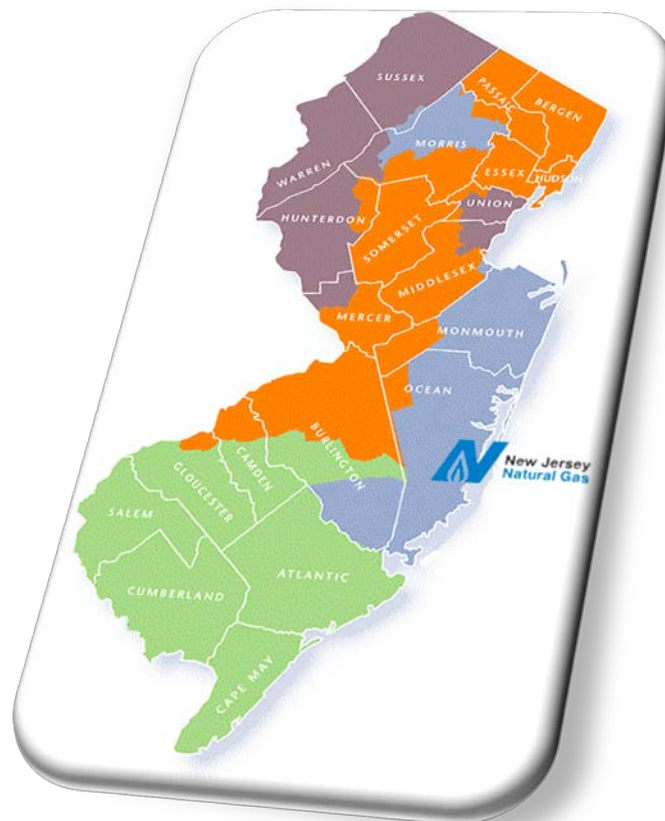


Analysis of the Southern Reliability Link as a Response to Single Point of Failure Concern



Author: Greg Lander

For

The Pinelands Preservation Alliance



www.skippingstone.com

July 2017

About Skipping Stone

Skipping Stone is an energy markets consulting firm that helps clients navigate market changes, capitalize on opportunities and manage business risks. Our services include market assessment, strategy development, strategy implementation, managed business services and talent management. Market sector focus areas are natural gas and power markets, renewable energy, demand response, energy technology and energy management. Skipping Stone's model of deploying only energy industry veterans has delivered measurable bottom-line results for over 270 clients globally.

Skipping Stone operates Capacity Center which is a proprietary technology platform and data center that is the only all-in-one Capacity Release and Operational Notice information source synced with the Interstate pipeline system. Our database not only collects the data as it occurs, it is a storehouse of historical Capacity Release transactions since 1994. We also track shipper entity status and the pipeline receipt and/or delivery points, flows and capacity. Our analysts and consultants have years of experience working in natural gas markets. Capacity Center has worked with over a hundred clients on a wide variety of natural gas market and pipeline related reports and projects.

Headquartered in Boston, the firm has offices in Atlanta, Houston, Los Angeles, Tokyo and London. For more information, visit www.SkippingStone.com.

###

Warranties and Representations. Skipping Stone endeavors to provide information and projections consistent with standard practices in a professional manner. SKIPPING STONE MAKES NO WARRANTIES HOWEVER, EXPRESS OR IMPLIED (INCLUDING WITHOUT LIMITATION ANY WARRANTIES OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AS TO THIS MATERIAL. Specifically, but without limitation, Skipping Stone makes no warranty or guarantee regarding the accuracy of any forecasts, estimates or analyses, or that such work products will be accepted by any legal or regulatory body.

Waivers. Those viewing this Material hereby waive any claim at any time, whether now or in the future, against Skipping Stone, its officers, directors, employees or agents arising out of or in connection with this Material. In no event whatsoever shall Skipping Stone, its officers, directors, employees, or agents be liable to those viewing this Material.

Disclaimer. "This report was prepared as work sponsored by Pinelands Preservation Alliance. Neither the Pinelands Preservation Alliance nor any agency or affiliate thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer or otherwise does not necessarily constitute or imply its endorsement, recommendation or favoring by the Pinelands Preservation Alliance or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the Pinelands Preservation Alliance or any agency or affiliate thereof."

Contents

Executive Summary	5
Abstract	5
Background on SRL	5
Reliability Analysis	5
Zero risk of disruption on TETCO mainline	6
TETCO mainline has become highly reliable	6
Alternative provides zero risk of disruption at any TETCO point	6
Introduction.....	8
Background.....	8
Prior Skipping Stone Report Conclusions	9
BPU Standard of Decision	9
Pertinent Facts Relating to Assessing Single Point of Failure as it Relates to TETCO Service to NJNG	10
Historic TETCO System Flow Configuration	10
Implications of Historical TETCO Flow Pattern on Single Point of Failure Impacting NJNG Area	12
The TETCO Flow Pattern Since the Shale Revolution	12
Identifying Potential “Single Points of Failure” of the TETCO System vis a vis the NJNG Area.....	14
TETCO Contracts with Customers Define TETCO Service Obligations.....	14
Impact on NJNG of a TETCO Area “A” Disruption	16
Disruption to the TETCO system in Area “B” Discussion	16
Discussion of Locale of Potential Disruption Potentially Meeting Single Point of Failure Standard.....	18
Disruption of the Freehold Lateral Presents a Potential Single Point of Failure	19
Addressing the Potential Single Point of Failure Risk.....	19
The Alternative Single Point of Failure Redundancy Solution a.k.a. the Freehold Back-Up Reliability Solution	19
Scenario 1	20
Scenario 2	21
Transco Supplies to the NJNG Area Can Supplement the Alternative Freehold Back-Up Reliability Solution....	21
Additional Likely Mitigation Measures Available to NJNG in the Event of the Single Point of Failure Risk involving the Freehold Lateral	22
The Level of Interruptible Electric Generation Demand Able to Contribute to Mitigating a Single Point of Failure Event.....	22
Comparative Cost of Alternative Freehold Back-Up Reliability Solution and SRL.....	23

Comparison of the SRL Solution to a Single Point of Failure along the Freehold Lateral 23

Answering the Question: “What magnitude of disruption of TETCO would necessitate a facility of the magnitude of the SRL in order to address the failure of such magnitude?” 24

Joint Base Load and Relevancy of SRL to Joint Base Service Reliability 24

Conclusion: 25

Executive Summary

Abstract

In this report, Skipping Stone analyzes the justification for the Southern Reliability Link (SRL) provided by the New Jersey Board of Public Utilities, namely a need for reliability in the event of a disruption of the Texas Eastern Transmission Company (“TETCO”) pipeline, the primary pipeline supplying gas to NJNG’s network. Our analysis shows that SRL is not an effective or reasonable response to a single point of failure scenario and that a less costly and less disruptive alternative exists to address a possible interruption on TETCO. The analysis also shows that SRL does not, in fact, provide an adequate remedy, and would leave NJNG with 66% of its requirements unmet.

This analysis demonstrates that there is only one genuine, though remote, Single Point of Failure scenario for the TETCO supply to NJNG’s system, based on a failure along a recently built 12-mile lateral line. Skipping Stone was unable to construct any scenario involving a major disruption of the TETCO mainline at a single point for which a facility of the magnitude of SRL would be an efficacious, reasonable or cost-effective response.

To address the only genuine risk on the TETCO system, Skipping Stone identified a viable alternative to SRL that would cost less than 20% of the cost of SRL and pose minimal local impacts, without traversing the protected region of the Pinelands. This analysis concludes that SRL is an unneeded and flawed project.

The documents in the Board of Public Utilities (BPU) proceeding on SRL include no analysis of SRL’s ability to mitigate the risk of disruption should a failure occur on TETCO. In the event of a failure at the only point on the entire TETCO system that would pose a serious risk to NJNG, SRL provides a poor solution, as it would still leave NJNG with 66% of its requirements unmet. In contrast, the alternative recommended in this report would enable NJNG to meet 100% of its requirements at 20% of the cost.

BPU did not even consider, and NJNG did not analyze, alternative means of addressing this specific, if highly remote, failure scenario.

Background on SRL

The Southern Reliability Link (SRL) is a 30-mile natural gas pipeline, proposed by New Jersey Natural Gas (NJNG) that would cost more than \$178 million to construct. NJNG promotes it as a second pipeline feeding the southern end of its territory that would enhance the reliability of the service provided to customers.

The project was approved by the New Jersey BPU in 2017 based on the stated rationale that it would provide greater reliability to NJNG’s customers in the event of a major interruption on TETCO, the primary pipeline supplying gas to NJNG’s network. In its approval, BPU explained that SRL would address the situation in which a major failure on TETCO, at a single point, would make NJNG unable to get a majority of its supplies from TETCO. If built, SRL would enable NJNG to get a portion of that supply at a new interconnection with Transco, a pipeline that is already a second source for NJNG.

BPU’s approvals of SRL relied entirely on the premise that SRL is reasonably necessary to serve the public because it would avoid major disruptions due to a Single Point of Failure in the TETCO supply to NJNG.

Reliability Analysis

Neither NJNG nor the Board of Public Utilities provided details or an analysis of the hypothetical single point of failure that could plausibly occur and result in NJNG becoming unable to get a majority of its supplies from TETCO.

Skipping Stone was asked to 1) determine whether there exists a specific single point of failure that could produce such consequences and 2) to evaluate whether SRL is a reasonable response to such a risk.

Zero risk of disruption on TETCO mainline

There is no point along the TETCO mainline pipeline system, 9,096 miles long, that would meet the risk of a 50% or greater supply loss, which is BPU's definition of what constitutes a disruption. In the event of a complete failure at any point along the TETCO mainline, Skipping Stone's analysis showed that NJNG would still be able to receive between 96% and 100% of its contracted supplies because of the high level of reliability that already exists in the TETCO supply system due to its bidirectional flow characteristics near the NJNG interconnect with TETCO.

Analysis of the worst-case failure of the TETCO mainline, the complete loss of one TETCO pipeline to the southwest of its connection to NJNG's network, found that re-routing supplies and taking advantage of underutilized capacity would replace all disrupted capacity. With the loss of a pipeline, NJNG would continue to receive 96% of its contracted amount on TETCO. In addition, underutilized capacity on the Transco system could supply at least 0.138 Bcfd of additional capacity to NJNG, an amount far in excess of the 0.023 Bcfd lost by the failure. The BPU's findings regarding NJNG's available capacity on Transco supports this conclusion.

TETCO mainline has become highly reliable

Historically, TETCO's supply sources were located in Texas and the Gulf Coast and brought to the Northeast throughout the year. This analysis shows that the historic pattern has changed and that TETCO is no longer a uni-directional system that previously would have been vulnerable to a major disruption. Almost two-thirds of peak supplies now enter the system near the NJNG service area, coming from new shale gas sources in Pennsylvania. Analysis of recent pipeline flow data that covers three peak winter seasons, shows that TETCO has become a bi-directional pipeline that, with respect to NJNG's interconnect location, now flows to the northeast during peak periods and to the southwest for much of the year.

The result of a bi-directional pipeline, in a region well supplied by other interstate pipelines, is that the system itself has become highly reliable, and can compensate for major disruptions with no loss of service.

Alternative provides zero risk of disruption at any TETCO point

Skipping Stone found only one section of the entire TETCO network across which a major failure would substantially disrupt supplies to NJNG: a 12-mile stretch known as the Freehold Lateral. While a failure in the Freehold Lateral has the potential to disrupt a majority of NJNG supplies, SRL is not a solution, because it would not provide sufficient replacement volume to NJNG and is both far more costly and disruptive than the alternative, right-sized solution identified here.

The Freehold Lateral connects the TETCO mainline to the NJNG service area. A failure along this stretch is unlikely, as this section was constructed only 15 years ago. Nevertheless, we examined options to mitigate a failure in the Freehold Lateral and identified an alternative approach that we named the Freehold Backup. The potential for disruption using the Freehold Backup alternative is near zero percent. The possible supply loss level for this alternative is well below the 50% level set by the BPU as justification for the SRL.

The Freehold Backup alternative relies on re-routing through Transco, the second major pipeline system serving NJNG. This analysis shows that the combination of providing a new 5-mile backup pipe together with re-routing to use existing pipeline capacity could provide sufficient flexibility to meet all NJNG contracted supply in the event of failure. If, however, existing TETCO-Transco interconnects are insufficient to satisfy 100% of contracted

amounts, NJNG could access additional supplies directly from Transco. Additional deliveries at the existing Transco-NJNG interconnects would fully eliminate any potential shortfall that would occur in re-routing supplies. Our analysis shows that at least 0.138 Bcfd of additional capacity can be obtained from Transco. Actual pipeline flow data from the winter of 2016 shows that NJNG was able to receive supplies from Transco far in excess of its existing contracts. This flow data demonstrates that NJNG can receive at least 0.138 Bcfd of gas supplies from Transco, as it did in the winter of 2016.

The proposed alternative Freehold Backup would require a new 5.4 mile, 24" pipeline, co-located near the existing Freehold Lateral and two new interconnects that would enable the Transco system to provide supplies into the NJNG system.

There is no evidence in the public record that BPU evaluated the operations of the TETCO pipeline system or considered any alternatives to SRL. It appears that BPU misunderstood the way the TETCO supply actually functions. Had the BPU understood the bi-directional nature of the TETCO mainline supply, it would have found that SRL is neither financially prudent nor the least disruptive means of addressing the risk of gas supply interruption. This analysis demonstrates that an alternative to SRL exists which is far less expensive, has a reduced impact on affected communities, and completely avoids the preserved Pinelands area.

With the cost of building SRL at nearly \$180 million, the Freehold Backup alternative at about \$26 to \$28 million is vastly less expensive and would save NJNG ratepayers more than \$150 million in construction costs.

Skipping Stone evaluated every scenario involving failures of the Freehold Lateral at various locations and concludes that for every scenario, the new Freehold Backup could satisfy 100% of NJNG's peak requirement of 0.57 Bcfd.

Introduction

In this Report, entitled: “Analysis of Southern Reliability Link as a Response to Single Point of Failure Concern,” Skipping Stone was asked by the Pinelands Preservation Alliance (“PPA”) to review documents and publicly available information to ascertain all of the following:

- 1) What, if any, single point of failure impacting the New Jersey Natural Gas Company (“NJNG”) would necessitate the creation of the Southern Reliability Link (“SRL”) to address the circumstance(s) of a single point of failure as characterized by the New Jersey Board of Public Utilities (“BPU”) as justification in its Order approving the SRL?
- 2) What failures of line or compression with respect to the major interstate pipeline (i.e., Texas Eastern Transmission Company - “TETCO”) serving NJNG could occur that would (or could) affect NJNG’s ability to get a majority (i.e., 50% or greater) of its supplies from TETCO?
- 3) What magnitude of disruption of TETCO would necessitate a facility on the scale of the SRL in order to address said failure?
- 4) Identify a worst case but possible failure of TETCO, and where such failure would have to occur to make the SRL facility a required facility to maintain gas service.
- 5) What alternative(s) (i.e., an “Alternative Single Point of Failure Redundancy Solution”) to the SRL back-up/redundancy facility could be built (if any) at less cost and/or environmental disruption to address such worst-case failure of a TETCO facility?
- 6) With regard to the natural gas load of the Joint Base:
 - a. What is the magnitude of the Joint Base gas demand and load? and finally,
 - b. Given this Joint Base load, is there any contribution to reliability of service for that load that can only be addressed by the SRL and not by any other Alternative Single Point of Failure Redundancy Solution?

Background

The SRL proposal by NJNG was filed before the BPU in 2015.¹ In its proposal, NJNG stated that the SRL was not intended to serve new load, but rather was intended to provide additional reliability of service to its service areas on the southern end of its service territory.

During the post-hearing briefing stage of that proceeding, the PPA asked Skipping Stone to review filings in that proceeding and determine: 1) what if any failure of NJNG’s backbone mainline system serving the coastal region of NJNG might be susceptible to disruption from a natural disaster; 2) what added resiliency the SRL might provide to those areas if built; and, 3) what alternatives to the building of the SRL might address such disruptions.

Skipping Stone has reviewed its earlier report memorandum and continues to support its conclusions drawn in that report.

¹ Initial NJNG BPU filing was April 2, 2015 and the Amended filing was on June 5, 2015

Prior Skipping Stone Report Conclusions

In this earlier report Skipping Stone concluded:

- 1) that the NJNG system north of the commencement of its single line system serving its southernmost areas was sufficiently resilient that it could continue to support service in the south without the addition of the SRL;
- 2) that the closest backbone line to the coast was adjacent to the Garden State Parkway (4.3 miles inland at its closest and buried below ground by at least 4 feet²); and
- 3) that no segment of its northern most system posed a reasonably discernible “single point of failure risk” to maintaining service to its southernmost service area.

Procedurally, PPA was not granted full intervenor status by the BPU and thus, while the PPA submitted the memorandum, the BPU appears to have relied on PPA’s lack of the technical intervenor status in that proceeding to not consider the memorandum evidence in its Order.

BPU Standard of Decision

The BPU, after looking at all the evidence admitted into the proceeding, decided to approve the SRL, resting the weight of its decision on its finding that the SRL would enable NJNG to mitigate a service disruption resulting from a single point of failure³ on the TETCO supply pipeline. The BPU defined a ‘failure’ as one involving a 50% loss of supply to NJNG.⁴

In its analysis for this report, Skipping Stone refers to and utilizes this BPU established standard for justification of the SRL when Skipping Stone examined alternatives to avoid the consequences to NJNG and its customers from experiencing a “Single Point of Failure” (i.e., the 50% reduction in supply from TETCO to NJNG).

With respect to the “need” for the SRL, the BPU cited NJNG’s representations that “The Project is exclusively a reliability project, meant to provide an alternate interstate transmission feed for customers, and is not designed to service new or additional load. Exhibit P-1A 9:2-4.”⁵

The BPU also stated that TETCO currently provides 85% of NJNG’s peak day natural gas requirements.⁶

² In addition, Skipping Stone determined that the type of natural disaster sufficient to disrupt such a facility would have wiped out the service area (and thereby eliminated the load of the service area) that such NJNG facility would otherwise serve. In short, as detailed in the memorandum “one has to envision an event of weather sufficiently violent to the point of causing failure of a pipeline lying 4.3 miles inland and which, at that inland location, rests 4-6 feet underground. In this regard, were this to occur, the more southerly coastal demand that NJNG serves with this one of three north-to-south lines would largely be decimated if not permanently destroyed from an event able to disturb the noted segment to the point of failure.

³ The BPU states in its Order “The current TETCO interconnection, at the northern end of NJNG’s transmission system servicing the Counties, essentially equates to a single point of failure.”

⁴ At page 13 of the March 16, 2016 Order the BPU states: “In the event of a fifty (50) percent reduction of supply from TETCO, which exceeds the capacity provided by a twenty-four (24) inch pipeline, the design of SRL [a 30” line] would ensure transmission system integrity.”

⁵ Exhibit P-1A 9:2-4. Refers to the testimony of Mr. Lynch of NJNG.

⁶ In the Order the BPU states as to Mr. Lynch (of NJNG)’s Testimony: “TETCO deliveries to NJNG’s city gate in Middlesex County comprise over eighty-five (85) percent of the winter season peak day gas supply and, because of this, customers at

Pertinent Facts Relating to Assessing Single Point of Failure as it Relates to TETCO Service to NJNG

To assess the SRL “solution” to the problem statement as framed by the BPU with respect to the 6 questions outlined above, it is important to first understand:

- 1) The physical configuration of the TETCO system,
- 2) Its historic flow patterns (i.e., pre-shale revolution), and,
- 3) Its flow patterns in existence today and prior to NJNG’s proposal for the SRL in 2015.

Historic TETCO System Flow Configuration

Historically TETCO’s predominant supply sources were in Texas and the Gulf Coast and its flow was predominantly from Texas and the Gulf Coast to the Northeast. In addition, TETCO had and continues to have substantial storage assets in Southwestern Pennsylvania that also historically flowed gas to the Northeast during winter periods. We define the area of interest in this report as the “NJNG Area.” The NJNG Area subject to analysis in this report takes supplies from the TETCO pipeline to serve its customers in Somerset, Middlesex, Monmouth, and Ocean Counties. NJNG’s service territory resides at the very northern end of the TETCO system, which terminates in New York City, and is connected beyond to pipelines taking gas to customers in the Northeast and New England.

Thus, historically, from the perspective of the pertinent NJNG Area, everything west and south of where this area received gas from TETCO was considered upstream or towards the origin of flow. Further, from the TETCO storage fields in Southwest PA to TETCO’s terminus in New York City, TETCO historically was a uni-directional flow system with a distinctive and predominant upstream to downstream flow pattern that relied on supplies coming from the west and south to reach their load centers.

The map that follows shows TETCO, the other interstate pipelines, the contiguous NJNG service territory (the “NJNG Area”), and the proposed route of the SRL.

the southern end of the NJNG system in Ocean, Burlington, and southern Monmouth Counties are particularly vulnerable to a supply interruption or system failure in the interstate pipelines, the gate station, or NJNG’s upstream transmission backbone system. Exhibit P-1A 8:7-16.”

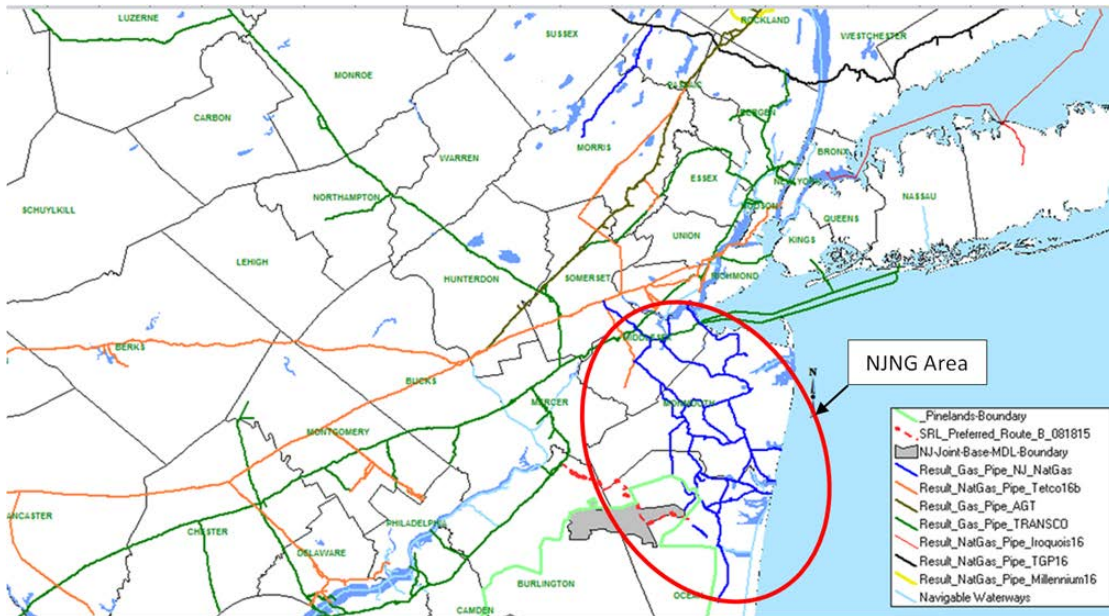


Figure 1 – Interstate Pipelines, the NJNG Area and the proposed SRL (Sources: Platts, Pinelands Commission, Skipping Stone)

Below is a TETCO Zone 3 map of the PA, NJ and NY portion of its system⁷ with arrows placed on it showing the historic (i.e., pre-shale revolution) gas flow pattern of TETCO (green arrows) and the NJNG Area (red circle).

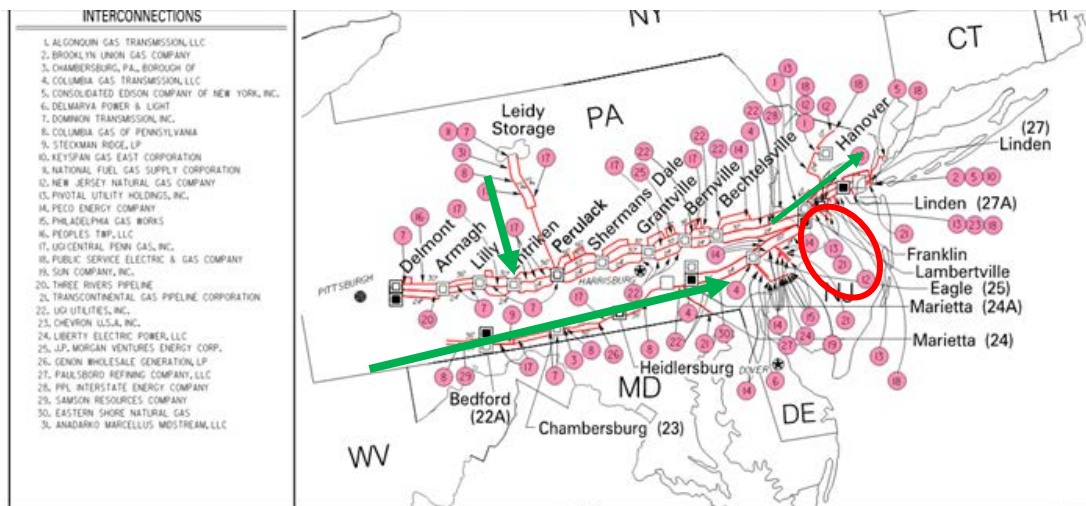


Figure 2 – TETCO Historical Uni-Directional Flow Pattern (Sources: TETCO Tariff, Skipping Stone)

As can be seen by the pre-shale stick figure additions above; all the gas that was delivered by TETCO to the NJNG Area in the winter had to come into the NJNG Area from areas to the south and west of the NJNG Area.

As will be described shortly, the discovery of large deposits of “shale” natural gas in the states of PA and OH has created a new, more diverse flow of gas to the NJNG Area as great volumes of this gas are transported across NY state and then down to the NJ-NY metropolis from pipelines delivering to TETCO in the area just to the north of the NJNG Area.

⁷ PA, NJ and NY comprise the furthest northern extent of its system which extends no further north or east.

Implications of Historical TETCO Flow Pattern on Single Point of Failure Impacting NJNG Area

With the older flow pattern, a major disruption of the TETCO system almost anywhere between the TETCO storage fields in SW PA and the NJNG Area could have reliability implications for the NJNG Area as well as any customers downstream of the major disruption location. Likewise, a disruption of the TETCO system to the northeast of the NJNG Area would not have had a reliability concern for the NJNG Area.

In summary, upstream disruptions on a long line, uni-directional flow system could have reliability implications while downstream disruptions would likely not.

The TETCO Flow Pattern Since the Shale Revolution

With the large-scale exploitation of shale gas, the pattern of gas flows in the TETCO system fundamentally changed in the NJNG Area. The new flow pattern is bi-directional and provides substantial new reliability to the system and greatly reduces the impact of a possible Single Point of Failure in the gas supply from the TETCO Mainline to NJNG.

This analysis evaluates current flow patterns on TETCO at the NJNG Area and beyond to the North and East, to the end of the line. As discussed above, the NJNG Area is those portions of Somerset, Middlesex, Monmouth and Ocean Counties where NJNG receives supplies from its pipelines and/or serves its load with such supplies (the red circle on the maps). In addition, as used in the chart below and in this report, we define the “Greater NJNG Area” as receipt and delivery points in the NJNG Area, as well as all receipt and delivery points to the North and East, up to and including the TETCO termini in NY and NJ⁸.

Following is a chart of gas flows for the Greater NJNG Area since January 2015. It is important to note that the first months of 2015 were colder overall than the first months of 2014, known as the Polar Vortex cold spell. In Chart 1, the blue line shows all the receipts of supply into TETCO from North and East of the NJNG Area. This supply can be available to serve customers to the north and east, or can flow south and west to serve the NJNG Area.

The green line on the chart illustrates that the gas being delivered by TETCO to the Greater NJNG Area is up to 3 billion cubic feet per day (Bcfd) during peak periods. During periods of high demand, there are net gas flows from the southwest to the northeast. During periods of low demand, gas flows from the north east to the south and west. The redline shows net flow direction of TETCO gas relative to the Greater NJNG Area – that is net flow **from** the south and west (positive values) or **to** the south and west (negative values).

The blue line is relatively steady because the blue line represents flow into TETCO that comes from producing areas where producers tend to flow constant quantities in an effort to get their gas to market. When the blue line occasionally dips it can be a result of maintenance on the lines connecting to TETCO or producers choosing to flow to other markets based upon price.

⁸ The receipt and delivery points to the North and East of the NJNG Area are those that were historically adjacent to and “downstream” of the NJNG Area.

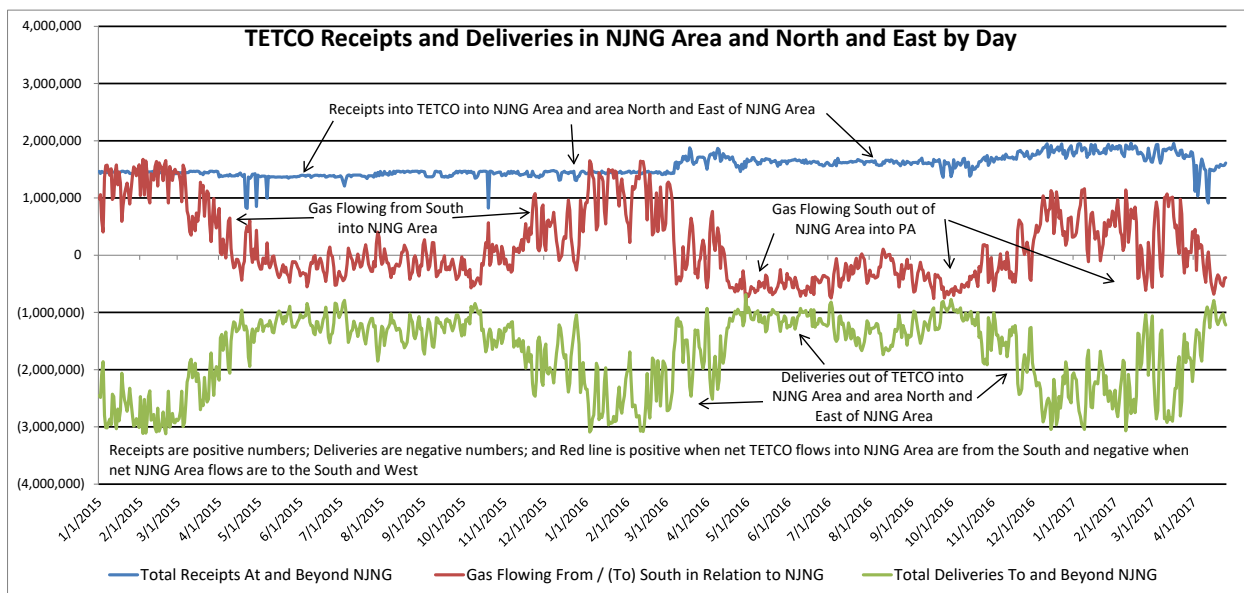


Chart 1: Receipts, Deliveries, and Net Flows Relative to NJNG Area Since Jan 2015 (Source: TETCO Flow Data, Skipping Stone)

As noted above, this chart’s green line shows deliveries out of TETCO into the NJNG Area and those locations further to the north and east of the NJNG Area (i.e., the Greater NJNG Area).

The chart’s red line is the summation of the green and blue lines, and shows net flow directions (i.e., **to** or **from** the south and west) relative to the Greater NJNG Area.

When the red line is above the zero horizontal axis, net flows are into the Greater NJNG Area and are composed of flows both from the south and west and from the northern shale supply. Likewise, when the red line is below the zero horizontal axis, net flows are out of the Greater NJNG Area and are to the south and west (e.g., for delivery to Philly).

During peak winter months, when total supplies delivered to the Greater NJNG Area reaches more than 3 billion cubic feet per day, nearly 2 billion now comes into TETCO from the North and East. Specifically, supplies flow into TETCO in the NJ counties of Bergen and Morris, and the NY county of Rockland.

This northeasterly component of supply into TETCO comes from pipelines located in what used to be downstream of the NJNG Area (i.e., the area to the North and East of the NJNG Area). So much flow into TETCO is coming in at the far northern end of TETCO that, for much of the year gas flows south past the NJNG Area towards Philadelphia.

Flow patterns from the most recent 28-month period, which covers three winter or peak periods, show that the flow on TETCO has fundamentally changed and the pipeline is now a bidirectional system. The NJNG Area is no longer at the tail-end of the TETCO system. The data show that deliveries out of TETCO to the NJNG Area may arrive from either of two directions. In addition, the new flow pattern allows the traditional supplies from the south and west to be redirected to other uses.

Identifying Potential “Single Points of Failure” of the TETCO System vis a vis the NJNG Area⁹

Below is a map of the pipelines serving the NJNG Area which has two red letters superimposed to indicate areas of the TETCO system that, *when the TETCO System was uni-directional*, were upstream of the NJNG Area (Area “A”) or downstream of the NJNG Area (Area “B”).



Figure 3: Map of Interstate Pipelines and TETCO System showing sections historically upstream and downstream of NJNG Area (Sources: Platts, Skipping Stone)

TETCO Contracts with Customers Define TETCO Service Obligations

While the recent and current pattern of gas flows identified above in Chart 1 are important, TETCO’s Firm contract obligations are also important and define what capacity service TETCO is required to provide. As of January 2017, TETCO had requirements to be able to deliver to points in NJ and NY 4.8 Bcfd. Of that 4.8 Bcfd, **0.84 Bcfd** is contracted to be **received** at the far northern end of its system, at point SS (See Figure 4), indicating the new “Shale Supply.” The Shale Supply is delivered to points in New Jersey between SS and the NJNG Area. This leaves 3.96 Bcfd that, by contract, TETCO can be required to deliver into NJ and NY from the south.¹⁰

⁹ Notably, neither NJNG nor the BPU identified or sought to quantify any possible location(s) of any Single Point of Failure, nor any attendant magnitude, probability, nor mitigation approaches. From all the documents and supplemental material in the BPU proceeding Skipping Stone found no analysis by either NJNG or the BPU remotely similar to that undertaken in this report.

¹⁰ All figures are taken from the TETCO Index of Customers filings with the FERC which pipelines are required to file quarterly and which present all the firm contractual entitlements they have with their customers including the location names at which such entitlements exist. Matching those location names with the FERC required postings of locations and their respective state and county designations enabled this analysis to be performed.

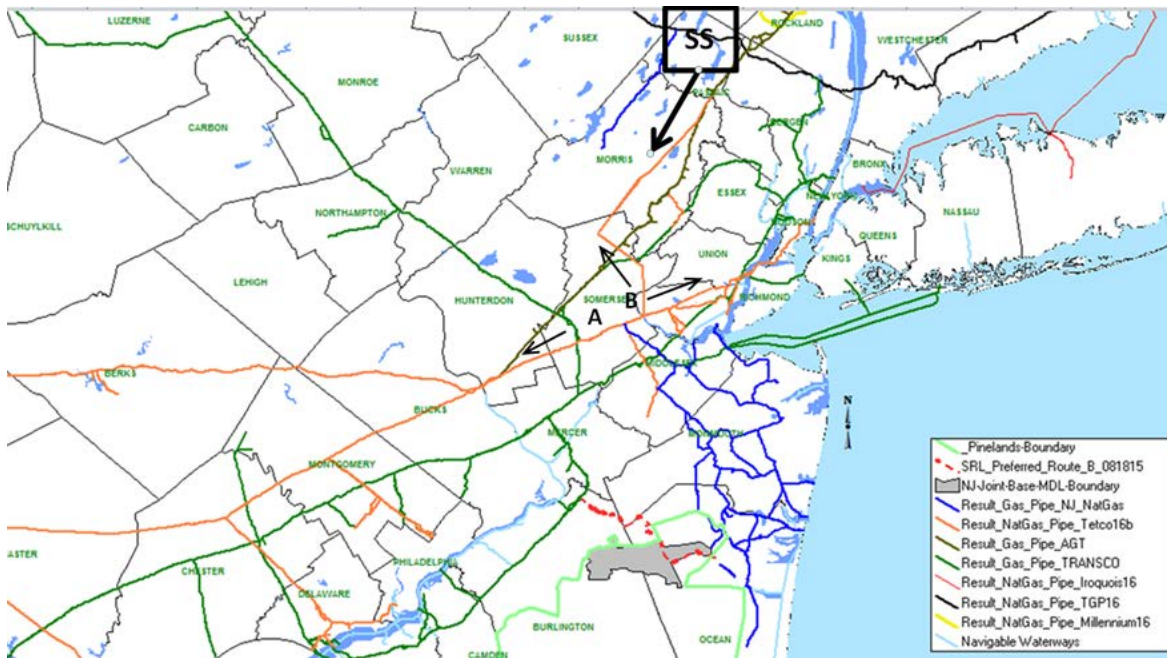


Figure 4: Map of Interstate Pipelines and TETCO System showing where new Shale Supply (“SS”) enters TETCO in relation to sections historically upstream (“A”) and downstream (“B”) of NJNG Area (Sources: Platts, Skipping Stone)

Looking at TETCO capacity from this “obligation” vantage point, it is noteworthy that while not shown on mapping software as independent lines, there are three separate TETCO lines in their right of way running south to north (i.e., from and past the “A” area) that carry this 3.96 Bcf/d, or about 1.32 Bcf/d on each line. If one such line from the south were to be interrupted (i.e., a disruption in the “A” Area) where would TETCO get the gas needed to meet that 1.32 Bcf/d of maximum firm demand which could be required on a peak day?

One option would involve bringing additional supplies from the north and east. In emergencies, gas can be redirected on the interconnected system, as long as the volume is within the physical constraints of the system. Actual data of historical delivered capacity provides an accurate depiction of minimum capacity that could flow if needed.

As noted above, TETCO already has firm obligations to receive 0.84 Bcf/d in the north that flows to the south and west. The key question is whether there is additional physical capacity that is not currently under firm contract that could be used. Recently measured flow data, as shown in Chart 1, indicates that TETCO has, in fact, received at least 2.0 Bcf/d in the north. After meeting the existing obligation of 0.84 Bcf/d, there remains about 1.16 Bcf/d of evidenced capability that could be used to fill the 1.32 Bcf/d of potential peak day demand shortfall.

If a disruption were to occur on the very coldest of days, there could be a shortage of up to 0.16 Bcf/d. The original firm demand for 1.32 Bcf/d from the south for the affected pipeline would largely be met. (i.e., 1.32 Bcf/d minus 1.16 Bcf/d or 0.16 Bcf/d)¹¹. Under pipeline allocation rules in cases of Force Majeure, this 0.16 Bcf/d of

¹¹ Under Federal Energy Commission regulations, pipelines are required to provide firm customers (situated in a zone) firm access to all receipt (i.e., supply) and delivery (i.e., market) points in that zone; at a priority of service one level down from primary (i.e., secondary) and above every other priority of service in that zone. Thus, NJNG to serve their load in the event of a disruption in the “A” Area has superior access to supply once the 0.84 have been served to the extent of their requests.

potentially remaining demand unserved (if requested), would be pro-rated among all parties in the affected area. In short, no one customer absorbs all of the shortfall. Thus, when the 0.16 Bcfd is allocated over the 3.96 Bcfd of obligations from the south on three pipelines, this means that each customer would be entitled to get 96% of their peak entitlement (i.e., 0.16 divided by 3.96 or 4%; which when subtracted from 100% yields 96%).

Impact on NJNG of a TETCO Area “A” Disruption

For NJNG, its peak TETCO entitlement into the NJNG Area (i.e., excluding the “lateral only” contract¹² and excluding the NJNG properties in Morris County) is 0.57 Bcfd. For a TETCO Area A disruption, this means that if every other customer were simultaneously taking their maximum entitlement (an unlikely but possible situation) NJNG would receive 96% of 0.57 Bcfd (or 0.547 Bcfd) or 23,000 Dth less than contracted with TETCO to serve the NJNG Area. This 23,000 Dthd or 0.023 Bcfd of potential shortfall is far less than the 70,000 Dthd available from NJNG’s Howell LNG plant and about equal to the 20,000 Dthd available from its Stafford LNG plant.¹³ On-system supplemental supplies could fill in the gap during even peak periods.

Notably this failure of an entire line (not a reduction in compression, but an entire line) would not constitute a 50% reduction for NJNG and would not be considered a “Single Point of Failure” using the BPU’s definition developed in its Standard of Decision.

Such a disruption in Area “A” would not constitute a “Single Point of Failure” because in its Zone 3 region, between the SW PA storage fields and its terminus, TETCO is no longer a uni-directional pipeline. It is more like a large pressure vessel with receipts and deliveries across its Zone 3 extent. And as was evidenced in the Chart 1 (the current flow pattern chart), gas routinely flows both into the NJNG Area from the north and flows to the south past the NJNG Area, as well as flowing from the south to and past the NJNG Area.

Moreover, as addressed in detail in the section concerning a hypothetical disruption of a portion of the Freehold Lateral, this potential 0.023 Bcfd shortfall (i.e., the 4% shortfall) can be addressed by simply taking more gas from the other pipelines with which NJNG has contracts to serve the NJNG Area (e.g., Transcontinental Gas Pipeline (“Transco”).

Disruption to the TETCO system in Area “B” Discussion

As presented in the preceding Figures 3 and 4 with Areas “A” and Area “B” identified, should there be a disruption at or downstream (i.e., north and east) of “B” **it would not impact the NJNG Area**. There are two reasons for this.

First, the NJNG contracts with TETCO for the NJNG Area *do not require* NJNG to receive gas from the north; although, under Federal rules, as noted above, NJNG is permitted (and TETCO is required) to provide such access. The result is that NJNG would receive its supplies from the south and west since NJNG has a firm contractual right with TETCO to provide service from the south and west.

¹² The “lateral only” contract is a contract to recover the cost of the Freehold Lateral which is discussed in detail below and which only connects from the TETCO mainline to the terminus of the lateral and does not give NJNG access to more supply from TETCO. Rather it is a way that NJNG gets its gas flowing under other contracts with TETCO from the mainline to the terminus of the lateral.

¹³ Note this potential shortfall could also be made up by NJNG with additional deliveries to its NJNG Area from Transco as discussed in more detail below

Second, should such a disruption occur, only those customers whose locations with TETCO are situated north and east of the NJNG Area would be impacted (because Area “B” is outside of the NJNG Area). In essence, for them such a disruption would be like NJNG having a disruption at or upstream of the “A” Area.

It is also important to realize that, just because flow directions and flow patterns have changed, this ***does not*** mean that any of the physical TETCO facilities have changed; in other words, what TETCO could historically pump from south to north (i.e., to and past NJNG) can again be pumped south to north in the event of need to receive gas from the south owing to a disruption downstream of the NJNG Area (i.e., in the “B” Area).

The conclusion that can be drawn from the analysis thus far regarding a disruption impacting the TETCO Mainline at either: 1) at or upstream of “A”, or, 2) at or downstream of “B” is that even with the potential loss of an entire TETCO line,¹⁴ there would be a *de minimis* impact on the NJNG Area, and neither disruption would constitute a Single Point of Failure using the BPU definition. This is because the persistent and prevailing flow patterns on TETCO have changed, and changed to the benefit of NJNG and NJNG Area reliability.

¹⁴ The most dramatic of potential losses because it removes an entire line from service, where a compressor failure may reduce flow (to the extent the compressor is being utilized) which it is noteworthy here because when operating in a “pressure vessel” state, pipelines generally require much less compression.

Discussion of Locale of Potential Disruption Potentially Meeting Single Point of Failure Standard

The next analysis will focus on the impact on the NJNG Area should there be a failure of line along what is known as the Freehold Lateral of TETCO which connects the TETCO Mainline to the NJNG system near Jamesburg Township, NJ.

In the map below, we focus our attention on the Freehold Lateral, a 12.4 miles long, 24" pipeline.

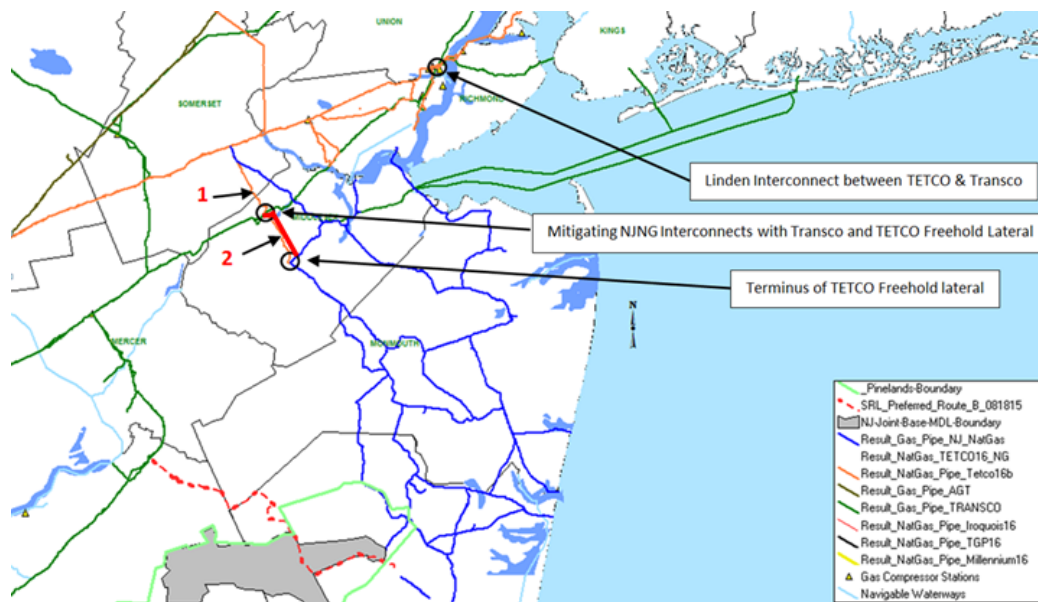


Figure 5: Map of Freehold Lateral serving the NJNG Area with Freehold Back-Up Reliability Solution showing as the redline in section labeled "2" (Sources: Platts, Skipping Stone)

The Freehold Lateral starts at the TETCO Mainline and runs 7 miles (the section marked with a red "1" on the map) to where it crosses the Transco Mainline (labeled with a circle and an arrow from a label called "Mitigating NJNG Interconnects with Transco and TETCO Freehold Lateral"). This terminology for this geographic location will be discussed below. From there, the Freehold Lateral continues another 5.4 miles (the section marked with a red "2" on the map) to its terminus where it delivers gas to NJNG in the NJNG Area.

The contracted capacity of the Lateral is posted in the TETCO Index of Customers as being 591,855 Dthd or ~0.592 Bcf/d.¹⁵ Paralleling the Freehold Lateral (from the TETCO Mainline to its terminus in the NJNG Area) is another TETCO line, a 10" line, which pre-dates the installation of the Freehold Lateral, which went into service in April 2008. The maximum capacity of the 10" line is nominally 55,000 Dthd. For this analysis, we assumed the 10" line is still in service or could be returned to service as part of the Alternative Single Point of Failure Redundancy Solution.

¹⁵ This 591,855 Dthd is the deliverability of the Lateral while there is only 570,525 Dthd of NJNG contracted capacity to the Freehold Lateral. The difference between these two quantities could be attributed to the use of line pack on the lateral enabled by the Franklin Compressor which is located at the "head" of the lateral.

Disruption of the Freehold Lateral Presents a Potential Single Point of Failure

With respect to identifying a “Single Point of Failure” that could reduce deliveries from TETCO to NJNG by 50% (as established by the BPU in its order), the 12.4 mile long Freehold Lateral is the only section of the entire TETCO system (a 9,096 Mile long system) that poses a Single Point of Failure risk to NJNG meeting the 50% disruption standard set by the BPU.

Notably, the Freehold Lateral is a 12.4 mile section of TETCO and is only 0.13% of the entire TETCO system, moreover, it is less than 15 years old.¹⁶

That said, if that line were to break, it could pose just the kind of “Single Point of Failure” established by the BPU as a risk to avoid. Given this risk, as established above, the BPU justified the building of the SRL. This raises the obvious question: Is the SRL, the least expensive, least disruptive means of addressing such a Single Point of Failure risk?

The short answer is “No.” The BPU did not consider, nor did NJNG analyze, alternative means of addressing this specific, if highly remote, failure scenario.

Addressing the Potential Single Point of Failure Risk

To address a possible failure of the Freehold Lateral, Skipping Stone analyzed the maps of the Lateral’s environs and established that there were two distinct possible failure scenarios needing to be evaluated.

The first would be a break along Section 1; with the second being a break along Section 2. We address both possible breaks with what we call the “Alternative Single Point of Failure Redundancy Solution or the “Freehold Back-Up Reliability Solution” for short.

The Alternative Single Point of Failure Redundancy Solution a.k.a. the Freehold Back-Up Reliability Solution

The “Freehold Back-Up Reliability Solution” (or FBURS) would be as follows:

- 1) NJNG to install 5.4 miles of 24” line from the location labeled “Mitigating NJNG Interconnects with Transco and TETCO Freehold Lateral” to the lateral’s terminus, thus effectively duplicating the TETCO Lateral’s function between the Transco mainline and the NJNG service area. This would extend the NJNG system to the Transco-TETCO Lateral crossing point. We refer to this new pipeline as the Freehold Back-Up Reliability Solution, and it is depicted on the map as the red line in the Section labeled “2.”
- 2) NJNG would install two new interconnects between the new line and its interconnecting interstate pipeline gas supply sources: one with TETCO on the Freehold Lateral at the location entitled “Mitigating NJNG Interconnects with Transco and TETCO Freehold Lateral” and the other with Transco at the same location.

¹⁶ A pipeline installed in the last 15 years is considered “new”. The Freehold Lateral was installed with all the most current engineering, safety, and inspection standards, giving it a very high degree of reliability. Note that much of the TETCO system was built in the 1940’s through the 1960’s making the vast majority of the TETCO system 60 or more years old.

- 3) TETCO would install a “Block Valve” on its Freehold Lateral downstream of the new NJNG Interconnect with TETCO on the Freehold Lateral¹⁷ allowing partial isolation of the Freehold Lateral should a disruption occur within Section 2.

The FBURS addresses possible independent failures of either of the line’s segments in Section 1 or Section 2. A possible Section 1 failure is addressed as follows.

Scenario 1

In the case of a Section 1 line failure, instead of NJNG getting its gas down the Freehold Lateral all the way to its terminus, NJNG would get some of its gas (~55,000 Dthd) along the 10” line to its system and would get the remainder of its gas from Transco at the new Transco interconnect where it puts the gas from Transco through the new NJNG 24” line to its system. (How the gas gets from TETCO to Transco at the new interconnect is discussed below).

With a line break in Section 1, TETCO would deliver into the 10” line the 55,000 Dthd discussed above; TETCO would also deliver NJNG’s gas to two northern Transco-TETCO interconnect locations in NJ for backhaul delivery on Transco to the new NJNG interconnect for subsequent onward delivery to NJNG via the new 24” FBURS line. Those two locations are Linden, at the very end of the TETCO and Transco lines just before NY, and Belle Meade, which is just a bit north of the new NJNG interconnect with Transco discussed above. Gas received by Transco at the interconnects, would be delivered by backhaul,¹⁸ because gas otherwise flowing on Transco to the north and east of Belle Meade that came from the south would enable gas to flow southward on Transco to the new 24” NJNG FBURS line interconnect.

The amount of gas that TETCO can deliver to Transco at Linden (a point that is rarely used) is 430,622 Dthd¹⁹. In addition, TETCO has delivered to Transco at Belle Meade in Somerset County a total 151,545 Dthd²⁰ to all shippers. In our modeling, we did not assume that this full amount would be available for NJNG to route gas to Transco; rather we calculated a lower bound for the potential capacity available to NJNG. That bound was the amount between the maximum delivered to Transco (i.e., the 151,545 Dthd) and the amount at which the Belle Meade interconnect is operating at its average condition (64,899 Dthd²¹) during the January 2015 through April 2017 period. This approach yielded an available lower-bound amount of 86,555 Dthd at the Belle Meade interconnect that NJNG might use in an emergency situation.

This analysis shows that rerouting NJNG supplies to Transco and back to the new Transco interconnect is possible, but is not entirely under the control of TETCO. With conservative assumptions, we arrive at a total of

¹⁷ This would be necessary only to the extent TETCO does not already have one or more of such valves already along the Freehold Lateral in the vicinity of its Transco crossing.

¹⁸ These deliveries into Transco would be delivered to NJNG by backhaul because the gas delivered by TETCO would flow into NY and the gas otherwise destined for NY would be delivered to NJNG upstream (i.e., to the west of Linden) – which is the definition of backhaul; a common practice in the wholesale natural gas industry; and required by pipeline tariffs to the extent gas is otherwise flowing in the forward haul direction between the upstream delivery location and the downstream receipt location.

¹⁹ This is the amount of gas (daily capacity) posted by Transco as available to be received from TETCO at Linden.

²⁰ This amount was delivered during an “Shoulder” period (i.e., October of 2015)

²¹ This is the amount of TETCO average deliveries over the Jan 2015 through April 2017 time period deliveries when those deliveries were equal to or less than the listed Design/Operating capacity discussed above.

approximately 572,177 Dthd (or ~0.57 Bcfd) that could be delivered to NJNG, just enough to fully satisfy 100% of NJNG's peak TETCO Freehold Lateral entitlement of 0.57 Bcfd²². The total includes the 55,000 Dthd capacity of the 10" TETCO lateral and the sum of the alternate routes (to Linden and to Belle Meade). Thus, the Freehold Back-Up Reliability Solution enables reduction of the potential disruption to the NJNG Area to well below the 50% threshold (i.e., to 0% to 4%) for Single Point Failure threshold set by the BPU. To further mitigate the risk of any shortage, we evaluated additional factors that would increase the total capacity available to NJNG, making it highly likely that it would receive 100% of its capacity in the event of a failure in Section 1 of the Freehold Lateral.

Scenario 2

In the case of a Single Point Failure along Section 2 of the Freehold Lateral, TETCO would close the Block Valve discussed above and divert (deliver) gas from Section 1 into the new NJNG interconnect for onward delivery to its system through the new FBURS 24" line. In the case of an interruption along Section 2, Transco is not involved in the resolution.

Transco Supplies to the NJNG Area Can Supplement the Alternative Freehold Back-Up Reliability Solution

In the unlikely event that the less than 15-year-old TETCO line comprising Section 2 does fail and the above routing of NJNG's TETCO gas through Transco to the new interconnect and redundancy line is still insufficient, NJNG can also receive as much as an additional 160,000 Dthd throughput at its interconnections with Transco at the far northern end of the NJNG system to supplement its requirements.

For instance, in the winter of 2016, NJNG received as much as 179,802 Dthd from Transco at its two Transco location(s).²³ This amount is ~161,000 Dthd in excess of NJNG's firm entitlements on Transco.²⁴ This 179,802 Dthd amount is 138,000 Dthd in excess of NJNG's average take on Transco during the November thru March period of 2016. Skipping Stone notes that the BPU in its Order stated, "These two Transco interconnections have an approximate capacity of 76,500 and 124,500 Dth/day." This 200,000 Dthd total cited by the BPU is 21,000 Dthd higher than deliveries recorded in the January through March 2016 period; and, if true, provides even more capability to make up for any shortage not directly addressed by the Freehold Back-Up Reliability Solution. In all likelihood, any possible shortfall in back-hauling gas through TETCO-Transco interconnects could be overcome by using the two existing Transco-NJNG interconnects (that are contractually undersubscribed relative to evident Transco capability).²⁵

²² Although, for the duration of the Force Majeure period affecting Section 1 of the Freehold Lateral, the additional deliverability due to line-pack (facilitated by the Franklin Compressor at the lateral origin) of the Freehold Lateral would not be available.

²³ Transco, in its postings of flow data, aggregates its customers' points that consume capacity along a discreet segment of its pipe into one number for the aggregated point(s).

²⁴ As of the January 2017 Index of Customers for Transco, NJNG had three contracts totaling 18,600 Dthd of entitlement.

²⁵ This contractual "undersubscription" is at the location. It is unlikely that Transco is contractually undersubscribed on a forward haul basis along the segment on which the location resides. The quantities observed as delivered to NJNG from Transco either arrived on other shippers' contracts with rights to deliver in that area of Transco or were delivered by means of backhaul from NYC on that segment.

Note also that the apparent ability of NJNG to accept deliveries from Transco to fully eliminate any potential shortfall occurring with Transco back-hauls cited here, also applies to the possible 4% shortfall due to curtailment resulting from a TETCO mainline disruption in Area “A.”

Thus, with the existing unutilized capacity at the existing Transco interconnects, *the alternative Freehold Back-Up Reliability Solution reduces the potential disruption of the Freehold Lateral to near zero percent supply loss, well below the 50 percent supply loss level set by the BPU as justification for the SRL. The Freehold Lateral is the only portion of TETCO that could conceivably cause a 50% reduction in supply to NJNG.*

As explained below, the Freehold Back-Up Reliability Solution is superior to building SRL because it would be vastly less expensive to ratepayers and avert SRL’s impacts on communities and natural resources.

Additional Likely Mitigation Measures Available to NJNG in the Event of the Single Point of Failure Risk involving the Freehold Lateral

During the periods of peak usage, when NJNG was taking the highest volumes of gas from its transmission pipelines (including, of course, its major source of supply – the Freehold Lateral), NJNG was serving natural gas fired electric generation plants.²⁶ This is significant and important because these loads are not considered “firm” loads under the NJNG tariff and would be interrupted during a period of Force Majeure, which the disruption of the Freehold Lateral would certainly be considered. The interruption of such loads would in turn reduce NJNG’s demand needing to be served.

The Level of Interruptible Electric Generation Demand Able to Contribute to Mitigating a Single Point of Failure Event.

NJNG serves several natural gas-fired generation plants in its service territory. The two most substantial of which (according to EIA 2016 data) are the Lakewood Cogeneration and Ocean Peaking Power Plants both listed as being operated by Essential Power.²⁷

According to EIA data, these two plants, when operating, have combined minimum MW run rates of 204 MW and 240 MW respectively.²⁸ To be conservative for likely mitigation purposes, assuming minimum MW operating levels, EIA data indicates the Lakewood plant operated approximately 16 hours per weekday²⁹ during

²⁶ See data response of NJNG S-NJSRL-16 where NJNG states that on the peak days listed in that response “...that Electric Generation volumes are included in the data”.

²⁷ Essential was recently acquired by and integrated into the Carlyle Group in late January of 2017.

²⁸ Maximum Winter period MW ratings of these two plants, according to EIA, are 251 MW (Lakewood) and 375 MW (Ocean Peaking).

²⁹ Calculations indicate that both units at the Lakewood plant would have operated ~376 hours at minimum load for that plant to produce the electricity it produced. In January 2016, there were 21 weekdays (including January 1st). Assuming 16 hours of operation per weekday (i.e., the typical PJM 6:00 AM to 10:00 PM weekday block) thus yields 336 weekday operating hours. At peak output, both units at the Lakewood plant would have operated 365 hours in January to produce its January output. This means that both units at the Lakewood plant, depending on operating output level, operated between 29 and 40 hours outside of the 16-hour per weekday periods in January 2016. The more efficient unit at the Lakewood plant is estimated to have operated additional hours (i.e., between 37 and 171 hours) in January depending on whether the units operated at minimum or peak output. Skipping Stone assumed the same average daily gas use because gas use is most closely dependent on output.

January and February of 2016³⁰. Based upon EIA data with respect to its output of electricity per input of fuel, Skipping Stone determined that this plant consumed ~ 36,704 Dthd on average in January and ~27,573 Dthd in February when operating.

Thus, assuming a Single Point of Failure (i.e., along the Freehold Lateral), during a worst case period of time (January), NJNG, by interrupting deliveries to the Lakewood plant, would reduce demand for gas by this 36,000 Dthd; which, with all the other mitigation measures outlined above and available to NJNG, would enable NJNG to completely avoid any disruption to firm residential and commercial load – without having to build the SRL - in order to achieve the goal of NJNG system resiliency, provided the FBURS was in place.

Comparative Cost of Alternative Freehold Back-Up Reliability Solution and SRL

The approximate cost of the alternative Freehold Back-Up Reliability Solution” is made up of two components.

1. The cost of the two interconnects which Skipping Stone estimates to be ~\$1.5 Million apiece³¹;
2. The cost of 5.4 miles of pipeline which it estimates as being \$4.2 Million per mile³² or ~\$22.7 Million for the redundancy line which yields a total cost of ~\$26 - \$28 Million.

Notably this alternative’s cost is more than \$150 Million less than the NJNG estimated cost of the SRL³³ “solution” to a Single Point of Failure.

Not only is the cost of the SRL nearly five times the likely cost of the Freehold Back-Up Reliability Solution proposed here, but the FBURS traverses existing Rights of Way without any of the additional community and Pinelands Area impacts attendant to the SRL Single Point of Failure “solution” adopted by NJNG. This approach could also help NJNG avoid the regulatory tangles and fierce public opposition SRL faces.

Comparison of the SRL Solution to a Single Point of Failure along the Freehold Lateral

If SRL were to be built, NJNG would obtain 0.18 Bcfd from Transco³⁴ at the new connection to SRL. In the event of a failure in either Section 1 or 2 of the Freehold Lateral, NJNG would lose 100%, or 0.57 Bcfd, of supplies to its TETCO terminus. SRL would protect NJNG against a loss of only about a third of the current total requirement (i.e., a 66% supply loss) which exceed the 50% level identified by the BPU.

Thus, in an emergency, the SRL solution would leave a gap of about 0.39 Bcfd, or ~66% of the capacity that NJNG requires to meet its peak needs, with no strategy or capacity to avoid a major disruption of service. In contrast, the Freehold Backup solution would meet all of NJNG requirements, resulting in no disruption to its customers,

³⁰ The Ocean Peaking Power Plant operated only 3 hours in January and 2 hours in February and thus can be disregarded as able to contribute to demand mitigation actions available to NJNG.

³¹ If the pipelines insisted that they (i.e., the pipelines) build the interconnect meter stations; and NJNG preferred to reimburse the pipelines rather than pay the pipelines a “return on investment” for years to come; and therefore determined to pay for the meters, this is considered a Contribution in Aid of Construction or CIAC, and the tax gross-up effect, if insisted upon by the pipelines, would turn the ~\$3.0 Million into ~\$4.6 Million

³² This is based upon the cost of the 30” SRL line scaled down from 30” to 24” in diameter.

³³ SRL is estimated to cost ~178 Million Dollars.

³⁴ See documents filed by NJNG in BPU Docket Nos. GO15040403 and GO15040402 and capacity provided by Transco’s Garden State Expansion (GSE) which is proposed to feed the SRL (See Exhibit P to Transco’s GSE FERC application). The GSE consist of a compressor and meter station capable of flowing 0.18 Bcfd which effectively limits the potential SRL flows to 0.18 Bcfd despite its 30” diameter size.

at \$100 million less than the cost of SRL. SRL, therefore, cannot be considered an effective and reasonable response to the Single Point of Failure scenario on which BPU based its decision.

Answering the Question: “What magnitude of disruption of TETCO would necessitate a facility of the magnitude of the SRL in order to address the failure of such magnitude?”

At the outset, the PPA asked Skipping Stone to answer this question. The short answer is that Skipping Stone was not able to construct an even remotely reasonable scenario for a Single Point of Failure that could only be addressed by a facility of the magnitude of the SRL. While we were able to conceive of two possible failures of the TETCO system (i.e., the two separate scenarios of a complete failure of the Freehold Lateral), Skipping Stone also identified a solution to not only mitigate, but substantially eliminate such remote risk. Moreover, it does so at ~20% of the cost of the SRL and with 1/6th the length of pipe and attendant potential environmental disruption.

Joint Base Load and Relevancy of SRL to Joint Base Service Reliability

Skipping Stone was asked to review the SRL and its capacity, and to analyze what, if any, contribution to the Joint Base’s service reliability from NJNG the SRL might provide that would *not* be available from the FBURS.

According to a 2013 submission³⁵ prepared by EHS Technologies for Army CERDEC Flight Activity, the annual natural gas load of the Lakehurst portion of the Joint Base at that time was 246,481 Mcf per year (roughly equivalent to 254,368 Dth per year³⁶). Assessing the typical peak day as a percentage of annual weather sensitive load, which is the load characteristic of the Base’s natural gas use, a weather sensitive Northeast U.S. load’s peak day use of natural gas is generally 1% of annual use. This would make the Base’s peak day usage ~2,544 Dthd. Comparing this to NJNG’s recent peak day send-out of 640,937 Dthd, the Base’s load is 0.4% (i.e., less than ½ percent) of NJNG’s recent peak and 0.043% of the sum of NJNG’s contracted capacity entitlements³⁷ for the NJNG Area (in which the Base resides).

Our analysis of this load (both its type – i.e., firm – and relatively de minimis magnitude) leads us to conclude that the SRL’s capacity (as opposed to the FBURS’ proposed capability) provides no additional reliability to the Joint Base load vis-a-vis a Single Point of Failure as set forth in the BPU Order.

³⁵ This submission referenced 2010 data.

³⁶ Using a typical Btu/cf conversion factor of 1,032 Btu’s per cubic foot and 1 million Btu’s per Dth

³⁷ The sum of NJNG TETCO NJNG Area contracts of 570,525 Dthd and its Transco contracts of 18,600 Dthd; both as posted in the respective pipelines’ Index of Customer for January 2017.

Conclusion:

Below is a Table Summarizing the results of Skipping Stone’s analysis of whether the proposed SRL is an appropriate facility for the purpose of addressing a Single Point of Failure as set forth by the BPU.

Possible Location of Pipeline Failure	Estimated Capacity Loss	Mitigation Actions Required?	Additional Mitigation Required?	Estimated Capacity Reduction for NJNG after Mitigation (worst case)	Meets Single Point of Failure Criteria?
TETCO Upstream of NJNG	1.32 Bcfd	Only if occurs on highest demand day(s). If so, receive TETCO supplies from North and possibly interrupt Electric Gen	None Required	0% to ~4%	No
TETCO Downstream of NJNG	1.32 Bcfd	No. Receive TETCO supplies from South and West per current contracts	None Required	0%	No
TETCO Freehold Lateral Section 1:	0.57 Bcfd	Yes, build ~ \$22-\$26 Million FBURS, and receive supplies from Transco and interrupt Electric Gen	FBURS	0%	Yes, absent Mitigation
TETCO Freehold Lateral Section 1:	0.57 Bcfd	Yes, however, even with SRL and interruption of Electric Gen, loss of gas supply would be 66%	SRL ³⁸	66%	Yes, even with SRL
TETCO Freehold Lateral Section 2:	0.57 Bcfd	Yes, build ~ \$22-\$26 Million FBURS, and in FBURS case receive supplies from TETCO	FBURS	0%	Yes, absent Mitigation
TETCO Freehold Lateral Section 2:	0.57 Bcfd	Yes, however, even with SRL and interruption of Electric Gen, loss of gas supply would be 66%	SRL ³⁹	66%	Yes, even with SRL

As discussed throughout this Report, Skipping Stone concludes that while there is a potential Single Point of Failure risk attendant to a remote (but non-zero) possibility of loss of the 15 year-old Freehold Lateral, the proposed SRL is not a reasonable solution to mitigating that risk, and in fact would not be sufficient to address the loss of the Freehold Lateral. Because:

as noted by the BPU in its Order, the SRL as proposed could, at most, meet a loss of barely one-third the magnitude of that attendant to the loss of the Freehold Lateral.⁴⁰ If the SRL’s uncontracted-for, but designed,

³⁸ As proposed and as contracted for with Transco via the Garden State Expansion

³⁹ Ibid.

capacity of 280,000 Dthd plus the 55,000 Dthd of TETCO's 10" line were available, then 335,000 Dthd would mitigate just over 60% of the only Single Point of Failure identified by Skipping Stone and thus is barely adequate to address the only such failure (i.e., 50%) set by the BPU as the standard for its decision.

If addressing a Single Point of failure is truly the problem to be solved, the proposed SRL does not do that. Only if all electric generation were interrupted and somehow uncontracted-for capacity were to be available to NJNG to flow through the SRL would it reduce the loss of supply to meet demand to a 34% level, and at a cost five times that of the Freehold Back-Up Reliability Solution, which solution would address all but at most 4% of peak demand.

Only a solution as outlined by Skipping Stone (or a similar one designed to meet the real risk) can mitigate the full risk posed by the only Single Point of Failure identified by means of comprehensive analysis. Such an analysis was not previously sought nor was one provided in the record of the SRL proceeding.

⁴⁰ At page 13 of the March 16, 2016 BPU Order the BPU states: "In the event of a fifty (50) percent reduction of supply from TETCO, which exceeds the capacity provided by a twenty-four (24) inch pipeline, the design of SRL would ensure transmission system integrity. In the event where a large scale TETCO interruption occurs, even without upgrades to the Transco interstate system, with a 30-inch pipeline the company could acquire in excess of the contract volume [i.e., 180,000] by entering into transactions with other firm shippers that have rights on the interstate system. ... Additional capacity transacted for in the event of an interruption (e.g., 280,000 Dth/day) could not flow through a twenty-four (24) inch pipe because it would result in an unacceptable pressure drop.