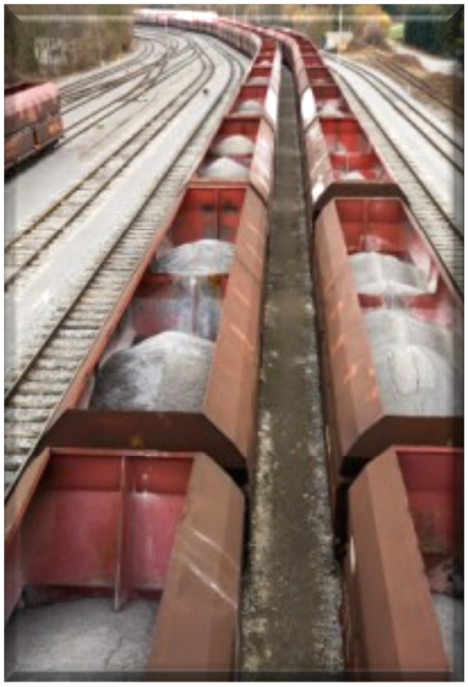
Marcellus Shale Freight Transportation Study

northern tier regional planning & development commission



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November 2011

Final Report

TABLE OF CONTENTS

TABLES AND FIGURES

LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
ADTT	Average Daily Truck Traffic
CDL	Commercial Driver's License
CP	Canadian Pacific Railroad
EMTA	Endless Mountains Transportation Authority
FAF	Freight Analysis Framework
FAQ	Frequently Asked Questions
FHWA	Federal Highway Administration
GIS	Geographic Information Systems
LRTP	Long Range Transportation Plan
LRWY	Lehigh Railway
NCRPDC	North Central Regional Planning and Development Commission
NS	Norfolk Southern Railroad
NTRPDC	Northern Tier Regional Planning and Development Commission
PADEP	Pennsylvania Department of Environmental Protection
PennDOT	Pennsylvania Department of Transportation
RBM&N	Reading Blue Mountain and Northern Railroad
RFP	Request for Proposal
RMS	Roadway Management System
RTAC	Rural Transportation Advisory Committee
SALDO	Subdivision and Land Development Ordinance
SRBC	Susquehanna River Basin Commission
STAMPP	Systematic Technique to Analyze and Manage Pennsylvania's Pavements
TIP	Transportation Improvement Program
W&C	Wellsboro and Corning Railroad

EXECUTIVE SUMMARY

STUDY BACKGROUND

The Marcellus shale gas industry was essentially non-existent in Pennsylvania in 2007, but today it is a common thread in the lives of workers and residents of the Northern Tier. Each new well generates new benefits for, and impacts to, Northern Tier residents, visitors, and businesses. This study examines the issues surrounding transportation impacts of the Marcellus Shale gas industry, which will likely dominate the transportation outlook – both rail and roadway – over the next 10 to 30 years. This study set out to gain a clear understanding of the related needs and freight generation issues associated with the natural gas industry in Pennsylvania's Northern Tier. Its study objectives are to:

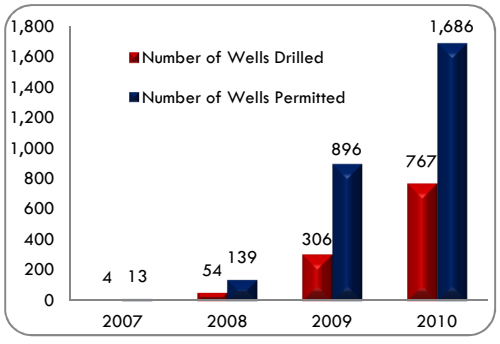
- **document** the Marcellus shale natural gas extraction process as it relates to transportation in the Northern Tier region;
- **estimate** current and future movements of freight traffic specific to Marcellus shale operations;
- **identify** short-, mid- and long-term freight movement needs as they relate to Marcellus shale operations in the Northern Tier region, and;
- **provide** guidance to the NTRPDC to assist in long-term planning of Marcellus shale transportation issues as well as on-going monitoring and managing of the evolving Marcellus shale impacts.

MARCELLUS SHALE PRODUCTION ELEMENTS

Freight activity in the Northern Tier has historically been centered on agricultural, timber, and consumer products. Over the past four years, transportation networks built and maintained to accommodate these industries have been overtaxed with trucking and rail activity resulting from Marcellus shale natural gas operations. Each part of the production process impacts the transportation system.

Permitting

The increase in the number of wells permitted and drilled in the past four years in the Northern Tier has been dramatic. The industry (which was almost non-existent in 2007) has doubled from 2009 to 2010. This increase in



number of wells permitted and drilled is expected to continue to increase in the near future.

Drilling and Fracturing

Marcellus Shale gas extraction requires the use of water, sand, and lubricant to fracture the rock formation, releasing the natural gas it contains. Each fractionation of a horizontal well may require anywhere from 500,000 to 1 million gallons of water. The fractionation process takes approximately 5 days to complete and generates approximately 400 truck trips for each well site.

Water Withdrawls

Water withdrawls are a required part of the drilling process. Gas companies in the Northern Tier must obtain permits from the Susquehanna River Basin Commission and the Pennsylvania Department of Environmental Protection to withdraw water from streams or rivers. Water withdrawals and delivery to well sites is the single largest generator of trucks specific to Marcellus shale gas extraction in the Northern Tier. A water management plan is required under DEP's permitting process for Marcellus Shale wells.

Sand Delivery

Sand for Marcellus shale gas production is almost exclusively delivered from the Midwest via rail and then trucked to the well site. An average rail car can carry 100 tons of sand which requires 4 or 5 trucks for offloading via a mobile conveyor. A single well may use up to 25 rail cars of sand.

New Personnel

The Pennsylvania Department of Labor and Industry estimates that between the fourth quarter in 2007 and the fourth quarter in 2010, direct (or core) Marcellus shale related employment in the Northern Tier increased over 1,500 percent. Supporting employment (ancillary) rose 54 percent over the same time period. This is the largest increase of any region in Pennsylvania. These significant personnel additions have increased, and will continue to increase, traffic activity in the region.

THE CURRENT TRANSPORTATION SYSTEM

Roadway Conditions

A major concern in the region is the impact of Marcellus shale operations on roads that were built to accommodate lower volumes of lighter traffic. Overall average annual daily traffic (AADT) in the 5-county region rose 12 percent and average daily truck traffic (ADTT)

rose 22 percent from 2007 to 2010. Between 2007 and 2010, the major US highways (US 6, US 220 and US 15) grew in overall truck traffic volume by nearly 125 percent. The region contains many bottlenecks that will continue to worsen as freight traffic resulting from gas operations increases. Regional bottlenecks include those in the following municipalities:

- Athens Borough
- Dushore Borough
- Hallstead
- Mansfield Borough
- Monroeton
- Montrose Borough
- New Milford
- Towanda Borough
- Troy Borough
- Tunkhannock Borough
- Wellsboro Borough
- Wyalusing Borough
- Wysox Borough

Railroad Conditions

The rail system is critical to the movement of goods for various tenants in the region. Recent trends in moving materials for Marcellus shale operations have increased the volume of rail movements dramatically.

The railroads serving the Marcellus shale industry within the Northern Tier region include:

- Reading Blue Mountain & Northern Railroad
- Wellsboro and Corning Railroad
- Lehigh Railway

THE FUTURE TRANSPORTATION SYSTEM

Forecast estimates were developed for the short-tem (2015), mid-term (2020), and long-term (2035) time horizons. Forecasts are based on:

- Well permit requests beginning to decline in the next five years
- Well drilling leveling off in 5 years and will begin to decline in 10 years
- Assumption that nearly all permitted wells will be drilled
- Railroads will continue to maintain their current share of commodities moved for Marcellus Shale operations
- The industry will begin to experience declines in drilling operations in approximately 15 years

Where the gas companies will drill is unknown, but it is assumed that these companies will take advantage of their current permits in the short-term while continuing to look for opportunities in more remote areas in the mid- and long-term. As a result, truck patterns may change in a way that is unexpected, impacting local roads and regional highways that have not experienced growth up to this time.

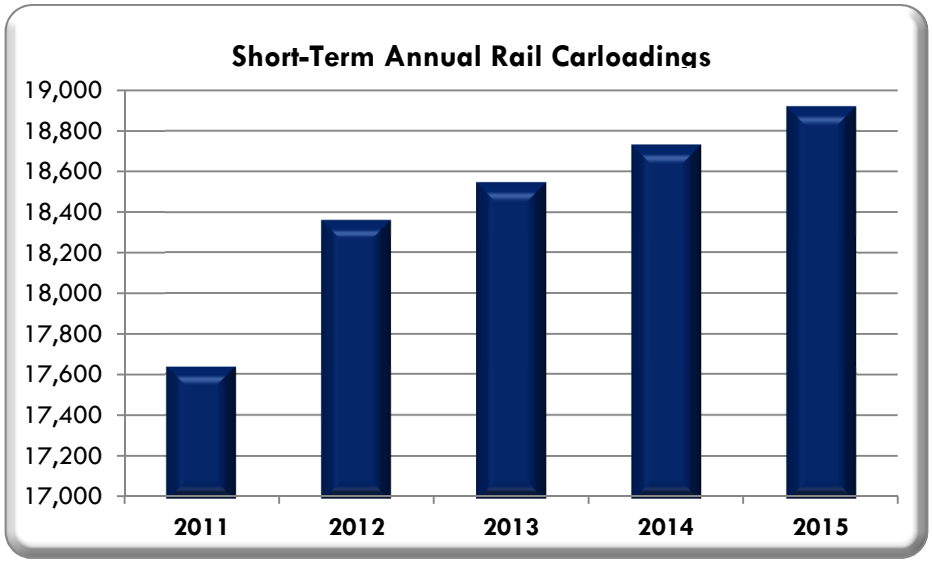
Well permits are expected to increase over the next five years and will then begin to decline over the next 20 years. It is estimated that as many as 13,000 permits will be sought for Marcellus Shale drilling over this time period in the Northern Tier.

Short Term Truck and Rail Forecasts (2015)

Specific roadways where congestion may increase include US 220, US 6, PA 29, PA 187, PA 14, and SR 2017. In the short term, railroads are expected to continue to experience growth of about seven percent.

Short-Term Total Daily Trucks

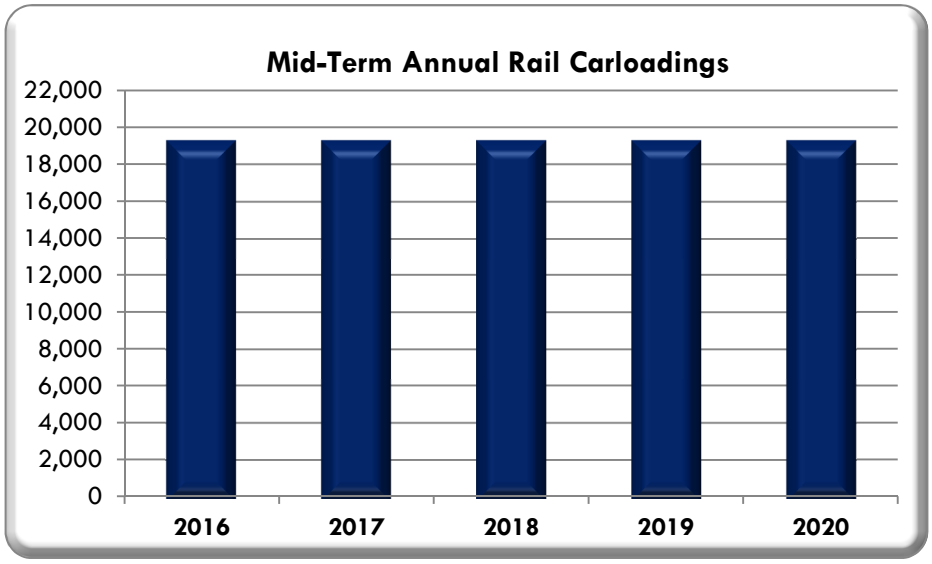
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2011	1,191	37	387	975	30	2,620
2012	1,276	40	415	1,045	32	2,808
2013	1,340	42	436	1,098	34	2,950
2014	1,406	44	457	1,151	36	3,093
2015	1,471	46	478	1,205	37	3,238



Mid Term Truck and Rail Forecasts (2020)

Overall truck traffic is expected to increase 24 percent between 2015 and 2020, while total rail carloadings are expected to remain strong at around 19,000 per year.

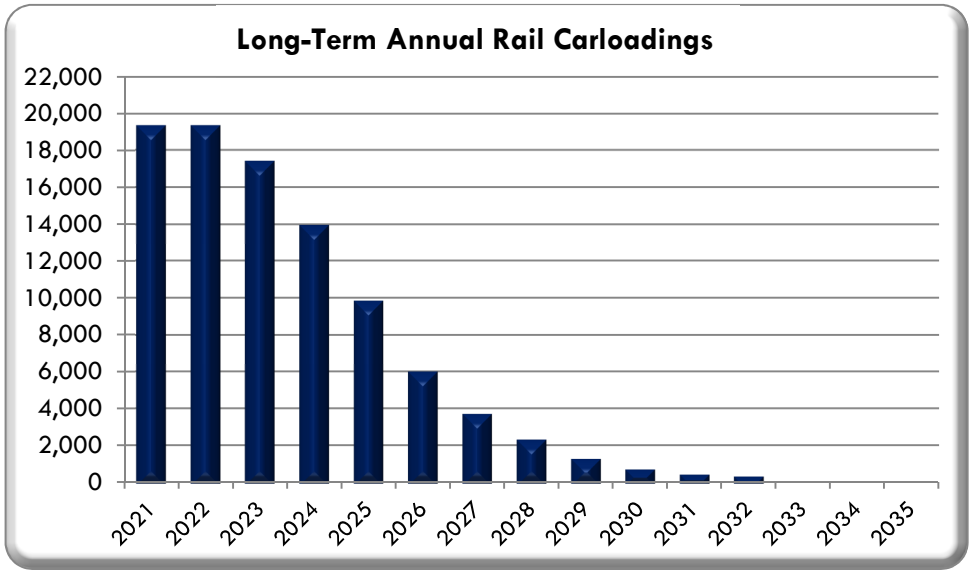
Mid-Term Total Daily Trucks						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2016	1,538	48	500	1,260	39	3,384
2017	1,593	50	518	1,305	40	3,505
2018	1,648	51	535	1,350	42	3,627
2019	1,703	53	553	1,395	43	3,748
2020	1,758	55	571	1,440	44	3,869



Long-Term Truck and Rail Forecasts (2035)

Longer-term projections are difficult, however truck volumes related to Marcellus shale gas operations are expected to hit their peak in the year 2022, at over 4,100 truck trips generated per day, which is nearly double the number of trucks today. Volumes are expected to decrease rapidly to near present levels by the year 2027. Carloadings will also begin to decline during this period.

Long-Term Total Daily Trucks						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2021	1,813	56	589	1,485	46	3,990
2022	1,868	58	607	1,530	47	4,111
2023	1,803	56	586	1,477	46	3,967
2024	1,636	51	531	1,340	41	3,599
2025	1,415	44	460	1,159	36	3,113
2026	1,200	37	390	982	30	2,639
2027	1,070	33	348	877	27	2,355
2028	993	31	323	813	25	2,185
2029	933	29	303	764	24	2,053
2030	900	28	292	737	23	1,981
2031	884	28	287	724	22	1,945
2032	877	27	285	718	22	1,930
2033	874	27	284	716	22	1,924
2034	873	27	284	715	22	1,921
2035	873	27	284	715	22	1,921



POLICY/PROCEDURAL IMPACTS

Major challenges remain for policy makers.

- The NTRPDC has faced increased pressure in its role as regional coordinator of Marcellus shale information.
- PennDOT, member counties, and local municipalities all maintain roads that have required resurfacing on average every 15 years in the past, now must be resurfaced every 7 to 8 years, which taxes maintenance budgets.
- Cities and counties do not have regulatory policies in place for gas production.
- Police and emergency responders are stretched to capacity.

RECOMMENDATIONS

- The region will need to continue to conduct official and on-going damage assessments for state and local roads.
- Traffic counts should be taken on a more frequent basis to determine travel patterns and impacts to congestion on major routes. In addition, there is a need to gather, coordinate, and disseminate information regarding Marcellus Shale activity at the regional level.
- Consolidate traffic data collection activities from the five member counties.
- Improved coordination is also required at the regional level. A Marcellus Shale Task Force should include PennDOT, NTRPDC staff, county planning offices, and private sector representatives.
- Address traffic operations improvements at identified bottlenecks. Review the current Transportation Improvement Program (TIP) and identify opportunities to address the long-term impacts to traffic routes.
- Coordination between the NTRPDC and the railroads to identify additional transload and trackage needs to serve the increased Marcellus activity. NTRPDC should continue to support applications for funding improvements through PennDOT's Rail Freight Assistance Program.
- Establish a countywide process/structure to manage local response.
- The Rural Transportation Advisory Committee (RTAC) should include on its monthly agenda discussion about the regional Marcellus Shale transportation improvements and prioritize them so that the region is well-positioned when funds become available.

BACKGROUND AND OBJECTIVES

PROJECT BACKGROUND

Marcellus Shale activity has profound impacts on the local economy, infrastructure, schools, emergency services, and the everyday lives of Northern Tier residents. The issues surrounding natural gas from the Marcellus Shale deposit will likely dominate the transportation infrastructure over the next 10 to 30 years. As such it is important to gain a clear understanding of the related needs and freight generation issues associated with the energy industry in the Northern Tier region.

> *"Oil and gas extraction is rapidly emerging as a burgeoning industry in the region, and is a candidate for extreme growth."*
>
> NTRPDC's Comprehensive Economic Development Strategy (CEDS), 2008

The Northern Tier Regional Planning and Development Commission's (NTRPDC) 2010 Annual Report recognizes the importance of providing guidance for natural gas development in the region, stating that the "*staff aims to provide reliable information and guidance in navigating these issues, and to help ensure that the people, businesses, and local governments of Bradford, Sullivan, Susquehanna, Tioga, and Wyoming counties derive as much benefit as possible from natural gas development.*" To that end, the NTRPDC developed this analysis to begin to frame the transportation issues related to Marcellus Shale operations and estimate the potential future impacts for the region.

Trucks provide the majority of Marcellus Shale related freight movements and are the primary focus of this analysis. Data show an extraordinary increase in truck traffic volume over the last four years directly as a result of natural gas extraction activity. Roadway congestion, intersection bottlenecks, and infrastructure deterioration have become common experiences resulting from increased truck traffic from Marcellus Shale-related operations.

Rail traffic has also increased substantially. Carloadings from moving materials for Marcellus Shale operations have increased dramatically. These movements, along with other rail traffic, have necessitated the need for rail-related improvements and operational changes by the railroads serving the region and gas industry.

Through interviews with area stakeholders, identified estimates of the lifespan of Marcellus Shale operations range anywhere from 10 to 100 years. The reason for this wide range is a result of the unknown

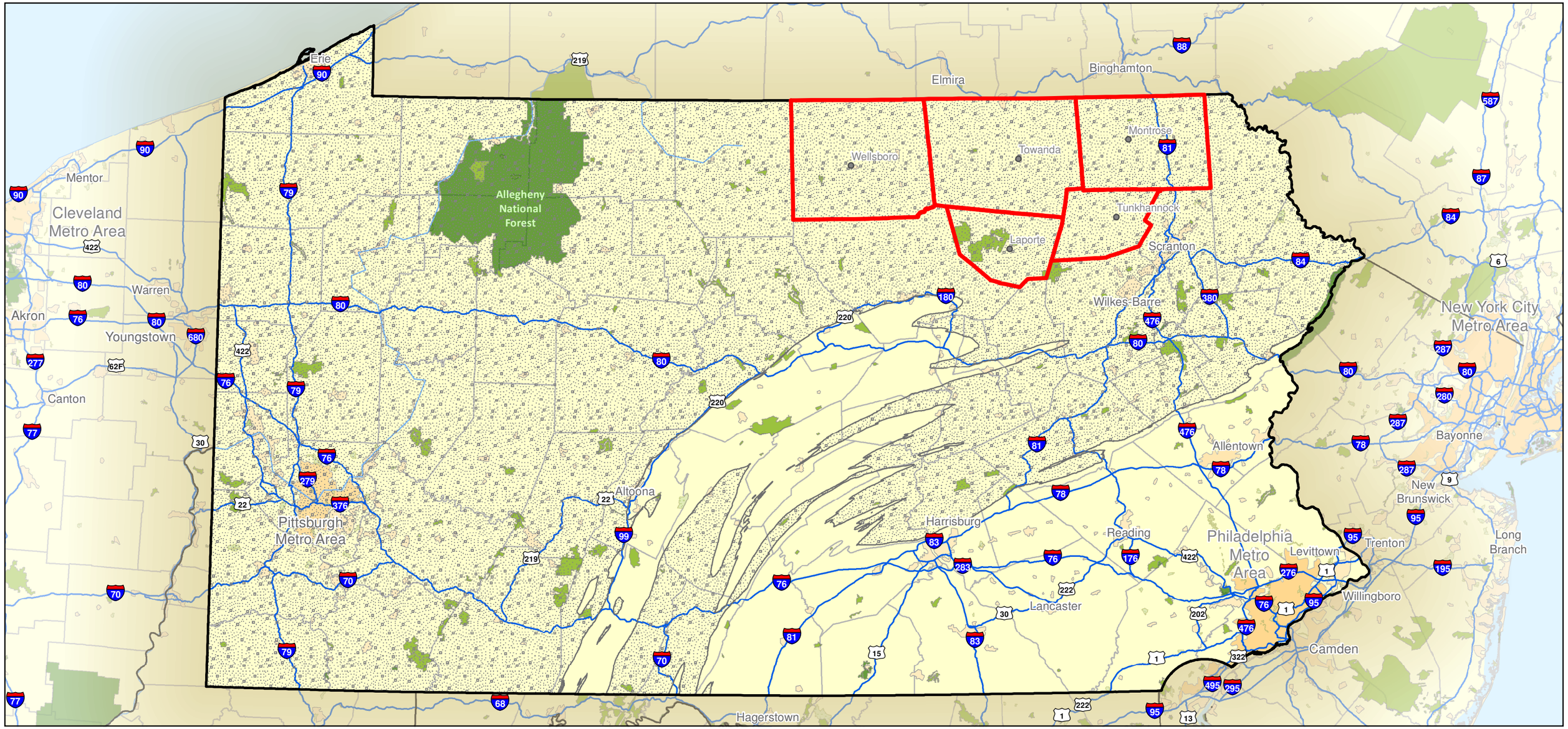
external variables related to natural gas production, gas prices, and demand. This wide range of estimates makes it difficult to provide a long-term temporal estimate of truck and rail traffic throughout the Northern Tier. However, short-term activity is easier to estimate because it is known that activity will remain in the area for at least 10 years. This analysis assumes that Marcellus Shale development will continue over the next 30 years with the drilling and development phase peaking within 10 years with ongoing maintenance of wells for the following 20 years.

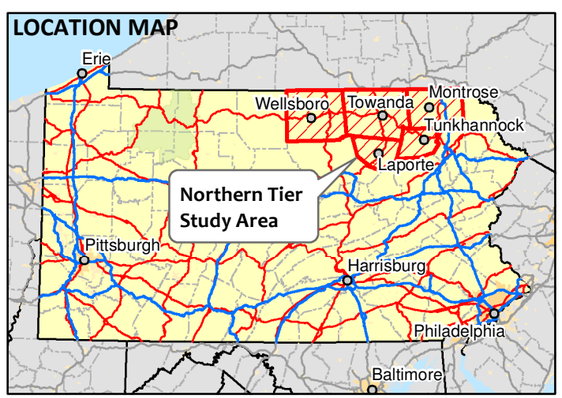
PROJECT OBJECTIVES

Issues associated with Marcellus Shale operations are wide-ranging. This study focuses specifically on the transportation issues associated with gas development and its impacts within the Northern Tier Region. It is intended to be a high-level assessment of the impacts of the industry on the regional transportation infrastructure, while documenting the wide array of associated issues. In order to focus the study on those key elements that are most influential, the following objectives were established.

- Document the Marcellus Shale natural gas extraction process as it relates to transportation in the Northern Tier region.
- Estimate current and future movements of freight traffic specific to Marcellus Shale operations.
- Identify short-, mid-, and long-term freight movement needs as they relate to Marcellus Shale operations in the Northern Tier region.
- Provide guidance to the NTRPDC to assist in long-term planning of Marcellus Shale transportation issues as well as on-going monitoring and managing of the evolving Marcellus Shale impacts.

Figure 1 below shows the Northern Tier study area and Marcellus Shale formation.





Legend

- Marcellus Shale Formation in Pennsylvania
- Northern Tier Counties
- Freeway System (State)
- National Park or Forest
- State Park or Forest
- County Park
- Regional Park
- Local Park

Scale (Miles)

0 12.5 25 50 75

N

Data Sources:
Pennsylvania Department of Conservation and Natural Resources, GIS data developed from research published as part of the U.S. Department of Energy's Eastern Gas Shales Project (EGSP) in the late 1970's.

Gannett Fleming

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Marcellus Shale Freight Transportation Study

Study Area and Marcellus Shale Formation

Figure 1

November 2011

REGIONAL FREIGHT ACTIVITY

GENERAL FREIGHT ACTIVITY

Freight activity in the Northern Tier has historically been centered on agricultural, timber, and consumer products. Over the past four years, roadways built and maintained to accommodate the volume of traffic for these industries, have been inundated with trucking and rail activity resulting from Marcellus Shale natural gas operations.

In 2009 the Federal Highway Administration's (FHWA) Freight Analysis Framework estimates that nearly 281 million tons of goods flowed into Pennsylvania (excluding the Pittsburgh and Philadelphia metro areas) and 285 million tons was shipped out. An estimated 10 percent of these goods were destined for, or shipped from, the Northern Tier region. Trucks carried approximately 84 percent of these goods and rail accounted for 11 percent. The FHWA estimates that shipments *from* Pennsylvania will increase 28 percent, and shipments *to* Pennsylvania will increase 25 percent in the next 20 years. It is universally understood that the recent economic downturn has affected these estimates. Table 1 through Table 4 show the tonnage of the top six commodities moved by mode in 2009.

Table 1: 2009 Truck Tonnage From Pennsylvania (excluding Pitt and Phila Metro)

Commodity	Mode	Tons (000)
Gravel	Truck	40,373
Coal	Truck	29,982
Waste/scrap	Truck	23,247
Nonmetallic minerals	Truck	16,413
Other foodstuffs	Truck	16,071

Source: FHWA FAF3

Table 2: 2009 Truck Tonnage To Pennsylvania (excluding Pitt and Phila Metro)

Commodity	Mode	Tons (000)
Gravel	Truck	34,644
Waste/scrap	Truck	19,657
Nonmetallic minerals	Truck	18,545
Cereal Grains	Truck	17,095
Other foodstuffs	Truck	16,443

Source: FHWA FAF3

Table 3: 2009 Rail Tonnage From Pennsylvania (excluding Pitt and Phila Metro)		
Commodity	**Mode**	**Tons (000)**
Coal	Rail	16,959
Gravel	Rail	2,366
Nonmetallic minerals	Rail	573
Coal and Petroleum Products (n.e.c.)	Rail	308
Waste/scrap	Rail	242

Source: FHWA FAF3

Table 4: 2009 Rail Tonnage To Pennsylvania (excluding Pitt and Phila Metro)		
Commodity	**Mode**	**Tons (000)**
Coal	Rail	11,395
Cereal grains	Rail	5,011
Waste/scrap	Rail	3,075
Gravel	Rail	2,864
Other foodstuffs	Rail	1,473

Source: FHWA FAF3

These latest tonnage estimates from the FHWA are based on 2007 data which were prior to the recent increase in Marcellus Shale activities, but provide a good backdrop of regional freight activity. Due to the fact that no commodity flow estimates take into account recent natural gas activity in the Northern Tier region, a qualitative assessment of the movement of materials and equipment was completed for this analysis. The focus is primarily on the activities themselves and the truck and rail traffic they create.

MARCELLUS SHALE FREIGHT ACTIVITY

Natural gas producers have invested billions of dollars in Pennsylvania in lease and land acquisition, new well drilling, infrastructure development, and administrative requirements. The Marcellus Shale gas production process (as it relates to transportation) includes:

1. Personnel
2. Leasing and Permitting
3. Exploration
4. Drilling
5. Water Withdrawal and Sand Delivery
6. Pipeline Development

PERSONNEL

The Pennsylvania Department of Labor and Industry estimates that between the fourth quarter in 2007 and the fourth quarter in 2010, direct (or core) Marcellus Shale related employment in the Northern Tier increased over 1,500 percent. Supporting employment (ancillary) rose 54 percent over the same time period. This is the largest increase of any region in Pennsylvania.

Table 5: Northern Tier Marcellus Shale Related Employment Growth from 2007 to 2010

	2007 (Q4)	2010 (Q4)	Vol. Change	% Change
Core	87	1,422	1,335	1,535%
Ancillary	1,728	2,668	940	54%

Source: PA Dept. of Labor and Industry

Direct and indirect employees require the use of personal vehicles for daily work trips. Although not the primary focus of this effort, small vehicle trips have significant impact on regional roadways.

LEASING AND PERMITTING

Interested property owners enter into gas development rights leases with private companies, allowing them not only the rights to potential natural gas deposits, but also access to conduct drilling and extraction operations, and the development of related infrastructure such as pipelines. Gas companies lease land for a fixed amount on a per acre basis for a specified number of years. Typically the lease includes a provision for royalties based on how much gas is produced under the lease.

Permitting is the consent to drill given to gas companies by the governing authority, which (in the case of Marcellus Shale) is the Pennsylvania Department of Environmental Protection (PADEP). Table 6 below shows the number of Marcellus Shale wells permitted within each county for each operator within the Northern Tier through the end of the 2010 calendar year.

Table 6: Number of Wells Permitted by County/Operator
(as of December 2010)

OPERATOR	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Grand Total
Chesapeake Appalachia LLC	807	78	166	5	77	**1,133**
Talisman Energy USA Inc.	455	-	-	99	-	**554**
East Resources Management LLC	8	-	-	485	-	**493**
Cabot Oil & Gas CORP	-	-	231	-	-	**231**
Ultra Resources inc.	-	-	-	185	-	**185**
Seneca Resources Corp.	-	-	-	91	-	**91**
Chief Oil & Gas LLC	38	21	17	-	8	**84**
EOG Resources Inc.	61	-	-	-	-	**61**
EQT Production	-	-	-	50	-	**50**
Southwestern Energy Production	44	-	5	-	-	**49**
Carrizo (Marcellus) LLC	-	-	18	-	13	**31**
Citrus Energy Corp.	-	-	-	-	23	**23**
Williams Production Appalachia LLC	-	-	20	-	-	**20**
Novus Operating LLC	-	-	-	20	-	**20**
Stone Energy Corp	-	-	6	-	-	**6**
EXCO Resources PA Inc.	-	3	2	-	-	**5**
Range Resources Appalachia LLC	3	-	-	-	-	**3**
Penn Virginia Oil & Gas Corp	-	-	-	1	-	**1**
Enervest Operations LLC	1	-	-	-	-	**1**
Grand Total	**1,417**	**102**	**465**	**936**	**121**	**3,041**

Source: PADEP

EXPLORATION

After a lease is in place, gas company geologists conduct seismic tests to determine the land's ability to produce natural gas. Seismic trucks and/or explosive charges are used to provide sonic information that can be translated into a rock formation profile showing potential locations for drilling.

Once a site is determined to be suitable for drilling, the site is prepared for the drilling process. A well pad is developed to provide an area for drilling equipment and for on-going activities related to the vertical and potential multiple horizontal wells. Construction of a well pad will use approximately 5,000 tons of aggregate per location, using full-time operation of bulldozer, excavator, and roller[1] for approximately one week.

DRILLING AND FRACTURING

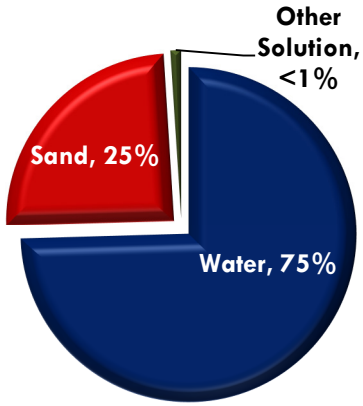
Marcellus gas wells are typically drilled both vertical and horizontal. The vertical wells provide access to the shale layer and the horizontal wells are drilled within the Marcellus Shale formation which provides greater access to natural gas deposits.

A drill rig is set up on the pad, along with the pipe necessary to drill to the appropriate depth, as well as the length of the horizontal wells. To provide structural integrity to the wells, they are cased in cement and metal to limit the amount of sand, water, and lubricant used in the fractionation process from seeping into non-designated areas. Wells are generally complete between 15 and 30 days, with 24/7 activity. Casing and drilling a well requires approximately 125 tons of cement per well[2].

Marcellus Shale gas extraction requires the use of water, sand, and lubricant to fracture the rock formation, releasing the natural gas it contains. The estimated shares of the materials required for the fractionation of a well is shown in Figure 2 below.

[1] Source: Marcellus Shale Coalition
[2] Source: Marcellus Shale Coalition

Figure 2: Percentage of Materials Required for Fractionation



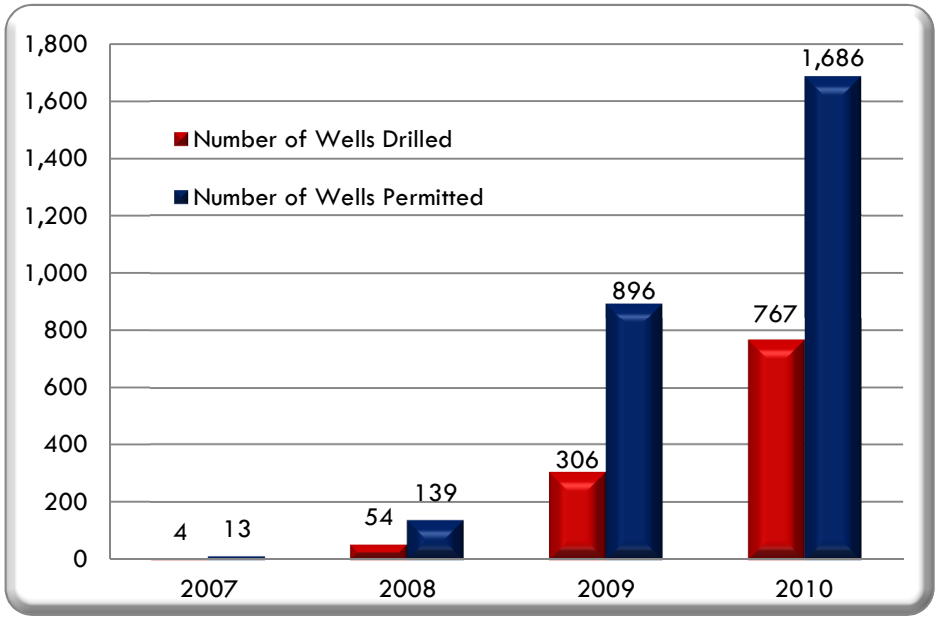
Each fractionation of a horizontal well may require anywhere from 500,000 to 1 million gallons of water[3]. Water is transported to the well site primarily via trucks which have a capacity of approximately 5,500 gallons each. Larger well sites may be supplied water via pipeline from the approved source. Often these pipelines are temporary but require teams of workers for assembly. The water is mixed with a specific type and shape of sand and lubricating agents (see Appendix A for list of chemicals included in the agents). Since drilling companies are beginning to reuse most of the water on site, removal and disposal of the water post-fracturing accounts for approximately 10 to 20 percent of the water transported to a site. This used water is hauled by truck to rail transload facilities or to disposal facilities in southwestern Pennsylvania or outside the state.

The fractionation process takes approximately 5 days to complete and generates approximately 400 trucks for each well site - primarily for the transport of water. This estimate does not include the removal of water or empty trucks leaving well sites.

As shown in Figure 3 below, the increase in the number of wells permitted and drilled in the past four years in the Northern Tier has been dramatic. The industry (which was almost non-existent in 2007) has doubled from 2009 to 2010, with the number of wells permitted increasing 88 percent and the number of wells drilled increasing 150 percent. This increase both in number of wells permitted and drilled is expected to continue to increase in the near future.

[3] Source: PADEP

Figure 3: Number of Wells Permitted and Drilled in 5 County Northern Tier Region



Source: PADEP

Because municipalities bear the brunt of impacts of gas operations resulting from large amounts of truck traffic on local roadways, they are the most at risk of not being able to keep up with the demands of the industry. These demands include the need for local roads to be posted and bonded to mitigate impacts resulting from truck traffic. Posting and bonding of roadways is explained in later sections.

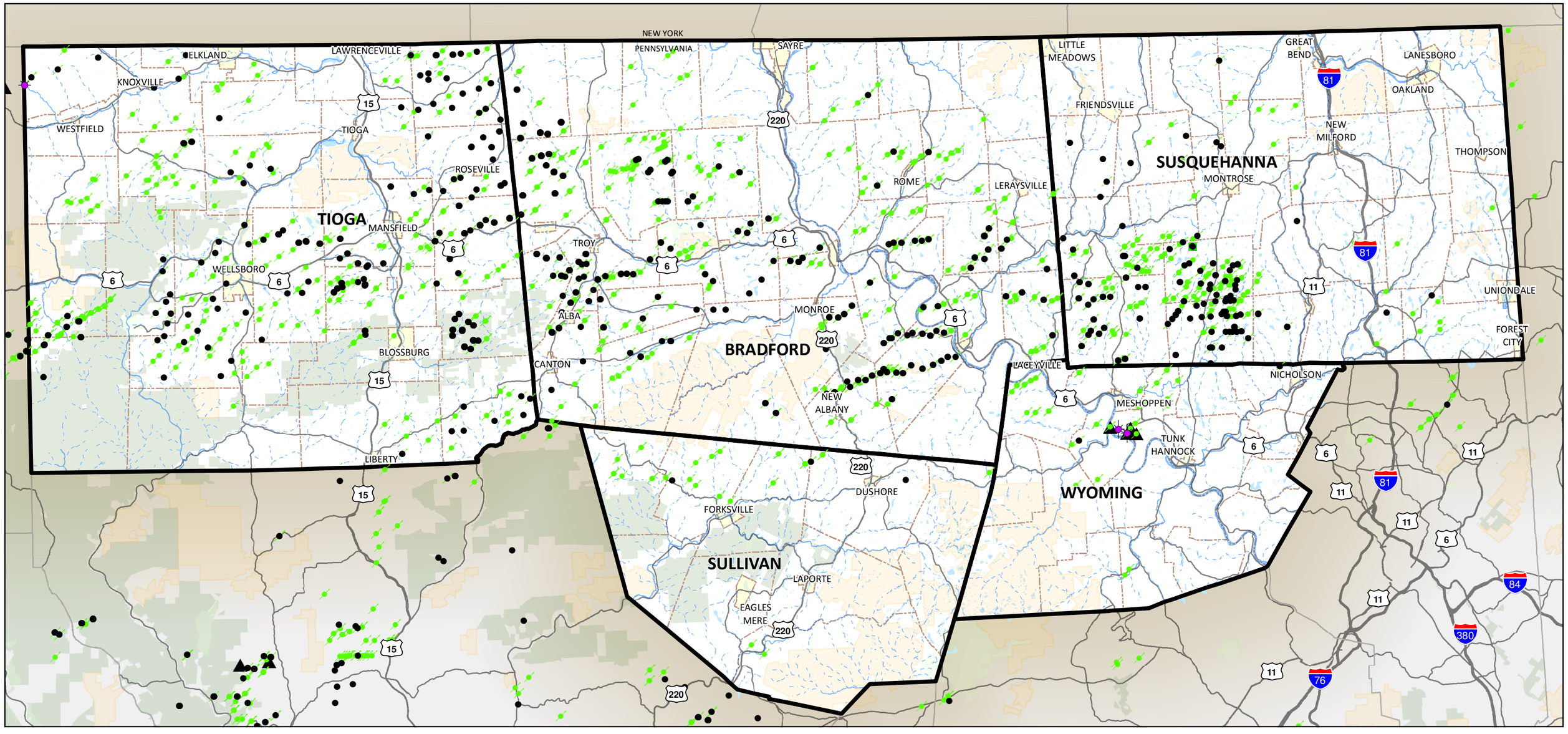
Table 7 below shows the 20 municipalities in the Northern Tier with the greatest number of active wells.

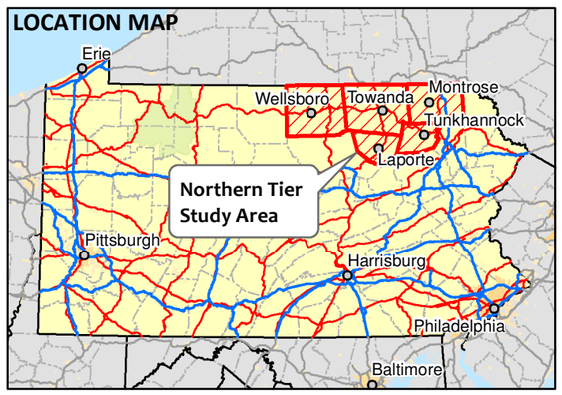
Table 7: Municipalities with the Greatest Number of Wells Drilled
(Top 20 as of December 2010)

Municipality	County	# of Drilled Wells
Columbia Twp	Bradford	86
Dimock Twp	Susquehanna	58
Sullivan Twp	Tioga	57
Ward Twp	Tioga	52
Wells Twp	Bradford	47
Springville Twp	Susquehanna	44
Jackson Twp	Tioga	43
Covington Twp	Tioga	43
Troy Twp	Bradford	40
Delmar Twp	Tioga	35
Armenia Twp	Bradford	35
Charleston Twp	Tioga	35
Terry Twp	Bradford	31
Granville Twp	Bradford	30
Auburn Twp	Susquehanna	30
Gaines Twp	Tioga	24
Canton Twp	Bradford	21
Rutland Twp	Tioga	20
Herrick Twp	Bradford	20
Springfield Twp	Bradford	19

Source: PADEP

From July of 2009 to the end of June 2010 gas wells in the Northern Tier produced 110 million mcf of natural gas. In the 6 months following, there was a 53 percent increase in well production in half the time. This trend indicates that as wells continue to be drilled, production of those wells is increasing at a larger rate, and the industry is beginning to mature. Figure 4 through Figure 7 show the wells that have been permitted and drilled as of December 2010 and the total production of active wells for the same time period.





Legend

- Gas Well Permit, Drilled
- Gas Well Permit, Not Drilled
- Oil Well Permit, Not Drilled
- Combination Oil/Gas Permit, Not Drilled
- Combination Oil/Gas Permit, Drilled

Scale (Miles)

0 3 6 12 18

N

Gannett Fleming

Data Sources:

2010 PENNDOT GIS layers, PA DCNR State Parks and State Forests, PA Game Commission State Gamelands, 2010 National Transportation Atlas Database, 2009 PADOT Rail Plan. 2010 PADEP, University of Pittsburgh: Center of Healthy Environments & Communities

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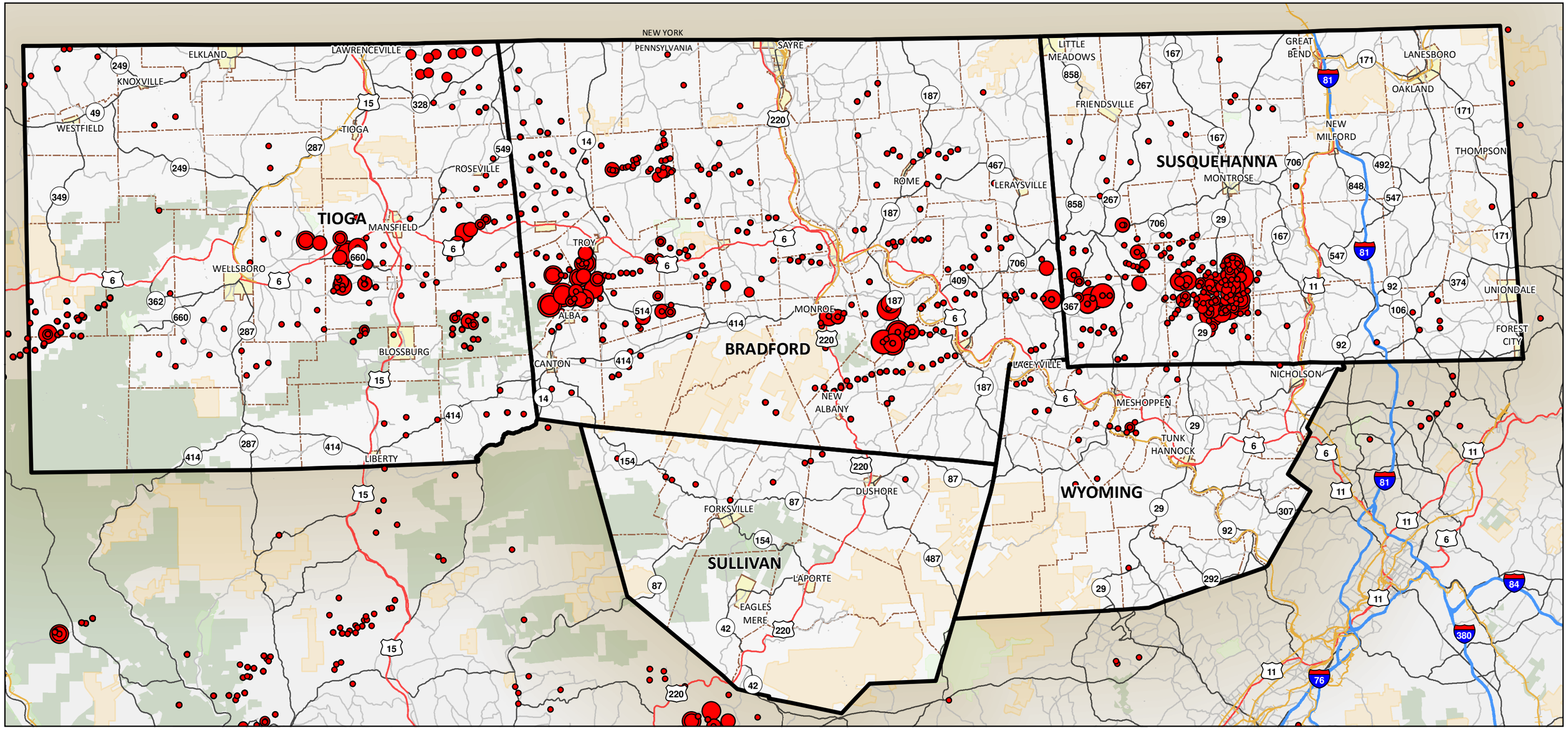
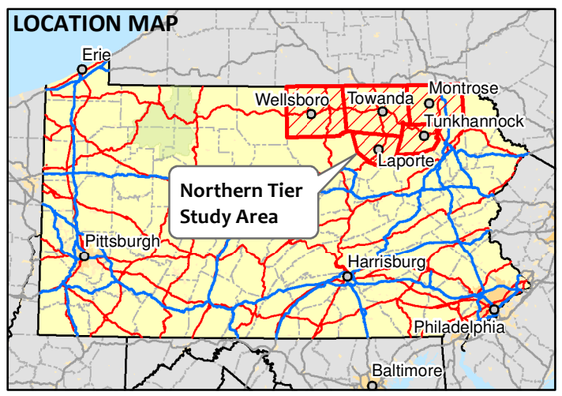
Marcellus Shale Freight Transportation Study

Marcellus Shale
Permitted & Drilled Wells
(2007-2010)

Figure 4

November 2011





Legend

Marcellus Gas Well Production (2009-2010)

Gas Quantity in MCF (One thousand cubic feet)

- 0 - 97,925
- 97,926 - 326,251
- 326,252 - 668,239
- 668,240 - 1,240,156
- 1,240,157 - 2,841,152

Scale (Miles)

0 3 6 12 18

N

Gannett Fleming

Data Sources:

2010 PENNDOT GIS layers, PENNDOT Bureau of Planning and Research & Bureau of Maintenance and Operations, Gannett Fleming, Transportation Operations Group, PA DCNR State Parks and State Forests, PA Game Commission State Gamelands, 2010 National Transportation Atlas Database, 2009 PADOT Rail Plan

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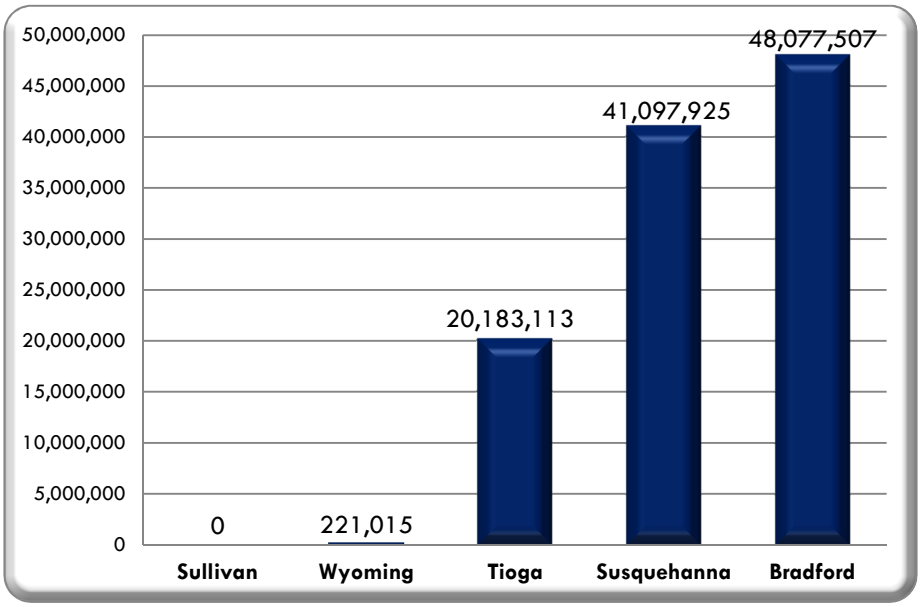
Well Production (2009 - 2010)

Figure 5

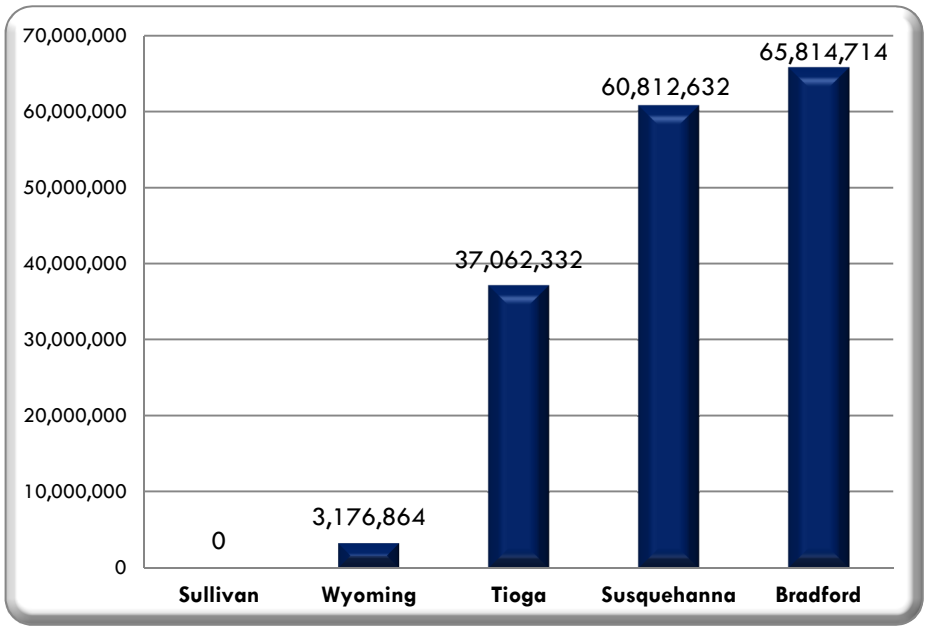
November 2011

Figure 6: Total Well Production (mcf) July 2009 to June 2010



Source PADEP

Figure 7: Total Well Production (mcf) July 2010 to December 2010



Source PADEP

WATER WITHDRAWAL

Water withdrawals and delivery to well sites is the single largest generator of trucks specific to Marcellus Shale gas extraction in the Northern Tier

Gas companies must obtain permits from the Susquehanna River Basin Commission and the Pennsylvania Department of Environmental Protection to withdraw water from streams or rivers. Water withdrawals and delivery to well sites is the single largest generator of trucks specific to Marcellus Shale gas extraction in the Northern Tier. A water management plan is required under DEP's permitting process for Marcellus Shale wells. Water used for wells in the Delaware, Potomac and Susquehanna River basins must be reviewed by interstate federal commissions prior to the withdrawal of water from waterways in those river basins.

The water withdrawal sites are often located off of major roadways and require trucks to access them via local rural roadways. Resulting from SRBC rules effective January 2009, some communities such as Troy are also selling water from municipal water supplies. The rules apply to consumptively used water taken from public water supply systems. A recent Penn State report states that "gas companies can use the procedure to seek approval for consumptive water use, no matter where the water comes from. This encourages the reuse of municipal wastewater, mine pool water, and other lesser quality sources instead of freshwater."[4] The report states that in 2009, just under 30 percent of water used for fractionation in the SRBC region originated at public water supplies.

Table 8: Use of Flowback Water in the PA Susquehanna River Basin (June 1, 2008 to May 21, 2010)

Wells using flowback water for fractionation	59%
Companies using flowback water for fractionation	56%
Flowback water brought onsite that is used	88%
Total flowback reused	44.1 million gal.
Total flowback disposed	21.0 million gal.

Source: SRBC (220 wells reporting)

Water withdrawals are a required part of the drilling process. Water is needed on an on-going basis during the fracturing and drilling process. This requires a steady flow of water deliveries by truck from water withdrawal sites to well pads. Water impoundments have been increasingly used to reduce the number of truck trips per site. These facilities have been gaining popularity for larger operations in remote

[4] Penn State College of Agricultural Sciences, Cooperative Extension, *Marcellus Shale Education Fact Sheet: Water Withdrawals for Development of Marcellus Shale Gas in Pennsylvania*, 2010

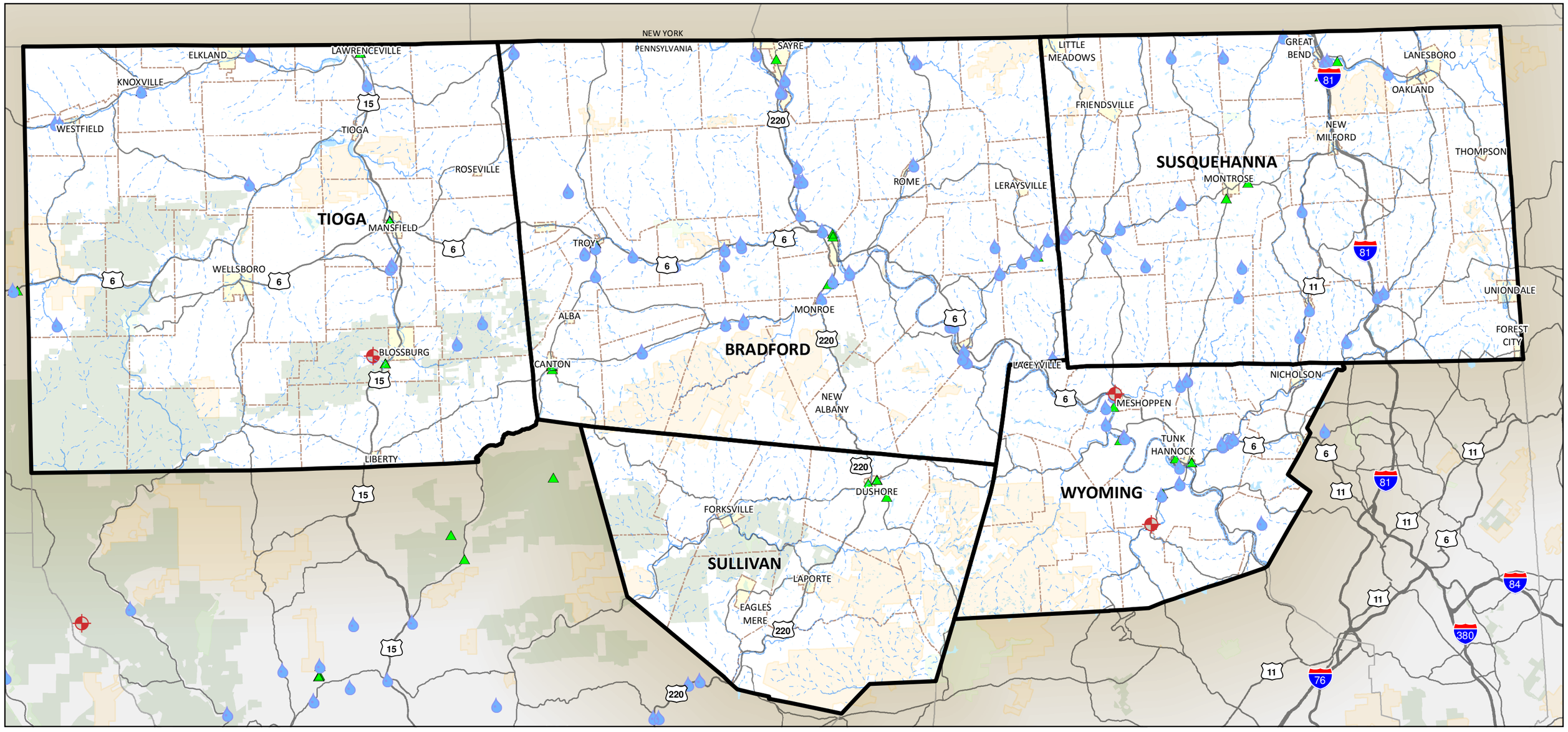
locations. In addition, pipelines are being built for larger and more consistent water delivery closer to well sites. On average, it is estimated that 300 trucks are needed to haul water to each well during its lifespan. Figure 8 below shows the permitted water withdrawal sites in the Northern Tier.

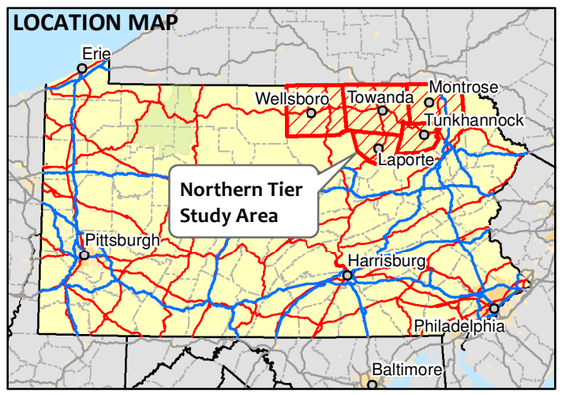
On average, it is estimated that 300 trucks are needed to haul water to each well during its lifespan

Once the fracturing process is complete, used water, or brine, is stored in lined, on-site holding ponds or tanks and is held until it is transported for treatment at a DEP permitted facility, or recycled. To limit the cost and time it requires for water delivery and recycling, gas producers are currently reusing between approximately 60 and 90 percent of the water used in the fractionation process. To reuse water it must be treated by employing one of the following processes:

- **Direct reuse without treatment**—Blending spent water with fresh water for reuse
- **On-site treatment and reuse**—Using equipment and processes to treat water on-site
- **Off-site treatment and reuse**—Using equipment and processes to treat water off-site

As would be expected, off site treatment and disposal increases the number of trucks generated per well and potential related regional congestion.





Legend

- Surface Water Withdrawal
- Ground Water Withdrawal
- Interconnection
- Streams
- Water Bodies

Scale (Miles)
0 3 6 12 18

N

Data Sources:
Water resources used in the oil & gas industry were gathered from Pennsylvania DEP, dated July 2011 and Bradford County GIS, 2010.

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Marcellus Shale Freight Transportation Study

Water Withdrawal Sites

(as of December 2010)

Figure 8

November 2011

SAND DELIVERY

Sand for Marcellus Shale gas production is almost exclusively delivered from the Midwest via rail. Transload facilities have been established along rail lines so that sand can be loaded into trucks for delivery to well sites. Transload sites are located in both New York and Pennsylvania for Northern Tier based gas operations.

The sand mix used is unique and selected for each specific well. The differences in sand are the diameter and shape of the grains. Sand for gas extraction must be more rounded to allow water used for fracturing rock to pass through while the sand maintains the fracture of the rock, allowing gas to be collected.

An average rail car can carry 100 tons of sand which requires 4 or 5 trucks for offloading via a mobile conveyor. A single well may use up to 25 rail cars of sand.

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PIPELINES

Currently, gas resulting from operations is carried by gathering pipelines. The gas is transported to compressor stations that assist it in moving to larger interstate pipelines which are regulated by the Federal Energy Regulatory Commission. More than half of all applications for new pipelines over the past year to the federal government were a result of Marcellus Shale gas operations.

Projects currently under construction and those proposed will have the capacity to move an additional four billion cubic feet of natural gas a day, which is double the current capacity. This includes a second 30-inch pipeline along the existing Tennessee gas pipeline. Additional compressor stations will be included with the project and will increase delivery capacity in the region. Thousands of smaller pipelines are being planned and constructed to tap into the new facility throughout the region. Local officials have stated that there is little coordination among the gas companies to collaborate and consolidate pipelines from various wells, and utilize common rights of way for major collection lines. This creates redundant pipelines and multiple applications that require review by municipalities.

Water pipelines are also being constructed to fill water impoundments in those areas where long-term water use is expected to be the greatest. According to PRNewswire, Aqua America Inc. and Penn Virginia Resource Partners, L.P. (PVR) have formed a joint venture to construct and operate a private pipeline system to supply fresh water for Marcellus Shale operations in Lycoming County. These lines will parallel the trunkline of PVR's gathering system. The group has entered into an agreement to provide water with Range Resources, and hopes that the $24 million investment will be off-set by additional drilling companies. The projected pipeline is expected to be completed and operational in the first quarter of 2012.[5] Such large scale water supply pipelines could be planned and executed in the Northern Tier region; however none were discovered through stakeholder interviews.

Pipeline construction requires moving crews to stage, dig, fasten, and bury the lines. Requests for gas pipelines to be placed within the right of way or across state highways are being received regularly by PennDOT. Pipeline development (specifically water) could reduce truck traffic significantly depending on the scale of operations and the proximity to well sites.

[5] PRNewswire, *Aqua America and PVR Partners Announce Joint Venture Private Water Pipeline in the Marcellus Shale*, September 20, 2011

CURRENT TRANSPORTATION SYSTEM

Common to all gas companies in the Northern Tier is their need for access to highway and rail infrastructure. The ability for workers, equipment, and materials to move to remote locations throughout the region is critical. Concerns about heavy vehicles on roadways that have not been engineered for such loads are felt by state and local road owners alike.

Current transportation conditions described in this section revolve around the volume of traffic and not the condition of the roadways, although the ability of the state and local agencies to handle deteriorating conditions is included.

ROADWAY CONDITIONS

Trucks provide the majority of Marcellus Shale related movements and are therefore the focus of this analysis. There are over 7,700 linear miles of roadway crisscrossing the Northern Tier. While the region has less than 1.5 percent of the state's total population, it has nearly 6.4 percent of its public roadways. The region also includes nearly seven percent of all the state's roadways that are maintained and operated by other agencies. These include facilities owned and maintained by other state and federal agencies such as state universities, the Pennsylvania Department of Conservation and Natural Resources, and the U.S. Forest Service.

Table 9: Northern Tier Roadway Mileage by Jurisdiction

	PennDOT	Other Agencies	Local Municipal	Total
Bradford	896	3	1,594	2,493
Sullivan	244	74	298	616
Susquehanna	793	0	1,075	1,869
Tioga	629	208	1,141	1,978
Wyoming	365	0	397	762
Northern Tier	2,927	285	4,505	7,717
Pennsylvania	39,839	4,058	77,526	121,990

Source: PennDOT Highway Statistics, 2009

TRUCK VOLUMES ON REGIONAL ROADWAYS

Roadway volumes in the Northern Tier have increased dramatically since 2007. Overall average annual daily traffic (AADT) in the 5-county region rose 12 percent and average daily truck traffic (ADTT) rose 22 percent from 2007 to 2010. The largest traffic growth is in Bradford and Susquehanna Counties while the largest percentage growth was in Tioga and Susquehanna Counties. Compared to a traffic growth rate of approximately one percent annually between 1996 and 2006, this four percent annual increase in average daily traffic and over seven percent in average daily truck traffic can be directly attributed to Marcellus Shale activity.

Compared to a growth rate of approximately one percent annually between 1996 and 2006, the four percent annual increase in average daily traffic and over seven percent in average daily truck traffic from 2007 to 2010 can be directly attributed to Marcellus Shale activity.

Table 10: Change in AADT and ADTT in the Northern Tier (2007 to 2010)

County	County-wide % Change in AADT	County-wide % Change ADTT
Bradford	1%	13%
Sullivan	4%	6%
Susquehanna	10%	12%
Tioga	38%	58%
Wyoming	4%	12%
Overall Avg.	**12%**	**22%**

Source: PennDOT RMS[6]

US highways such as US 6, US 220, and US 15 carry a great deal of regional truck traffic between well sites and the materials required for gas production. These regional arteries are maintained by PennDOT and are "traffic routes" which do not allow the Department to post and bond the roads. Therefore, all traffic is allowed to use them, with no attribution of deterioration to a single user or industry.

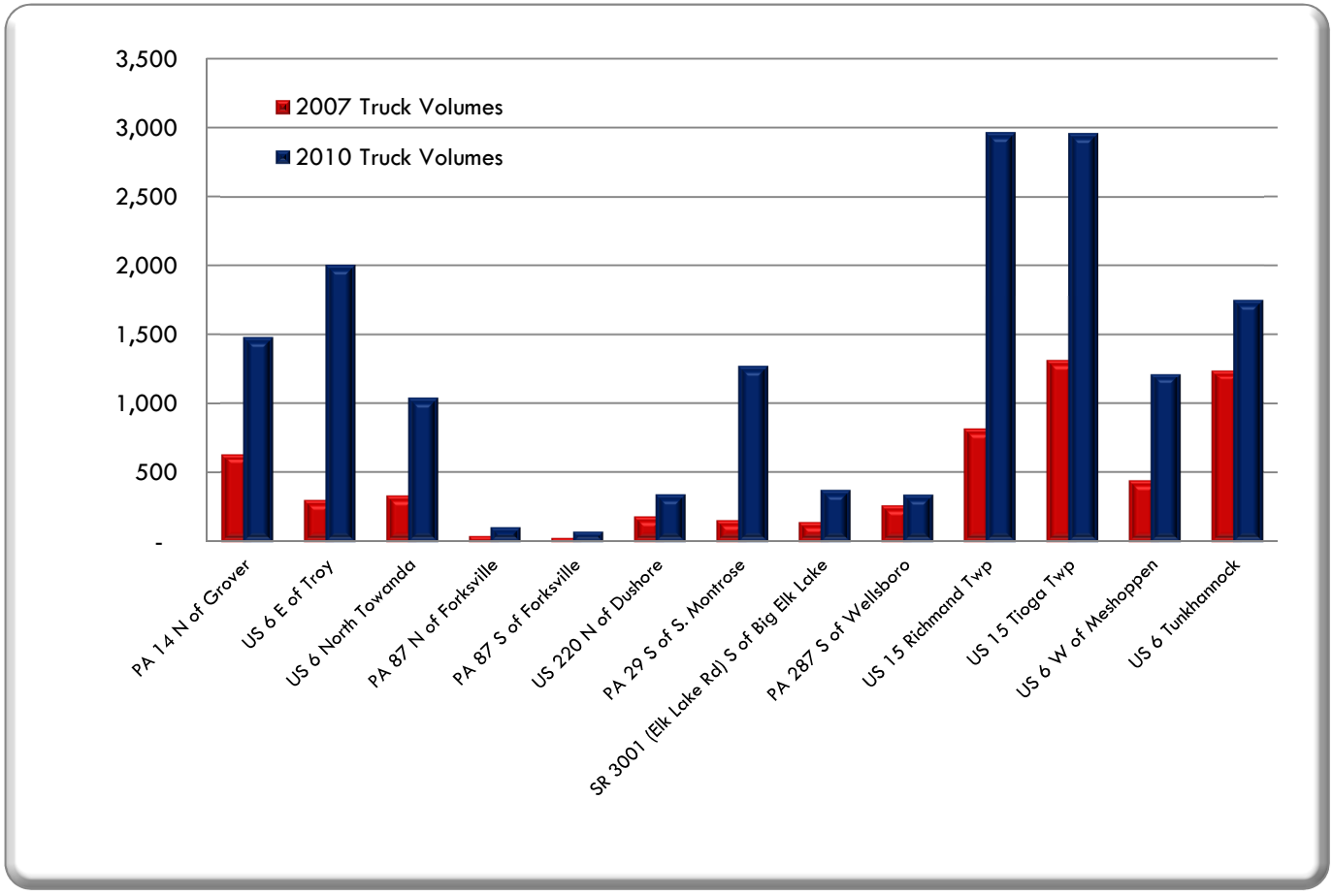
Between 2007 and 2010, overall truck traffic volume on the region's US highways grew by nearly 125 percent, accounting for 16.5 percent of all traffic on these roadway segments, up from 8.6 percent just three years prior.

In addition, a major concern in the region is the impact of Marcellus Shale operations on secondary roads, which were built to accommodate lower volumes of lighter traffic.

[6] Many routes in the RMS database do not have 'current' ADT but rates applied to base counts. Therefore, actual increases may be more than indicated.

Figure 9 and Table 11 below show a sample of selected roadways within the region. These links show a dramatic increase in truck traffic and are examples of the issues facing the region.

Figure 9: 2007 vs. 2010 Daily Truck Volume Examples



Source: PennDOT and traffic counts

Table 11: 2007 and 2010 Daily Truck Volume Examples						
County	Location	2007 Truck Volumes	2007 Truck %	2010 Truck Volumes	2010 Truck %	Truck % Increase
Bradford	PA 14 N of Grover	634	18%	1,482	27%	134%
Bradford	PA 14 (Canton Street) Troy	1,115	15%	1,202	14%	8%
Bradford	US 6 E of Troy	302	9%	2,005	34%	564%
Bradford	US 6 North Towanda	333	4%	1,039	10%	212%
Bradford	US 6 Burlington	168	6%	1,313	20%	682%
Bradford	US 6 Sylvania	152	6%	580	12%	282%
Bradford	SR 2024 (Airport Rd)	25	10%	34	10%	36%
Sullivan	PA 87 N of Forksville	44	5%	107	11%	143%
Sullivan	PA 87 S of Forksville	32	4%	76	10%	138%
Sullivan	US 220 N of Dushore	184	8%	342	9%	86%
Sullivan	PA 487	48	3%	162	10%	238%
Susquehanna	PA 29 S of S. Montrose	158	6%	1,275	28%	707%
Susquehanna	SR 3001 (Elk Lake Rd) S of Big Elk Lake	144	10%	373	20%	159%
Susquehanna	SR 2063 (Creek Rd.)	32	6%	98	6%	206%
Tioga	PA 287 S of Wellsboro	263	12%	340	12%	29%
Tioga	PA 660 (Pine Creek Rd) W of Wellsboro	124	4%	246	8%	98%
Tioga	SR 2022 (Old State Rd) Btwn Aumick & Tice Rd	24	10%	52	13%	117%
Tioga	US 15 Richmand Twp	819	8%	2,965	33%	262%
Tioga	US 15 Tioga Twp	1,317	12%	2,957	28%	125%
Tioga	US 6 W of Mainesburg	247	7%	1,303	24%	428%
Tioga	US 6 W of SR 0362 (by airport)	386	14%	690	19%	79%
Tioga	SR 4002 (Charleston Rd.)	94	6%	116	6%	23%
Wyoming	US 6 W of Meshoppen	441	9%	1,215	18%	176%
Wyoming	US 6 Tunkhannock	1,240	13%	1,750	15%	41%
Wyoming	SR 4008 (Meshoppen Crk Rd.)	15	2%	172	16%	1,047%

Source: PennDOT and traffic counts

POSTED AND BONDED ROADS

PennDOT has taken significant steps to mitigate on-going and potential damage to state owned secondary roads. Under the state's posted and bonded road program, heavy truck carriers are financially responsible for excess maintenance on the highways they use. When a roadway is to be used by heavy truck traffic, PennDOT will conduct a study to determine if the road can accommodate expected traffic. If PennDOT

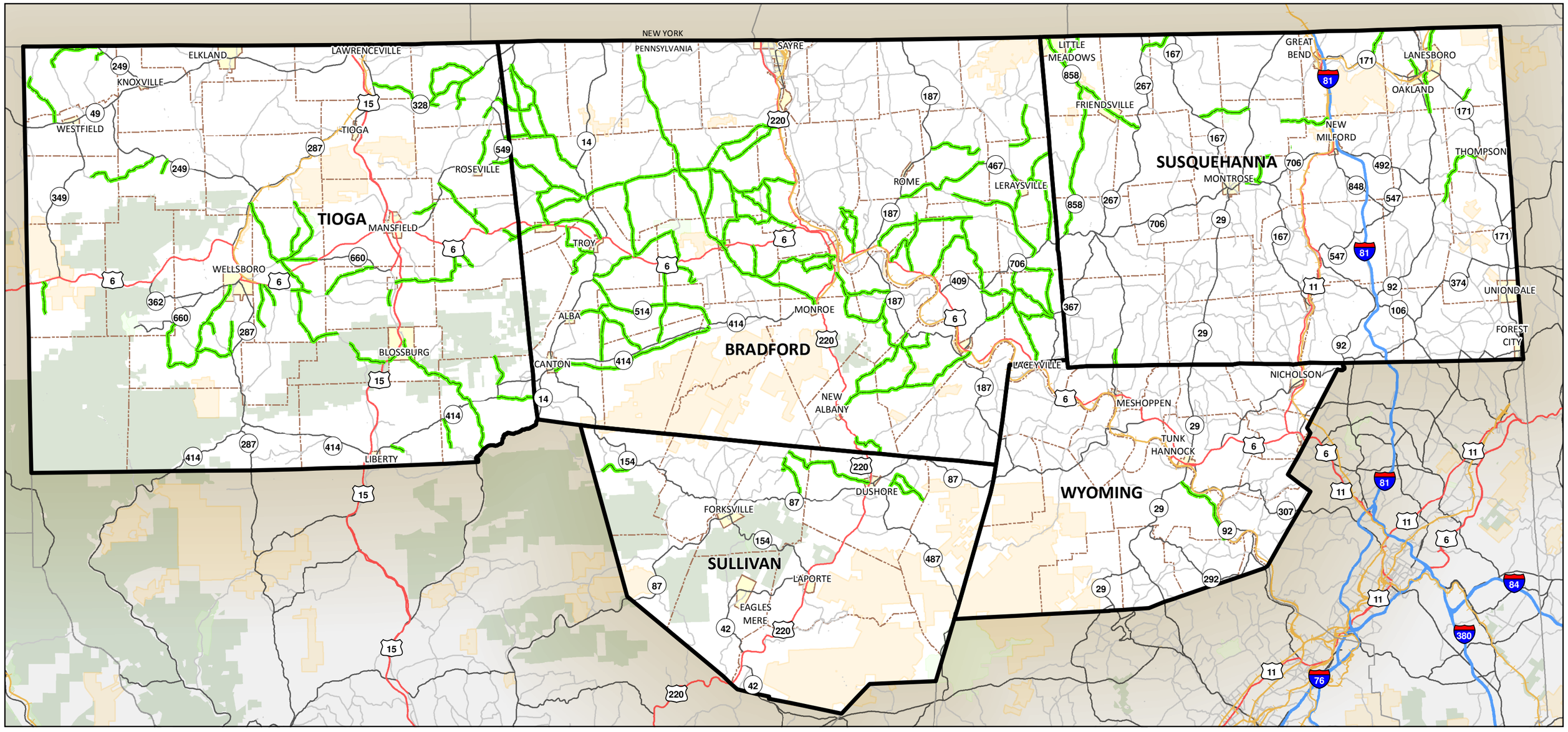
sets a weight limit on a road, anyone that intends to exceed the limit must reach an agreement with PennDOT to make any repairs necessary.

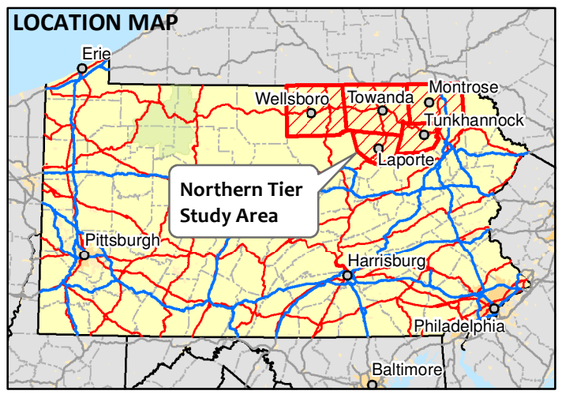
The increase in truck traffic resulting from Marcellus activity has prompted PennDOT to post a large portion of their system. This includes most of the secondary system and some minor traffic routes which are not built to handle the large amount of truck traffic. The table below shows the mileages of posted and bonded PennDOT roadways in the Northern Tier region. In the Northern Tier, 70 percent of all state roadway miles have been posted. This is up from just over 2 percent three years prior. As shown in Table 12, a total of 47 percent of all roads are bonded by one or more entities. Figure 10 shows the posted and bonded roads within the Northern Tier.

Table 12: PennDOT Posted and Bonded Roadway Mileage

County		Posted Miles	% of Total Miles	Bonded Miles	% of Total Miles
Bradford		703	78%	574	64%
Sullivan		152	62%	85	35%
Susquehanna		555	70%	308	39%
Tioga		416	66%	299	48%
Wyoming		230	63%	115	32%
Total		**2,056**	**70%**	**1,381**	**47%**

Source: PennDOT Dist. 3-0 and PennDOT Dist. 4-0 as of Nov 2011





Legend

- Bonded Roads
- Northern Tier Counties
- Railroad
- Interstates
- US Routes
- PA Routes
- Other State Roads
- Municipal Boundaries
- Borough
- State Parks
- State Game Lands
- State Forests

Scale (Miles): 0 3 6 12 18

N

Data Sources:
2010 PENNDOT GIS layers, PENNDOT Bureau of Planning and Research & Bureau of Maintenance and Operations, Gannett Fleming, Transportation Operations Group, PA DCNR State Parks and State Forests, PA Game Commission State Gamelands, 2010 National Transportation Atlas Database, 2009 PADOT Rail Plan

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Northern Tier Bonded Roads

(as of December 2010)

Figure 10

November 2011

US 6 CORRIDOR AUDIT

With increased truck traffic in the Northern Tier, there will be additional freight demands on the US 6 corridor. US 6 is the primary east-west roadway through the region. For most of the corridor, US 6 is a two-lane roadway with one lane per direction, with some passing and truck climbing lanes east of Towanda. There are several intersections without left-turn lanes, as well as several bottlenecks that may slow the flow of traffic along this corridor.

Table 13 is a summary of traffic-related areas of need for the corridor that were generated from a US 6 corridor audit. In keeping with the high-level nature of this study, traffic engineers identified locations along the corridor that appear to have deficiencies based on professional judgment. These needs are based only on appearance and the judgment of the study team. For example, needs were identified if there appeared to be grade changes, intersections that may delay traffic from a lack of turn lanes, other appearances of delays, or possible safety-related issues. More detailed study would be required before programming specific projects; keeping in mind that truck traffic may increase and then begin to decrease before certain projects are able to be completed. There may also be additional areas of need along the corridor that are not noted within this section.

The audit was conducted in the three counties that US 6 traverses in the Northern Tier region (Tioga, Bradford, and Wyoming). The intent of this audit (which was conducted and summarized from west to east) is to provide an awareness of these areas of need, and to consider upgrades and further study as traffic increases and funding becomes available.

Table 13: US Route 6 Audit Locations Summary

Location	Existing/Preferred Condition
US 6 at SR 349	 **Existing:** The intersection with SR 349 forms a three-leg intersection. There is no left-turn lane. **Preferred:** Consider widening to add a left-turn lane. This will minimize delay to through traffic as traffic waits for a gap to turn left.
US 6 at SR 362	 **Existing:** The intersection with SR 362 forms a three-leg intersection. There is no left-turn lane. Additionally, there is a slight downgrade for left-turn traffic. **Preferred:** Consider widening to add a left-turn lane. This will minimize delay to through traffic as traffic waits for a gap to turn left. It will also add a haven for vehicles turning left, which would be especially beneficial due to the downgrade.
US 6 at SR 287	 **Existing:** Although not a formal left-turn lane, this intersection has a bypass lane for through vehicles to bypass left-turn vehicles. There is a curve approaching this intersection which reduces sight distance. **Preferred:** Convert this bypass lane into a formal left-turn lane. Although the bypass lane assists from a capacity standpoint, because of the curve, it would be preferred if all vehicles would be directed into their lane.

Location		Existing/Preferred Condition
US 6 in Wellsboro		**Existing:** There are three traffic signals along US 6 in Wellsboro Borough. Although they are new or being upgraded, the existing lanes are a limitation to capacity. **Preferred:** As these intersections act as a bottleneck, ensure that the traffic signals are properly maintained. The only remedy long-term is to provide additional capacity which is not feasible in the downtown setting.
US 6 East of Wellsboro		**Existing:** East of Wellsboro traveling eastbound, there is an upgrade. This begins as traffic accelerates leaving Wellsboro. **Preferred:** Consider adding a truck climbing lane. Since traffic accelerates to a greater speed leaving Wellsboro, trucks could limit acceleration due to lower acceleration rates.
US 6 at SR 660		**Existing:** The intersection with SR 660 is a four-leg intersection without left-turn lanes. **Preferred:** Add left-turn lanes in both directions to be used by traffic turning from US 6.

Location		Existing/Preferred Condition
US 6 west of Mansfield		**Existing:** West of Mansfield traveling westbound, there is an uphill grade change. This begins as traffic accelerates leaving Mansfield. **Preferred:** Consider adding a truck climbing lane. Since traffic accelerates to a greater speed leaving Mansfield, trucks could limit acceleration due to lower acceleration rates.
Mansfield Borough		**Existing:** The traffic signal at the intersection with Business 15 acts as a bottleneck. Although this signal is being upgraded, the available width limits capacity upgrade potential. **Preferred:** Monitor and retime the signal periodically to ensure that operations are maximized. It may be possible to add capacity in the form of left-turn lanes if on-street parking is eliminated.
US 6 at SR 549		**Existing:** The intersection with SR 549 lacks left-turn lanes. There is a left-turn bypass lane at this location. **Preferred:** Upgrade this intersection to provide a formal left-turn lane. Although the bypass lane aids traffic flow by minimizing delay to through vehicles, through traffic should remain in their lane.

Location		Existing/Preferred Condition
US 6 at Scouten Road		**Existing:** Although the side street appears to be low-volume, this intersection lacks left-turn lanes. There is a crest vertical curve in this area which may limit sight distance. **Preferred:** Even though they may not be needed from a pure volume standpoint, if left-turn lanes were provided at this location, they would reduce potential safety concerns related to the crest curve.
US 6 west of Sylvania		**Existing:** West of Sylvania traveling westbound, there is an upgrade. **Preferred:** Consider adding a truck climbing lane. Since traffic accelerates to a greater speed leaving Sylvania, trucks could limit acceleration due to lower acceleration rates.
Troy Borough		**Existing:** The traffic signal with SR 14 acts as a bottleneck. This signal is pretimed, and operates inefficiently during several hours of a typical day. **Preferred:** Consider upgrading this traffic signal. The width available limits capacity, however if the signal were upgraded, operations would improve.

Location		Existing/Preferred Condition
US 6, east of Troy		**Existing:** This bridge lacks shoulders. This limits the ability to provide a left-turn lane at this adjacent intersection. **Preferred:** As the bridge requires upgrade or replacement, consider providing full shoulders.
US 6, east of Troy		**Existing:** This location has a driveway for an active gas well. Turn restriction signs are posted due to sight distance limitations. There is no adequate location to turn around in this area. **Preferred:** Upgrade to provide adequate sight distance for all turning movements, and require this of future developers.
US 6 in West Burlington		**Existing:** The intersection with SR 3009 is offset and lacks left-turn lanes. **Preferred:** Ideally, this intersection should have left-turn lanes, and not be offset. At a minimum left-turn lanes would minimize delay to through vehicles.

Location	Existing/Preferred Condition	
US 6 at SR 3009 in Burlington		**Existing:** This intersection lacks left-turn lanes. **Preferred:** Ideally, this intersection should be widened to provide left-turn lanes. Land use would complicate improvements.
US 6 at SR 4001 (Saco Rd)		**Existing:** This intersection lacks a left-turn lane. Additionally, there is an upgrade approaching the intersection. If vehicles are stopped waiting to turn left, delays to through vehicles will be worsened due to the grade. **Preferred:** Widen to provide a left-turn lane to minimize delays to left-turn vehicles.
US 6, just west of US 220		**Existing:** East of the interchange with US 220, there is an upgrade. **Preferred:** Consider adding a truck climbing lane to minimize delays resulting from trucks accelerating at lower rates.

Location	Existing/Preferred Condition
Towanda Borough	  **Existing:** Intersections in Towanda currently operate unacceptably. At Bridge Street, the intersection is limited due to width. At the intersection with the Susquehanna River bridge, the signal operates inefficiently due to the complex signal phasing due to two closely-spaced intersections operating under one signal controller. **Preferred:** PennDOT is currently performing a study on intersections and traffic flow in Towanda. Consider possible improvements such as signal upgrades, opportunities for additional capacity, potential for a one-way pair for US 6 with Merrill Parkway.
US 6 at SR 187	 **Existing:** Existing intersection configuration is tight. Corner radii are tight. Right-turning movements are difficult for large trucks. **Preferred:** Widen intersection and provide correct turning radii.

Location		Existing/Preferred Condition
US 6 at SR 409		**Existing:** There are no turn lanes approaching the intersection with SR 409. It is on a grade in this area, through vehicles must slow for turning vehicles. US 6 is built to a higher design speed; vehicles are likely to travel faster through this area. **Preferred:** Provide left-turn and right-turn lanes at this intersection.
US 6 at Second St in Laceyville		**Existing:** This intersection lacks turn lanes. **Preferred:** Consider providing left-turn lanes for each direction. The overpass limits taper rates needed for turn lanes.
US 6 at SR 367		**Existing:** There are no left-turn lanes at this intersection. **Preferred:** Consider adding turn lanes at this intersection to minimize delays to through vehicles.

Location		Existing/Preferred Condition
US 6 at SR 267		**Existing:** This intersection lacks turn lanes. **Preferred:** Consider providing left-turn lanes for each direction.
US 6 at SR 4008		**Existing:** There are no turn lanes approaching this intersection. It is on a grade in this area; through vehicles must slow to for turning vehicles. US 6 is built to a higher design speed; vehicles likely travel faster in this area. **Preferred:** Provide left-turn lanes at this intersection.

BOTTLENECKS

Bottlenecks are a major concern in the Northern Tier. They contribute to congestion, air pollution, and noise at specific locations. Within the region these are primarily located at busy intersections within boroughs; however Marcellus drilling activity creates bottlenecks at more remote well access points during periods of heavy traffic such as well drilling and fracturing. Because these locations are relatively short-term, they are difficult to identify and most will be eliminated once drilling activities subside. This makes them difficult for state and local roadway agencies to contend with, except through the posting and bonding process. Bottlenecks identified include:

- US 6 in Wellsboro Borough
- US 6 in Mansfield Borough
- US 6 in Troy Borough
- US 6/Main Street in Towanda Borough
- US 6 in Wysox Borough

- US 220 in Dushore Borough
- Main Street in Athens Borough
- US 220 in Monroeton
- US 6 in Wyalusing Borough
- PA 167 in Montrose Borough
- US11 in New Milford
- US 11 in Hallstead
- US 6 and PA 29 in Tunkhannock Borough
- Staging locations for sand, pipe and water extraction (which are temporary)

BRIDGE CONDITIONS

State bridges may also pose a problem with the movement of Marcellus Shale related truck traffic. As bridges become structurally deficient, trucks may need to be diverted to alternate routes, increasing truck vehicle miles traveled throughout the region. Susquehanna County is of particular concern as over one quarter of all bridges are categorized as structurally deficient. In addition, the county is expected to contain 15 percent of all wells drilled in the region. Table 14 shows those structurally deficient state-owned bridges under 8 feet within the Northern Tier.

Table 14: State Bridges > 8 Ft. by County
(as of December 2010)

	Total No. of Bridges	Structurally Deficient	
		No.	%
Bradford	509	58	11%
Sullivan	139	10	7%
Susquehanna	410	115	28%
Tioga	522	43	8%
Wyoming	201	51	25%
Total	**1,781**	**277**	**17%**

Source: PennDOT Bridge Reports 6/29/11

Counties are responsible for the maintenance of over 100 regional county-owned bridges more than 20 feet in length. These bridges provide critical linkages along roadways that carry Marcellus Shale truck traffic. Bridges that weren't designed for heavy truck traffic or have deteriorated over time pose a significant constraint in rural areas,

where detours can require trucks to add many additional miles to their trip. Table 15 below shows the county-owned bridges under 20 feet in length that are closed and posted in the Northern Tier by County.

Table 15: Posted and Closed County-Owned Highway Bridges > 20 Ft.
(as of June 2011)

	No. of Bridges	Closed		Posted		Structurally Deficient	
		No.	%	No.	%	No.	%
Bradford	48	1	2%	18	38%	25	52%
Sullivan	6	0	0%	2	33%	1	17%
Susquehanna	32	0	0%	6	19%	3	9%
Tioga	13	0	0%	2	15%	2	15%
Wyoming	10	0	0%	3	30%	3	30%
Total	**109**	**1**	**1%**	**31**	**28%**	**34**	**31%**

Source: PennDOT Bridge Reports 6/29/11

Municipal bridges were also not designed to carry the heavy loads they are being tasked to accommodate. In the Northern Tier over 40 percent of municipal-owned bridges are structurally deficient, over 30 percent have posted weight limits, and 3 percent are closed as shown in Table 16 below.

Table 16: Closed and Posted Municipal-Owned Highway Bridges > 20 Ft.
(as of June 2011)

	No. of Bridges	Closed		Posted		Structurally Deficient	
		No.	%	No.	%	No.	%
Bradford	80	0	0%	24	30%	35	44%
Sullivan	32	3	9%	14	44%	18	56%
Susquehanna	26	1	4%	4	15%	9	35%
Tioga	80	3	4%	26	33%	28	35%
Wyoming	14	1	7%	5	36%	9	64%
Total	**232**	**8**	**3%**	**73**	**32%**	**99**	**43%**

Source: PennDOT Bridge Reports 6/29/11

RAILROAD CONDITIONS

The rail system is critical to the movement of goods for various tenants in the region. Recent trends in moving materials for Marcellus Shale operations have increased the volume of rail movements dramatically. These movements along with other rail traffic have required the need for rail related improvements and operational changes. In addition, the locations of transload facilities also have significant impacts on the adjoining highway network, as well as a reduction in long-haul trips destined for, or originating from, the Northern Tier Region.

Railroads are investing heavily in their lines in the Northern Tier by adding additional track, sidings, and transload terminals. Additional needs exist due to the dramatic increases in rail freight activity.

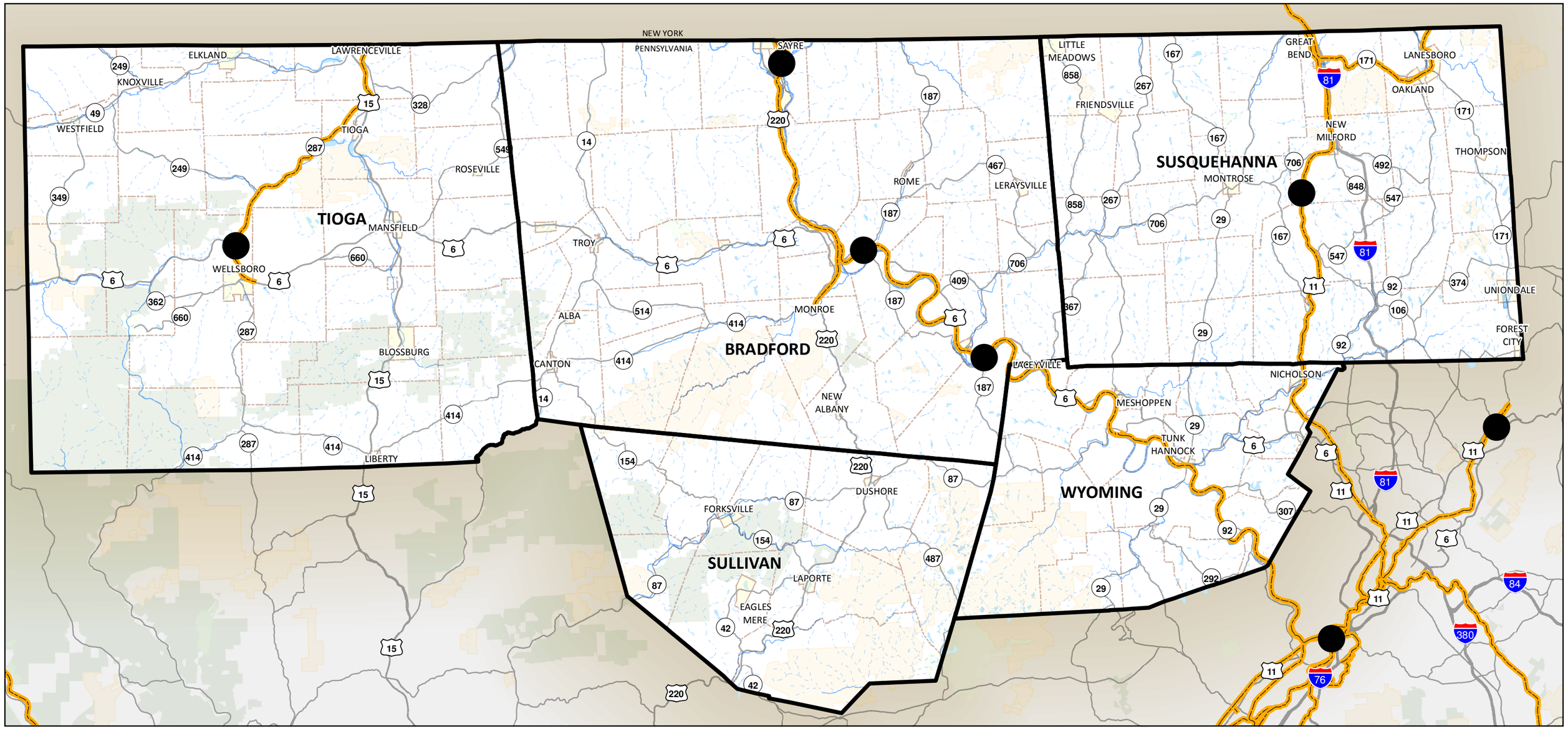
Commodities handled by rail in the region include:

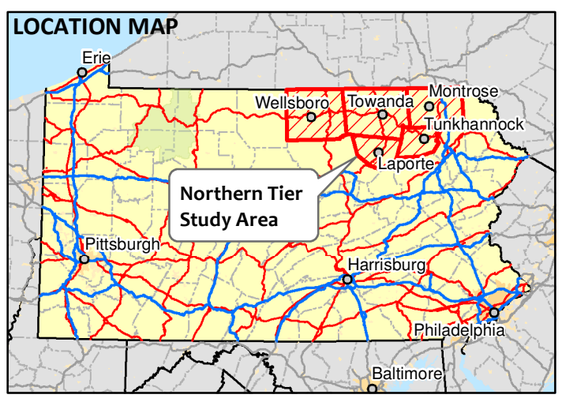
- Sand used in the fractionation process
- Pipe for drilling, casing, and gathering of extracted gas
- Cements and related materials for pad development and casing
- Hydrochloric acid for the fracturing process
- Used brine water for disposal after fractionation process
- Miscellaneous equipment and supplies

The railroads serving the Marcellus Shale industry in the region include:

- Reading Blue Mountain & Northern Railroad
- Wellsboro and Corning Railroad
- Lehigh Railway

Other railroads such as Norfolk Southern, CP Rail, Lycoming Valley Railroad, and North Shore Railroad also provide services that feed Marcellus Shale industries by delivering rail cars to connecting railroads or transloading goods to trucks. The railroad facilities in the Northern Tier are shown in Figure 11.





Legend

- Railroad Transload Facilities
- Railroad

Scale (Miles): 0 3 6 12 18

N

Data Sources:
Railroad transload facilities were mapped by Gannett Fleming based on mapping from SEDA-COG Joint Rail Authority. Marcellus shale ormation thickness was mapped by DCNR PA Geologic Survey and distributed by www.fractracker.org.

Gannett Fleming

northern tier regional planning & development commission

Northern Tier Regional Planning & Development Commission

Marcellus Shale Freight Transportation Study

Northern Tier Marcellus Shale Railroad Facilities

Figure 11

November 2011

READING BLUE MOUNTAIN & NORTHERN RAILROAD

Recently the Reading Blue Mountain & Northern Railroad (RBM&N) purchased the Towanda-Monroeton Shippers Lifeline Railroad and is now providing rail service on the six-mile line between Towanda Borough and Monroeton. It is marketing the local rail line for use by companies involved in the natural gas industry. The RBM&N operates two railroad properties within the Northern Tier. In addition to the 6-mile Towanda-Monroeton Shippers Lifeline, it also operates on the former Norfolk Southern line south of the Proctor & Gamble plant in Mehoopany.

It has recently opened a large sand terminal in the region at the Pittston Yard near Scranton, and also carries brine water out of Mehoopany. Future plans include developing a smaller sand truck transfer facility in the Towanda area.

RBM&N has invested in developing its yard facility in Pittston in Luzerne County as a Marcellus Shale sand terminal. It has the ability to store up to 800 cars within the terminal. The terminal covers 80 acres and, although it is located outside of the Northern Tier, it is the railroad's main yard serving P&G and other customers in the Greater Scranton area.

In its first full year of operation, the yard handled 1,500 cars of sand. The railroad will be opening a second sand transload facility at an undisclosed location and will look to open a third in the Montrose area sometime in 2012. Although sand is its primary commodity, the railroad is planning to backhaul drill cuttings later this year.

Planned improvements include changing out the rail, the joists and curves on six miles of railroad track between the Pittston Yard and Dupont. All of the railroad's Marcellus Shale-related traffic traverses this section of railroad. The railroad is seeking grant money from the state capital budget, but did not seek any funds from the Rail Freight Assistance Program in 2011. One of the railroad's customers, DNI Silica, received a grant for improvements to upgrade three storage tracks in the Pittston yard this year in order for cars to be held in storage and unloaded quickly.

Norfolk Southern continues to own the former Lehigh Valley line from Sayre through to Tunkhannock, yet it does not maintain any trackage rights. It has reserved the right to terminate the lease, which is a common arrangement when a Class I leases a line to a shortline railroad.

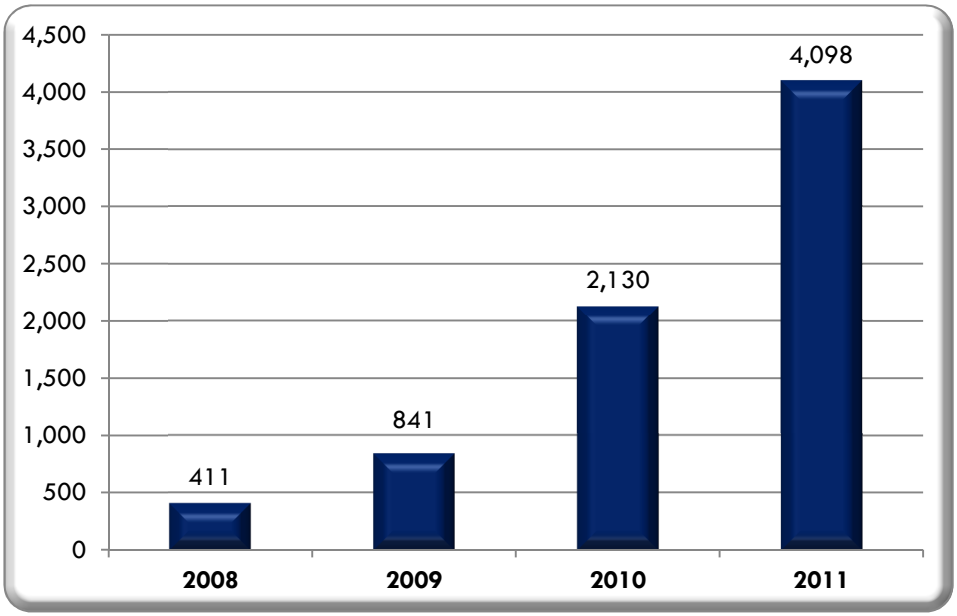
WELLSBORO AND CORNING RAILROAD

The Wellsboro and Corning Railroad (W&C) has seen rail volume increase dramatically over the past three years. As shown in Figure 12, the railroad's carloadings have increased over 500 percent between 2007 and 2010, and have nearly doubled through 10 months in 2011, primarily due to the increase in sand deliveries.

The W&C's primary transload facility is located to the north of Wellsboro near the juncture of US 6 and PA 287. Additional transload facilities are in the planning stages and were confidential at the time of this writing. Congestion Mitigation Air Quality (CMAQ) funds are being used to add an additional 4,300 feet of rail sidings and additional track along its system.

Among other non-disclosed shipments, future plans include the backhauling of drill cuttings to the Midwest from their Wellsboro terminal.

Figure 12: Wellsboro and Corning Carloads



Source: Wellsboro and Corning Railroad (2011 Carloads as of October 31, 2011)

LEHIGH RAILWAY

The Lehigh Railway (LRWY) operates 56 miles of track in North Central PA. The mainline of LRWY runs from Athens to Mehoopany on a long term leased line from Norfolk Southern. The LRWY interchanges with Norfolk Southern in Sayre, as well as with regional carrier Reading & Northern at Mehoopany and Towanda.

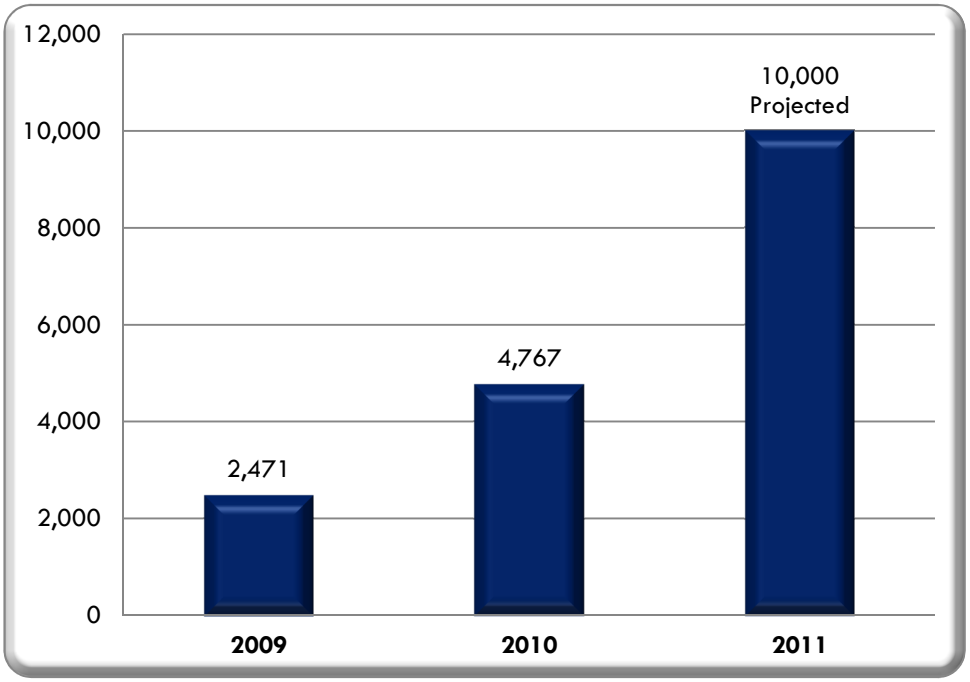
The LRWY began operations in January 2009 and hauled nearly 2,500 carloadings in its first year of operation and nearly 5,000 cars in 2010. The railroad expected to double its carloadings once again in 2011 to 10,000. The railroad hauls sand, pipe, mats (for protection of environmentally sensitive areas), lime, and drill cuttings along their three Marcellus lines.

In 2009 the line was essentially a single track line left in place to serve Global Tungsten, Craftmaster, and Proctor and Gamble. The strategic location of the line prompted the railroad to invest over $2M in private capital to add several "Marcellus Terminals" on the line such as those in Meshoppen, Wyalusing, and Wysox. Over 4 miles of new rail sidings were constructed in 2009 and 2010, with construction of another 3 miles in 2011. These new sidings will be in Meshoppen, North Towanda, Wysox, and Ulster. In addition, a construction supply company (Glenn O. Hawbaker, Inc.) is in the process of locating a new terminal immediately south of the Wyalusing Terminal along the line.

The LRWY operates terminals at Meshoppen, Wyalusing, and Wysox. It also operates the Owego Harford Railway in southern New York. Along this line, it operates terminals at Owego, NY and Newark Valley, NY which also supply materials to the Northern Tier region. It anticipates new terminals coming on-line at Meshoppen II, Wysox II, Ulster, and Wyalusing II.

Additional facilities will be required in the future due to poor maintenance by previous owners. In 2009 the railroad sought, but did not receive, a grant from the Pennsylvania Rail Freight Assistance Program and will be pursuing grant money in the future to fund additional infrastructure. Figure 13 shows the carloadings since the railroad began operations in 2009.

Figure 13: Lehigh Railway Carloads



Source: Lehigh Railway

PLANNED IMPROVEMENTS

To address the increase in truck and rail traffic resulting from gas operations in the Northern Tier, highway improvements are on-going. PennDOT and the NTRPDC must remain agile as maintenance and roadway degradation continues in a somewhat unpredictable fashion. However, long term planned improvements must also continue so that larger, system level enhancements are made. These will be conducted with Marcellus Shale operations in mind since they are the current drivers for highway congestion and maintenance needs throughout the region.

Regional planned improvements are located in the region's Transportation Improvement Program and Long Range Transportation Plan. The region is planning to fund over $2 billion in projects through 2035.[7] The long-term project portfolio is almost exclusively oriented towards bridges and system preservation projects. Over half of the planned investment through 2035 will be specifically for bridge projects with the middle and later years of the LRTP (2013-2035) seeing an increase in highway restoration and system preservation projects. Most of the projects that have implications for Marcellus Shale gas operations are being undertaken as part of maintenance budgets or by gas companies under agreements with PennDOT or municipalities.

Improvements being completed by gas companies include full depth reclamation, structural overlays, mill and fill. At the beginning of calendar year 2011, there were 65 miles of improvements planned by gas companies.

PennDOT estimates show that, based on 35,000 wells by 2020, there will be a need to accommodate approximately 50 million trucks to support well activities statewide. The estimated annual cost of maintaining and repairing roads from this activity will be $40 million[8].

[7] Source: PennDOT Financial Guidance for funding from 2009 to 2035.
[8] Christie, Scott, P.E. PennDOT Deputy Secretary—Highway Administration, Presentation: "*Marcellus Shale Advisory Commission Infrastructure, Highway System Impacts*", May 9, 2011.

FUTURE TRAFFIC ESTIMATES

In developing projections, it is important to consider the different factors of the gas extraction process. In addition, it is necessary to make assumptions related to when drilling may occur and the lifespan of the industry within the region.

TIME HORIZON

Through interviews with stakeholders, estimates of the lifespan of Marcellus Shale operations were identified and range anywhere from 10 to 100 years. The reason for this wide range is a result of the unknown external variables related to natural gas production, gas prices, and demand.

This wide range of estimates makes it difficult to provide a long-term temporal estimate of truck and rail traffic throughout the Northern Tier. However, short-term activity is easier to estimate because it is widely speculated that activity will remain at high levels in the area for the next 8 to 10 years. This analysis assumes that Marcellus Shale development will continue over the next 30 years with the drilling and development phase peaking within 10 years with ongoing maintenance of wells for the following 20 years.

Based on conversations with industry representatives, it is believed that equipment constraints (i.e. drilling rigs) and the market price of natural gas will likely be the factors that level off drilling activity.

MARCELLUS SHALE TRAFFIC GENERATION ESTIMATES

The estimation of future Marcellus Shale truck traffic relies on several variables related to industry and well development processes. The values given to the various elements are based on discussions with industry representatives and review of published documents. These are planning level estimates that provide some confidence in the future generation and impacts of gas extraction operations. The elements associated with Marcellus Shale truck generation and their values are shown in Table 17 below.

Table 17: Marcellus Shale Truck Generation Elements		
Element	**Value**	**Source**
Time from permit issuance to beginning of drilling	71 Days	Median value based on historic DEP data from 2007 to 2010
Drilling time	15 days	Average drilling and casing time based on DEP data from 2007 to 2010
Hydraulic fracturing time	10 days	Average fracturing time from Marcellus Shale Coalition
Well monitoring and maintenance time	1 truck	Est. 1 truck every other week per well for the life of the well
Total average well production time	25 days	Drilling time + Hydraulic fracturing time
Truck generation per well—Pad development, drilling, other construction trips	300/yr	PennDOT Highway Systems Impact Presentation
Truck generation per well—Sand	100	Calculated based on interviews with railroads and the number of trucks needed per rail car and per well
Truck generation per well—Water	300	Of the estimated 400 trucks per well, 75% of material needed is water
Truck generation per well—Other	12	Based on trucks for well rigs, cement for casing and pad, mixing tanks, and other materials
Rail generation per well—Sand	20	Interviews with railroads
Rail generation per well—Other	2	Estimated
Truck generation at rail transload facilities	4 trucks/ rail car	Interviews with railroads
Light truck/Worker vehicle generation per well	2,340	85 percent of total trips based on NCRPDC US219 Economic and Community Impact Analysis

The following sections describe forecast estimates for the short-tem (2015), mid-term (2020), and long-term (2035) time horizons. These forecasts are based on the following assumptions:

- Permit requests will begin to decline in the next five years
- Well drilling will level off in five years and will begin to decline in ten years
- Nearly all permitted wells will be drilled
- Processes and material requirements for Marcellus Shale wells will not change over time
- The mode share between rail and truck for materials will remain consistent
- Railroads will continue to maintain their current share of commodities moved for Marcellus Shale operations
- The industry's capacity to drill wells is limited to approximately 1,200 wells per year throughout the region
- The industry will begin to experience a decline in drilling operations in approximately 15 years in lieu of well maintenance activities

Where the gas companies will drill is unknown. It is assumed that they will take advantage of their current permits in the short-term while continuing to look for opportunities in more remote areas in the mid- and long-term.

Where the gas companies will drill is unknown. It is assumed that they will take advantage of their current permits in the short-term while continuing to look for opportunities in more remote areas in the mid- and long-term. As a result, truck patterns may change in a way that is unexpected, impacting local road and regional highways that have not experienced growth up to this time.

In addition, railroad operating agreements and clients may also change over time. This could result in a shift of railroad commodities from one terminal to another, which may have significant impacts on the local roadway network as a result of transload truck traffic.

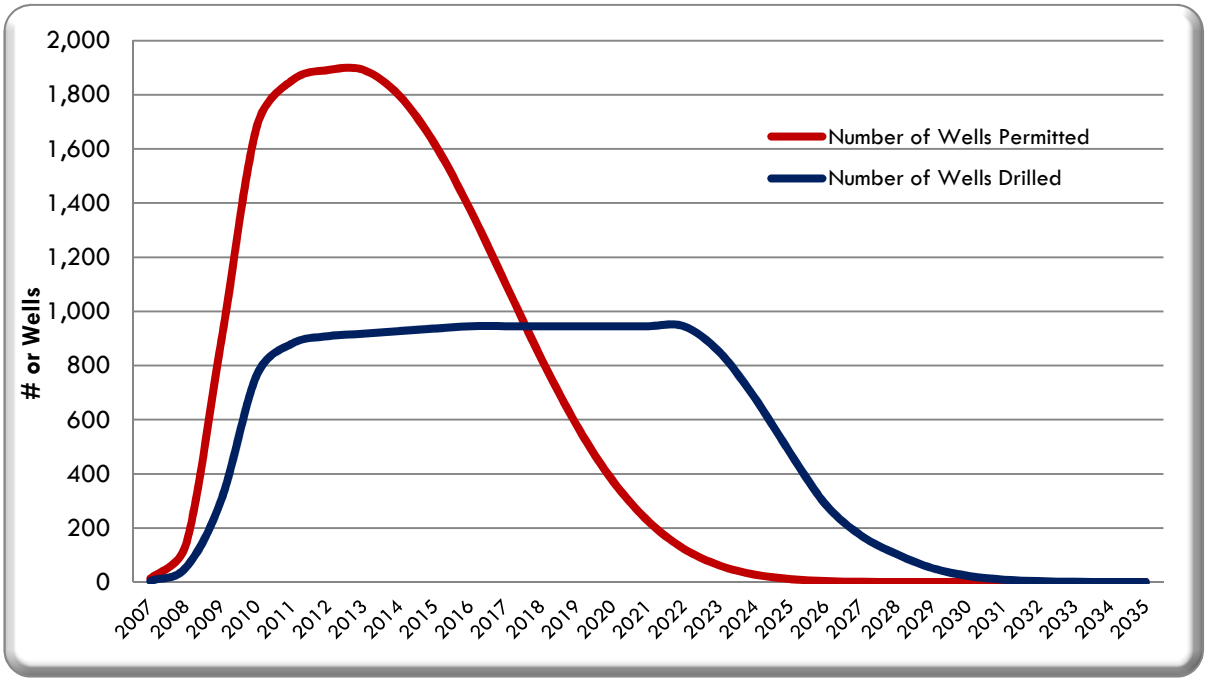
ESTIMATES OF WELL PERMITS AND WELLS DRILLED

In order to develop estimates of Marcellus Shale traffic, forecasts of the wells to be drilled are needed. This requires estimates of the capacity of the industry to drill wells and the amount of time it will take to drill wells that have been permitted.

Well permits are expected to increase over the next five years and will then begin to decline over the next 20 years. It is estimated that as many as 13,000 permits will be sought for Marcellus Shale drilling over this time period in the Northern Tier. The drilling of these wells will take additional time due to manpower and equipment requirements. It is estimated that well drilling will level off in five years and remain steady

for the next 15 years, where it will then begin to decline as the industry catches up to its permit limits. Figure 14 below shows the estimates of the temporal distribution of permitted and drilled wells to the year 2035. Based on the similar need required by well, truck traffic generated by Marcellus Shale operations in the region will closely mirror this pattern.

Figure 14: Forecasts of Well Permits and Wells Drilled



Between 2007 and 2010, the percentages of the number of wells permitted and those drilled vary. Table 18 below shows these historic data.

Table 18: Number of Wells Permitted and Drilled by County
(as of December 2010)

County	Wells Permitted	Wells Drilled	% Drilled
Bradford	1,417	514	36%
Sullivan	102	16	16%
Susquehanna	465	167	36%
Tioga	936	421	45%
Wyoming	121	13	11%
Grand Total	**3,041**	**1,131**	**37%**

Source: PADEP

Applying the estimated growth to the county share yields the following distribution of wells permitted and drilled by county until the year 2035.

Table 19: Estimated Future Marcellus Shale Permits and Wells Drilled

Year	Bradford		Sullivan		Susquehanna		Tioga		Wyoming	
	Permitted	Drilled	Permitted	Drilled	Permitted	Drilled	Permitted	Drilled	Permitted	Drilled
2011	860	400	60	10	280	130	570	330	70	10
2012	880	410	60	10	290	140	580	340	80	10
2013	880	420	60	15	290	140	580	340	80	10
2014	840	420	60	15	270	140	550	340	70	10
2015	750	430	50	15	250	140	500	350	60	10
2016	640	430	50	15	210	140	420	350	50	10
2017	510	430	40	15	170	140	340	350	40	10
2018	380	430	30	15	120	140	250	350	30	10
2019	270	430	20	15	90	140	180	350	20	10
2020	180	430	10	15	60	140	120	350	15	10
2021	110	430	10	15	30	140	70	350	10	10
2022	60	430	5	15	20	140	40	350	5	10
2023	30	390	2	10	10	130	20	320	2	10
2024	10	310	1	10	4	100	10	250	1	8
2025	5	220	0	7	2	70	3	180	0	5
2026	2	130	0	5	1	40	1	110	0	3
2027	1	80	0	2	0	30	0	60	0	2
2028	0	50	0	1	0	15	0	40	0	1
2029	0	20	0	1	0	10	0	20	0	0
2030	0	10	0	0	0	3	0	10	0	0
2031	0	4	0	0	0	1	0	3	0	0
2032	0	2	0	0	0	1	0	1	0	0
2033	0	1	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0

These estimates serve as the basis for the short, medium, and long term forecasts. Estimates are summarized by county with discussion about impacts to the regional roadway and rail systems. Due to the fact that long-term (and even short-term) operation locations are not known, and the industry is reluctant to share which wells they will be drilling in the near future, it is difficult to estimate which routes (and to what level) will

experience impacts of increased truck traffic, without a more detailed analysis. As discussed in previous sections, secondary and local roads bear much of the brunt of Marcellus Shale truck traffic and localized impacts are certain to continue in the future.

In order to provide a reasonable estimate of truck traffic, truck generation estimates must include those required for the movement of goods to and from well sites as well as the travel of trucks after goods are transported. This includes empty, partial-load and backhaul traffic, which can be substantial.

To account for these movements a factor was applied to the estimates of full trucks. For example, a truck full of water entering a site and leaving a site empty is a generation of two truck trips and therefore a factor of 2.0 should be applied. For a truck that delivers pipe for well casing and removes other equipment from the site (eliminating the need for a separate truck trip) the factor is 1.0 (assuming it is a 1:1 relationship for that commodity).

Because Marcellus Shale operations often require trucks (primarily water) to drop off and leave empty, a high factor of between 2.0 and 1.75 is appropriate for this high-level analysis. Therefore a factor of 1.95 was used for the traffic generation estimates for well development, and 1.8 for on-going maintenance.

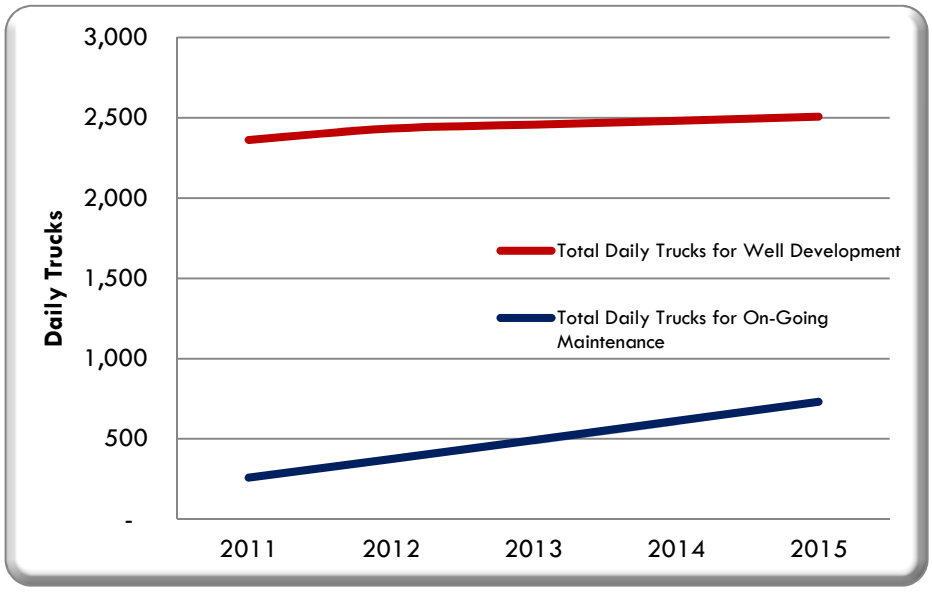
SHORT-TERM TRUCK AND RAIL FORECASTS

The estimates in the short-term (to the year 2015) are the most critical for the Northern Tier as the region continues to grapple with the effects of the industry on regional roads and rail. Traffic is expected to continue to increase for both truck and rail volumes during this time period.

TRUCK

By 2015 daily trucks generated from Marcellus Shale operations in the Northern Tier will equal almost 3,300, an increase of nearly 24 percent compared to movements today (see Figure 15). This is a combination of trucks whose purpose is well development activities (such as pad development, well drilling and casing, fracturing, etc.) and on-going maintenance of wells. It is estimated that each well that comes on-line will require one heavy truck every other week to deliver materials for on-going operations or maintenance.

Figure 15: Estimated Short-Term Marcellus Shale Daily Truck Trips



Bradford County is expected to experience the most truck traffic in the Northern Tier in the next 4 years and beyond due to the most number of wells forecasted to be drilled. Because traffic impacts are felt on a daily basis, the estimated truck volumes are shown as a daily average in Table 20 (well development), Table 21 (well maintenance), and Table 22 (total) below.

Table 20: Short-Term Daily Trucks for Well Development

Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2011	1,074	33	349	879	27	2,362
2012	1,106	34	359	906	28	2,433
2013	1,117	35	363	915	28	2,457
2014	1,128	35	366	924	29	2,482
2015	1,139	35	370	933	29	2,507

Table 21: Short-Term Daily Trucks for On-Going Well Maintenance

Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2011	117	4	38	96	3	258
2012	170	5	55	139	4	375
2013	224	7	73	183	6	492
2014	278	9	90	227	7	611
2015	332	10	108	272	8	731

Table 22: Short-Term Total Daily Trucks						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2011	1,191	37	387	975	30	2,620
2012	1,276	40	415	1,045	32	2,808
2013	1,340	42	436	1,098	34	2,950
2014	1,406	44	457	1,151	36	3,093
2015	1,471	46	478	1,205	37	3,238

The regional roadways most likely to be impacted are those in Bradford, Susquehanna, and Tioga Counties. Resulting from where permitted sites are located and the recent pattern of drilling, specific roadways where congestion may increase are:

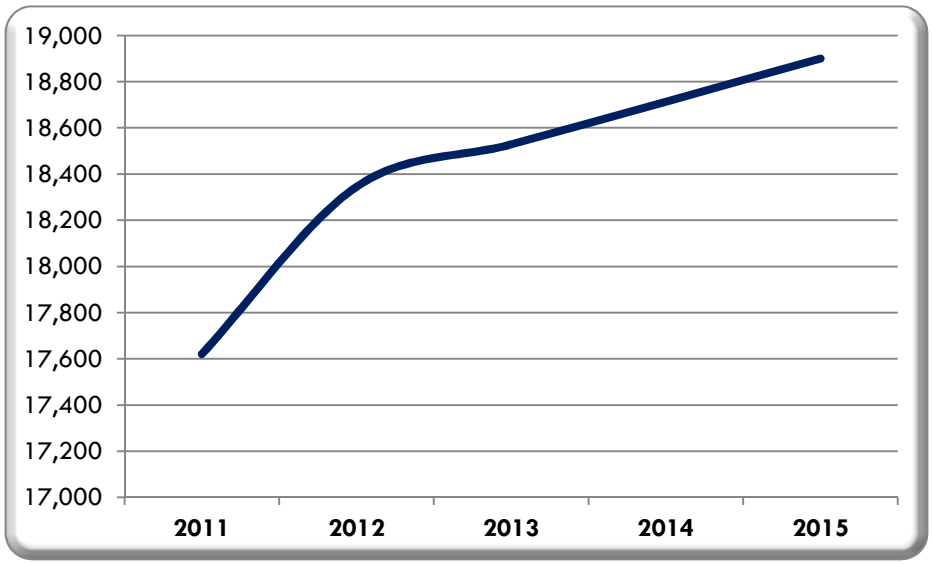
- US 220 near New Albany
- US 220 near Monroeton Borough
- US 6 in Troy Borough
- US 6 in Wyalusing Borough
- US 6 in Mansfield Borough
- US 6 in Wellsboro Borough
- PA 29 near Springville
- PA 29 near Montrose Borough
- PA 187 near Rome Borough
- PA 14 near Gillett
- SR 2017 in Blossburg Borough

Many of these routes have seen significant increases in truck traffic. Forecasts show that these routes will increasingly be used by trucks over the next 5 years.

RAIL

Because rail commodities are primarily those for well development, such as fractionation sand and pipe delivery, it is expected that the pattern of movements will closely resemble the well development patterns forecasted. On-going maintenance is expected to be supplied primarily by truck, therefore regional railroads will accommodate minor transfers for this operation. In the short-term however, railroads are expected to continue to experience growth. This growth is expected to become slower however, with growth over the next four years to be at about seven percent. This is still a significant increase from carloadings prior to 2008.

Figure 16: Estimated Short-Term Marcellus Shale Annual Rail Carloadings



MID-TERM TRUCK AND RAIL FORECASTS

TRUCK

Truck volumes related to Marcellus Shale gas operations are forecast to continue to increase to the year 2020. Within this time period, it is expected that gas companies will begin to access more remote areas for drilling and therefore, changes in congestion locations may occur. Figure 17 and Table 23, Table 24, and Table 25 below show the estimates of daily truck generation for the counties within the Northern Tier. Overall truck traffic is expected to increase 14 percent between 2015 and 2020. It is expected that the industry will reach its estimated drilling capacity in the region of 1,200 wells per year, therefore well development truck traffic will remain steady as those trucks for on-going maintenance continue to increase as wells come on-line.

Figure 17: Estimated Mid-Term Marcellus Shale Daily Truck Trips

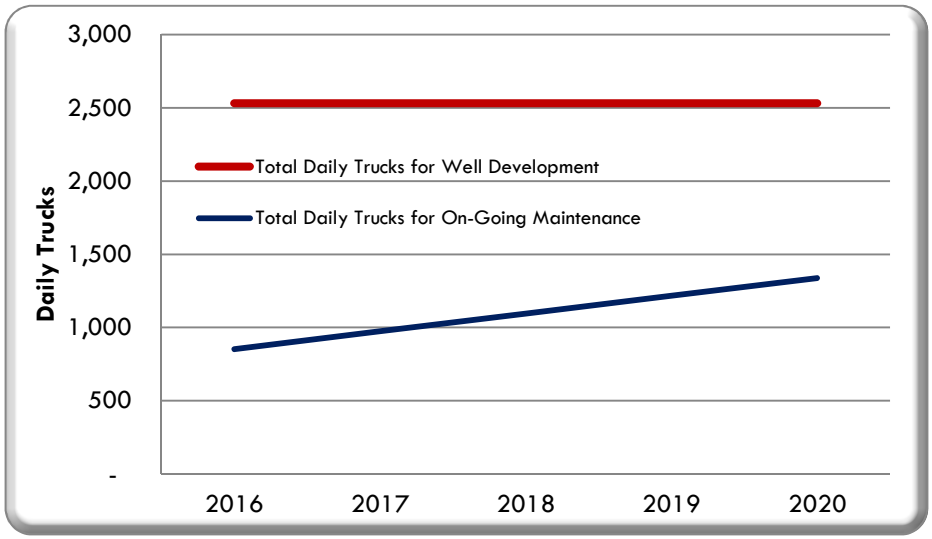


Table 23: Mid-Term Daily Trucks for Well Development						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2016	1,151	36	374	942	29	2,532
2017	1,151	36	374	942	29	2,532
2018	1,151	36	374	942	29	2,532
2019	1,151	36	374	942	29	2,532
2020	1,151	36	374	942	29	2,532

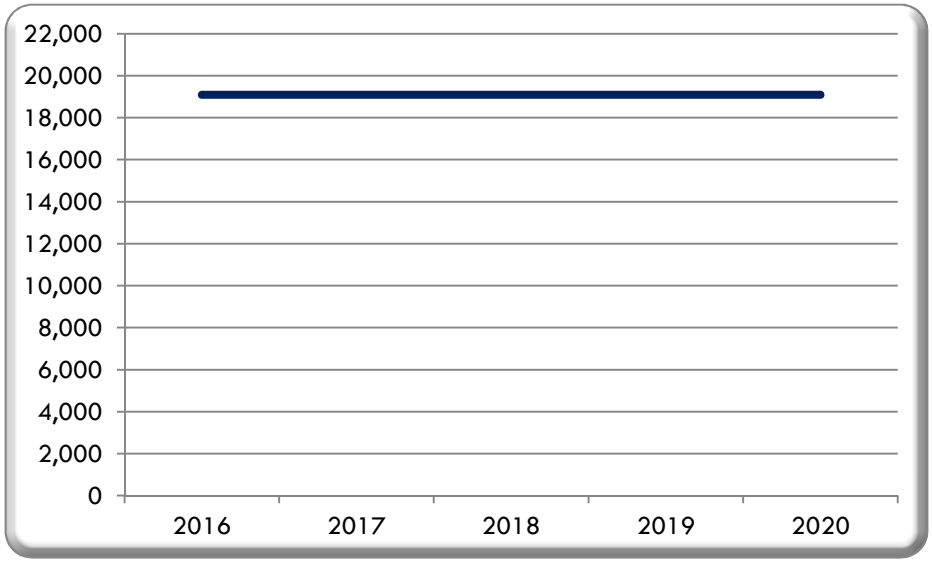
Table 24: Mid-Term Daily Trucks for On-Going Well Maintenance						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2016	387	12	126	317	10	852
2017	442	14	144	362	11	974
2018	498	15	162	408	13	1,095
2019	553	17	180	453	14	1,216
2020	608	19	197	498	15	1,337

Table 25: Mid-Term Total Daily Trucks						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2016	1,538	48	500	1,260	39	3,384
2017	1,593	50	518	1,305	40	3,505
2018	1,648	51	535	1,350	42	3,627
2019	1,703	53	553	1,395	43	3,748
2020	1,758	55	571	1,440	44	3,869

RAIL

As the gas industry begins to mature and work through its backlog of gas permit holdings, the growth of the regional rail industry is also expected to level off as it continues to supply the necessary drilling and fracturing materials for gas extraction. Minimal growth is expected between 2016 and 2020, however rail carloadings are expected to remain strong at approximately 19,000 per year.

Figure 18: Estimated Mid-Term Marcellus Shale Annual Rail Carloadings



LONG-TERM TRUCK AND RAIL FORECASTS

Truck volumes related to Marcellus Shale are expected to reach their peak in the year 2022, at over 4,100 truck trips generated daily.

TRUCK

Truck volumes related to Marcellus Shale gas operations are expected to hit their peak in the year 2022, at over 4,100 truck trips per day, which is double the number of trucks today. This generation is a result of on-going well drilling as the well maintenance increases. Because the truck requirements for on-going maintenance of wells is much less than in the development process, volumes are expected to decrease rapidly to near present levels by the year 2027. Forecasted trips are shown in Figure 19 and Table 26, Table 27, and Table 28 below.

Figure 19: Estimated Long-Term Marcellus Shale Daily Truck Trips

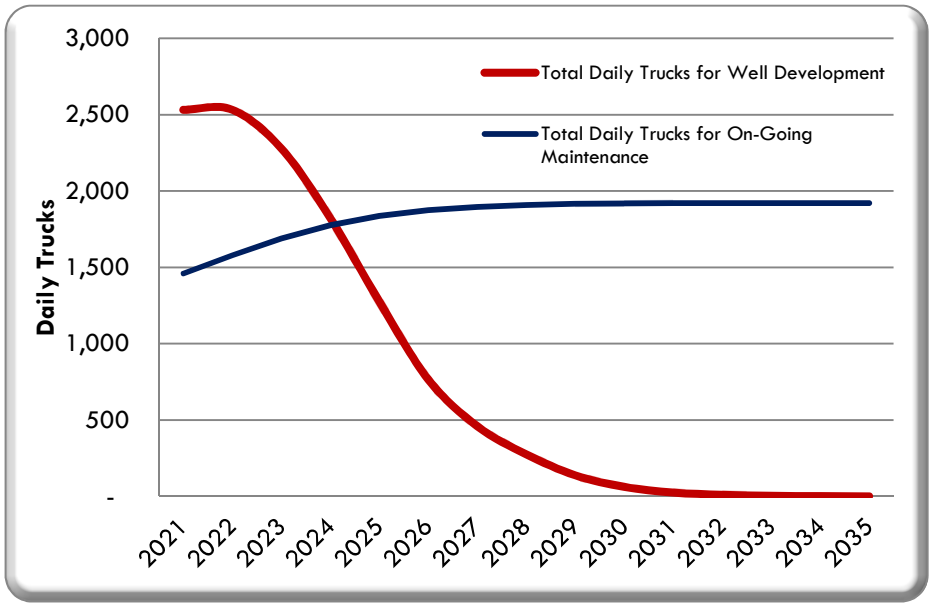


Table 26: Long-Term Daily Trucks for Well Development						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2021	1,151	36	374	942	29	2,532
2022	1,151	36	374	942	29	2,532
2023	1,036	32	336	848	26	2,279
2024	828	26	269	679	21	1,823
2025	580	18	188	475	15	1,276
2026	348	11	113	285	9	766
2027	209	6	68	171	5	459
2028	125	4	41	103	3	276
2029	63	2	20	51	2	138
2030	28	1	9	23	1	62
2031	11	0	4	9	0	25
2032	5	0	1	4	0	10
2033	2	0	1	1	0	3
2034	0	0	0	0	0	1
2035	0	0	0	0	0	0

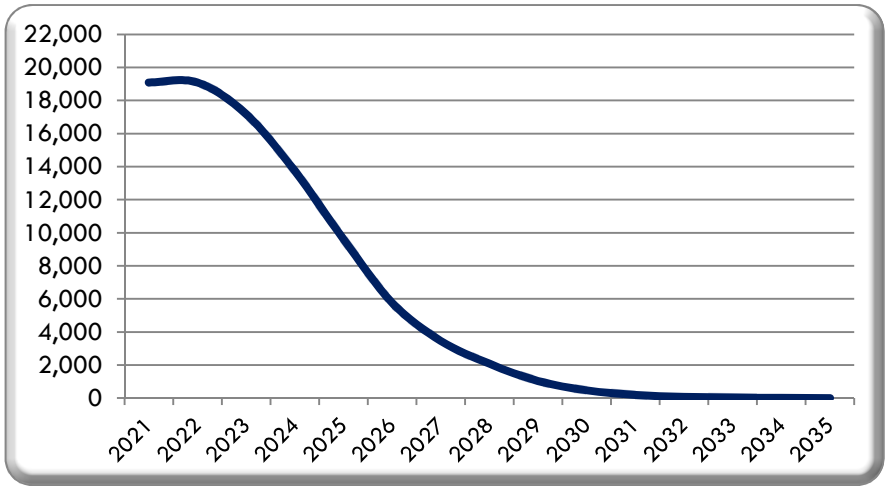
Table 27: Long-Term Daily Trucks for On-Going Well Maintenance						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2021	663	21	215	543	17	1,458
2022	718	22	233	588	18	1,580
2023	767	24	249	629	19	1,689
2024	807	25	262	661	20	1,776
2025	835	26	271	684	21	1,837
2026	852	27	277	697	22	1,874
2027	862	27	280	706	22	1,896
2028	868	27	282	711	22	1,909
2029	871	27	283	713	22	1,916
2030	872	27	283	714	22	1,919
2031	872	27	283	715	22	1,920
2032	873	27	284	715	22	1,920
2033	873	27	284	715	22	1,920
2034	873	27	284	715	22	1,920
2035	873	27	284	715	22	1,920

Table 28: Long-Term Total Daily Trucks						
Year	Bradford	Sullivan	Susquehanna	Tioga	Wyoming	Total
2021	1,813	56	589	1,485	46	3,990
2022	1,868	58	607	1,530	47	4,111
2023	1,803	56	586	1,477	46	3,967
2024	1,636	51	531	1,340	41	3,599
2025	1,415	44	460	1,159	36	3,113
2026	1,200	37	390	982	30	2,639
2027	1,070	33	348	877	27	2,355
2028	993	31	323	813	25	2,185
2029	933	29	303	764	24	2,053
2030	900	28	292	737	23	1,981
2031	884	28	287	724	22	1,945
2032	877	27	285	718	22	1,930
2033	874	27	284	716	22	1,924
2034	873	27	284	715	22	1,921
2035	873	27	284	715	22	1,921

RAIL

Just as with trucking, as the Marcellus Shale well development stage begins to sunset, carloadings will also begin to decline for commodities used by the gas industry. The need for sand will be minimal as well operations require little to maintain the well fractionation process. Volumes are expected to hold during the early part of the long-term period where they are then expected to decline.

Figure 20: Estimated Long-Term Marcellus Shale Annual Rail Carloadings



POLICY/PROCEDURAL IMPACTS

Due to the fact that Marcellus Shale related transportation issues have surfaced only in recent years, it is important to look at how the industry impacts the policies and procedures of various public organizations in the Northern Tier. This includes the following organizations:

- Northern Tier Regional Planning and Development Commission
- PennDOT (Districts 3-0 and 4-0)
- Counties
- Municipalities
- Safety and Enforcement
- Gas companies

The gas industry's activity has challenged each organization to define their roles and determine their individual decision-making issues and needs.

NORTHERN TIER REGIONAL PLANNING AND DEVELOPMENT COMMISSION

As the regional planning organization for the five-county area, the NTRPDC serves as coordinator of planning activities. The Commission takes the lead in efforts that look closer at transportation issues around the region and coordinate needs among the various stakeholders and PennDOT (as the state's transportation funding agency). This is done through a study process (such as this effort), or the development and maintenance of the Transportation Improvement Program (TIP) or Long-Range Transportation Plan (LRTP).

Marcellus Shale activity has swept through the region quickly and the NTRPDC is beginning to catch up through close coordination with gas companies, PennDOT, counties, and municipalities. The NTRPDC developed and sponsored the Natural Gas Summit for Municipal Officials which focused on issues faced by municipalities in the region, including roads, water, land use, and environment.

There remain needs that the Commission must address in order to continue to improve in its coordination. First and foremost is part of its role as regional coordinator. Because the NTRPDC's purview is regional, the organization is well-positioned to be the clearinghouse of regional Marcellus Shale related information.

Due to the fact the Marcellus Shale activities are primarily being conducted by private entities, information can be sporadic and

incomplete. However, there is a wealth of information about the operations resulting from the necessary coordination between gas producers and public sector permitting agencies. This information can be culled by Commission staff and organized to assist in regional, county-wide and municipal planning and decision-making. This is not a simple or short-term task. It will require the development of data expertise and capacity to not only to develop and maintain a Marcellus database, but also to fulfill data requests from regional partners.

PENNDOT DISTRICTS 3-0 AND 4-0

As the owner of nearly 3,000 miles of roadways in the Northern Tier, PennDOT has seen much of its roadway system fall in to disrepair early in the Marcellus Shale boom. Since that time, PennDOT districts 3-0 and 4-0 have established checks and safeguards to ensure that the roadways are safe and passible for all traffic, not just that of gas company trucking contractors.

PennDOT District Counties in the Northern Tier Region	
District 3-0	Bradford Sullivan Tioga
District 4-0	Susquehanna Wyoming

Many state roads in the region are built of a gravel base and one to two inches of oil and chip or blacktop. When these roads were built, trucks were lighter and loads were smaller. The heavy trucks of today, their increased numbers, and the freeze and thaw cycles of the area greatly diminishes pavement quality and can completely destroy the roadways.

PennDOT has taken significant steps to mitigate on-going and potential damage to state owned roads through the state's posted and bonded road program. This has created a major work focus for the Districts in posting roads, handling bonding procedures, and the ongoing road monitoring.

Between February and December 2010, PennDOT District 3-0 temporarily suspended hauling permits 39 times until companies began mandated repairs. The impact of trucks and the resulting degradation of state roads has been felt within the operations and budgets of the PennDOT districts in the Northern Tier. At an estimated additional cost of over $1 million annually, PennDOT staff has had to:

- Conduct additional maintenance
- Increase surveys of industry roads to every week
- Issue notifications to ensure that damages are repaired
- Move staff to assist in issuing highway occupancy permits
- Conduct engineering studies
- Review of winter maintenance plans submitted by gas companies
- Make and install posted road signs

- Process additional agreements and permits
- Coordinate with haulers
- Prepare invoices
- Review roadway improvement plans submitted

Major challenges remain for the Districts. Major routes that have required resurfacing every 15 years in the past now must be resurfaced every seven to eight years, which taxes maintenance budgets.

Major challenges remain for the Districts. Major routes that have required resurfacing every 15 years in the past now must be resurfaced every seven to eight years, which taxes maintenance budgets. This could have significant impacts on the regional TIP with increased demand for Betterment funding and major restoration projects. In 2010, increased truck traffic on bridge structures warranted the posting of 4 bridges in the region, and damage resulting from trucks scrapping sidewalls and overhead structures has created additional maintenance demands. All these demands have taken staff time and budget that could not be applied to roads and bridges.

COUNTIES

In addition to providing coordination, guidance, and data to municipalities within their borders, County planners have been inundated with additional requests and tasks associated with Marcellus Shale activities. Since the middle of 2008, county planning offices have experienced a dramatic increase in requests for county GIS data, mainly related to digital tax parcels.

Additionally, county offices have been the clearinghouse for Permit Notices from different sources (Commissioner's office, direct from companies, SRBC, etc.) related to gas wells, water impoundments, gathering lines, water lines, and compressor stations.

County planning offices perform subdivision and land development review and approval for municipalities, and plan review and technical comment for those that retain their own subdivision and land development ordinances. They also perform planning guidance and technical assistance to municipalities interested in developing comprehensive plans, zoning ordinances, and conditional use applications.

Marcellus Shale activity has created shifting responsibilities and challenges for county staff. They have seen an increase in land development applications but a decrease in subdivision requests. This is a result of land owners wanting to hold on to their land in hope of increased royalties from gas leases. In addition, it has taxed senior staff with additional coordination responsibilities among other Counties, regional organizations, municipalities, gas companies, and industry experts.

Counties are feeling tasked with responsibilities for which they don't have complete knowledge. For example, they are not attuned to the overall scope of the gas industry. Understanding how long major operations will last, housing impacts, employment increases, demographic changes, traffic impacts, water usage, and the processes related to drilling, fracturing technology, production and the long-term impacts of gathering pipeline development is critical information for county-wide planning. Keeping up with duties has been more difficult since no additional revenue has been directed to county planning offices to take on the additional responsibilities. Some of the increased responsibilities noted by county planners include:

- Fulfilling data requests and SALDO reviews
- Preparing RFPs for engineering and traffic studies for posting and bonding of local roads
- Land development plan reviews related to gas industry including compressor stations
- Guidance/technical assistance to municipalities on ordinances, road posting and bonding, floodplain ordinances, etc.
- Mapping wells location and SRBC/DEP permits
- Updating County Comprehensive Plans to address Marcellus Shale industry impact issues
- Collecting and reviewing model ordinances for potential implementation by municipalities
- Inspection and posting of county-owned bridges
- Development of guide for municipalities to explain their roles

Some county representatives noted benefits associated with Marcellus Shale activity in the region. These include:

- Financial gains for some individuals
- New job opportunities to keep residents in the region
- Increased business for quarries and cement plants
- Renovations and expansions to hospitals, hotels, and service industry buildings

Sullivan County has taken steps to recuperate costs associated with the time and effort it takes to fulfill some of the increased responsibility. They began to collect fees for data and maps to gas companies and related parties. This data is primarily GIS-based and includes roads, tax parcel information, acreage, mineral rights holders, etc. In 2010 the County collected approximately $20,000 in fees for this service.

Some of the issues and challenges noted by county officials include:

- There is no review of well pad development due to lack of County zoning
- Most county service increases as a result of the MS activity are not supported by existing revenue.
- Trucks moving large equipment block traffic for extended periods of time while they negotiate the roadways, particularly moving through narrow intersections

- Rental units for local residents are being overtaken by workers willing to pay a higher price
- Lodging for tourists has been reduced
- Sporadic truck traffic with little warning during the drilling process makes it difficult to plan for these events
- Regional transit authority (EMTA) is having difficulty retaining mechanics and drivers with CDLs, as they take higher paying jobs with trucking companies hauling Marcellus Shale related materials
- Volunteer emergency response agencies are responding to more incidences that require specialized training
- Lack of overall plan to address traffic corridors in need of up-dates to handle increased truck traffic
- Future land use conflicts and lack of industry coordination in pipeline development
- Question if counties will have the resources to support the added development of hotels

The counties within the Northern Tier have noted a drop-off in the number of leases between land owners and gas companies, and are now trying to grapple with the impacts. They continue to try and understand past and future impacts of the industry.

MUNICIPALITIES

Municipalities in the Northern Tier also face significant challenges related to Marcellus Shale operations. They must keep up with infrastructure when they are having difficulty maintaining current systems.

In addition, municipalities are rightly concerned about quality of roads and the impacts of heavy truck traffic. There are nearly 4,500 miles of municipal roads in the Northern Tier and many townships in the region have thin surfaced or dirt roads which were not built for the heavy trucks needed by the industry. As a result, many have posted bonds against these roads or have excessive use agreements in place.

The goal of the posting and bonding program is to ensure that heavy road users rebuild or pay for the road damages that they have caused. To do this a municipality must do an engineering and traffic study. This can be expensive and is the reason many municipalities do not want to participate in posting and bonding. An engineering study determines the status of all roads and how they should be posted. After the study, the municipality adopts an ordinance, and heavy road users are notified, and weight limit signs are installed.

Most municipalities in Pennsylvania are entering directly into excessive road-use agreements rather than posting and bonding, and enacting road-protection ordinances because it is a less complicated process.

Agreements are made with heavy users of the posted roads so that they post a bond. The first bond has set limits ($6,000 per mile for unpaved and $12,000 per mile for paved) but once that bond is used for damages, a subsequent bond may be set at any limit. It is the responsibility of the municipality to monitor the condition of the road and collect bonds when the damages occur.

Most municipalities in Pennsylvania are entering directly into excessive road-use agreements rather than posting and bonding, and enacting road-protection ordinances because it is a less complicated process. These are agreements between the heavy users of the road and municipalities state the user will repair any damage that occurs as a result of their use.

Some other challenges that municipalities face is the potential for unplanned growth, especially with secondary development related to the gas industry. Many local zoning ordinances are centered on agricultural and residential uses, with all other uses being addressed by exception. These ordinances as well as municipal comprehensive plans are in need of updating, in light of this new industry and the real and potential impacts to Northern Tier communities. It is important to note that state courts have upheld local municipalities' use of zoning to guide drilling locations.

Municipalities are impacted by changing wage scales in the region. As an example, they are having difficulty retaining drivers with CDLs, as they are taking higher paying jobs with trucking companies hauling Marcellus Shale related materials. Basic road activities such as winter maintenance and other road maintenance require CDL-licensed drivers. Municipalities are forced to either pay higher wages or contract for services which have impacts on small municipal budgets.

It is acknowledged the regional rural communities may not have the capacity to develop and maintain planning documents. Coordination with regional and county planning organizations can go a long way to helping municipalities establish good planning process and procedures as they relate to the gas industry.

SAFETY AND ENFORCEMENT

When dealing with heavy trucks, transient employees, a potentially dangerous industry product, steep grades, and subpar roadways, safety and enforcement are paramount. Drilling in the Marcellus Shale region has created impacts on all aspects of local emergency management and response. This activity leads to the potential for many types of incidents, and many will require specialized response, and equipment that may not readily available in rural areas.

Crash data show a significant increase in truck related crashes. Between 2007 and 2010 region-wide truck crashes increased over 60 percent with truck crashes doubling in Bradford, Sullivan, and Wyoming Counties. Only Susquehanna County experienced a drop during this three year time period. Trucks were involved in 8.9 percent of all crashes in 2010 in the Northern Tier compared to 6.2 percent in 2007.

Table 29: 2007 vs. 2010 Crash Statistics						
	2007		2010		% Increase	
	Total Crashes	Heavy Truck Crashes	Total Crashes	Heavy Truck Crashes	Total Crashes	Heavy Truck Crashes
Bradford	615	31	771	78	25%	**152%**
Sullivan	89	3	105	7	18%	**133%**
Susquehanna	510	44	472	31	(7%)	**(30%)**
Tioga	461	30	553	49	20%	**63%**
Wyoming	332	17	346	36	4%	**112%**
Total	**2,007**	**125**	**2,247**	**201**	**12%**	**61%**

Source: PennDOT CDART

Since 2009, the Bradford County Emergency Management Agency experienced an increase in 911 calls from approximately 114,000 calls to 123,000 total emergency calls in 2010 (an 8 percent increase). There are also reports of increasing crimes such as assault, speeding, theft, and DUIs which is proving to be financially and operationally burdensome on the police forces and court system.

Many safety challenges face the region. A vast majority of Northern Tier emergency responders are volunteers and have been stretched to capacity when it relates to the constant response to accident scenes, fires, and injuries. Increased State Police patrols require knowing where the trucks are (or will be) which can prove difficult since a flurry of activity occurs when a well is being developed and then moves to a different location.

Emergency responders and police are attempting to get ahead of the curve. They have been proactive in talking with companies to obtain specific well locations and have had scenario based trainings to learn what works and what doesn't. In addition the state police have teamed up to set up weigh stations to enforce weight limits and vehicle safety, levying heavy fines on violators. State police have also ramped up patrols to enforce speeding and overweight vehicle violations throughout the Northern Tier.

The industry itself is taking steps to increase the safety of its employees and residents of the Northern Tier. Incidents and violations cost gas companies money in addition to poor relations with the community. As a result the industry has developed training courses for its employees on proper procedures and behavior to limit unsafe practices and poor public relations.

GAS INDUSTRY

The primary motivation of the companies involved in the Marcellus Shale industry is economic prosperity. If gas companies realize they will be using a roadway for an extended period of time, it is advantageous for them to upgrade the road from a financial perspective rather than repeatedly repairing it. Companies have begun to be proactive and are approaching PennDOT and municipalities to propose upgrades to roads they will be using for years to come. PennDOT estimates that nearly 250 miles of roadways were improved in the Northern Tier region by gas companies since 2008.

In addition (as stated earlier) companies are also entering into agreements with municipalities to repair local roads damaged as a result of Marcellus Shale gas operations. The Marcellus Shale Coalition has reported that of 28 gas companies that responded to a recent survey, the industry spent $325 million on state roads and $127 million on local roads since 2008 in the Northern Tier region.

RECOMMENDATIONS

The Marcellus Shale gas industry was essentially non-existent in Pennsylvania in 2007, but today it is a common thread in the lives of workers and residents of the Northern Tier. The explosion in the volume of truck traffic has proven difficult to address for state, regional, and municipal organizations alike. Roadways not designed for such heavy use sustain damage as the industry moves to develop wells. Often it is unknown where and when gas companies will be, making staying ahead of roadway damage a challenge.

These recommendations are centered on institutional considerations and actions, and not particular roadway improvements, although some have been identified. Roadway improvements are generally limited to the roadway surface and not large-scale capacity additions. There are many roadway surface improvements needed, and PennDOT and municipalities are working through the process with the industry to ensure that the industry's use of the regional roadway system does not adversely impact long-standing residents and businesses.

DAMAGE ASSESSMENTS AND ON-GOING DATA COLLECTION

First and foremost, the region will need to continue to stay vigilant in **conducting official and on-going damage assessments** for state and local roads. Documentation of the conditions before and after Marcellus Shale activity has taken place will not only provide information on the impact of these types of activities on the regional roadways, but also provide the data necessary to hold the industrial users accountable for any damaged caused.

In addition, **traffic counts** should be taken on a more frequent basis to determine travel patterns and impacts to congestion on major routes. Secondary routes that experience sustained truck volumes should also be included in this enhanced data collection initiative. PennDOT could then be in better position to continuously evaluate the impacts of the Marcellus Shale activity, particularly as it expands into currently undeveloped areas of the region.

Increased damage assessments and data collection will assist the Department in:

- **Informing and improving the Systematic Technique to Analyze and Manage Pennsylvania's Pavements (STAMPP) program**, by updating its components compared with 'real world' data and analyzing increased deterioration rates.

- **Updating traffic projections** to keep current with industry projections and make more informed decisions regarding resurfacing projects, and road posting decisions.

In addition, there is a need to **gather, coordinate, and disseminate information regarding Marcellus Shale activity at the regional level.** Data such as pipeline, water withdrawal sites, posted and bonded roadways, and other Marcellus Shale related activity is largely unavailable and incomplete for the entire region. Some counties have very good databases; however, definitions and data detail are somewhat inconsistent. Regional coordination of this information would:

- Provide a **more comprehensive understanding** of materials sources and Marcellus Shale traffic generators
- **Consolidate data collection activities** from the five member counties and provide a consistent set of data for regional, county-wide, and local planning.

LOCAL, REGIONAL, AND INDUSTRY COORDINATION

Rapid deterioration of regional roadways prompted the need for PennDOT and municipalities to coordinate bonding or user agreements with the gas industry to ensure that roads were maintained to standards. There are other **opportunities for continued and expanded coordination** among public and private entities in the Northern Tier.

Ongoing coordination with the gas industry is required to discuss the likeliness and location of future gas exploration and production, by both PennDOT and municipal roadway owners. This information will:

- Require the **identification of where gas production will occur** in the future in order to allow PennDOT and municipalities to identify patterns for better roadway maintenance decisions. The lack of knowledge of where next drilling activity makes it difficult to plan.
- Require **a more unified approach** between the Department and the industry, in order to formulate a less fragmented response.

PennDOT is well equipped to handle proprietary data with care and any confidentiality agreements between the Department and private industry can be executed. For the purposes of this information, it does not need to be made public. PennDOT will be able to use this information to monitor roadway conditions for the benefit of users with discretion as needed.

In addition, **coordination among local municipalities and county planning offices** will provide information to counties so that larger county-wide issues are kept in sight. The duties of county planning offices require that they are aware of changing conditions, and coordination will also provide a more consistent process with the industry. Some of the coordination activities that could occur between counties and their municipalities include:

- Keeping a **database of posted and bonded roads**, their condition, and users.
- Providing **bonding and user agreement guidance** for roadways that have multiple users.
- Referring development requirement questions from gas companies to county offices for **more consistent guidance on permitting, roadway usage, and preferred truck routes**.

Improved coordination is also required at the regional level. The regional Marcellus Shale Expo brings together public and private sector interests on an annual basis and improves communication among responsible organizations. **A Marcellus Shale Task Force should include PennDOT, NTRPDC staff, county planning offices, and private sector representatives** or, at the very least, a subcommittee should be established under the Regional Transportation Advisory Committee (RTAC) with these representatives to conduct quarterly meetings to discuss regional issues. The committee should include:

- Clear objectives for each meeting so that private and public representatives share information that is critical for regional planning activities and gas operations.
- Summary results that are developed by NTRPDC staff or PennDOT representatives documenting issues and decisions made by the group. The summary should be sent to municipalities to inform them of the proceedings.

REGIONAL REPORT CARD

A **quarterly or biannual report card** should be developed that rates how well each of the gas companies is doing with regard to adhering to permitting requirements, agreed upon roadway maintenance, information sharing, cooperation with municipal officials, and other measurable elements. The effort is proposed to be led by PennDOT and would objectively lay out the compliance and coordination record of each gas company conducting business within the Northern Tier. The report card will:

- **Provide feedback to gas companies and the general public** about how well the region is doing with regard to transportation-related interests, impacts, and coordination.
- **Incentivize compliance** by companies responsible to various highway improvements.
- **Measure the progress** of various coordination and improvement initiatives over time.

POSTING AND BONDING COORDINATION

As documented there are many roadways that have been posted and bonded throughout the region. It has proved challenging from the standpoint of educating the gas companies so that they understand their responsibilities and processes, as well as PennDOT and municipalities' understanding of the extent of Marcellus Shale operations and its impacts on the roadway system.

Coordination has come a long way in a short time; however, some improvements would provide additional safeguards to ensure the system remains in good working order. Some of the coordination improvements related to posting and bonding of state and local roads includes:

- **Providing guidance for municipalities** in the form of an FAQ and process guidebook. The FAQ will provide general information on the where, what, why, and how of posting and bonding. The process guidebook will provide (at a minimum) detailed instructions on posting and bonding requirements, permitting process and grounds for revocation, billing process to recover costs (including guidance for multiple users), inspection requirements, etc.
- A study of the **needs associated with remaining non-posted roads** within the region to document current conditions and use as well as determining whether additional roads should be posted ahead of potential heavy truck use.
- **Addressing information needs within the PennDOT Roadway Management System** (RMS) and determine the best way to manage the posting and bonding program at a state and district level.
- Providing **guidance to gas companies that explain posting and bonding processes** on submissions and expectations in advance of roadway upgrades.
- Development of a **model posting and bonding agreement** to provide more consistency and coordination among the public and private sectors.

ROADWAY IMPROVEMENTS

Roadway improvements are ongoing throughout the region. Since this study is an overview of the region, it is difficult to assess every location in need to improvement. However, the bottlenecks identified are a good starting point for alleviating congestion in the Northern Tier. Opportunities to address roadway improvements are:

- Address **traffic operations improvements at identified bottlenecks** to include traffic signal modifications and upgrades, turning lanes, and turning radii improvements to accommodate increased truck movements. Specific improvements may require additional study.
- Incorporate findings of this report along with **ongoing impact analysis into future updates of the LRTP and TIP**. Special emphasis should be given to restoration needs, particularly on traffic routes which are not among roads that are posted or bonded.
- Identify those **specific bridges that are critical to the movements** of Marcellus well activities and determine necessary upgrades or detours.
- Review the current Transportation Improvement Program (TIP) and **identify opportunities to address the long term impacts** to traffic routes. Shorter life cycles for major roadways will require identification of funding through the TIP or other sources.

Roadway improvements should be considered in coordination with those of rail and transload facilities. These terminals have been shown to generate a large number of trucks and roadway improvements should be planned as new facilities are being considered.

RAIL IMPROVEMENTS

Rail improvements have been on-going with the addition of equipment, rail sidings, and small transload facilities along the shortline railroads. Facilitating the movement of Marcellus Shale related materials by rail is an important step to reducing or mitigating an increase in regional truck traffic. Improvements to date have been almost exclusively a result of private funding.

Transload facilities and sidings are relatively low cost items, and provide rail access to many gas companies in need of Marcellus Shale well production materials. These improvements also provide rail car staging locations that allow the rail line to continue operations along the line while material transfer occurs. To assist railroads in making the best use of the rail lines for the benefit of the region, there should be:

- Coordination between the NTRPDC and the railroads to **identify additional transload and trackage needs** to serve the increased Marcellus activity. Emphasis should be placed on improvements that will provide long-term solutions for operations several years away.
- NTRPDC **support of applications for funding improvements** through PennDOT's Rail Freight Assistance Program. The NTRPDC should sponsor improvements to strengthen the applications.

SAFETY AND SECURITY COORDINATION

Safety and security is critical to the gas industry in the Northern Tier. The industry provides safeguards to workers in the field to ensure that OSHA requirements and federal safety standards are met. However, larger events that may occur must be responded to by local first responders. Reaching sites that are remote and difficult to find remains an obstacle that the largely volunteer first response units must contend with. Efforts to improve the response to gas activities should include:

- **Establishing a countywide process/structure to manage local response**. This coordination at the county level would provide professional response expertise while coordinating local volunteer organizations that may be needed outside of their jurisdiction.

In addition to coordination of local response, the Pennsylvania State Police have stepped up efforts to ensure that speeding, weight limits, and truck safety laws are enforced. State Police representatives should be included on the Marcellus Shale subcommittee for input related to gas company safety, and their **input should be solicited for the Regional Report Card.**

FUNDING

Funding of improvements is difficult in this time of Federal, State, and local budget cuts. Funding may not be available in the near future for necessary improvements, but may be available if draft legislation is enacted related to impact fees or increase in transportation revenues. These funding sources are currently being discussed at the Federal and state levels, and the region should be ready by setting priorities for Marcellus Shale related improvements.

The Regional Transportation Advisory Committee (RTAC) should include on its monthly agenda **discussion about the regional Marcellus Shale transportation improvements and prioritize them** so that the region is well-positioned when funds become available.

APPENDICES

APPENDIX A: LIST OF FRACTIONATION LUBRICANT CHEMICALS

**Chemicals Used by Hydraulic Fracturing Companies in Pennsylvania
For Surface and Hydraulic Fracturing Activities
Prepared by the Department of Environmental Protection
Bureau of Oil and Gas Management
Compiled from Material Safety Data Sheets obtained from Industry**

1,2,4-Trimethylbenzene	Glycol Ethers (includes 2BE)
1,3,5 Trimethylbenzene	Guar gum
2,2-Dibromo-3-Nitrilopropionamide	Hemicellulase Enzyme
2.2-Dibromo-3-Nitrilopropionamide	Hydrochloric Acid
2-butoxyethanol	Hydrotreated light distillate
2-Ethylhexanol	Hydrotreated Light Distilled
2-methyl-4-isothiazolin-3-one	Iron Oxide
5-chloro-2-methyl-4-isothiazotin-3-one	Isopropanol
Acetic Acid	Isopropyl Alcohol
Acetic Anhydride	Kerosine
Acie Pensurf	Magnesium Nitrate
Alchohol Ethoxylated	Mesh Sand (Crystalline Silica)
Alphatic Acid	Methanol
Alphatic Alcohol Polyglycol Ether	Mineral Spirits
Aluminum Oxide	Monoethanolamine
Ammonia Bifluoride	Naphthalene
Ammonia Bisulfite	Nitrilotriacetamide
Ammonium chloride	Oil Mist
Ammonium Salt	Petroleum Distallate Blend
Ammonia Persulfate	Petroleum Distillates
Aromatic Hydrocarbon	Petroleum Naphtha
Aromatic Ketones	Polyethoxylated Alkanol (1)
Boric Acid	Polyethoxylated Alkanol (2)
Boric Oxide	Polyethylene Glycol Mixture
Butan-1-01	Polysaccharide
Citric Acid	Potassium Carbonate
Crystalline Silica: Cristobalite	Potassium Chloride
Crystalline Silica: Quartz	Potassium Hydroxide
Dazomet	Prop-2-yn-1-01
Diatomaceus Earth	Propan-2-01
Diesel (use discontinued)	Propargyl Alcohol
Diethylbenzene	Propylene
Doclecylbenzene Sulfonic Acid	Sodium Ash
E B Butyl Cellosolve	Sodium Bicarbonate
Ethane-1,2-diol	Sodium Chloride
Ethoxlated Alcohol	Sodium Hydroxide
Ethoxylated Alcohol	Sucrose
Ethoxylated Octylphenol	Tetramethylammonium Chloride
Ethylbenzene	Titaniaum Oxide
Ethylene Glycol	Toluene
Ethylhexanol	Xylene
Ferrous Sulfate Heptahydrate	
Formaldehyde	
Glutaraldehyde	

Source: Pennsylvania Department of Environmental Protection (DEP)

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