helps the company reduce liquidity requirements and manage commodity price volatility associated with securing feedstock and selling refined product.

and extend debt maturities out to 2022. The $260 million in new cash includes: $65 million in cash for equity from non-debtor parents; $120 million in debtor-in-possession-to-exit facility from certain Term Loan B lenders (Term Loan B includes an undisclosed syndicate of lenders originally represented by JP Morgan Chase) that will convert to a new collateralized loan upon exit;[7] and $75 million in additional financing facility mortgage-type loan from Sunoco Logistics (Kirkland and Ellis LLP 2018, 32). In addition, $107 million of an existing $523.9 million term loan would be converted to equity.

As detailed in Section 4, one of the many critical parts of the reorganization plan assumed the EPA and bankruptcy court would excuse PES from more than $350 million in existing, unmet RIN obligations (Kirkland and Ellis LLP 2018, 54). If PES failed to win court approval of its Chapter 11 reorganization, the plan could convert to a Chapter 7 liquidation proceeding (see Section 4 for more information on liquidation).

In its filing with the U.S. Bankruptcy Court for the District of Delaware, PES primarily blamed its economic woes on regulatory compliance costs associated with the federal Renewable Fuels Standard (RFS) policy, followed by loss of access to cheap domestic crude, eroding gross refining margins, and other factors.

7 Interest rate on the post exit loan is LIBOR + 625 basis points with a LIBOR floor of 100 basis points. (Kirkland and Ellis LLP 2018, Exhibit B). This is considered a high default risk premium.

SECTION 2: BASICS OF REFINERY MARKET TRENDS AND TECHNOLOGY

This section provides basic background on refined product supply, flows, and demand in the critical markets impacting PES in order to highlight trends facing refineries in different regions. A general overview of crude oil quality and refinery technology explains how these components critically interact. A more detailed analysis of PES's refinery technology is presented to contextualize the facility's competitiveness against the rest of the U.S. refinery fleet.

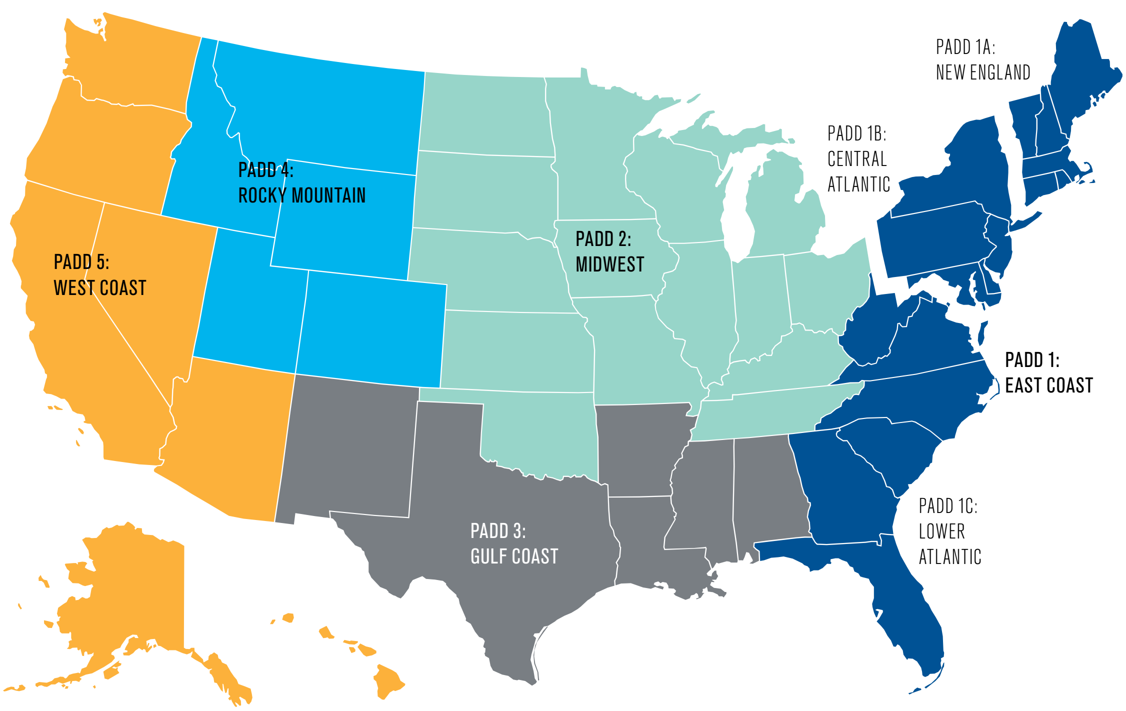
REFINED PRODUCT SUPPLY AND FLOWS

As shown in **Figure 4**, the U.S. petroleum market is geographically identified by Petroleum Administration for Defense Districts (PADDs). The Gulf Coast PADD 3 is the largest supplier of transportation fuels (i.e. motor gasoline, distillates, and jet fuels) and East Coast PADD 1 is the largest transportation fuel consumption market. Generally, Gulf Coast PADD 3 refineries supply three times the in-region's transportation fuel demand, while East Coast PADD 1 refineries supply only about 20% of the in-region's demand (U.S. Energy Information Administration 2016). In 2014, PADD 3 refineries supplied 58% of the transportation fuel consumed in PADD 1 (U.S. Energy Information Administration 2016).

In 2016, PADD 3 maintained over 50% of total U.S. crude oil distillation capacity at 9,546 thousand barrels per calendar day (Mbbl/d), followed by PADD 2 at 3,873 Mbbl/day, PADD 5 at 2,795 Mbbl/day, PADD 1 at 1,254 Mbbl/day, and PADD 4 at 669 Mbbl/day (U.S. Energy Information Administration 2018). Between 2007 and 2016, overall U.S. refinery capacity increased by 6% with capacity gains in PADD 3 (18.2%), PADD 4 (12.6%), and PADD 2 (7.9%) offsetting capacity losses in PADD 1 (25.8%) and PADD 5 (11.4%).

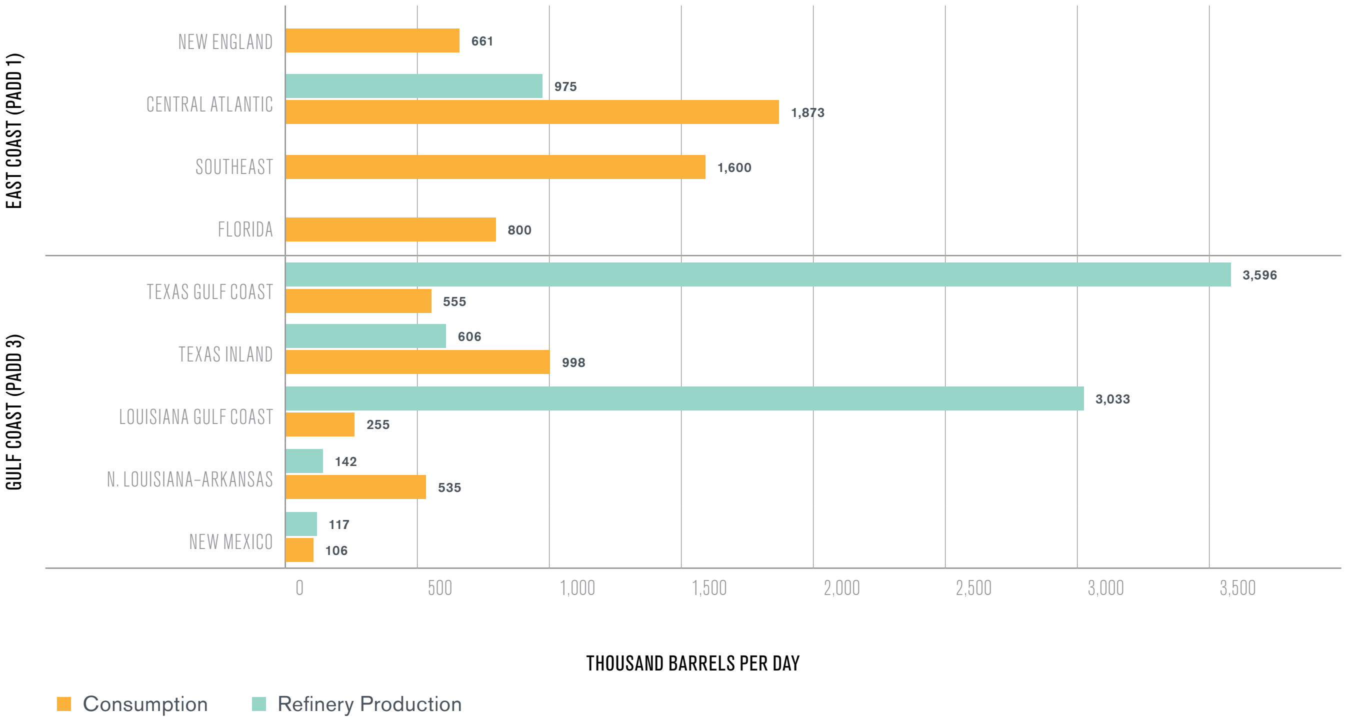
In 2014, 47% of PADD 1 transportation fuel consumption was supplied by pipeline (i.e. Colonial and Plantation pipelines), 20% by in-region refineries, 16% by waterborne foreign imports, 11% by waterborne supply from PADD 3, and the remainder by ethanol (U.S. Energy Information

FIGURE 4: U.S. PETROLEUM ADMINISTRATION FOR DEFENSE DISTRICTS



U.S. Energy Information Administration

FIGURE 5: TRANSPORTATION FUEL PRODUCTION AND CONSUMPTION BY SUB-PADD REGION, 2014



(U.S. Energy Information Administration 2016, 5) (Source: ICF Analysis of EIA, FHWA, and Airlines for American Data)

Administration 2016, 9). Pipeline and waterborne shipments from PADD 3 met 58% of PADD 1 consumption, equivalent to only 37% of PADD 3 total refinery supply (U.S. Energy Information Administration 2016, 13).

As shown in **Figure 5**, the majority of transportation fuel consumption in PADD 1 occurs in the Central Atlantic sub-PADD 1 region, including Delaware, Maryland, New Jersey, New York, and Pennsylvania, where PES is located. As of 2014, the Central Atlantic sub-PADD 1 region was also the only sub-region in PADD 1 with refining capacity, enough to meet about 50% of the sub-region's consumption needs with all other PADD 1 sub-regions relying on pipeline (from PADD 3 or PADD 2) or waterborne supply deliveries (from PADD 3 or foreign imports). Transportation fuel supplies in the Central Atlantic can be consumed in-region, sent to other domestic markets (e.g. Northeast) via waterborne vessels, or exported (primarily as distillates).

There are three main pipelines serving the Central Atlantic PADD 1 sub-region, including the Colonial, Buckeye, and Sunoco Logistics lines (U.S. Energy Information Administration 2016). These lines are particularly relevant to PES. The Colonial pipeline primarily transports supply to PADD 1 from refining areas along the Gulf Coast. The Colonial line 3 interconnects with the Buckeye and Sunoco lines in the greater Philadelphia area, then extends to Linden, NJ. Buckeye's Long Island Pipeline System transports supply from Linden, NJ to the New York City metropolitan area. Buckeye's Eastern Products Pipeline system transports supply received from the New York Harbor and Philadelphia area to a southeastern Pennsylvania hub that can distribute supply to western and central Pennsylvania (via Buckeye's Laurel Pipeline) and to upstate New York.

Sunoco Logistics has two pipelines that originate in the greater Philadelphia area—the Harbor and Twin Oaks/Newark lines—that move refined supply to the New York Harbor, and additional pipelines that move supply to Eastern Pennsylvania, and upstate New York markets. To the west, Sunoco's Allegheny Access Pipeline moves refined supply from Ohio refineries in PADD 2 to the Pittsburgh metropolitan area. Supply from the greater Philadelphia area can also be distributed via truck racks at refineries and terminals, or moved by barge to the Baltimore market via the Chesapeake and Delaware canal.

REFINED PRODUCT DEMAND

The following U.S. Energy Information Administration (EIA) data uses "product supplied" information to approximate consumption of refined petroleum products. EIA notes that measuring U.S. gasoline demand can be difficult, because there are over 160,000 retail gasoline stations and over 250 million vehicles in the country (U.S. Energy Information Administration 2013). "Product supplied" data measures demand by tracking disappearance of products from their prime suppliers (such as refineries, blending plants, pipelines, and bulk terminals) and also accounts for changes in inventories, imports, exports, and other factors.

As shown in **Table 3**, U.S. demand for refined petroleum products has declined from pre-recession levels, which has been attributed to many factors, including improved vehicle efficiency and increased biofuel use. Since 2012, demand for these products has increased, but not enough to offset losses. Demand reductions in PADD 1 have been the most significant, stressing refineries like PES that target PADD 1 markets.

According to PES, its facility produces 3% high value petrochemicals, 45% gasoline, 40% distillate, and 12% lower value products (9% residual fuel, 2% liquefied petroleum gas, 1% other) (Philadelphia Energy Solutions Inc 2015, 77). As seen in **Table 4**, the largest drop in demand came from residual fuels, followed by distillates, jet fuel, and motor gasoline.

TABLE 3: FINISHED PETROLEUM PRODUCT SUPPLIED BY PADD AREA, 2007–2016 (THOUSANDS OF BARRELS)

	2007	2012	2016	% Change (2007–2012)	% Change (2012–2016)	% Change (2007–2016)
U.S.	6,736,961	5,914,945	6,275,878	-12%	6%	-7%
East Coast (PADD 1)	2,205,440	1,856,190	1,950,413	-16%	5%	-12%
Midwest (PADD 2)	1,744,468	1,623,460	1,705,939	-7%	5%	-2%
Gulf Coast (PADD 3)	1,405,813	1,211,776	1,291,710	-14%	7%	-8%
Rocky Mountain (PADD 4)	233,985	229,662	236,111	-2%	3%	1%
West Coast (PADD 5)	1,147,256	993,857	1,091,706	-13%	10%	-5%

(U.S. Energy Information Administration 2018)

TABLE 4: EAST COAST PADD 1 PRODUCT SUPPLIED, 2007–2016 (THOUSANDS OF BARRELS)

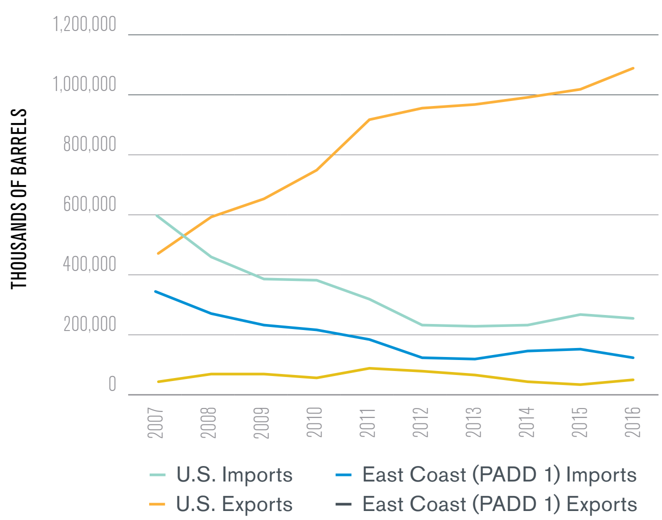
	2007	2012	2016	% Change (2007–2016)
Finished Motor Gasoline	1,215,865	1,129,107	1,187,002	-2%
Distillate	506,541	396,682	430,349	-15%
Residual	125,779	64,742	33,904	-73%
Kerosene-Type Jet Fuel	231,657	198,289	212,755	-8%

(U.S. Energy Information Administration 2018)

In addition to refined product demand, the dynamic of imports and exports is also meaningful to refinery markets. In 2016, PADD 1 imported over 2.5 times more refined product than it exported, which is down significantly compared to 2007 when PADD 1 imported 7.5 times more finished product than it exported. As seen in **Figure 6**, between 2007 and 2016, imports (i.e. competition from foreign refineries) of refined products decreased by 58% for the U.S., and decreased by 63% into PADD 1. During the same period, U.S. exports of refined product, i.e. opportunity for domestic refineries, increased 139% for the U.S. (led by PADD 3 refineries), but only increased by 8% in PADD 1.

Maintaining refinery capacity in the Central Atlantic portion of PADD 1 has historically been considered a national security imperative, given the lack of PADD 1 refinery capacity compared to refined product demand and the resultant dependence on a handful of delivery methods of PADD 3 supply to PADD 1. However, PADD 1 demand for refined product waned significantly after the recession, more so than in other regions. In addition, PADD 1 refining capacity continues to decline, even as capacity in other regions increases, with increased export of refined products. As will be explored in the next section, significant changes in North American crude oil availability may explain some of these trends. PADD 1 refineries have largely returned to reliance upon high quality crudes shipped across the Atlantic, but refineries in other areas are better geographically or technologically positioned to access cheaper crudes.

FIGURE 6: IMPORT AND EXPORT OF FINISHED PETROLEUM PRODUCTS, 2007–2016 (THOUSANDS OF BARRELS)



(U.S. Energy Information Administration 2018)

BASICS OF REFINERY TECHNOLOGY

Refinery technology dictates the flexibility, or inflexibility, in choice of crude oil feedstock quality and cost. As such, it is important to appreciate this relationship.

Feedstock Quality

Not all crude oil is the same. Crude oil can vary in its density (heavy or light),[8] sulfur content ("sweet" or "sour"),[9] acidity (total acid number),[10] and other factors. Light–sweet, low acid crude feedstock is easier to process and therefore trades at premiums compared to heavy–sour, more acidic crudes that are more difficult to process (i.e. require greater investment in process units). **Figure 7** on page 17 provides information on the quality and location of crude oil reserves. The majority of global crude oil reserves are sour. Most crudes used for benchmark pricing (e.g. WTI, Brent) are light, sweet (Simmons 2017).

Figure 8 on page 17 shows various crude oil qualities and corresponding price discounts or premiums to the Brent crude benchmark. The lower quality Mexican Maya (heavy sour) and Argus Sour Crude Index grades regularly trade at deep discounts to the higher quality Brent crude. An increase in U.S. shale–oil production and insufficient pipeline takeaway capacity drove the deep discount seen for high quality light–sweet West-Texas Intermediate (WTI) starting after 2010.

Refinery Types and Processes

Refineries process crude into four general categories of refined product, listed here in decreasing order of quality: gases, gasoline, distillate (e.g. jet and diesel fuel), and heavy residual fuel oil (e.g. marine bunker fuel). Light sweet crudes inherently yield a greater percentage of high quality refined products; heavy sour crudes yield a greater percentage of low quality heavy fuel oil. However,

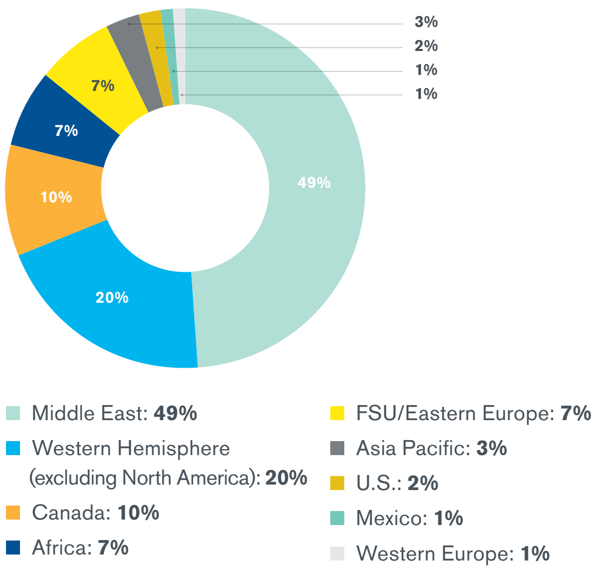
8 Density is measured in American Petroleum Institute (API) gravity, relative to water density. An API gravity above 10 is considered light; an API below 10 is considered heavy.

9 Sulfur content under 0.7% is considered "sweet," greater than 0.7% is considered "sour."

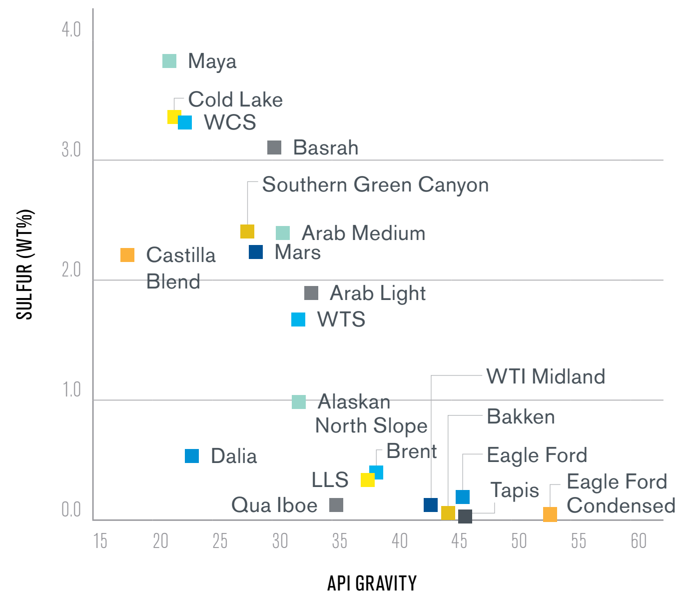
10 Acidic crudes can lead to refinery equipment corrosion and may require additional investments to process. High acid crudes have a total acid number greater than 0.7.

FIGURE 7: CRUDE OIL RESERVES AND QUALITY

Estimated 1.66 Trillion Barrels of Oil Reserves (2015)



Crude Oil Quality

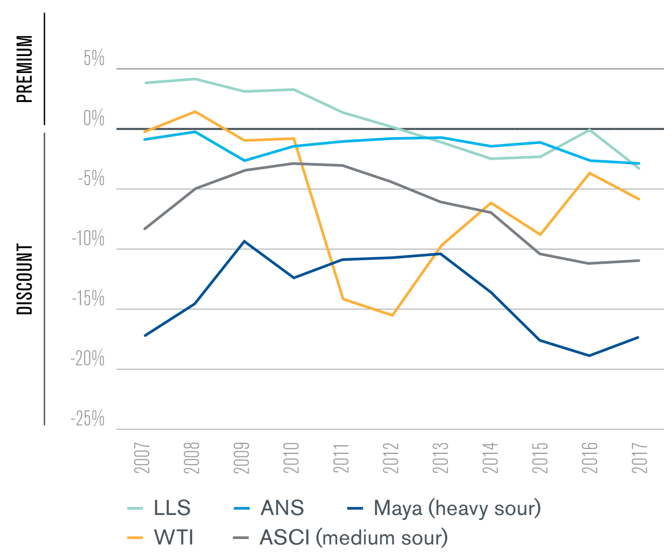


(Simmons 2017)

refineries can add processing technology (e.g. coking) to greatly increase the yield of high quality products from cheap, heavy sour crude. For example, refineries that have coking technology can increase the volume of high quality refined products derived from cheap, low quality Western Canadian Select (WCS) feedstock. The ability to buy cheap inputs and sell more expensive outputs increases the potential for positive refinery profit margins.

The basic refinery process begins with distillation. Crude oil is separated into different hydrocarbon molecules using heat and pressure, i.e. vaporization through targeted boiling temperatures. Then, the different hydrocarbon streams are converted into specific products through use of chemical (i.e. catalyst) and physical processing. The last step is the finishing stage where impurities are removed and final products are prepared. In general, all refineries are slightly different in configuration and complexity, but all consist of a collection of integrated processing units and ancillary equipment (e.g. storage capacity, pipelines, etc.).

FIGURE 8: CRUDE OIL PRICE DIFFERENTIALS VERSUS THE ICE-BRENT BENCHMARK



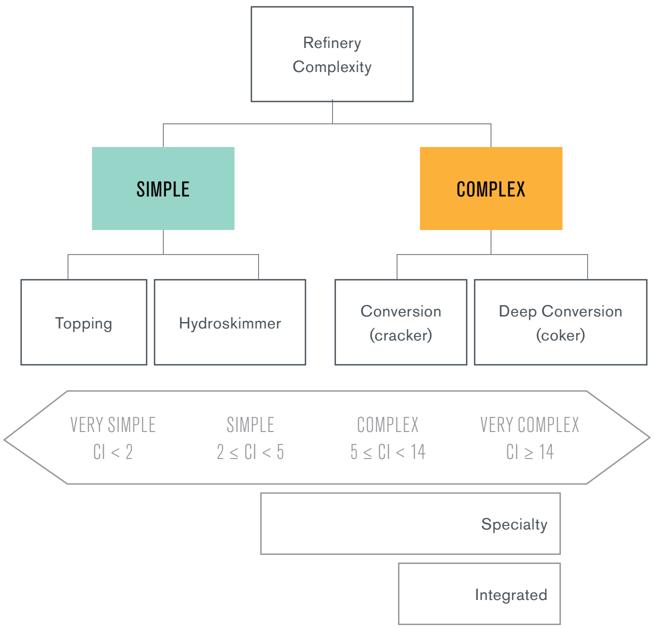
(Simmons 2017)

Refinery complexity—measured by the Nelson Complexity Index[11]—helps identify a facility's ability to process feedstocks into valuable products. So, a very

11 In 1960, Wilbur Nelson developed the Nelson Complexity Index to quantify investment costs and compare the value proposition of different refineries. The index is a measure of secondary conversion capacity compared to primary distillation capacity and indicates both investment intensity and ability to produce high quality products.

complex refinery is able to yield high volumes of quality product from low-quality feedstock. As shown in **Figure 9**, refineries are generally categorized as 1) topping, 2) hydroskimming, 3) conversion cracker, or 4) deep conversion coker, each with corresponding Nelson Complexity Index (CI) ranges.

FIGURE 9: REFINERY COMPLEXITY CATEGORIES AND NELSON COMPLEXITY INDEX VALUES



(M. Kaiser 2017)

PES REFINERY TECHNOLOGY

Some have called the PES refinery antiquated and geographically disadvantaged; PES management calls the refining complex "state of the art" and strategically located (Philadelphia Energy Solutions 2018). Some basic background on the refinery business and details about the PES refinery technology can help contextualize these competing claims.

The PES refineries uses fluid catalytic cracking (FCC) technology, for which light sweet crude is the preferred feedstock but for which some medium sour grades may be viable. According to PES, its facility produces 3% high value petrochemicals, 45% gasoline, 40% distillate, and 12% lower value products (9% residual fuel, 2% liquefied petroleum gas, and 1% other) (Philadelphia Energy Solutions Inc 2015, 77). PES also states, "[b]ecause approximately 12% of our production is lower-value products that generally sell at prices below crude oil cost, our actual total gross margin per barrel is typically significantly less than the 2-1-1 crack spread" (Philadelphia Energy Solutions Inc 2015, 77). In terms of size, PES is the eleventh largest refinery in the country, measured in atmospheric distillation capacity at 350,000 barrels per stream day. However, size is a poor indicator of competitiveness in the refinery business (M. Kaiser 2017).

Complexity Rating

The complexity or sophistication of a refinery is based on its secondary conversion capacity, or plant equipment that enables production of high value products from lower value inputs. Using 2016 data on individual refinery capacity from the U.S. EIA and unit complexity factors,[12] Professor John Jechura of the Colorado School of Mines[13] calculated complexity ratings for all 133 operating U.S. refineries (U.S. Energy Information Administration 2017). As shown in **Figure 10**, the complexity factor for PES was calculated at 9 (in red), which is well below the U.S. fleet wide unweighted average of 10.56.[14] These data suggest PES is relatively simple compared to its competitors. PES is reliant upon higher cost, higher quality feedstock to produce refined products and is unable to take advantage of the lowest cost, low-value crudes that more complex refineries can exploit.

Conversion Capacity

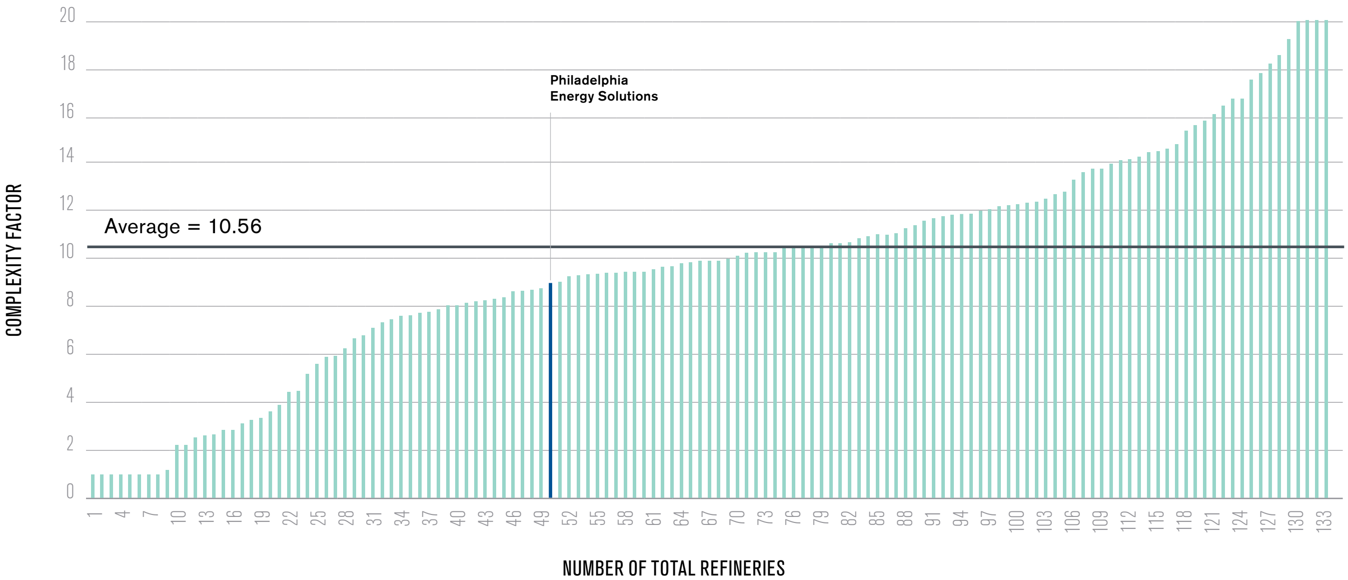
Conversion capacity is the ratio of a refinery's conversion units to its atmospheric distillation capacity, providing additional insights into the complexity and competitiveness of a facility. Using 2016 EIA data, conversion capacity was calculated by summing catalytic cracking, catalytic hydrocracking, and thermal

12 Key complexity factors considered included: distillation capacity (1), vacuum distillation (2), catalytic cracking (6), catalytic hydrocracking (6), delayed or fluid coking (6), thermal cracking—other (3), visbreaking (2.5), catalytic reforming (5), isomerization (15), alkylates (10), hydrotreating (3), aromatics (15), asphalt (1.5), lubricants (60), sulfur (6). More information on complexity factors used is available through Reliance Industries Limited's Nelson Complexity Factors discussion document: *http://pakpas.org/0.REFINERY%20LIBRARY/2.EDC-business_petroleum_refiningmktg_lc_ncf.pdf*

13 Professor John Jechura is a professor of practice in the Chemical and Biological Engineering Department at the Colorado School of Mines: *https://chemeng.mines.edu/project/john-jechura/*

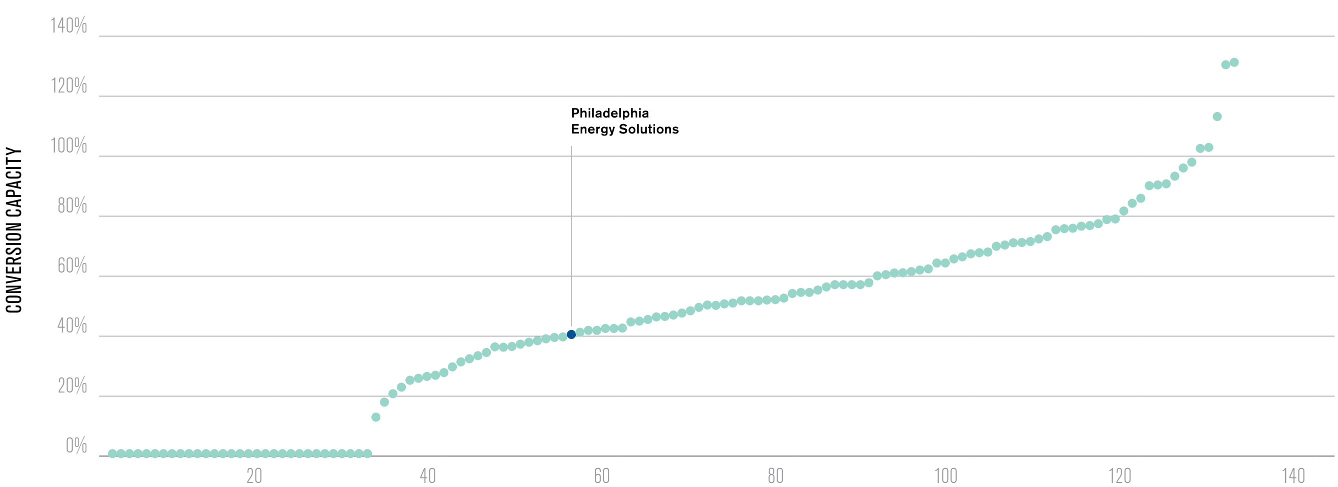
14 PES calculated its complexity factor at 9.8 (Philadelphia Energy Solutions Inc 2015, 112). However, PES does not provide the date of the underlying data nor does it list complexity factor values used.

FIGURE 10: COMPLEXITY RATINGS OF U.S. REFINERIES, AS CALCULATED BY J. JECHURA BASED ON EIA DATA



(U.S. Energy Information Administration 2017)

FIGURE 11: CONVERSION CAPACITY AT U.S. REFINERIES, CALCULATED USING EIA DATA



(U.S. Energy Information Administration 2017)

conversion capacity and dividing by atmospheric distillation capacity[15] (U.S. Energy Information Administration 2018). As shown in **Figure 11**, PES had a conversion rate of 39.29% (blue dot); the U.S. fleet average conversion capacity was 43.93%. The U.S. fleet average conversion capacity rate, excluding topping and hydroskimming facilities (that have zero conversion capacity), is 57.28%. Note that conversion capacity can exceed 100% in some cases. PES may be considered "complex" because it has conversion capacity, but this capacity is limited to catalytic cracking and does not include additional catalytic hydrocracking or thermal cracking technologies that enhance a plant's ability to convert low-value feedstock into high quality product.

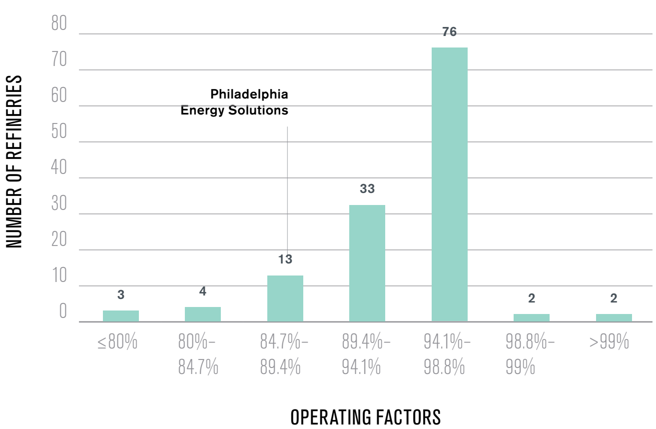
15 Conversion capacity examined includes catalytic cracking (fresh and recycled), catalytic hydrocracking (distillate, gas oil, residual), and thermal cracking (delayed coking, fluid coking, visbreaking, and other).

Operating Factor

The operating factor, or on-stream factor, of a refinery provides insights into facility performance and economics. In 2016, PES had a design capacity of 350,000 bbl per stream day (bpsd), but only a 310,000 bbl per calendar day capacity (bpcd) (U.S. Energy Information Administration 2017). The calendar day number accounts for downtime for maintenance, repairs, equipment replacements, and other factors. Using 2016 EIA data, operating factors for all U.S. refineries were calculated by dividing bpcd by bpsd. PES has an operating factor of about 88.6%, placing it towards the bottom of the U.S. fleet, as can be seen in **Figure 12.** This low operating factor indicates the facility is performing suboptimally, and may be experiencing frequent outages that can negatively and meaningfully affect the facility's economics.

Interestingly, 2012 U.S. EIA data (published January 2013) indicates the Philadelphia Refinery Complex (then fully-owned by Sunoco) had a design capacity of 355,000 bpsd and an operating capacity of 335,000 bpcd, indicating an operating factor of 94.3% (U.S. Energy Information Administration 2013). EIA data consistently showed these figures for PES until its January 2017 refinery capacity report with operational data for 2016, where both bpsd, bpcd, and the operating factor dropped considerably. **Table 5** compares the 2012 and 2016 data and the changed capacity values.

FIGURE 12: 2016 OPERATING FACTORS FOR U.S. REFINERY FLEET (BPCD/BPSD)



(U.S. Energy Information Administration 2017)

It is unclear why PES lost so much capacity to key units in this timeframe. These decreases in capacity could be related to normal, pre-scheduled equipment turnarounds or from unpredicted equipment outages. PES might typically be expected to increase run rates in the summer, but PES cut production by 10% at the Point Breeze facility on July 6, 2016, as high regional supply inventories eroded economics (Renshaw, July 2016). By July 28, 2016, Reuters reported PES was buying gasoline in the open market to meet contractual obligations after an air-blower at the facility's Girard Point gasoline unit failed, causing an unpredicted outage (Reuters Staff 2016). In 2016, there were additional media reports about planned unit outages as well as unexpected outages related to fires at the facility in May and December of that year (Renshaw January 2017) (Reuters Staff May 2016).

In summary, PES is a large, but not state of the art, facility. It is below average in all of the measures examined. It is a rather simple refinery compared to the rest of the U.S. fleet, and it has below average conversion capacity (limited to fluidized catalytic cracking) reliant on higher quality, higher cost feedstocks. On top of this, the facility falls short on reliability, operating with lots of costly down time.

TABLE 5: CHANGE IN PES REFINERY CAPACITY (2012–2016) BY PRODUCT TYPE

Product	Change (2012–2016)	% Change from 2012
Alkylates (bpsd, except sulfur and hydrogen)	500	1.9%
Catalytic Cracking; Fresh Feed (bpcd)	(7,700)	-5.7%
Catalytic Cracking; Fresh Feed (bpsd)	(1,000)	-0.7%
Catalytic Reforming: High Pressure (bpcd)	(21,400)	-27.6%
Catalytic Reforming: High Pressure (bpsd)	(15,500)	-18.0%
Desulfurization, Naptha/Reformer Feed (bpsd)	(10,000)	-11.4%
Desulfurization, Other Distillate (bpsd)	(6,000)	-3.7%
Isomerization: Isobutane (bpsd, except sulfur and hydrogen)	(4,200)	-52.5%
Sulfur (short tons/day) (bpsd)	(49)	-39.2%
Total Operable Capacity, Atmospheric Distillation Capacity (bpcd)	(25,000)	-7.5%
Total Operable Capacity, Atmospheric Distillation Capacity (bpsd)	(5,000)	-1.4%

(U.S. Energy Information Administration 2017) (U.S. Energy Information Administration 2013)

PES has an operating factor of about 88.6%, placing it towards the bottom of the U.S. fleet. This low operating factor indicates the facility is performing suboptimally, and may be experiencing frequent outages that can negatively and meaningfully affect the facility's economics.

SECTION 3: FACTORS LEADING TO PES BANKRUPTCY

With the background information provided in Section 2, one can be better prepared to examine PES's bankruptcy claims. In this section, the top three factors that PES cites in driving the company into bankruptcy are reviewed and analyzed along with other critical factors.

INCREASING RENEWABLE FUEL STANDARD (RFS) COMPLIANCE COSTS

PES pegs its RIN compliance costs from 2012 to 2017 at $832 million—see **Table 2** for a breakdown of annual RIN expenses. PES asserts it is disadvantaged, because as a merchant refinery it does not generate its own RINs through blending and therefore must pay large sums to purchase RINs on the market. Merchant refiners like PES have asserted integrated refiners obtain RINs "for free" when they purchase renewable fuel, and can generate windfall profits when excess RINs are sold, but the EPA has historically rejected such assertions (U.S. Environmental Protection Agency 2017).

It is reasonable that any crude oil refinery—merchant or integrated—would find the RFS policy objectionable. A policy mandate to increase the use of non-petroleum, alternative fuels is likely to reduce sales of the traditional products petroleum refineries produce. This is especially true where demand for refined petroleum products has contracted. Not only does the RFS reduce market share for refined petroleum products, it also creates new costs associated with achieving compliance.

It is true that RIN costs have greatly increased in the time since PES was established in mid-2012. Prices for RINs used for RFS compliance were generally very low (a few cents per RIN) prior to 2013 when the 10% ethanol (E10) blendwall was reached. And these prices have remained much higher and more volatile than pre-2012 levels in the years thereafter (U.S. EPA 2015, 11). The U.S. EPA asserts that after 2013, for the first time, the portion of an entity's RFS obligation that could be satisfied with RINs (D6) exceeded the quantity of RINs that could be obtained by blending ethanol with gasoline to yield E10. As a result, the market for RINs tightened and prices increased. These increased prices provide an incentive for entities with RFS obligations to explore options to obtain RINs by increasing biofuel penetration—such as 85% ethanol blends (E85) and increased blending non-ethanol biofuels—or by carrying over RINs generated in one year for compliance in the following year. Because the RFS-required renewable fuel volumes exceed the volume of ethanol that can be blended solely by E10, EPA did not expect the price of RINs to return to pre-2012 levels (U.S. EPA 2015, 13).

Merchant refiners, integrated refineries, and gas and diesel importers also have RFS obligations and associated costs. They just exercise different compliance options. The integrated refineries comply by purchasing renewable fuel feedstock that is bundled with the implied RIN value, then they blend the renewable fuel with their refined product to comply with the RFS. Here, the RIN cost may or may not be tracked separately.

Merchant refiners without blending capacity must purchase standalone RINs. According to the EPA, for merchant refiners, the RIN-based compliance cost is more direct and evident compared to costs to integrated refiners and therefore can be accounted for and tracked separately on company balance sheets (U.S. EPA 2015, 15). For integrated refiners, EPA analysis indicates the RIN value is used to subsidize the price of purchasing renewable fuels (U.S. EPA 2015, 28).

The EPA asserts the cost of RFS compliance is recovered through the incremental increase in the sale price of the final product (U.S. EPA 2015). However, the EPA does acknowledge that a merchant refiner's business decisions on RFS compliance strategy can create marketplace disadvantages. For example, the decision to limit RFS compliance strategy to reliance only on market purchase of RINs can expose the firm to market-related volatility and other issues that may not exist with a hedged portfolio approach to compliance (e.g. investing in blending infrastructure, long-term contracts, renewable fuel purchase, etc.) (U.S. EPA 2015). In November 2017, EPA denied petitions to change the point of RFS obligation from refiners to blenders, thereby rejecting the notion that the RFS program disadvantages merchant compared to integrated refiners.

Other merchant refining companies maintained profitability despite escalating RIN costs and RIN market price volatility. Figure 13, developed by Turner, Mason & Company, shows how RIN costs have escalated for the entire merchant refining sector over time.[16]

As shown in Figure 14, with the exception of 2016, most of these merchant refining companies have maintained positive net income while presumably complying with federal RFS requirements. The 2016 sector-wide downturn has largely been attributed to the erosion of the discount between WTI and Brent crudes, weak gasoline margins, and increasing RIN costs.

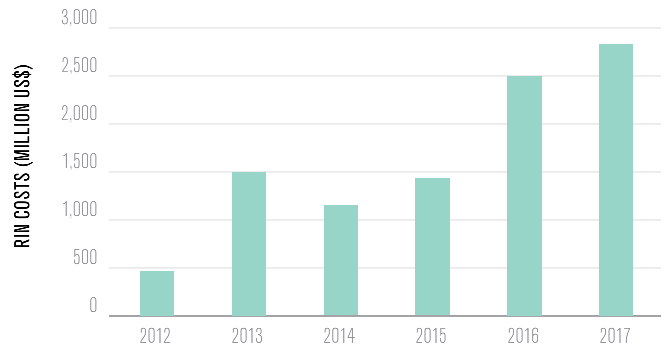
In summary, merchant refiner PES has experienced significantly increased RFS compliance costs since the firm's inception. However, competing refiners have also experienced these increased costs. These merchant competitors may have had stronger financial fundamentals or employed more effective strategies to manage RIN cost increases.

LOSS OF ACCESS TO CHEAP DOMESTIC CRUDE

Between the time PES was formed in 2012 through much of 2014, WTI-priced crude was trading at a significant discount to Brent priced crude. During 2015 to 2016, the WTI discount eroded significantly, but has been increasing in 2017 and 2018. These differentials are show in Figure 3.

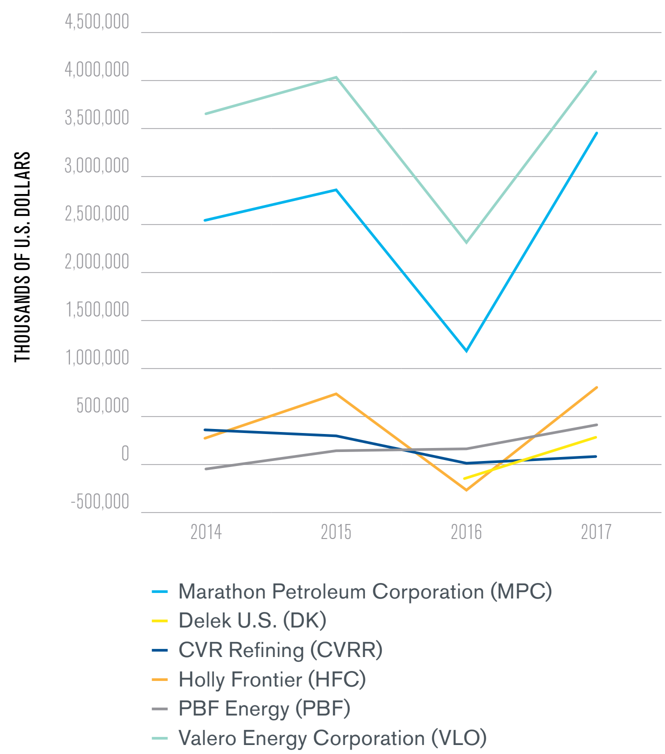
PES was enjoying rail-based access to WTI-priced crudes that were cheaper than the Brent-priced imported crudes the refinery historically relied upon. As described by Sandy Fielden of Morningstar Commodities Research, a series of events occurred that effectively shut out East Coast PADD 1 refineries from cheap domestic crude (Fielden October 2016). In 2013–2014, new pipeline investments made to reduce congestion in the Midwest began to decrease the WTI-to-Brent discount.

FIGURE 13: MERCHANT REFINER RIN COST (2012–2017E)



(Hilbourn and Auers 2017) Includes Delek US Holdings, Calumet, Alon USA Energy, Western Refining, Tesoro, Delta Airlines, Philips 66, CVR Refining, HollyFrontier Corp, Marathon Petroleum, PBF Energy, and Valero Energy.

FIGURE 14: NET INCOME OF PUBLICLY TRADED MERCHANT REFINERS (2014–2017)

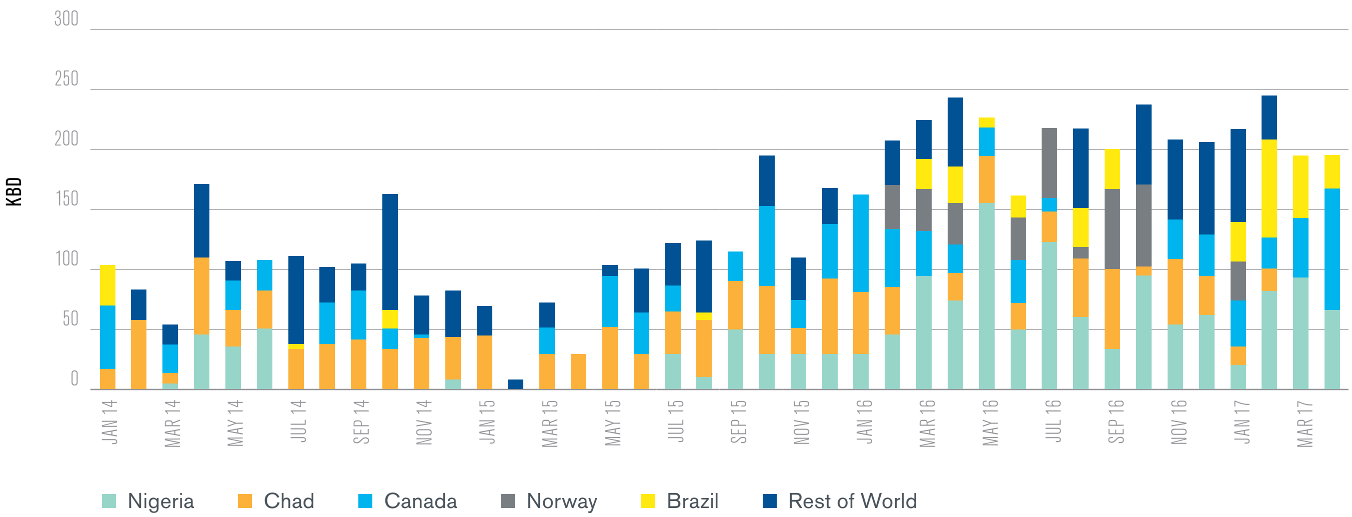


(NASDAQ 2014–2017)

Note: Marathon Petroleum Corporation owns the retail Speedway chain.

16 Here, the merchant refining sector includes the following companies: Delek US Holdings, Calumet, Alon USA Energy, Western Refining, Tesoro, Delta Airlines, Philips 66, CVR Refining, HollyFrontier Corp, Marathon Petroleum, PBF Energy, and Valero Energy.

FIGURE 15: WATERBORNE CRUDE IMPORTS TO PES, BY ORIGIN



(Smith 2017)

Next, the global crash in crude prices further eroded the WTI-to-Brent discount and reduced domestic crude production volumes, no longer covering the premium to ship crude-by-rail to PES. Finally, as the WTI discount was returning, the Dakota Access project came online in 2017 (enabling the "Bakken Pipeline"), and PES was largely shut out from the supply of cheap domestic crude. The loss of access to cheap domestic crude forced PES to return to more expensive Brent-priced imports. As shown in **Figure 15**, crude imports to PES bottomed out in early 2015, as production from the Bakken formation was peaking (Smith 2017). Since then, rail deliveries of crude slowed, and reliance on imports increased.

By June 2017, after the Dakota Access pipeline began operations in May, it was expected that PES would no longer be taking rail deliveries of domestic crude (Renshaw April 2017). Not only did this eliminate a key component of PES's revival strategy, it also rendered the rail logistics investment at the North Yard terminal obsolete.

COMPRESSED REFINING MARGINS

In its bankruptcy filing, PES greatly downplays the role that loss of access to WTI priced crudes played in its economic hardships, partly by highlighting only moderate decreases in Brent crack spreads.

PES blamed compressed gross refining margins—citing the Brent 2-1-1 crack spread trends—as the third factor driving it into bankruptcy. The crack spread is the difference between the price of crude oil and the price of refined petroleum product derived from the feedstock. Crude crack spreads vary based on the type of crude input and destination market for the refined product output. Crack spreads also include a series of numbers (e.g. 2-1-1) where the first number represents input barrels of feedstock, followed by output barrels of refined product, usually gasoline barrels followed by distillate barrels. So, two barrels of crude would yield one barrel of gasoline and one barrel of diesel.

PES noted the average Brent crude crack spread sold into the New York Harbor market moved from $14.52/barrel (bbl) (average from September 2012 to September 2015) to $13.37/bbl (average October 2015 to December 2017), or a $1.15/bbl drop. PES claimed that for every $1 drop in the crack spread, it lost $110 million in annual revenues (Kirkland and Ellis LLP 2018, 28). By citing these data, PES seems to indicate a little over a dollar drop in the average crack spread from 2012 to 2017, greatly understating its reduced profitability from loss of WTI access.

PES's comparing Brent-to-Brent crack spreads to justify its claim of lost annual revenues is misleading. PES was predominately reliant on WTI feedstocks through much of 2014 and into 2015. As Sandy Fielden from Morningstar notes, gross refining margins (based on the 3-2-1 WTI crude to New York Harbor crack spread) experienced record highs in 2012 as the average WTI discount to Brent crude was $18/bbl; shut-in Bakken crude was being offered further below WTI prices; and demand for refined product was high (Fielden June 2016).

Fielden shows that average WTI 3-2-1 crack spreads were $10/bbl in 2010, jumping to $30/bbl in 2012. Subsequent pipeline developments resulted in the WTI to Brent crude price discount eroding to $3/bbl for much of 2015 (Fielden June 2016). By May 2016, Fielden notes average 3-2-1 gross refining margins year-to-date dropped back to a little over $15/bbl, more in line with historic levels.

DEBTS AND INVESTOR DEMANDS

PES does not mention the financial demands of its majority equity holders as one of the events leading to its bankruptcy. However, Jarrett Renshaw of Reuters reported in great detail the Carlyle Group's financial demands on PES (Renshaw 2018). In 2012, the Carlyle group invested $175 million in PES, but extracted at least $594 million in cash distributions from the company prior to its bankruptcy petition.

In March 2013, PES borrowed $550 million, paid investors $200 million, and spent additional sums (plus state grants) to build and expand the North Yard rail terminal (a $130 million investment). In January 2015, PES spun off the North Yard terminal into a separate logistics company that it planned to take public as a master limited partnership. A 10-year, take-or-pay contract was executed between the refinery and logistics company where the refinery would pay for logistics at $1.95 per barrel of oil unloaded with a minimum volume commitment of 170,000 bpd per quarter, and $0.51 per barrel for unloaded barrels above the minimum commitment (Renshaw 2018).

The minimum commitment guaranteed about $30 million in revenues per quarter to the logistics company. The contract with the refinery was the only source of revenue for the rail logistics company (Kirkland and Ellis LLP 2018, 21). This fee-based contract was essential to the master limited partnership structure of the North Yard Logistics IPO, and was a long-term bet on rail-based access to cheap domestic crude.

According to Renshaw, the logistics company averaged 58,000 bpd since the contract was signed, as the narrowing Brent to WTI spread made the economics of crude-by-rail unattractive. However, the refinery paid a total of $298 million to logistics "between 2015 and August 2017", of which the Carlyle Group received $151 million in eight distributions from the logistics company (Renshaw 2018)—not a bad return for a $130 million total investment in the North Yard.

Meanwhile, in 2012, PES signed a 10-year, take-or-pay dock and terminaling contract with Sunoco to unload and store more than 300,000 bpd of waterborne crude (domestic or foreign) at the Fort Mifflin Terminal and Darby Creek tank farm (Philadelphia Energy Solutions Inc 2015, 160). At an operating capacity of between 310,000 to 335,000 bpd, this contract would have met almost all of PES's feedstock needs.

The contract included a per barrel fee with inflation escalators and average annual minimum volume commitment of 300,000 bpd. The actual per barrel fee could not be located, but PES disclosed it paid Sunoco as a part of this agreement: $6.2 million (three-month period, September 2012 through December 2012), $16.8 million (2013), and $14.8 million (nine-month period, January 2014 through September 2014) (Philadelphia Energy Solutions Inc 2015, 160). These sums generally indicate the per barrel dock and terminal fee was far less than the per barrel rail unloading fee. Between the minimum volume commitments in the two ten-year unloading contracts (rail and docking), PES was obligated to pay for a minimum of 470,000 bpd of crude unloading capacity. With a design capacity of 350,000 bpd, this minimum was far more crude than PES could ever use.

In November 2017, PES borrowed an additional $161 million, collateralized this debt against the rail terminal, and distributed the money to PES investors. All told, PES subsidiaries made over $616 million in payments to the PES parent company between 2012 and 2017, with proceeds generally distributed to equity holders (Kirkland and Ellis LLP 2018, 22).

ESTIMATED FINANCIAL IMPACTS OF BANKRUPTCY FACTORS

Some very rough calculations were performed to estimate the effects of the four primary factors leading to PES's bankruptcy, as reviewed in the previous sub-section. These calculations assume:

- PES was predominately reliant on WTI-priced supply between 2012 and 2015, and Brent for 2016 to 2017. This is an overly simplified assumption, but reasonable since it will overstate gains in some years, but understate losses in others. Data on exact feedstocks was not available.
- Use of the average annual WTI 3-2-1 crack spreads from Morningstar and the average 2-1-1 Brent crack spreads that PES reports in its Chapter 11 bankruptcy filing (Fielden, U.S. Refiners Lose Crude Price Advantage 2016).
- For every $1 reduction in crack spread, PES loses $110 million in annual revenues, as stated in its bankruptcy filing (Kirkland and Ellis LLP 2018, 28).

As shown in **Table 6**, this leads to a total reduction in revenues related to crude supply dynamics of almost $1.83 billion between 2012 and 2017. Note the sum total revenue reductions between 2012 and 2017 are the same if the $14.52 average Brent crack is used for 2015.

The refining business is extremely capital intensive, as capital investments are regularly required for facility maintenance and equipment turnarounds. PES invested $750 million in refinery complex infrastructure to sustain operations, plus another $130 million to expand rail receiving capacity at the North Yard Terminal (Kirkland and Ellis LLP 2018, 15). Of these investments, $25 million were Pennsylvania taxpayer grants, and are therefore subtracted from capital expenditures in the table below. PES also distributed over $616 million between 2012 and 2017 in dividends, debt repayment, and advisory fees to equity investors (Kirkland and Ellis LLP 2018, 22). In addition, there is the $832 million in RFS compliance costs.

The data in **Table 7** provides a clear picture of the various factors leading to PES's bankruptcy. The primary challenge PES faced was the disappearance of the attractive margins PES enjoyed when shut-in Bakken crude was very cheap and accessible. Further, WTI and Brent crack spreads dropped precipitously and shrank margins for all refineries. Next, PES management invested significantly in refining and rail capacity, which rail capacity was largely or completely underutilized. RFS compliance costs were high indeed, but recall that all refineries—both merchants and integrated refiners—had to comply with the RFS program.

The key differences between these companies include lack of transparency on RFS compliance costs for integrated refineries and comparative effectiveness of merchant refiner strategies to minimize compliance costs. Finally, PES investors siphoned cash from the company and in turn saddled PES with debt secured by the refinery's assets. The refinery's 10-year rail unloading contract seems like a clear example of investors prioritizing creation of an attractive master limited partnership structure for an IPO rather than preserving the refinery's long-term viability.

TABLE 6: ESTIMATED FINANCIAL IMPACT OF WTI TO BRENT FEEDSTOCK SWITCH AND MARGIN COMPRESSION

	WTI-NYMEX (Morningstar)			ICE-Brent (PES Ch. 11 Filing)		
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
Annual Average Crack Spreads	$30.00	$24.00	$19.00	$20.00	$13.37	$13.37
Revenue Impact		$(660,000,000)	$(550,000,000)	$110,000,000	$(729,300,000)	$0

TABLE 7: ESTIMATED FINANCIAL IMPACT OF KEY FACTORS LEADING TO PES BANKRUPTCY

Select PES Costs/ Revenue Reductions	2012–2017
WTI to Brent, with Margin Compression	$1,829,300,000
Capital Projects (less PA grants)	$855,000,000
RFS Compliance (RINs)	$832,000,000
Dividends, debts, fees	$616,000,000
Total	$4,132,300,000
Annualized Total	$688,716,667

RATIONAL INVESTOR BEHAVIOR

PES investors likely knew well in advance that PES was going to face these key regulatory and market challenges. When creating PES, investors knew the merchant refinery would face escalating RFS compliance obligations written into law. They knew inexpensive shale oil production in the Bakken formation was ramping up; crude-by-rail traffic was increasing to accommodate this new domestic volume; and the refinery's rail access would give it a competitive advantage. Investors also knew the refinery needed deferred, capital intensive investments that Sunoco was unwilling to make. They also knew that the Carlyle Group, a private equity firm, would be looking for a quick return of and on its investment.

More interestingly, the same month Sunoco's parent company ETP helped create PES, it also was appealing to FERC for approval to build an oil pipeline from the Bakken formation to the Gulf Coast.[17] This pipeline would effectively remove PES's competitive advantage and threaten to completely shut PES out of the market given the premium associated with rail-based transport. ETP was an investor in PES, but it was rational for the company to prioritize the much more lucrative pipeline investment over the speculative PES venture.

On the RFS, by 2013, enough public information was available for PES to understand the E10 blendwall had been reached and the resultant high RIN prices would likely remain.[18] Sunoco could have entered into a long-term contract with PES for discounted RINs generated at its Belmont Rack (located on the PES property footprint) or else sold the Belmont Rack to PES outright. However, Sunoco didn't exploit these options, likely because it represented too high of an opportunity cost for the firm.

For Carlyle, the PES investment was likely an option in the event a large diameter natural gas pipeline was built into southeastern Pennsylvania—enabling the refinery to be retooled as a natural gas and petrochemical refining facility. At the time, local officials were actively exploring private sale of PGW, the City of Philadelphia's large municipal gas utility. Private ownership of PGW would have expanded opportunities to realize new pipeline construction by opening different financing streams and taking advantage of regulatory privileges afforded to public utilities, which could facilitate pipeline construction. However, PGW was not sold and efforts to build natural gas pipelines into the southeast remain extremely contentious. These realities largely thwarted hopes to resurrect the refinery as a profitable asset.

For ETP, the refinery was a legacy that came with their April 2012 acquisition of Sunoco. Sunoco hoped to unload the facility, but had to remain a partner for Carlyle to invest. On top of this, Sunoco was still on the hook for the site's legacy contamination liabilities. On the other hand, the refinery would provide a hedge if ETP's Bakken Pipeline was delayed or derailed.

ETP and the Carlyle group are extremely sophisticated energy investors. However, they could not have

17 On July 26, 2012, ETP began efforts at FERC to convert its Trunkline Gas Company, LLC natural gas pipeline, which runs from Illinois to Texas, into an oil pipeline (Federal Energy Regulatory Commission 2013). This step was the beginning of a multi-stage effort to enable the movement of Canadian and Bakken crude to the Gulf Coast, a goal sought by others in the crude oil pipeline business, such as Oneok and Enbridge (Argus Media 2014). The Energy Transfer Crude Oil (ETCO) pipeline project subsequently converted portions of the Trunkline pipeline to move crude oil from Pakota, Illinois to Sunoco's petroleum terminal in Nederland, Texas. The proposal for a newly constructed Dakota Access, LLC pipeline to move Bakken crude from North Dakota to Illinois began with an open season in March 2014 and came into service in June 2017 (Federal Energy Regulatory Commission 2014). The combination of ETP's ETCO and Dakota Access projects—collectively the "Bakken Pipeline"—enabled Bakken crude to move to the Gulf Coast, largely shutting out the East Coast refineries from cheaper WTI-priced crude once operational in June 2017.

18 RIN costs began to escalate significantly in 2013. By June 2013, the U.S. EIA released an online publication explaining the RIN price increase was due to market concerns that rising ethanol mandates and the E10 blendwall would increase the cost of blending biofuels to meet RFS volume requirements. (U.S. Energy Information Administration 2013). The same publication also predicted these RIN prices would remain high in the future.

predicted the lifting of the oil export ban in December 2015, or that OPEC would continue to produce oil in the face of low prices. These factors reduced production, increased competition for supply, and contributed to the shrinking of the WTI-Brent differential that PES was profitably exploiting. However, they likely were able to predict PES's failure, but did not want to sacrifice more profitable ventures or devote precious capital to a failing asset.

ETP and the Carlyle group are extremely sophisticated energy investors. However, they could not have predicted the lifting of the oil export ban in December 2015, or that OPEC would continue to produce oil in the face of low prices.

SECTION 4: THE SPECULATIVE FUTURE OF PES

PES gained court approval of its bankruptcy reorganization plan, but the facility will still be faced with a long list of significant challenges. Likely, during the next five years—leading up to maturity of significant debts—the facility may again face dire financial straits. Post-bankruptcy, PES will be more highly leveraged than before, will face many old and new challenges, and will continue to operate with financial projections that are "approaching the limit of viability." These factors reduce the probability of future investors in PES (or buyers); limit the viability of future bankruptcy reorganizations; and increase the likelihood of liquidation.

PES BANKRUPTCY IS APPROVED

In April 2018, PES successfully navigated court approval of its bankruptcy reorganization plan after a somewhat contested process and completed reorganization in August 2018. Because the bankruptcy was "pre-packaged"—meaning a core group of current creditors had agreed to the terms in advance—the bankruptcy was controversial beyond these core creditors. These controversies related to PES's settlement on outstanding RIN obligations with the EPA and with tax authorities to whom PES owed back taxes.

RIN Settlement

The initial bankruptcy plan relied on EPA excusing PES of all $350 million in compliance costs under the RFS, corresponding to about 467 million RINs owed from historic operations in 2016 and 2017 (Kirkland and Ellis LLP 2018, 54). This would reduce PES's compliance obligations and also allow the company to sell (rather than retire) the RINs it currently held. On March 12, the U.S. Department of Justice, on behalf of the U.S. EPA, filed a settlement agreement with PES where PES would be obligated to (1) retire 138 RINs currently held by the company for pre-bankruptcy RFS obligations; (2) retire 64.6 million RINs for post-bankruptcy RFS obligations for 2018; (3) consent to retire RINs on a semiannual basis through 2022; and (4) submit itself to stipulated penalties if it failed to achieve its RIN obligations (Wood 2018).

This settlement amounted to PES complying with less than half of its outstanding RFS obligations. The settlement required a ten-day comment period and a separate RIN settlement hearing, which occurred on April 4. In support of the RIN settlement, the U.S. Department of Justice hired certified public accounting firm Harris & Associates to assess PES's financial ability to comply with the RFS. The accounting firm found that,

> ". . .PES's plan is already approaching the limit of viability. In my opinion, any requirement to retire RINs to meet past obligations, either presently or in the future, in addition to the 138 million outlined in the settlement agreement, poses a significant risk to the company remaining a viable entity post bankruptcy." (HARRIS 2018)

On April 5, the court approved the settlement agreement, thereby effectively clearing the way for the bankruptcy reorganization's approval.

Back Taxes

The RIN settlement was an expected controversy in the PES's bankruptcy, but multiple assertions of significant, unpaid back-tax liabilities were unexpected. Several government agencies and taxing authorities, including but not limited to the U.S. trustee and government, Pennsylvania Department of Revenue, City of Philadelphia, and various Texas taxing authorities, protested PES's bankruptcy plans. Each objection was slightly different, but these creditors generally objected to certain expedited procedures sought by PES, asserted PES owed or may owe back taxes, and that the refiner's bankruptcy plan would potentially impair these creditors' ability to recover taxes owed.

Most remarkably, the Pennsylvania Department of Revenue asserted PES potentially owed an estimated $3.81 billion in unpaid sales and use tax and liquid fuels taxes, interest, and penalties accrued between January 1, 2015 and January 21, 2018. It noted an audit was underway to determine the exact amount owed (Shapiro 2018). To have these objections withdrawn, PES was forced to make concessions, including inserting language in the bankruptcy order that preserved creditor rights to recover taxes owed. As a result, post-bankruptcy, PES may still be liable for significant back-tax obligations.

Recall, the accounting firm Harris & Associates found the costs associated with RFS compliance— pegged at a few hundred million dollars—would create significant risk to PES's financial viability going forward. As such, if even if the Commonwealth's ongoing audit finds PES owes only a fraction of the $3.8 billion in potential back taxes, it may add terminal financial stress to the company. The Department of Revenue's audit is expected to be completed sometime in summer 2018.

POST REORGANIZATION FINANCIAL FORECAST

PES's bankruptcy filings include financial forecasts for 2018 to 2021, presenting the company's estimates of future performance upon successful completion of the Chapter 11 bankruptcy reorganization. (Kirkland and Ellis LLP 2018, Exhibit E). The forecast assumes:

- Annual capital spending of $139 to $191 million and assumes refinery equipment turnarounds (i.e. refurbishments and replacements) in 2019 and 2021;
- An average 315,000 barrel per calendar day throughput, producing 50% gasoline, 40% distillate, and 10% other products;
- An approximate $61/barrel (bbl) Brent crude price;
- A Brent $13.25/bbl 2-1-1 crack spread net of renewable fuel standard compliance credits (i.e. RINs);
- Consumed crude differential of $2.51/bbl, excluding logistics fees;
- An annual RIN expense of $232–$245 million and a RIN value of 67 cents per gallon;
- Zero 2017 RIN compliance costs; and
- Sale of $150 M in RINs in Q1 2018.

With these and other assumptions in mind, PES forecasts net income of $386 million in 2018, $33 million in 2019, $99 million in 2020, and $121 million in 2021. These projections indicate relatively thin projected, but positive margins.

LIQUIDATION VALUE

In the event reorganization plans were not approved, a liquidation pathway and analysis was included as part of PES's bankruptcy filings (Kirkland and Ellis LLP 2018, Exhibit C). PES states liquidation would take place over a nine-month period, but acknowledges the process could take longer. The liquidation values fail to account for historic environmental contamination at the site, which remains Sunoco's responsibility. The combined liquidated value of the refinery and rail terminal is estimated, at best, at a little over $700 million. Recall PES's bankruptcy petition identifies over $678 million in debt secured by the refinery and its rail assets, in addition to other unsecured obligations.

The refining and marketing segment of PES had a net book value of just under $1.8 billion, reduced to $1.12 billion after adjustments and expenses. Of this, the largest line item recoverable value is $260 million for the estimated value of the property, plant and equipment, net of accumulated depreciation, and of course excluding historic environmental contamination for which PES is not liable. Estimated total value of potentially recoverable assets, after administrative expenses, would fall between $543 million (low) to $607 million (high).

For the North Yard Logistics segment, the net book value is listed as $197 million, increasing to just over $200 million after adjustments. The net book value of the property, plant, and equipment is listed as $85.5 million, but only about $100,000 to $500,000 of this is estimated to be recoverable. PES received at least $10 million in grant subsidies from the Commonwealth of Pennsylvania's Department of Transportation to build the North Yard Terminal and offloading facility, which is now essentially worthless. The estimated total recoverable value, after Chapter 7 administrative expense, is between $73 million (low) to $95.6 million (high).

It is important to understand these values and amounts sought for recovery are subject to change post-bankruptcy.

POST-BANKRUPTCY CHALLENGES

Primarily, bankruptcy will delay PES's debt service burden, but will not change the business's fundamental challenges. While refining margins could improve, PES will continue to largely be shut out from cheap domestic crude, presenting a strategic disadvantage. However, this may change if significant oil development from the Mid-Atlantic Utica formation occurs or the Merchant

Marine Act of 1920 (i.e. the Jones Act) is amended to improve the economics of waterborne delivery of domestic crudes.[19]

PES will continue to be subject to RIN market price volatility, unless a better partnership contract or strategic investment is developed (e.g. acquisition of blending facility or other asset that generates RINs). Alternatively, the Trump administration could potentially waive, cap, shift, or otherwise reduce the RFS compliance requirements, which PES and others in the refinery industry are actively pursuing. However, the powerful agricultural lobby has objected to changes that would weaken RFS policy. But there are additional ongoing and new challenges that PES will have to face in the future.

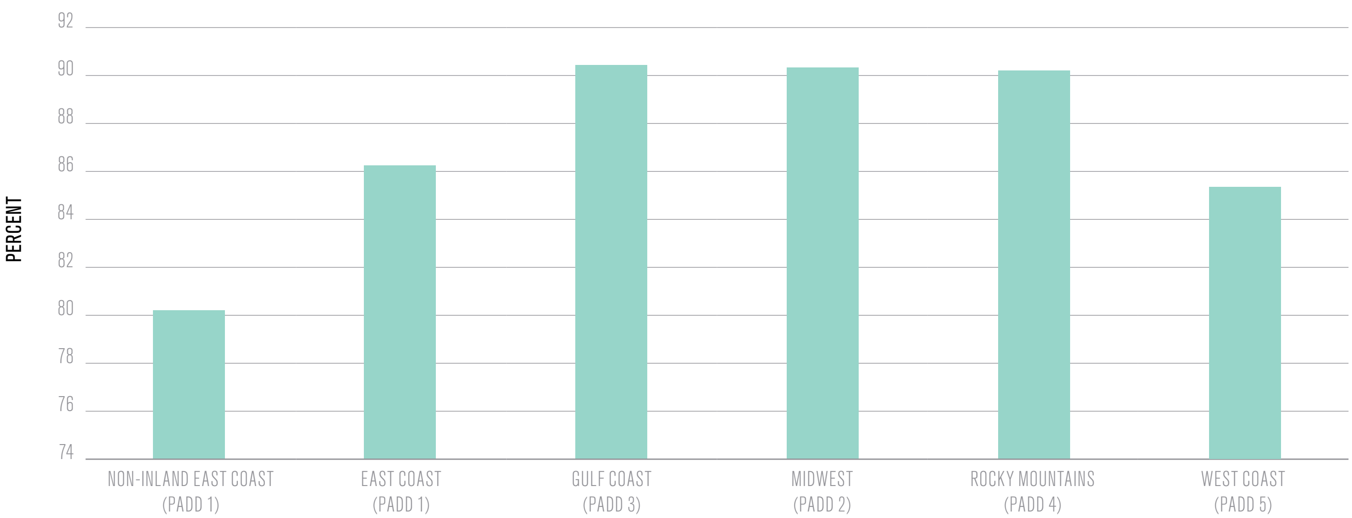
Low Utilization of East Coast Refineries:
As shown in **Figure 16**, the non-inland East Coast portion of PADD 1 has the lowest refinery utilization rates in the country, indicating less competitive refining capacity. PES is the largest non-inland East Coast refiner, and likely contributes significantly to these data.

Capital Needs for Turnarounds
The PES Chapter 11 plan includes an infusion of $230 million of new capital, but it is unclear how PES will use this capital. PES notes significant annual capital spending and turnarounds between 2018 and 2020 needed to maintain ongoing operations, including investments in equipment renewals: sulfuric alkylation (2018), low sulfur gasoline (2019), sulfur plant (2019, 2020), distillate desulfurizer (2020), hydrofluoric alkylation (2020), Girard Point FCC (2019), reformer (2020), Udex (2020), butane isomerization (2020) (Kirkland and Ellis LLP 2018, 16). In addition, many additional costly turnarounds are needed in 2021 and 2022.

Capital Needs for Sulfur Compliance
PES will require capital investments for compliance with new regulatory programs affecting motor and marine fuels. According to SEC filings in 2015,

> "On March 4, 2014, the EPA finalized its Tier 3 Motor Vehicle Emission and Fuel Standards (Standards). The Standards establish more stringent vehicle emissions standards and will reduce the sulfur content of gasoline beginning in 2017. The gasoline currently manufactured by the Philadelphia refining complex does not fully meet the requirements. The Standard requires additional capital investment to install new technologies and could materially increase compliance costs, which could have an adverse effect on our financial position, results of operations, and liquidity."
> (PHILADELPHIA ENERGY SOLUTIONS INC 2015, F-46)

FIGURE 16: PERCENT UTILIZATION OF REFINERY OPERABLE CAPACITY (2008–2017 AVERAGE)



(U.S. Energy Information Administration 2018)

19 The Jones Act regulates marine commerce in the U.S. and requires that shipment of goods among domestic ports occurs on ships built, owned, and operated by U.S. citizens or permanent residents.

The first annual reports to EPA demonstrating 2017 compliance with the Tier 3 standards were due March 31, 2018. PES mentioned the need for Tier 3 investment in its 2015 IPO filings, and its plans to raise and allocate capital for the project (Philadelphia Energy Solutions Inc 2015, 27; 90). There were reports in June 2016 that PES contracted to spend $100 to $125 million on a Tier 3 compliance program that included operational and equipment changes (Brelsford 2016). It is unclear whether these compliance investments occurred, or if PES secured a compliance waiver from the EPA.

The International Maritime Organization (IMO) is a special agency of the United Nations with the authority to set safety, security, and environmental standards in international shipping. The IMO recently put in place global low sulfur rules on ocean going vessels that will require an 85% reduction in sulfur emissions by January 2020. November 2017 reports indicate PES has not yet made the investment to reduce sulfur levels in its bunker fuels (Mathews and Alessi 2017). It is expected these vessels will opt to use cleaner fuel rather than invest in costly retrofits, creating opportunities for Gulf Coast refineries and disadvantaging less complex East Coast refineries that may be forced to sell their high sulfur bunker fuel at deep discounts (Mathews and Alessi 2017).

Competition from Midwest Refineries

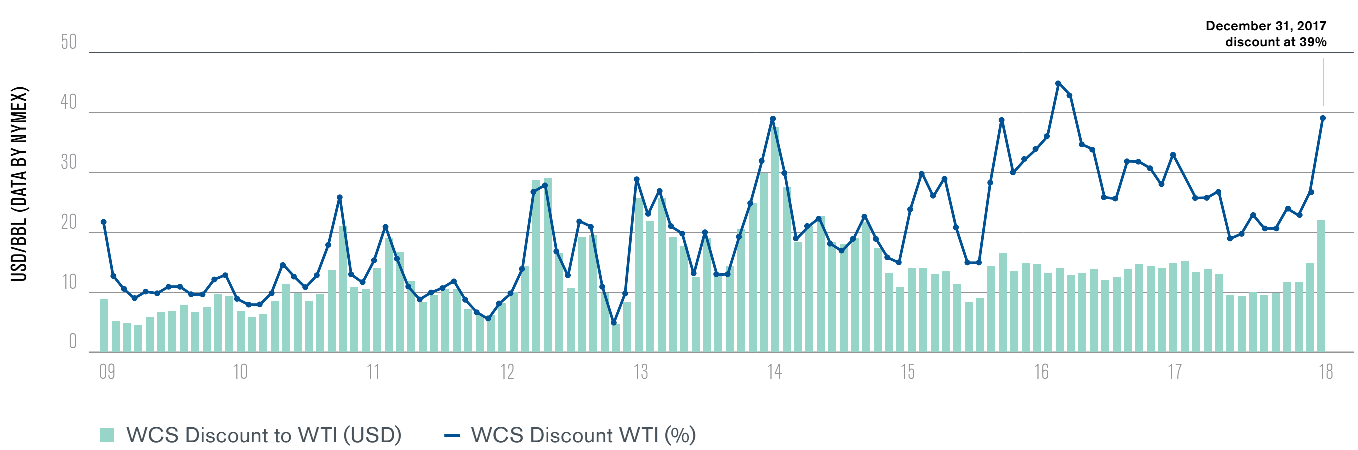
Midwest refineries in PADD 2 have invested heavily to increase capacity and their ability to process heavy crudes in expectation of new Canadian feedstocks, ramping up production from 3.3 million barrels per day (mb/d) in 2010 to 3.6 mb/d in 2016 (Fielden 2017). Between 2009 and early 2018, Canadian crude priced at the Western Canada Select (WCS) has traded at a 5% to 46% discounts to WTI crudes, as shown in **Figure 17**. Morningstar maintains that midwestern refinery heavy crude crack spreads will continue to be more attractive than light crude spreads, as long as Canadian crude production stays high and pipeline takeaway capacity is constrained. While Midwest refineries recently increased capacity, U.S. EIA data indicated PES has actually derated capacity (as shown in **Table 5**).

Laurel Pipeline Reversed or Bi-Directional Flows

PES objected to a proposal before the Pennsylvania Public Utility Commission (PA PUC) that would allow the existing Laurel Pipeline to reverse direction of oil flow (from east to west instead of west to east) on a portion of its line (Seltzer 2017). PES maintains that 20% of its total production is delivered to the Pittsburgh area on the Laurel pipeline and flow reversal would materially damage its business. Buckeye Partners, the owner of the Laurel Pipeline, maintains it has seen a two-thirds drop in east-to-west fuel deliveries (e.g. from East Coast refiners), while demand from Midwestern refineries to move product from west to east has increased.

In March 2018, an administrative law judge recommended the PA PUC reject Buckeye's reversal proposal, expressing doubts that increased reliance on

FIGURE 17: MONTHLY AVERAGE WESTERN CANADIAN SELECT CRUDE OIL DISCOUNT TO WTI CRUDE (JAN 2009–FEB 2018)



(Oil Sands Magazine 2018)

midwestern product supply would provide lower costs to consumers compared to competition between eastern and midwestern supply (Vero 2018). On July 12, the PA PUC denied Buckeye's reversal petition.

However, on April 6, 2018, Buckeye announced it was pursuing bi-directional service on the Laurel line—meaning it would maintain the existing intrastate east-to-west service while adding new interstate west-to-east to accommodate midwestern refineries (Buckeye Partners, L.P. 2018). Buckeye maintains the bi-directional approach would keep PA PUC-jurisdictional service and tariffs in place for east-to-west intrastate service, while establishing FERC-jurisdictional interstate tariffs for the new west-to-east service. Successful transition to bi-directional service on the Laurel line will expose PES to greater competition from Midwestern refineries. PES maintained in its pleadings to the PA PUC that ending east to west service on the Laurel line would eventually force the refinery to close, while the impacts of bi-directional service on PES are less clear (Vero 2018).

Adelphia Gateway Pipeline Project

Morningstar believes PES and Delta's Monroe (in Trainer, Pennsylvania) refineries are the weakest performers on the East Coast (Fielden October 2016). In 2017, reports surfaced that Monroe hired consultants to investigate various impacts related to closing the refinery, which it purchased primarily to reduce jet fuel costs (Renshaw and Resnick-Ault 2017). Historically, closing one East Coast refinery increases utilization of other area refineries.

In the current competitive environment, it may be that only one of these weak refineries can survive. As such, a recent application to FERC to convert an existing oil pipeline to move Marcellus natural gas to SE Pennsylvania, including building a 16-inch lateral (the "Tilghman Lateral") to deliver gas to the Monroe refinery may not bode well for the future of PES (Valori 2018). While the lateral is not large enough for feedstock delivery, it could enable Monroe to reduce fuel costs. On the other hand, the Adelphia project would also connect to the Marcus Hook refinery. Sunoco pipelines connect Marcus Hook to PES. To the degree these pipelines can be converted to natural gas, PES could also benefit from the Adelphia project.

Elimination of Gasoline Volatility Requirements for Pittsburgh Region

Pennsylvania Act 50 of 2014 began the process of repealing the 7.8 pounds per square inch (psi)-or-lower Reid vapor pressure (RVP) gasoline requirement for the Pittsburgh–Beaver Valley area that includes Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, and Westmoreland counties. Low RVP gasoline is required to be sold in the Pittsburgh–Beaver Valley area between May 1 and September 15 of each year, in an effort to reduce emissions of volatile organic compounds and meet federal pollution limits on ground-level ozone and fine particulate matter. The low RVP requirement increases the cost of gasoline by 10 to 15 cents per gallon compared to gasoline with standard RVP (around 9 psi).

On April 7, 2018, the Pennsylvania Department of Environmental Protection (PA DEP) finalized regulations that would eliminate the low RVP requirement for the Pittsburgh–Beaver Valley region, upon approval of the U.S. EPA (Pennsylvania Bulletin 2018). EPA approval is required, since the low RVP rule was part of Pennsylvania's federally-enforceable state implementation plan to achieve compliance with National Ambient Air Quality Standards. On April 21, 2018, PA DEP notified the public it would not enforce the low RVP requirement in the Pittsburgh–Beaver Valley region for summer 2018, as rescission of the rule was pending federal approval (Pennsylvania Bulletin 2018). According to court documents, low RVP gasoline in the Pittsburgh–Beaver Valley region is currently sourced from East Coast refineries (e.g. PES and Monroe) and transported through the Laurel pipeline, causing volumes on the Laurel line to consistently increase in summer months. More poignantly, "…east coast refineries supply almost all of the gasoline to the Pittsburgh area during the low-RVP summer months" (Vero 2018, 150). Essentially, PES can produce and supply the Pittsburgh area with low RVP gasoline in a competitive manner, compared to other available options. Elimination of the low-RVP requirement will result in PES losing its seasonal competitive advantage in the western Pennsylvania market.

Federal Reserve Regulations

In September 2016, the Federal Reserve proposed rules that would strengthen requirements and limits on financial holding companies engaged in physical commodities activities. PES believes finalizing this rule as proposed would harm its business by limiting innovation and increasing costs associated with use of commodities-based derivatives (McShane 2016). If and how the Federal Reserve finalizes its proposed rules may impact PES. This may be especially relevant to the intermediation agreements PES maintains with financial institutions to manage feedstock inventory and market refined products.

Collective Bargaining Agreement Expiration
Another uncertainty is the ability for PES to negotiate an attractive extension or replacement to its collective bargaining agreement with the United Steelworkers union (USW), that expires on September 9, 2018 (Kirkland and Ellis LLP 2018, footnote on 14). Approximately 650 of PES's 1,100 employees belong to USW.

Loss of Keystone Opportunity Zone Status
After December 31, 2023, PES will lose the attractive Keystone Opportunity Zone state and local tax benefit and will be subject to full state and local tax rates (Philadelphia Energy Solutions Inc 2015, F-39).

Resolution of Back Tax Liabilities
This potentially includes:

- $3.8 billion to the Commonwealth of Pennsylvania for unpaid sales and use and liquid fuels taxes,
- More than $232,000 in unpaid business income and receipts tax due to the City of Philadelphia for 2015 and 2016,
- More than $105,000 to certain Texas taxing authorities,
- Other potential back tax liabilities.

In short, even though the refinery was able to successfully navigate bankruptcy reorganization, the future is still quite uncertain for PES.

SECTION 5: THE UPCOMING OPPORTUNITY

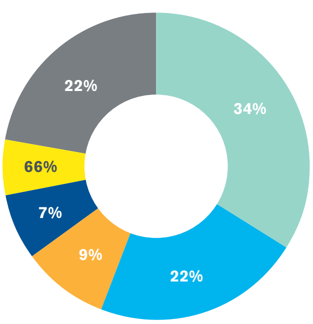
Independent from the refinery's operations, Sunoco will be embarking on an effort to remediate the widespread legacy contamination—such as lead and benzene (a known human carcinogen)—that exist at the property. There is a compelling opportunity for the city and neighboring communities to engage in this process to leverage Sunoco's efforts. If the refinery cannot continue to operate, the opportunities for the city, community, and other industries will exponentially increase. Cessation of air pollution emissions from the facility will improve regional air quality and ease permitting requirements for other industrial entities. Closure of the facility may also create redevelopment opportunities, the potential for which requires further investigation.

POLLUTION FROM REFINERY OPERATIONS

Operation of the refinery contributes significantly to a host of environmental pollutants, which would cease to be released upon the facility's closure. 2016 data from the U.S. EPA's Toxic Release Inventory—which tracks releases of certain toxic chemicals that may be hazardous to human health and the environment—indicates PES released 469.6 thousand pounds of on-site air (464.2 thousand pounds) and water (5.3 thousand pounds) pollution. **Figure 18** shows the top five air and water pollutant releases at PES in 2016.

In 2016, Pennsylvania ranked 14th out of 56 states and territories with respect to total toxic releases per square mile (U.S. Environmental Protection Agency 2017). There are 31 facilities listed in the TRI for Philadelphia County and PES is by far the largest source of toxic pollution in the county, with the second ranked facility releasing a total of 159.1 thousand pounds, or about a third of the total toxic chemical releases of PES (U.S. Environmental Protection Agency 2017). PES also contributes a significant majority of certain criteria air pollution emissions, which are also harmful to human health and the environment. As shown in **Table 8**, 2014 annual data from the U.S. EPA provides information on PES and Philadelphia County select toxic and criteria pollutant emissions, in tons.

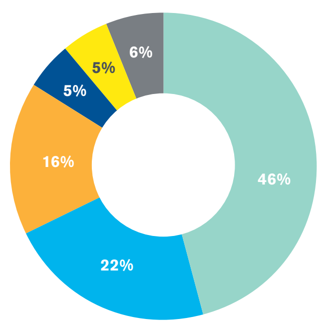
FIGURE 18: U.S. EPA'S TOXIC RELEASE INVENTORY DATA FOR PES AIR AND WATER RELEASES IN 2016



AIR (464.2 THOUSAND POUNDS)

- Sulfuric Acid (1994 and after "acid aerosols" only): **34%**
- Hydrogen Cyanide: **22%**
- Benzene*: **9%**
- N-Hexane: **7%**
- Cumene: **6%**
- Other: **22%**

* Carcinogenic Chemical



WATER (5.3 THOUSAND POUNDS)

- Ammonia: **46%**
- Antimony Compounds: **22%**
- Phenol: **16%**
- Hydrogen Sulfide: **5%**
- Lead Compounds: **5%**
- Other: **6%**

(U.S. Environmental Protection Agency 2017)

TABLE 8: PES AND PHILADELPHIA COUNTY ANNUAL EMISSIONS OF SELECT CRITERIA AND TOXIC AIR POLLUTANTS (2014)

Pollutant	PES Emissions (Tons)	Philadelphia Emissions (Tons)	PES as % of Philadelphia Total Emissions
Benzene	17.62	20.11	87.6%
Black Carbon	53.86	176.10	30.6%
Carbon Monoxide	1531.75	2126.86	72.0%
Chromium VI Compounds	0.01	0.01	74.2%
Formaldehyde	4.09	5.96	68.7%
Nitrogen Oxides	1458.36	2528.00	57.7%
PM2.5	654.60	1017.34	64.3%
PM10	703.89	1104.00	63.8%
Sulfur Dioxide	354.84	517.94	68.5%
Volatile Organic Compounds	593.31	1253.60	47.3%

(U.S. Environmental Protection Agency 2014)

According to the U.S. EPA greenhouse gas reporting tool, PES is the eight largest emitter of greenhouse gases (GHGs) in the Commonwealth of Pennsylvania, eclipsed only by a handful of large coal and natural gas fired power plants (U.S. Environmental Protection Agency 2017). Philadelphia County has 11 large emitting GHG facilities that are required to report emissions annually to the U.S. EPA. Of these 11 facilities, PES has by far the greatest amount of annual GHG emissions at 3,216,284 metric tons of carbon dioxide equivalent (MTCO2e), with the second-ranked facility emitting 670,440 MTCO2e, or about a fifth the GHG emissions of PES.

HISTORIC CONTAMINATION AND REMEDIATION ACTIVITIES UNDERWAY

Regulatory documents from the PA DEP indicate most of the refinery's site contamination is due to legacy operations, rather than during Sunoco's tenure. Historic information uncovered by Fredric Quivik provides potentially disturbing details about past incidents at the site, most of which occurred prior to the petroleum industry's regulation (F. L. Quivik 2015). Quivik references alarmingly high turn-of-the-century product leakage rates, an 1879 fire that destroyed over 25,000 cases of stored petroleum leaving the soil saturated, and reports of oil contamination of groundwater as early as 1884 from the Philadelphia Water Department (PWD).

There were other fires, accidents, explosions, leaks, and other incidents (including numerous fatalities) described in Quivik's informative article. By 1930, a few years after Congress passed the Oil Pollution Act, the refinery began to use oil–water separator equipment to treat wastewater and water runoff collected in the sewers, plus a team of 37 individual leak detection employees to monitor the refinery's five thousand miles of pipes. Between the separators, drip pans, and other devices installed at the refinery, between 46,000 to 53,000 barrels of oil *per month* were collected, presumably these products were being released into the environment prior to that time (F. L. Quivik 2015, 284).

Perhaps the most disturbing account of the magnitude of contamination relates to the Philadelphia Water Department's 1962 interceptor sewer project.

Installation of sewer pipes 40 feet below the surface (at or below the water table) encountered persistent infiltration of hydrocarbon contaminated water. Attempts to complete the sewer project in the presence of hydrocarbons eventually led to an explosion, the death of four construction workers, and subsequent litigation. The hydrocarbons were determined to be gasoline, which in the early years of the oil industry—when kerosene and lubricating oils were the primary marketable products—was considered a waste product of the distillation process (F. L. Quivik 2015, 278).

During the 1966 litigation against PWD and Atlantic Refining (then owner of the refinery), William Wakeley, Atlantic's refinery plant protection superintendent, testified. Wakeley admitted some of the leaking material was from the Atlantic refinery, but estimated that petroleum had been sitting in the water table in the eastern portion of the Point Breeze property line for about one hundred years. The Atlantic Petroleum Storage Company had been established one hundred years prior to that time. Former refinery manager Charlie Stose also testified the company was well aware of the contamination and it was his belief the ground could not be decontaminated of liquid hydrocarbons (F. L. Quivik 2015, 287–288).

Based on a 2012 agreement with the U.S. EPA, Sunoco retains responsibility for the significant environmental remediation liabilities at the site associated with contamination that pre-dates PES and Sunoco operations (U.S. Environmental Protection Agency 2012).

Evergreen Resources Management Operations is a Sunoco subsidiary tasked with responsibility over the company's legacy environmental liabilities. In 2006, Sunoco entered the refinery complex into Pennsylvania's Act 2 Land Recycling Program.[20] In 2011, Sunoco entered the refinery complex into the One Cleanup Program where meeting Pennsylvania's Act 2 state standards would also fulfill certain federal standards, including the Resource Conservation and Recovery Act of 1976 (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), for liabilities associated with legacy contamination.[21]

The refinery site has been divided into 10 separate areas of interest (AOI), plus an eleventh AOI concerning the deep groundwater aquifer used as a water source by the state of New Jersey, which underlies the entire site.[22]

Remedial investigation reports (RIR) are used when the remediator seeks to achieve a pollution concentration standard above (i.e. less stringent than) the statewide health standards, based on site-specific risk assessments. The RIR for each AOI provides a detailed site characterization to identify contaminants and contaminated media (i.e. soil, groundwater); models potential migration of pollution; and establishes locations where compliance will be measured. Evergreen received approval for eight of the eleven RIRs pertaining to the refinery complex, with approval of RIRs for AOI's 4, 9 & 11 still pending. EPA expects to have the remaining RIRs completed by the end of 2018 and estimates a cleanup plan will be available for public comment by mid-2020 (Wzorek 2018). Remediation occurs after regulators approve the final cleanup plan. Then, Evergreen must demonstrate attainment of applicable standards and submit a final report. Once the PA DEP approves the final report, it releases the remediator from further remediation liability, including from citizen suits. Liability protection may apply not just to the remediator, but also to current or future owners of the site, developers, occupiers, successors or assigns, entities performing remediation activities, and others. However, post-remediation monitoring and maintenance may be required, as well as environmental covenants associated with engineered or institutional controls used to attain the site-specific standard.

A detailed description of contamination in each AOI is included in Appendix C. Generally, the site is primarily contaminated with light non-aqueous phase liquids (e.g. hydrocarbons like gasoline), which are in the soil and the groundwater. Specific chemicals of widespread concern

20 In 1995, Pennsylvania established a series of laws (Acts 2,3, and 4 of 1995) aimed at encouraging voluntary clean up and reuse of contaminated sites. These programs are often collectively referred to as "Act 2" or the Land Recycling Program.

21 In 2004, the Pennsylvania Department of Environmental Protection (PA DEP) and the U.S. Environmental Protection Agency (EPA) signed a memorandum of understanding (MOU) identifying procedures by which remediation under the Land Recycling Program may also satisfy federal requirements under RCRA, CERCLA, and the Toxic Substances Control Act. This MOU established the One Cleanup Program that created a "one-stop shop" for remediators to follow when attempting to meet state and federal standards for remediation and liability relief.

22 The Lower or Farrington Sand aquifer of the Potomac–Raritan–Magothy formation

include benzene, lead, MTBE, toluene, benzo(a)pyrene, and many other volatile and semi-volatile organic compounds, as well as other compounds where contamination is less widespread. In some areas, contamination is migrating off site (e.g. at AOIs 1, 4, 9, & 11).

Except for the baseball field in AOI 8, the majority of the property will be remediated to a site-specific, non-residential standard. It may be feasible for additional areas of the property to achieve higher remediation standards that would allow for future residential use (Brown 2018). However, if technically feasible, achieving these higher standards will involve additional costs and are not required as a part of Sunoco's existing compliance obligation. Once Sunoco's remediation efforts are complete and PA DEP approves a final report, the site would need to re-enter the Act 2 program in order to pursue more stringent remediation standards. Alternatively, and assuming incremental funding is available, there may be an opportunity to achieve the more stringent statewide health-based standards (residential or non-residential) as part of the Act 2 remediation process currently underway.

Sunoco's 2012 agreement with the U.S. EPA requires Sunoco to maintain financial assurances to fund remediation of the refinery complex (U.S. Environmental Protection Agency 2012). In February 2018, ETP reported it had established a wholly-owned captive insurance company in December 2013 for Sunoco's legacy sites that are subject to environmental remediation, including, but not limited to, closed or sold refineries (Energy Transfer Partners 2018, 26). As of December 31, 2017, the captive insurance company held $207 million in cash and investments. Correspondence with the U.S. EPA confirmed Sunoco's captive insurance policy serves as the established financial mechanism for funding remediation, and noted current cost estimates for completing investigations and implementing and operating remedial systems are $17.4 million (Wzorek 2018).

Independent from the refinery's operations, site remediation activities have taken place for years and will continue to take place, improving environmental and public health conditions for over 1,300 acres of land near Center City, Philadelphia. Unfortunately, many of these remediation activities have taken place without the benefit of legally-required public participation. This is particularly troubling given the refinery footprint is situated among environmental justice neighborhoods.[23]

Sunoco is pursuing remediation of the facility to site-specific standards. When pursuing site-specific standards, community involvement requirements of Act 2 stipulate that,

> "Persons using site-specific standards are required to develop a public involvement plan which involves the public in the cleanup and use of the property if the municipality requests to be involved in the remediation and reuse plans for the site. *The plan shall propose measures to involve the public in the development and review of the remedial investigation report, risk assessment report, cleanup plan and final report.* Depending on the site involved, measures may include techniques such as developing a proactive community information and consultation program that includes door-step notice of activities related to remediation, public meetings and roundtable discussions, convenient locations where documents related to a remediation can be made available to the public and designating a single contact person to whom community residents can ask questions; the formation of a community-based group which is used to solicit suggestions and comments on the various reports required by this section; and, if needed, the retention of trained, independent third parties to facilitate meetings and discussions and perform mediation services."[24] (italics added for emphasis)

23 PA DEP defines Environmental Justice areas as any census tract where 20 percent of more individuals live in poverty, and/or 30 percent of more of the population is minority. More information on Pennsylvania's environmental justice neighborhoods can be found at PA DEP's Office of Environmental Justice website at https://www.dep.pa.gov/PublicParticipation/OfficeofEnvironmentalJustice/Pages/PA-Environmental-Justice-Areas.aspx

24 PA Act 2 of 1995 (P.L. 4, No. 2), Chapter 3, Section 304(o), a copy of the Act is available at the PA General Assembly website at http://www.legis.state.pa.us/cfdocs/legis/LI/uconsCheck.cfm?txtType=HTM&yr=1995&sessInd=0&smthLwInd=0&act=0002.

In addition, there are notice and review requirements for facilities pursuing site-specific remediation standards, including but not limited to the following:

> "(2) The following notice and review provisions apply *each time* a remedial investigation report, risk assessment report, cleanup plan and final report demonstrating compliance with the site-specific standard is submitted to the department:
>
> > (i) When the report or plan is submitted to the department, *a notice of its submission shall be provided to the municipality in which the site is located, and a notice summarizing the findings and recommendations of the report or plan shall be published in a newspaper of general circulation serving the area in which the site is located*. If the municipality requested to be involved in the development of the remediation and reuse plans, the reports and plans shall also include the comments submitted by the municipality, the public and the responses from the persons preparing the reports and plans."[25] (italics added for emphasis)

It is clear the Act requires remediators to provide public notice with summary results, and submit public comments received with responses to those comments to PA DEP at the same time as the relevant plans and report are submitted, making these comments and responses key inputs into the department's decision-making process regarding approval, deficiency, or rejection of said plans. This is reaffirmed in PA DEP's Act 2 technical guidance document,

> "The reports and plans submitted to the Department must include the comments received from the public and the municipality as well as responses to those comments. *The Department will consider the comments as part of its review of the plans and reports*."[26] (italics added for emphasis)

Sunoco published its initial NIR in *The Philadelphia Inquirer* and the *Philadelphia Daily News* on October 16, 2006 and sent a letter to the Philadelphia Department of Public Health, dated October 12, 2006. The City of Philadelphia timely submitted its request for a PIP on November 3, 2006 (City of Philadelphia 2006). In its letter, the City requested the development of a PIP and also notified Sunoco about several perceived deficiencies in its NIR, for example the failure to sufficiently describe location and remediation strategies. Sunoco developed a PIP that included one information session (which was subsequently held on September 19, 2007), proposed to make documents available to the two area libraries, identified a single point of contact for questions, agreed to publish a notice of the public information session in local newspapers, and committed to offer a meeting space and a facilitator for the information session (Sunoco 2006).

Inconsistent with Act 2's community involvement requirements, Sunoco's PIP did not include measures to involve the public in the development of the risk assessment reports, remedial investigation plans, cleanup plan, or final plan. It also appears Sunoco did not comply with the notice and review requirements including notifying the municipality when RIRs or risk assessments were submitted, or publishing summary findings in local newspapers. As a result, the public was not afforded the opportunity to provide comments on the eight RIRs or any applicable risk assessments. This means PA DEP did not have the opportunity to consider public comments and Sunoco's responses to these comments during the department's review process of these RIRs or risk assessments. In fact, it seems Sunoco has only hosted one public meeting through the remediation process thus far.

Eight of the eleven RIRs have been developed by Sunoco and approved by PA DEP with no opportunity for involvement and comment from the City, neighboring communities, or other stakeholders. This is inconsistent with the requirements of Act 2 and raises serious legal questions about the validity of these approvals. In addition, a nonresidential site-specific lead in soil standard of 2,240 mg/kg was approved by DEP for the site on May 6, 2015. The nonresidential statewide health-based standard for lead in surface soil is 1,000 mg/kg.

25 PA Act 2 of 1995 (P.L. 4, No. 2), Chapter 3, Section 304(n)(2)

26 See the Section I. D. 9. c) pertaining to "Notice Requirements and Procedures" in PA DEP's Land Recycling Program Technical Guidance Manual dated June 8, 2002 (Document # 253-0300-100) located at *http://files.dep.state.pa.us/EnvironmentalCleanupBrownfields/LandRecyclingProgram/LandRecyclingProgramPortalFiles/GuidanceTechTools/tgm-section1.pdf*

It is unclear why Sunoco's PIP failed to meet statutory requirements for community involvement and public notice and review. The omission could have been purposeful, but there is a less nefarious potential explanation. There is significant inconsistency between PA DEP regulations on public involvement, and the actual requirements of Act 2. Applicable provisions of PA DEP's regulations stipulate minimum requirements for a PIP shall include:

- Public access at convenient locations for document review,
- Designation of a single contact person to address questions from the community,
- A location near the remediation site for any public hearings and meetings that may be a part of the PIP, and
- Submission of the PIP along with RIRs[27]

However, the minimums outlined in the regulation exclude key provisions from the community involvement and notice and review sections of Act 2. For example, the regulation excludes the requirement to "…propose measures to involve the public in the development and review of the remedial investigation report, risk assessment report, cleanup plan and final report" and to submit public comments and responses to those comments to PA DEP. Sunoco's PIP seems generally consistent with the minimums outlined in the PA Code, although it does not seem PIPs were being submitted with RIRs.[28] PA DEP's technical guidance on public involvement plan requirements clearly refers to the community involvement and notice and review requirements of Act 2.[29] This reaffirms the fact that regulations cannot overrule statutory requirements.

The omission of public involvement in the remediation planning for the refinery is a meaningful grievance. Given the size of the site, magnitude, and severity of hazardous contaminants involved, migration of contamination off site, and proximity to residential environmental justice neighborhoods and population centers, City and public involvement is critical to informing the remediation process and easing community concerns about potential health and property impacts related to nearby contaminants. Lack of public involvement reduces the ability for the City and community to understand the risks associated with the site-specific standards sought by Sunoco, future restricted uses for the site, ongoing monitoring or control requirements, and other remediation options, let alone advocate on behalf of community interests.

Sunoco, PA DEP, the City of Philadelphia, communities surrounding the refinery, and other stakeholders need to determine how to correct these serious oversights in a manner consistent with legal requirements. This includes, but is not limited to:

- Conducting an audit of the overall refinery remediation project for community involvement and notice and review compliance to develop a complete understanding of legal insufficiencies.
- Determining how to correct these insufficiencies. Specifically, what are the acceptable methods to meaningfully incorporate public comments for the eight RIRs and applicable risk assessments that have already been approved by PA DEP? This may be complicated given the law envisions public comment and remediator responses being inputs into PA DEP's review prior to approval or rejection of the relevant plans.
- Revising the PIP to ensure the last three RIRs, and future risk assessments, cleanup plans, and final reports incorporate the community involvement and notice and review requirements of Act 2.

The remaining three RIRs involve contamination that has migrated off site, making it even more critical for public involvement prior to approval of these regulatory milestones. Once the RIRs are finalized, a cleanup plan will be prepared, additional risk assessments will be performed, remediation and demonstration of attainment will occur, and a final report will be submitted. These are all critical regulatory milestones for which public involvement should be integrated. Along these lines, the state of New Jersey may be particularly interested in the review of AOI 11 investigations to better understand the

27 See PA Code Title 25 § 250.6. Public participation located at *https://www.pacode.com/secure/data/025/chapter250/chap250toc.html#250.6.*

28 This is evidenced by initial lack of clarity by DEP and the City of Philadelphia about the existence of a PIP, which was clarified during the research phase of this report.

29 See the Section I. D. 9. pertaining to "Notice Requirements and Procedures" in PA DEP's Land Recycling Program Technical Guidance Manual dated June 8, 2002 (Document # 253-0300-100)

extent of potential drinking water source contamination and remediation options. It should, therefore, be consulted when exploring public involvement plan revisions.

It is important to remember that once PA DEP approves the final report, the chance to leverage Sunoco's remediation effort will largely be closed, unless new contamination is discovered, exposure assumptions change, or fraud is suspected.

REDEVELOPMENT OPPORTUNITY

In 2013, the Philadelphia Department of Commerce, Philadelphia City Planning Commission, and the Philadelphia Industrial Development Corporation released "The Lower Schuylkill Master Plan" (Master Plan), a comprehensive redevelopment strategy for the city's oldest and largest industrial district (Philadelphia Department of Commerce 2013). The Master Plan acknowledged key developments around the Lower Schuylkill—such as growth of the academic cluster in University City, expansion investments at the Philadelphia Airport, and ongoing revitalization of the Navy Yard—and sought to identify a long-term implementation plan for public investment that could enable revitalization of the blighted industrial corridor. Revitalization of the area was seen as a particularly attractive economic growth opportunity given the city's shortage of industrial space and that 68% of the city's vacant and underutilized industrial land is located in the Lower Schuylkill. The plan elements for the 3,700-acre corridor, of which the PES refinery comprised over 1,300 acres, included:

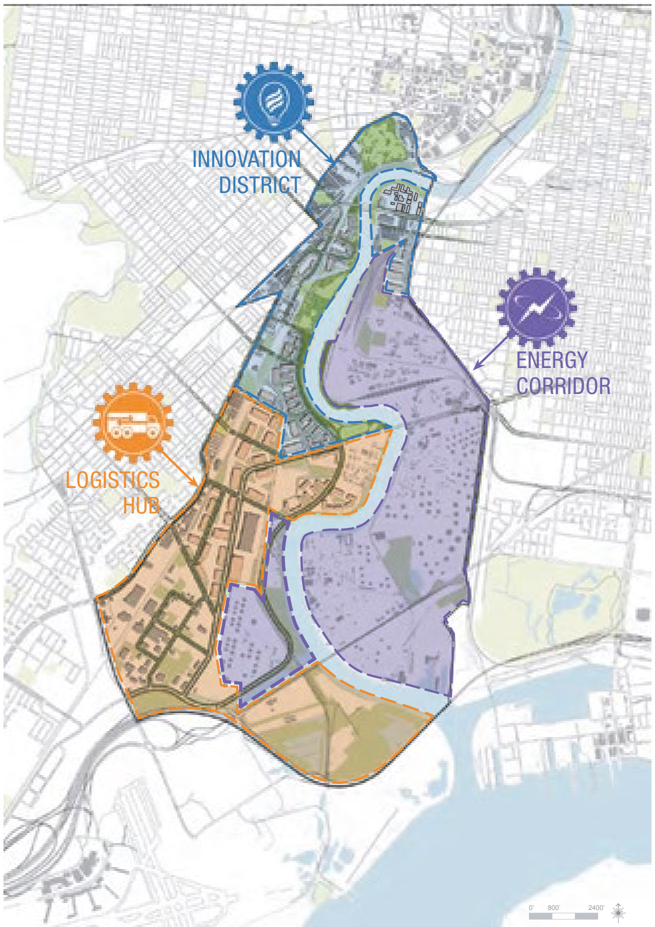
- $411 million in public infrastructure investment;
- $860 million in private investment leveraged;
- $63 billion in economic impact to the city and state;
- 5,500 to 6,500 permanent jobs created;
- 5.5 to 6.6 million square feet of development capacity;
- 46 acres of green space; and
- 5 miles of recreational trails created.

In May 2013, the Philadelphia City Planning Commission adopted the Master Plan. It creates no legal obligation, but is intended to guide the city's activities, including land acquisition and investment prioritization (Brey 2013).

As shown in **Figure 19**, the Master Plan separates the Lower Schuylkill area into three distinct campuses, each with different strengths, intended uses, and development potentials. The northern most "innovation district" included the opportunity to develop small and mid-sized parcels (3–20 acres) that would leverage opportunities associated with the academic and medical institutions throughout University City. The southwestern portion of the corridor was dubbed the "logistics hub" that could leverage connectivity to the airport, interstate highways, and Center City to accommodate a robust distribution center with warehousing, manufacturing, and other industrial park uses. The third campus, called the "energy corridor," consists primarily of the privately owned refinery complex (plus land owned by CSX rail and PGW).

At the time of the Master Plan's development in 2011 to 2013, the Sunoco refinery was first under threat of closure and later was converted to PES through investments the Carlyle Group and ETP's Sunoco made. Given the uncertainty at the time, the Master Plan's goals for the energy corridor were fairly limited and only included ongoing refinery operation and attraction of additional energy-related investments that could leverage the refinery and pipeline infrastructure, as well as strong rail, port, and highway access.

FIGURE 19: THE LOWER SCHUYLKILL MASTER PLAN'S THREE DEVELOPMENT DISTRICTS AND KEY ECONOMIC DEVELOPMENT FIGURES



Key Development Figures

	Public Infrastructure Investment	Private Investment	Development Capacity	Jobs Created	Economic Impact
Innovation District	$230M	$420M	183 acres 2.4M–2.8M SF	2,800–3,300	$33B
Logistics Hub	$181M	$340M	311 acres 3.1M–3.8M SF	2,500–3,000	$30B
Energy Corridor		$100M+	320 acres	200+	
The Lower Schuylkill Totals	$411M	$860M	814 acres 5.5M–6.6M SF	5,500–6,500	$63B

(Philadelphia Department of Commerce 2013)

Given the majority of the energy corridor campus is privately owned, the report acknowledged economic growth and development opportunities may depend on how the refinery site is used. In fact, the economic development benefits listed for the energy corridor were attributed to maintaining refinery operations (i.e. avoiding Sunoco's closure of the facility) and building out rail receiving capacity for crude oil. As shown in **Figure 19**, the other campuses in the Lower Schuylkill incorporated significantly greater public investment, private investment, job creation, and overall economic impact compared to the status quo of maintaining the energy corridor's refinery. This outcome partly relates to the limited scope of redevelopment opportunity explored in the Master Plan for the energy corridor.

According to the Master Plan, environmental contamination from legacy industrial activities served as a "profound deterrent" to investment and revitalization throughout the Lower Schuylkill footprint. The Master Plan acknowledged that redevelopment plans must incorporate remediation efforts for contaminated soil and groundwater that occur throughout most of the Lower Schuylkill area. It identifies strategies to facilitate remediation, including: developing an inventory of available funding for brownfield remediation; integrating these resources into a coordinated portfolio of local, state, federal, and private resources and interlocking tools to be deployed; grouping properties together for remediation to maximize efficiencies; and preapproving soil management plans and land use covenants to streamline review processes, as well as other strategies.

Given the potential future liquidation of PES, there is significant opportunity to build upon the 2013 Master Plan to explore more detailed redevelopment options for the energy corridor, including potentially remediation and redevelopment of all or parts of the refinery complex.

SECTION 6: CONCLUSION

THIS IS A TRANSFORMATIVE TIME FOR PHILADELPHIA'S NEIGHBORHOOD REFINERY.

Although PES successfully navigated bankruptcy reorganization in 2018, it is likely the company will face Chapter 11 again in the near future (on or before its debts mature in 2022). But this time PES will arrive in court even more highly leveraged than in 2018. Given the firm's debts and competitive disadvantages, the probability another investor will materialize to save the refinery is lower than in 2012. The U.S. oil and refining business continues to adjust to changing production patterns from shale, tar sands, and infrastructure developments. Absent additional and significant market disruption (e.g. changes to the Jones Act that would reduce domestic oil shipping costs between U.S. states, or oil production increases from the nearby Utica shale), PES seemingly can no longer leverage these new market conditions to compete effectively. PES will require major investments to remain operational, to say nothing of the additional capital expenditures necessary to improve competitiveness and better manage RFS compliance costs (e.g. investment in a blending facility or other RIN-generating asset).

Independent from the refinery's operations, Sunoco maintains responsibility for legacy environmental site contamination. The history of site soil and water contamination is profound, given it has been home to petroleum storage or refining for over 150 years. Sunoco and its subsidiary Evergreen have performed extensive site characterization of contamination and Sunoco is required to provide financial assurances for remedial activity. There is widespread hydrocarbon contamination of soil and groundwater at the site, including migration outside the property line and potentially into the deep aquifer New Jersey uses as a water source. In addition, there is lead contamination throughout the site. Evergreen is working with state and federal regulators on an initiative to stabilize or remediate pollution at the site to the level required by risk-based standards.

Inconsistent with the law, the City of Philadelphia and the public have not been involved in remediation planning activities for the refinery. This is because the public involvement plan developed by Sunoco (back in 2006) does not meet the minimum requirements for community involvement and public notice and review contained within Act 2. As a result, site characterization and planning reports (called remedial investigation reports or RIRs) for eight of the eleven areas of concern at the refinery—in addition to a lead in soil cleanup standard that is twice the statewide health-based maximum—have been approved without opportunity for PA DEP to consider comments from the public.

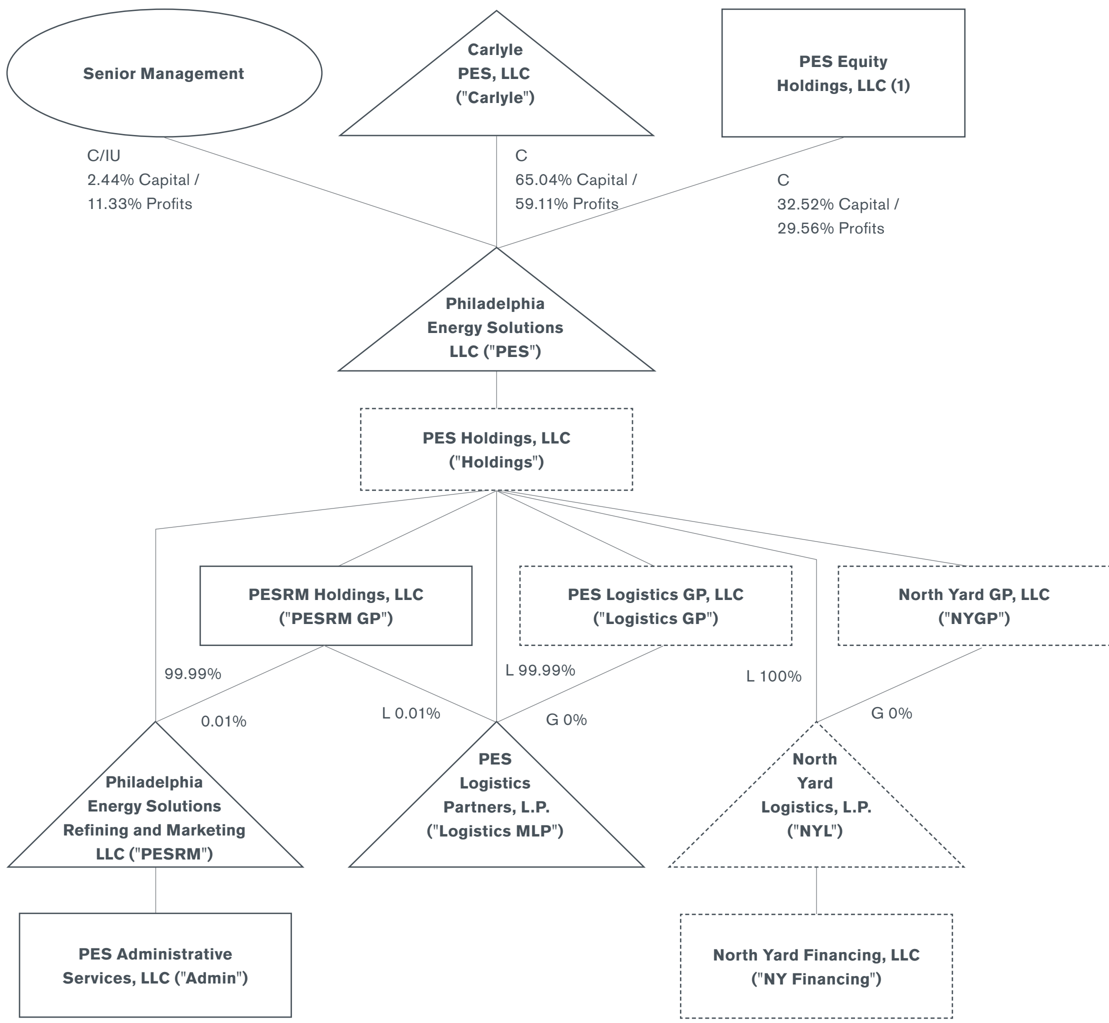
Sunoco, PA DEP, the City of Philadelphia and other stakeholders need to determine how to correct the omission of public involvement in a manner consistent with Act 2 requirements. This includes reviewing the entire project to determine public involvement deficiencies, developing an approach to ensure PA DEP has the opportunity to consider public input for the eight RIRs already approved, and revising the PIP to ensure compliance with Act 2's public involvement requirements for the remaining three RIRs, risk assessments, cleanup plans, and final reports. Throughout this process, the potential for the refinery ceasing operations should be considered, as future uses for the site impact the appropriateness of site-specific standards sought.

Pertaining to potential alternative future uses of the site, there is the need for City and stakeholders to explore the highest and best uses for the refinery site, given the possible future bankruptcy and liquidation of PES. In 2013, Philadelphia released and began to implement a Master Plan for redevelopment of the industrial Lower Schuylkill corridor. This plan was comprehensive in nature, but was limited to ongoing refinery operations and did not explore the opportunity for redevelopment of all or parts of the refinery complex. Given the near-term potential for closure of the refinery complex, there is a compelling opportunity for relevant city and community stakeholders to expand upon the 2013 Master Plan. Potential future uses for the site are important to understand when developing site-specific remediation standards.

It is also important for public officials to acknowledge the potential for the refinery's closure, and plan for managing and minimizing hardships associated with refinery worker displacement and job loss for those employed in the refinery's supply chain.

APPENDIX A: CORPORATE ORGANIZATIONAL CHART

The following graphic depicting the corporate structure of PES was provided in Exhibit F to the Bankruptcy Disclosure Statement (Kirkland and Ellis LLP 2018).



— = ownership

⬚ = disregarded entity for U.S. federal income tax purposes

△ = partnership of U.S. federal income tax purposes

☐ = corporation for U.S. federal income tax purposes

- - =indebtedness

G = general partner

L = limited partner

C = common units

S = subordinated units

IDRs = incentive distribution rights

C = Common Units

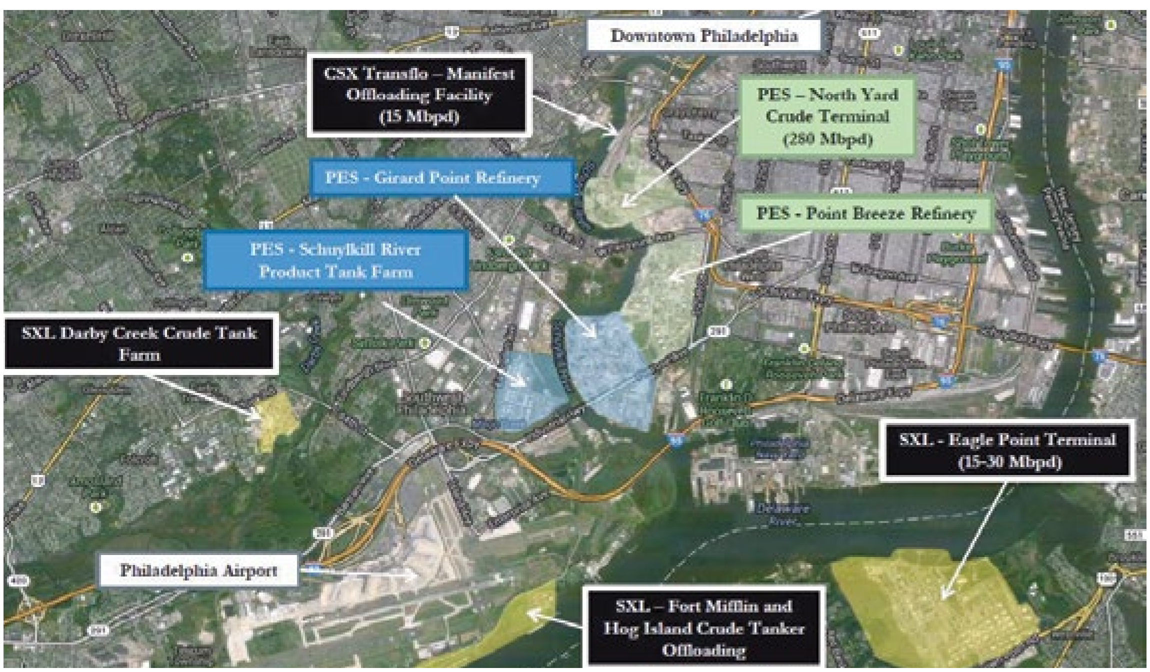
IU = Incentive Units

(1) PES Equity Holdings, LLC is a subsidiary of Energy Transfer Partners, L.P.

APPENDIX B: MAP OF PHILADELPHIA ENERGY SOLUTIONS REFINERY COMPLEX AND RELATED INFRASTRUCTURE

These maps are reproduced from the PES Bankruptcy disclosure statement (Kirkland and Ellis LLP 2018).

Point Breeze	Capacity	Upgrade	Next TA
A 210 Crude Units	145 Mbpd	2014	2021
B 860 Reformer	34 Mbpd	2017	2022
C 864 Naphtha Pre-treater	34 Mbpd	2017	2022
D 859 Distillate De-Sulpherizer	50 Mbpd	2009	2020
E 865 Distillate De-Sulpherizer	55 Mbpd	--	--
F 866 Distillate De-Sulpherizer	20 Mbpd	--	--
G 868 FCC	48 Mbpd	2014	2021
H 869 Sulfuric Acid Alkylation	8 Mbpd	2007	2018
I 870 Low Sulphur Gasoline	65 Mbpd	2013	2019
J 867 Sulphur Plant	110 Tpd	2015	2019 (South 2020 (North
Girard Point			
A 137 Crude Unit	190 Mbpd	2013	2023
B 231 Distillate De-Sulphurizer	30 Mbpd	2015	2023
C 433 Hydroflouric Acid Alkylation	20 Mbpd	2015	2020
D 1232 FCC	85 Mbpd	2013	2019
E 1332 Reformer	35 Mbpd	2008	2020
F 1732 Udex	18 Mbpd	1999	2020
G 1733 Cumene	12 Mbpd	1998	2023
H 331 Butane Isomerization	8 Mbpd	2013	2020



APPENDIX C: SUMMARY OF PHILADELPHIA REFINERY COMPLEX SITE CONTAMINATION

Much of the contamination that exists at the Philadelphia Refinery Complex occurred from historic petroleum refining and storage operations at the site prior to the development of environmental regulations pertaining to the sector. However, federal laws, including the Resource Conservation and Recovery Act of 1976 (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), require Sunoco to retain and address liabilities associated with such legacy contamination.

In 1995, Pennsylvania established a series of laws (Acts 2,3, and 4 of 1995) aimed at encouraging voluntary clean up and reuse of contaminated sites. These programs are often referred to as Act 2 or the Land Recycling Program.[30] In 2004, the Pennsylvania Department of Environmental Protection (PA DEP) and the U.S. Environmental Protection Agency (EPA) signed a memorandum of agreement (MOA) identifying procedures by which remediation under Pennsylvania's Land Recycling Program may also satisfy federal requirements of RCRA, CERCLA, and the Toxic Substances Control Act. This established the One Cleanup Program that created a "one-stop shop" for remediators to follow when attempting to meet state and federal standards for remediation and liability relief.[31] Under Pennsylvania's Land Recycling Program, remediators (not regulators) generally choose between three remediation options:[32]

1. **Background Standards:** this applies to regulated substances present on a property that are unrelated to releases at that property (e.g. migration of contamination from neighboring property).
2. **Statewide Health Standards:** regulations are developed that establish statewide medium-specific concentrations (MSC) based on acceptable cancer and systemic health risk. Mediums include: direct contact with soil; soil-to-groundwater pathways; groundwater, etc. Concentrations vary based on residential or nonresidential exposure and relate to established or intended use of the site.
3. **Site-Specific Standards:** this option creates more flexibility for the remediator by allowing site-specific cleanup levels to be established based on exposure and risk factors related to the intended use of the site, as well as cost effectiveness. However, this option requires greater public involvement, and additional analysis and reporting requirements. Cleanup standards are based on site characterization, assessment of exposure pathways and toxicity, and risk characterization.

The Land Recycling Program's general process includes submitting a notice of intent to remediate (NIR) to the PA DEP. Then, a site characterization is performed to identify contaminants, media impacted by contaminants, the fate-and-transport of contamination in soil and groundwater, and establishing the "points of compliance" (i.e. location where demonstration of attainment is measured). For those wishing to pursue site-specific standards, remedial investigation reports (RIRs) must be submitted for PA DEP approval.[33]

In addition, site-specific risk assessments and cleanup plans may also be required. Remediation is then performed, if needed, to one of the three standards (or a combination of these standards) listed above. Sampling to demonstrate compliance is then performed and a final report, including public notice, is submitted to PA DEP for review. Public notice is also required for the NIR, RIR, risk assessment, and cleanup plan. If PA DEP approves the final report, it releases the remediator from further remediation liability, including from citizen suits.

30 More information on Pennsylvania Land Recycling Program can be found at http://www.dep.pa.gov/BUSINESS/LAND/LANDRECYCLING/Pages/default.aspx

31 More information on the One Cleanup Program can be found at http://www.dep.pa.gov/Business/Land/LandRecycling/OneCleanup/Pages/default.aspx

32 A fourth option related to "special industrial area requirements" may also be available.

33 Specific requirements for the Remedial Investigation Reports are contained in PA Title 25, Article VI, Chapter 250, Subchapter D § 250.408, located at https://www.pacode.com/secure/data/025/chapter250/s250.408.html

Liability protection may apply not just to the remediator, but to current or future owners of the site, developers, occupiers, successors or assigns, entities performing remediation activities, and others. However, post-remediation monitoring and maintenance may be required, as well as environmental covenants associated with engineered or institutional controls used to attain the site-specific standard.

Evergreen Resources Management Operations is a Sunoco subsidiary tasked with responsibility over the company's legacy environmental liabilities. Via Evergreen, Sunoco chose to pursue site-specific, nonresidential standards for remediation of the Philadelphia Refinery Complex, on the assumption that the property remains industrial. An initial NIR was submitted for the complex on October 6, 2006, entering the property into the Act 2 program. In November 2011, the facility entered into the One Cleanup Program. The facility is divided into 11 areas of interest (AOIs) for purpose of site characterization. In December 14, 2016, Evergreen revised its NIR to pursue the residential statewide health standard for lead in soil for the baseball park located in AOI 8 (Doerr 2016). On May 6, 2015, PA DEP approved a nonresidential, site-specific standard of 2,240 mg/kg for lead in soil at the Philadelphia Refinery, based on a risk assessment report. This is more than twice the nonresidential statewide health standard concentration of 1,000 mg/kg for lead in soil.

At the time this report was drafted, the PA DEP and EPA had approved RIRs for all but AOIs 4, 9, & 11. EPA expects to have the remaining RIRs completed by the end of 2018 and estimates cleanup plans will be available for public comment by mid-2020 (Wzorek 2018). In February 2018, ETP reported it had established a wholly-owned, captive insurance company in December 2013 for Sunoco's legacy sites that are subject to environmental remediation, including but not limited to, closed or sold refineries (Energy Transfer Partners 2018, 26). As of December 31, 2017, the captive insurance company held $207 million in cash and investments. Correspondence with the U.S. EPA confirmed Sunoco's captive insurance policy serves as the established financial mechanism for funding remediation, and noted current cost estimates for completing investigations and implementing and operating remedial systems are $17.4 million (Wzorek 2018).

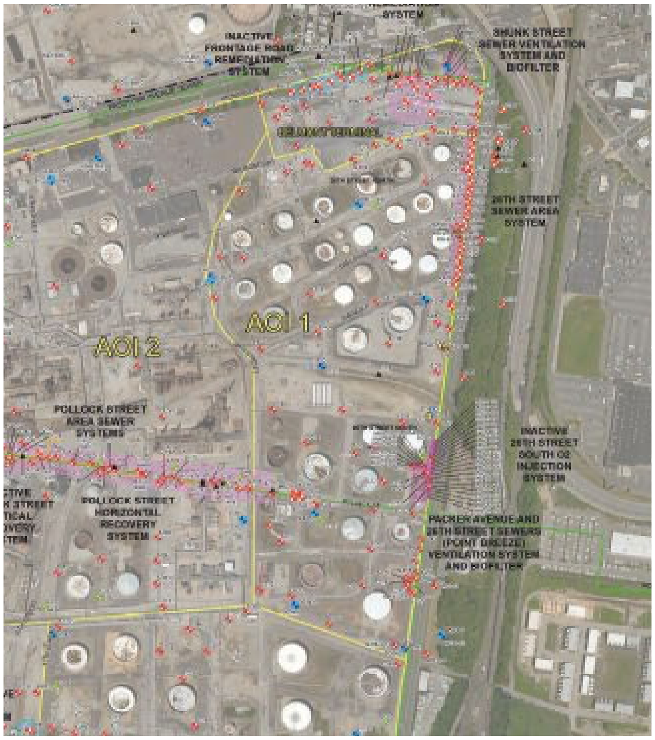
The subsequent pages provide detail about the extent of site contamination at the refinery related to legacy releases. More recent releases are not detailed, as these tend to be less severe and are covered under separate regulatory programs. Data was obtained by a public information request to PA DEP for technical information from the RIR for each AOI.

PA DEP publishes a petroleum products shortlist identifying parameters to be tested for when dealing with certain types of petroleum products in soil or groundwater.[34] For the refinery, many of the common parameters are grouped within the following broad classifications:

1. **Volatile Organic Compounds (VOCs):** organic chemicals with low boiling points, meaning significant number of molecules change phase to gas at ordinary temperature and pressure. Examples of VOCs include benzene, toluene, and gasoline.
2. **Semi-Volatile Organic Compounds (SVOCs):** SVOCs are organic compounds but they are not as volatile as VOC, as they have higher boiling points. Examples of SVOCs include polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCBs).
3. **Metals:** including lead.

In addition, light non-aqueous phase liquid (LNAPL, pronounced *el-nap-el*) is a hydrocarbon-based groundwater contamination that settles at the top of the water table because it is less dense than water and not water soluble. Examples of LNAPL include: gasoline, benzene, toluene, and many other hydrocarbons. Dense non-aqueous phase liquids (DNAPL, pronounced *dee-nap-el*) will move through groundwater and settle below the water table at bedrock, since it is denser than water and not water soluble. Examples of DNAPL include: extra heavy crude oil, coal tar, PCB's, creosote, and chlorinated solvents.

34 The most recent version of PA DEP's petroleum short list for the Land Recycling Program can be found on the department's website at http://files.dep.state.pa.us/EnvironmentalCleanupBrownfields/LandRecyclingProgram/LandRecyclingProgramPortalFiles/GuidanceTechTools/short_list_table_final.pdf



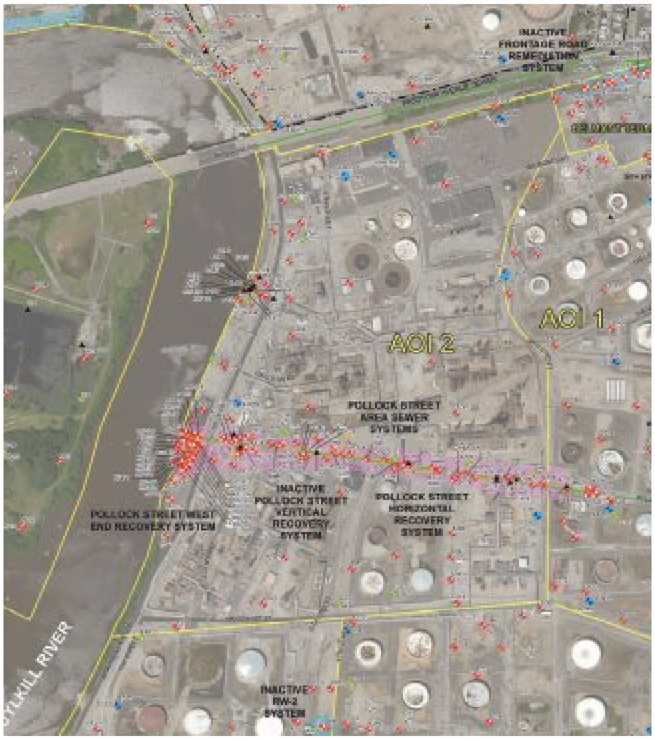
Area of Interest 1

This is a 67-acre plot of land on the northeast section of the Point Breeze South Yard and includes Tank Farms Nos. 1 and 2, with the Belmont Terminal bordering to the north. There are 35 above ground storage tanks used to store or blend light petroleum products (e.g. gasoline) in this AOI, with others existing in the past. Most tanks were constructed in the 1950s with the oldest dating from 1931 and the most recent installed in 1982.

Petroleum contamination exists from historic operations of above ground tanks and pipelines and from Belmont Terminal releases that have migrated to AOI 1. Hundreds of borings for soil sampling have taken place in AOI 1 since the 1980s, and 120 groundwater monitoring wells are present in and around AOI 1. The primary soil and groundwater concerns include 10 VOC, 10 SVOCs, and lead. LNAPL (light and middle distillates) plumes exist in AOI 1, including some that have migrated offsite. Exceedances of MSCs for VOC, SVOCs and lead have been observed, with benzene and MTBE[35] exceedances being the most widespread, consistent, and significant. Benzene exceeds the MCS of 5µg/L throughout most of AOI 1, with the maximum concentration at 88,000 µg/L south of Tank 121, as well as elevated levels (1,400—2,400 µg/L) measured offsite. Benzene concentrations in the lower aquifer are significantly elevated (22,000 µg/L) at the Belmont Terminal. MTBE exceeds the MSC of 20 µg/L in a large portion of AOI 1, with concentrations reaching 7,000 µg/L, and offsite migration confirmed.

Three remediation systems—26th Street north, 26th Street south, and Point Breeze sewer ventilation and biofilter—to treat contamination have been operated within AOI, with all but 26th Street south still in operation. Among other things, Evergreen must prepare a cleanup plan to address direct-contact exceedances of 1,2,4-TMB and lead in soil, achievement of a site-specific standard for groundwater, and long-term environmental covenants to address mobile LNAPL plumes. (PA DEP October 2016).

35 Methyl tert-butyl ether (MTBE) is added to gasoline as an oxygenate, meaning it raises the oxygen content of the fuel.



Area of Interest 2

This is a 111-acre plot of land known as the Point Breeze Processing Area, bordered by the Schuylkill River to the west and PGW facility to the north and other areas of the refinery on the east and south. Historic and current operations at AOI 2 include petroleum processing, storage in above ground tanks, and a wastewater treatment plant. An active dock operates for product loading and unloading.

Approximately 110 soil samples and 85 subsurface soil samples were collected and analyzed for 10 VOCs, SVOCs, and lead. Soil-to-groundwater MSC exceedances were found for benzene, lead, 1,2,4-TMB, and PAHs. Direct contact exceedances for lead and Benzo(a)pyrene were found near the tank field in the west–central portion of AOI 2. Groundwater monitoring wells were installed from the 1980's through 2016, with LNAPL contamination plumes (some mobile) found as recently as 2016 consisting of light, middle, and heavy distillates. MSC exceedances were found for benzene, MTBE, 1,2,4-TMB, naphthalene, and lead. In addition, at least two of the occupied buildings in AOI 2 had indoor air samples that exceeded health-based occupational standards.

There are several remediation systems in AOI 2, including: the deactivated Pollack Street vertical well system; the Pollack street horizontal well system; the Pollack Street west end system; and controls at PWD's combined sewer outfall at the Schuylkill River to collect LNAPLs. Among other things, Evergreen will need to perform further ecological review, if needed, to determine the potential presence of endangered shortnose sturgeon and threatened eastern redbelly turtle; develop a clean-up plan to manage direct soil and LNAPL exposure pathways and achieve soil and groundwater site-specific standards; and implement restrictions to deal with groundwater contamination among other activities (PA DEP October 2017).

Area of Interest 3

This is a 107-acre plot of land known as the Point Breeze Impoundment Area that includes tank farm No. 5 and storm water retention basins and is located in the southwest section of the Point Breeze South Yard. Historically, there were six above ground storage tanks in the No. 5 tank farm.

Between 2010–16, about 100 soil samples were collected, with historic soil sampling occurring in 1988–1990 and 2006–2007. Exceedances for soil-to-groundwater MSC were found for benzene and lead, as well as ethylbenzene and 1,2,4-TMB. Direct contact exceedances were identified in two locations. Over 70 groundwater monitoring wells are present in AOI 3, with plumes of LNAPLs identified as consisting of light, middle, and heavy distillates.

Significant exceedances, up to 150,000 µg/L and 340 µg/L, of the MSC (5 µg/L) for benzene were found in the shallow and lower aquifer, respectively. Exceedances for MTBE, toluene, 1,2,4-TMB, and lead were also identified. According to PA DEP, insufficient information exists to determine the stability of these plumes. There are occupied structures on AOI 3 that have the potential for vapor intrusion, though indoor air sampling revealed no exceedances of occupational limits. There are two plant species of potential concern, as well as the Atlantic sturgeon and eastern red-belly turtle.

Sunoco operated a total fluids recovery system for LNAPL and groundwater contamination at RW-2 from an unknown start date through 2009. Evergreen will submit a plan to achieve a site-specific soil and groundwater standard that also addresses soil direct contact and LNAPL exposures and vapor intrusion. Groundwater restrictions will be put in place and institutional controls may be use for inhalation pathways. Additional ecological analysis is required for plant and animal species of potential concern (PA DEP June 2017).

Area of Interest 4

This 104-acre lot of land is known as the Point Breeze No. 4 Tank Farm located in the southwest section of the Point Breeze South Yard. There are 40 above ground storage tanks in AOI 4, as well as oil pipelines and pump stations.

Surface and subsurface soil samples have been collected between 2005—2016, with numerous exceedances of soil-to-groundwater MSCs for benzene and lead. Isolated exceedances of soil-to-groundwater MSCs for 1,2,4-TMB, toluene, and naphthalene were also found, as well as direct contact exceedances for lead in four locations. Multiple shallow and deep aquifer wells have been installed, as well as groundwater monitoring wells.

Sampling in 2014 to 2016 indicated significant MSC exceedances in the shallow aquifer of benzene, toluene, MTBE, 1,2,4-TMB, naphthalene, and ethylbenzene.

Benzene is the most widespread contaminant of concern, which exceeds throughout most of AOI 4. The primary groundwater plume is at the southeast border of AOI 4 with high exceedances of benzene, as well as elevated benzene concentrations in the northeast. Benzene concentrations exceeded acceptable levels in the lower aquifer in one well, and MTBE exceedances were found in two wells. LNAPL plumes were found in many areas of AOI 4, mostly characterized as light and middle distillate, with most plumes being characterized as mobile. A preliminary fate-and-transport analysis for benzene was performed for the southeast portion of AOI 4. The potential plume length was estimated at 900 feet, which would extend on to several properties. Indoor and ambient air sampling was performed at a pump house in AOI 4 in 2012, with slight indoor air screening exceedances found for 1,2,4-TMB. Elevated levels of 1,2,4-TMB found outdoors and indoors did not exceed occupational standards.

Two past remedial systems were in place in AOI 4: the S-30 system installed in 1996 to recover LNAPL, and the S-36 system to recover LNAPL between 2004 to 2010. In 2013, the Penrose Avenue system was established to separate and recover LNAPL from groundwater. Evergreen intends on attaining site-specific standards for groundwater and soil, developing a cleanup plan for direct contact and LNPAL exceedances, performing further vapor intrusion evaluation, managing groundwater contamination through use restrictions, establishing environmental covenants, and implementing institutional controls to prevent inhalation pathways.

PA DEP recommended disapproving Evergreen's RIR given the estimated extent of the plume beyond the property line in the southeast portion of AOI4 and the lack of offsite wells to confirm model results (PA DEP June 2017).

Area of Interest 5

This is a 114-acre plot of land known as the Girard Point South Tank Field Area. Most above ground storage tanks have been removed from the area. Other current or historic operations occurring at AOI 5 include product packing, as well as rail, truck, and marine transfer facilities.

Between 2007–16, over 350 soil samples were collected in AOI 5 with results showing MSC soil-to-groundwater exceedances for lead and VOCs. Three areas had lead levels greater than 5,000 µg/L, meeting the criteria for leaded tank bottom material. Direct contact MSC exceedances were found for benzene, cumene, benzo(a)pyrene, and lead. Over 80 monitoring wells are present in AOI 5, with samples indicating an isolated LNAPL plume of middle distillates occurring in the southwest corner of AOI 5, adjacent to the river. A larger plume of heavy distillate LNAPL exists in the southeast, but is not near the river. Both plumes have been categorized as relatively stable and immobile. Benzene exceeds groundwater MSCs in only a few wells, with none near the river. Exceedances were found in several wells for SVOCs and lead, some adjacent to the river. One deep well exhibited MTBE exceedance. Outdoor sampling and indoor air sampling of occupied buildings did not exceed occupational limits.

Sunoco operated a total fluids recovery system for LNAPL and groundwater contamination at Berth No. 9 until 2009. Evergreen intends on attaining site-specific standards for groundwater and soil, developing a cleanup plan for direct contact and LNPAL exceedances, performing further vapor intrusion evaluation, managing groundwater contamination through use restrictions, establishing environmental covenants, and implementing institutional controls to prevent inhalation pathways. Ecological evaluation for the eastern red-bellied turtle will also be required (PA DEP April 2017).

Area of Interest 6

This 117-acre plot of land is known as the Girard Point Chemicals Processing Area. Historic and current operations at this AOI include petroleum and chemical processing, steam boiler plants, storage in regulated above-ground storage tanks, oil-water separators, maintenance and office buildings, and a laboratory.

There have been approximately 190 surface and 55 subsurface soil samples taken between 2002 and 2016, primarily focusing on two leaded tank bottom solid waste management units (SWMUs), four above ground storage tanks, and other areas. No lead direct contact standard exceedances or TCLP[36] exceedances were found. However, soil-to-groundwater MSC exceedances were identified for benzene, as well as limited exceedances for toluene, cumene, naphthalene, and lead. In addition, there were numerous and significant nonresidential direct contact MSC exceedances throughout AOI 6 for benzene, benzo(a)pyrene, and lead.

Since 1986, there are numerous shallow wells (10 to 15 feet deep) and four deep wells in AOI 6 where recent water samples were taken in 2012, 2016 and 2017. LNAPL was found in numerous well samples, with a primary LNAPL plume identified under the "27 Pump House" area. The LNAPL bodies were classified as not significantly mobile, not impacting the Schuylkill River, and consisting of gasoline, middle distillate, and residual oil. Samples exceeded nonresidential statewide health standard MSCs for several substances, the most widespread being benzene that reached concentrations of 480,000 mg/L (1,000 mg/L is MSC). A few wells displayed exceedances of toluene, cumene, 1,2,4-TMB, 1,2-dibromoethane, and naphthalene. There were also exceedances for SVOCs and one exceedance of dissolved lead. There were no 2016 exceedances in the lower aquifer.

Vapor intrusion evaluations in 2016 and 2017 indicated benzene and naphthalene exceedances in the site-specific standard screening values in some buildings. Additional sampling and an inhalation risk assessment was planned for this AOI. In addition, an ecological evaluation is planned to determine if the site affects threatened and endangered species in the area.

Between 2001 and 2010, a twelve-well groundwater remediation system operated under the 27 Pump House, where over 12,900 gallons of LNAPL was recovered. The system is now inactive. A site-specific standard with pathway for elimination for soil and groundwater is sought for this AOI, and an environmental covenant will be required to manage groundwater use restrictions (PA DEP February 2018).

36 Toxicity Characteristic Leaching Procedure (TCLP) is a soil sampling and testing methodology to determine the mobility (e.g. from soil to water) of a toxic substance, which among other things, can affect how the soil is disposed (i.e. as either municipal or hazardous waste).

Area of Interest 7

This 130-acre plot of land is known as the Girard Point Fuels Processing Area. Historic and current operations at AOI 7 included: petroleum processing; a sulfur plant; a hazardous waste incinerator; material storage in underground and above ground storage tanks; a wastewater treatment plant; and various buildings.

A few hundred surface and subsurface soil samples were collected between 1992 and 2016, focusing on five leaded bottom tanks, five above ground storage tanks, and other areas. No leaded bottom materials were observed. Soil-to-groundwater MSC exceedances included benzene, 1,2,4-TMB, naphthalene, and lead. Direct contact MSC exceedances were identified for benzo(a)pyrene, and hexavalent chromium (in 1992 samples).

There are 63 shallow wells and four deep wells in AOI 7 installed around 1986 with sampling occurring in 2010, 2012, 2013, and 2016. In 2016, LNAPL was found in 13 of the wells (with a maximum thickness of 2.5 feet) and a primary plume located near the No. 3 Separator and the river bulkhead. Sheening on the river has been observed in that area in the past. LNAPL was found in other areas of AOI 7, and characterized as crude oil and heavy distillate. It is possible that some of the LNAPL at AOI 7 is mobile, based on modeling performed in 2012. Nonresidential exceedances of MSC for benzene, naphthalene, and 1,2,4 TMB, in addition to low-level SVOC exceedances were found in several wells.

Indoor and outdoor air sampling performed in 2016 did not yield results in excess of occupational standards. Further ecological evaluation may be needed to determine potential impacts to area threatened and endangered species.

In 2012, ten total fluids recovery wells were installed to recover LNAPL, which was then recycled at the refinery. Approximately 112,00 gallons of LNAPL was recovered between 2012 and 2016. Groundwater is processed through the wastewater treatment plant that continues to operate and partially controls movement of contamination near the bulkhead.

A site-specific standard with pathway elimination is sought for soil and groundwater, with soil direct exceedances and LNAPL exposure pathways to be addressed in a subsequent cleanup plan. Additional vapor intrusion and ecological evaluations are planned, as well as environmental covenants to ensure restrictions on groundwater use (PA DEP August 2017).

Area of Interest 8

This 250-acre plot is referred to as the Point Breeze North Yard. AOI 8 is bisected by an active CSX railway line, and the south portion of AOI 8 is next to property owned by PGW. The north portion of the area includes several petroleum-related above ground storage tanks and the southern portion operates plants that produce petroleum byproducts such as paraffin wax, asphalt, and other industrial substances.

Soil samples and categorization have occurred at AOI 8 since 2004. Contaminated soil runs throughout the AOI, much of which may be related to anthropogenic fill material measuring up to 50' deep. The main soil contaminants are metals and semivolatile compounds that may or may not be related to historic refinery activities, as the South Philadelphia area contains many other legacy fills with similar contaminants.

Soil sampling took place at over 194 locations in this AOI, with numerous surface and subsurface samples being collected. Soil-to-groundwater MSC exceedances were observed for benzene, naphthalene, ethylbenzene, total xylenes, 1,2,4-TMB, lead, nickel, benzo(a)pyrene, and benzo(b)fluoranthene. There were no exceedances for direct contact standards deeper than two feet. Direct contact exceedances for depths at 0 to 2 feet included lead, benzo(a) pyrene, and benzo(b)flouranthene. Soil contamination is found at the AOI all the way to the Schuylkill River, where it is bounded by a hardened (i.e. steel and wood) shore bulkhead.

In AOI8, 127 wells have been established for groundwater monitoring in the various subsurface hydrologic formations underlying the area. The most recent sampling rounds identified the following compounds above statewide health standards: 1,2,4- TMB, 1,3,5-TMB, 2-methylnaphthalene, anthracene, benzene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)flouranthene, benzo(g,h,i)perylene, benzo(k) fluoranthene, BEHP, chrysene, cobalt, ethylbenzene, dibenz(a,h)anthracene, flouranthene, indeno(1,2,3-c,d)pyrene, lead, naphthalene, nickel, pyrene, toluene, vanadium, and zinc. A qualitative fate-and-transport model was developed for AOI8 (separate from the larger model for the entire refinery complex) focusing solely on benzene.

Through this model, three benzene plumes were identified, at the south bordering the PGW property (originating in part from AOI 1 and the PGW facility), the northern portion of the site near property owned by Verizon, and the western portion of the site near the Schuylkill River bulkhead (with contamination likely associated with the asphalt, acid, and wax plants). The highest concentrations of lead and benzene were located in the northern portion of the AOI. Seventeen individual areas of LNAPL have been found at the site, with plumes covering tens of acres of the AOI, characterized mostly as heavy and middle distillates. The most notable plumes generally correspond to the three areas noted in the benzene fate-and-transport model.

Indoor and outdoor vapor intrusion sampling in 2016–2017 did not yield exceedances. Additional sampling and pathway elimination will be required at the site. A comprehensive ecological risk assessment is required, especially related to the Eastern Redbelly Turtle.

A land treatment unit and a leaded sludge weathering pad operated on AOI8 until 2000 and 1990, respectively. There are several inactive remediation systems onsite, including the PGW border system, North Yard bulkhead system, and Jackson Street fluid recovery system. The Jackson Street water curtain is operational and functions to minimize vapor intrusion risks. A combination of nonresidential statewide health and site-specific standards via pathway elimination are being pursued for groundwater (PA DEP March 2018).

Area of Interest 9

This 211-acre plot is known as the Schuylkill River Tank Farm, consisting of 37 vessels constructed beginning around 1952.

Between 2009 and 2016, about 170 soil borings were advanced in AOI 9 and hundreds of samples were taken. Numerous exceedances of soil-to-groundwater MSCs for VOCs were found, as well as several direct contact exceedances for 1,2,4-TMB, benzo(a) pyrene, and benzo(b)flouranthene. Twelve borings found exceedances of site specific lead standards of 2240 mg/kg and of these 12, five TCLP tests showed exceedances of 5,000 µg/L.

In AOI 9, 70 active monitoring wells are present, including 6 deep wells. Samples were taken in 2009, 2015, and 2016. Persistent LNAPL was found in one of the aquifers underlying the site, and was characterized as gasoline. LNAPL was also found in 2016 samples at two wells along the western side of the AOI, characterized as light/middle distillate. Groundwater MSC exceedances for benzo(a)pyrene, benzo(g,h,i) perylene, and lead were found, as well as MTBE exceedances in the lower aquifer. Three plumes of benzene and MTBE occurred with possible contiguous, widespread exceedances. One plumb exists in the aquifer, originating at the southern portion of the AOI with maximum benzene concentrations at 7,000 µg/L. A second and more extensive plume exists in the western section of the AOI that potentially extends offsite, with maximum concentrations of benzene at 1,000 µg/L. Modeling of this plume found that it could potentially extend as far as 1,700 feet offsite to the west, affecting several properties in the Eastwick Industrial Park. Lastly, MTBE plumes at concentrations of 200 µg/L were identified at the southwestern property boundary, but are considered to be stable.

Indoor air sampling found no exceedances of occupational limits in occupied buildings or in outdoor samples; only the pump house exceeded DEP's screening values. A total fluid recovery system for LNAPL and groundwater contamination operated from an uncertain date until 2004 near the blending area, but was taken offline due to lack of recoverable LNAPL after 1,900 gallons were recovered. A site specific standard with pathway elimination for soil and groundwater is sought, with direct contact exceedances and potential LNAPL exposures to be addressed in a cleanup plan.

After previous disapprovals of the RIR for AOI 9, PA DEP recommended disapproval of the RIR addendum in April 2017 due to insufficient delineation of offsite groundwater and lack of offsite monitoring wells (PA DEP April 2017).

Area of Interest 10

This 80-acre plot is known as the Point Breeze West Yard, and currently consists primarily of open spaces. Historic activities at this AOI included petroleum storage in above ground tanks, pump stations, fuel docks, and waste disposal. A pipeline and manifold (a larger pipe that separates into smaller pipes) is located in this AOI.

Waste was disposed of in four areas of the AOI in the 1950s and 1960's consisting of leaded tank bottom and separator sludges, spent catalysts, acid and caustic wastes, paraffin, and miscellaneous debris. Clay caps were installed over these areas in the 1980s.

In 2011, shallow soil samples were collected from 55 locations, including additional samples of soil and waste in and under capped areas. Soil-to-groundwater MSC exceedances for benzene and PCE in soil were found, as well as benzo(a)pyrene, lead, vanadium, dibenzo(a,h) pyrene exceedances for nonresidential direct contact MSCs in shallow soil. The waste samples taken under the clay caps yielded multiple exceedances, but Act 2 does not cover this medium. Direct contact MSC exceedances for shallow soil were also mentioned for ethylbenzene, naphthalene, and chrysene.

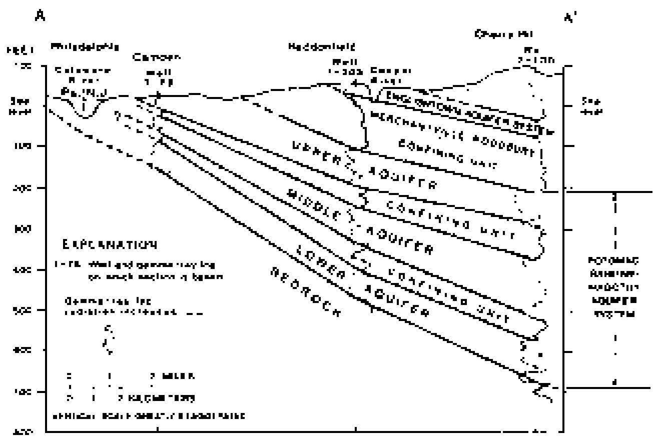
30 shallow and six intermediate-depth groundwater monitoring wells exist in AOI 10, which were sampled in 2011. Three wells near the waste disposal areas contained LNAPL characterized as residual oil and middle distillate. Groundwater exceedances were measured for benzene, chrysene, naphthalene, and lead. A fate-and-transport model indicated benzene could migrate to Lands Creek, but at concentrations within regulatory maximums. Vapor intrusion was not performed as there are no occupied buildings in the AOI.

Likely, the threatened Eastern Redbelly Turtle occupies the area. Surface water and sediment samples were taken from Lands Creek. There were several SVOC and metal exceedances in sediment, which were normalized to the relatively high levels of background total organic carbon, and subsequently determined to not be an excess risk to the turtle.

A cleanup plan for benzo(a)pyrene and lead in soil is being prepared. Additional risk assessment and remediation may be required. Soil-to-groundwater exceedances will be addressed through attainment of groundwater site-specific standards via pathway elimination. Environmental covenants will be required (PA DEP November 2016).

Area of Interest 11
This AOI pertains to the deep groundwater in the Farrington Sand of the Potomac–Raritan–Magothy aquifer, which is used as a water source in areas of New Jersey. The Farrington Sand aquifer does not directly connect with the Delaware or Schuylkill Rivers. **Figure 19** presents a depiction of the Potomac–Raritan–Magothy aquifer system and its relationship to Philadelphia, the Delaware River, and New Jersey.

FIGURE 20: GENERAL HYDROGEOLOGIC SECTION OF POTOMAC-RARITAN-MAGOTHY AQUIFER SYSTEM



(USGS 1994)

Between 1984 and 2010, Sunoco installed 45 deep monitoring wells onsite and sampled at least three times between 2008–10. In addition, four consecutive quarters of attainment sampling occurred in 2012–13. No LNAPL was found in any of the wells, however, statewide health standard MSCs exceedances were found in some wells for benzene, naphthalene, MTBE, chrysene, arsenic, and cobalt, and other compounds. There were pervasive exceedances of manganese and iron. Thirty-five wells had consistent manganese exceedances of the statewide MSC of 300 µg/L, with 23 of them in concentrations over 1,000 µg/L and a maximum concentration of 20,500 µg/L. The highest concentrations generally occurred in the northeast section of the facility at AOIs 1, 2 & 8. The highest iron concentration was 1,690,000 µg/L, while the statewide MSC is 300 µg/L.

A preliminary fate-and-transport analysis for contaminant migration (excluding manganese and iron) to the Delaware and Schuylkill Rivers or offsite properties was performed that indicated contaminants would not reach the rivers or would not exceed waste load allocations in the rivers. At least one area may have an offsite benzene impact associated with AOI 4.

No remediation has been performed and Sunoco is seeking a nonresidential, site-specific groundwater standard for the entire refinery complex by demonstrating there are no exposure pathways, environmental covenants and annual deep well sampling.

In September 2013, PA DEP recommended issuing a technical deficiency letter in response to the RIR. The cited deficiencies included: exclusion of point of compliance monitoring wells at the western edge of AOI 9; incomplete evaluation of groundwater exposure pathways for potential human receptors (e.g. water supply wells in New Jersey); deficient groundwater fate-and-transport model due to unjustified input parameters and lack of calibration; absence of fate-and-transport analysis for inorganic substances (e.g. manganese and iron) in the deep aquifer; and lack of detail on how institutional controls would be implemented (PA DEP 2013).

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