Best Practices of Road User Maintenance Agreements Amongst Local Government Agencies in Ohio


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16. Abstract

Recent innovations in the oil and gas industry have increased horizontal drilling and hydraulic fracturing activity in Ohio. As of July 2015, 1559 wells were planned or drilled in Ohio and 935 were producing. During its lifetime, each well site can generate up to 3000 additional truck loads. There is also increased truck activity to haul waste water away to injection well sites and to construct compressor stations and pipelines. These activities have resulted in a significant increase to the normal truck traffic volume experienced on the local road and bridge system.

Ohio Senate Bill 315 requires oil or gas well operators enter into a Road User Maintenance Agreement (RUMA), or demonstrate a good-faith effort to do so prior to obtaining a drilling permit. By entering into a RUMA the company assumes a contractual obligation for maintaining or improving roads and bridges to mitigate the damage due to the excessive loads. A RUMA template was cooperatively developed by the Ohio Department of Transportation (ODOT), Ohio Department of Natural Resources (ODNR), oil and gas industry representatives, the County Engineer's Association of Ohio (CEAO), and other local transportation officials. As a home rule state, local agencies may modify the template for specific situations, resulting in many variations of the RUMA. Local agencies have also executed RUMAs with other industries such as coal, timber, wind energy, etc. In some instances, RUMAs may have been used in situations where their use is not necessarily appropriate, which has caused confusion among the local agencies and the industry.

Although there has been a significant amount of study of the topic, this information is neither widely disseminated nor easily accessible to local officials. This information was collected from agencies in Ohio and elsewhere to find current and proposed practices via a literature search, a survey of counties and townships in Ohio, and interviews of select county engineers and township trustees. These practices are compared and the best presented in a matrix of best practices as well as guidelines and recommendations for local officials in Ohio.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(°F-32)/9 or (°F-32)/1.8	Celsius temperature	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in^2 or psi	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celsius temperature	1.8°C + 32	Fahrenheit temperature	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2 or psi

* SI is the symbol for the International Symbol of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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1 Project Background

1.1 Energy Development

1.1.1 Gas and Oil Extraction

Economic development in Ohio has resulted in changes to volume, weight, and configuration of truck traffic on state, local, and municipal roads and bridges. The largest impact has come from the recent innovations in the oil and gas industry. Many shale formations in the United States contain vast amounts of gas and oil, as shown in Figure 1, but these deposits could not be economically recovered with vertical drilling technology.

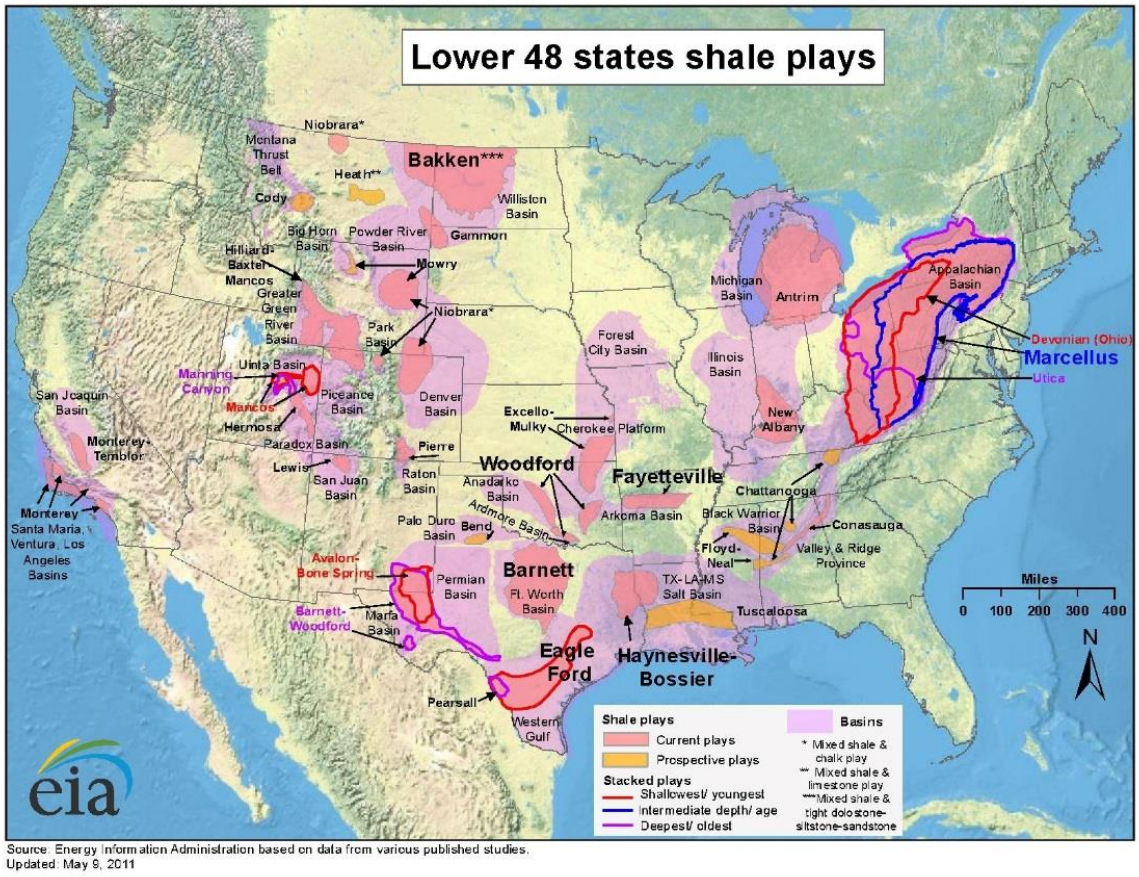

Figure 1. Map of the shale plays in the lower 48 United States. [http://www.lib.utexas.edu/maps/us_oil_and_gas_maps.html]

The combination of horizontal drilling with hydraulic fracturing technology in the early 1990s allowed the recovery of oil and gas from a larger subsurface area, which made the recovery of gas and oil economically competitive with conventional techniques [Holditch, 2010]. This technology has led to extensive drilling into two shale formations in Ohio, the Utica and Marcellus, shown in Figure 2 and Figure 3 respectively. As of October 1, 2016, 1836 horizontal wells have been or are being drilled and 1423 are producing in Ohio [http://buckeyehills.org/development/marcellus-and-

utica-shale/]. The construction of the well pads, delivery of water for the hydraulic fracturing process, and the removal of the flowback brine to injection wells, located as shown in Figure 4, can result in an additional 3000 or more truck loads on roads leading to a well site. This has resulted in a volume of trucks significantly higher than expected on a typical county or township road in eastern Ohio.

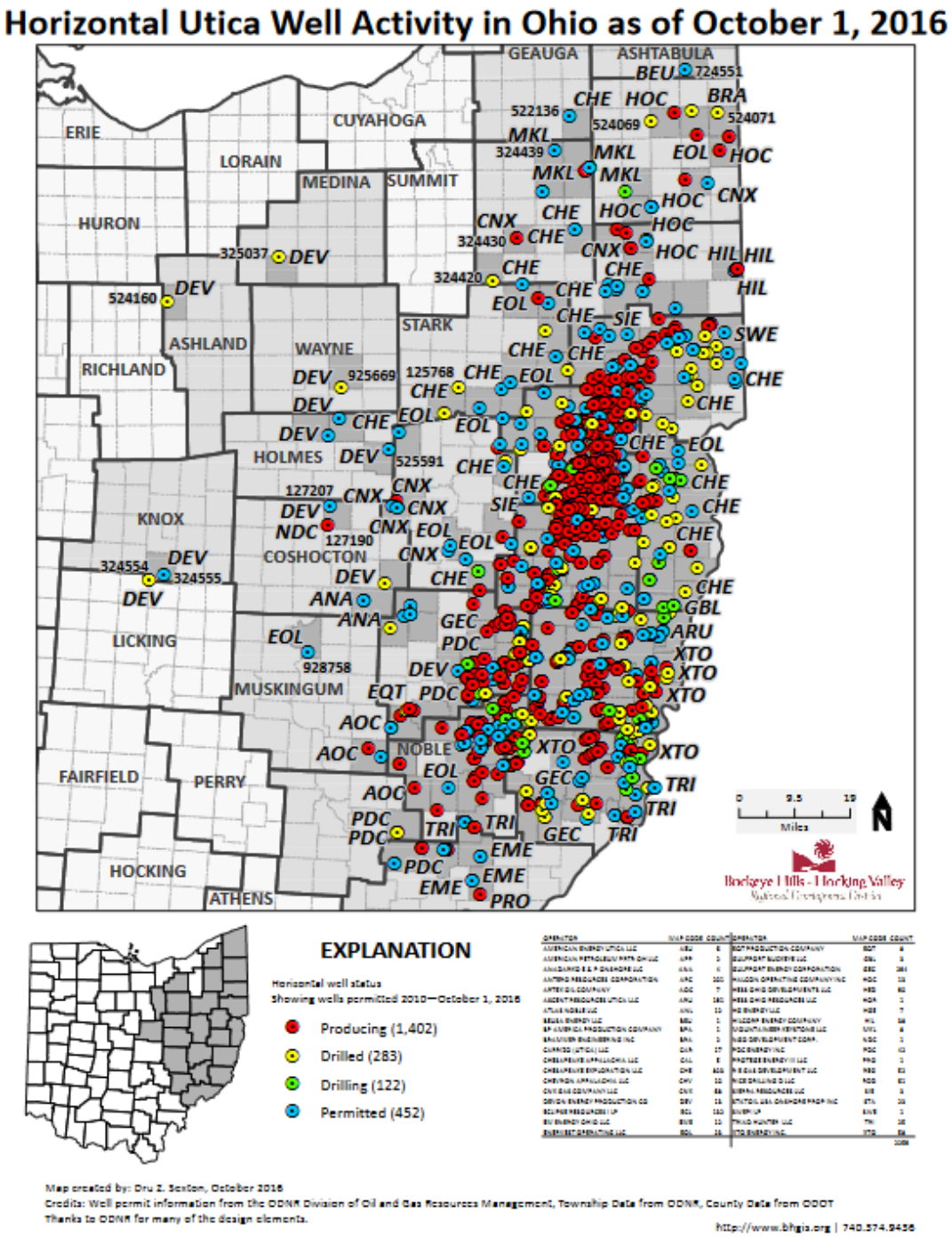

Figure 2. Horizontal Utica Well Activity in Ohio [http://buckeyehills.org/development/marcellus-and-utica-shale/]

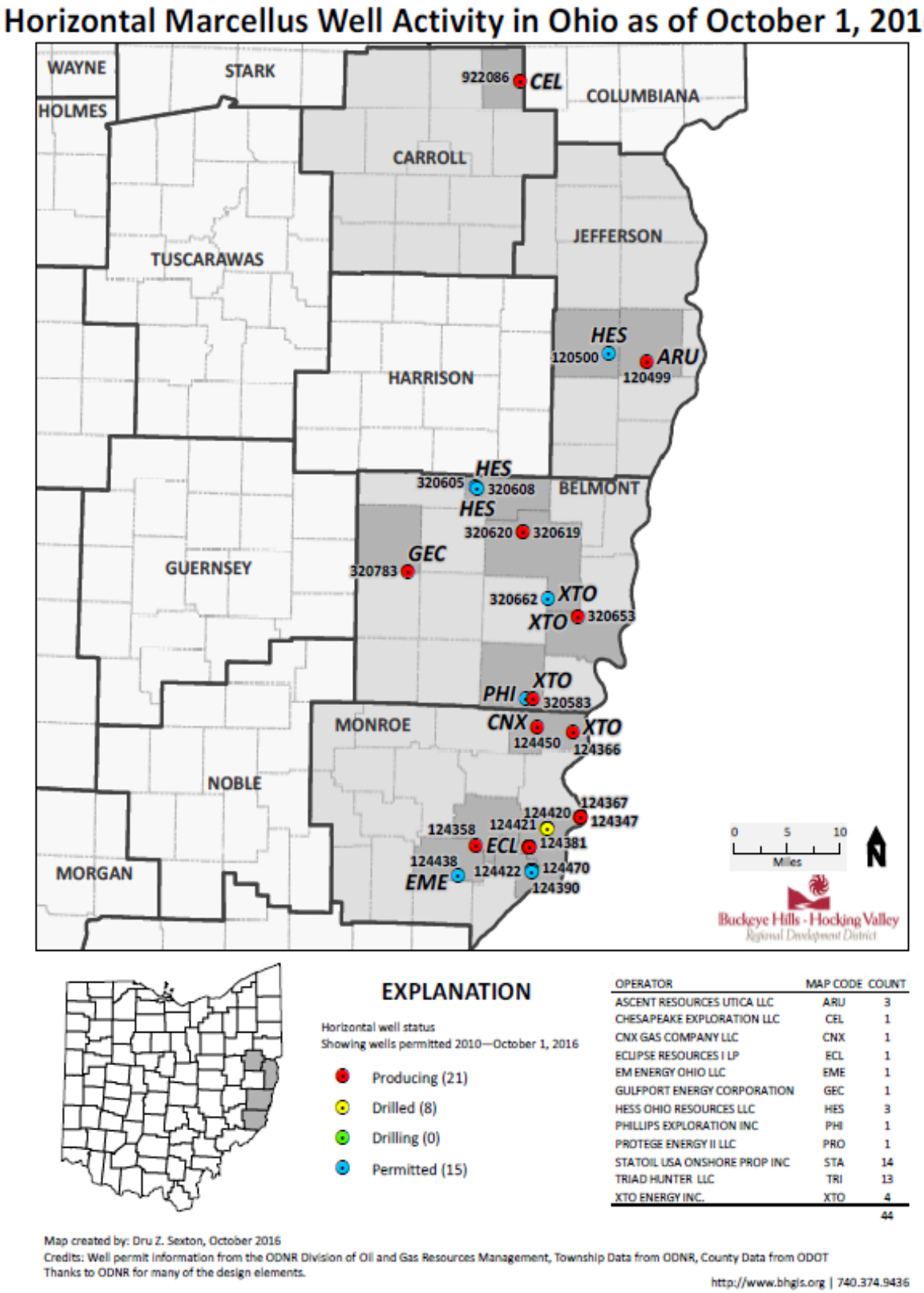

Figure 3. Horizontal Marcellus Well Activity in Ohio [http://buckeyehills.org/development/marcellus-and-utica-shale/]

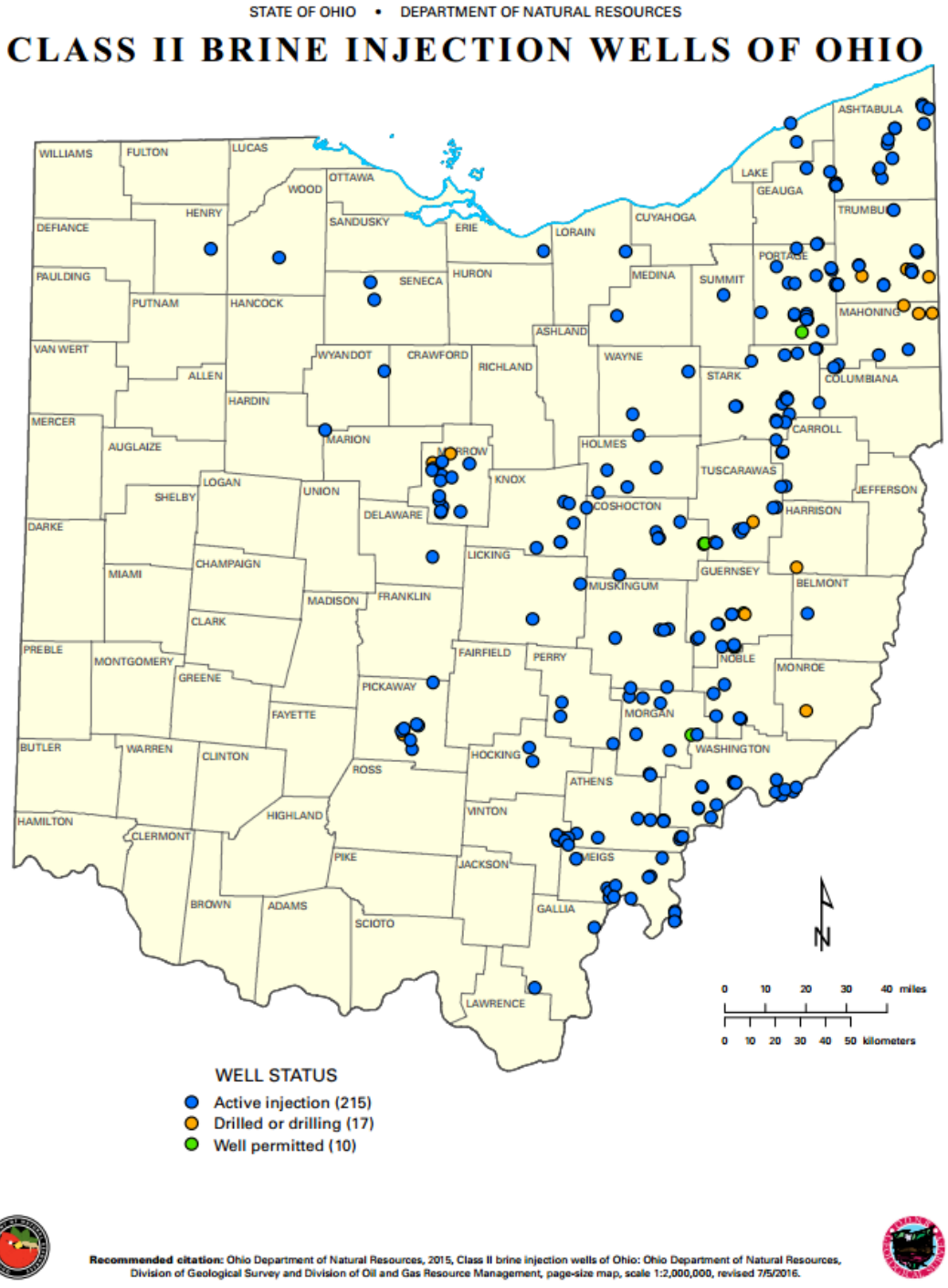

Figure 4. Class II Brine Injection Wells of Ohio
[http://geosurvey.ohiodnr.gov/Portals/geosurvey/Energy/Class_II_Brine_Injection_Wells_07-05-2016.pdf]

Increased drilling has also led to an increase in the construction of pipelines and compressor stations to transport the oil and gas from the well site to processing facilities, where the product is then transported to market through national pipelines, such as the proposed Rover pipeline project shown in Figure 5.

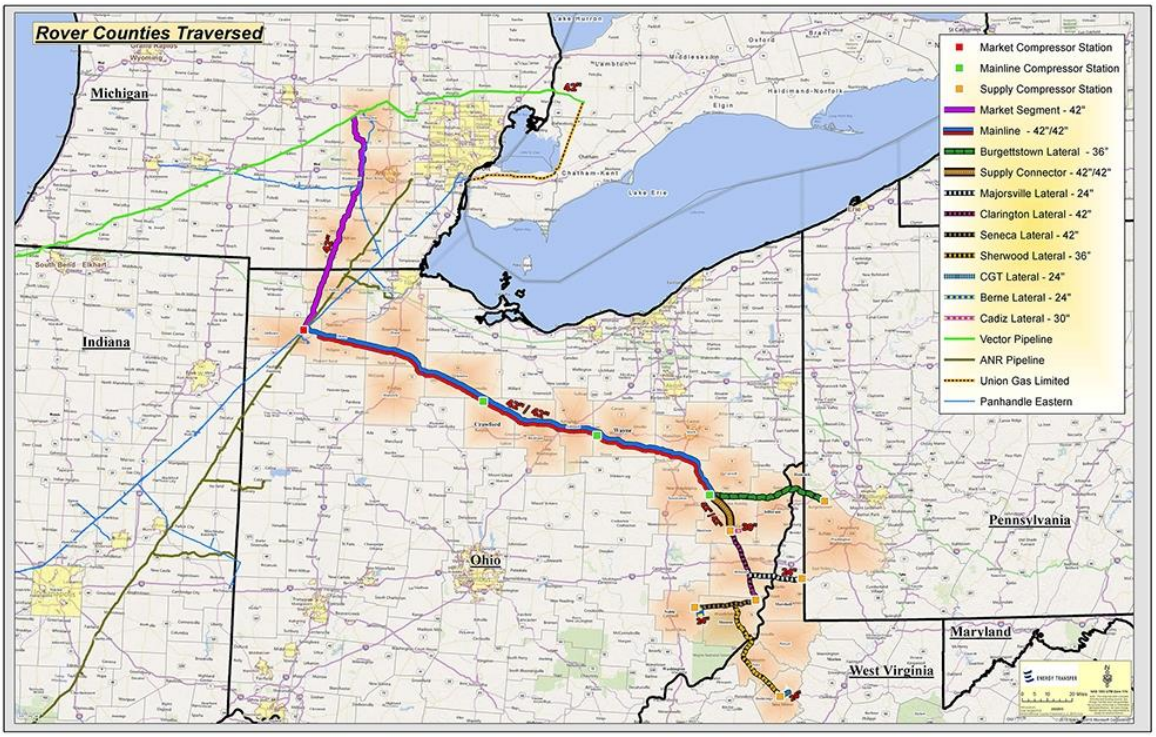

Figure 5. Map of the Proposed Rover Pipeline Project [http://www.roverpipelinefacts.com/about/route.html].

1.1.2 Wind Power

Federal and state subsidies and tax credits have resulted in an increase in the construction of wind farms to generate electricity. The wind capacity in the northwest quadrant of Ohio, see Figure 6, is favorable to the use of wind turbines for the generation of electricity. As shown in Figure 7, wind power is not a major source of electricity in Ohio but several large wind farms have been and are currently under development.

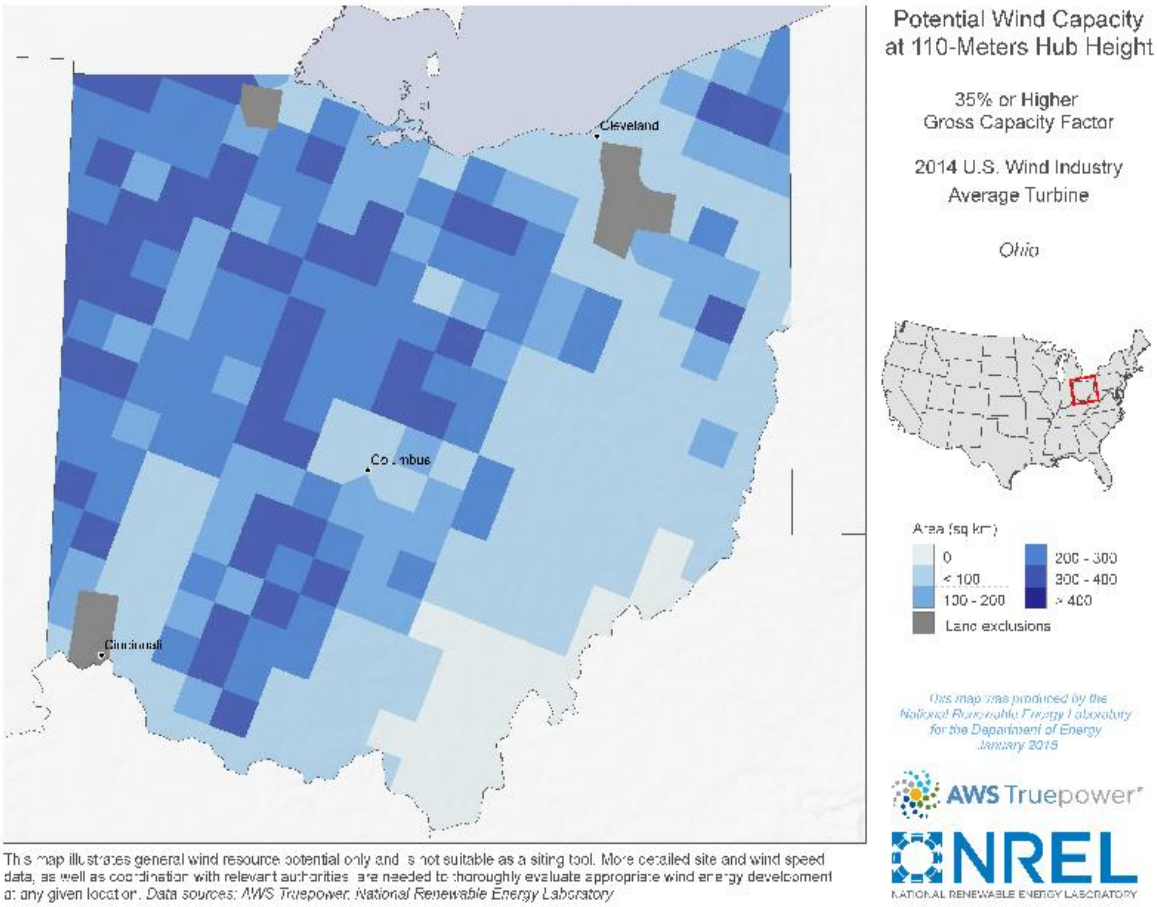

Figure 6. Wind Capacity in Ohio at 110 m (360 ft) height is greatest in the Northwest part of the state. [http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=oh]

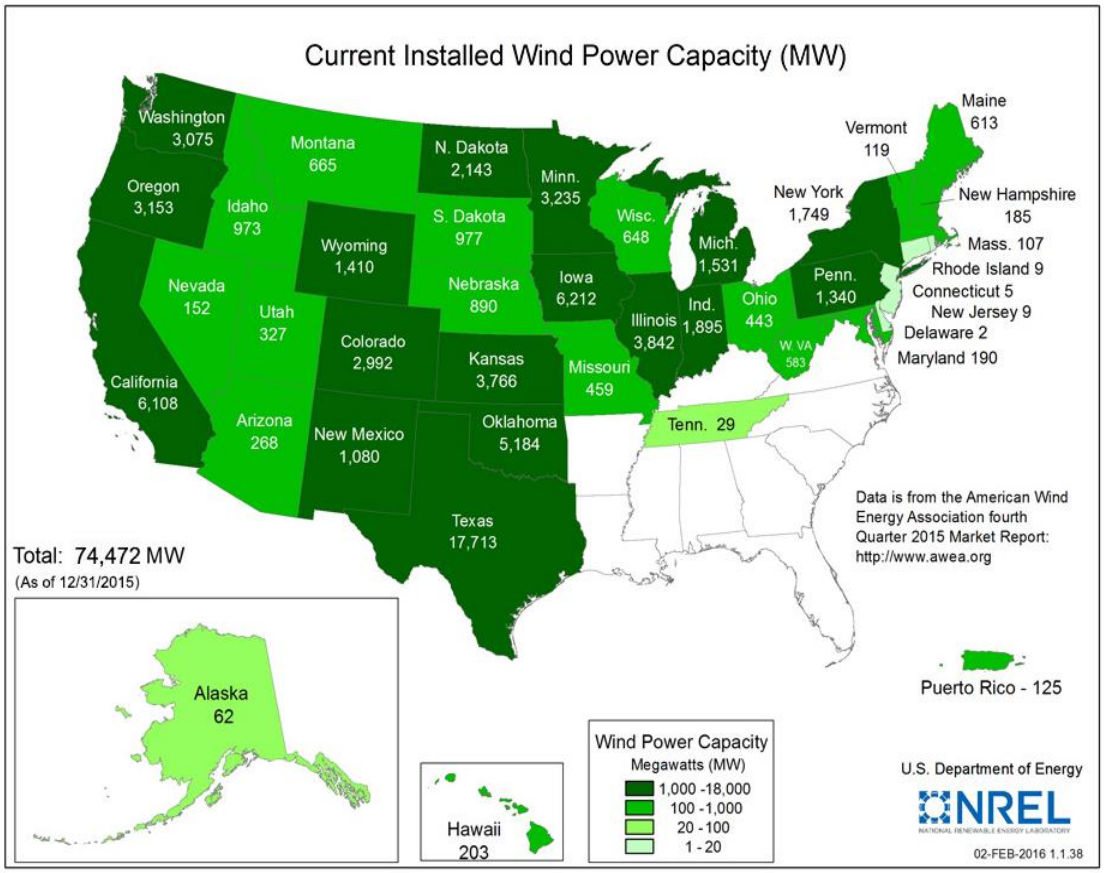

Figure 7. Current Installed Wind Power Capacity
[http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp]

Heavy construction equipment needed to erect the towers, such as the cranes used to install wind turbines may weigh up to 500 tons. This equipment must be trucked to sites mostly located in rural areas. Once assembled, the equipment may need to cross the road to move from one turbine farm to another. Blades, as shown in Figure 8, and turbines transported to the construction site typically require oversize and overweight permits. When sites are decommissioned, these towers are disassembled and the turbines and blades transported from the sites.

Figure 8. Wind Turbine Blades

1.1.3 Other Development Activities

During the conduct of this research, additional development activities were identified during the literature search, survey, and interviews which resulted in an increased in traffic during construction and/or production. These activities include biofuel production as shown in Figure 9, commercial animal farming, erecting electric transmission lines, landfills, building solar cell installations such as that shown in Figure 10, and logging timber.

Figure 9. Biofuel Production Facility [http://www.greenenergyoh.org/]

Figure 10. A Solar Cell Installation [http://www.greenenergyoh.org/]

For low volume roads, which typically have cross sections designed for local traffic, increased loading due to development can result in significant damage to the pavement if the traffic is not anticipated and the road and bridges not maintained or upgraded for the loading. Many of the local agencies do not have the staff and resources needed to predict future truck traffic movement due to development and improve the pavement structure. However, these agencies have ownership and operational responsibility for the local infrastructure, as defined in the Ohio Constitution and Ohio Revised Code.

In these situations, the local agency may enter into a Road User Maintenance Agreement (RUMA) with the private company in which the company assumes a contractual obligation for repairing or improving the road and bridges to prevent or mitigate the damage due to the excessive loading prior to the company being issued a permit. On June 11, 2012, the Governor signed into law Ohio Senate Bill 315 which requires horizontal oil/gas well operators to enter into RUMAs or demonstrate a good-faith effort to do so. A model RUMA has been cooperatively developed by the Ohio Department of Transportation (ODOT), Ohio Department of Natural Resources (ODNR), the County Engineers Association of Ohio (CEAO), and other local transportation officials [MacAdam, 2012]. The template has been posted on the CEAO website for use by local agencies and a copy has been included as Appendix B. Local agencies have modified the template for their specific situation, resulting in many variations of the RUMA. In addition, RUMAs may have been used in situations where not necessary or appropriate [Seipel, 2014; Settineri, 2014]. This has resulted in confusion among the local agencies and the industry. The RUMA concept may also be applicable to other industries such as coal, timber, wind energy, etc. Although there has been a significant amount of study on the topic, this information is not widely disseminated and is not manageable and accessible to local officials. This synthesis study was initiated to collect this information, compare and contrast current practices and RUMAs used by other states and agencies, and assemble the information into guidelines and recommendations for local officials.

1.2 Relevant Sections of the Ohio Constitution and Revised Code

During the course of the literature review, interviews, and meetings with the technical advisory committee, sections of the Ohio Constitution and Revised Code were referenced. Inclusion of all codes related to truck size and weight, mining, oil and gas development, agriculture, wind farms, etc. would be too voluminous for this report. Therefore, the most relevant sections are identified and summarized below.

1.2.1 Home Rule and Local Agency Duties

Critical to the development and execution of a RUMA is the identity of the parties authorized to enter into a contract with the developer. Municipalities, Counties, and Townships are granted the authority of their respective jurisdictions by the Ohio Constitution, Article XVIII, Section 3; Article X, Section 1; and Article X, Section 2, respectively [OLSC, 2010]. These sections establish Ohio as a "home rule" state. However, ORC section 1509.02 created the Division of Oil and Gas Resources Management in the Ohio Department of Natural Resources, which has "…sole and exclusive authority to regulate the permitting, location, and spacing of oil and gas wells and production operations within the state, excepting only those activities regulated under federal laws for which oversight has been delegated to the environmental protection agency and activities regulated under sections 6111.02 to 6111.028 of the Revised Code".

ORC Section 5543.01(2) states a county engineer in Ohio has "general charge" of the "Construction, reconstruction, improvement, maintenance, and repair of all bridges and highways within the engineer's county, under the jurisdiction of the board of county commissioners…" Likewise, ORC section 5571.01(A) states: "A board of township trustees may construct, reconstruct, resurface, or improve any public road or part thereof under its jurisdiction…" And ORC 5571.02 states, "The board of township trustees shall have control of the township roads of its township and … shall keep them in good repair". Section 5543.01(C) restricts the duties of the county engineer duties with regard to inspection, repair, maintenance, and grading of township roads unless requested by the township trustees.

1.2.2 Truck Size and Weight

Section 5577 of the Ohio Revised Code (ORC) defines the limits of the size and weight of vehicles on highways. ORC Section 5577.04 limits the total weight of a pneumatic tired vehicle on the non-interstate system to 80,000 lb (36,000 kg or 356 kN). The section also limits the load on single and multi-axle combinations. ORC Sections 5577.042 and 5577.043, allow for variation in farm, log, coal, solid waste, or mining vehicles or vehicles hauling hot mix asphalt, concrete, manure, turf, sod, silage, chips, sawdust, mulch, bark, pulpwood, biomass, or firewood. These vehicles may exceed the weight limits by no more than 7½% without penalty. ORC Section 5577.044 allows natural gas powered vehicles to exceed the weight limits by no more than 2000 lb (910 kg or 9 kN) without penalty.

Limits on the dimension of a vehicle are provided in ORC Section 5577.05. Truck widths are limited to a maximum of 102 in (2.6 m). A tractor-trailer combination is limited to a maximum length of 53 ft (16 m). Height of all vehicles is limited to a maximum of 13'6" (4.1 m). ORC Section 5577.05 exempts the movement of certain types of vehicles from the dimension limits. These vehicles include farm machinery and equipment as defined in ORC 4501.01(u), vehicles and trailers transporting wood or metal poles, and pipes or well drilling equipment.

ORC Section 5577.13 assigns enforcement of size and weight limits to the county sheriff and allows the use of county road fund money to equip and compensate one or more deputies for the work. The specifications for scales used for enforcement and the method for determining weight in the field are provided in ORC Section 4513.33.

Loads exceeding the legal weight or size may be hauled over a road if a written special hauling permit is issued by the governing agency as provided in ORC Section 4513. ORC Section 4513 also provides "…a local authority, as a condition of issuance of an overweight permit, may require the applicant to develop and enter into a mutual agreement with the local authority to compensate for or to repair excess damage caused to the roadway by travel under the permit."

1.2.3 Weight and Speed Reduction

ORC Section 5577.07, commonly called the "Frost Law", allows the reduction of truck weight and speed limits, not to exceed 50%, on county and township roads during the time when thaw or excess moisture makes the road susceptible to damage from heavy loads. Routes with reduced weight/speed limits must be signed with the load reduction amount and dates of reduction.

ORC Section 5577.071 provides procedures for reducing the weight or speed of vehicles on deteriorated or vulnerable bridges, when the condition of the bridge justifies a reduction.

ORC Section 5577.08 provides a procedure for county commissioners to establish and make rules for load and speed limits for county and township road and bridges within their county based on roadbed, pavement buildup, and other related factors. Roads classified under this section are to be signed as detailed in ORC Section 5577.09.

1.2.4 Horizontal Gas and Oil Wells

The requirements for obtaining a permit for drilling horizontal gas and oil wells is the only code found which required an agreement with the local agency to maintain the roads. ORC Section 1509.06 (A)(11)(b) requires the applicant for a permit to drill a horizontal gas or oil well provide with the application, a list of local roads used to access the well site, and a copy of an agreement with the local agency concerning the maintenance and safe use of the local roads or an affidavit that the owner attempted in good faith to enter an agreement.

1.2.5 Wind farms

ORC Section 5727.75 requires the owner or lessee of an energy project, i.e. wind farm, with a capacity of 5 MW (6700 hp) or greater, to restore affected roads, bridges, or culverts to preconstruction condition. The county engineer, "…in consultation with any affected local jurisdiction…", is responsible for determining the rehabilitation needed for construction and decommissioning of the energy facility. This section also requires the owner/lessee post a bond in an amount established by the county engineer to ensure funding for roads affected during construction and decommissioning. ORC Section 5727.75 does not require an agreement but states the owner/lessee "…may enter into an agreement regarding specific transportation plans, reinforcements, modifications, use and repair of roads, financial security to be provided, and any other relevant issue."

1.2.6 Injection wells

ORC Section 1509.22 provides four methods for disposing of brine from oil & gas wells:

- injection underground
- applied to road surface for dust or ice control
- reused to enhance recovery or storage of oil and gas
- other methods approved by ODNR

The ORC does not specifically address the maintenance of roads used to haul brine to injection wells.

2 Objectives

The goal of this research is to conduct a synthesis study of current practices related to the development and execution of RUMAs. The objective of this research is to identify current best practices and provide recommendations for RUMA development to assist Ohio's local transportation officials.

3 Research Approach

3.1 Literature Review

The purpose of the literature review was to acquire knowledge from Ohio and other states on the subject of "Road User Maintenance Agreements" (RUMAs) that are currently being used. Targeted journals, articles, and reports were consulted for this literature review, among which the most valuable source was NCHRP Synthesis 469, *Impact of Energy Development on U.S. Roads and Bridges* [McCarthy et al., 2015]. Summaries of the literature that was reviewed in making this report are in Appendix A. Upon reading the literature, a set of best practices followed by different agencies are highlighted in the form of a matrix in Chapter 4 of this report.

3.2 Survey

After consultation with the TAC, it was deemed beneficial to identify which energy industries are active in Ohio, whether related construction activities are occurring, and whether RUMAs are being used to mitigate damage. The research team followed a two phase process. The first phase was the development, distribution, and analysis of an online survey of county engineers and township trustees. The results of the online survey was used to select county engineers and township trustees for follow up interviews, either in person or by phone.

The online survey questions are listed in Appendix C. The initial survey was distributed through a link to a web-based survey engine. The survey was publicized using the County Engineers Association of Ohio (CEAO) web site and newsletter, as well as Ohio Township Association (OTA) meeting and newsletter, and further emailed to all county engineers in Ohio.

The first question of the survey sought to determine whether the respondent had experienced or anticipated energy related development in their jurisdiction. If none of the industries listed was checked then the respondent was directed to the last item in the survey, otherwise further questions were asked to verify the impact of the energy development on road usage, and if the respondent required or requested a RUMA with the energy developer. If RUMAs were not used, then the respondent was directed to the last item in the survey, otherwise further questions about the RUMA were asked, including whether the RUMA used was the standard RUMA or a modified version, and whether there were fees associated with signing a RUMA. The name and address of the respondent was the last item in the survey. The answers from the survey were further analyzed after a period of time deemed sufficient by the researchers to have reached all possible entities in Ohio. The answers from the survey were automatically tabulated and the results are discussed below. Table 1 lists and Figure 11 maps the 31 counties and 46 townships that responded to the survey. One main purpose of the online survey was to identify counties and townships for in-depth interviews.

Table 1. List of Counties and Townships that responded to the online survey.
Note: "Engineer" in the Township column indicates response by the County Engineer's office.

	County	Township		County	Township		County	Township
1	Adams	Engineer	27	Guernsey	Millwood	53	Miami	Newton
2	Allen	Marion	28	Guernsey	Engineer	54	Monroe	Benton
3	Ashtabula	Williamsfield	29	Hamilton	Harrison	55	Monroe	Engineer
4	Athens	Bern	30	Hancock	Engineer	56	Montgomery	Engineer
5	Athens	York	31	Harrison	Engineer	57	Montgomery	German
6	Auglaize	Moulton	32	Harrison	Washington	58	Morgan	Engineer
7	Belmont	Mead	33	Henry	Pleasant	59	Morrow	Harmony
8	Belmont	Engineer	34	Hocking	Engineer	60	Muskingum	Engineer
9	Butler	Engineer	35	Holmes	Salt Creek	61	Portage	Mantua
10	Carroll	Loudon	36	Holmes	Knox	62	Portage	Engineer
11	Carroll	Engineer	37	Holmes	Engineer	63	Preble	Jefferson
12	Champaign	Engineer	38	Jackson	Scioto	64	Richland	Engineer
13	Columbiana	Engineer	39	Jackson	Milton	65	Stark	Engineer
14	Coshocton	Engineer	40	Jackson	Engineer	66	Trumbull	Newton
15	Darke	Engineer	41	Jefferson	Smithfield	67	Tuscarawas	Engineer
16	Delaware	Berkshire	42	Jefferson	Ross	68	Warren	Engineer
17	Erie	Milan	43	Jefferson	Engineer	69	Washington	Salem
18	Erie	Engineer	44	Jefferson	Salem	70	Washington	Engineer
19	Fairfield	Violet	45	Jefferson	Salem	71	Wayne	Engineer
20	Fairfield	Bloom	46	Knox	Engineer	72	Wayne	Plain
21	Fayette	Union	47	Miami	Concord	73	Williams	Engineer
22	Franklin	Prairie	48	Licking	Hartford	74	Wood	Lake
23	Franklin	Perry	49	Lorain	Penfield	75	Wyandot	Engineer
24	Fulton	Franklin	50	Mahoning	Engineer	76	Portage	Rootstown
25	Geauga	Montville	51	Medina	Montville	77	Clermont	Pierce
26	Guernsey	Richland	52	Mercer	Marion			

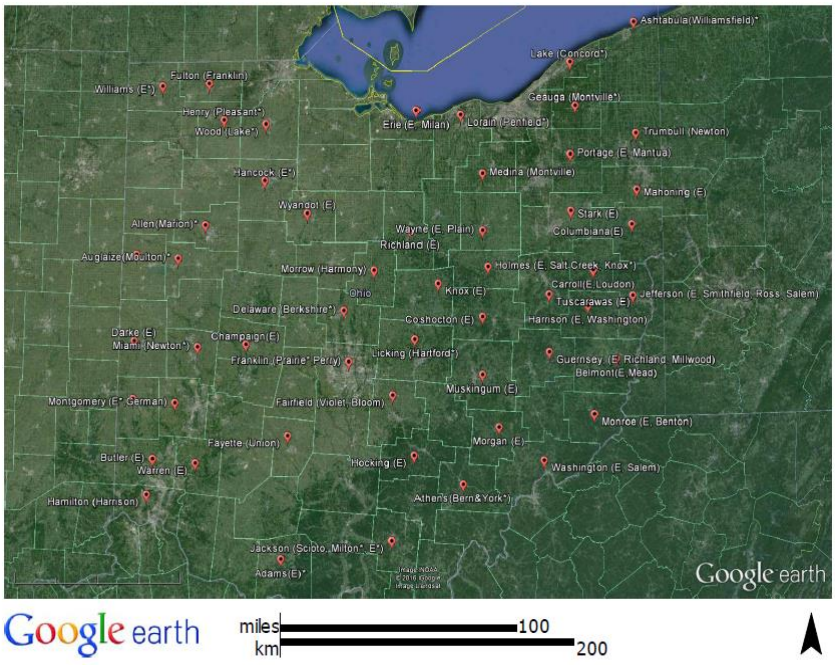

Figure 11. Counties and townships that responded to the online survey (E designates county engineer).

3.2.1 Survey Results

In answering Question 1, 28 of the respondents indicated they do not anticipate any significant energy related development activity. A summary of answers to the first question is provided in Table 2.

Table 2. Summary responses to Question 1.

#	Answer		Response	%
1	Oil		43	41%
2	Gas		48	45%
3	Solar		3	3%
4	Wind		7	7%
5	Mining		6	6%
6	Bio-fuels		3	3%
7	Pipelines		58	55%
8	None		28	26%
9	Other, Please list		6	6%

Other, Please list

New electric poles & lines

Logging

Electric line upgrades

Nexus gas transmission

Electric overhead transmission line

Of those respondents that anticipated significant energy development in their jurisdiction, 37% indicated they anticipate minimal effect on their budget, as shown in Table 3; 35% expected significant effect on truck volumes, per Table 4; and 41% indicated minimal effect on traffic congestion, as shown in Table 5. 31% of the respondents indicated that energy development had a minimal effect on road damage, as indicated in Table 6 and 45% indicated no damage to bridges, see Table 7.

Table 3. Answers to the effect of development the respondent's budget.

#	Answer		Response	%
1	Significant		8	12%
2	Moderate		16	25%
3	Minimal		24	37%
4	None		17	26%
	Total		65	100%

Table 4. Effect of development on truck traffic.

#	Answer		Response	%
1	Significant		23	35%
2	Moderate		15	23%
3	Minimal		15	23%
4	None		12	18%
	Total		65	100%

Table 5. Effect of energy development on traffic congestion.

#	Answer		Response	%
1	Significant		8	13%
2	Moderate		16	25%
3	Minimal		26	41%
4	None		14	22%
	Total		64	100%

Table 6. Effect of energy development on road damage.

#	Answer		Response	%
1	Significant		16	25%
2	Moderate		17	26%
3	Minimal		20	31%
4	None		12	18%
	Total		65	100%

Table 7. Effect of energy development on bridge damage.

#	Answer		Response	%
1	Significant		4	6%
2	Moderate		8	12%
3	Minimal		24	37%
4	None		29	45%
	Total		65	100%

75% of the respondents indicated their agency required or requested a RUMA from the industry prior to commencement of activities, as shown in Table 8; 56% of those indicated they have between 1 and 10 RUMAs, and 29% indicated more than 10 RUMAs, per Table 9.

Table 8. Agency require or requested a RUMA prior to commencement of energy activities.

#	Answer		Response	%
1	Yes		49	75%
2	No		16	25%
	Total		65	100%

Table 9. Number of RUMAs executed.

#	Answer		Response	%
1	None		7	15%
2	1 to 10		27	56%
3	More than 10		14	29%
	Total		48	100%

According to the survey, 57% of the respondents indicated they have not terminated a RUMA while 43% said they have, as shown in Table 10.

Table 10. RUMAs terminated.

#	Answer		Response	%
1	Yes		20	43%
2	No		26	57%
	Total		46	100%

A large majority of those terminations, 80%, as seen in Table 11, were due to completion of work pursuant to the terms of the RUMA. Most respondents, 72% indicated they use the standardized RUMA or a modified version of the standardized RUMA, as shown in Table 12.

Table 11. Reasons for terminating RUMAs

#	Answer	Response	%
1	Due to completion pursuant to the terms of the RUMA	16	80%
2	Initiated by the energy developer	4	20%
3	Initiated by the local agency	0	0%
4	Other, explain:	0	0%
	Total	20	100%

Table 12. Type of RUMAs used by respondents

#	Answer		Response	%
1	Yes, as is		7	16%
2	Yes, modified		24	56%
3	No, used RUMA developed "in house"		7	16%
4	No, did not have an agreement		1	2%
5	Other		4	9%
	Total		43	100%

A majority of respondents, 71% indicated road improvement were being made by energy developers prior to their hauling on the roads, as shown in Table 13. 58% of respondent indicated they have required bonds at the time of RUMA signing, per Table 14, and 70% indicated they did not require special hauling fees, per Table 15. Of the 26 % who indicated they still required special

hauling fees, 61% indicated those fees were not reduced if a RUMA was signed, as shown in Table 16.

Table 13. Are energy developers improving roads prior to start of operations?

#	Answer		Response	%
1	Yes, frequently		14	34%
2	Yes, occasionally		15	37%
3	No		12	29%
	Total		41	100%

Table 14. Are bonds required?

#	Answer		Response	%
1	Yes		23	58%
2	No		15	38%
3	Other		2	5%
	Total		40	100%

Table 15. Are special hauling permits required?

#	Answer		Response	%
1	Yes		11	26%
2	No		30	70%
3	Other		2	5%
	Total		43	100%

Table 16. Are fees were waived or reduced if a RUMA was signed?

#	Answer		Response	%
1	Yes		4	12%
2	No		20	61%
3	Other		9	27%
	Total		33	100%

Based on the results of the online survey, and in coordination with the TAC team, a set of 16 questions was created for the in-depth interviews. These are given in Appendix D. The questions would help the research team gain insight into the practices of the Ohio counties and townships, and how they deal with the increased development activities from the energy sector.

The original intent was to interview local agency personnel in 12 counties by making 6 trips to agency offices and conducting one interview in the morning and one in the afternoon. After the first two interviews, the research team found little added value in traveling to the interview; documents at the county/township were also available in electronic format so there was no need to be present to obtain copies of RUMAs and Ohio University also had the capability to conduct conference calls so it was also possible to include all members of the research team in the interview which would not have been possible with in-person meetings. Therefore, the team decided, with the TAC approval, to conduct telephone interviews and only travel to the county and township which lacked the ability to email copies of sample RUMA. As a result, the 15 County Engineers

and 9 Township Trustees in the 16 counties listed in Table 17 were interviewed in person or by phone. In addition, personnel with the Regional Planning Organization in southeast Ohio, Buckeye Hills – Hocking Valley Regional Development District, and ODOT Office of Permits, were interviewed.

The counties/townships for the interview were selected to obtain a range of energy development activity, use/nonuse of RUMAs, use/nonuse of bonds/fees/escrows, etc. Each of the officials listed in Table 17 were contacted by phone or email, to schedule an in-depth RUMA processes interview in their jurisdiction. Once a date and time were set, the questions were emailed, when possible, to give the official time to review and provide the team with appropriate responses. The team would then visit or call the official at the scheduled time to conduct the interview. Responses were evaluated to determine best practices which are summarized in Chapter 4.

Table 17. Interview List. Numerals in parentheses indicate more than number of people from that agency interviewed when more than one.

Activity								Agency	
Oil	**Gas**	**Wind**	**Mining**	**Bio-fuels**	**Pipelines**	**Other**	**County**	**County Engineer**	**Township Trustee**
			x			Injection Wells	Athens	X	Bern
X	X		X		X		Belmont	X (3)	
X	X				X		Carroll	X	
		X					Champaign	X	
				X	X		Coshocton	X	
	X				X		Fairfield	X (2)	Bloom (2), Violet
							Harrison	X	Greene, Washington
	X				X	Electric line upgrades	Hocking	X	
X	X		X		X		Jefferson	X (2)	Salem
X	X				X		Monroe	X	Switzerland (2)
X	X						Muskingum	X	
							Noble	-	Seneca
		X					Paulding	X	
						X	Portage	X	
						X	Trumbull	X	
		X					Van Wert	X	

3.2.2 Interviews and Sample RUMAs

The 2012 CEAO model RUMA can be broken down into nine basic components:

1. Who/what the RUMA applies to: This section identifies the operator, county, and roads included in the RUMA.
2. Pre-Development Upgrades: The operator and county mutually agree on the portions of road that need to be upgraded/strengthened, the type of improvement, and requirements for maintenance of the road during the drilling activity.
3. Railroad Crossings: Requires the operator notify and coordinate with any railroads located on affected roads during drilling operations.
4. Identification and Completion of Work at Termination of Agreement: Provides for the inspection and repair, if any, of the road and termination of the RUMA.
5. Bond or Surety: Sets bond or surety amount and defines any exceptions.
6. Size and Weight Limits: Requires the operator comply with all legal size, load, and weight limits per state law, and all non-conforming vehicles obtain the proper local permit.
7. Contact Information: Requires the operator provide emergency contact information.
8. Traffic Signage: Requires the operator provide any additional signs needed for safety.
9. Liability: Requires the operator indemnify the county from any liability that may arise from violations of any laws or ordinances.

During the interview process, a sample RUMA for the various development activities for which the local agency has obtained a RUMA was requested. In addition, the literature was searched for RUMAs employed in other states. These RUMAs were compared and contrasted to the CEAO model RUMA focusing on the latter's nine basic components. The comparison with RUMAs obtained from out of state agencies is presented in Table 18. The analysis of RUMAs obtained from Ohio local agencies during the interview process is presented afterwards. Sample RUMAs were obtained from the following 12 counties: Athens, Belmont, Carroll, Champaign, Fairfield, Harrison, Hocking, Jefferson, Muskingum, Portage, Van Wert, Washington. Additional RUMAs were obtained from three townships: Bern Township in Athens County, Greene Township in Harrison County, and Washington Township in Harrison County. Hocking County provided three separate RUMAs, one for electrical overhead lines, one for gas/pipelines, and one for timber.

Many county engineers were successful in obtaining a RUMA from developers whose operations would result in a significant increase in truck traffic and damage to local roads, even though the ORC did not require the developer enter into an agreement. In two instances, one injection well and one biofuel plant, the developer refused to cooperate because their vehicles were operating within the legal weight and size limits.

Table 18. Comparison of CEAO model RUMA to RUMAs from out of state.

Sample RUMA Topic	Major Components of Model RUMA Developed by CEAO 2012	Location		
		DeKalb County, Illinois	Steuben County, New York	Southlake, Texas
Who/What it applies to	The specific industry that the RUMA applies to	Wind	Not specified. Extremely detailed RUMA	Drilling gas and/or oil wells
Pre-development upgrades	Operator and county mutually agree on the portions of road that need to be upgraded/strengthened	Yes. Pre-Project Roadway Condition Survey is done. Prior improvements are solely at the expense of the company	Yes	Not specified
	The upgrade/strengthening needs to be sufficient to sustain the anticipated activity, as approved by County Engineer (as detailed in Appendix A). Work to be done at operator's expense	Yes.	Yes.	Yes
	Operator to maintain roads during period of agreement to the level at start of activity	Yes. Post completion work should be completed within 6 months.	Yes	Not specified
Railroad crossings	Must give notice to RR 30 days prior to any known drilling activity utilizing a RR crossing so that a joint inspection of crossing can determine its condition	Not specified	Not specified	Not specified
	Operator must coordinate any work to crossing with RR	Not specified	Not specified	Not specified
Identification and completion of work at termination of agreement	Either party may terminate agreement with 30 days notice	Yes. In written form	The County can terminate within 10 days of notice.	Not specified. Until the work is over
	As soon as possible after notice, County and operator shall inspect roads & bridges & appurtenances. Following completion of restorative work identified during inspection, agreement shall be terminated	Within 30 days	Yes	Not specified
Bond or Surety	Prior to drilling activity, post a bond or other surety in a form satisfactory to County to cover cost of any damage caused by drilling activity	A performance bond is issued	Bond.	Road Damage Remediation fee
	Amount of bond is a "fill-in-the-blank" item (apparently determined on a case by case basis)	The following should be maintained in the performance bond. The construction of the projects, post construction repairs and maintenance period. Evidence of Three million dollar liability insurance should be presented	The dollar amount per mile varies based on the Class of the road. Insurance amount must also be showed as evidence. The value of the insurance changes based on list item.	Charged per lane mile based on type of excisting roadway section
	Exceptions to bond/surety	Have to provide bond 30 days prior to the start of project	Not specified	Not specified
Size and Weight Limits	All vehicles used by operator shall comply with all legal size, load, and weight limits per State law, and all non-conforming vehicles shall require the proper local permit	Yes	Yes. Commissioner reserves the right to exclude certain county roads from designated haul routes	Not specified
Contact Information	Operator to provide contact information including a 24-hour emergency contact for the local representative of operator; must be kept current at all times	Not specified. Communication in written form.	Yes. Emergency repairs should be done in 12 hours	Not specified. Notice in written form
Traffic Signage	If County determines that additional signs are needed for safety, operator shall provide at own expense	Should be obtained from the County but placed by the company	Not specified	Not spcified
	In the event that other safety concerns arise during agreement, operator and County agree they will mutually discuss such concerns and reach a resolution satisfactory to all concerned	Yes	Yes and it will be promptly performed	Yes
Liability	Operator shall indemnify County from any liability that may arise from violations of any laws or ordinances	Yes	Yes	Yes

3.3 RUMA components as adopted by agencies in Ohio

In this section, each RUMA component is listed along with the counties and townships that have adopted the component as is in their sample RUMAs, or have adapted the component in some way.

3.3.1 Who/what the RUMA Applies To

Here are the industries to which RUMAs apply by county, or at least ones that have had RUMAs within the jurisdiction. Champaign and Fairfield Counties indicated they did not have any currently active RUMAs at the time of the interview.

Athens: Gas pipelines.
Athens (Bern Township): Timber
Belmont: Horizontal drilling, pipelines, and electric substation.
Carroll: Timber, gas, and oil pipelines and drilling.
Champaign: Wind farms.
Fairfield: Pipelines and gas.
Harrison: Horizontal drilling, other infrastructure.
Harrison (Greene Township): Gas and oil.
Harrison (Washington Township): Horizontal drilling.
Hocking: Electric overhead lines, pipelines and gas, and timber.
Jefferson: Horizontal wells, pipelines, compressor stations, and mining.
Muskingum: Gas, quarries, major construction, oil, timber, and commercial agriculture.
Portage: Injection wells.
Van Wert: Oil, biofuel, solar development, wind farms.
Washington: Timber, transmission lines, pipelines, gas, and oil.

3.3.2 Pre-Development Upgrades

Provision – Operator and county mutually agree which portions of road that need upgrading.

This provision has been adopted as is by the following counties and townships: Athens, Belmont, Carroll, Fairfield, Harrison, Hocking, Jefferson, Muskingum, Portage, Van Wert, Washington, Bern Township (Athens County), Greene Township (Harrison County), and Washington Township (Harrison County).

Champaign County adds that any damages be repaired to their previous condition.

Provision – The upgrade/strengthening needs to be sufficient to sustain the anticipated activity, as approved by county engineer. Work to be done at operator's expense.

This provision has been adopted as is by the following counties and townships: Athens, Belmont, Carroll, Fairfield, Harrison, Hocking, Muskingum, Portage, Van Wert, Washington, Bern Township (Athens County), Greene Township (Harrison County), and Washington Township (Harrison County).

Champaign County adds that any upgrades and strengthening performed should be removed upon completion unless the county approves.

Jefferson County adds that the upgrades could be temporary or permanent at the county's discretion.

Provision – Operator to maintain roads during period of agreement to the level at start of activity.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Champaign, Fairfield, Harrison, and Muskingum.

This provision has been adopted by the following counties and townships with the option of having the road restored to the condition before the start of activity if needed: Athens, Hocking, Jefferson, Portage, Van Wert, Washington, Bern Township (Athens County), Greene Township (Harrison County), and Washington Township (Harrison County).

3.3.3 Railroad Crossings

Provision – Must give notice to RR 30 days prior to any known drilling activity utilizing a RR crossing so that a joint inspection of crossing can determine its condition.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Harrison, Greene Township (Harrison County), and Washington Township (Harrison County).

This provision is not specified by these counties and townships: Athens, Champaign, Fairfield, Hocking, Jefferson, Muskingum, Bern Township (Athens County), Portage, Van Wert, Washington.

Provision – Operator must coordinate any work to crossing with railroad.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Harrison, Greene Township (Harrison County), and Washington Township (Harrison County).

This provision is not specified by these counties and townships: Athens, Champaign, Fairfield, Hocking, Jefferson, Muskingum, Bern Township (Athens County), Portage, Van Wert, Washington.

3.3.4 Identification and Completion of Work at Termination of Agreement

Provision – Either party may terminate agreement with 30 days notice.

This provision has been adopted by the following counties and townships, with written notice required: Belmont, Carroll, Harrison, Washington, Washington Township (Harrison County).

This provision has been adopted by the following county, with 60 days written notice required: Portage.

This provision has been adopted by the following counties, with no specified notice time: Champaign, Van Wert.

This provision has been adopted by the following county, with hand written notice required, but no specified notice time: Muskingum.

This provision has been adopted by the following county, with reasonable notice time required: Hocking.

This provision is not specified by the following counties and townships: Athens, Fairfield, Jefferson, Bern Township (Athens County), Greene Township (Harrison County).

Provision – As soon as possible after notice, county and operator shall inspect roads & bridges & appurtenances. Following completion of restorative work identified during inspection, agreement shall be terminated.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Harrison, Portage, Washington, Greene Township (Harrison County), and Washington Township (Harrison County).

This provision is not specified by the following counties and townships: Fairfield, Hocking, Muskingum, Van Wert, Bern Township (Athens County).

This provision is not specified by the following counties and townships, but the developer shall immediately discontinue hauling operations: Champaign.

The following counties and townships require a written request for an inspection when no more vehicles are operated: Athens.

This provision has been adopted by the following counties and townships with the specification that damages will be assessed: Jefferson.

3.3.5 Bond or Surety

Provision – Prior to drilling activity, post a bond or other surety in a form satisfactory to county to cover cost of any damage caused by drilling activity.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Harrison, and Washington Township (Harrison County).

The following counties specify a performance assurance bond: Hocking (pipelines, gas), Jefferson, Washington.

The following counties and townships specify an escrow account: Champaign, Van Wert, Greene Township (Harrison County).

The following counties specify a surety bond: Fairfield, Hocking (electric overhead lines), Portage.

This provision is not specified by the following counties and townships: Athens, Muskingum, Hocking (timber), Bern Township (Athens County).

Provision – Amount of bond.

This amount is left blank, to be filled in on a case-by-case basis, by the following counties and townships: Belmont, Carroll, Washington Township (Harrison County).

This amount is set at $100,000 per mile for county roads and $50,000 per mile for township roads by the following county: Hocking (pipelines, gas).

This amount is set at $200,000 per mile by the following counties: Champaign ("to be maintained in escrow at all times"), Van Wert ("to be maintained in escrow at all times"), Washington.

This amount not to exceed $250,000 per mile by the following county: Jefferson.

This amount includes $750,000 retained until 1 year after completion by the following counties: Fairfield, Hocking (electric overhead lines).

This amount is $5000 maintained: Greene Township (Harrison County).

This provision is not specified by the following counties and townships: Athens, Harrison, Hocking (timber), Muskingum, Portage, Bern Township (Athens County).

Provision – Exceptions to bond or surety.

This provision is similar to the Sample RUMA for the following counties and townships: Belmont, Carroll, Harrison, Washington, Washington Township (Harrison County).

This provision is not specified by the following counties: Muskingum, Portage.

No exceptions are specified by the following counties and townships: Athens, Champaign, Fairfield, Harrison, Hocking, Jefferson, Bern Township (Athens County), Greene Township (Harrison County).

This provision is not applicable to the following county: Muskingum.

3.3.6 Size and Weight Limits

Provision – All vehicles used by operator shall comply with all legal size, load, and weight limits per State law, and all non-conforming vehicles shall require the proper local permit.

This provision has been adopted as is by the following counties and townships: Athens, Belmont, Carroll, Fairfield, Harrison, Hocking, Muskingum, Portage, Van Wert, Washington, Bern Township (Athens County), Greene Township (Harrison County), and Washington Township (Harrison County).

This provision has been adopted with the requirement of overload permits if applicable by the following county: Jefferson.

This provision has been adopted with special heavy haul routes and speed limits where applicable by the following county: Champaign.

3.3.7 Contact Information

Provision – Operator to provide contact information including a 24-hour emergency contact for the local representative of operator; must be kept current at all times.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Harrison, Portage, and Washington Township (Harrison County).

This provision has been adopted with requirement for notifications by email or fax by the following counties: Fairfield, Hocking (or in person for pipelines and gas), and Washington.

This provision has been adopted with a requirement to contact township trustees, and emergency responders by the following township: Greene Township (Harrison County).

This provision has been adopted with a requirement to contact the county engineer by the following county: Athens

This provision is not specified other than a general requirement for communication in writing by the following counties: Jefferson, Van Wert.

This provision is not specified by the following counties and townships: Champaign, Muskingum, and Bern Township (Athens County)

3.3.8 Traffic Signage

Provision – If County determines that additional signs are needed for safety, operator shall provide at own expense.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Harrison, Greene Township (Harrison County), and Washington Township (Harrison County).

This provision has been adopted with the statement the developer is responsible by the following counties: Hocking (electric overhead lines and pipelines and gas), Jefferson, Muskingum, and Washington.

This provision has been adopted with signs provided by operator and local parties by the following county: Van Wert.

This provision has been adopted with county engineer posting signage by the following county: Fairfield.

This provision has been adopted with local parties posting signage by the following county: Champaign.

This provision is not specified by the following counties and townships: Athens, Hocking (timber), Portage, and Bern Township (Athens County).

Provision – In the event that other safety concerns arise during agreement, operator and County agree they will mutually discuss such concerns and reach a resolution satisfactory to all concerned.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Champaign, Harrison, Muskingum, Portage, Van Wert, Washington, Greene Township (Harrison County), and Washington Township (Harrison County).

This provision is not specified by the following counties and townships: Athens, Fairfield, Hocking, Jefferson, and Bern Township (Athens County).

3.3.9 Liability

Provision – Operator shall indemnify County from any liability that may arise from violations of any laws or ordinances.

This provision has been adopted as is by the following counties and townships: Belmont, Carroll, Champaign, Harrison, Hocking (electric overhead lines and pipelines and gas), Jefferson, Van Wert, Washington, Bern Township (Athens County), Greene Township (Harrison County) (operator assumes all liability), and Washington Township (Harrison County).

This provision is not specified by the following counties and townships: Athens, Fairfield, Hocking (timber), Muskingum, and Portage.

4 Best Practices

4.1 From Interviews and Surveys (Ohio)

The practices presented in this section are considered to represent best practices currently being used by some local agencies in Ohio. Specific recommendations for practices in Ohio are provided in Chapter 5 based on these current Ohio practices, best practices from other agencies throughout the United States, and other practices deemed to be useful even if they are currently not being used by any known agencies.

4.1.1 Bonding/Escrow

- One county waives the requirement to have a bond if the roads are upgraded prior to hauling. This gives incentive to the developer to do a pre-development upgrade.
- The amount of bond required is based on the type of pavement (amount per mile is $100k for gravel roads; $200k for oil and stone roads; $400k for asphalt roads).

4.1.2 RUMA Tracking and Enforcement

- One county is using GIS and spreadsheets to keep track of all RUMAs, roads used by each company, and the location of known wells and pipelines.
- One county makes the sheriff aware of active RUMA sites and the sheriff patrols them regularly and reports damage to the county.
- In four counties, the county engineer acts on behalf of the townships in the area of negotiation and administration of RUMAs. This practice could extend to cities and villages.
- Some counties have acquired portable weigh scales and have placed law enforcement officers on the county payroll to enforce load limits.

4.1.3 Pre-Development Upgrades

- Many counties report that they require the energy developer to hire an engineer to do a study if truck traffic is expected to increase significantly. The study includes pavement cores and soil borings, sometimes supplemented with falling weight deflectometer (FWD) testing to assess existing pavement strength. Developers are encouraged to upgrade the road prior to hauling but they may elect to repair damage after it occurs as an alternative. One county waives the need for an engineering analysis if the pavement is rebuilt to a standard cross section (3 in (7.5 cm) of hot mix asphalt over 12 in (30 cm) of full depth reclaimed pavement). Based on past experience, this cross section would be adequate for most hauling associated with natural gas or wind farm development; in some cases it may represent an overdesign.
- Full depth reclamation with an asphalt overlay is the predominant pavement upgrade approach. This approach was successful and is generally well suited to the typical low volume, low strength county and township roads that are receiving the heavy truck traffic associated with energy development projects.

4.1.4 Design Standards

- Many counties report that they require the energy developer to follow ODOT design standards when repairing or strengthening pavements and county standards for geometric improvements.

4.1.5 Inspection of Repairs and Upgrades

- Repairs and upgrades are inspected by a county employee or a third party either hired by the developer with county approval or hired by the county. In all cases the cost of the inspector is paid by the developer.

4.1.6 Pavement Damage Assessment and Reimbursement

- The predominant method being used by Ohio counties and townships to assess pavement damage is to videotape pavement surface conditions at the start of the RUMA and upon termination of the RUMA. At least one county is using FWD testing at the start and end of the RUMA period to assess pavement deterioration. This is potentially a better method than simply a visual inspection of the surface (see Conclusions and Recommendations in Chapter 5).
- One county requires the developer with a RUMA to be responsible for damages to road outside the limits of the RUMA if used by one of their trucks or one of their subcontractor's trucks.

4.1.7 Multiple Users

- Most counties require multiple companies under a RUMA on the same road to determine amongst themselves how the repair costs will be shared between them. One county has developed a shared use agreement that formalizes the process. One of the companies with a RUMA is responsible to pay the county for repairs and that company is expected to get others sharing the same road to pay for damage in proportion to their respective usage of the road.

4.1.8 Frost Law

- Some, but not all, counties impose the frost law and some waive it if a pre-development upgrade is done.

4.1.9 Maintaining Safe Pavement Conditions

- Three counties allow the developer to supplement the county's normal snow and ice control if they are not satisfied with the county's schedule (i.e. if there is heavy activity at a site during a bad snow storm).

4.1.10 Signage

- Some counties require the developer to sign routes covered by their RUMA to guide drivers from the company and their subcontractors and avoid hauling on roads outside of the RUMA limits.

4.1.11 Right of Way Acquisition

- One county requires the developer to request ROW from the county, then the county will supervise the work and use ODOT standards.

4.1.12 Communication and Collaboration

- In one county, a county RUMA coordinator administers all RUMAs for the townships and the county. The position is funded half by the county and half split between the townships.
- A regional task force consisting of representatives from the oil and gas industry, county engineers, township trustees, and ODOT was formed in ODOT District 11. The task force meets four times per year to discuss issues of mutual interest.

4.1.13 Matrix of Best Practices in Ohio

The practices of several counties and townships in Ohio related to energy development road impacts and road use agreements are summarized in the agency practices matrix in Table 19.

Table 19. Matrix of Best Practices in Ohio.

Topic	Sub-Category	Description of Practice
Practices Addressing Engineering and Design Challenges	Design Standards	Roads are repaired to ODOT specifications with minor modifications to suit the county needs. Roads will meet geometric standards of the county or township.
		At the end of construction it is expected that the road will remain the same if not be better.
Maintaining Safe Pavement Conditions	Incentive	Try to provide an incentive for industry to rebuild rather than "break and fix".
	Signage	Truck route signs are done by the company. This is part of the RUMA. These truck signs are also used in times of an emergency.
RUMA Enforcement		Use portable scales and place law enforcement on payroll to enforce load limits. Violations sufficient to cover cost.
		Legal (Prosecuting Attorney) review of RUMA to identify and close legal loopholes.
		No fees for overload and/or oversize permits. Removes the financial reason to not obtain a permit.
		Must have insurance to obtain permit.
		Good communication between developer and public reduced/eliminated safety and congestion issues.
		Define formal process for completion.
		Hold bond for one year after completion. Forces the developer to follow completion process to close bond. (However, this assumes bonds are a good practice, Muskingum County didn't think so.)
	Bonding/Escrow	Bond required only if road is not upgraded before work. Rates per mile of road are $400k for asphalt, $200k for oil & stone, and $100k for gravel, plus bridges. If given the option, county prefers fixing the road prior to start of activities.
	Post Completion Traffic	Considering a "production" RUMA until maintenance needs are back to normal.
		Additional traffic for decommissioning windmills is covered in the RUMA. Overweight or oversize vehicles handled with permit.
	Multiple Users	Identify the need for having a RUMA for multiple users on the same road.
Analysis Methods	Administration	One agency, the county engineer, acting on behalf of the townships (this could also apply to cities or villages also) in the area during negotiations and administration.
	Engineering Analysis Methods	Video and borings for most horizontal drilling. FDR is most commonly used method of upgrading roads.
		The proper loading standards for bridges are used. ODOT PCR for all roadways.
		County does not enforce overloads since the road is designed for it.Initial designs were 3" to 6" (7.6 to 15.2 cm) of asphalt on 12" (30 cm) of 304. Current design is AC on cement-treated FDR.
		County videos all roads as part of pavement management process.
		Have an engineering company that does a video log, soil boring, GPR, Falling Weight Deflectometer before the start of the development activity. This company must be licensed in Ohio.
Maintenance and Inspection	Road Maintenance	Hauling company responsible for maintenance and signing of pipeline crossings. County engineer's office handles inspections.
		County will evaluate damage. If routine wear and tear, county repairs. If due to company activity, company repairs.
		County does snow and ice control. Company can also perform snow and ice control if they are not satisfied with the county schedule and method (i.e. if there is heavy activity at a site during a bad snow event).
		Company is responsible for any damage to a road not included in the RUMA but used by their (or a subs) truck.
	ROW acquisition	They have to request ROW from the County Engineers. The County Engineer will supervise and use ODOT standards.
	ROW permit	Company had to apply for and receive a ROW permit prior to work.
	Inspection	County engineer's office assigns at least 1 person to inspect affected roads. Modified ODOT inspection sheet used. Uses a camera with GPS.
	Inspection	Review all roads at least once a month. Video by county for PMS every Fall. Upgrades and repairs are inspected by third party acquired by the company.
	Inspection - routine/ special events	Inspector, on county payroll, will be on hand daily during construction. Developer will pay cost. Not known how this will be accomplished at this time. In past, county would determine cost and submit invoice to company.Possibility of hiring a consultant on behalf of the county by energy developer.
	Reporting/Enforcement	Use a GIS-based system to track and analyze road, company and known pipelines.

4.2 From Literature Review

The practices presented in this section are drawn from those found across the United States and which appear to be applicable to local agencies in Ohio, including counties and townships. Specific recommendations for practices in Ohio are based on these best practices and other practices deemed to be useful even if they are currently not being used by any known agencies.

4.2.1 Bonding/Escrow

- PennDOT requires those entering an excess maintenance agreement (EMA) to provide a bond or other security in amount specified in 67Pa Code, Chapter 189 to ensure compliance with EMA. Amounts vary from $6,000 to $50,000 per mile depending upon the type of permit.
- In Ohio, the requirement for a bond or security is waived by several counties if a geotechnical report shows the road can withstand the expected truck traffic or if the developer agrees to pay for a pre-development upgrade.

4.2.2 Pavement Impact Predictions and Pre-Development Upgrades

- PennDOT allows developers to choose whether they want to upgrade a road prior to hauling associated with their development or to repair damage when it occurs. If the developer elects to perform a pre-development upgrade they are required to submit an upgrade plan subject to the review and approval of PennDOT.
- A projection of pavement impacts (i.e. prediction of pavement damage based on projected truck traffic) can be useful in determining if a pre-development upgrade (pavement strengthening) is needed to avoid early failures. Preventing such failures is beneficial to the road owner in that unsafe conditions are avoided. This is also beneficial to the development company since significant pavement damage disrupts their ability to operate efficiently. PennDOT has a written policy that allows the developer to either construct pre-development upgrades or repair pavement damage after it occurs. Several Ohio counties have indicated they encourage developers to perform pre-development upgrades but they do not require them. Many energy development companies in Ohio and Pennsylvania have elected to construct the upgrades as they have learned from earlier projects that allowing the pavement to fail is too disruptive to their operations. PennDOT's Publication 23, Chapter 15, Section 15.16 [PennDOT, 2015] provides a detailed step-by-step process to compare the existing pavement structural capacity to that required to support projected traffic and to assess the need for a pre-development pavement strengthening. Two alternative approaches are presented that consist of coring and visual pavement condition assessment or less extensive coring supplemented by non-destructive testing with a falling weight deflectometer (FWD).
- A very commonly used method for pre-development upgrades has been full depth reclamation. Pennsylvania, Texas, and Ohio report success with this process. Often the paved width of road is increased as part of the upgrade to provide adequate lane width and edge support for heavy truck traffic.

4.2.3 Truck Routing

- One approach that could be taken by some agencies is to forecast potential travel routes to/from the location of future well sites, wind farms, or other development projects, then require developers to limit truck traffic to specific routes that currently have favorable geometry (lane and shoulder width, turn radii, etc.) and pavement strength or require use of agency funds to upgrade roads to be used as designated truck haul routes.
- Iowa DOT is doing this now by recommending preferred routes for OS/OW permitted trucking associated with energy development projects. They have a goal to integrate local jurisdiction truck permitting into the automated state system.

4.2.4 Design Standards

- PennDOT requires upgrades to be done in accordance with their design standards and must use approved materials.

4.2.5 Inspection of Repairs and Upgrades

- The construction of upgrades is inspected by PennDOT or their consultant and the cost of inspection is reimbursed by the developer.

4.2.6 Pavement Damage Assessment and Reimbursement

- The predominant method used to determine pavement damage and to get developers to reimburse the road agency for damage is to conduct a pre- and post-development visual survey of the pavement surface condition. The areas of damage not recorded in the pre-development survey are required to be repaired (typically with a full-depth patch) by the developer or the agency repairs them and is reimbursed by the developer.
- An alternate method developed by the University of Kansas, commissioned by FHWA, estimates pavement damage in terms of the loss of service life (number of ESALs consumed compared to design ESAL life) [Bai, et al., 2009]. A paper by Wilke presented at the Pennsylvania Shale Conference [Wilke, 2014] proposed a similar method and indicated it would better account for the total cost of pavement damage including some that may not be visible on the pavement surface. Pavement damage cost would be determined by multiplying the percentage of ESAL life consumed by the cost to replace the pavement.
- A hybrid of these two approaches was developed for Tompkins County, NY. The visual condition method is used for a low level of projected truck traffic or if the existing pavement is in poor condition at the start of the development project. The ESAL life consumed method is used for medium or high level of truck traffic if the pavement is in fair to good condition at the start of the development project.
- The City of Southlake, Texas requires reimbursement for estimated road damage per lane-mile of road, depending upon the type of pavement. The road damage per lane-mile is based on an engineering study that quantified the anticipated road damage associated with various truck volumes and pavement structures.

4.2.7 Multiple Users

- PennDOT requires each company to enter into a separate excess maintenance agreement (EMA) with PennDOT and the EMA states that multiple users are to attempt to determine their own method to allocate repair costs amongst themselves. The EMA further states that

if the users cannot agree on a method to allocate damage costs that PennDOT will allocate costs based on each user's percentage of total loads hauled on the posted roads; thus users are encouraged to keep track of their tonnage hauled in case it is needed by PennDOT to allocate damage costs.

4.2.8 Seasonal Load Restrictions

- Johnson County, Iowa posts roads for a maximum of 8 tons during freeze-thaw periods when road subgrades are weakened. It was not clear from the literature review if agencies that use seasonal load restrictions waive the restriction for companies who enter a road use agreement with the road owner.

4.2.9 Maintaining Safe Pavement Conditions

- As noted above, many agencies are requiring energy development companies to restore pavement conditions to the pre-development level or reimburse the agency to do so. However, it is also important to ensure that road conditions do not deteriorate to the point that the road is unsafe for travel at any time during the period of developer's activity, even if the developer will eventually repair the damage. To address this issue, PennDOT requires the company to maintain road conditions to a level that is "safe and passable" at all times throughout the duration of the road use agreement. As part of this requirement, companies are required to submit an annual roadway maintenance plan that details how they will proactively monitor pavement conditions and maintain them at a safe level throughout the agreement period. If unsafe conditions are detected by PennDOT representatives when performing their regular windshield surveys, a 5-day letter is issued that requires emergency repairs to be completed within 5 days or the agreement will be terminated.

4.2.10 Practices to Mitigate Impacts on Safety

- In North Dakota and Texas a public outreach campaign was launched to remind motorists to be patient and cautious in oil producing areas of the state.
- In Texas, increased signage and other intelligent transportation systems were deployed to warn motorists of heavy truck traffic.
- In Texas, signage was erected for all bridges under 18 ft (5.5 m) vertical clearance to prevent bridge impacts by haulers.
- The Pennsylvania Department of Environmental Protection developed guidelines for the spreading of brine on unpaved roads to control dust.

4.2.11 State and Local Legislation and Regulations

4.2.11.1 Infrastructure Funding

- Several state legislatures have enacted legislation that levies a severance tax or some type of fee for extraction of oil and gas. A portion of these funds are used for repair or upgrading of roads and bridges in areas affected by oil and gas development.
- Texas designated an energy transportation reinvestment zone and eligible counties can apply for grant money for infrastructure projects in areas impacted by increased oil and gas production.

4.2.11.2 Requirements for Road Use Agreement

- Ohio law requires a good faith effort to enter into a road use agreement as part of the requirement for obtaining a permit for drilling of horizontal gas and oil wells.
- Pennsylvania law requires all haulers, except those from distressed industries, to enter into an "excess maintenance agreement" and post a bond to ensure that all road damage is repaired if they want to haul loads exceeding the posted limit. Separate legislation provides road agencies the ability to post a load limit if an engineering study indicates that a road may be damaged by heavier loads.

4.2.12 Right of Way Acquisition

- PennDOT requires that any right of way needed for the user to construct necessary road upgrades, must be acquired by the user. The right of way plans must be prepared in accordance with PennDOT's standard procedures. After completion the user must transfer the title for the right of way to PennDOT.

4.2.13 Manuals and Training

- The Pennsylvania Local Technical Assistance Program (LTAP) offered courses to local agencies on how to legally enforce load limits and to collect fees from energy developers to reimburse for infrastructure damage.
- PennDOT developed new specifications and a Best Practice Guide for full depth reclamation since this technique has been widely used for pavement upgrades to local roads affected by gas well development. These documents were developed to help ensure consistent quality in the application of this pavement rehabilitation technique.

4.2.14 Communication and Collaboration

- The benefit of communication and collaboration was documented in several publications.

4.2.15 Global Impact Fee

- A unique approach was developed in Rio Blanco County, Colorado that imposes a one-time impact fee on new construction/development at the permitting stage [RPI Consulting, 2008]. The fee is based on the number of equivalent single axle loads (ESALs) projected from truck traffic needed to complete the project/development. A fee of $9.07/ESAL was developed for road and bridge damage; when applied to typical oil and gas development that uses an average of 1955 ESALs per well, this equates to $17,732/well. The fees are kept in a separate fund that may be used only for capital expenditures made necessary by the development projects.

4.2.16 Best Practices Matrix from Literature Review

The practices of several road agencies throughout the United States related to energy development road impacts and road use agreements are summarized in the agency practices matrix in Table 20.

Table 20. Matrix of Best Practices from Literature Review.

Topic	Sub-Category	State	Description of Practice	Reference
Practices for Addressing Engineering & Design Challenges	Truck Routing	IA	Iowa DOT uses systematic routing of trucks combined with permitting, geometric improvements to the roads (especially for turning radii), assessing the structural damage to roads and bridges, adjust pavement design standards to a higher level, aggressive dust control program, shoulder stabilization, and use of geosynthetics on county gravel roads and cement stabilization of subbases	NCHRP Pages 39-42
		IA	Encourage use of detours or alternate routing for heavy trucks and collaborate with energy development companies to adjust timing and logistics of truck movements	NCHRP Pages 39-42
		ND	Chanel traffic flow to reconstructed roads to minimize impacts on other roads.	NCHRP Pages 43-45
		OH	Definition of the needed route from State Route to Pad	MacAdam
	Pavement Impact Prediction and Evaluation	CO	Pavement research, at CO DOT, with AASHTOWare Pavement ME Design to predict pavement performance at various truck axle configurations.	NCHRP Pages 36-39
		ND	The most widely used assesment method reported was the observation and management of the pavement structure, where roadway inspections are done on all posted roads. Therefore an accurate forecast of the anticipated truck traffic volumes in the energy development areas is identified as important.	NCHRP Pages 43-45
	Pavement Design	TX	Developing best practices for pavement structural design and assessment, nondestructive testing tools (FWD, GPR) to evaluate existing pavement structural conditions	NCHRP Pages 50-54
		TX	Monitoring effectiveness of structures being built with proposed design methods	NCHRP Pages 50-54
		ND	Predictive model developed to analyze capabilities (based on both average and frozen moduli) of various subgrade soils to support heavy loads	NCHRP Pages 43-45
	Seasonal Weight Requirement	IA	During freeze/thaw, Johnson County posts roads to a maximum of 8-ton loading	NCHRP Pages 39-42
	Multiple Permit Holders	PA	RUMA states that multiple users are to decide amongst themselves how repair bill will be split or Penn DOT will allocated damage based on estimated equivalent single axle loads (ESALs) applied by each permittee	PennDOT Pub 23
	Other	TX	Other identified practices from Texas DOT are the development of standard lease agreement with an associated fee, as well as the temporary use of water lines in state right-of-way in order to reduce roadway truck volumes	NCHRP Pages 50-54
	Permitting Procedures	IA	Iowa DOT implemented an automated truck OS/OW permitting system that considers and reviews all bridge and pavement conditions and restrictions associated with energy plant locations to recommend preferred routes with better pavement surfaces	NCHRP Pages 39-42
	Protection of Bridges	TX	Placing concrete culverts or jump bridges to minimize structural damage to the bridge	NCHRP Pages 50-54
Communication and Collaboration	State & Local → Haulers	TX	In March 2012, a task force, composed of representatives from state agencies, local governments and the energy industry, was formed to find ways to address the impact on the state's infrastructure of increased energy development activities	NCHRP Pages 50-54
		IA	Iowa DOT reported that the establishment of effective communications between state and local jurisdictions with the energy companies can create a constructive and collaborative environment, which enhances pre and post construction and operations.	NCHRP Pages 39-42
	State → Local	IA	Inclusion of Safety, Engineering Design and Bridge offices in planning improvements	NCHRP Pages 39-42
		PA	Penn DOT offers a posting and bonding course to educate local agencies on how to legally enforce weight limits and to collect costs from energy developers for the infrastructure damages.	NCHRP Page 46
		CO	Colorado Oil & Gas Conservation Commission (COGCC) established to foster responsible development of oil and gas and to administer regulatory programs. Local Government Designee (LGD) receives copies of state oil and gas permit applications.	NCHRP Pages 36-39
	Local → Haulers	CO	El Paso County, Colorado has website containing regulations and specific oil & gas permit application form.	NCHRP Pages 36-39
		CO	La Plata County, Colorado: 100 O&G companies created a coalition to enhance coordination and communication with the county	NCHRP Pages 36-39
	State → Haulers	PA	Marcellus Shale Coalition (MSC) represnting natural gas industry meets with PennDOT every 1 to 2 months since 2010 to discuss issues of interest to both parties. MSC provided input to over 2 dozen policies & procedures develop by PennDOT related to gas industry's road maintenance & repair responsibilities. Education & training provided by both PennDOT and MSC	NCHRP Pages 49-50 & Public Private Collaboration, Matter & Benzon
		TX	Launch a publicity campaign and printing billboards to educate people on overpass height restrictions	NCHRP Pages 50-54
	State → Public	ND	Public awareness campaign called "Progress Zone" developed by stakeholders, including North Dakota DOT, Petroleum Council, and Highway Patrol to decrease accidents	NCHRP Pages 43-45
	Local → Public	CO	Deteriorating surface conditions could become a safety issue by causing traffic to cross over into oncoming lanes of traffic. As a result El Paso County Instituted both public service and other media announcements to warn the traveling public of danger from trucking in the area	NCHRP Pages 36-39

Topic	Sub-Category	State	Description of Practice	Reference
Tools to Assess Damage Costs	Pavement Damage Assessment	PA	For roads with weight restrictions, estabilish the initial condition through pre-hauling inspections. (includes photos and videos)	PennDOT Pub 23
		OH	Requirement for an engineering report, including videotaping of the route prior to drilling activities	MacAdam
		IA	Base pavement deterioration rate on measurement of incremental maintenance costs on pavement for new traffic generated as a result of energy development; consists of calculating the total ESALs resulting from energy development, then comparing it to the number of ESALs for which the road was designed.	NCHRP Pages 39-42
	Global Impact Fee	CO	Rio Blanco County imposes a one time impact fee on new construction/development at permitting stage. Fee is based on ESALs projected from truck traffic needed to complete the project/development. A fee of $7.19/ESAL was developed; when applied to typical oil and gas development, this equates to $17,600 /well. The fees are used exclusively for captial expenditures made necessary by the new developments.	Rio Blanco paper 2008
State and Local Legislation and Regulations	Infrastructure Funding	CO	Application of severance tax, which is imposed on non-renewable natural resources removed from the earth in Colorado. Calculated based on gross income from crude oil, natural gas, carbon dioxide, oil (including shale oil), and gas.	NCHRP Pages 36-39
		CO	A portion of energy tax goes to trust fund. Local agencies are developing fees to address issues with infrastructure damage	NCHRP Pages 36-39
		IA	Permit cost quantification and county Road Preservation Ordinances that permit collection of funds for repair of road damage caused by renewable energy industry	NCHRP Pages 39-42
		IA	Establishment of Tax Increment Financing (TIF) counties that are financed through issuance of general obligation bonds	NCHRP Pages 39-42
		ND	State legislature imposes oil & gas production tax and an oil extraction tax in lieu of property tax on oil & gas producing properties.Types of financing; Oil Gross Production Tax, Gas Gross Production Tax, Oil Extraction Tax, Coal Conversion Tax, Legacy Fund, Tribal/Slate Oil and Gas	NCHRP Pages 43-45
		ND	The state legislature has provided general fund money from the oil extraction fund to DOT and local jurisdictions for road and bridge improvements	NCHRP Pages 43-45
		ND	ND DOT is involved in planning and programming improvements to state and local roads. State Legislature has taken the lead in oversight and funding of impact studies	NCHRP Pages 43-45
		ND	Various financing and operating agreements including Oil Gas production tax, and Oil Extraction tax	NCHRP Pages 43-45
		PA	Comprehensive Pennsylvania ACT 13 legislation, a tax on energy companies based on level of drilling activity	NCHRP Pages 49-50
		TX	SB 1747 designated energy transportation reinvestment zone (http://www.roadsfortexasenergy.com). Eligible counties can apply for grant money for infrastructure projects in areas of Texas impacted by increased oil & gas production.	NCHRP Pages 50-54
	Permitting Procedures	PA	3 types of permits identified, depending on road being gravel or asphalt & whether permit covers one specific vehicle or many vehicles & if it covers one specific road or many roads	Penn DOT Pub 221
		ND	One Stop permit, building permit, and conditional use permit	NCHRP Pages 43-45
		PA	Chapter 189 of the 67 Pa. Code requires haulers from all industries, including energy development, to apply for permit, post bond, and enter "excess maintenance agreement" if they want haul loads over posted limit	NCHRP Pages 49-50
		OH	Townships issue permits after receipt of an application to operate or move vehicles that exceed the maximum size or weight limits. Permit fee covers administrative costs and costs of damages caused by the nonconforming vehicle.	Legal Boundaries on the Scope of Township RUMAs
	Bonds and Securities	PA	User provides bond or other security in amount specified in 67Pa Code, Chapter 189 to ensure compliance with agreement. Amounts vary from $6,000 to $50,000/mile depending upon the type of permit	Pub 23, Chpt 15.10
		OH	Bonding requirement unless one of the following conditions is met: geotechnical report shows the road can withstand the expected truck traffic; drilling operator agrees to pay for or perform upgrade to route; a bond or surety covering the Agency is already in place	MacAdam
	Local Traffic Exemptions	PA	Local traffic may be exempt from the requirement to enter an excess maintenace agreement if the projected traffic (ESALs) is less than60% of the estimated remaining pavement life for roads used	Pub 23, Chpt 15.4
		OH	Require RUMA to address compensation for or to repair damage to roads caused by the nonconforming vehicles.	Legal Boundaries on the Scope of Township RUMAs
		OH	In some instances these RUMAs extend beyond road repairs. (E.g. Delivery of aggregate stockpiles for township use and assistance in snow removal on township roads.)	Legal Boundaries on the Scope of Township RUMAs
	Load Postings as Trigger	PA	Engineering study done to determine if road likely to damaged by loads exceeding some weight. If so, agency may post a load limit. Companies wanting to haul loads above posted limit must enter into an "excess maintenance agreement" or RUMA	Pub 221,pg 2

Topic	Sub-Category	State	Description of Practice	Reference
Education	Training	PA	LTAP offered courses to educate local agencies on how to legally enforce weight limits and to collect costs from energy developers for the infrastructure damages	NCHRP Pages 49-50
		TX	Training workshops conducted by Texas DOT technical specialists and Texas A&M University held every 3 to 6 months with Texas DOT maintenance personnel in Districts impacted by energy development, focusing on pavement improvement techniques and issues related to topics such as subgrade performance, pavement stabilization methods, etc.	NCHRP Pages 50-54
	Specifications	PA	Pennsylvania DOT implementing FDR specification for DOT Publication 408 Construction Specifications in order to ensure consistent quality for its use on low-volume roads impacted by energy development activities, as well as all state-owned roadways within the Commonwealth	NCHRP Pages 49-50
		PA	DEP has developed guidelines for the spreading of brine on unpaved roads used to control dust, found under the authority of Clean Streams Law, the Solid Waste Management Act, and Chapters 78 and 101 of the Rules and Regulations	NCHRP Pages 49-50
	Manual	PA	Penn State University published the Environmentally Sensitive Road Maintenance for Dirt and Gravel Roads manual that provides information on practices that are designed to reduce the long-term maintenance costs on low-volume rural roads and to address runoff and sediment pollution to nearby vegetation and forests	NCHRP Pages 49-50
Pre-Development Upgrades	Road Upgrade Plan/Design Standards	PA	Upgrades (more than maintenance & repair) are defined as > 500 ft (150 m) of road receiving > 3" (7.6 cm) overlay , full depth reclamation, or widening. They are done solely at the discretion of the permittee, but if permittee elects to do an upgrade it must meet DOT standards. A road upgrade plan must be submitted to DOT for approval before work begins. Designs must meet DOT requirements & must use approved materials. DOT provides inspection of upgrade construction & is reimbursed by developer.	Penn DOT Pub 23, section 15.16
	Capacity Upgrades	IA	Upgrade of two-lane roads to four-lane corridors to add capacity	NCHRP Pages 39-42
		CO	Routt County increases pavement thickness in preparation for energy development activities	NCHRP Pages 36-39
		IA	Increase pavement thickness, width and shoulder stabilizations	NCHRP Pages 39-42
		IA	Geosynthetics on county gravel roads and cement stabilization of subbases	NCHRP Pages 39-42
	Pavement Design	ND	Adjustments to traditional pavement designs have been made by County engineers, on an experimental basis, in an attempt to armor roads that are experiencing heavy truck traffic	NCHRP Pages 43-45
		ND	Use of cement-treated subbases, surface treatment with increased thickness (12 to 16 inches) on major collectors, and geosynthetic materials such as geogrids	NCHRP Pages 43-45
		PA	Use of Full Depth Reclamation (FDR) of pavements has been very successful and widely used	NCHRP Pages 49-50
		TX	Use two course surface treatment (add gravel on top of a base layer and then two additional courses on top for farm-to-market roads.	NCHRP Pages 50-54
			Use of stabilizers for unbound roadways impacted by energy development activities	NCHRP Pages 50-54
			Using recycled pavement or FDR which are both more environmentally friendly maintenance strategies.	NCHRP Pages 50-54
			In Tarrant County, many roads do not have shoulders and therefore rapidly deterioate from truck loading. In problem areas the county has widened the road with a stabilized base and an asphalt surface or with a two-couse asphalt surface.	NCHRP Pages 50-54

Topic	Sub-Category	State	Description of Practice	Reference
Mitigating Impacts on Safety	Enforcement	TX	County law enforcement monitors truck speeds.	NCHRP Pages 50-54
		PA	Revoke road use permit when repairs are not made. Proactive roadway monitoring and roadway repair responsibility assignment to energy companies	NCHRP Pages 49-50
	Traffic guidance	TX	Roadway geometric feature modifications, revision of speed limits, and addition of signs and traffic signals	NCHRP Pages 50-54
		IA	Modify roadway geometric features such as building temporary road embankments. Encourage or require the use of detours and alternate routing for heavy trucks. Proactively review any proposed facilities along with local jurisdictions and attempt to provide appropriate improvements	NCHRP Pages 39-42
		TX	Install increased signage to warn motorists of heavy truck traffic volumes, and use of intelligent transportation systems	NCHRP Page 207
		CO	Use of regulatory warning signage. Particularly in LaPlata County	NCHRP Pages 36-39
		CO	Col DOT helping county assess access and turning movements at intersections with state routes (since energy development traffic is exceeding acceleration/deceleration thresholds). Energy developer pay for the improvements.	NCHRP Pages 36-39
	Bridge Posting: load and height limits	CO	Posting of bridges is done on a regular basis according to bridge rating manual	NCHRP Pages 36-39
		TX	Energy companies can request OS/OW but cannot cross a posted bridge	NCHRP Pages 50-54
		TX	Use of emergency load zone posting when pavement conditions are rated as significantly poor due to the extra amount of heavy trucks generated by energy developers	NCHRP Pages 50-54
		TX	Signage for all bridges under 18 ft. height to prevent bridge impacts by haulers	NCHRP Pages 50-54
	Communication	CO	Institution of both public service and other media announcements to warn the traveling public	NCHRP Pages 36-39
		ND	The marked increase in traffic and crashes that result in serious injuries and fatalities, prompted the North Dakota DOT, the ND Petroleum Council, the ND Highway Patrol and other groups to develop a public Safety stakeholder . Launched campaign/public outreach (called ProgressZone) to remind motorists to be patient & cautious in oil producing areas of state	NCHRP Pages 43-45
		OH	Notification for the Railroad industry if a crossing is involved	MacAdam
	Dust control	CO	La Plata County expanded an aggressive dust stabilization program to help prevent the loss of gravel on unpaved roads.	NCHRP Pages 36-39
		PA	DEP developed guidelines for the spreading of brine on unpaved roads to control dust	NCHRP Pages 49-50
Maintaining Safe Pavement Conditions	Maintenance Plan	PA	Plan includes key contacts, detailed hauling activities by date and type. Also, proposed repair strategies to keep road safe and passable; no environmental impacts & not revert asphalt surfaces to gravel or mud. Need approval to place asphalt Oct 31-April1	Penn DOT Pub 23, section 15.12
		OH	Requirement for a list of 24-hour emergency contacts	MacAdam
	Inspection of Road Conditions	PA	Inspection of pavement done before, periodically during, and after hauling. Actual cost for inspection is paid by permittee	NCHRP Pages 49-50
		PA	Agency performs periodic windshield survey to assess if a condition survey is required. If excess damage is observed, notice given to permittee. If repairs not done or fee paid for repairs, permit is suspended.	Penn DOT Pub 23, section 15.6
		PA	A biweekly roadway inspection on all posted roadways by PennDOT and are paid for by developer	NCHRP Pages 49-50
		PA	Energy companies' responsibility for inspecting roads they use and have built, reconstructed, or repaired	NCHRP Pages 49-50
		PA	Energy developers responsible for necessary Pennsylvania DOT inspection fees.	NCHRP Pages 49-50
	Maintenance	OH	Maintenance of the route during the drilling activity	MacAdam
		PA	Haulers under permit are given option to repair when excess damage observed by agency or wait until end of permit to repair, however, no paved road allowed to revert to gravel, or mud surface.	NCHRP Page 206
		PA	Requirement for energy development companies to submit an annual roadway maintenance plan to inform Pennsylvania DOT, an excess maintenance agreement, security bond, and permit	NCHRP Pages 49-50
		PA	Under the terms of the energy company's Excess Maintenance Agreement (EMA), it must proactively monitor pavement conditions and immediately begin repairs to keep the road safe.	NCHRP Pages 49-50
Program Organization	Administration	CO	Colorado Oil and Gas Conservation Commission to administer regulatory process on oil and gas development	NCHRP Pages 36-39
	Infrastructure Funding	CO	Department of Local Affairs provided grants through the Energy Impact Grant program. These funds were provided for the maintenance and improvements of impacts resulting from development of oil and gas.	NCHRP Pages 36-39

5. Conclusions and Recommendations

The increase in energy development projects throughout the United States, including Ohio, has resulted in a substantial increase in heavy truck traffic on local roads that are being used to develop oil and gas wells, construct wind farms, and serve other energy development infrastructure. These local roads were not designed to withstand such heavy truck loading and consequently significant damage to these roads has occurred. Road agencies throughout the country have had to react to this rapidly developing change in local road usage and to develop policies and procedures to protect their infrastructure investment.

The literature review conducted in this study revealed a variety of approaches to dealing with this multi-faceted challenge. Some approaches have widespread usage with only subtle differences between jurisdictions while others are unique and have not seen widespread use despite their potential value. In this chapter, recommendations are provided for use by Ohio counties and townships based on the practices considered to be "best practices" by agencies outside of Ohio and practices being used by some counties and townships within Ohio that are considered to represent a "best practice" from which other local agencies within Ohio could benefit. First, practices that have seen widespread use, that are recommended for implementation by Ohio's local agencies are presented. Then, approaches that have been developed by others that appear to be valuable but have not seen widespread use are presented for consideration and potential adoption.

5.1 Practices Recommended for Adoption by Local Agencies in Ohio

The proactive approach by ODOT, ODNR, and CEAO to address the horizontal oil and gas well drilling and hydraulic fracturing in eastern Ohio has worked well in addressing development activity which places an unanticipated burden on the local roadway system. Legislation was passed which mitigated damage to the local roads and bridges without placing an undue burden on the developer. A regional task force composed of state and local agencies as well as the industry was organized to promote communication and uniformity in application of the law. A model RUMA was developed which is used as is or in modified form by more than 70% of local agencies in Ohio surveyed for this research.

The following practices are considered to be valuable and should be relatively easy to implement with minor changes or additions to currently used RUMAs and related operating procedures.

5.1.1 Bonding/Escrow

- It is recommended a bond or other security be provided to the agency to ensure the requirements of the RUMA are followed. The amount of the security should be established on a per mile basis and should be adequate to reconstruct the pavement its original condition in case it is necessary. It would be reasonable to establish the amount of the bond based on the type of road surface (for example gravel or asphalt).
- It is recommended the security requirement be waived if a pre-development upgrade is performed that is based on an engineering study that shows the upgraded road will withstand the truck traffic projected during the RUMA period and the upgrade is completed

to the satisfaction of the road agency. This will encourage the developer to perform a pre-development upgrade if significant traffic is projected and will preserve their bonding capacity for other uses.

5.1.2 Pre-Development Upgrades

- It is recommended an engineering study be completed by an engineering consultant with expertise in pavement evaluation and design to forecast truck traffic associated with the developer's proposed project, to evaluate the structural capacity of the existing pavement, and to determine the extent of pavement strengthening, if any, required. It is recommended that the procedures outlined in the 1993 AASHTO Guide For Design of Pavement Structures, Section 5.3.3 [AASHTO, 1993], be used to evaluate the structural capacity of the existing pavement (i.e. the pavement's remaining life in terms of ESALs). If the developer's projected truck traffic (in ESALs) is expected to consume more than 80 percent of the remaining life, a pre-development pavement upgrade is strongly recommended to decrease the likelihood of early pavement failure that can jeopardize the developer's RUMA and/or decrease the efficiency of transporting materials and equipment to support its operations. If an upgrade is warranted, the pavement upgrade should be designed in accordance with Section 5.4 of the AASHTO Guide referenced above.

5.1.3 Design Standards

- It is recommended upgrades and repairs be performed in accordance with ODOT standards. In some cases, ODOT standards may be higher than the municipality's standards. However, in most cases the roads will be subjected to traffic levels similar to state roads during the period of the RUMA, and ODOT standards would be appropriate or slightly conservative.
- If ODOT's specifications and design guidelines for full depth reclamation have not been updated recently, it is recommended that it be done. This would help ensure that proper procedures are employed when using this common road upgrade technique. The CEAO and OTA could also develop their own set of formalized specifications based on the appropriate AASHTO publications.

5.1.4 Inspection of Repairs and Upgrades

- Ideally repairs and upgrades should be inspected by an employee of the local agency, however, most local agencies do not have adequate staff to perform this function in addition to their traditional duties. If the amount of energy development work requiring a RUMA is substantial enough to warrant a full time employee, it is recommended the local agency hire an individual with experience in this area. If the work is intermittent and does not warrant a full time employee, then it is recommended that a qualified engineering consultant be hired by the local agency and paid by the developer.

5.1.5 Pavement Damage Assessment and Reimbursement

- It is recommended pavement damage be assessed by review of pre- and post- development visual surveys of pavement condition that quantify distress on a per-mile or per-tenth-mile basis, supplemented by photographs or videos. Also, the RUMA should state that the local agency shall require resurfacing of the pavement in addition to isolated repairs if the local

agency deems it necessary in order to restore the road to its pre-development functionality and integrity.

- The RUMA should give the local agency the option to request an alternate approach for damage assessment based on pre- and post- development non-destructive structural pavement testing with a falling weight deflectometer (FWD) if deemed appropriate. Guidelines could be provided to assist local agencies in determining when FWD testing would be appropriate. Generally, this alternate technique would be useful if consultants with FWD equipment are available in reasonable proximity to the site and if the road was in relatively good condition at the start of hauling. In these cases, the true extent of damage may not be apparent solely through visual surveys of the pavement surface.

5.1.6 Multiple Users

- It is recommended a shared use agreement be executed by each company and by the county if more than one company proposes to use a road currently under a RUMA. The first company to enter a RUMA is expected to get others sharing the same road to pay for damage in proportion to their respective usage of the road.

5.1.7 Frost Law

- It is recommended the frost law be included in the RUMA but waive the requirement for the route if a pre-development upgrade is completed and approved by the agency.

5.1.8 Maintaining Safe Pavement Conditions

- It is recommended RUMAs require the company to maintain road conditions to a level that is "safe and passable" at all times throughout the duration of the RUMA. If unsafe conditions that require emergency repairs are detected by the local agency's representatives at any time the RUMA is active, a verbal notice will be given by phone requiring that repairs be completed immediately. If the developer does not complete the repairs immediately, the agency will complete the repairs and be reimbursed for such repairs by the developer. If the developer does not complete the repairs within an acceptable timeframe or does not reimburse the agency for the repairs, the RUMA will be terminated.

5.1.9 Signage

- It is recommended developers be encouraged to sign routes covered by their RUMA to guide drivers from the company and their subcontractors and avoid hauling on roads outside of the RUMA limits. This would help the company avoid unnecessary damage repair and lesson the burden on the agency to detect damage outside the limits of the agreement and to enforce the repair requirement. Additionally, the signs should alert motorists to heavy truck traffic.

5.1.10 State and Local Legislation and Regulations

- It is recommended the existing Ohio law be strengthened to require all companies hauling high volumes of heavy loads over county or township roads to enter into a RUMA with the county or township. The definition of a "high volumes of heavy loads" should be determined for specific roads by the local agency based on an evaluation of its sustained load carrying capacity.

- Heavy hauling, common for the functional classification which would be considered in the thickness design procedure, i.e. school buses, trash collection trucks, local commercial traffic, etc., should be exempt from the RUMA requirement.

5.1.11 Right of Way Acquisition

- It is recommended the developer acquire any ROW necessary for road upgrades. The ROW plans should be prepared in accordance with ODOT or local agency standards. After the right of way is acquired, the title shall be transferred to the local agency.

5.1.12 Manuals and Training

- It is recommended the Ohio CEAO and/or the LTAP office provide training to local agencies on how to establish load limits for RUMAs and how to administer and enforce RUMAs. The training should also be made available to interested developers wishing to haul heavy loads over municipal roads.

5.1.13 Communication and Collaboration

- In counties where several townships experience significant heavy hauling requiring a RUMA, it is recommended a county RUMA coordinator, funded jointly by the county and affected townships, administer all RUMAs for the townships. This should save costs and provide uniformity in RUMAs within the county that would benefit the municipalities and developers.
- The regional task force consisting of representatives from the oil and gas industry, county engineers, township trustees, and ODOT that was formed a few years ago should be continued. The task force should meet at appropriate intervals throughout the year to discuss issues of mutual interest. A regional task force should be considered for any activity, i.e. wind farms, which results in a substantial medium to long term increase in truck traffic volume on local roads.

5.2 Other Unique Approaches for Future Consideration

The following approaches that have been developed by others for potential use or that are being used by a relatively small number of agencies, that are deemed to be valuable, are recommended for future consideration by local agencies in Ohio. In some cases, further development of these approaches may be necessary and/or existing laws in Ohio changed to allow their implementation.

5.2.1 Global Impact Fee

A significantly different approach could be used to get reimbursement from developers for road damage associated with their heavy hauling. An approach similar to that described above for Rio Blanco County, Colorado could be used. Ohio legislation would need to be introduced to levy an impact fee and the fee used to repair and/or upgrade roads being used for energy development related hauling. Ideally, such an approach would be used across the entire state. A study should be done to develop an appropriate fee that is defensible and based on projected road and bridge damage due to anticipated heavy hauling associated with gas development and other industrial developments. A procedure for development of an impact fee is presented in a paper by Wilke entitled “Road Impacts from Shale Energy Development” presented at the ASCE Shale Energy conference at Pittsburgh in 2014 [Wilke, 2014].

5.2.2 Pre-Development Upgrade by Road Agencies

An alternative to developers upgrading roads in advance of their heavy hauling is for the road agency (county or township) to upgrade the roads using state and/or local funds. The funds could come from the impact fee presented above or from other state funding if the state legislature is interested in such an approach. The roads to be upgraded could be determined from an analysis of industry projections for energy development and developers would be required to restrict their heavy hauling to the upgraded routes. This approach has been used in Texas.

5.2.3 Cost Reimbursement Based on Pavement Life Consumed

An alternative to having developers repair visible damage to roads or to reimburse local agencies for such repair at the end of the RUMA period, is to assess a damage cost based on the life of pavement consumed by the developer's truck traffic. In this approach, the damage cost is determined by multiplying the percentage of ESAL life consumed by the cost to replace the pavement. The percentage of ESAL life consumed is calculated as the number of ESALs applied by the developer divided by the theoretical life of a new pavement, in terms of ESAL applications the pavement can withstand before its functional service life is consumed. This approach would more fairly compensate road agencies for damage since the cost to replace the ESAL life consumed would typically be far greater than the cost to fill cracks and patch failed areas of pavement that are visible from the surface. Fatigue cracking that results from the application of heavy loads to an asphalt pavement initiates at the bottom of the asphalt layer where tension arises from bending of the pavement under load. The cracking eventually propagates upward to the pavement surface and manifests itself as alligator cracking and eventually potholes. In many cases, not all fatigue cracking will have manifested itself on the surface at the conclusion of the RUMA period.

The challenge in implementing this approach is in determining the number of ESALs applied by the developer's hauling. It is usually not practical for an agency representative to track each trip, axle configuration, and weight for each truck during the RUMA period. One method to determine the ESALs applied could be to use records supplied by the developer that indicates truck trips by day, truck type (axle configuration), and weight. Accurate reporting by the developer could be encouraged by the agency spot checking daily hauling and incorporating a financial penalty for any under-reporting detected. Alternatively, the developer could be required to install a GPS unit in each of their trucks and to provide a report to the agency that tracks the routes taken by each truck, each day during the RUMA period.

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Appendix A: Annotated Bibliography

Note: Some of these sources, particularly reports from the media, use the term "fracking" in reference to hydraulic fracturing. The term "fracking" is generally has negative connotations in the industry, but is retained in this bibliography when used in the source material, particularly in titles and web links.

Penny Seipel, 2014, "Improper Uses of RUMAs", *The Ohio Oil and Gas Association (OOGA) Bulletin*, July 2014, p. 15-16. http://www.nxtbook.com/naylor/OOGM/OOGM0714/index.php#/0,

- RUMA was meant to be a tool to help both local governments as well as oil and gas producers easily negotiate road agreements in preparation for the heavy traffic local roads would experience.
- Requires, that as a part of the permitting process, oil and gas producers must either have a RUMA or attest that they made a good faith effort to enter into a RUMA with a local government in 2012.
- It's different now and it appears to the industry that some are looking at the RUMA process as a way to push local government operational costs onto the backs of private companies.
- It has been found that the RUMA was modified to suit the needs of the local government and seems unreasonable.
- Operators are asked to buy materials like aggregate and even help in times of inclement weather.
- The processing fee is undisclosed for a RUMA which leads to the question "Why should a private company be forced to pay fees to government employees performing their normal duties, especially when the local government is actually going to benefit from the agreement being negotiated.
- Local governments may want to think carefully about the unreasonable demands they place upon the oil and gas industry.

Michael Settineri, "Legal Boundaries on the Scope of Township RUMAs", *The Ohio Oil and Gas Association (OOGA) Bulletin*, November 2014, p. 12-15. http://www.nxtbook.com/naylor/OOGM/OOGM1114/index.php

- Execution of RUMAs to improve and repair township roads in Ohio due to the development of Utica and Marcellus Shale plays.
- Cover both legal loads as well as overweight vehicles.
- In some instances these RUMAs extend beyond road repairs. (e.g. Delivery of aggregate stockpiles for township use and assistance in snow removal on township roads.)
- Lack of consistency as producers are forced to develop procedures and RUMAs that are specific to townships. Producers can however not agree if the RUMA is unreasonable.
- The Attorney General found that there was no express or implied authority allowing townships to ban trucks from township roads to prevent damage to road surfaces.
- Townships cannot stop legal load traffic, but can regulate overweight loads by the General Assembly.
- Townships issue permits after receipt of an application to operate or move vehicles that exceed the maximum size or weight limits. There is a fee imposed on this permit that covers administrative costs and costs of damages caused by the nonconforming vehicle.

- The RUMA is intended to relate to compensation for repairs of excess damage cause to the roads by travel of the overweight vehicle under the permit.
- A local authority can only require a RUMA to address compensation for or to repair damage to roads caused by the nonconforming vehicle.
- The statute does not give a township the right to condition an overweight permit on road improvements, aggregate stockpiles, snow removal, or any other provisions that are found in RUMAs proposed by some townships.

"Joseph", 2012, "Kasich Flip-flops (twice?) On Fracking Road Maintenance Agreements", *Plunderbund,* n.p., 22 Feb. 2012. http://plunderbund.com/2012/02/22/kasich-flip-flops-twice-on-fracking-road-maintenance-agreements/

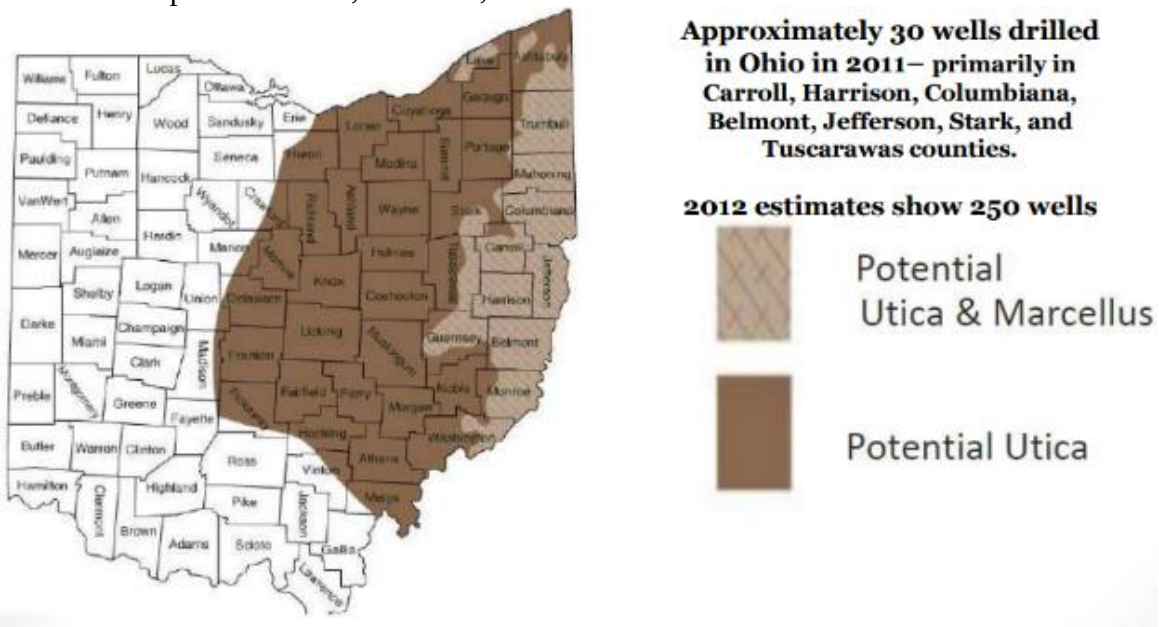
- In October 2011, County Engineers, officials from ODOT District 11 and representatives from the oil and gas industry started developing a RUMA. The goal of this was to have a guarantee that oil and gas companies will maintain roads that may be excessively damaged due to oil and gas extraction related truck traffic.
- RUMA is to be signed before issuing horizontal drilling permit.
- RUMA is important because the tax collections to pay for road repairs for local roads is not sufficient with the increase of truck traffic and hence the drillers will be required to pay as a result.
- All seven County Engineers from ODOT District 11, Ashland County Engineer, County Commissioners Association of Ohio (CCAO) and the Ohio Township Trustee Association got together to discuss a development of a model for the RUMA.
- The second meeting included Chesapeake Energy, Enervest, and Ohio Department of Natural Resources (ODNR). The third meeting on December added Hess Energy, Ohio Township Association, and the Governor's office. The Governor's office was supporting the effort to develop a RUMA to be signed before issuing a drilling permit until the Governor changed his mind.
- "Officials said that rather than require a RUMA as a condition to an ODNR permit to drill, ODNR will instead mimic the concentrated animal feeding operation (CAFO) process by only inquiring whether a RUMA is in place or if good faith efforts have been made to negotiate a RUMA. If the answer to either question is yes, the permit will be granted. According to ODNR officials, there will be no discretion from their department as to whether a true "good faith" effort has been made."
- This translates to the fact that the lack of a RUMA will not prevent a permit from being granted by ODNR.
- The Governor's position seems to have been switching from months of "yes" to RUMA to suddenly "no" and then "maybe".

Lloyd MacAdam, 2012, *Working with Local Government: RUMA*, Presentation at 2012 Ohio Transportation Engineering Conference, Columbus OH, October 2012. Version for Mid-America Freight Coalition March 13, 2013 available online at http://midamericafreight.org/wp-content/uploads/MacAdam_WorkingWithLocalGovernments.pdf, original version formerly at http://www.dot.state.oh.us/engineering/OTEC/2012%20Presentations/10C-MacAdam.pdf

Lessons learned from Pennsylvania:

	2007	2008	2009	2010	2011
New Marcellus Shale Wells Drilled	60	229	685	1395	1045

Ohio has the potential for 7,000 to 15,000 wells.



Pennsylvania vs. Ohio:

Pennsylvania	Ohio
Pennsylvania is not a "Home Rule" state like Ohio.	Ohio is a "Home Rule" state.
PennDOT has jurisdiction over nearly all paved roads.	ODOT has jurisdiction only over state routes.
PennDOT required an Excess Use Agreement for all posted roads, which accounts for 26% of all roads in PA.	Township Trustees and County Engineers have jurisdiction over many of the roads which will be needed for access to drilling pads.
Excess Use Agreement required bonding at $12,500 per paved mile.	No statewide Road Use Maintenance Agreement exists, and the majority of the traffic to the sites are legal loads.

Why the need for a RUMA?

- Regional Government to Government meetings were held by ODNR in summer of 2011 in Steubenville, New Philadelphia, Youngstown, Marietta, and Zanesville. Local township and county officials had concerns about notification prior to dDrilling aActivity.
- No guarantee of maintenance on township and county road system which has not been designed for repeated legal truck loads that the horizontal drilling process requires.
- Furthermore, the following meetings also resulted in realizing the need for a RUMA,
- ODOT District 11 Quarterly County Engineers meeting May 2011 meeting in Jefferson County Engineer Jim Branagan's office.
- September 2011 meeting in Holmes County Engineer Chris Young's office for Chesapeake Energy presentation.

- The issue of needing a standardized RUMA was apparent to both the local government side (County and Townships) and the shale development industry.
- RUMA Development Process
- ODOT District 11 agreed to assist county engineers and oil and gas drillers to develop a locally-supported RUMA.
- Three sessions took place with up to 31 people and on December 6th 2011 a final RUMA was approved.

What is in the Model RUMA?

- Definition of the needed route from State Route to pad
- Bonding requirement unless one of the following conditions is met:
    - A geotechnical report shows the road can withstand the expected truck traffic.
    - Drilling operator agrees to pay for or perform upgrade to route.
    - A bond or surety covering the agency is already in place.
- Maintenance of the route during the drilling activity.
- Notification for the railroad industry if a crossing is involved.
- Requirement for an engineering report, including videotaping of the route prior to drilling activities.
- An appendix for county and/or township requirements which can be agreed upon with the drilling company.
- Requirement for a list of 24-hour emergency contacts.

What is NOT in the Model RUMA?

- Hard and fast bonding ranges (bonds are negotiable).
- Expiration dates – Gives an "out" to both parties with a 30 day requirement notice.

A release of the operators to get overweight, overheight, and/or overwidth permits. These permits are still required.

RPI Consulting, 2008, *Road & Bridge Department Impact Fee Support Study*, Prepared for Rio Blanco County, Colorado, April 2008.

- One-time impact fee imposed on new construction or development in the unincorporated area of Rio Blanco County.
- Fee is assessed at permitting stage of project.
- Impact fee is kept in separate account and can only be used for new capital facilities made necessary by the new development.
- Impact fee is calculated based on Equivalent Single Axle Load (ESAL) estimate from the truck traffic needed to complete the project. An "Independent Fee Calculation Manual" is provided on Rio Blanco County website under the Building Department section.
- Fee for oil and gas wells is made up of 3 components:
    - $7.19/ESAL for road system improvement.
    - $0.06/ESAL for buy-in for past projects designed to accommodate future traffic.
    - $1.82/ESAL for equipment fleet and facilities incremental expansion.
    - Total = $9.07/ESAL
- Cost per ESAL was derived as follows:
    - The environmental impact statement (EIS) required by NEPA for oil & gas leases was used to provide accurate data on traffic generated by oil & gas development (p. 21).

- Types of trucks and axle configurations expected to be used for each well were estimated and number of ESALs per truck determined based on half of trips being made with truck empty and half of trips being made with truck loaded to legal limit. Study indicated typical total ESALs per well of 1,955.
- Truck trips were distributed to transportation zones based on expected well locations.
- Number of ESALs on each road was compared to thresholds that trigger road upgrades (per AASHTO Pavement Design Guide Chapter 4 Low Volume Road Design) and the necessary upgrades determined.
- Applied unit construction costs to the lengths of roads requiring upgrade over 15 year planning horizon (20017-2022) to determine total cost for all upgrades.
- Calculated average cost per ESAL = cost of all projected upgrades divided by total projected ESALs. Result was $6.87/ESAL.
- A similar evaluation was made of bridge upgrades needed to accommodate projected number of ESALs and the cost of the improvements, which resulted in a unit cost of $0.32/ESAL.
- Combined $/ESAL for road & bridge improvements = $7.19/ESAL
- Also determined cost per ESAL for past projects completed to accommodate future traffic ($0.06/ESAL) and for upgrades to County road and bridge facilities and vehicle fleet anticipated due to increased volume of trucks and associated work needed ($1.82/ESAL).

- Based on the estimated number of ESALS per well noted above, an impact fee of $17,600/well was derived (1955 ESALs/well * $9.07/ESAL)
- If developer doesn't agree with the county's estimated ESALs projected for the development, developer may conduct their own study to determine ESALs generated by the development.
- The fee of just under $17,600/well generated $2.44 million in 2008.

Yong Bai, Steven D. Schrock, Thomas E. Mulinazzi, Wenhua Hou, Chunxiao Liu, and Umar Firman, 2009, *Estimating Highway Pavement Damage Costs Attributed to Truck Traffic*, Report for the Mid-America Transportation Center by the Kansas University Transportation Research Institute, The University of Kansas, Lawrence, KS, December 2009. http://www2.ku.edu/~iri/publications/HighwayDamageCosts.pdf.

- Study by University of Kansas developed a methodology to estimate highway damage costs due to truck traffic associated with processed meat and related industries in southwest Kansas.
- Methodology is based on models originally developed from the AASHTO Road Test and incorporated into the AASHTO pavement design procedure.
- The basic concept is to determine the damage cost per truck type and load expressed in terms of dollars per ESAL.
- ESAL is an equivalent single axle load- a parameter widely used for pavement design and evaluation to equate the pavement damage caused by a specific truck load and axle configuration to that of a standard 18,000 lb (8200 kg or 80 kN) single axle load.
- ESAL life of a new pavement is defined as the number of ESALs a pavement can withstand before it causes the condition, or pavement serviceability rating (PSR), to drop to an unacceptable level.

- Cost is determined as the average annual cost per mile for all rehabilitation and maintenance work done on the pavement over its life.
- This method also recognized that over the life of a pavement (typically 30 years) some degradation of the pavement occurs due to environmental factors (i.e. temperature fluctuations, rainfall, etc.) in addition to traffic loading. This portion of degradation was deducted from the cost per ESAL to determine the unit cost per ESAL for damage caused solely by truck traffic.
- This methodology was applied to truck traffic associated with the processed meat industry in Kansas by estimating the number, weight, and axle configurations of trucks projected to use roads in Kansas, estimating their structural strength in terms of ESALS they could withstand, and determining the unit cost per mile for rehabilitating these pavements.
- The formula used to determine damage cost is:
  Damage Cost Due to Truck Traffic = (average annual maintenance & rehabilitation cost) * (%PSR loss due to traffic loading) / ESAL life of pavement

T. C. Martin, 2002, "Estimating Heavy Vehicle Road Wear Costs for Bituminous-Surfaced Arterial Roads", *ASCE Journal of Transportation Engineering,* Vol. 128, No. 2, March 2002, p. 103-110.

This paper provides estimates of the attributable heavy vehicle road wear cost, which is an approximation for the marginal cost of road wear, for thin bituminous-surfaced roads in Australia. These estimates were based on:

- A statistical relationship between the road maintenance costs and a heavy vehicle road use variable.
- A pavement deterioration model that forms the basis of a load-related road wear model.

In Australia heavy road freight vehicles operate in a highly competitive market where large haul distances occur between the major coastal urban cities.

Road wear costs were estimated using different methods, including:

- Statistical Relationship between Maintenance Costs and Road Use.
- Pavement Deterioration Model.

The results obtained from the methods are summarized in Table 3, retyped from the source:

Table 3. Summary of Heavy Vehicle Attributable Roads Wear Cost Estimates

	National Average		National rural	National urban
Type of study	% Attributable Cost	Attribution Variable	% Attributable Cost	% Attributable Cost
Maintenance and cost relationship (Martin 1994)	50	GVM-km	25	60
Maintenance and cost relationship (Rosalion and Martin 1999)	55	ESAL-km	25	60
Direct road wear management (Martin 1995)	39	GVM-km	39	39
ARRB TR scaled granular pavement model	65	ESAL-km	65	65

In conclusion, the recent estimates for road wear cost vary from 65% to 55% attributable to heavy vehicles for the average level of traffic loading on bituminous surfaced arterials.

The fourth power law-based ESAL-km road use variable can be used for attributing the road wear costs. However no simple replacement for this is available in Australia.

P. Wilke, 2014, "Road Impacts from Shale Energy Development", *Shale Energy Engineering 2014,* Proceedings of the ASCE Shale Energy Conference, July 21-23, 2014, Pittsburgh PA, p. 633-642.

The paper describes the engineering background for methods developed to project long-term damage caused by heavy hauling associated with the energy development industry, to quantify damage to specific roads, to determine the need for pre-development pavement upgrades, and to allocate damage costs to multiple users of the same road.

PROJECTION OF OVERALL COST IMPACT

A method was developed to project the long term cost impact of heavy hauling to assist the road owners in planning long-term capital and maintenance budgets and/or assessment of some type of impact fee to help compensate for the expected road impacts. The method essentially consists of comparing the projected truck traffic associated with energy development to the expected life of pavements in the agency's road network, determining the percentage of pavement life consumed by the development traffic, and estimating the cost of this consumed pavement life. The proposed methodology is based on the American Association of State Highway and Transportation Officials (AASHTO) empirical models that relate pavement life to truck axle loads and consists of the following 8 steps:

1. Estimate Truck Traffic Associated with The Development.

For example, for oil and gas development, the number of wells to be developed is estimated; then the truck trips associated with each well is estimated. Next the volume, weight, and axle configuration of heavy vehicles associated with each development is estimated.

2. Convert Truck Fleet into ESALs.

Using the AASHTO procedure each truck type in the fleet is converted to equivalent single axle loads (ESALs) based on their weights and axle configurations and these are added together to determine the total ESALs anticipated to use the pavement. See Appendix D of the AASHTO *Pavement Design Guide* for ESAL factors used in the conversion of trucks to ESALs.

3. Determine Representative Pavement Section for the Roads Expected to be Impacted by the Development.

If the pavement section varies significantly over the network of roads to be used, it may be useful to divide the road network into classes and estimate an average or representative pavement section for each class.

4. Determine the Structural Number for each Pavement Section.

Using the AASHTO procedure, the Structural Number (SN) is determined by multiplying the structural layer coefficient (or contributing strength from each layer) by the thickness of each layer, then summing them together. Applying the appropriate layer coefficients to the typical pavement sections identified in Step 3, the SN is determined for the road network or for each road class if the analysis is done for separate classes.

5. Determine the Pavement Life for each Pavement Section.

The AASHTO design method calculates the required pavement structural strength (in terms of structural number, SN) for a given level of projected traffic, subgrade soil strength and other parameters. The same design principles may be applied in reverse to determine the pavement design life in terms of ESALs carried for a known pavement strength (SN).

6. Estimate Pavement Life Consumed by Heavy Vehicle Traffic.

The portion of pavement life consumed by projected traffic associated with shale gas development projects is determined by dividing the projected ESALs applied (from Sstep 2) by the ESAL life of typical pavements (from Sstep 5).

7. Determine Unit Cost for Pavement Replacement.

The replacement cost is estimated for the typical pavement section referenced in Step 3.

8. Determine Pavement Replacement Cost due to Projected Traffic.

The cost to replace pavements consumed by the projected traffic is determined by multiplying the portion of pavement life consumed by the replacement cost.

The cost impact projected using this method may be used as the basis for a development impact fee or for maintenance and capital planning.

Example Applications of Cost Impact Projection

This process was used by the Pennsylvania Department of Transportation (PennDOT) near the beginning of the Marcellus shale development boom to estimate the overall damage to non-posted roads. One county in New York State is using this procedure to estimate potential damage from specific, proposed developments and to set bond amounts on this basis for use in road use permits.

ASSESSMENT OF DAMAGE TO SPECIFIC ROADS FROM SHALE GAS DEVELOPMENT

Using the same concept of ESAL life consumed, noted above, with road-specific data, the projected damage to the specific roads may be determined. A determination of the structural capacity (ESAL life) of specific roads may be determined through a structural evaluation of the pavement, to determine its structural number and the strength of the underlying subgrade soils. Either destructive (cores and borings) or non-destructive (falling weight deflectometer) evaluations may be used; procedures for each approach were provided in the paper. The effective SN, and corresponding remaining ESAL life is determined before and after the hauling period; the difference between these two values represents the ESAL life consumed. The cost of the damage (or lost ESAL life) is determined by multiplying the ESALs consumed by the unit cost per ESAL, where the cost/ESAL = (cost to construct a new pavement with the same layer thicknesses as the subject road)/(ESAL life of the new pavement). It should be noted that in most cases, this method will result in a greater cost impact than the method currently being used by some highway agencies that requires the developer to repair only significant distress visible at the pavement surface. If FWD testing is used, any fatigue cracking that may be present in the bottom portion of the pavement that has not yet manifested at the road surface will result in lower pavement stiffness and less remaining pavement life.

DETERMINATION OF NEED FOR PRE-DEVELOPMENT UPGRADES

Compare the projected truck traffic, in terms of ESALs, to the remaining life determined in Step 2. If the projected ESALs provided in the developer's permit is expected to result in a remaining pavement life below some threshold, after a specific agency defined period (example: if remaining life is less than 2,000 ESALs after 6 months of hauling), it is recommended that the pavement be upgraded prior to the start of hauling. The upgrade should include a repair of any base failures and an overlay designed to carry the projected ESALs. The purpose of this evaluation is to prevent premature, severe failures that have been known to occur that would render the road unsafe for the traveling public.

Pennsylvania Department of Transportation (PennDOT), 2015, "Chapter 15- Weight Restrictions on Highways", PennDOT Publication 23 – *Maintenance Manual,* Update No. 8, January 2015. http://www.dot.state.pa.us/public/PubsForms/Publications/PUB%2023/Pub%2023-Chapter%2015%20.pdf.

This document has been in place for many years but was significantly updated to deal with road impacts from Marcellus shale gas development, most recently in January 2015. Excerpts from various sections pertinent to Road Use Agreements and road impacts from heavy hauling are summarized, by section, below. A companion document (Publication 221- "Posting and Bonding Procedures") provides a 39-step process to follow from initial engineering study that identifies the need for a posted weight restriction to removal of the weight restriction.

15.2 Posting Procedures:

- If road owner (posting authority) is concerned about the ability of a specific road to withstand heavy traffic, an "engineering and traffic study" is performed. Information regarding this study is contained in Pub 221, page 2. Elements considered in study are geometry, past experience of pavement damage, pavement analysis, and traffic volume. Traffic may be restricted (e.g. load limit posted) if serious damage to the pavement is anticipated or turning radii or horizontal width are inadequate.
- Seasonal load limits may be used if the study and engineering judgement indicates permanent posting is unnecessary but there is concern for damage during spring thaw.

15.3 Modification/Removal of Weight Restriction:

- The posting authority may modify or remove a load posting if conditions no longer warrant the restriction.
- A road user may request modification or removal of the posting if the road has been upgraded.

15.4 Local Traffic Determination:

- Traffic meeting the definition of "local" may be exempt from entering an "excess maintenance agreement" to use a load posted road (67 Pa, Code, Chapter 189) and issued a Letter of Local Determination (LoLD)
- Exemption applies to "at risk industries" as defined in the code
- "unconventional oil and gas" (ie.- oil and gas development requiring hydraulic fracturing) is not eligible
- Haulers may apply for a LoLD by submitting application form M-4902-APPL
- When reviewing application, agency will consider several factors including whether the hauling will occur during the period of spring thaw (approximately Feb 15th to April 15th)
- A hauler may eligible if the number of equivalent single axle loads (ESALs) is projected to be less than 60% of the remaining life of the pavement (in terms or ESALs). The remaining ESAL life is estimated based on the pavements construction history and estimate structural number (SN) contained in PennDOT's pavement management system (RMS).
- A LoLD may be terminated at any time if the agency determines that damages are attributed to the user's activities or for fraud or abuse.
- If hauler doesn't qualify for a LoLD, it must enter an excess maintenance agreement in order to haul load in excess of the posted weight.

15.5 Agreements and Permits:

- Once a road is posted, any company wanting to haul in excess of the posted limit (typically PennDOT limits have been 10 tons) must enter into an excess maintenance agreement (EMA) with the agency. An EMA template is provided in form M-4902-EMAC.
- 3 types of permits are available:
  - Type 1 – Valid for only one vehicle on one specific posted road.
  - Type 2 – Valid for any number of vehicles driven from or to a common destination, on one specific road.
  - Type 3 – May be used on a number of specific roads for one vehicle.
- Contribution Agreements - A private company may contribute funds to the highway agency to enhance an already scheduled highway agency project.

15.6 Agreement and Permit Administration:

- If there are multiple users on the same road, each enters a separate EMA. The road agency first suggests the users attempt themselves to decide how the costs for road repairs will be assigned amongst them. If they cannot agree, the road agency will allocate costs based on each user's percentage of total loads. Each user is encouraged to keep track of their tonnage hauled for the purpose of determining their percentage of total loads hauled on the posted road.
- When one user requests termination of their EMA, or a new user is added, a road inspection must be conducted to assess the extent of damage to be repaired by the users. The users may either pay the road agency for damages or conduct the repairs themselves.
- Road agency makes periodic "windshield reviews". If a road is experiencing heavy use, a more detailed road condition survey is performed. If deterioration is detected, the road agency either makes the repairs and bills the users or notifies the users that are required to perform the necessary repairs within 5 days (a "5-Day Notification of Repair Letter" is issued). If repairs are not started within 5 days, the permit is suspended and won't be re-instated until the repairs are done or the road agency reimbursed for repairs.
- If damage has rendered the road conditions dangerous, the users are notified by phone, followed by a letter, that corrective action is required within 24 hours. If repairs are not made, road agency does the repairs and bills the users.

15.7 Maintenance and Restoration Responsibility:

- The user is given the option to maintain the road to a level consistent with the existing road type as established at the time of initial inspection, or to maintain the road at a lower level and restore it to the initial condition at termination of the EMA. In no case will the road be allowed to revert to gravel, dirt, or a mud surface.

15.8 Road Inspections:

- Inspections, consisting of video and photos of pavement conditions are conducted at start and end of the permit period. The agency may elect to do interim inspections also. Form M-4902ISP is used to document conditions.

15.9 Cost Recovery:

- Agency bills user for cost of condition inspections.
- Agency bills user for cost of construction inspection for road upgrades done by user.
- Agency bills user for cost of repairs unless user constructs the repairs.

15.10 Agreement Security and Insurance:

- User provides agency security in amount specified in 67Pa Code, Chapter 189 to ensure compliance with the EMA.

- For Type 1 or 2 permit, security = $6,000/mile of unpaved roads or $12,500/mile for paved roads to be maintained a level consistent with the type of highway; $50,000/mile for paved roads the agency allows to be maintained below a level consistent with the type of highway (i.e.- maintain paved road as an unpaved road during heavy hauling, then return to paved road upon completion of hauling)
- For Type 3 permits, security = $50,000/mile for any highway agency allows to be maintained below a level consistent with the type of highway.

- Preferred forms of security are letter of credit or performance bond.
- The security is released after hauling on road is over and all obligations of the EMA are completed.

15.11 Agreement Close-Out Process:

- User submits form M-4902APP to notify agency of their desire to cease using the posted road and close out the EMA.
- Agency conducts final inspection and identifies any road damage and necessary repairs.
- User either makes the repairs or agency makes repairs and bills user.

15.12 Maintenance Plans:

- User submits maintenance plan that describes how they will: a) maintain the road to pre-existing conditions, b) ensure paved surfaces do not deteriorate to gravel or mud, c) maintain safe and passable condition, and d) prevent negative environmental impacts.

15.15 Right of Way Procedures for Excess Maintenance Agreements:

- If right of way is needed for the user to construct necessary road upgrades, the user must prepare right of way plans (per PennDOT requirements) and transfer title of right of way to the agency.

15.16 User Upgrade Plan

- The users is encouraged to evaluate the structural capacity of the pavement and/or bridges to assess their ability to safely and efficiently carry the anticipated truck traffic. If structural capacity is inadequate, early failures may occur that could impact the efficiency of user's operations, result in unsafe conditions, and require the user to make immediate repairs.
- The user may elect to upgrade roads and/or bridges prior to or during their hauling operations to increase the structural capacity and go beyond the activities outlined in their maintenance plan.
- Upgrades are defined as project over 500 ft (150 m) long and include full depth reclamation, reconstruction, or overlays greater than 3 in (7.6 cm) or any widening of the road.
- If user elects to construct upgrades, user is required to submit a User Upgrade Plan in accordance with PennDOT Guidelines. The User Upgrade Plan Guidelines are intended to provide uniform procedures for the design and construction of safe roads and bridges.

Leslie Ann McCarthy, Seri Park, Paul Cassazza, and Anthony Giancola, 2015, *Impacts of Energy Developments on U.S.Roads and Bridges*, National Cooperative Highway Research Program Synthesis 469, Transportation Research Board, Washington, D.C., 2015. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_469.pdf.

Energy development, including gas, wind, and solar, requires movement of equipment, parts, material, and supplies along roads not designed for the heavy traffic or loadings. There may also be an increase in crashes.

Observations [2]:

- 20 of the 41 responding DOT's indicated an increase in damage or congestion due to energy development activities.
- Development associated with long term damage were those with sustained hauling activities such as oil, gas, and biofuels.
- Found economic costs associated with the development.
- Method used most often to assess the heavy load and high traffic is the remaining service life (RSL). Determined from:
    - Portable or virtual WIM.
    - FWD and ground penetrating radar (GPR).
    - Automated road analyzer.
- Reported practices to address damage:
    - Stabilize unpaved roads.
    - Use of full depth reclamation (FDR) on existing pavements.
    - Addition of paved shoulders.
    - Use of superstructure temporary "jumper" bridges.
    - Use of geosynthetic materials for strengthening gravel or dirt roads.
- Roadway degradation, bridge deterioration, and/or increased risk to roadway safety is observed in areas where energy development activities occur.
- Tools to assess costs:
    - More accurate truck volumes and payload.
    - Assessing taxes, fees, public facility ordinances, and other reimbursement mechanisms.
    - Apply truck traffic percentage or VMT as a factor for cost formula.
    - Continuous communications and collaboration with energy development companies.
- Future research needs [3]:
    - Safety:
        - Collection of safety and crash statistics.
        - Improved methods for both pavement and geometric design.
        - Engineering based methods for detour routing.
    - Environmental impact:
        - Dust.
        - Erosion.
        - Impacts to endangered species.
    - Social impacts.

Introduction:

Initial measures taken by agencies to address damage include [5]:

- Surety instruments.
- Permits.
- Excess maintenance agreements.
- Bonds.

Federal Perspective – MAP-21:

- In 167 Section D.1.B.vi, one factor for the designation of the primary freight network is access to energy exploration, development, installation, or production areas.

Objectives for Synthesis include [6]:

- Identify areas where infrastructure damage from energy development is a factor.
- Types of development associated with the damage.
- Economic costs associated with providing adequate and sustained infrastructure.
- Current design standards used to address frequency and weights of trucks.
- Engineering methods used to assess and address the heavy truck loads and high traffic.
- Tools used to assess costs and pay for damages.
- Agency practices that address the safety implications.
- Examples of agency and industry collaboration.

Criteria used to select "focus" states for additional data gathering after survey & literature review [7]:

- Geographic distribution.
- Distribution of type and extent of energy development.
- Inclusion of states with roads and bridges owned by local agencies which were significantly impacted.
- Range of safety data.
- Use of innovative solutions.

More than 41 interviews with people from 5 focus states (Colorado, Iowa, North Dakota, Pennsylvania, Texas) and from New Jersey, Mississippi, Federal Lands Highway, Bureau of Land Management, and Tribal Governments.

Chapter 2 Literature Review of Energy Development Review in the US [10]:
The information reported will assist in defining the types of energy development, the magnitude of their activities, and the extent to which they are impacting roads and bridges.

Types of current and emerging energy development industries:

1. Crude oil [10]:
   Oil traffic can be categorized into five types of movement.
   1) Inbound materials (sand, water, cement, scoria/gravel, drilling mud, fuel).
   2) Inbound movement of chemicals.
   3) Outbound movement of oil and byproducts.
   4) Outbound movement of saltwater.
   5) Movement of specialized vehicles (rigs, cranes and utility vehicles).
      [North Dakota State University, 2013]

2. Natural Gas [10,11]:

Nonrenewable fossil fuel that is closely related to oil and is drilled from the same wells as crude oil or is removed from the distilling process.
Requires large volumes of moderately heavy trucks over rural roads [Wilke and Harrell 2011].
Low volume local roads with thin pavement sections fail within hours of heavy loading with energy related activities.

1) Inbound fracturing proppants.
2) Inbound water.
3) Outbound oil and byproducts.
4) Outbound flow back fluids.
5) Movement of specialized vehicles (rigs, cranes, etc.).

3. Coal.
4. Biofuel and Wood – fuel produced from living organisms. Wood can include forests as well as post-consumer wood and processed wood based fuel.
5. Nuclear – not a significant amount of transportation is required for activities related to nuclear energy [12].
6. Solar:
    1) Photovoltaic panels.
7. Wind – movement of heavy equipment to construct wind farms:
    1) Wind powered electricity generator.

Information by state [12]:

AR	Arkansas DOT discovered that low volume roads were experiencing 20-year accumulated traffic loadings within a few months of energy development activities. Vertical well: 1800 ESAL per drilling with piped water, 2800 ESAL without piped water. No non-Interstate roadway was designed to carry this in Arkansas. 812 miles are affected by energy development activities.
CO	Studies of a sample of sites found a lag of 1-3 years between infrastructure improvement needs and identification of capital revenues. [15]
IA	Wind farm construction caused roadway damage. Need to construct temporary embankment at intersections due to turning radius. Major damage to unpaved roads. Damage to roads due to biofuel production include plant construction and hauling of raw products.
MT	Counties receive large revenues from state's severance tax but municipalities face more infrastructure costs than they have revenue to address, due to the limited share of severance revenue going to municipalities.
NY	1148 one way trips generated per well without water pipeline. The shale development will result in both increased heavy traffic and increased employment and population, which also generate traffic demand. An assessment was also produced regarding the potential impacts of high-volume hydraulic fracturing on forest resources in Tioga County.
ND	A study by the Upper Great Plains Transportation Institute at the North Dakota State University (2013) reported that the size and mass difference between 80,000-pound (36,000 kg or 356 kN) trucks and 4,000-pound (1800 kg or 17.8 kN) passenger vehicles, combined with operational differences such as acceleration and deceleration rates and turning radii, heighten the risk for crashes to occur. [16]
PA	1450 trucks per well development. Penn DOT can post weight limits and require an Excess Maintenance Agreement (EMA) to obtain a permit. EMA requires: Initial inspection to establish base condition of roadway, User responsible for excess maintenance, Approval of a maintenance plan, Routine roadway condition survey for heavy users, security which is typically bonding.

SD	Wind and ethanol development projects had led to significant damage which is affected by the geometry (too narrow) of the roads. It was also reported that existing road conditions, such as the depth of gravel to asphalt surfacing, roadway width, general surface conditions, and damage should be noted before any heavy truck traffic begins and continue to be inspected at reasonable intervals thereafter, after heavy or prolonged rainfall, and at the end of the project.
TX	Wind development projects as well as the crude oil supply chain including drilling and hydraulic fracturing have led to damage of the roads. Study indicated average reductions in pavement service life of 30% for natural gas extraction, 2% for oil extraction and 9% for oil production. Texas DOT found that proactive approaches have been more cost effective in maintaining roads because permit fees are too low to recoup costs of potential damage. [17]
WY	Oil and gas industry causes most damage on low-volume county roads in southeastern Wyoming. $145 million recommended improvements for roads impacted by energy development activities.

Literature Review of strategies used by federal agencies and states:

AR	Pavement edge damage is a big problem with lane widths of 9 or 10 ft (2.7 to 3.1 m). [19]. ARAN measurement of low-volume pavement conditions, along with mapping of existing and permitted wells. Development of crack index for all routes accessed by energy developers and analysis of all roads with rut depths greater than 1 in (2.5 cm). Sections of pavement on horizontal curves were first to show damage due to heavy trucks braking which caused washboarding and shoving of the pavement.
ID	Use of geosynthetic materials in low volume roadways was found to be successful in enhancing longevity of roads. Study suggested charging a development impact fee based on the magnitude of the development or a user fee based on specific road damage.
IA	Study presented approach to measure incremental maintenance costs on pavements subjected to energy development traffic. Method consists of calculating ESALs from energy development and comparing to design ESALs to determine deterioration rate. Some counties design pavements for double or triple the ESALs compared to previous design standards to account for anticipated heavy loads.
MN	Minnesota DOT developed a Heavy Traffic Generation tool to estimate the damage due to energy developments. [20] Truck weight education classes hosted by Minnesota DOT Local Technical Assistance Program (LTAP) for energy company haulers, law enforcement officers, and local agencies. State legislation allows for special hauling permits for heavy vehicles with added axles, enabling permit fees to be deposited into a special account at Minnesota DOT for use in bridge inspections and signage.
MS	Increase of county severance tax for petroleum extraction; significant portion goes to roads and bridges. Mississippi Power Company (MPC) is building a new gas-fired power plant that will generate significant traffic on low volume roads. MPS allocates about $3 million per year for road and bridge upgrades and maintenance. [20]
MT	Has a monitoring system in place. State legislation to address funding and operations demands on roads with infrastructure degradation. Planning forecast studies identified high-use corridors for energy development to facilitate design modifications and accelerate reconstruction projects to satisfy forecasted demands. Facilitation of multimodal shift (use of rail and pipeline for oil industry) and consolidation of shipping locations (for energy and non-energy commodities) to higher demand locations.

NY	Uncertainty about timing and location of shale gas developments has limited ability of agencies to consider shale gas impacts in long range planning.
ND	Road limits are to be imposed during the spring thaw [21].
PA	PennDOT does road surveys on roads impacted by energy developments. Surveys are paid by developer. If survey shows damage and if the company does not handle the situation in a satisfactory manner their permit is suspended.
TX	Texas bill SB1747 gives counties ability to create County Energy Transportation Reinvestment Zones. A formula created for grants to counties (20% based on annual weight tolerance permits, 20% based on annual oil & gas production taxes, 50% based on annual well completions, 10% based on annual volume of oil & gas waste injected). The bill also created a transportation fund, consisting of eligible federal and state funds and grants for county energy transportation reinvestment zones.[21&22]
WI	DOT developed tools for managing impacts from sand mining on roads including truck tonnage projections from mining permits; use of road upgrade maintenance agreements with developers; and use of FWD and GPR to determine subgrade strength and establish seasonal load restrictions for roads. [22]

Major Practices Reported to Address Energy Development Activities.
Practices Reported By Federal Agencies:

- US Department of the Interior Bureau of Indian Affairs – It is the policy of the BIA road Maintenance Program to preserve, repair, and restore the BIA system of roadways and transportation facilities. Responsible for 29,500 mi (47,500 km) of roadway and 930 bridges. 17% are in acceptable condition and the other 83% are not. Three Affiliated Tribes on North Dakota (TAT) have roads with significant oil development traffic. 100 mi (160 km) of road have been maintained and repaired by energy developers through maintenance agreements. [22&23]
- US Department of Interior, Bureau of Land Management – Has a source document entitled "Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development". The document was developed to assist energy operators in obtaining permits. [23]
- US Department of Agriculture, Forest Service – US Forest Service manages an extensive road and rail transportation system and provides planning, management, maintenance and improvement of 7,500 bridges and 375,000 mi (604,000 km) of National Forest System roads. Energy industry activities require a Road Use Permit (RUP) and key permits. There is a list of several effective practices that require energy developers to upgrade or repair roads. [24]
- Practices Reported by Tribal Nations: Oil and gas development is anticipated in the 2006 Ignacio Area Corridor Access Plan. The project team used historic truck traffic growth volumes to determine future traffic impacts. [24]

Chapter 3 Survey on Energy Development Impacts on State and Local Roads and Bridges.
Introduction: [25]

- 40 states and District of Columbia responded. Survey response rate of 79%.
- More than half DOTs reported an increase in congestion and damage to roads and bridges in energy development areas.
- Rural secondary roads are subjected to most damage.

- The most common challenges are:
    - Issuance and tracking of permits.
    - Accelerated roadway and bridge degradation.
    - Shortage of maintenance funds.
- Efforts to resolve these challenges include:
    - Assigning permit fees.
    - Funding of inspection fees assigned to energy companies.
    - Shift some transporting activities from road to rail.

Impacts on infrastructure: Roadways and Bridges: [25]

- 32 DOTs experienced sustained or expanded level of energy development activities which impacted roads.
- OS/OW permits issued has increased in Wisconsin.
- Maine DOT mentioned short term impacts from windmill towers.
- Continuous escalation in wind tower loads are observed in Wisconsin and Vermont.
- Rural traffic patterns changed in Minnesota with increase of corn and ethanol shipments.
- Pennsylvania has posted weight restrictions in several thousand miles.
- Seven states reported no increase in truck traffic.
- Two states foresee growth.
- Illinois and Alabama reported 60% of roads impacted by increase of trucks.
- Windshield inspections and visual observations were the most widely reported measure for assigning impacts.
- 23 DOT respondents said that local agencies, DOT District maintenance officers, or the Division of Motor Carriers have reported an increase in damage or congestion where there are energy developments.
- Montana DOT performed pavement analysis and population estimate to analyze effects on pavement condition, roadway capacity, safety by forecasting truck traffic increases.
- Municipalities or counties will perform scheduled maintenance in rural and local roadways in Alabama. [26]

Reported approaches to addressing the damages done to infrastructure by energy-related activities. **Reactive:** Two DOTs reported using a reactive approach that potentially included OW/OS vehicle fees assigned; recouping payment after damages for fixing roads; extended duration closures of local roads or bridges; and/or an increased presence of law enforcement along heavily used roadways.

Proactive: Three DOTs reported using a proactive approach that covered preventing damage before it happens by posting load limits; applying pavement preservation treatments; improving structural capacity of pavements; designating truck routes; other mitigation strategies; and continuously updating design standards.

Legislative: No DOT reported using a legislative approach that included road ownership responsibilities (interjurisdictional); local ordinances; state laws on energy development; permitting restrictions; roadway usage fee scaled to vehicle load or type; or modal shifts of freight dictated legislatively.

Partnering with energy development companies: Two DOTs reported partnering with energy development companies, an approach that potentially included having energy companies design new roads; having energy companies pay for reconstruction of local roads; using Concessionaire agreements (public–private partnerships); or having procedures in place for recouping damage costs.

Twelve states used a combination of approaches [27]:

AL	In Alabama, bridges are upgraded based on periodic inspections. Roads are widened to meet mitigation requirements. Alabama DOT is preparing a 2014 Statewide Alabama Freight Network.
MN	DOT assists local agencies by coordination OS/OW permits and posting load limits on roads and bridges. DOT developed updated design standards for better pavement but locals don't have budgets to accomplish this. DOT has offered truck weight education classes at low costs To local agencies and haulers. Special hauling permit for vehicles that have an added axle to better distribute weight. [27]
MO	Law enforcement is very effective. Most issues are concentrated on low volume roadways during construction of wind farms.
MT	Updating design standards and plans. Establish legislation to address infrastructure degradation, funding and operations demands. Forecasted high-use corridors which was used to accelerate projects and design modifications.
SD	Pavement conditions are monitored continuously. Proactive treatments such as seal coats, mill and overlay are done routinely.
WV	Partnered with energy development companies to enter into voluntary road maintenance agreements to restore infrastructure to existing conditions. [27]
AR, MT, ND, PA	Decrease in bridge rating or performance due to energy development activities. Damage or performance-related issues on infrastructure due to energy development are plotted. [28]

- Table 9 summarizes information from 7 states [28]. Indicates successful approaches to help address situations that arise from energy developments.
- 16 states have seen an increase in damage or congestion.
- OW/OW permit requests increase in Arkansas, Montana and Iowa [29].

Engineering Tools and Design Standards:

- Freeze/Thaw has resulted in an accelerated damage in North Dakota, Ohio and Pennsylvania. Regulations are put in place for hauling activity during the spring thaw periods.
- Missouri, North Dakota and Texas DOTs have realized the importance of anticipating truck volumes in energy development areas. Design modifications are made by Montana, based on projected trucks. [29]
- Posting of signs is the best method to help reduce damage to bridges in 19 DOTs.
- 8 states said reported seasonal road postings is a strategy. [30]
- New Jersey DOT currently upgrading or retro fitting 12 weigh-in-motion (WIM) sites to become virtual WIM sites. [30]

Economic Impacts of Energy Development on Roads and Bridges:
Table 11 provides state road and bridge posting information. [30]
Tools Used to Assess Costs: [31]
Table 12 presents the states and their practices for assessing costs to roads and bridges. [31]

State	Practices for Assessing Infrastructure Costs
IA	Permit cost quantification.
MN	Web-based road wear cost calculator.
MT	Continuous monitoring of population and traffic growth.
TX	Ad-hoc method (http://www.roadsfortexasenergy.com). In March 2012, a task force, composed of representatives from state agencies, local governments, and the energy industry, was formed to find ways to address the impact on the state's infrastructure of increased energy development activities.
UT	Asset management and maintenance system.

- Four states identified methods for the quantification of costs of damage from energy development activities.
- Colorado reported that the relatively new energy industry requires significantly different pavement degradation models than more predictable seasonal, non-energy industries.
- Colorado has no method to assess non-energy related impacts. In Arkansas this is not comprehensive. [31]
- Montana DOT encourages and facilitates multimodal shift for oil industry such as rail.
- North Dakota integrates truck traffic and VMT for roadway design improvements. [31]
- Figure 5 shows percentage of costs shared between their agency and the energy companies in some states. [32]
- Many agreements between state/local agencies and energy companies in Arkansas. [32] Example given. Maintenance assessment and fee calculations.
- Pennsylvania – Local agencies use Road Use Maintenance Agreement whereas PennDOT uses EMA. [32]
- Utah – Local agencies use energy developers to maintain local roads and bridges whereas Utah DOT does all state roads. [32]
- New Jersey DOT has funded multiple research projects to find reasons and solutions for this impact due to energy developments. [32]

Impacts on Roadway Safety and Operations: [32]

- Nineteen states reported an increase in conflicts with local traffic by energy development heavy vehicles. [32]
- Traffic conflicts with other modes, run-off-road incidents, and head-on collisions also increased. [32]
- North Dakota and Texas DOTs – increase in rear end and fatality crashes. Failure to control speed and inattention of driver.
- Table 13 – Safety Strategies Used and Rated Effectiveness [33]:

Measures Reported	States	
	Measure Rated as Very Effective	Measure Rated as Somewhat Effective
Reinforcement of roads (e.g. use of geotextiles, stabilization of aggregates or subgrade).	WV	IA, NB, PA, UT
Roadway geometric feature modifications (e.g. widening paved shoulder, horizontal curve realignment, etc.).	AR, CO, IA, KS, TX	AL, MT, ND, PA, UT
More frequent use of law enforcement (e.g. limit traffic, especially during periodic heavy rainfall).	CO	AR, MT, PA, TX, UT
Encourage or require use of detours and alternate routing for heavy trucks.	CO, IA, WV	MN, NB, PA, SC, UT
Install additional signage to warn motorists of heavy truck traffic volumes in the area.	WV	AL, PA, UT
Lower the posted speed limit.		CO, MT, PA
Specific state or local legislation or regulations that apply to specific energy development industries (e.g. adequate public facilities ordinances, specific road and bridges design standards, etc.).	CO	AL, PA
Temporary measures such as roadway embankments.	KS	PA
Campaigning and public outreach (e.g. ProgressZone in state of North Dakota).	ND	CO, PA, TX, UT
Use of intelligent transportation systems (e.g. advance warning systems).	AL, CO	PA, UT

- Alabama, Utah, West Virginia DOTs – Property damage crashes only. [33]
- Montana DOT – possible injury crashes increased.
- 12 states said road geometric issues responsible for congestion. Roadway capacity also an issue. [33]
- Table 14 – Effective measures set by DOTs to address observed congestion issues. [34]
- Figure 6 – challenges reported by DOTs. [34]
- 17 of 19 states said they are responsible of repairing public roads in the vicinity of energy development using state funds. [33]
- Municipalities in Pennsylvania can pass ordinances to allow posting and bonding of roadways (and use of excess maintenance agreements) or choose to use RUMA; with either approach the heavy hauler is responsible for repairs. [33]
- Table 15 – Tools used to address challenges as reported by agencies.
- Local agencies are developing fees to address issues with infrastructure damage, e.g. Colorado.
- An approach where the permit fee applied is commensurate with the number of permits issued to address funding issues, e.g. Missouri.
- Cost is being extracted from corresponding annual budget, as the amount is not significant, e.g. Nebraska

- State legislature has provided general fund money from the oil extraction fund to the DOT and local jurisdictions for road and bridge improvements, e.g. North Dakota
- Energy development sector is responsible for excess maintenance costs, inspection fees, and roadway condition survey costs, e.g. Pennsylvania
- Unique collaboration enabled Texas DOT to plan for the increased impacts to highway, rail, and ports. Other identified practices from Texas DOT are development of standard lease agreement with an associated fee, as well as temporary use of water lines in state right-of-way to reduce roadway truck volumes, e.g. Texas
- Repair and maintenance of functionally classified roads assigned to state and federal funds, e.g. Alabama.
- MPOs and regional planning plays a role the process of managing road damage from energy development in Colorado, Iowa, Minnesota, Pennsylvania, Utah and South Carolina.
- Pennsylvania avoids load posting of major traffic routes and works with MPO's/RPO's to program affected roads for repair. [34]
- 13 states share data when energy development impacts are seen. [35]
- Ohio DOT and Alabama DOT use Memoranda of Agreement as a type of contractual agreement with energy developers.

Chapter 4 Case Examples of State and Local Practices [36]:

- Focused on road system impacts that agencies have observed and are addressing.
- Effective practices that come in form of: [36]
    - Techniques to address design challenges.
    - Tools to assess cost.
    - Use of contractual agreements.
    - Methods to mitigate for impacts on safety.
- Focus States: Colorado, Iowa, North Dakota, Pennsylvania, Texas
- Summary of Findings From Focus States – most frequently used engineering approaches by both DOT's and locals:
    - Increase the lane widths and add a paved shoulder.
    - Increase pavement thickness.
    - Stabilize surface layers of unpaved roads.
    - Address needs for: Seasonal road signs, increased turning radii, adding turning lanes, pavement strengthening.

Practices used to address energy development impacts in Colorado:

- 2007-2012 – crude oil production rose 89%. Natural gas rose 38%. 64% of electricity generated in 2013 is from coal, 20% from natural gas, and 17% from renewable energy [36]. Colorado Oil and Gas Conservation Commission established to foster responsible development of oil & gas and administer regulatory program. Program identified a local government designee (LGD) to receive copy of all permit applications.
- Road System Impacts – DOT reported an increase in truck traffic impacting 31%-60% or roads; especially on secondary roads. [37]
- Colorado DOT – Not yet entered into maintenance agreement with energy companies [37] Exception: State Highway 317.

- Tools to Assess Costs and Contractual Agreements – Department of Local Affairs provided grants through Energy Impact Grant program. These provide money for road maintenance. Regulatory warning signs for paved and unpaved roads. [39]
- Instituted both public service and other media announcements to warn traveling public of deteriorated surface conditions.

Practices used to address energy development impacts in Iowa: [39]

- Wind and biofuel industries impact roads and bridges.
- 27% of all electricity is from wind power.
- Wind turbine lengths and size of next gen biofuels require large transportation vehicles with larger turning radii. [40]
- Road system impacts – estimated increase in weight is 19.3 billion tons (171 TN) to 37.2 billion tons (331 TN) in 2035. [40]
- Corn delivering to ethanol plants using secondary roads is also a problem.
- Resolution Approving Conditional Use Permit Fees for Wind Energy Facilities. [40]
- Iowa DOT – Implemented and automated truck OS/OW permitting system that recommend preferred routes by considering and reviewing all bridge and pavement conditions and restrictions associated with energy plant locations. [41]
- Addressing Design Challenges – Increased structural capacity [41]. Adjusted pavement design standards at an additional cost [41]. Maximum weight signs of 8 tons (7300 kg or 71 kN) in Johnson County. [41]
- Tolls to assess costs and contractual agreements include Tax Increment Financing. [42]
- Safety: addition of turn lanes, increase turning radii, upgrade to four-lane corridor. [42]

Practices used to address energy development impacts in North Dakota: [42]

- Energy development in coal, oil, natural gas, biofuels and wind.
- Many local roads are now accessed by heavy trucks. [42]
- 930,000 barrels/day – oil production in 2013.
- Road system Impacts – All available roads are utilized by energy companies. [43]
- North Dakota State University has provided research information for about 20 years. [43]
- $930 million for county and township roads. $2.5 billion over two years.
- Design Challenges – Higher routine maintenance, step away from traditional pavement designs, increased frequency of blading and graveling. [43]
- Better prediction mechanisms. [44]
- Description of the various financing techniques used in North Dakota. [44]
- Significant increase in crashes. [44 &45]

Practices used to address energy development impacts in Pennsylvania:

- Natural gas industry is growing. [45]
- US 15 is heavily used and badly damaged. It requires $20 million to reconstruct. [46]
- Penn DOT and shale companies meet often to share policy and to address problems. [46]
- Roadway condition surveys are performed regularly and in 2014 average cost of $10.83 per mile for repairs. [46]
- Use of emulsified asphalt or Portland cement. [46]
- Municipalities agree to use RUMA. [47]

- ACT 89 Legislation allows the utilization of user fees to establish a funding source for transportation needs. [48]
- Figure 8 – Steps in the process for maintaining roads bonded by unconventional energy industries in Pennsylvania. [48]
- Permit required all energy development companies to ensure that it repairs damages to infrastructure. [48]
- Energy Companies submit an annual road maintenance plan to inform Pennsylvania DOT. [48]

Practices used to address energy development impacts in Texas:

- One-half of the oil and gas drilling rigs located in Texas. [49]
- 16,650 drilling permits issued annually.
- 13,413 wells drilled annually.
- Trucks weighing in excess of 80,000 lb (36,000 kg or 356 kN) impact many roads. [49]
- 4-6 in (10-15 cm) of asphalt pavement deteriorated rapidly in state route SR-72. [50]
- $1 billion needed for roadway repairs annually. [50]
- Expanding cross-sectional width, layer thickness and shoulder materials and widths are some solutions. [50]
- Texas DOT conducts training workshops to maintenance crews to talk about improvement techniques.
- Texas does not have maintenance agreements with energy companies. [53]
- Increase signage on narrow bridges for safety reasons. [54]

Chapter 5 Conclusions and Knowledge Gaps: [55]

- 40 states and the District of Columbia provided information that was valuable. [55]
- Strong correlation between increase in negative impacts to bridges and roads in areas of energy development. [55]
- Increase lane width and stabilize unpaved roads is a frequently reported solution.
- Tools: [55]
    - Stabilization of unpaved roads.
    - Use of full depth reclamation of existing pavements.
    - Paved shoulders.
    - Jumper bridges.
    - Geosynthetic placement.
- Compensation: [55]
    - Donation agreements with energy developers.
    - Permit fees.
    - Severance fees.
    - Sales tax.
- 32 DOTs sustained or expanded energy development.
- 27 DOTs observed increase truck traffic.
- Secondary and minor arterials mostly impacted. [55]
- Increase and damages and congestion to bridges near energy development.
- Only six DOTs have established agreements for energy companies to pay for repairs. [55]
- 15 of 41 DOTs use state or local permits as the contractual agreement for road use.

- 5 of 41 use VMT traveled to evaluate [56]
- Many state DOTs do not have and accurate predictor for pavement life nor an accurate means of estimating damage on secondary roads. [56]
- Minnesota DOT Heavy Traffic Generator allows to account for damage and cost for repairs. [56]

Future Research:

- States observed that primary impacts on roadways off of the state highway. [56]
- General lack of information on safety and crash statistics. [56]
- Review contribution to maintenance of roads from energy companies based on the size of the company. [56]
- Investigation into detour routing.
- Prediction mechanisms of pavement life and bridge life. [56]
- Collaboration of multiple of agencies to gain more resources. [57]
- Explore the identification and/or development of generic tools to assist LPAs in collecting and analyzing traffic and economic and other important information.
- Research in specific areas. Near port facilities or modal shift locations. [57]
- This study focuses only on the United States. [57]

Brigitte Osterath, 2015, "What ever happened with Europe's fracking boom?", Deutsche Welle website, July 20, 2015. http://www.dw.com/en/what-ever-happened-with-europes-fracking-boom/a-18589660.

Fracking (aka hydraulic fracturing) is going through a boom in the United States, where mining companies say high energy prices are forcing them to look for more unconventional deposits of gas. About five years ago, a shale gas boom started in Europe, with countries looking into the potential of this new fossil fuel source. Natural gas from horizontal drilling was initially advertised as "green" and "environmentally-friendly" energy. Many countries, particularly in Eastern Europe, hoped that shale gas would make them energy-independent from Russia. Nowadays, these high expectations have more or less faded in most parts of Europe

When shale gas is being "fracked," high-pressure water is injected into the rock at depths of 1,000 m (3300 ft) to 5,000 m (16000 ft) below the earth's surface. Sand is then sent down to fill up the cracks and make sure they stay open. Later, natural gas passes through the sand to reach the surface. Because sand and water do not mix well, drilling companies have to add chemicals to turn this into a homogenous, viscous fluid. Other chemicals are used to break up the water-sand mixture again, stop rocks from clogging things up, and to stop bacteria and yeast from contaminating the fluid. Activists fear that this "chemical cocktail" could contaminate the groundwater. And if not the chemicals, then the natural gas itself could cause pollution: In 2010, a documentary about hydraulic fracturing in the US claimed that methane water had polluted water so heavily through the process that it was possible to set fire to the water. Another fear is that hydraulic fracturing and injection wells may cause earthquakes. In the US and northern Germany, some earthquakes over past years are suspected to be linked with natural gas drilling. Activists fear that extracting shale gas might cause even more tremors.

Environmentalists and concerned citizens in many European countries went on the defensive when it became known that companies were eyeing potential new shale gas deposits. France is

apparently one of the countries with the highest potential for developing such unconventional hydrocarbons. However, a hydraulic fracturing moratorium has been in place since 2011. Bulgaria, the Czech Republic and others followed France's example when environmental concerns became overwhelming. Even in those nations where the technique isn't banned, such as the United Kingdom and Spain, regions of these countries – like Scotland and Wales in the UK, or Catalonia in Spain – still decided to ban hydraulic fracturing regionally. Germany continues its moratorium on exploiting shale gas deposits. A new law in Germany – which will probably be decided on after the summer – is not likely to impose an outright ban on hydraulic fracturing, but will restrict it heavily. It will only allow scientific test-drilling under strict conditions while assessing the risks and environmental impact.

Amanda Woodrum, 2014, *Fracking in Carroll County, Ohio: An Impact Assessment*, Report for Policy Matters Ohio by The Multi-State Shale Research Collaborative, April 10, 2014. Available online at http://www.policymattersohio.org/fracking-apr2014, with full report at http://www.policymattersohio.org/wp-content/uploads/2014/04/Shale_Apr2014.pdf.
This article concludes that whether the shale development is helping or hurting Carroll County is somewhat murky. Economically, the industry's claim of 40,000 new Ohio jobs was inaccurate and the initial sense of how much gas and oil there would be was inflated. But the drilling has brought out-of-state workers, some local jobs, and a measurable increase in demand for locally sold products and housing. This has helped car dealers, hardware stores, restaurants and landowners in this small rural community, while also driving up prices for renters. It has strengthened the still-weak local labor market, allowing some unemployed residents in Carroll County to find work and some already employed to find higher pay, even as the higher-paying jobs that the industry itself has delivered have often gone to out-of-state workers. And many drilling jobs are dangerous – there have been deaths and exposures to toxic chemicals – and apparently don't provide health insurance coverage.

Oil and gas development has raised local land prices, delivered leases to those who own land that could be developed for drilling, and helped those with property to rent, while raising worries about pollution and degradation of property. Wear and tear on roads, traffic, and collisions (including fatal ones) have risen, raising road maintenance costs for local government.

More alarming implications emerge with health and environmental impacts. Hydraulic fracturing uses a staggering six million gallons (22,700 m^3) of water per well, mixes it with toxic chemicals and radioactive materials, leaves some of it below ground close to drinking water supplies, deposits some of it in landfills, and injects some back into land elsewhere. Ohio does less to regulate these practices than neighboring states. Air pollution is another problem – one company flared an Ohio well for two weeks, causing bright light, noxious fumes, and noise levels comparable to that of a tornado warning all night long. People living near wells have experienced rashes, eye irritation, breathing problems, headaches and dizziness in the short term. Long-term exposure to the substances released can affect the immune system and cause cancer and brain damage. In addition to hurting people and pets, the environmental damage can kill plants, fish and other wildlife.

Communities also face great costs to increase training, road maintenance, police, fire, and other government infrastructure. At the same time, industry development has increased local tax revenue,

helping schools and communities in an economically disadvantaged region that has suffered from declining state contributions to schools and local government.

In short, the development has fallen far short of expectations, and caused environmental, housing, infrastructure and health problems. It has brought some jobs, outside spending, and tax revenue to beleaguered communities. Opposition to hydraulic fracturing is not strong enough to halt the development, which is already well underway.

At a minimum, Ohio needs to join other states by putting in place a more reasonable severance tax to allow communities to deal with the health, environmental, infrastructure and safety costs that this unpredictable industry has brought to eastern Ohio. A stronger severance tax would also help to compensate Ohio and its people for natural resources that are being permanently extracted and harmed by hydraulic fracturing, and to help communities be ready to face the costs imposed when this industry finishes extracting oil and gas, and leaves Ohio.

Jeffrey M. Reynolds and James "Chip" Northrup, n.d., "Frack Truck Impacts On New York Villages and Towns: Separating Fracks from Fiction", PowerPoint presentation, Otsego 2000 website, Cooperstown NY. http://www.otsego2000.org/documents/FrackingShaleTrucks.pdf.

Fracking (aka hydraulic fracturing) requires a large number of trucks and this is one of the biggest reasons for degrading of pavement conditions. 2.4 to 7.8 million gallons (9100 to 30000 m^3) of water per well and thousands of gallons (1000 gal = 3.8 m^3) of chemicals are trucked. The presentation also identifies that with the use of heavy trucks, roads and bridges are damaged and that there is air pollution from the diesel exhaust and on top of that there is noise pollution both day and night. Wells are also drilled 24/7 which adds up to all these damages. The presentation also talks about how there are no alternatives to trucks as the railroads do not provide enough coverage and propane extraction is uneconomic.

Trucks are paid by the load and therefore they drive fast to get more loads which means more money. This is also a problem. Most truck drivers are also out of state which results in them not adhering to local rules and regulations and driving conditions.

In Texas there are no 200-year-old villages, Small towns developed along highways, larger towns have highway bypasses and county seats have courthouse squares with highways on one side of square or which bypass the square completely. According to the presentations, the solution for this problem is to get a tough law and enforce it. For this you will need a land use plan, land use ordinance, truck route plan, road use ordinance, and enforcement.

Chenango Delaware Otsego Gas Group, (n.d.), "How Many Tanker Trucks Does It Take To Supply Water To, And Remove Waste From, A Horizontally Drilled And Hydrofracked Wellsite? Let's Do The Math!". Available online at the B.C. (British Columbia) Tap Water Alliance web site http://www.bctwa.org/Frk-HowManyTankerTrucks.pdf.

There are many factors to consider in determining an estimated range, because there can be an enormous difference in water usage (and resultant toxic waste production), between one drill pad and another. This article identifies some facts in this regard.

- Gallons of fresh water per well: 2 million to 9 million (7570 to 34,000 m^3)

- 320 truck trips for a 2 million gallon (7570 m^3) hydraulic fracturing
- 1440 truck trips for a 9 million gallon (34,000 m^3) hydraulic fracturing
- Multiple horizontal wells per pad: 2 to 20. Up to 6 wells per pad using old conventional rigs; 10 to 20 wells per pad using new HP rigs
- Hydraulic fracturing operations required over 30-year well life: 1 to 6
- Duration of hydraulic fracturing: 21 days

Bob Whipp, 2014, "Truck Traffic Reduction and Road Upgrades", Presentation at Ohio Transportation Engineering Conference, Columbus, Ohio, October 29, 2014. http://www.dot.state.oh.us/engineering/OTEC/2014%20OTEC%20Presentations/Wednesday,%20Oct.%2029/56-C220-222-830-10/Whipp.pdf.
This PowerPoint presentation was prepared by Bob Whipp, a Road Engineer at Gulfport Energy Corporation. This presentation talks about why road upgrades are important, Truck traffic reduction methods, road upgrades, and comparison of different projects. Safety, Reliability, and Efficiency are described as the three most important reasons why road upgrades are important. The presentation also identifies five truck traffic reduction methods: Minimizing Pad Size, Reducing gravel sections on pads by full depth reclamation (FDR), Reducing stone and asphalt needs on roads by FDR, Reducing or eliminating extraction-related truck traffic, and reducing rig moves logistically. Road upgrades that are mentioned in this presentation are stone overlay, aggregate overlay with double chip seal, aggregate widening with overlay, asphalt overlay, and FDR.

State leaders visited eastern Ohio to discuss shale boom and Model Road USE Maintenance Agreement for local governments.
This article refers to the RUMA that was developed with input from county and township officials, railroads, the oil and gas industry, ODOT, ODNR, The Ohio Emergency Management Agency, and other stakeholders. Ohio is experiencing significant new development in areas thought to be rich in oil and gas, and this development will create thousands of new needed jobs. As we have learned from other states experiencing similar activity, many rural roads used by the industry to move heavy equipment to and from well sites were not built to handle the volume or type of traffic they will soon experience. Maintaining roads is a priority, as is making sure the companies causing the wear and tear meet responsibilities. It is agreed upon that the RUMA developed is a useful tool and periodic meetings will be hosted to invite feedback and modifications.

Melody Matter and Amber Benzon, 2014, "Public Private Collaboration: PennDOT and the Marcellus Shale Coalition", Presentation at Ohio Transportation Engineering Conference, Columbus, Ohio, October 29, 2014. http://www.dot.state.oh.us/engineering/OTEC/2014%20OTEC%20Presentations/Wednesday,%20Oct.%2029/63-C223-225-1030-12/benzon_matter.pdf.
- Marcellus Shale Coalition (MSC) was formed in 2008.
- Consists of over 200 companies that support the shale gas development industry in Pennsylvania.
- MSC represents the unconventional natural gas industry to the state, federal, and local governments, regulators and the public regarding the development of the Marcellus and Utica Shale formations.

- In September 2010 the MSC established a Roadway Use Committee to provide information on transportation issues to the MSC membership and to serve as a liaison to the stakeholders in the public sector and the broader community.
- Meetings between PennDOT and MSC Road Use Committee provided an opportunity to discuss issues of interest to both parties, to share information, and to develop solutions. Meeting minutes were prepared and distributed and follow-ups and resolutions were documented (over 150 follow-ups were addressed)
- Meetings were held on a regular basis (bi-monthly as of October 2014); they are attended by PennDOT Deputy Secretary and his staff at PennDOT's central office and via webex.
- PennDOT developed over two dozen policies and procedures related to the gas development companies' road maintenance and repair responsibilities. All draft procedures were reviewed by the MSC committee and they were afforded an opportunity to provide input before the procedures were finalized.
- Education and training was provided by both PennDOT and the MSC (examples – MSC Safety Day and PennDOT training on posting and bonding).

Appendix B: CEAO Model RUMA

MODEL ROADWAY USE AND MAINTENANCE AGREEMENT FOR HORIZONTAL DRILLING PROJECTS AND INFRASTRUCTURE

THIS AGREEMENT is entered into at _____, Ohio, by and between _____COUNTY / TOWNSHIP_____, a political subdivision, whose mailing address is _____ (hereafter "Authority"), and_____, whose address is _____ _____(Hereafter "Operator"), and shall be as follows:

RECITALS

WHEREAS, Authority has control of the several county/township roads within Township, in _____ County, Ohio and is required by law to keep such roads in good repair; and

WHEREAS, Operator is the operator of certain oil and gas leasehold, and intends to develop and operate the [DEVELOPMENT SITE NAME], including the equipment, facilities, impoundments, and pipelines necessary for the operation of the [DEVELOPMENT SITE NAME] (hereafter collectively referred to as "oil and gas development site") located in _____ Township, in _____ County, Ohio; and

WHEREAS, Operator intends to commence use of _____miles of CR/TR (_____) and _____miles of CR/TR (_____) for the purpose of ingress to and egress from the [DEVELOPMENT SITE NAME], for traffic necessary for the purpose of constructing sites and drilling horizontal oil and gas wells, and completion operations at the [DEVELOPMENT SITE NAME] (hereinafter referred to collectively as "Drilling Activity"); and

WHEREAS, Authority and Operator desire to enter into an agreement, providing for the repair and maintenance of said roads and bridges thereon as a result of such Drilling Activity; and

WHEREAS, if any county or township roads contemplated herein contain any railroad crossings, Section 4 below shall apply;

NOW THEREFORE, in consideration of the good faith performance by each party of the mutual covenants hereinafter set forth, and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Operator agrees to the maintenance and repair of said roads and bridges, to their pre-Drilling Activity condition or as modified pursuant to Appendix A, thereon for any damages thereto, as a result of Drilling Activity related to such sites.

FURTHER, Operator shall also provide for the strengthening and upgrading of the roads and bridges if mutually agreed to be necessary, prior to or during any Drilling Activity. The areas and structures required to be strengthened and/or upgraded shall be determined by an engineer provided by the Operator with the approval of the County Engineer to be provided within thirty (30) days of a written request submitted by the Operator. Operator's engineer shall provide a written report to the County detailing the condition of the roads and appurtenances covered under this Agreement along with any recommendations, if necessary.

BOTH PARTIES FURTHER AGREE to the following additional terms and conditions:

1. The portion of CR_____ , to be utilized by Operator hereunder, is that exclusive portion beginning at _____*(route description here ending at the intersection of CR/TR)*_____. It is understood and agreed that the Operator shall not utilize any of the remainder of CR/TR (_____) for any of its Drilling Activities hereunder.

2. The portion of CR/TR ( ), to be utilized by Operator hereunder, is that exclusive portion beginning at *(the intersection of CR/TR ending at the oil and gas development site)* wherein Operator's site are to be constructed herein. It is understood and agreed that the Operator shall not utilize any of the remainder of CR/TR ( ) for any of its Drilling Activities hereunder.

3. Those portions of said roads and bridges and their appurtenances to be used by Operator hereunder and mutually agreed to require necessary strengthening and/or upgrading by the Operator's Engineer in conjunction with the County Engineer, shall be strengthened and/or upgraded to a condition sufficient and adequate to sustain the anticipated Drilling Activity by Operator, at Operator's sole expense, and with the advice and approval of the County Engineer as detailed in Appendix A. Thereafter, such roads shall be maintained by Operator for damages caused by Operator's Drilling Activity, at Operator's sole expense, throughout the term of this Agreement, to a level consistent with the condition of such roads at the commencement of its use by the Operator hereunder or as modified pursuant to Appendix A, as determined by the Operator's engineer and the County Engineer. The maintenance of aforementioned roads includes the use of a commercially recognized dust palliative to control the airborne dust created and/or contributed to by the Operator or the Operator's contractors and or agents.

4. The Operator shall give notice to the railroad at least thirty (30) days prior to any known Drilling Activity utilizing a railroad crossing so that a joint inspection can determine the condition of the crossing. Additionally, the Operator shall coordinate all work needing to be performed at a railroad crossing with the railroad company at least thirty (30) days prior to starting work on a railroad crossing. If the railroad company fails to respond to the Operator's notice of work needing to be performed at a railroad crossing within thirty (30) days of receipt of such notice, then the railroad waives all rights it has under this agreement with respect to the work specified in the notice. Work performed at a railroad crossing may include a separate agreement at the railroad's discretion. The Authority shall not be liable for any incidents arising out of or related to work performed at any railroad crossing pursuant to this Agreement or any separate Agreement between the Operator and the railroad company, or lack of notification by Operator.

5. Either the Operator or the Authority may terminate this Agreement with just cause following at least thirty (30) days written notice to the other of its intent to terminate. As soon as possible after receipt of such notice, the Authority and the Operator shall inspect said roads and bridges and their appurtenances. Following final inspection, the parties shall meet, and all restoration resulting from Operator's Drilling Activity shall be identified and thereafter completed by the Operator, at Operator's sole expense. Following completion of all restoration work, this Agreement shall be terminated and of no further force or effect.

6. Unless excepted for the reasons provided below, prior to the Drilling Activity on the Route, Operator shall post a bond or other surety in a form satisfactory to the Authority to cover the costs of any damage caused by the Drilling Activity on the Route by Operator. The amount of the bond or surety shall be in an amount no greater than _____ & 00/100 DOLLARS ($_____.00) per mile. However, no such bond or surety shall be required of Operator, if any of the following conditions are satisfied:

a. A geotechnical analysis of the Route provided by the Operator and mutually accepted by the Authority and Operator exhibits that the Route's condition is sufficient for the expected traffic necessary for the development of the oil and gas development site.
b. The Operator provides a geotechnical analysis of the Route, mutually accepted by the Authority and Operator, and based on that analysis, an Operator and Authority-approved maintenance plan for the Route or an Operator and Authority-approved preventative repair plan of the Route is attached to the Agreement as an addendum.
c. The Operator has provided a sufficient bond or surety, mutually accepted by the Authority and Operator, in favor of the Authority for road usage by the Operator within the Authority's oversight.

7. All motor vehicles to be utilized by Operator hereunder, whether owned by Operator or others, shall comply with all legal size, load and weight limits in accordance with State Law, and all non-conforming vehicles shall require the proper local permit.

8. Operator shall furnish the Authority with a written Letter of Authority, setting forth all necessary contact information, including a twenty four (24) hour emergency contact number, for the authorized local representative of the Operator, and such information shall be maintained and kept current at all times concerned hereunder.

9. If Authority determines that any additional traffic signage is needed, or desired, as a result of this Agreement and in the interests of safety, then Operator shall provide for such signage at Operator's sole expense. In the event that any other safety concerns should arise during the course of this Agreement, Operator and Authority agree that they will mutually discuss such concerns and reach a resolution satisfactory to all concerned.

10. Operator shall protect, save, indemnify, and hold the Authority, its officials and employees harmless from any liability, claims, damages, penalties, charges, or costs which may arise or be claimed as a result of any violations of any laws or ordinances, or any loss, damage or expense, including injury or death to any person, from any cause or causes from Drilling Activity whatsoever.

11. Operator assumes all liability for subcontractors and or agents working on Operator's behalf.

12. This Agreement shall be binding upon Operator and Authority, and their respective successors and assigns.

13. In any event that any clause, provision or remedy in this Agreement shall, for any reason, be deemed invalid or unenforceable, the remaining clauses and provisions shall not be affected, impaired or invalidated and shall remain in full force and effect.

14. Agreement shall be governed by the laws of the State of Ohio.

15. This Agreement shall be in effect on _____, 201 ___.

Executed in duplicate on the dates set forth below.

Authority	**Operator**
By: _____ Commissioner/Trustee	By: _____
By: _____ Commissioner/Trustee	Printed name: _____
By: _____ Commissioner/Trustee	Company Name: _____
By: _____ County Engineer	Title: _____
Dated: _____	Dated: _____
Approved as to Form: _____ County Prosecutor	

SAMPLE

Appendix A

Operator shall be required to:

1) Provide for videotaping of the road prior to Drilling Activity.
2) Provide an engineering report detailing pavement thickness and composition, base thickness and composition, and subgrade composition, as and if reasonably determinable. Engineering report to also provide an analysis of conditions along with a recommendation, if mutually agreed to be necessary, for upgrading roadway to handle anticipated Drilling Activity.
3) Upgrade CR/TR in accordance with the attached plans and/or county standards, dated 10/10/11.
4) Maintain CR/TR during Drilling Activities for those damages caused by said Drilling Activities.
5) Reimburse the Authority for minor maintenance of the road during the hauling period (or provide for a contractor to perform minor maintenance on 24 hour notice) for damages caused by Drilling Activities.

Authority shall:

1) Provide for minor maintenance of the road during the Drilling Activity for damages not caused by said Drilling Activity. For any work that is to be reimbursed by the Operator to the Authority, Authority agrees to give 24 hour prior notice to the Operator (or agrees to notify Operator when maintenance is needed).
2) Provide for maintenance of the roadway and bridges for damages not caused by the Drilling Activity at the Authority's cost and expense, including snow/ice control, mowing, etc.

The intent of this Appendix A is to include anything agreed to by the parties –If the Authority wants plans prior to construction, then include – etc., etc. If the Authority doesn't want anything in Appendix A, then that is their option.

The parties could also address the scenario where more than one Operator is involved on the same Route in this appendix.

Appendix C: Survey sent to Ohio Agencies

Improvement in technology and changes in policy have resulted in increased construction activity in the gas, oil, pipeline, solar, and wind industries with a resulting increase in traffic volume and congestion on state and local roads. In these situations, the local agency may enter into a Road User Maintenance Agreement (RUMA) with the private company in which the company assumes legal responsibility for repairing or improving the road and bridges to mitigate damage due to the excessive loading. The purpose of this survey to identify which energy industries are active in Ohio, where related construction activities are occurring, and whether RUMAs are being employed to mitigate damage. The results of this survey, as well as follow up survey/interviews, will be used to develop a Best Practices document for use by local governments. The researchers would appreciate your response to the following questions.

1. Has your jurisdiction experienced or do you anticipate significant energy related development activity in any of the following areas (check all that apply)?
    - ☐ oil
    - ☐ gas
    - ☐ solar
    - ☐ wind
    - ☐ mining
    - ☐ biofuels
    - ☐ pipelines
    - ☐ none
    - ☐ other, please list _____

If you answered none, proceed to question 18

2. Has the effect of the development on your budget been
    - ☐ significant
    - ☐ moderate
    - ☐ minimal
    - ☐ none
3. Has the effect of the development on truck volume been
    - ☐ significant
    - ☐ moderate
    - ☐ minimal
    - ☐ none
4. Has the effect of the development on traffic congestion been
    - ☐ significant
    - ☐ moderate
    - ☐ minimal
    - ☐ none
5. Has the effect of the development on road damage been
    - ☐ significant
    - ☐ moderate
    - ☐ minimal
    - ☐ none
6. Has the effect of the development on damage to bridges been

- significant
- moderate
- minimal
- none

7. Did your agency require/request an agreement (RUMA) from the industry prior to the commencement of activity?
   - yes
   - no

If you answered no, proceed to question 18

8. How many RUMAs agreements have you executed (signed)?
   - none
   - 1 to 10
   - more than 10
9. Have you terminated any RUMAs?
   - yes
   - no
10. Was the termination
    - due to completion pursuant to the terms of the RUMA
    - initiated by the energy developer
    - initiated by the local agency
    - other, explain: _____
11. Did you use the standardized RUMA developed by Ohio's state and local governments (available on the County Engineers Association website www.ceao.org)?
    - yes, as is
    - yes, modified
    - no, used RUMA developed "in house"
    - no, did not have an agreement
    - other _____
12. If you used a RUMA, what clauses and/or requirements of the RUMA were effective?
13. If you used a RUMA, what clauses and/or requirements of the RUMA were not effective?
14. Are road improvements being made by energy developers prior to their hauling on your roads?
    - yes, frequently
    - yes, occasionally
    - no
15. Do you require any bonds at the time of the RUMA signing?
    - yes
    - no
    - other _____
16. Do you require fees for special hauling permits?
    - yes
    - no
    - other _____
17. If so, are the fees waived/reduced with the signed RUMA
    - yes

- no
- other _____

18. Should we have additional questions, please provide the following information?

Name: _____
Position: _____
Agency:_____
Phone Number: _____
Email Address: _____

Thank you for completing the survey

Appendix D: Interview Questions

Energy Development Activity

Which industries have seen a sustained or increased level of activities which are impacting your roads and bridges?
If you do not use a RUMA, describe the approach your agency is taking to address the damage done to infrastructure by energy sector transportation activities?

Frost Law (ORC 5577) load restrictions

Does your jurisdiction typically impose load restrictions as permitted by the frost law?
If yes:

- What is the load limit?
- How are begin and end dates determined?
- How is it enforced?
- Do you impose the frost law after improvements are made?

Do you enforce weight limits during the frost law period? When the frost law is not in effect? How?
Does your agency observe an increase or acceleration in truck traffic damage on roadways during the frost law period?

Review/tracking/reporting/enforcement

Who reviews, and who approves, a RUMA? How long does the process typically take?
What reports are required from the industry and, is there any information which should be included in the report, which is not currently included?
How are RUMAs tracked?
What efforts are taken to ensure the energy developer's subcontracts also comply with the RUMA?
How have the increased impacts due to heavier loading on roads and bridges, due to energy development activities, been reported or measured?
Are the MPOs and/or RPOs, or equivalent planning groups, engaged in the process of working with the energy developers on managing the damage to public roads?

Engineering analysis methods

How are pavements/bridges/culverts analyzed before, to determine if pre-development upgrading (strengthening or other geometric improvements) is needed, and after to determine damage?
How is the analysis adjusted to consider the effect of multiple users on the same road segment?
How is routine truck traffic; i.e. garbage trucks, busses, grain haulers, etc. considered in the analysis?
Have you had disputes between the owner and developer regarding the need for pre-development upgrading or the extent of repairs required after development?
How is maximum loading determined?
Which types of damage or performance related issues have arisen on roads due to energy development activities in the area?

In the documentation of recent bridge inspections, have there been any decreases in either bridge ratings or performance that can be directly attributable to energy development activities in the area?

Modification to RUMA

The following were identified as effective/beneficial clauses and ineffective/non-beneficial clauses.

Effective/beneficial clauses

- condition improved prior and/or restored after
- maintenance
- bond
- analysis of existing road conditions undertaken and necessary
- agreement prior to permitting

Ineffective/non-beneficial clauses

- maintenance
- apply to subcontractors
- inactivity

Comments on the effective/beneficial clauses?

How can the RUMA be modified to address the ineffective/non-beneficial clauses?

Design standards

Which design standards (AASHTO/ODOT/other?) are used for roads repaired or built by energy developers?

How effective are the design standards for addressing safety issues and/or damage incurred by the increased heavy truck traffic?

Right-of-way acquisition

Who acquires necessary ROW?

Multiple users on the same route

How is the RUMA modified to address multiple energy development users?

Do these strategies or methods differ from those in place to deal with sources of damage to pavements and roadway infrastructure from agriculture, mining, logging, or other heavy industry that use the same network of roads and bridges?

Bonding/escrow

Do you require?

- Bonds
- Escrow account
- None
- other

If so, how is the amount determined?

Is the bond or escrow well site specific or multi site?

Is the bond or escrow ever waived? When?

Drainage
Do you require the energy developer clean or clear ditches before development? during? after?
Do you require culvert replacement or relocation during road improvement/widening?

Signs
Trucks traffic signs

- what types of posting are required from energy developers for roads and bridges
- what type are acceptable
- where may they be placed

Injection wells
Do you have any injection wells in your jurisdiction?
If yes, what is the effect on truck traffic? Congestion?
Have you been successful in obtaining a RUMA? If yes, what is the duration? What are the requirements?

Inspection - routine/special events
How often are roads and bridges inspected to insure compliance with the RUMA?
Are the roads/bridges inspected after special events (i.e. heavy rain)
Who does the inspection?
Do you perform regular inspections (eg- weekly,monthly) to ensure the road is safe and passable?
Do you inspect upgrades or repairs made by the developer to ensure quality, and /or do you require a warrantly on the upgrades/repairs?
How are inspections documented?

Maintenance - when? By who?
What type of maintenance is required?
What type of notification and by whom?
Who is responsible for performing and/or funding maintenance?
Who is responsible for maintenance during periods of inactivity?
Time frame for completion of maintenance after notification?

Safety
Has there been a noticeable increase in crashes involving large or heavy trucks that are attributable to changes in traffic composition as a result of energy development in recent years in your jurisdiction?
If yes, rate the level of increase in crashes?
How is your agency or the local agencies addressing the safety issues attributable to the increase in heavy truck traffic?
Has your agency or the local agencies, noticed any increase in the level of congestion on public roads due to the heavy truck volumes associated with energy development?

Post completion traffic
What maintenance has the industry agreed to provide after completion?

Termination

If you terminated a RUMA for well completion, was well completion an appropriate time to terminate?

If the energy company initiated the termination, why?

Does truck traffic volumes return to near normal levels after well completion, or does it decrease, but remains significant?

Notes:

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