Is the Trans Alaska Pipeline System in Danger of Being Shut Down?

Prepared for

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Executive Summary

In this report we analyze whether the Trans Alaska Pipeline System (TAPS) is in danger of being shut down due to declining throughput. We first provide background information on TAPS, including the operating challenges that TAPS has faced thus far, forecasts of TAPS future throughput and its estimated useful life with and without additional investment in the pipeline. We then assess the Low Flow Impact Study ("LoFIS") recently released by the Alyeska Pipeline Service Company ("Alyeska"), the owner of TAPS. Finally, we analyze the projected economic benefit to the pipeline owners from making an investment in the pipeline in order to reduce the minimum throughput. The major findings of our analysis include:

- If no investment is made in the pipeline, TAPS is expected to experience operational problems that may force the pipeline to shut down when the throughput falls to 500,000 barrels per day (b/d).

- Making a relatively modest investment in TAPS can reduce the minimum throughput and extend its useful life. For our analysis we rely on estimates that TAPS can operate at minimum throughput levels of between 200,000 to 150,000 b/d with an investment of between $539 and $721 million. This is a lower minimum throughput level than what is implied in Alyeska's Low Flow Impact Study (LoFIS). We did not use the minimum throughput level implied by LoFIS because we have serious reservations about the assumptions used in the study and the LoFIS does not provide adequate data to support its claims.

- We find that making an investment of between $539 and $721 million to reduce the minimum throughput of the pipeline would result in approximately $47 to $49 billion in additional revenue from the 2.4 to 2.7 billion barrels of oil that would otherwise be stranded in the North Slope. Additional pre-tax profits of between $17 and $28 billion would be generated, with a significant portion of that money flowing to state coffers. In fact, the $539 to $721 million investment in the pipeline would be paid off in less than *one month* from the additional pre-tax profits that would be earned from preventing TAPS from shutting down. Thus making a modest investment with an extremely high payout will mean that TAPS can continue to operate and is not in danger of being shut down in the near future.

Introduction and Summary

The Natural Resources Defense Council (NRDC) requested that Innovation and Information Consultants, Inc. (IIC, Inc.) analyze the argument that the Trans Alaska Pipeline System (TAPS) is in danger of being shut down in the near future due to the declining level of throughput. TAPS is an essential component of an integrated production and transportation system and is the only method for transporting oil from Alaska's North Slope to market.[1] Therefore, a shutdown of TAPS would leave the remaining oil stranded on the North Slope. Advocates for greater domestic access claim that without access to additional supply, TAPS is in danger of being shut down.[2] On the other hand, we show that with a minimum level of additional investment in TAPS, the pipeline can continue to serve the currently producing fields for at least the next 30 years and perhaps longer without opening up new areas for exploration or reducing the production tax in Alaska (known as Alaska's Clear and Equitable Share or ACES),[3] thereby avoiding the stranding of billions of barrels of oil reserves. We conclude that an investment of between $540 and $720 million could add $12 billion in additional profit and an equal amount to State coffers in the form of additional royalty and tax revenue by extending the life of the TAPS, and allow production of over 2 billion additional barrels of oil.

In this report, we first provide an overview of the TAPS. We then discuss estimates of the minimum throughput on the pipeline based on various assumptions. First, we present estimates of the minimum throughput without any additional investment. Next we discuss approaches to reduce the minimum throughput with modest levels of investment. We then present a critique of the Low Flow Impact Study released by the owners of TAPS and explain why we find the study's conclusions to be misleading.[4] Given the estimated investment levels required to reduce the minimum throughput of TAPS, we present our methodology for comparing the costs of reducing the TAPS minimum throughput with the associated benefit of extending the life of the pipeline without opening up new areas for exploration. We show that both the owners of the pipeline and the state of Alaska will receive substantial financial benefits from

[1] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 123.

[2] See for example Gold, Russell "Shrinking Oil Supplies Put Alaska Pipeline at Risk" *The Wall Street Journal*, May 11, 2011.

[3] Some who argue that TAPS is in danger of being shut down advocate Governor Sean Parnell's proposal to reduce the state production tax as a way to encourage additional production and therefore increase the amount of oil that passes through the pipeline. See for example Epler, Patti, "Murkowski: Pass ACES Reform Now" *Alaska Dispatch*, February 24, 2011.

[4] The purpose of the LoFIS study was not to determine a minimum throughput level, but it implies that the minimum throughput is 350,000 b/d.

reducing the minimum throughput on the pipeline, and we conclude that arguments offered by some that TAPS is in danger of being shut down in the very near term without opening up new areas of production are clearly incorrect.

TAPS Background

TAPS is an 800 mile long crude oil pipeline system that connects the Alaska North Slope with the oil loading port and terminal at Valdez. TAPS was built following the discovery of oil at Prudhoe Bay in the North Slope in 1968 and is the only pipeline that connects the North Slope to market. At the time the pipeline was built, there were approximately 9.6 billion barrels of oil in proven reserves in the North Slope and at peak production it carried over 2 million barrels of crude oil per day.[5]

TAPS was constructed between 1975 and 1977 and cost over $8 billion to build. It is now valued at $8.7 billion[6] and would cost $18.7 billion to replace.[7] The pipeline system crosses three mountain ranges and passes through three climate zones. Due to the permafrost in Alaska only about half of the pipeline is buried below ground in the manner that was conventional at the time of construction and large portions remain above ground.[8]

TAPS is owned by BP Pipelines (Alaska) Inc., ConocoPhillips Transportation Alaska, Inc., ExxonMobil Pipeline Company, Koch Alaska Pipeline Company and the Unocal Pipeline Company, a subsidiary of Chevron Corporation. The Alyeska Pipeline Service Company is the operating agent for the owners. Each of the owners is an affiliate of a group that uses the pipeline as an integrated part of their operations. The majority of the oil that moves through the pipeline consists of shipments in which the shipper is an affiliate of one of the pipeline owners.[9] In fact, the three owners with the largest shares, BP, ConocoPhillips and ExxonMobil, have a combined 95 percent

[5] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 39.
[6] Loy, Wesley, "TAPS Value: $8.7 billion" *Petroleum News* 16(24), June 12, 2011.
[7] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 169.
[8] Alyeska Pipeline Service Company, "TAPS: Quick Facts" (http://www.alyeska-pipe.com/Pipelinefacts/TAPS%20Quick%20Facts.pdf).
[9] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 40.

ownership interest in the pipeline and are expected to produce 88 percent of the oil that flows through the pipeline through 2050.[10]

As the TAPS owners are also the major producers on the North Slope, one would expect that they would have an incentive to invest to keep the pipeline operational. However, their participation in the "sky is falling" argument that the TAPS is about to reach its minimum throughput level and may be shut down in the near future if more production is not forthcoming strongly suggests that they also seek financial incentives to do so including opening up new areas for exploration and production.[11]

Since TAPS began operations in 1977, over 16 billion barrels of oil have passed through the pipeline.[12] Remaining reserves on the North Slope are estimated to be approximately 6.1 billion barrels.[13]

TAPS Operational Issues

TAPS has experienced a number of operational issues since it began operating in 1977, many of which remain problems today. The TAPS leak detection system emerged as a problem from the very beginning of TAPS operations. The cold restart plan has been another ongoing issue since Alyeska began closing pumping stations in 1996. Additionally, Alyeska has encountered problems related to implementing the strategic reconfiguration project and has received several citations from the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) for violations of federal requirements that have led to operational problems and pipeline safety concerns.

The leak detection system failed to live up to Alyeska's promises that "no spill is likely to flow unnoticed for more than a few minutes" almost immediately after TAPS began operations.[14] Alyeska began experiencing problems with its leak detection equipment at the end of 1977, and in 1979 the Antigun Pass spill went for two to four days without triggering an alarm in the leak detection system.[15] In 2001 the Joint

[10] Ibid., p. 41.
[11] For example, the Make Alaska Competitive Coalition, of which James Mulva, CEO of ConocoPhillips is a member, has stated that "The decline not only jeopardizes state revenues and the economic viability of the pipeline, but also poses serious technical challenges that could force shutdown in the next 10 years." (see Make Alaska Competitive, Learn More, http://www.makealaskacompetitive.com/learn-more/, visited June 27, 2011).
[12] Alyeska Pipeline Service Company, "TAPS: Quick Facts" (http://www.alyeska-pipe.com/Pipelinefacts/TAPS%20Quick%20Facts.pdf).
[13] DOE/NETL, "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?" April 2009, p. viii.
[14] See Fineberg, Richard, "Leak Detection," in *Pipeline in Peril: A Status Report on the Trans-Alaska Pipeline* (Alaska Forum for Environmental Responsibility, 1996), Ch. 7.
[15] Ibid., Page 7.8.

Pipeline Office noted that the leak detection system still performed poorly when detecting small, slow leaks and that the leak detection system performs worse during shutdowns and startups.[16] Most recently, the leak detection system was questioned after the January 2011 leak that led to a temporary shutdown of the pipeline was not discovered by the leak detection system but was instead identified while someone was walking on operator rounds.[17]

In addition to experiencing problems with the leak detection system, TAPS has struggled to comply with the cold restart requirement since Alyeska began closing pump stations in 1996. TAPS was originally designed to be able to restart after a 21 day shutdown with an average temperature of negative 40 degrees Fahrenheit, an operating margin of safety known as the cold restart requirement. However, its ability to do so came into question once Alyeska began closing pump stations in response to reduced throughput in 1996-1997 and Alyeska admitted that it was no longer able to comply with this requirement in 1998.[18] Since admitting that it has been unable to comply with this requirement, Alyeska has repeatedly failed to meet deadlines for developing a viable cold restart program with the reduced number of pump stations in operation.[19] Alyeska still does not have a viable cold restart plan. When faced with the possibility of having to perform a cold restart after the January 2011 leak, Alyeska was unable to get all of the equipment to the necessary location along the pipeline and would have had to disregard regulatory requirements in order to implement the latest version of its cold restart plan.[20]

Alyeska has also encountered problems implementing its strategic reconfiguration project. Strategic reconfiguration involves replacing four of the original pumps with electric pumps and increasing automation at the four pumping stations.[21] The project was started as a way to reduce the minimum throughput of the pipeline and lower operating and maintenance costs to decrease both the amount of equipment in use and the number of employees required to operate the pipeline.[22] Originally projected to be completed in 2005 and cost $250 million,[23] it is now expected to be

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[16] See Fineberg, Richard, "Leak Detection System," in *The Emperor's New Hose: How Big Oil Gets Rich Gambling with Alaska's Environment* (Alaska Forum for Environmental Responsibility, 2002), pp. 27-28.
[17] Schneyer, Joshua, "Alaska Oil Line that Leaked Deemed Risky Since 2008" *Reuters*, Friday, January 21, 2011, http://www.reuters.com/article/2011/01/21/alaska-pipeline-leak-idUSN2127984620110121.
[18] See Fineberg, Richard, "Establishing a Rational Foundation for Review, Formulation and Implementation of Alaska's Oil and Gas Fiscal Policy" [http://www.finebergresearch.com/pdf/Fineberg HB110 Report 110410.pdf [1]], April 7, 2011, p. 26.
[19] Ibid., Appendix C.
[20] Pipeline and Hazardous Materials Safety Administration, "Notice of Proposed Safety Order", CPF 5-2011-5001S, February 1, 2011, p. 3.
[21] Alyeska Pipeline Service Company, "Pipeline Reconfiguration Project Overview", March 2004 (http://www.alyeska-pipe.com/Strategic%20Reconfiguration/PRO_12pg_Final_LR.pdf).
[22] Ibid.
[23] Ibid.

completed in 2013 and cost $750 million.[24] Cost overruns have become the subject of a tariff dispute between the TAPS owners and the Federal Energy Regulatory Commission,[25] indicating that Alyeska may have mismanaged the project.

In addition to the above ongoing problems that have not yet been resolved, Alyeska has received numerous citations from PHMSA for violations of federal requirements and pipeline safety regulations. For example in 2007, PHMSA cited Alyeska for violations of operating procedures that led to a fire, violations of operating procedures that led to an oil spill and failure to implement anti-corrosion measures in a timely manner.[26] The fire and oil spill also prompted PHMSA Administrator (now Alyeska President) Thomas Barrett's statement that "[R]ecent significant events in Alaska, including pipeline failure on the North Slope, have highlighted the need for the state's oversight agencies and PHMSA to implement a more comprehensive and effective 'system of systems' approach."[27] In 2011, PHMSA issued a Notice of Proposed Safety Order that raised concern over portions of the pipeline that cannot be inspected for corrosion, the inability to launch pigs[28] at interim locations in the pipeline, the feasibility of the cold restart program and the lack of sufficient storage facilities at certain locations along the pipeline.[29]

TAPS Minimum Throughput

The TAPS minimum throughput without any additional investment has been estimated at 500,000 barrels per day (b/d),[30] although the TAPS owners have recently claimed that 550,000 b/d is the minimum throughput with the pipeline's current

[24] Alaska Department of Revenue "Revenue Source Book", Fall 2007, p. 44.
[25] See Fineberg, Richard, "Establishing a Rational Foundation for Review, Formulation and Implementation of Alaska's Oil and Gas Fiscal Policy" [http://www.finebergresearch.com/pdf/Fineberg HB110 Report 110410.pdf [1]], April 7, 2011, p. 24.
[26] U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), *Notice of Probable Violation, Proposed Civil Penalty and Proposed Compliance Order* (CPF 5-2007-5041), p. 2-8 and 12-13.
[27] Thomas Barrett in State of Alaska, "Alaska Teams with Pipeline Safety Agency", May 15, 2007, http://www.dog.dnr.alaska.gov/PSIO/Documents/letter_of_intent_govpr.pdf.
[28] A pipeline pig runs through a pipeline to clean (i.e. scraper pigs) and/or inspect the pipeline (i.e. smart pigs).
[29] U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration (PHMSA), *Notice of Proposed Safety Order* (CPF 5-2011-5001S), p. 4.
[30] Mustang Engineering Study prepared for the Alyeska Pipeline Service Company, see Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 122. This number is also implied in "TAPS: Quick Facts" on the Alyeska Pipeline Service Company website (http://www.alyeska-pipe.com/Pipelinefacts/TAPS%20Quick%20Facts.pdf).

configuration.[31] There is little dispute that when the throughput drops below 500,000 b/d, TAPS may begin to experience problems that could prevent it from operating if no additional investment is made in the pipeline. According to production forecasts from the United States Department of Energy, TAPS throughput will drop below 500,000 b/d by 2026.[32] When the amount of oil that flows through the pipeline reaches this minimum throughput level, the temperature of the oil will dip below freezing during the winter months and the water that travels with the oil in the pipeline will begin to freeze.[33] Other potential problems from reduced throughput include wax buildup and frost heaves.[34]

A number of different approaches have been proposed to reduce TAPS minimum throughput and extend the life of the pipeline. Potential methods of reducing the minimum throughput include installing heaters and insulation to prevent ice buildup, installing additional pigging stations to prevent wax buildup and injecting chemicals into the pipeline to prevent corrosion caused from water and wax accumulation.[35]

There is disagreement regarding the minimum throughput that can be achieved by making an additional investment in the pipeline. Until recently, there was little dispute that the minimum throughput can be reduced to 200,000 b/d through a variety of different strategies.[36] The owners of the Alyeska Pipeline Service Company have indicated that the pipeline would be configured to allow for a 200,000 b/d minimum throughput through completion of the strategic reconfiguration project,[37] although it would not be configured to comply with the cold restart requirement. Additionally, the owners have indicated that the pipeline as currently configured could operate down to 200,000 b/d through the installation of heaters.[38] However, according to Dr. Jerry Modisette, a physicist and pipeline consultant who served as an expert witness in the

[31] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, Executive Summary, p. 3.
[32] DOE/NETL, "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?" April 2009, Appendix A.
[33] Testimony of Tom Barrett on behalf of the Alyeska Pipeline Service Company before the Alaska State House Finance Committee, March 18, 2011.
[34] Ibid.
[35] Alyeska Pipeline Service Company, "TAPS Low Flow Study Status," January 31, 2011, slide 3.
[36] As we discuss later, Alyeska recently published a study called the "Low Flow Impact Study" which recommends certain investments in the pipeline in order to reduce the minimum throughput to 350,000 b/d. However, the study does not claim that 350,000 b/d is the actual minimum throughput of the pipeline. Furthermore, as we discuss, there are a number of flaws with this study that render its conclusions unreliable.
[37] Deposition of Tom Stokes, see Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 121.
[38] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 121.

field of pipeline modeling for the municipalities during the trial to determine the 2006 value of TAPS, the minimum throughput can be reduced to at least 150,000 b/d by completing the strategic reconfiguration project, installing heaters and, perhaps, adding pigging[39] stations.[40]

Production Forecasts and Estimated Life of TAPS

Figure 1 shows historical and forecasted production for Alaska's North Slope. North Slope production forecasts are used as a proxy for TAPS throughput estimates because TAPS is the only method for transporting oil from the North Slope to market.[41] Figure 1 shows two different forecasts from 2009: one from a US Department of Energy (DOE) report[42] and one from the Alaska Department of Natural Resources (DNR).[43] The DOE forecasts include production from currently producing fields, fields with announced or pending development plans, producing pools with projects under evaluation and discovered fields with near-term development potential. The DOE estimates exclude undiscovered potential oil resources but include heavy oil reserves that they believe are economically recoverable. They do not include reserves in the Beaufort Sea Outer Continental Shelf or the Chukchi Outer Continental Shelf. Similarly, the DNR estimates include currently producing fields and fields with announced or pending development plans, but not fields with near-term development potential. They also do not include reserves in the Outer Continental Shelf. The DNR estimates exclude undiscovered oil resources and most known heavy oil reserves as well.

[39] Though there are multiple types of pigs that are run for different purposes, the pigging stations proposed by Dr. Modisette would be used to remove wax buildup in the pipeline.

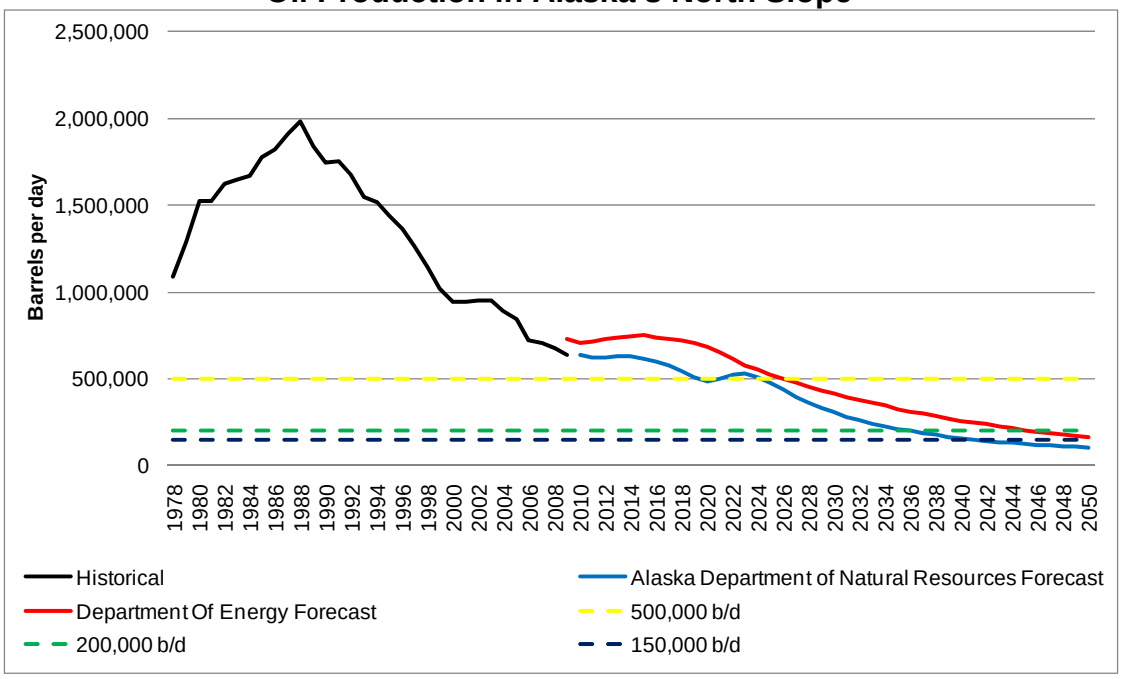
[40] Dr. Modisette has presented evidence that the minimum throughput may be as low as 40,000 barrels per day (See Modisette, Jerry "TAPS Pipeline at Low Flows" April 8, 2009 p. 11). While we agree that the TAPS minimum throughput may be lower than 150,000 b/d, we cannot say with certainty that it can go all the way down to 40,000 b/d and Judge Gleason did not find that it could.

[41] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 120, 123.

[42] DOE/NETL, "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?" April 2009, Appendix A.

[43] Alaska Department of Natural Resources, Department of Oil and Gas, "Annual Report 2009", p. 29.

Figure 1
Oil Production in Alaska's North Slope



As shown in Figure 1, TAPS throughput is expected to drop below 500,000 b/d by 2026, to 200,000 b/d by 2046 and to 150,000 b/d sometime after 2050 according to the DOE estimates. According to the DNR estimates, the TAPS throughput will drop to 500,000 b/d by 2020, to 200,000 b/d by 2036 and to 150,000 b/d by 2041. Both estimates show production increases at certain points which occur when the fields with development potential begin producing. The difference between the two estimates is due to differences in the amount of heavy oil reserves included, the DOE's inclusion of fields with near-term development potential, as well as a slight difference in production decline rates.[44] The forecasts by the DOE more closely resemble those accepted by Judge Gleason, who was presented with several different production estimates heard testimony from a number of experts in 2010 as well as those accepted by the State Assessment Review Board in 2011, which indicated that the TAPS throughput would not drop to 200,000 b/d until 2047 and 2045, respectively.[45]

Both estimates show that, in contrast to statements made by the Alyeska Pipeline Service Company that imply that oil production will fall at about 5.4 percent per year,[46] oil production is expected to fall at rates ranging from 3.7 to 4.5 percent per

[44] The difference between the two estimates may also be driven by a difference in timing (i.e. using fiscal year versus calendar year estimates).
[45] Loy, Wesley, "TAPS Value: $8.7 billion" *Petroleum News* 16(24), June 12, 2011.
[46] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, p. 2-3.

year.[47] This indicates that TAPS throughput is not expected to fall as quickly as the overly conservative estimates owners imply. Advocates for increased domestic production point to variations between production forecasts and actual production in order to support their assertion that production is expected to fall quickly.[48] However, there are a number of reasons that actual production may deviate from forecasts or that short term forecasts may change. For example, in 2005 the Alaska Department of Revenue projected that production would be 865,000 b/d in 2006 and 843,000 b/d in 2007.[49] However, in 2006 actual production was only 845,000 b/d due to corrosion problems in the North Slope.[50] These corrosion problems resulted in oil spills and temporary shutdown and stemmed from improper maintenance.[51] While actual production in 2006 was lower than projections, this merely represents a short term deviation and not a longer term trend. In the long term, production that is deferred due to maintenance or other problems will become additional production at a later point in time. Furthermore, while production forecasts do change as more information comes available, recent evidence has consistently pointed to 2045 as being a reasonable estimate for the year when throughput declines to 200,000 b/d.[52]

Alyeska's June 2011 Low Flow Impact Study ("LoFIS")

On June 15, 2011 Alyeska's Low Flow Study Project Team released a report that presented the results of their evaluation of the potential risks to TAPS operations at throughputs between 600,000 b/d and 300,000 b/d. This study claims that the pipeline can only reliably operate at a minimum throughput of 550,000 b/d without any investment and down to 350,000 b/d with certain recommended investments in the pipeline.[53] The majority of the issues identified by the study can be solved by remedying the difficulties with wax buildup and pigging at lower throughputs and by applying heat to the oil. Additionally, the study recommends modifying the current water specifications, injecting corrosion inhibitors into the pipeline and continued analysis of a

[47] The DOE estimates indicate an average rate of decline of 3.7 percent from 2010 to 2050 while the DNR estimates indicate an average rate of decline of 4.5 percent over the same period.
[48] See for example, Maloney, Tom, "Production and Drilling Drops Significantly Since ACES," Resources Development Council, April 2011.
[49] Alaska Department of Revenue, "Revenue Sources Book: Fall 2005", p. 12.
[50] Ibid. p. 12.
[51] See Fineberg, Richard, "BP North Slope Spill Reveals a History of Substandard Environmental Performance", March 15, 2006.
[52] See 2011 decision by the State Assessment Review Board which determined that the life of the pipeline was at least 2045 and the decision by Judge Gleason in *Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System* which determined that the life of the pipeline was at least 2047 (Loy, Wesley, "TAPS Value: $8.7 billion" *Petroleum News* 16(24), June 12, 2011).
[53] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, Executive Summary, p. 3.

number of areas, including the leak detection system, the cold restart program and pigging operations below 350,000 b/d.[54] Although the cost of investment was not included in the study, according to TAPS spokeswoman Michelle Egan, the mitigation measures could cost between $300 million to $500 million over several years.[55]

We find that Alyeska's Low Flow Impact Study raises a number of questions which cast doubt on the reliability of its conclusions. First, we have serious reservations about several of the key assumptions used in the study. Second, we believe it is possible that many of the hazards identified by the study are misrepresented and question why Alyeska has not been able to identify and deal with low throughput problems in a more timely manner. Third, we have reservations about the reliability of the study's estimates for the throughput level at which many of the hazards that it identifies use up their margin of safety and become a serious threat to TAPS ability to operate. Finally, the issues raised above cast doubt on the report's conclusion that the recommended investment needed in order to reduce the minimum throughput of the pipeline would only allow the pipeline to operate down to 350,000 b/d and that that the pipeline can only operate down to 550,000 b/d without investment, which contradicts both previous statements made by the TAPS owners and the Mustang report prepared on behalf of the TAPS owners.

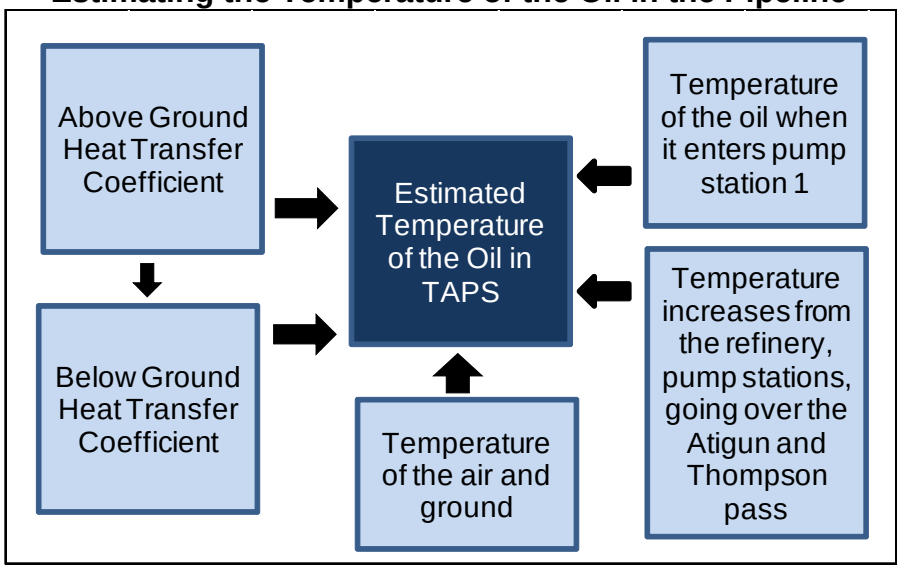
LoFIS Throughput and Temperature Assumptions

The LoFIS uses the overly conservative estimate that TAPS throughput will decline at an annual rate of 5.4 percent.[56] Although the study does not offer any direct support for this assumption, it appears to be based on the difference between the average January throughput between 1988, when TAPS throughput peaked at 2 million b/d, and present.[57] However, the study does not provide any basis for its assumption that the TAPS throughput will continue to decline at the same rate. In fact, according to the DOE and DNR forecasts, TAPS throughput will decline at a slower rate. The DOE and DNR forecasts predict an average annual decline from 2011 to 2050 of 3.7 percent and 4.5 percent, respectively. North Slope production forecasts may provide a more reliable estimate of future TAPS throughput than historical rates of decline because they take into account both experience and the remaining amount of recoverable oil in the North Slope oil fields.

[54] Ibid., p. 5-7 and p. 48.
[55] Egan, Michelle quoted in Bradner, Tim, "Alyeska: TAPS can operate at 350,000 barrels with fixes" Alaska Journal of Commerce, July 7, 2011, http://www.alaskajournal.com/stories/070711/oil_atcpa3.shtml.
[56] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, p. 2-3.
[57] Ibid., p. 2.

We also question the assumptions used in the LoFIS to estimate the temperature profiles of the oil in the pipeline at lower throughputs. The study did not disclose key inputs to the temperature estimates such as the above ground and below ground heat transfer coefficients or the air and ground temperature profiles. As shown in Figure 2, these inputs heavily influence the estimated temperature of the oil as it travels along the pipeline. This study, which estimates that the temperature of the oil drops below freezing at 550,000 b/d,[58] does not appear to use the same estimates as the Mustang Engineering Study prepared for Alyeska for the 2006 tax valuation case, which estimates that the temperature of the oil does not drop below freezing until 500,000 b/d.[59] However, according to Dr. Modisette, even the estimate by Mustang is too high. He believes that the above ground heat transfer coefficients used by Mustang Engineering are too low and that using an estimate that is too low for the above ground heat transfer coefficient leads to errors in calculating the below ground heat transfer coefficient.[60] Dr. Modisette determined that the temperature of oil does not drop below freezing until between 200,000 b/d to 300,000 b/d throughput.[61]

Figure 2
Estimating the Temperature of the Oil in the Pipeline



[58] Ibid., Executive Summary, p. 1.
[59] Mustang Engineering Study prepared for the Alyeska Pipeline Service Company, see Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 122 and Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*
[60] Modisette, Jerry, "TAPS Pipeline at Low Flows", April 8, 2009, p. 10.
[61] Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*

We also have reservations about the reliability of the LoFIS' presentation of crude oil temperatures at various flow volumes and believe that it may be misinterpreted by the reader.[62] The study presents a figure that shows the estimated temperature profiles for different levels of TAPS throughput assuming that no heaters are installed. This figure may be misinterpreted for a number of reasons. First, the figure implies that the coldest part of the pipeline is the portion right before the North Pole Refinery. While this may be true at higher throughput rates, as the flow of the pipeline decreases, the coldest part of the pipeline moves up the pipeline.[63] The figure also places emphasis on the North Pole Refinery as a source of heat and the study explains that Alyeska does not have control over the refinery. However, the study also notes that the heat provided by the refinery is "equivalent to having a crude oil heater installed at this location".[64] Therefore, if the refinery were to shut down, Alyeska could simply install a heater at this location to replicate this source of heat. Next, the figure assumes that no heaters are installed in the 400,000 b/d case even though the study also states that the oil needs to be heated in order to operate below 550,000 b/d.[65] Therefore, the 400,000 b/d scenario that is illustrated in the figure does not represent likely operating conditions at 400,000 b/d. Finally, based on this figure it appears that the study may not have appropriately accounted for the additional heat provided at Atigun Pass (at approximately mile 165) and Thompson Pass (at approximately mile 775), where the oil temperature increases between 5 and 10 degrees due to the energy it takes to get the oil over the pass.[66]

LoFIS Operating Assumptions

The LoFIS also did not use appropriate operating assumptions, particularly the assumption that no external heat was added to the pipeline at any throughput level.[67] This is particularly important given that the study's estimates of the temperature of the oil appear to be too low. Furthermore, this assumption is inconsistent with the Mustang Engineering Study prepared for Alyeska for the 2006 tax valuation case which determined that adding heat to the pipeline is necessary in order to operate the pipeline below 500,000 b/d. It is surprising that the LoFIS assumed that no external heat was added to the pipeline given that one of the first tasks undertaken by the team was a

[62] See Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, Figure 3, p. 4.
[63] Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*
[64] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, p. 3.
[65] Ibid., Executive summary, p. 1.
[66] Ibid.
[67] Ibid., Table 1, p. 5.

literature survey[68] and that it is generally understood that the principal solution to low throughput problems is to heat the oil in TAPS and keep it warm.[69]

The assumption that no external heat is added to the pipeline means that the estimated temperature of the oil in the pipeline at all throughputs examined by the LoFIS below 550,000 b/d is too low and therefore almost every hazard identified by the study at throughputs below 550,000 b/d is misrepresented. Not only does the temperature of the oil in the pipeline affect ice formation and frost heaves, it also affects the way the oil flows in the pipeline and the settlement behavior of things such as wax that travels with the oil in the pipeline. This is because the temperature of the oil changes the viscosity of the oil, which in turn affects the Reynolds number. The Reynolds number measures the ratio of inertial forces to viscous forces and determines whether the oil in the pipeline is traveling in laminar or turbulent flow.[70] When the Reynolds number is above a certain point,[71] the oil remains in complete turbulence, meaning that the oil in the pipeline moves in a flow that contains random vortices. This type of flow helps prevent other things traveling in the oil from separating or settling in the pipeline. However, if the Reynolds number falls below a certain point,[72] the oil may start laminar flow, which would mean that other things traveling in the pipeline such as wax and sediment would start to settle in various areas of the pipeline and affect pipeline operations.[73] Therefore, because the LoFIS assumed that the oil in the pipeline was not heated, the Reynolds numbers used by the study for throughputs level below 550,000 b/d[74] are inaccurate.

Hazards Identified by LoFIS

We believe that many of the hazards identified by the study may be misrepresented. Although the study presents all of the problems it lists as being related

[68] Ibid., p. 7.
[69] See for example Testimony of Jerry Modisette, August 26 and 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.* See also Fineberg, Richard, "Establishing a Rational Foundation for Review, Formulation and Implementation of Alaska's Oil and Gas Fiscal Policy", April 7, 2011 [http://www.finebergresearch.com/pdf/Fineberg HB110 Report 110410.pdf [1]], p. 27.
[70] Modisette, Jerry, "TAPS Pipeline at Low Flows", April 8, 2009, p. 1.
[71] The number at which the oil remains in complete turbulence depends on the friction factor and the roughness of the pipes and can vary between 6,000 and over 100,000,000 (See Moody's Diagram in Pao, Richard, *Fluid Mechanics* (New York: John Wiley & Sons, 1961), p. 284 shown in "Laminar and Turbulent Flows", http://udel.edu/~inamdar/EGTE215/Laminar_turbulent.pdf, p. 14).
[72] This number is lower than Reynold's number at which the oil remains in complete turbulence. If the Reynold's number is between the two critical points, the flow is in a transition zone and is not laminar but is also not completely turbulent. The point at which the oil becomes laminar is at a Reynold's number of 2,100 (see Modisette, Jerry, "TAPS Pipeline at Low Flows", April 8, 2009, p. 1).
[73] Testimony of Jerry Modisette, August 26, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*
[74] See Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, Table 1, p. 5.

to lower throughput in TAPS, several of them have actually been problems for years and are issues that need to be resolved regardless of the operating level of the pipeline. This indicates that is it possible that the hazards identified by the study may be exaggerated. Furthermore, it raises the issue of why Alyeska has not been able to identify and deal with the problems associated with low throughput in a more timely manner.

The LoFIS identifies both the "questionable viability of the leak detection system at low flow rates" and the uncertainty of the cold restart program[75] as areas "of uncertainty at throughputs below 350,000 BPD".[76] However, as discussed previously, these are two problems that TAPS has faced for years. Though they may be problems when TAPS throughput falls below 350,000 b/d, they are also problems right now.

Additionally, the LoFIS identifies corrosion as a hazard at low flows and corrosion monitoring as uncertain at throughputs below 350,000 b/d.[77] Corrosion and corrosion monitoring have also been an ongoing issue for TAPS, as noted in the 2007 and 2011 PHMSA citations. The area of the pipeline that leaked in January 2011 had not had a corrosion inspection since 2008, and even that inspection was deemed too risky and stopped prior to completion.[78] Perhaps more alarming is the fact that there are other parts of TAPS that are susceptible to corrosion which cannot be evaluated.[79] This indicates that corrosion monitoring is not only an issue at 350,000 b/d, but is a problem faced by TAPS right now. Given that corrosion monitoring, the leak detection system and the cold restart plan are all issues that TAPS is currently facing, it is obvious that they will also be problems as the throughput declines. However, these are issues that should be addressed now, not put off for further study as the TAPS throughput falls.

Several other issues that are identified by the LoFIS are related to something that the TAPS owners have considered a problem for a number of years: wax buildup at lower throughputs. In 2008 the TAPS owners identify wax buildup as a critical issue at low throughputs and recommend that Alyeska further evaluate wax buildup, develop a wax management process, increase pigging frequency, heat the crude oil and use chemical additives to deal with this issue.[80] The LoFIS still identifies wax buildup as an

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[75] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, p. 4.
[76] Ibid., Executive Summary, p. 3.
[77] Ibid., Executive Summary, p. 3.
[78] Schneyer, Joshua, "Alaska Oil Line that Leaked Deemed Risky Since 2008" Reuters, Friday, January 21, 2011 (http://www.reuters.com/article/2011/01/21/alaska-pipeline-leak-idUSN2127984620110121).
[79] Pipeline and Hazardous Materials Safety Administration (PHMSA) in Loy, Wesley, "TAPS Safety Questioned" Petroleum News Vol. 16.8, February 20, 2011 (http://www.petroleumnews.com/pntruncate/300494049.shtml).
[80] Chuck Coulson (Chair, TAPS Owners Committee), et al., "TAPS Low Throughput Issues", October 1, 2008 (http://taps-flow.com/TAPS%20Throughput%20Issues.ppt). It is also notable that sludge buildup and management of pigging operations were problems in the 2006 BP oil spill in the North Slope. In the wake of spill it was discovered that the BP pipeline had extensive corrosion that had not been discovered

area requiring further analysis and recommends establishing a pigging program to manage wax buildup.[81]

The LoFIS claims that at flow rates below 350,000 b/d, it may not be feasible to use pigs to remove the wax in the pipeline because large wax accumulation in front of pigs may cause them to get stuck in the pipeline and they may experience other operational problems due to the lower speed at which the pigs are able to travel.[82] The study purports to support this claim by presenting data showing increasing amounts of wax that they expect to be deposited in the pipeline at lower throughputs. However, wax deposition modeling is sensitive to the oil temperature and heat transfer characteristics and, as discussed above, we question whether the study used appropriate assumptions for the oil temperature and heat transfer characteristics.[83] Furthermore, the amount of wax deposited in the pipeline does not in itself demonstrate that more frequent pigging, installing additional pig launchers and receivers, developing more advanced pigs, applying heat, injecting chemicals or using some other method will not be able to manage the additional wax in the pipeline. Wax buildup is one of the hazards that was assessed by Mustang Engineering in the study they prepared for Alyeska for the 2006 tax valuation case. Mustang determined that, if wax buildup were to become a problem, it could be solved with increased pigging, adding heat or adding chemicals such as solvents.[84] However, the LoFIS does not address the conclusions of the Mustang Engineering study and does not even consider the use of chemicals as a solution to wax buildup.[85] Therefore, without any supporting data provided in the LoFIS study, we cannot agree with the LoFIS analysis of wax buildup.

Slackline flow is another hazard identified by the LoFIS that is also a current concern. Slackline flow can occur at locations in the pipeline with large drops in elevation. This does cause some operational challenges, such as making leak detection more difficult. However, as mentioned in the study, TAPS is currently operating with some areas of slackline flow. While the amount of slackline flow may increase as throughput falls and this is certainly a topic that warrants Alyeska's attention, we question whether this would in fact prevent the pipeline from operating. If

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earlier because BP had failed to run smart pigs through the pipeline. Following the spill, PHMSA ordered BP to clean and inspect the pipeline. At that point, it was discovered that as a result of BP's failure to run cleaning pigs in that section of the pipeline, sludge buildup had been so extensive that the inspection pigs could not get through the pipeline (Fineberg, Richard, "'Shocking?' Evidence Mounts from Alaska and Elsewhere that BP's Inadequate North Slope Performance Should Have Been no Surprise to Public Officials or Monitors", September 3, 2006, p. 7 and 9).

[81] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, p. 42.

[82] Ibid., p. 31.

[83] Ibid., p. 10.

[84] Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*

[85] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, p. 48.

slackline flow is indeed such a grave threat to TAPS' ability to operate, we question why Alyeska has not already started working on this issue.

The other hazards identified include ice formation in the pipeline, frost heave and tank volatility, all of which are all highly dependent on the temperature of the oil in the pipeline. Frost heave occurs when the soil around the pipeline freezes, forming ice lenses. Tank volatility refers to the study's finding that lower crude oil temperatures change the vapor space compositions of the tanks and places them in the flammable range. We agree that these are all legitimate concerns for pipeline operations. However the point at which they use up the desired margin of safety and pose a serious threat to TAPS ability to operate is heavily dependent on the assumed temperature of the oil in the pipeline. As we discuss in the next section, the LoFIS estimates of the throughput at which the hazards identified by the study use up their margin of safety are unreliable due to the inappropriate assumptions of the study.

The study also notes that there is operational uncertainty as the throughput falls below rates previously experienced in TAPS. We do not dispute this possibility. However, should any additional problems arise, we are confident that the TAPS owners will have the financial resources to make any necessary investments because, as we show later, the owners would have to forfeit such a large financial benefit if they were forced to shut down the pipeline. Furthermore, given that the TAPS owners are aware that the throughput will continue to fall and that additional operational problems may be identified as this occurs, we would expect that the owners would devote considerable attention to identifying any problems that may be a threat to TAPS operations in the future and determining how to solve them.

Throughput Levels at which Hazards Identified by the LoFIS Prevent TAPS Operations

We have serious reservations about the estimates for the throughput at which the hazards identified by the LoFIS become problems for pipeline operations. This is because the inappropriate assumptions of the study lead to illogical results when examining throughputs below 550,000 b/d. For example, the study claims that ice lenses, which are formed when the temperature of the pipeline gets so low that the soil around the buried portion of the pipeline freezes, will form at 350,000 b/d assuming no heating of the crude oil.[86] However, the study also determined that, unless the crude oil is heated, its temperature will drop below the freezing point of water when the throughput reaches 550,000 b/d.[87] This is why one of the study's proposed mitigation

[86] Ibid., Executive summary, p. 2.
[87] Ibid., Executive summary, p. 1.

strategies in order to reduce the throughput below 550,000 b/d is to heat the oil.[88] In fact, it is generally understood that the principal solution to low throughput problems is to heat the oil in TAPS and keep it warm.[89] Therefore, the conclusion that ice lenses will form at 350,000 b/d under the assumption that the oil is not heated is unreliable, because in order to reduce the throughput below 550,000 b/d the oil will need to be heated.

The inappropriate assumptions of the LoFIS at throughputs below 550,000 b/d are also an issue in the study's discussion of wax formation and pigging operations. The study claims that at 350,000 b/d the larger quantity of wax and lower velocity of the oil that pushes the pig in the pipeline may create problems for pigging operations.[90] However, wax deposition modeling is strongly influenced by oil temperature and throughput.[91] As discussed previously, we believe that the study used inappropriate assumptions about the temperature of the oil when assessing the problems of wax buildup. Therefore, we find the conclusion that wax buildup and pigging operations may become a serious threat to TAPS ability to operate at 350,000 b/d unreliable.

LoFIS Conclusions

We are not convinced by the study's claim that the recommended investment would only allow the pipeline to operate down to 350,000 b/d. The study claims that "measures to mitigate these issues utilizing the 48-inch pipeline at throughputs below 350,000 BPD have not been determined at the date of this report."[92] However, this position *directly contradicts* statements by both the pipeline owners and those contained in the Mustang Report prepared for the TAPS owners in the 2006 trial to determine the value of TAPS, which indicated that TAPS throughput could be reduced to 200,000 b/d with the installation of heaters.[93] The LoFIS does not address this contradiction, which is surprising given that it claims that one of its first steps was to conduct a literature survey in order to "identify low throughput equations and physical models, identify any existing data that validated these models, and make a preliminary assessment of

[88] Ibid., p. 38.
[89] Fineberg, Richard, "Establishing a Rational Foundation for Review, Formulation and Implementation of Alaska's Oil and Gas Fiscal Policy", April 7, 2011 [http://www.finebergresearch.com/pdf/Fineberg HB110 Report 110410.pdf [1]], p. 27.
[90] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, Executive Summary, p. 3-4.
[91] Ibid., p. 10.
[92] Ibid., p. 3.
[93] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 121.

processes that may impede TAPS operation at low flow rates."[94] One would expect the literature survey to include a review of prior reports that have assessed the operational issues and recommended mitigation measures at low flows, particularly those done by or for the pipeline owners.

We also find that the LoFIS only provides weak evidence that the minimum throughput without mitigation is 550,000 b/d. All of the specific issues that the study identifies occur at 500,000 b/d or lower.[95] Although the study notes that the pipeline will reach the freezing point of fresh water at 550,000 b/d, it also states that the water that enters the pipeline contains salt and therefore has a freezing point of 31 degrees instead of 32 degrees.[96] The entire argument that the minimum throughput without investment is 550,000 b/d appears to rest on their assessment that "there is sufficient rate turn-down with legacy pumping equipment at PS01 to operate to a rate of about 500,000 BPD. However, a degree of uncertainty is associated with the ability to operate this equipment at low flow rates for an extended period of time."[97] However, this contradicts the Mustang Engineering Study prepared for Alyeska, which claimed that TAPS could operate without additional investment down to 500,000 b/d.[98] Therefore, we are not convinced that the actual minimum throughput without any additional investment is 550,000 b/d.

Analysis of Investments to Reduce the TAPS Minimum Throughput

Methodology

Given that the TAPS minimum throughput can be reduced by making an investment in the pipeline, the argument that the pipeline is in danger of being shut down due to falling throughput depends on the likelihood that the TAPS owners would not make the investment necessary to reduce the minimum throughput.[99] In order to determine the likelihood of the TAPS owners making such an investment, we created a model that compares the expected oil revenue and profits from Alaska's North Slope if no additional investment was made in TAPS compared with the revenue and profits that

[94] Alyeska Pipeline Service Company, "Low Flow Impact Study", June 15, 2011, p. 7.
[95] Ibid., p. 21-23 and 26-27.
[96] Ibid., p. 26-27.
[97] Ibid., p. 21.
[98] Mustang Engineering Study prepared for the Alyeska Pipeline Service Company, see Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 122.
[99] Recall that the three major owners of TAPS presently control an estimated 95 percent of North Slope production and are estimated to control 88 percent in 2050. The pipeline investment is necessary to assure continued profits from that production.

would be earned if the owners invested in reducing minimum throughput. We projected revenues and costs in the different scenarios and then discounted them to their present values in order to determine the total benefit from each scenario.

As shown in Table 1, we modeled three different potential outcomes for TAPS. In the first scenario, there is no additional investment in the pipeline and it shuts down once throughput reaches 500,000 b/d. In the second scenario the minimum throughput is reduced to 150,000 b/d, through the completion of the strategic reconfiguration project, the installation of heaters and two additional pigging stations. This scenario is based on the estimates made by Dr. Jerry Modisette.[100] The total expected cost of reducing the minimum throughput is $539 million. This includes $232 million for completing the strategic reconfiguration project,[101] $257 million for installing the heaters[102] and $49 million for the two additional pigging stations.[103] It is notable that the cost of investment in this scenario is higher than the estimated $300 million to $500 million necessary to make the investments recommended by the LoFIS, which would reduce the minimum throughput to 350,000 b/d.

In the third scenario, the installation of heaters alone reduces the minimum throughput to 200,000 barrels per day. This scenario is based on the pipeline owners' estimate that the TAPS minimum throughput could be reduced to 200,000 barrels per day with the installation of heaters.[104] This scenario involves more heaters than the previous scenario and therefore has a higher cost. The expected cost of installing the heaters is $721 million,[105] which is also higher than the estimated cost of investments recommended in the LoFIS. We assumed that the investment in scenarios 2 and 3 would take 5 years to complete and would begin in 2015.

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[100] Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*

[101] The strategic reconfiguration project is projected to cost a total of $750 million (see Alaska Department of Revenue "Revenue Source Book" Fall 2007, p. 44). We assumed that each of the four pumps that are being reconfigured would cost the same amount. With only one of the four pumps left to reconfigure, we estimate that $187.5 million is left to be spent. We then inflated this from 2007 dollars to the value at the time of investment (2015) using the producer price index for finished goods from the Bureau of Labor Statistics.

[102] Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.* We then inflated this from 2006 dollars to the value at the time of investment (2015) using the producer price index for finished goods from the Bureau of Labor Statistics.

[103] Ibid. We then inflated this from 2006 dollars to the value at the time of investment (2015) using the producer price index for finished goods from the Bureau of Labor Statistics.

[104] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 121.

[105] Mustang Engineering Study prepared for the Alyeska Pipeline Service Company, see Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*

Table 1
Investment Scenarios[106]

Scenario 1: No investment in Pipeline	**500,000 bpd**
No investment	$0
Scenario 2: Modisette	**150,000 bpd**
Complete Strategic Reconfiguration	$232,300,505
Install Heaters	$257,365,015
Additional Pigging Stations	$48,899,353
Total Cost of Modisette Proposal	$538,564,873
Scenario 3: Mustang Report	**200,000 bpd**
Install Heaters	$720,622,042

Once we determined the three scenarios in our model and the associated costs of investment, we projected the amount of oil revenue and profit that would result from each scenario. We used oil production forecasts from the Department of Energy 2009 report[107] as a proxy for pipeline throughput because TAPS is the only method for transporting oil from the North Slope to market.[108] We selected the Department of Energy forecasts over the Alaska Department of Natural Resources forecasts because they more closely resemble those recently accepted by Judge Gleason in 2010 and the State Assessment Review Board in 2011. However, we also present the results of our analysis using the Alaska Department of Revenue forecasts as a quasi-sensitivity analysis. We assumed that the investment made in scenarios 2 and 3 would begin by 2015 in order to ensure that there was enough time to complete the project before the minimum throughput threshold would be hit. In order to calculate revenue, we relied on ANS oil price forecasts by the Alaska Department of Revenue.[109]

We relied on a number of estimates in order to determine the total profit from each scenario. We used estimates by the Alaska Department of Revenue (DOR) to determine the cost of marine transportation, the TAPS tariff, the operating costs and capital costs per barrel.[110] The Alaska DOR forecasted that the cost of marine

[106] Values are in 2015 dollars.
[107] DOE/NETL, "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline?" April 2009, Appendix A.
[108] Superior Court Judge Gleason Sharon L. Gleason, *Amended Decision Upon Reconsideration Following Trial de Novo: 2006 Assessed Valuation of the Trans Alaska Pipeline System (BP Pipelines [Alaska] Inc., et al., v. State of Alaska Department of Revenue, et al.*; Case No. 3AN-06-8446 CI [Consolidated]), October 26, 2010, p. 123. Although there is a refinery in North Pole, Alaska that uses oil from TAPS, this refinery is located between pump stations 7 and 8, while the coldest portion of the pipeline is estimated to be at pump station 5 (Testimony of Jerry Modisette, August 27, 2009, *In the Matter of the Trans-Alaska Pipeline System, Oil & Gas Property Tax [AS 43.56], 2006 Assessment Year.*). Therefore, we do not believe that this refinery will have a significant impact on the life of the pipeline.
[109] Alaska Department of Revenue, "Spring 2011 Forecast", April 5, 2011 and Alaska Department of Revenue, "Fall 2010 Revenue Sources Book", p. 35.
[110] See Alaska Department of Revenue, "Fall 2010 Revenue Sources Book", p. 36, 38.

transportation would increase at a rate of $0.05 per barrel per year through 2020[111] and we assumed that this cost would continue to increase at the same rate after 2020. We assumed that field operating costs would increase proportionally at the same rate that oil prices increase,[112] but that capital costs would increase by 4 percent per year.

The Alaska DOR forecasted that the TAPS tariff would increase to $5.80 per barrel by 2020.[113] We assumed that the tariff would continue to increase after 2020 at the rate of increase prior to 2020. We made an adjustment to the tariff rate for each scenario in order to account for the fact that any investment in extending the life of the pipeline would be rolled into the rate base and therefore would increase the tariff. For the two scenarios that involved investing in extending the life of the pipeline, we calculated an increase to the tariff rate each year between when the investment was made and the last year of operations. Additionally, since the DOR estimated tariff rates appear to include the costs of finishing the strategic reconfiguration project,[114] we calculated a deduction from the tariff rate for the two scenarios that did not involve completing the project. To calculate the adjustment, we calculated a 10.85 percent rate of return[115] on the addition to the rate base from the investment adjusted for depreciation[116] and then indexed the incremental rate increase at 3 percent per year based on the FERC rate index.[117] We indexed the tariff rate because each year in which there are no ongoing tariff disputes, pipeline rates may be increased consistent with the FERC index. Although the TAPS tariff has often been disputed and would therefore not be indexed during those years, we indexed the rate as a conservative assumption.

Due to the fact that these tariffs are spread over billions of barrels of oil and the expected price of oil is so much higher than the expected tariff rate, the adjustments made to the tariff rates do not significantly impact our results. The largest tariff adjustment we calculate is the adjustment in 2045 in scenario 3, when $0.39 per barrel

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[111] Ibid.

[112] Fineberg, Richard, "Establishing a Rational Foundation for Review, Formulation and Implementation of Alaska's Oil and Gas Fiscal Policy", April 7, 2011 [http://www.finebergresearch.com/pdf/Fineberg HB110 Report 110410.pdf [1]], p. 19-20.

[113] Alaska Department of Revenue, "Fall 2010 Revenue Sources Book", p. 38.

[114] Ibid., p. 35.

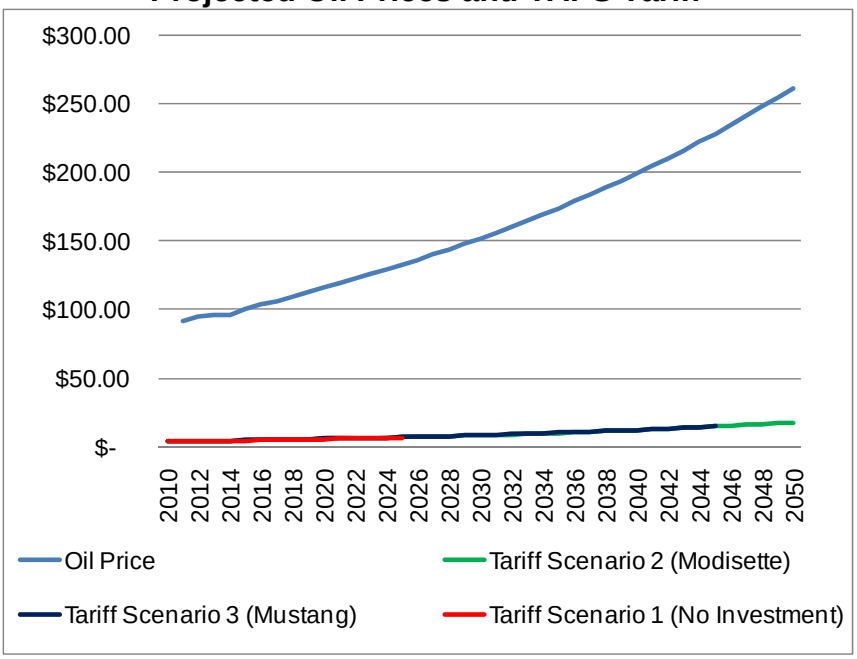
[115] BP Pipelines (Alaska), Inc., ConocoPhillips Transportation Alaska, Inc., ExxonMobil Pipeline Company, Koch Alaska Pipeline Company LLC, Unocal Pipeline Company, "Compliance Filing of the Taps Carriers Calculating Rates for 2007 and 2008 Consistent with Opinion No. 502", January 28, 2009, Attachment B Statement C.

[116] The investments in scenarios 2 and 3 to extend the life of the pipeline were depreciated over the year the investment was made (2015-2019) and the remaining life of the pipeline (either 2046 or 2050). The investment in strategic reconfiguration was depreciated over 2013-2034. We chose these dates because the strategic reconfiguration project is on hold, expected to be completed in 2013 and the Alaska Department of Revenue Estimates assume that the end of the TAPS useful life is 2034 as mandated by FERC (see Alaska Department of Revenue, "Fall 2010 Revenue Sources Book", p 37).

[117] 1.02998 represents the average of the index from 2000-2012. See Federal Energy Regulatory Commission, "Oil Pipeline Index" at: http://www.ferc.gov/industries/oil/gen-info/pipeline-index.asp

is added to the rate. In comparison, the nominal price of oil is expected to be $220.37 in 2045. This is illustrated in Figure 3, which shows our forecast of TAPS tariff rates compared with the expected price of oil. Figure 3 illustrates an important point: the TAPS tariff is a miniscule figure when compared with the price of oil, which is one of the reasons that the revenue that the TAPS owners receive from pipeline operations primarily comes from their ability to bring oil they produce in the North Slope to market, not from the tariff itself.[118] Furthermore, the rising price of oil illustrated in Figure 3 partially offsets the economic effects of lower volumes produced.[119]

Figure 3
Projected Oil Prices and TAPS Tariff



In addition to calculating pre-tax earnings, we also calculated the estimated royalties and taxes that would be paid on the oil revenue. We calculated royalties using a 12.5 percent royalty rate,[120] as well as the production tax,[121] the state income tax[122] and tax credits.[123] We used an estimate of $1.26 per barrel for the state and local

[118] Fineberg, Richard, "Establishing a Rational Foundation for Review, Formulation and Implementation of Alaska's Oil and Gas Fiscal Policy", April 7, 2011 [http://www.finebergresearch.com/pdf/Fineberg HB110 Report 110410.pdf [1]], p. 13-22.
[119] Ibid.
[120] Alaska Department of Revenue, "Fall 2010 Revenue Source Book", p. 31.
[121] Calculation according to Alaska Department of Revenue, "Fall 2010 Revenue Source Book", p. 30. This represents Alaska's Clear and Equitable Share (ACES) tax rates, not the governor's proposal to reduce the production tax.
[122] The state income tax also includes the 10.85 percent rate of return to the pipeline owners.
[123] Alaska Department of Revenue, "Fall 2010 Revenue Source Book", p. 30.

property tax in 2011 and assumed that this amount would increase with inflation.[124] Finally, we calculated the estimated federal tax using a 21 percent tax rate.[125]

Once we had forecasted the revenues and expenses in the three different scenarios, we discounted these to the present value in order to be able to compare the results. We used the midpoint convention, which uses the midpoint of the year in order to calculate the present value. We calculated the present values using both a 10 percent discount rate and a 12.5 percent discount rate.[126]

Results

Table 2 shows the present value of revenues and profits when we use a 10 percent discount rate. Our analysis shows that the *TAPS owners would lose money if they did not invest in reducing the minimum throughput* regardless of which investment strategy they pursue. This is because the investment necessary to reduce the TAPS minimum throughput is small in comparison to the additional amount of revenue and profit that the pipeline owners would otherwise have to forego. TAPS is an essential component of an integrated production and transportation system, which means that if the pipeline were to shut down, the remaining oil in the North Slope would be stranded there. The initial investment of $539 to $721 million is dwarfed by the $47 to $49 billion in additional revenue from the 2.4 to 2.7 billion barrels of oil that would otherwise be stranded in the North Slope.[127] In fact, when we consider the initial cost of investment compared with the pre-tax profit that would be foregone if no investment were made in the pipeline, the entire investment would be paid off in less than one *month*. Of this considerable amount of pre-tax profit, the State of Alaska would stand to earn an additional $14 billion in royalty and tax revenue.

[124] Fineberg, Richard, "Establishing a Rational Foundation for Review, Formulation and Implementation of Alaska's Oil and Gas Fiscal Policy", April 7, 2011, p. 9 [http://www.finebergresearch.com/pdf/Fineberg HB110 Report 110410.pdf [1]]. 2.8 percent represents the average rate of inflation over 2001-2010 as measured by the producer price index for finished goods from the Bureau of Labor Statistics.

[125] Ibid., note to Line 12. This number represents an approximation. See Fineberg, *The Profitability and Economic Viability of Alaska North Slope and Associated Pipeline Operations* (Prince William Sound Regional Citizens' Advisory Council, 2005), pp. 55-61, for discussion and additional data.

[126] In our experience in the oil industry major oil producers often apply a discount rate in the range of 10-12 percent.

[127] Recall that our analysis examines potential revenue from oil in currently producing fields, fields under development and fields with development potential. This analysis does not assume that any fields that are currently closed to drilling are opened.

Table 2
Present Values of Alternative Investment Scenarios - 10 Percent Discount Rate

	Total Revenue	Pre-Tax, Pre-Royalty Profit	After-Tax Profit	Revenue to State
Scenario 1: No Investment	$213,227,852,232	$136,470,370,589	$56,138,495,633	$65,154,817,277
Loss (compared with Modisette)	($49,022,523,806)	($28,709,370,665)	($14,398,035,848)	($12,038,833,530)
Loss (compared with Mustang)	($46,741,221,282)	($27,265,613,643)	($13,848,249,018)	($11,242,187,075)
Scenario 2: Modisette	$262,250,376,038	$165,179,741,253	$70,536,531,481	$77,193,650,807
Scenario 3: Mustang	$259,969,073,514	$163,735,984,232	$69,986,744,651	$76,397,004,352

As shown in Table 3, we obtain similar results when we use a 12.5 percent discount rate. Although the present values are lower in the 12.5 percent discount rate case, the modest investment that is necessary to reduce the TAPS minimum throughput is still overwhelmed by the additional revenue and profit that would be earned from extending the life of the pipeline. Therefore, the TAPS owners forego substantial profits by not making this investment and the State of Alaska would likewise lose substantial royalty and tax revenue.

Table 3
Present Values of Alternative Investment Scenarios - 12.5 Percent Discount Rate

	Total Revenue	Pre-Tax, Pre-Royalty Profit	After-Tax Profit	Revenue to State
Scenario 1: No Investment	$187,433,339,607	$120,181,467,914	$49,549,322,440	$57,237,026,729
Loss (compared with Modisette)	($30,017,185,451)	($17,504,076,438)	($10,088,471,667)	($6,171,365,478)
Loss (compared with Mustang)	($29,029,444,211)	($16,821,681,854)	($9,793,102,199)	($5,826,521,720)
Scenario 2: Modisette	$217,450,525,058	$137,685,544,352	$59,637,794,107	$63,408,392,207
Scenario 3: Mustang	$216,462,783,818	$137,003,149,768	$59,342,424,639	$63,063,548,449

Tables 4 and 5 show the results of our analysis when we use the production forecasts from the Alaska Department of Natural Resources instead of the Department of Energy. As shown in Table 4, when we used the DNR forecasts and a 10 percent discount rate, we observe an even greater amount of foregone revenue if no investment is made in the pipeline. This is primarily due to the fact that the DNR forecasts predict that the TAPS throughput will fall below 500,000 b/d six years earlier than the DOE forecasts. Using the DNR estimates instead of the DOE estimates results in 1.8 billion fewer barrels of oil being produced and $81 billion less total revenue in the No Investment Scenario. In contrast, the DOE and DNR estimates differ much less in their estimates for the amount of oil that would be stranded if no investment were made in the pipeline. According to the DOE estimates, 2.4 to 2.7 billion barrels of oil would be stranded on the North Slope if no investment were made in the pipeline, while the DNR estimates that 2.2 to 2.5 billion barrels of oil would be stranded.

Table 4
Present Values of Alternative Investment Scenarios - Alaska Department of Natural Resources Forecasts, 10 Percent Discount Rate

	Total Revenue	Pre-Tax, Pre-Royalty Profit	After-Tax Profit	Revenue to State
Scenario 1: No Investment	$131,326,415,958	$84,795,607,040	$35,367,117,060	$39,871,487,351
Loss (compared with Modisette)	($75,339,135,879)	($45,836,945,844)	($20,952,320,350)	($20,547,862,492)
Loss (compared with Mustang)	($70,859,831,398)	($43,080,202,647)	($19,904,742,674)	($19,073,470,656)
Scenario 2: Modisette	$206,665,551,836	$130,632,552,885	$56,319,437,410	$60,419,349,844
Scenario 3: Mustang	$202,186,247,356	$127,875,809,688	$55,271,859,734	$58,944,958,007

Table 5 shows the results of our analysis when we use the DNR forecasts and a 12.5 percent discount rate. Although the present values in Table 5 are lower than those in Table 4, we still observe that the TAPS owners stand to lose even more in revenue and profits by not making an investment to extend the life of the pipeline when we use the DNR forecasts instead of the DOE forecasts. Likewise, the State of Alaska would stand to lose even more in royalty and tax revenue according to the DNR forecasts.

Table 5
Present Values of Alternative Investment Scenarios - Alaska Department of Natural Resources Forecasts, 12.5 Percent Discount Rate

	Total Revenue	Pre-Tax, Pre-Royalty Profit	After-Tax Profit	Revenue to State
Scenario 1: No Investment	$120,495,005,277	$77,879,466,043	$32,500,981,107	$36,595,686,527
Loss (compared with Modisette)	($53,807,301,321)	($32,737,304,686)	($15,730,157,453)	($13,982,730,429)
Loss (compared with Mustang)	($51,378,173,104)	($31,207,940,563)	($15,127,565,228)	($13,183,375,783)
Scenario 2: Modisette	$174,302,306,598	$110,616,770,729	$48,231,138,560	$50,578,416,956
Scenario 3: Mustang	$171,873,178,380	$109,087,406,606	$47,628,546,335	$49,779,062,310

Conclusion

In contrast to the “sky is falling claims” by certain groups and individuals, the TAPS is not in danger of being shut down in the immediate future without opening up new areas to drilling or a reduction to Alaska’s production tax as long as modest investments are made to reduce the minimum throughput on the pipeline. Minimum throughput can be reduced by making a moderate investment in the pipeline which would pay substantial dividends to the pipeline owners as well as the State of Alaska. Indeed, our analysis shows that the TAPS owners would lose money by not making such investments. This is because, without reducing the TAPS minimum throughput, billions of barrels of oil would be stranded on the North Slope.

An investment of only $500 million or so will allow an additional 20 years of production from existing reserves totaling over 2 billion barrels on the North Slope without requiring opening of new areas for exploration and production and would contribute upwards of $12 billion in additional tax and royalty revenue as well. Therefore, opening up new areas of production is unnecessary in order to prevent a shutdown of TAPS in the near term.