Impact Analysis of the Marcellus Shale Safe Drilling Initiative

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Acronyms and Abbreviations

ACS	American Community Survey
bcf	billion cubic feet
CVM	contigent valuation method
DNR	Department of Natural Resources
EUR	estimated ultimate recovery
FMR	fair market rent
Interior AU	Interior Assessment Unit
mcf	thousand cubic feet
MDE	Maryland Department of the Environment
NAICS	North American Industry Classification System
OLS	ordinary least squares
REMI PI+	Regional Economic Modeling, Inc. Policy Insight +
RESI	Regional Economic Studies Institute
TPA	tourism promotion agency
USGS	U.S. Geological Survey
USDA	U.S. Department of Agriculture
WTP	willingness to pay

1.0 Executive Summary

1.1 Project Objective

As part of the Marcellus Shale Safe Drilling Initiative led by MDE and DNR, RESI of Towson University examined the potential impacts of Marcellus Shale drilling on Western Maryland. RESI's study investigated the following elements to develop a comprehensive and context-sensitive understanding of potential impacts of natural gas exploration and extraction in the Marcellus Shale:

- Community impacts,
- Tourism-related impacts,
- Economic impacts, and
- Fiscal impacts.

Through research, analyses, surveying, and stakeholder input, RESI quantified the impacts of Marcellus Shale drilling on Allegany and Garrett Counties. The timeframe for this study includes the short-term drilling period from 2017 through 2026 and the ten-year long-term economic impacts following the last well drilled in 2026. This report serves as a comprehensive impact analysis for informed policymaking.

1.2 Assumptions

RESI estimated the number of wells and well pads that will be developed under two different possible extraction scenarios. RESI selected the two scenarios because they project conservative and feasible extraction rates given the total natural gas reserves in Maryland and the production curve of a horizontal well. The two scenarios illustrate the parameters of these recovery expectations:

- **Scenario 1**, where 25 percent of the total shale gas would be extracted, and
- **Scenario 2**, where 75 percent of the total shale gas would be extracted.

RESI also made several other assumptions to estimate impacts throughout the report. These assumptions and are discussed fully in each relevant section.

1.3 Community Impacts

To analyze the potential community impacts of Marcellus Shale drilling in Maryland, RESI conducted a thorough review of relevant literature, engaged with and surveyed stakeholders, and performed a spatial and qualitative analysis of relevant data.

Stakeholder Feedback

RESI's discussions with community members and local representatives revealed several major concerns should drilling occur in the region. These concerns included impacts to agriculture, education and schools, environmental protection, housing availability and values, infrastructure and investment, economic and fiscal sustainability, and property rights.

Allegany County anticipates lesser impacts compared to its western neighbor considering the Marcellus Shale play underlies nearly all of Garrett County, and a smaller western section of Allegany County. RESI used the relevant concerns expressed through the stakeholder interviews to guide the topics for the community impact analysis.

Housing Impacts

RESI conducted in-depth research and estimates of the potential housing impacts of Marcellus Shale drilling. The following are RESI's key findings:

- RESI found that Western Maryland has a sufficient housing surplus, not accounting for construction of new units or deterioration of existing units, to handle the projected population growth from RESI's analysis of drilling activity impacts.
- The continued shortage in for-sale housing is primarily due to the existing shortage identified in 2012; this shortage could be reversed if more vacant housing were put back on the market to meet new demand.
- Based on the experience of areas of similar size and drilling activity, RESI does not expect rental housing to become unaffordable due to the relatively small number of wells expected in both drilling scenarios and the substantial housing surplus in the area.
- For both drilling scenarios, Allegany County will experience a shortage in available housing as early as the third year of drilling. Including vacant housing units not for sale or rent, Allegany County is not projected to experience a shortage until the ninth and tenth year of Scenario 1 and Scenario 2, respectively.
- Under both drilling scenarios, Garrett County will not experience a housing shortage in available or currently unavailable housing units. However, the surplus of available housing will fall below 100 units by the ninth and tenth years of drilling for both drilling scenarios.

Trucking Impacts

During RESI stakeholder meetings, residents of Western Maryland also expressed concerns regarding the possible increase in truck volume due to drilling activity. The true magnitude of impacts will ultimately depend on the number of well pads, number of wells per pad, and the total volume of water needed for each well. To quantify the possible magnitude of impacts to truck trips for each drilling scenario, RESI used data for truck trip estimates provided by MDE. RESI applied these estimates to the projected well pad and well build out from Scenarios 1 and 2. The following are the impacts to truck activity that can be expected for the active drilling period between 2017 and 2026:

- For Scenario 1, the increase in truck activity for Western Maryland amounts to an average annual addition of 22,595 truck trips for heavy-duty trucks and 7,903 for light-duty trucks.
- For Scenario 2, the increase in truck activity for Western Maryland amounts to an average annual addition of 67,785 truck trips for heavy-duty trucks and 23,708 for light-duty trucks.

1.4 Tourism-related Impacts

Due to a lack of data regarding the coexistence of tourism and drilling, the possible impacts to tourism activity in Western Maryland were difficult to quantify. However, RESI's research identified some potential impacts relying on both actual and perceived changes brought on by drilling activity:

- For tourism businesses, annual wages in certain tourism sector occupations, such as trucking, would have to increase by up to $30,000 to compete with higher wages in natural gas and related sectors.
- If drilling occurs, nonresidents may have more flexibility to avoid Western Maryland if they perceive the local trails, streams, and woodlands to be of lesser quality near drilling activity—ultimately impacting the popular second-home market of Garrett County.
- Negative economic impacts on the tourism industry may be offset by increased hotel taxes in the short term, but state and local governments will need to evaluate existing hotel and amusement tax policies to fully capture the expenditures of a transient workforce.

1.5 Economic and Fiscal Impacts

To analyze the economic and fiscal impacts associated with Marcellus Shale drilling in Western Maryland, RESI used several economic modeling tools including a dynamic input/output model (REMI PI+), a WTP model, and a hedonic pricing model. Most prior studies regarding this topic have only used an input/output model. RESI expected that the inclusion of the WTP and the hedonic price models would provide more comprehensive estimates of economic and fiscal impacts**.**

RESI incorporated several key economic drivers into the REMI PI+ model and analyzed the impacts on employment, output, and wages over a twenty-year period. The following section details the economic and fiscal impacts in each county for the two drilling scenarios.

Scenario 1, 25 Percent Extraction

Allegany County

- During the "boom" years, the greatest change from the baseline will occur in 2021, adding 546 jobs, $51.2 million in output, and $13.5 million in wages.
- Drilling activity will increase employment over the baseline forecast by approximately 271 jobs on average annually between 2017 and 2026.
- In the period after drilling, 2027 through 2036, residual economic activity will change baseline employment by an average of approximately 38 additional jobs annually.
- During the height of drilling activity, tax revenues will increase annually by $0.6 million on average. During the period after active drilling, tax revenues will increase by $0.3 million annually.

Additionally, wages will increase over the baseline forecast between 2017 and 2026. During the ten-year period following 2026, the results indicate a loss of wages as the employment levels in higher wage earning sectors begin to decline.

Garrett County

- During the "boom" years, the greatest change from the baseline will occur in 2021, adding 1,294 jobs, $143.4 million in output, and $35.6 million in wages.
- Drilling activity will increase employment over the baseline forecast by approximately 1,056 jobs on average annually between 2017 and 2026.
- In the period after drilling, 2027 through 2036, the region will experience significantly less job retention, recording an average of approximately 113 additional jobs annually.
- During the height of drilling activity, tax revenues will increase annually by $2.4 million on average. During the period after active drilling, tax revenues will increase by $0.8 million annually.

These results are consistent with the projected experience in Allegany County. However, given the more rural nature of Garrett County and the greater intrusion by Shale operations, it is feasible that factors such as wages and output will experience a greater decline than in Allegany County.

Scenario 2, 75 Percent Extraction

Allegany County

- During the "boom" years, the greatest change from the baseline will occur in 2024, adding 952 jobs, $102.4 million in output, and $26.9 million in wages.
- Drilling activity will increase employment over baseline forecast by approximately 732 jobs on average annually between 2017 and 2026.
- In the period after drilling, 2027 through 2036, residual economic activity will change baseline employment by an average of approximately 109 additional jobs annually.
- During the height of drilling activity, tax revenues will increase annually by $1.7 million on average. During the period after active drilling, tax revenues will increase by $0.7 million annually.

Additionally, the wages will increase over the baseline between 2017 and 2026. During the period of well operation with no new additional drilling, there will be year-over-year decrease in wages from the baseline beginning in 2029.

Garrett County

- During the "boom" years, the greatest change from the baseline will occur in 2021, adding 2,743 jobs, $341.8 million in output, and $80.2 million in wages.
- Drilling activity will increase employment over the baseline forecast by approximately 2,093 on average annually between 2017 and 2026.

- In the period after drilling, 2027 through 2036, the county will experience significantly less job retention, recording an average of approximately 80 additional jobs annually (when compared to the baseline forecast).
- During the height of drilling activity, tax revenues will increase annually by $4.4 million on average. During the period after active drilling, tax revenues will increase by $0.9 million annually.

These results are consistent to the projected experience in Allegany County. However, wages will experience a more pronounced fall in Garrett County after active drilling ceases under this scenario. Again, due to the economic climate in Garrett County, it is possible that the rural areas will not be able to absorb the loss as well as the more urbanized Allegany County.

2.0 Introduction to Western Maryland

The majority of the Marcellus Shale formation that is within Maryland's borders is located beneath Western Maryland—specifically, Allegany and Garrett Counties.[1] Residents and other stakeholders in Western Maryland face unique economic challenges compared to those in other regions of Maryland. The region contends with slower employment growth, higher unemployment rates, and other socioeconomic challenges.

To accurately analyze the impacts of the Marcellus Shale drilling, RESI first collected background information on the counties comprising the impacted region. Such information included the economic conditions and trends in Western Maryland (Allegany and Garrett Counties), the history of energy development in the region, and prospects for Marcellus Shale drilling.

2.1 Economic Conditions and Trends

To provide background on the unique challenges faced by Western Maryland, RESI collected data regarding employment, unemployment, income, and educational attainment. Where appropriate, RESI included state-level statistics for the purpose of comparison.

The labor force[2] of Western Maryland included an estimated 48,839 workers,[3] with Allegany County's labor force comprising 69.3 percent of that total, as of 2012.[4] Of the total civilian labor force, 48.7 percent[5] and 57.5 percent[6] were employed in Allegany and Garrett Counties, respectively, in 2012, compared with 63.6 percent[7] statewide.

Figure 1 shows the top five industries by employment for Allegany and Garrett Counties.

[1] For the purpose of this analysis, RESI considered the Western Maryland region to include Allegany and Garrett Counties.
[2] Note that labor force counts comprise both employed and unemployed workers whereas employment counts comprise only employed workers.
[3] U.S. Census Bureau, "SELECTED ECONOMIC CHARACTERISTICS," in *2008-2012 American Community Survey 5-Year Estimates*, accessed February 7, 2014, http://factfinder2.census.gov/.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] Ibid.

Figure 1: Top Five Industries by Private Employment and County, 2012

County/Industry	Employment	Percentage
Allegany County		
Health care and social assistance	6,142	27.3%
Retail trade	3,758	16.7%
Accommodation and food services	3,056	13.6%
Manufacturing	2,511	11.1%
Administrative and waste services	1,351	6.0%
Top 5 Total	**22,537**	**74.6%**
Garrett County		
Retail trade	1,670	17.2%
Accommodation and food services	1,204	12.4%
Manufacturing	1,050	10.8%
Construction	779	8.0%
Arts, entertainment, and recreation	411	4.2%
Top 5 Total	**9,708**	**52.7%**

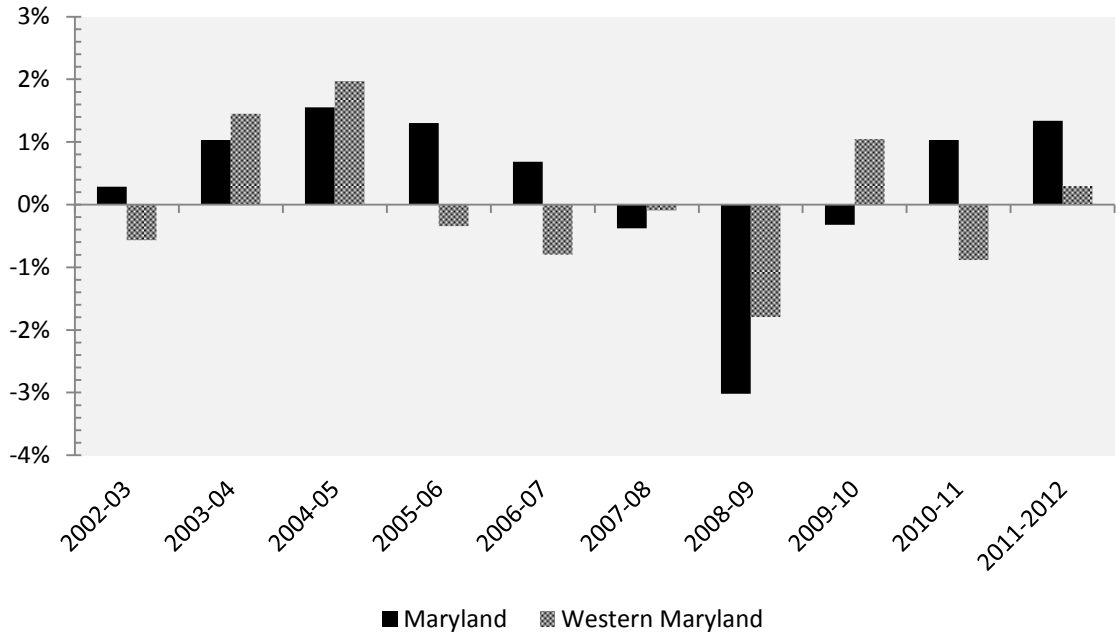
Source: BLS QCEW

As shown in Figure 1 above, the top five industries by employment vary between Allegany and Garrett Counties, with Health Care and Social Assistance and Retail Trade as the largest industries, respectively. The top five industries in Allegany County encompass 74.6 percent of all employment in the county, whereas 52.7 percent of Garrett County employment is captured in its top five industries.

Figure 2 shows the year-over-year change in employment for Western Maryland over the ten-year period between 2002 and 2012.[8]

[8] "Employment" as measured by the Quarterly Census of Employment and Wages refers to the total number of employees who worked or received compensation at some point(s) over a specific period (in this case, a calendar year).

Figure 2: Percent Change in Employment, 2002–2012



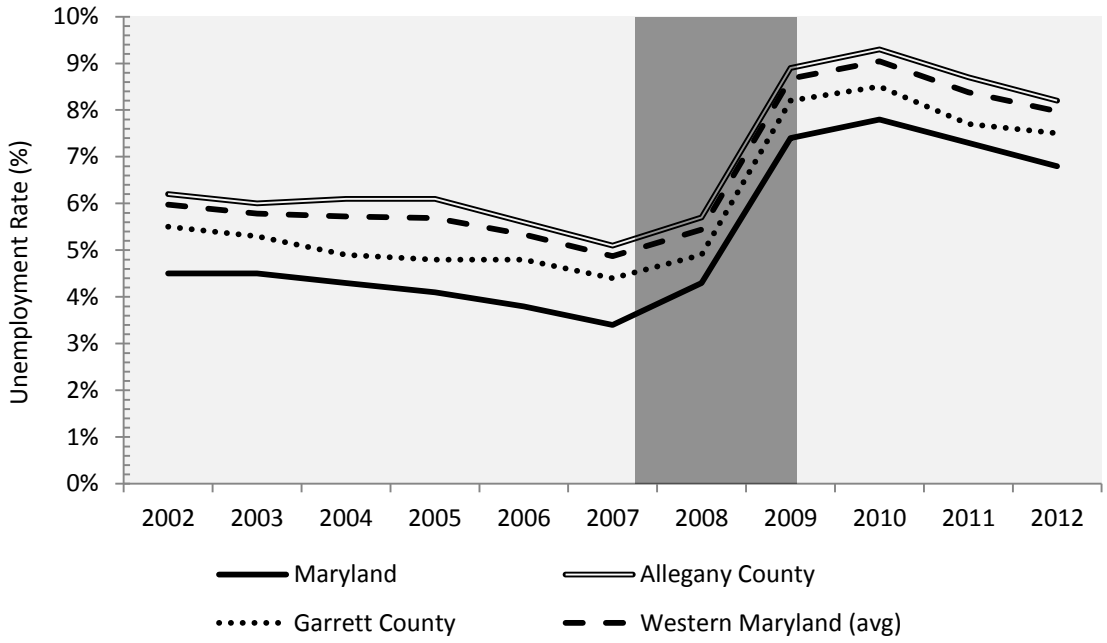
Source: BLS QCEW

As shown in Figure 2, Western Maryland's year-over-year change in employment has not always followed the trend for Maryland. Since 2002, the region has lost employment over four different periods during which employment increased statewide. Regional employment growth between 2002 and 2012 was relatively negligible, at 0.2 percent—compared to a 3.5 percent growth rate for the state during the same period.[9]

Figure 3 shows the unemployment rate for Maryland, Western Maryland, and its component counties between 2002 and 2012.

[9] "Quarterly Census of Employment and Wages," U.S. Bureau of Labor Statistics, 2012, accessed February 7, 2014, http://www.bls.gov/qcew/.

Figure 3: Unemployment Rate, 2002–2012[10]



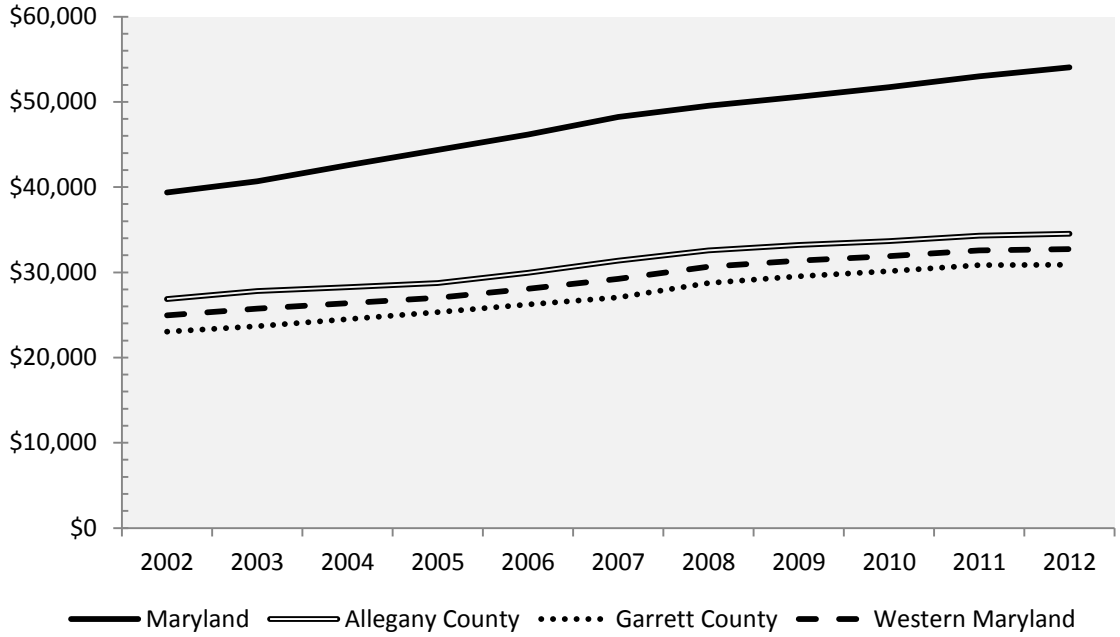
Source: BLS LAUS, NBER

As shown in Figure 3, Western Maryland's unemployment rate (expressed as an average between Allegany and Garrett Counties weighted for the total labor force for each county) has been historically higher than that for the state overall between 2002 and 2012. However, the region's unemployment rates appear to have followed a similar trend to Maryland's over the ten-year period, dipping to their lowest in 2007, increasing through 2010 (coinciding with the Great Recession), and then falling again through 2011 and 2012.

Figure 4 shows the average annual pay for all industries in Western Maryland between 2002 and 2012.

[10] In Figure 3, the shaded area represents the official time period of the Great Recession according to the National Bureau of Economic Research.

Figure 4: Average Annual Pay, 2002–2012



Source: BLS QCEW

As shown in Figure 4, average annual pay for Western Maryland workers has historically been lower than annual pay statewide, although it has steadily increased since 2002. As of 2012, the average annual pay for a worker in Western Maryland (averaged between Allegany and Garrett Counties) was approximately $32,706, compared with $54,035 for all Maryland workers.[11] Median household income in Western Maryland has fared similarly, at $42,221[12] as of 2012 compared to $72,999 for Maryland overall.[13]

Despite comparatively lower average annual pay and median household income compared to Maryland, Western Maryland's cost of living is lower. According to the Department of Business and Economic Development's Cost of Living Index for Maryland Counties, Allegany and Garrett Counties have indices of 86.7 and 99.8, respectively, as compared with an average index across all Maryland counties of 106.3.[14] The Cost of Living Index uses "a standard set of goods and services based on the Bureau of Labor Statistics' Consumer Expenditure Survey, including housing, utilities, transportation, food and clothing, to calculate consumer expenditures for Maryland jurisdictions" and compare those expenditures to the U.S. averages.[15]

[11] "Quarterly Census of Employment and Wages," U.S. Bureau of Labor Statistics.
[12] U.S. Census Bureau, "SELECTED ECONOMIC CHARACTERISTICS."
[13] Ibid.
[14] "Cost of Living," Department of Business and Economic Development, accessed April 17, 2014, http://www.choosemaryland.org/live/pages/costofliving.aspx.
[15] Jim Palma, "Baltimore's cost of living stacks up well," *MDBIZNews*, August 21, 2012, accessed May 19, 2014, http://mdbiznews.choosemaryland.org/2012/08/21/baltimores-cost-of-living-stacks-up-well/.

Figure 5 includes the educational attainment levels for Allegany and Garrett Counties as well as the state.

Figure 5: Educational Attainment, 2008–2012

Educational attainment	Maryland	Allegany County	Garrett County
Some high school, no diploma	11.5%	13.1%	15.1%
High school graduate (includes equivalency)	26.0%	42.8%	42.7%
Some college, no degree	19.9%	19.9%	17.2%
Associate's degree	6.2%	8.0%	7.0%
Bachelor's degree	20.0%	8.9%	10.2%
Graduate or professional degree	16.4%	7.2%	7.8%

Source: Census 2008-2012 American Community Survey 5-year estimates

As shown in Figure 5 above, the component counties of Western Maryland have lower educational attainment than for the state overall. The plurality of residents of Allegany and Garrett Counties—42.8 and 42.7 percent, respectively—indicated high school as their highest form of completed education.[16] A smaller share of residents of both counties holds a Bachelor's or graduate or professional degree.

After collecting data regarding the current economic conditions of Western Maryland, RESI explored the history of energy development in the region. The following section provides a brief overview of the history of energy development.

2.2 History of Energy Development

Coal and natural gas have historically played a significant role in the economies of Allegany and Garrett Counties. According to representatives from MDE, coal mining began in the 1700s, and production peaked in the early 1900s at over five million short tons per year. It declined to less than one million short tons per year by the 1950s; production fluctuated thereafter, peaking above five million in 2004 but then dropping to between two million and three million short tons per year between 2007 and 2012.[17] In recent years, employment in coal mines in Maryland has varied between 400 and 500.[18]

Natural gas has been produced in Allegany and Garrett Counties for decades, with production peaking in the 1950s and declining thereafter.[19] There are still a few wells producing natural gas in Garrett County, according to MDE. Natural gas arrives in Garrett County by interstate

[16] U.S. Census Bureau, "SELECTED SOCIAL CHARACTERISTICS," In *2008-2012 American Community Survey 5-year estimates*, accessed February 7, 2014, http://factfinder2.census.gov/.
[17] Brigid Kenney, email message to author, February 4, 2014.
[18] Ibid.
[19] Ibid.

pipelines and is temporarily stored in the depleted reservoir of the Oriskany sandstone in the Accident Storage Field so that it is available to meet peak demand.[20]

The Deep Creek Power Plant, located in Garrett County, is a hydroelectric power station that has been in operation since 1925.[21] According to its website, the plant is capable of producing 18 megawatts of electricity through two turbines. Deep Creek Lake, which is the reservoir that is used to power the turbines, is also an attractive area for recreational activities.

More recently, renewable energy sources in the form of wind turbines have been established in Western Maryland. According to MDE, two installations have been completed; a third one has been approved by the Public Service Commission. In addition, there is interest in the use of forest products in biomass (wood) boilers.[22] Other distributed electricity generation approaches, such as solar and small scale wind, have also gained popularity within the region.[23]

2.3 Prospects for Marcellus Shale Gas Development

Interest in natural gas development in Western Maryland waned until advancements were made in horizontal drilling and high volume hydraulic fracturing. With these technologies, it became potentially economical to extract gas from deep shale deposits like the Marcellus Shale.

According to a 2011 report by the USGS, the Interior AU of the Marcellus Shale region holds approximately 96 percent, or 41,607 bcf, of the total undiscovered resources.[24] USGS estimates that Maryland has approximately 1.69 percent of the Interior AU.[25] Using these numbers, RESI estimated that the total potential undiscovered resources of Marcellus Shale gas in Maryland was approximately 703 bcf—less than 10 percent of the total Shale play in the region.

Beginning in 2009, a few applications were filed with MDE for permits for natural gas wells in the Marcellus Shale, but the applications were withdrawn before any final decision. In 2011, Governor Martin O'Malley issued Executive Order 01.01.2011.11, the Marcellus Shale Safe Drilling Initiative, directing MDE and DNR in consultation with an Advisory Commission to investigate various issues relating to gas development from the Marcellus Shale, including an assessment of the possible economic impacts.

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[20] Kenney, email message to author, February 4, 2014.
[21] "Station Statistics," Deep Creek Hydro, accessed February 26, 2014, http://www.deepcreekhydro.com/StationStatistics.html.
[22] Kenney, email message to author, February 4, 2014.
[23] "Smart Energy Investment Map," Maryland Energy Administration, accessed February 26, 2014, http://energy.maryland.gov/map/index.html.
[24] James L. Coleman et al., "Assessment of Undiscovered Oil and Gas Resources of the Devonian Marcellus Shale of the Appalachian Basin," U.S. Geological Survey (2011): 2, accessed September 18, 2013, http://pubs.usgs.gov/fs/2011/3092/pdf/fs2011-3092.pdf.
[25] Brigid Kenney, discussion with RESI, October 18, 2013.

This report seeks to estimate the potential community, economic, and fiscal impacts associated with the Marcellus Shale Safe Drilling Initiative. The report uses current estimates provided by USGS and EIA for potential reserves to build two hypothetical scenarios and estimate impacts, as discussed in more detail in Section 5.0 of this report.

3.0 Impacts of Shale Drilling Experienced by Other States

To provide background and potential points of comparison for its results and findings, RESI completed a review of literature regarding the community and economic impacts of shale drilling that other states expected to experience, have experienced, or perceived to have experienced. Below is a discussion of such impacts in other states.

3.1 Community Impacts

Actual and potential community impacts of shale drilling, as noted in a variety of states, have been both positive and negative and span a wide variety of topic areas. Given the broad range of potential community impacts of drilling, RESI focused on several topic areas that aligned with the topic areas discussed during stakeholder interviews hosted by RESI in preparation for this report:[26]

- Agriculture,
- Schools,
- Health and safety,
- Housing,
- Traffic and roads, and
- Tourism and recreation.

While additional research exists, RESI focused on recent research relevant to these seven topic areas.

Agriculture

Because the hydraulic fracturing process requires the use of large amounts of water treated with chemicals, stakeholders often voice concerns regarding water supply and availability, which could impact not only residents but also agriculture.

In South Texas, numerous stakeholders expressed concern regarding the demand that drilling of the Eagle Ford shale play put on the water supply during a drought in 2011. The drought caused "widespread pasture losses, crop failures and shortages of water in rivers, reservoirs and wells."[27] With expectations of many more wells to be drilled in that region over the next twenty years, demand for water is likely to increase. Due in part to stakeholders' concerns in

[26] For more information regarding RESI's stakeholder engagement process, please refer to Section 4.0 of this report.
[27] Tracey Idell Hamilton, "Drought spurring fracking concerns," *mySA*, July 2, 2011, accessed February 17, 2014, http://www.mysanantonio.com/news/energy/article/Droughtspurringfrackingconcerns-1450808.php.

South Texas, companies involved in hydraulic fracturing in the region have offered to consider using alternate water sources or recycling their wastewater.[28]

Schools

A 2012 Penn State research brief discussed shale development's potential effects on schools, including "school demographics; student outcomes and workforce development; effects on local roads and transportation; broader community services and infrastructure."[29] The study team surveyed educational leadership and interviewed educational and community stakeholders. The results indicated that survey respondents expected the potential influx of workers to impact school demographics, student needs, social services, and housing.[30] The potential impacts for schools are important considerations for educational leadership in areas where drilling has occurred or is expected to take place. The research brief concluded the following:

> A pressing—and difficult—question is how the shorter term economic boom of Marcellus development can be strategically managed so that Pennsylvania schools and communities can maximize their opportunities for long-term social, economic, and environmental sustainability.[31]

In some cases, schools have capitalized on the presence of shale development in their areas. The Blackhawk School District in Pennsylvania leased land to a shale developer in 2011 following an $800,000 budget cut.[32] Other school districts, primarily in Pennsylvania and Texas, "have struck deals with natural gas companies, either for underground mineral rights or for rights to drill on the earth's surface" due in part to the fact that they "are experiencing an energy boom at the same time that they've been cutting state aid for K-12 education."[33] For the Blackhawk School District, the lease agreement also provided an additional $300,000 for its $30 million budget.[34]

Health and Safety

The health and safety topic area is perhaps the top concern for stakeholders in areas considering or pursuing shale drilling. Generally, concerns regarding health and safety fall under the following categories:

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[28] Hamilton, "Drought spurring fracking concerns."
[29] Penn State Cooperative Extension, "Marcellus Shale Gas Development: What Does It Mean for Pennsylvania Schools?" *Marcellus Education Fact Sheet* (2012): 3, accessed February 28, 2014, http://pubs.cas.psu.edu/freepubs/pdfs/ee0019.pdf.
[30] Ibid, 7.
[31] Ibid, 8.
[32] Ben Wieder, "Schools Fill Budget Holes With Fracking Revenues," *STATELINE*, August 30, 2011, accessed February 28, 2014, http://www.pewstates.org/projects/stateline/headlines/schools-fill-budget-holes-with-fracking-revenues-85899375145.
[33] Ibid.
[34] Ibid.

- Water contamination,
- Air contamination,
- Blowouts, and
- Seismic risks.

Psychosocial stress and its effects have also been cited as potential impacts of shale drilling.

A preliminary EPA document following up a 2012 investigation into water-related issues in Dimock, Pennsylvania, suggested that "drilling or fracking, in which water, sand and chemicals are shot underground to free trapped gas, caused methane to leak into domestic water wells."[35] However, Cabot Oil and Gas Corporation, the company involved in drilling in Dimock, has refuted these assertions, and the EPA has publicly stated that such findings are preliminary in nature and require additional investigation.[36]

In addition to the possibility of underground water contamination, shale drilling activities above ground can also lead to water contamination. A Right-to-Know request submitted to Pennsylvania Department of Environmental Protection in 2010 revealed "hundreds of examples of spills at natural gas drilling sites in the state…recorded by at least 92 different drilling companies."[37]

There is some evidence that suggests that air emissions related to gas drilling could also be a health risk. A 2012 University of Colorado report estimated the "health risks for exposures to air emissions from a NGD [natural gas development] project in Garfield County, Colorado with the objective of supporting risk prevention recommendations in a health impact assessment."[38] The report found that residents living closer to well pads were more likely to experience adverse health effects, although the authors recommended further research. According to the report, "Risk prevention efforts should be directed toward reducing air emission exposures for persons living and working near wells during well completions."[39]

Significant interest surrounds the effects of gas drilling on human and animal health. A 2012 analysis that involved "interviews with animal owners who live near gas drilling operations" in six states found that high-volume hydraulic fracturing of horizontal wells was "more commonly

[35] Mark Drajem, "EPA official links fracking and drinking water issues in Dimock, Pa." *The Washington Post*, July 29, 2013, accessed April 16, 2014, http://www.washingtonpost.com/politics/epa-official-links-fracking-and-drinking-water-issues-in-dimock-pa/2013/07/29/7d8b34b2-f8a1-11e2-afc1-c850c6ee5af8_story.html.
[36] Ibid.
[37] Laura Legere, "Hazards posed by natural gas drilling not always underground," *thetimes-tribune.com*, June 21, 2010, accessed February 16, 2014, http://thetimes-tribune.com/news/hazards-posed-by-natural-gas-drilling-not-always-underground-1.857452.
[38] Lisa M. McKenzie et al., "Human health risk assessment of air emissions from development of unconventional natural gas resources," *Science of the Total Environment* (2012): 1, accessed February 17, 2014, DOI: 10.1016/j.scitotenv.2012.02.018.
[39] Ibid, 8.

associated with animal health problems" than conventional well drilling.[40] However, the authors note that there was significant "difficulty in obtaining definitive information on the link between hydrocarbon gas drilling and health effects."[41] Due to these difficulties, the authors provided the following recommendations to improve analysis:

- Full disclosure of air and water testing data,
- More food safety research relating to chemical contaminants,
- More air sampling to expand knowledge of various routes of exposure,
- Comprehensive air and water testing before and during drilling.[42]

Given the findings, the authors concluded that "the use of commonsense measures to reduce the impact on human and animals must be required in addition to full disclosure and testing of air, water, soil, animals, and humans" in states that allow drilling.[43] Best practices in regard to human and animal health are essential in avoiding adverse impacts.

Other studies do not find a definitive correlation between shale drilling and adverse health and safety effects. An article from Physicians for Social Responsibility opens with the following disclaimer:

> The only statement that we can make with certainty to date about the effects of hydraulic fracturing on the public's health is that there are multiple pathways for potential harm, and that none have been researched enough to definitively link the process to specific health impacts.[44]

However, the article provides another, perhaps less obvious, potential pathway: socioeconomic change and the resulting psychosocial stress. Many of the socioeconomic changes that come with an increase in drilling activity—including but not limited to increased traffic, more temporary workers without community ties, increases in crime—bring stress to communities.[45] Reports of such impacts, however, are mostly anecdotal at present; as in other cases, more research is needed to determine whether or not a correlation exists.

A 2010 briefing paper from Worldwatch Institute, which supported the correlation between gas drilling and groundwater, soil, and air contamination, also explored the possibilities of blowouts and seismic risks. The report cited gas well blowouts that had recently occurred as a result of drilling of the Marcellus Shale in Pennsylvania and West Virginia. While adherence to

[40] Michelle Bamberger and Robert E. Oswald, "Impacts of Gas Drilling on Human and Animal Health," *New Solutions* 22 (2012): 54, accessed February 17, 2014, http://www.psehealthyenergy.org/data/Bamberger_Oswald_NS22_in_press.pdf.
[41] Ibid, 66.
[42] Ibid, 67–70.
[43] Bamberger and Oswald, "Impacts of Gas Drilling on Human and Animal Health," 72–73.
[44] Jill Kriesky, "Socioeconomic Change and Human Stress Associated with Shale Gas Extraction," *Physicians for Social Responsibility*, accessed February 17, 2014, http://www.psr.org/environment-and-health/environmental-health-policy-institute/responses/socioeconomic-change-and-human-stress.html.
[45] Ibid.

regulations and best practices is important, the report also stressed that proper training of personnel is "critical to the protection of the public and the environment."[46]

In addition to blowouts, low-magnitude earthquakes experienced in Texas in 2008 and 2009 point to the possible risk of seismic activity relating to "the injection of waste water from gas operations into numerous saltwater disposal wells that were being operated in the vicinity."[47] More recently, officials have begun an investigation into whether earthquakes in northeastern Ohio in early March could have been caused by hydraulic fracturing itself.[48] As a result, proper monitoring of drilling operations and their seismic impacts is another best practice to be considered during hydraulic fracturing.

Housing

Several recent studies assessed the impacts of shale drilling on housing in the Pennsylvania portion of the Marcellus Shale. These studies predominantly focused on rural housing in the Appalachian region, where much of the Pennsylvania portion of Marcellus Shale is located. Findings from these studies indicated that housing was impacted by finances, human capacity, land use planning, and zoning.

A 2011 study interviewed various stakeholders across six Pennsylvania counties on topics relating to drilling and housing. The counties varied in terms of shale drilling progress. From these interviews, the authors cited three major findings:

- "First, the severity of the housing problem…depends on the nature and scale of the growth of the natural gas industry in a given county or community and on the existing pre-Marcellus capacity of that county or community to absorb the increased demand for housing."[49]
- "Second, the effects of increased housing demand are broad-based, but the negative impacts are felt heaviest by those living at the economic margins."[50]
- "Finally, the capacity of the development community varies considerably from county to county in its ability to meet the need for additional housing."[51]

[46] Mark Zoback, Saya Kitasei, and Brad Copithorne, "Addressing the Environmental Risks from Shale Gas Development," *Worldwatch Institute* (July 2010): 9, accessed February 17, 2014, http://www.worldwatch.org/files/pdf/Hydraulic%20Fracturing%20Paper.pdf.
[47] Ibid.
[48] Hunter Stuart, "Ohio Fracking Operations Halted Following Area Earthquakes," *Huffington Post*, March 12, 2014, accessed April 16, 2014, http://www.huffingtonpost.com/2014/03/12/fracking-earthquakes-ohio-hilcorp_n_4950768.html.
[49] Jonathan Williamson and Bonita Kolb, "Marcellus Natural Gas Development's Effect on Housing in Pennsylvania," Center for the Study of Community and the Economy–Lycoming College (September 31, 2011): 1, accessed February 28, 2014, http://www.cohhio.org/files/HOUSING%20PHFA%20Marcellus_report.pdf.
[50] Ibid.
[51] Ibid, 2.

These findings seem to suggest that the potential for adverse effects on housing may vary depending on a multitude of factors. Therefore, determining and employing the best policies relating to land use planning, zoning, etc. may provide the best possible outcome.

A similar study from the Institute for Public Policy & Economic Development analyzed drilling activity and housing in twelve counties in Pennsylvania and found that the financial and human capacity strains to local government and construction presented housing challenges, but noted that "the shale play is not necessarily the cause of a housing crisis in Pennsylvania" as "any catalytic event causing growth or change would have affected these communities in the same way."[52] The report provides a number of policy recommendations aimed at reducing the impact on housing, among them rental ordinances and exclusionary zoning ordinances.

Traffic and Roads

Shale drilling requires near-continuous truck trips as water and chemicals are transported to development sites and wastewater is transported away. As a result, shale development often has a significant impact on traffic flow and roads surrounding development sites.

A 2010 guide of best practices to protecting roads impacted by drilling noted, "Dust, noise, and road damage from industry truck travel are tops on the list of citizen complaints in areas where shale gas is extracted via shale gas drilling."[53] In addition, existing road infrastructure is frequently inadequate to handle the volume and load of such truck travel. The guide recommends the following measures for areas impacted by shale drilling:

1. Studying traffic flow impacts,
2. Collecting data regarding road conditions,
3. Adopting Road Use Agreements,
4. Managing trucking routes, and
5. Enforcing traffic and road regulations.[54]

A 2012 Wall Street Journal article discussed similar infrastructure impacts in Texas around the Eagle Ford shale play. The chief administrator of one of the impacted counties estimated that the "cost of building up the county's 230 miles of rudimentary roads to withstand the inflow of drilling-related traffic exceeds $100 million," whereas the county's entire budget comes to

[52] Institute for Public Policy & Economic Development, "Impact on Housing in Appalachian Pennsylvania as a Result of Marcellus Shale," November 2011, 16, accessed February 28, 2014, http://www.institutepa.org/PDF/Marcellus/housing11.pdf.
[53] CJ Randall, "Hammer Down: A Guide to Protecting Local Roads Impacted by Shale Gas Drilling," *Working Paper Series: A Comprehensive Economic Impact Analysis of Natural Gas Extraction in the Marcellus* Shale (December 2010): 2, accessed February 28, 2014, http://www.greenchoices.cornell.edu/downloads/development/shale/Protecting_Local_Roads.pdf.
[54] Ibid, 4–7.

approximately $6 million.[55] County governments are not able to collect taxes relating to energy production as the state government does; therefore, they experience significant financial issues in keeping up with infrastructure needs stemming from shale development.[56]

Tourism and Recreation

A 2011 analysis found that tourism was impacted in Pennsylvania, Texas, and Wyoming by shale development, and similar impacts could be felt in the New York Southern Tier Central Region—among them, availability of accommodations, changes to view sheds, and increased truck traffic.[57] Tourism in the Southern Tier surrounds the "agriculture; rolling hills, scenic farmlands, rural vistas, and viticulture" of the area. [58] Stakeholders in the region expressed concern whether or not these aspects, as well as the appeal and impacts of these aspects, would be permanently damaged by drilling.

Tourism-related businesses (hotels, restaurants, retail, etc.) can provide the amenities needed by shale drilling workers. Also, tourism can be part of long-term economic development strategy, whereas employment growth associated with drilling is typically short-term.[59] While it is unlikely that direct drilling activity will have long-term consequences, "the regional industrialization associated with widespread drilling could do substantial damage…threatening the long-term growth of tourism."[60]

3.2 Economic Impacts

In addition to considering community impacts, a number of analyses have sought to estimate the traditional economic impacts (employment and output) and fiscal impacts (state and local tax revenues) of shale drilling in other states. Figure 6 summarizes the key findings from these impact analyses.

[55] Ana Campoy, "Drilling Strains Rural Roads," *The Wall Street Journal*, July 26, 2012, accessed February 28, 2014, http://online.wsj.com/news/articles/SB10000872396390444840104577551223860569402.
[56] Ibid.
[57] Andrew Rumbach, "Natural Gas Drilling in the Marcellus Shale: Potential Impacts on the Tourism Economy of the Southern Tier," Cornell University, 1, accessed February 12, 2014, http://www.greenchoices.cornell.edu/downloads/development/shale/Impacts_on_Tourism_Economy.pdf.
[58] Ibid, 6.
[59] Ibid, 9.
[60] Ibid, 19.

Figure 6: Summary of Economic and Fiscal Impacts for Other States

State	Jobs	Output	Tax Revenues
Marcellus Shale			
New York[61]	8,136–16,272	$764.9 million–$1.53 billion	$4.3 million–$8.6 million
West Virginia[62]	7,600	$2.4 billion	$14.5 million
Pennsylvania[63]	29,000–48,000	$2.3 billion–$3.8 billion	$240 million–$400 million
Other Shale Plays			
Louisiana[64]	25,000	-	$150 million
Texas[65]	119,216	$13.7 billion	$1.6 billion
Ohio[66]	65,680	$9.6 billion	$433.5 million

Sources: see footnotes

In most cases, these studies estimated impacts based on assumed drilling scenarios. It is important to note that some claims and assumptions made in these and similar analyses have created significant debate. However, these estimates provide general background on the range of economic and fiscal outcomes that have been reported that could result from drilling.

New York

The Marcellus Shale in New York makes up 10 to 20 percent of the total Marcellus Shale Formation—most of the formation in New York is found beneath the Southern Tier of the state. In recent years, every county in southern New York has undergone exploratory drilling.[67]

[61] Bernard L. Weinstein and Terry L. Clower, "Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York," July 2009, 10, accessed February 12, 2014, http://www.gobroomecounty.com/files/countyexec/Marcellus-Broome%20County-Preliminary%20Report%20for%20distribution%207-27-09.pdf.

[62] Amy Higginbotham et al., "The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009," West Virginia University (December 2010): 24, accessed February 12, 2014, http://www.be.wvu.edu/bber/pdfs/BBEr-2010-22.pdf.

[63] Timothy J. Considine, Robert Watson, and Seth Blumsack, "The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update," Pennsylvania State University (May 24, 2010), accessed February 12, 2014, http://marcelluscoalition.org/wp-content/uploads/2010/05/PA-Marcellus-Updated-Economic-Impacts-5.24.10.3.pdf.

[64] Manfred Dix and Greg Albrecht, "An Economic Impact Analysis of the Haynesville Shale Natural Gas Exploration, Drilling and Production: Some Preliminary Results," August 28, 2008, accessed February 12, 2014, http://dnr.louisiana.gov/assets/docs/mineral/haynesvilleshale/manfred-dix-impact-analysis.pdf.

[65] The Perryman Group, "A Decade of Drilling: The Impact of the Barnett Shale on Business Activity in the Surrounding Region and Texas," August 2011, 18, accessed February 12, 2014, http://barnettprogress.com/media/BarnettShaleStudy11.pdf.

[66] Thomas et al., "An Analysis of the Economic Potential for Shale Formations in Ohio," Ohio Shale Coalition (2012): 2, accessed February 13, 2014, http://urban.csuohio.edu/publications/center/center_for_economic_development/Ec_Impact_Ohio_Utica_Shale_2012.pdf.
Ohio Shale Coalition, 2012, 2.

[67] Weinstein and Clower, "Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York," 1.

However, a 2013 moratorium on any additional exploration was extended until May 2015.[68] A 2009 impact analysis of natural gas production on Broome County, New York, estimated an employment impact ranging from 8,136 to 16,272 jobs, an output impact ranging from $764.9 million to $1.53 billion, and a tax revenue impact ranging from $4.3 million to $8.6 million, depending on production levels.[69]

A 2011 report analyzed the potential economic and tourism impacts of shale development in the New York Southern Tier Central Region. As visitor spending in the Southern Tier surpassed $239 million, and the tourism industry accounted for 4,691 jobs, $113.5 million in income, and nearly $31 million in state and local tax revenues in 2008, the potential negative impacts to the industry resulting from shale development are of significant concern.[70]

West Virginia

In the past decade, activity in West Virginia's Marcellus Shale play has become integral to the state's natural gas industry. In 2009 alone, more than 500 permits for shale development were issued. That same year, the entire industry—not just activity directly associated with the Marcellus Shale play—"employed 9,869 individuals and paid over $551.9 million in wages" and "paid approximately $88.4 million in property taxes to the state."[71] Analysis of the Marcellus Shale play in particular projected impacts of 7,600 jobs, $2.4 billion in output, and $14.5 million in tax revenues.[72]

Drilling operations in the shale play raised new policy questions. Some key policy questions cover tax, legal, and environmental issues such as the following:

- The utilization of roads,
- The relationship between property ownership and mineral ownership, and
- The size of the local labor pool.[73]

Pennsylvania

An analysis conducted by Pennsylvania State University in 2010 estimated the Marcellus gas industry's economic impact in 2008 and projected its impact for 2009 and beyond. The study cited economic impacts for 2008 and 2009 at 29,000 and 48,000 jobs and $2.3 billion to $3.8 billion in economic activity, respectively. Fiscal impacts were estimated at $240.0 million and

[68] "New York State Assembly votes to block fracking until 2015," *Reuters,* March 6, 2013, accessed March 5, 2014, http://www.reuters.com/article/2013/03/06/energy-fracking-newyork-idUSL1N0BYFK320130306.
[69] Weinstein and Clower, "Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York," 10.
[70] Rumbach, "Natural Gas Drilling in the Marcellus Shale," 6–8.
[71] Higginbotham et al., "The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009," 1.
[72] Ibid, 24.
[73] Ibid, 1.

$400.0 million for 2008 and 2009, respectively. The study also projected impacts to 2020—175,000 jobs, $13.0 billion in economic activity, and $12.0 billion in tax revenues.[74]

Penn State's analysis showed a positive trajectory for the gas industry's impacts, with the assumption that the industry was just emerging as of 2010. According to the report, the majority of these positive impacts can primarily be attributed to the indirect impact of the gas industry requiring inputs from other sectors of the economy and the induced impact of "lease and royalty payments to land owners, who also spend and pay taxes on this income."[75]

Although the Penn State report shows significant positive economic impacts, there is much debate regarding the best methods for estimating the economic impacts of shale drilling. A 2010 Bucknell University report that assessed Penn State's analysis (as well as an earlier analysis from the same Penn State research team) discussed a number of weaknesses in the assumptions, specifically those relating to household spending patterns. The report suggests that the following additions would strengthen the Penn State analyses:

> (1) including better assumptions of when and where households spend windfall gains, (2) clarifying the process used to determine where suppliers to the industry and royalty earnings households are located (in Pennsylvania or not), and (3) developing a more appropriate econometric model to estimate well drilling as a function of current price and other relevant variables.[76]

Much of the analysis focusing on the economic impacts of shale drilling in northeast states cites the example of Pennsylvania. An analysis of New York drilling based on the model of Pennsylvania found that there could be a link between the presence of gas wells and better economic performance. The results suggest that gas wells correlated with higher per-capita income and job growth rates. According to the report, "These results could equally well be applied to counties in New York and other states, from California to West Virginia, that have the potential to drill for oil and natural gas."[77] For New York, the potential impact for total income could reach as high as $8 billion.[78]

[74] The estimated tax revenues reflect the net present value over a ten-year period.
[75] Considine, Watson, and Blumsack, "The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update," iv.
[76] Thomas C. Kinnaman, "The Economic Impact of Shale Gas Extraction: A Review of Existing Studies," Bucknell University (January 1, 2010): 18, accessed February 12, 2014, http://digitalcommons.bucknell.edu/cgi/viewcontent.cgi?article=1004&context=fac_pubs.
[77] Diana Furchtgott-Roth and Andrew Gray, "The Economic Effects of Hydrofracturing on Local Economies: A Comparison of New York and Pennsylvania," *Growth and Prosperity Report* 1 (May 2013): 9, accessed February 12, 2014, http://www.manhattan-institute.org/pdf/gpr_1.pdf.
[78] Ibid.

Louisiana

The Haynesville shale play is located beneath northern Louisiana. As a result of relatively recent technological advancements, the shale play has begun to be explored and drilled as of the mid-2000s.[79] Much information regarding the Haynesville shale is currently unknown—however, the shale play is expected to provide significant positive impacts.[80]

A 2008 report led by the Louisiana Department of Natural Resources estimated the employment impact at 40,000 jobs over the first five years and 25,000 jobs annually thereafter.[81] Estimated impacts also include approximately $150 million in annual state tax revenues and between $2.0 billion and $3.0 billion in gross regional product from 2007 and 2023, according to the report. It should be noted, however, that the authors of the report stated that "so little is actually known of the Haynesville Shale" that they "had to make many…assumptions."[82] As a result, these impacts should be considered preliminary in nature.

Texas

The Barnett Shale in north central Texas is currently the largest producer of natural gas in the continental U.S. Since drilling began, it is estimated that natural gas production has exceeded 9 trillion cubic feet.[83] Researchers found that these activities resulted in increased population, employment, income and local tax revenues.

A 2011 report investigated the benefits of investment in and production of Barnett Shale to north central Texas. The cumulative economic benefits from 2001 to 2011 "stemming from activity associated with the Barnett Shale include $65.4 billion in output (gross product) and 596,648 person-years of employment in the region, with even larger gains for the state as a whole ($80.7 billion in output and 710,319 person-years of employment)" and $5.8 billion in state and local tax revenues.[84] The Perryman Group estimated that shale activity in 2011 alone generated $13.7 billion in annual output and more than 100,000 jobs for Texas, as well as $1.6 billion in state and local tax revenues.[85]

In addition to serving as a significant fuel source for the nation, Barnett Shale activity is a substantial source of economic stimulus for Texas. The effect due to Barnett Shale activity surpasses that of aircraft manufacturing, air transportation, and motor vehicles in the state.[86] The report notes that, while "the production and development at the Barnett Shale will

[79] Dix and Albrecht, "An Economic Impact Analysis of the Haynesville Shale Natural Gas Exploration, Drilling and Production," 2.
[80] Ibid.
[81] Ibid, 8.
[82] Ibid, 4.
[83] The Perryman Group, "A Decade of Drilling," 3.
[84] Ibid, 30, 5.
[85] Ibid, 18.
[86] Ibid, 25–26.

continue to fluctuate over time….the Barnett Shale is expected to continue to generate economic stimulus for local area and state economies for decades to come."[87]

Ohio

In 2012 the Ohio Department of Natural Resources reported that nearly 90 wells were currently producing close to 636,000 barrels and more than 12.8 billion cubic feet of natural gas from the Utica Shale formation.[88] To determine the resulting impacts of development of the Utica Shale, a study team conducted an economic development impact analysis for 2011 through 2014.

By 2014 investment in shale development is expected to generate more than $9.6 billion in output and more than $433.5 million in state and local tax revenues while supporting approximately 65,700 jobs and nearly $3.3 billion in labor income.[89] The study team concluded that, in addition to positive economic impacts (increased employment, output, labor income, and tax revenues), Ohio will also likely see "increased land and property values throughout the region."[90]

According to the research team, new drilling technologies have placed Ohio in a position to extract both oil and gas from Utica Shale plays. Utica Shale, unlike Marcellus Shale, produces both liquids and natural gas—the liquids "are valuable and can be separated from the "dry" gas (methane) through processing and fractionation procedures."[91] However, to implement horizontal drilling and hydraulic fracturing in Ohio, considerable investments will be required, including the following:

- Acquisition of mineral rights,
- Road and bridge upgrades,
- Drilling and completing wells, and
- Post-production development.[92]

4.0 Impacts of Special Interest to Residents of Western Maryland

During the week of Monday, June 25, 2013, staff from both RESI and MDE conducted stakeholder interviews for the purposes of (1) obtaining sources of economic data and information and (2) identifying local concerns and perceptions of the anticipated impacts of potential Marcellus Shale drilling in Western Maryland.

Local stakeholder input was necessary to gauge expected impacts on not only their businesses but also their families and friends who are residents of Western Maryland. Common areas of concern brought up during interviews included the following:

[87] The Perryman Group, "A Decade of Drilling," 30.
[88] "Oil & Gas Well Production," ODNR Division of Oil & Gas Resources, accessed February 13, 2014, http://oilandgas.ohiodnr.gov/production.
[89] Thomas et al., "An Analysis of the Economic Potential for Shale Formations in Ohio," 2.
[90] Ibid, 3.
[91] Ibid, 2.
[92] Ibid, 1–2.

- Agriculture,
- Education and schools,
- Environmental protection,
- Housing availability and values,
- Infrastructure and investment,
- Economic and fiscal sustainability,
- Property rights, and
- Overarching perceptions of each should drilling occur.

RESI heard from stakeholders in support of and in opposition to drilling. However, the purpose of engaging these stakeholders was not to solicit support or opposition, but to gain insight regarding the anticipated areas of impact from those who are most familiar with Western Maryland. The insights that RESI gained from interviews acted as a guide for the research and analysis provided within this report. The following subsections summarize the perceptions of existing economic conditions in Allegany and Garrett Counties in addition to the anticipated positive and negative perceptions of potential Marcellus Shale drilling and its impacts.

Opinions and information provided in these sections are paraphrased from interviewees. Factual accuracy was not verified. While many issues were discussed during stakeholder interviews, the scope of this study does not cover each issue extensively. A full summary of RESI's notes and a list of attendees from stakeholder interviews were published on MDE's website in September 2013 and are available for public viewing.[93]

4.1 Community Impacts

Allegany County stakeholders who were interviewed appeared more supportive of drilling compared to Garrett County interviewees. Allegany County anticipates lesser impacts compared to its western neighbor, considering that the Marcellus Shale formation underlies nearly all of Garrett County and only a small western section of Allegany County. Within Garrett County, there may disproportionate impacts between the Deep Creek Lake area and the rest of the county. Fortunately, Maryland benefits from being able to observe the impacts of drilling on other states, and the moratorium allows officials to consider potential impacts of drilling activity when updating economic development plans.

Agriculture

Stakeholders indicated support from the farming community for responsible natural gas development. Agribusiness and natural gas development currently coexist in Accident, Maryland (in Garrett County), where gas pipelines, storage wells, and a large compressor

[93] Maryland Department of the Environment, "Stakeholder Meetings—Summary Notes," in *Impact Study of Marcellus Shale Safe Drilling Initiative—Stakeholder Interview Notes* (September 3, 2013), http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/economicStudy_Stakeholder_Interview_Summary_Notes_9_3_2013.pdf.

station are located. Farmers' positive perceptions of drilling in western Maryland are credited to farmers currently farming around storage wells without significant health or environmental impacts. Stakeholders identified the largest perceived impact to be the stigma of the industry and occasional small leaks. Stigma and negative perceptions, in comparison to environmental and economic impacts of an area, can be difficult to eliminate through policy changes, and interviewees acknowledged that larger wells with greater impacts are anticipated should horizontal drilling occur.

One stakeholder noted that farmers have begun to take jobs out of state to work on shale development in states where it is currently permitted. Extraction industries provide new and higher paying job opportunities for workers of industries requiring similar skill sets. For example, a worker experienced in operating heavy machinery and performing physical labor, such as a farmer, could perform many of the job duties required in extractive industries. Additional training to perform industry-specific tasks is completed within months, and programs are provided throughout Pennsylvania. The closest training program is available in Somerset County, Pennsylvania, though plans are said to be in place to provide training in Garret County to prepare the local workforce for jobs in the natural gas industry.

Migration of labor from farms to out-of-state well pads can reduce the time spent maintaining farms. Allowing Marcellus Shale drilling in Maryland could allow these farmers to spend more time on the farm and with their families, while also earning supplemental income working in the natural gas industry or through leasing of mineral rights. Furthermore, stakeholders believe one of two scenarios could occur if drilling is permitted on agricultural land:

1. Lease and royalty payments from shale development would sustain farmers who are otherwise losing money, allowing farmers to sustain their farms after the inevitable "bust" phase of drilling, or
2. Farmers will use the lease and royalty payments to retire from farming, creating a near extinction of agribusiness in Western Maryland, and therefore less economic diversity.

Schools

Drilling is expected to bring a significant number of jobs into Maryland. As a result, there is the potential for overcrowding of schools if new workers bring young families with them. This possibility is a particular concern for Garrett County, where an education funding deficit in the millions and a decline in the population of school-aged children have led to school closures. A study from the University of Maryland reported the following data for K-12 schools in Western Maryland as of August 2012:

- Allegany County Public Schools comprised 22 schools, with renovations for two middle schools and new construction of a high school facility, and Garrett County Public Schools comprised 14 schools, with two middle school closures expected.[94]

[94] National Center for Smart Growth Research and Education–University of Maryland, "Sustainable Transformation of the Appalachian Region Data Brief: Transportation and Infrastructure," Sustainable Transformation of the

- Garrett County Public Schools ultimately made the decision to close three schools in 2012.[95]

Meanwhile, Maryland's education formula has determined a decreased need for funding Garrett County's school system; Garrett County is the fifth wealthiest in Maryland.[96] Maryland's education formula, known as the Thornton Plan, is part of the Bridge to Excellence in the *Public Schools Act of 2002*. The formula was built to ensure that poorer counties "receive a larger per-pupil share of state funding than wealthier counties" and considers each county's total enrollment, number of children living in poverty, children with limited English proficiency, and use of other aid programs as factors for the formula.[97] The Thornton Plan is now twelve years old, and is hoped to be adjusted to better represent the current conditions of public school systems in Maryland.

If the population of young families suddenly increases, the remaining facilities may not have the capacity for more students. Stress on teachers and administrators could present both health risks and a potential decline in the quality of education in the area. In addition, increased truck traffic is expected, and raises concerns regarding increases in traffic along school bus routes. Both counties would need to consider either regulating traffic so that trucks and school buses are on the road during separate hours or assuring that trucks and buses use separate routes.

Stakeholders stressed that, in existing conditions, Garrett County graduates a number of bright students from high schools and nearby colleges but does not currently provide the requisite balance of job opportunities for its graduates. Graduates either struggle to find gainful employment within Western Maryland or leave the region. Graduates may leave to work in the natural gas industry in other states. A potential positive impact of allowing drilling in Western Maryland would be an increase in job opportunities for residents.

Environmental Amenities

Perceptions of the quality of environmental amenities of western Maryland are already impacting existing residents as well as deterring potential residents looking to retire in the scenic Appalachian region. Proprietors of ecotourism and recreation businesses note that chemical leaks, spills, and other contamination near the Deep Creek Lake area are reported in the news—for example, a sewage spill from a nearby pump station—leading to cancellations of reservations and loss of business.

Appalachian Region, Appalachian Regional Commission (2012): 5, accessed July 11, 2013, http://smartgrowth.umd.edu/assets/documents/star/star_population_brief.pdf.

[95] Janet Wilson, "Dr. Wilson's Facility Presentation," presentation, October 28, 2013, accessed February 28, 2014, http://www.garrettcountyschools.org/resources/public-information/pdf/Garrett-County-Schools---Dr.-Wilsons-Facility-Presentation-10-28-13.pdf.

[96] "School Funding," Maryland State Education Association, accessed March 13, 2014, http://www.marylandeducators.org/hot-issues/school-funding.

[97] Ibid.

The Savage River and Youghiogheny River Watersheds are two major watersheds that flow into the Potomac and Mississippi rivers, respectively. The Youghiogheny Watershed occupies roughly two-thirds of Garrett County, including land susceptible to drilling activity. Even with best practices regarding water quality in place, Garrett County is already stretching its water resources thin, making overall use and conservation a paramount issue. Some stakeholders feel that the preservation of pristine water resources may hold more value than the consumption of natural gas. Furthermore, the State does not own mineral rights to all public land, which leads to concerns regarding drilling on public forest land; roughly 70 percent of the Savage River Watershed is covered by forested land, according to one stakeholder.

The scenic viewsheds and abundant wildlife are other draws for the area, with many stakeholders agreeing that the natural and rural appeal of the region attracts both visitors and residents. Wind farms are another point of contention for stakeholders regarding energy development in the area. Wind turbines have already interrupted mountain views, fragmented forests, and disrupted habitats. The fear is that drilling, if implemented with the same lack of research and planning, would further destroy the environmental and rural amenities that bring so many to Allegany and Garrett Counties.

Housing

Stakeholders have heard reports describing unmanageably large populations of young, male workers moving into areas with intense drilling activity. These workers are well-paid and tend to take up residence in hotels, rental homes and apartments, or mobile homes and camps. Depending on the rate of development, the influx of workers can drive up rental rates.

In rural areas where average household income is already low, the increase in rental rates threatens to displace permanent residents and increase rates of homelessness. Allegany and Garrett Counties seem able to handle increased housing demand, with stakeholders stating that the current housing market has an excess of supply in some areas, with new developments being built. One stakeholder expressed concern that Maryland's new septic laws may slow the pace of development as landowners and local government work to meet stricter requirements and best practices.

Traffic and Roads

In addition to environmental impacts, the presence of compressor stations and truck traffic increases noise and road usage—the opposite of what tourists seek when visiting western Maryland. In addition to presenting an issue for tourism, noise and traffic also impact the quality of local health, safety, and infrastructure. Management of inspections and enforcing compliance of drilling activity can be costly for local government. Health, safety, and public works departments in Maryland are concerned about their capacity for handling increased demand for various services such as water quality testing, infrastructure maintenance, and emergency response. Garrett County's Health Department has experienced large budget cuts, which adds to the stress experienced by environmental and public health officials. This report

will not cover environmental and health issues in detail, as those topics will be covered by other studies being conducted in Maryland.

If roads are not properly bonded, heavy truck traffic from any existing or future construction and industrial activity is expensive to repair. If roads are properly bonded, increased usage does not pose a significant problem. Truck traffic is already evident in Oakland, Maryland, where trucks travel through to West Virginia. Alternatively, some stakeholders view the increased truck traffic as sign of growing job opportunities in the area.

Companies drilling near the Maryland border and using Maryland roads have voluntarily entered into bonding agreements with Garrett County, but such agreements are not currently required. The perception is that most companies have willingly entered into such agreements. Setback requirements from protected land and watersheds can protect some roads from damage, but stakeholders wonder if certain routes, especially unpaved, private roads, can be protected from shale-related traffic. Enforcement can be difficult not only between government and drilling companies but also between companies and their subcontractors.

Tourism and Recreation

Tourism and related businesses in Western Maryland struggle to make money during "shoulder seasons," or times between low and peak tourism, so Garrett County is seeking ways to attract more permanent residents. A permanent resident population of approximately 30,000 cannot support retail year-round without the additional patronage of tourists and non-permanent residents during peak travel seasons. Stakeholders would like to know how drilling will impact tourism in per dollar terms, with the expectation that potential environmental damage could render Deep Creek Lake unsuitable for its primary uses: tourism and recreation.

The quality of the experience of recreational activities on other lakes and rivers could also be compromised. Media coverage of the sewage spill from a pump station near Deep Creek Lake not only deterred tourism but also may have deterred potential residents wanting to live in Western Maryland in its current condition. Tourism and other industries can suffer from bad press from events like the spill, but general economic downturn plays a role as well. Stakeholders who own businesses in western Maryland reported an estimated 30 to 40 percent loss of revenue in recent years; revenues were down by an estimated 60 percent for construction and related businesses. The amount of losses attributable to local versus national economic issues is difficult to distinguish.

The loss of revenue for tourism and construction businesses has been compounded by difficulty in retaining workers. Similar to workers in the agricultural industry, workers in tourism and construction possess the applicable skills and knowledge to easily migrate to higher paying jobs in the natural gas industry. Such jobs are currently concentrated outside Maryland, but the distance is not great enough to prevent withdrawal of workers from Maryland. It is possible

that Maryland workers commuting to well sites out of state would otherwise be unemployed or earning significantly lower wages.

4.2 Economic and Fiscal Impacts

Marcellus Shale drilling brings hope to rural areas in need of economic opportunity, especially following the recent recession. Stakeholders speculated on the short-term and long-term impacts to the economy based on expected jobs, wages, and market behavior generated by the addition of drilling activity. Discussion also revolved around the potential revenues from impact fees and changes to revenue generation from property taxes dependent on Marcellus Shale drilling's impacts on property values in the region.

Economic Impacts

A common overarching concern for both counties was long-term economic development and sustainability. As described in Section 2.2, both counties have a history of extractive industry development, as well as recent development of wind turbines and hydroelectric power. The two counties are seeking ways to strengthen and diversify their economies; however, neither counties' stakeholders identified shale development as a silver bullet, and they hope for more extensive planning to be completed compared to the rapid development of wind energy.

Ultimately, stakeholders are concerned that development of natural gas in western Maryland will mirror the "boom and bust" cycle observed in other extractive industries, and thereby edge out other sources of growth that provide a more sustainable economic future. Others questioned if the natural gas reserves in western Maryland are abundant enough to attract a damaging rate of development or if market behavior will be enough to keep a manageable pace. Stakeholders seemed split on whether shale development has been managed properly in other states.

Fiscal Impacts

Stakeholders conceded that most leases have expired in Maryland, and property owners had been leasing mineral rights for as low as 5 dollars per acre. Stakeholders hoped that property owners will use time during the moratorium to become more educated on property rights and get a fair price for leasing mineral rights. A fair price is believed to be valued in thousands of dollars per acre. Stakeholders pointed to a decline in participation in State agricultural and conservation easements as a sign of eagerness to enter into gas leases. If property owners continued participating in such easements, they would be prohibited from allowing industrial activity, including drilling for natural gas, on the eased properties.

Should property owners continue to lease mineral rights for cheap prices, concern arose that the costs of damage to property values and environmental amenities will far outweigh the payout of leases. Allegany and Garrett Counties impose severance taxes of 7.0 percent and 5.5 percent, respectively. The revenues from severance taxes are meant to feed into the general fund and municipalities. Currently, Garrett County's budget is heavily dependent on property

taxes generated by properties in the Deep Creek Lake area, an area with over 80 percent of non-residents whose expenditures are not captured within the county year round. Relating to concerns about economic sustainability, some see the potential for growing severance tax revenues as a method of decreasing dependence on property taxes, if not to offset potential losses in property tax revenue should property values fall.

Retaining the resort community appeal around the lake is important when considering impacts on the local housing market. Home values are down due to the recent housing crisis, and drilling has the potential to further reduce home values. After the "bust," stakeholders are concerned that values may remain low. The lack of zoning in areas outside of the Deep Creek Lake area is also suspected to have impacted property values in Garrett County, and a lack of regulation on land use could be increasingly detrimental with the presence of increased industrial activity.

With over half of Garrett County's budget generated by lake area property taxes, and a majority of sales tax revenues generated by tourism, stakeholders are concerned that natural gas drilling in Maryland could be a zero-sum game. If properties around Deep Creek Lake are devalued by the presence of natural gas drilling, the core of the County's property taxes could deteriorate. In addition, stakeholders noted bonds for reclamation of land are too small and do not encourage commitment to reclaiming land after abandoning a well.

5.0 Assumptions and Scenarios

To estimate the impacts associated with potential Shale drilling in Western Maryland, RESI first developed a series of assumptions. These assumptions shaped the two scenarios used for analysis. The number of wells, well pads, royalty/lease payments, production decline, and total EUR of a well are some of the assumptions that are outlined in this section. From these assumptions, RESI created two scenarios:

- **Scenario 1**, where 25 percent of the total shale gas would be extracted, and
- **Scenario 2**, where 75 percent of the total shale gas would be extracted.

RESI chose the 25 and 75 percent estimates as these projections are conservative, feasible extraction rates. Although some researchers have cited 30 percent as a minimum rate of total extraction, RESI's lower bound of 25 percent captured the estimated 30 percent with feasible profitability for existing producers. RESI considered these scenarios throughout the analysis to determine the potential impacts of Marcellus Shale drilling in Western Maryland. RESI used these scenarios as guidelines to establish assumptions regarding Marcellus Shale drilling, as discussed in Section 5.1.

5.1 Assumptions

To determine the potential impacts associated with Marcellus Shale drilling in Western Maryland, RESI assumed some aspects of natural gas drilling. These assumptions reference the following:

- Total natural gas reserves in Maryland,
- Number of wells and well pads for extraction,
- Production curve of a well, and
- Potential industry sales.

Several studies regarding natural gas drilling impacts using direct and indirect methodologies have been done in the past. However, since there is no recent natural gas drilling to date in Maryland, RESI made some assumptions to build the model for analysis. To capture the overarching economic and fiscal impacts associated with shale drilling in Western Maryland, RESI considered both industry and indirectly associated data, such as conservation funding and housing prices. Using Scenarios 1 and 2, 25 percent and 75 percent rates of extraction, respectively, RESI built a set of assumptions to define the model development.

5.1.1 Total Natural Gas Reserves in Maryland

According to a 2011 report by the USGS, the Interior AU of the Marcellus formation holds approximately 96 percent of the total undiscovered resources, or 41,607 bcf.[98] The USGS estimates that Maryland holds approximately 1.69 percent of the Interior AU of the Marcellus region. The Interior AU mainly comprises RESI's study area of Allegany and Garrett Counties. Marcellus Shale units are measured in thickness, or size, where the Interior represents shale deposits equal or greater to 50 feet.[99] RESI applied this percentage against the 41,607 bcf total and estimated that the total potential undiscovered resources of shale gas in Maryland are approximately 703 bcf.

Under the low scenario of extraction, or Scenario 1, RESI assumed that producers will extract 25 percent of the total potential recoverable shale gas, or approximately 175 bcf.[100] Alternatively, under the high scenario of extraction, or Scenario 2, RESI assumed producers will extract 75 percent of the total reserves, or approximately 527 billion cubic feet.[101] Using these total

[98] Coleman et al., "Assessment of Undiscovered Oil and Gas Resources of the Devonian Marcellus Shale of the Appalachian Basin," 2.
[99] U.S. Geological Survey Oil and Gas Assessment Team, "Variability of Distributions of Well-Scale Estimated Ultimate Recovery for Continuous (Unconventional) Oil and Gas Resources in the United States," 2012, accessed September 18, 2013, http://pubs.usgs.gov/of/2012/1118/OF12-1118.pdf.
[100] According to EIA, Maryland has approximately 1.09 percent of the areal extent of the Marcellus formation. Considering the three Assessments Units (Interior, Foldbelt, and Western Margin) separately, USGS estimates that Maryland has approximately 1.69 percent of the Interior AU, which contains 96 percent of the total undiscovered resource, 2.28 percent of the Foldbelt AU, and none of the Western Margin AU. The number chosen for the scenarios represents the Interior AU only (703 bcf). The number in the December 2011 report of MDE and DNR used the Interior and the Foldbelt AUs (711 bcf). Based on discussion with Brigid Kenney on October 18, 2013.
[101] Ibid.

potential estimates, RESI estimated the number of wells needed to generate the total estimated extraction.

5.1.2 Wells and Well Pads

To determine the number of wells needed under each scenario, RESI projected the total EUR of a well over its lifetime. A 2012 USGS report on well production estimated that an Interior AU Marcellus well could produce 1.158 bcf over its lifetime.[102] Dividing the total potential recovery under Scenario 1 by 1.158 bcf, RESI estimated that producers will need approximately 150 wells for extraction. Under Scenario 2, RESI estimated that producers will need approximately 450 wells for extraction.

Contrary to their historical preference for vertical wells in Allegany and Garrett Counties, natural gas producers are beginning to shift toward horizontal drills in the Marcellus Shale region. Since the industry continues to move away from vertical wells, RESI assumed throughout the report that the new wells in the region will all be horizontal wells. No Marcellus Shale wells have been permitted or drilled in Maryland to date; therefore, no data exist for currently active horizontal well pads in Maryland.

To create a potential industry estimate for wells per pad, RESI used historical data from Pennsylvania's drilling activities. Pennsylvania's Department of Environmental Protection Oil & Gas Division is responsible for collecting and publicly distributing reports regarding well activity within the state. Data regarding production reports and active permits are made available through its website. According to the website, for 2012 six-month unconventional wells production reports, more than half of producers are shifting toward a six well per pad setup.[103]

At a total of six wells per pad, RESI assumed the total number of well pads needed under Scenario 1, with a 25 percent extraction rate, and Scenario 2, with a 75 percent extraction rate. A summary of the number of total wells needed and pads to accommodate the wells is reported in Figure 7. Well pads are multi-well pads, and it is feasible that more than one pad can be located on a single property.

Figure 7: Summary of Wells and Needed Well Pads by Scenario

Scenario	Total Wells Needed	Total Well Pads Needed
Scenario 1 (25% extracted)	150	25
Scenario 2 (75% extracted)	450	75

Source: RESI

[102] U.S. Geological Survey Oil and Gas Assessment Team, "Variability of Distributions of Well-Scale Estimated Ultimate Recovery for Continuous (Unconventional) Oil and Gas Resources in the United States."

[103] In some cases, producers are filing for well permits to total more than 10 active wells on active well pads. RESI dropped well pads holding more than 15 wells per pad in their average estimate since these pads accounted for a small portion of the total active producing well pads in Pennsylvania.

Using the number of wells and well pads needed for extraction in Figure 7, RESI estimated the build outs for wells and pads for both scenarios from 2017 through 2026. These estimates can be found in Figures 8 and 9 for Scenarios 1 and 2, respectively.

Figure 8: Well Pad Build Out for Western Maryland—Scenario 1, 25 % Extraction

Year	Number of New Wells	Number of New Well Pads	Total Number of Wells	Total Number of Well Pads
2017	8	4	8	4
2018	16	4	24	8
2019	29	3	53	11
2020	22	3	75	14
2021	18	3	93	17
2022	15	2	108	19
2023	12	2	120	21
2024	12	2	132	23
2025	12	2	144	25
2026	6	0	150	25

Source: RESI

Over the course of the ten-year period, RESI assumed that some wells will be drilled on pads as exploratory wells. Exploratory wells are wells drilled to determine (1) if a given area will be profitable and (2) whether the amount of gas that can be extracted is worth additional drilling. If an exploratory well is successful and produces, it is likely that producers will continue to drill more wells in that location.

Under both scenarios, RESI assumed that producers will be successful with each exploratory well and will complete the build out on a given pad within a few years after exploration. Figure 9 continues this assumption in estimating the number of wells added annually in Western Maryland if producers are able to extract 75 percent of the total undiscovered resources.

Figure 9: Well Pad Build Out for Western Maryland—Scenario 2, 75 % Extraction

Year	Number of New Wells	Number of New Well Pads	Total Number of Wells	Total Number of Well Pads
2017	36	12	36	12
2018	72	12	108	24
2019	63	9	171	33
2020	54	9	225	42
2021	63	9	288	51
2022	42	6	330	57
2023	36	6	366	63
2024	36	6	402	69
2025	36	6	438	75
2026	12	0	450	75

Source: RESI

As reported in Figures 8 and 9, RESI assumed that there will be either 25 or 75 well pads with 150 or 450 wells in operation by 2026 depending on the potential achievable recovery rate.

The total well pads for each scenario, reported in Figures 8 and 9, were split through GIS mapping to determine the total per county. First, RESI created a grid of points covering Garrett County and the Marcellus Shale study area in Allegany County. In Garrett County, the points of the grid that intersected with the historical data of those landowners approached by producers were used to randomly select potential well locations. In Allegany County, since no existing comparable data exists, all of the potential location points were determined by randomly selecting well locations over the whole area. The random selection was weighted to include more points in Northern Garrett County, as this area was identified through past lease data and conversations with stakeholders as that which would most likely be targeted for Marcellus Shale drilling.

Through this random selection, RESI determined the total number of wells for each county under both Scenario 1 and Scenario 2. Well pad build outs for Allegany and Garrett Counties are reported in Figures 10 and 11, respectively.

Figure 10: Well Pad Build Out for Allegany County

Year	Scenario 1		Scenario 2	
	Total Cumulative Wells	Total Cumulative Well Pads	Total Cumulative Wells	Total Cumulative Well Pads
2017	2	1	6	2
2018	5	0	18	4
2019	8	2	27	5
2020	11	0	33	6
2021	14	3	40	7
2022	17	0	46	8
2023	18	0	52	9
2024	0	0	58	10
2025	0	0	60	0
2026	0	0	0	0

Source: RESI

Figure 11: Well Pad Build Out for Garrett County

Year	Scenario 1		Scenario 2	
	Total Cumulative Wells	Total Cumulative Well Pads	Total Cumulative Wells	Total Cumulative Well Pads
2017	6	3	30	10
2018	19	7	90	20
2019	45	9	144	28
2020	64	12	192	36
2021	79	14	248	44
2022	91	16	284	50
2023	102	18	314	55
2024	114	20	344	60
2025	126	22	378	65
2026	132	0	390	0

Source: RESI

5.1.3 Production Curve

Shale production from a well can vary over time. Here, "production" refers to the amount of shale gas extracted in a given period, whereas "recovery" refers to the overall amount. To determine the level of industry activity, RESI estimated the level of production per well annually over the ten-year period. Unlike vertical wells, horizontal wells do not produce continuously on an exponential decline.[104] Instead, horizontal wells produce high extraction amounts in the first

[104] Terry Engelder, "Marcellus Reserves and Estimates Substantiated by Production Data," research presented online through Penn State Extension Webinar on the Marcellus Shale, September 30, 2013, http://extension.psu.edu/natural-resources/natural-gas/webinars/marcellus-reserves-and-estimates-

few years, then drop off significantly in later years.[105] To determine the level of industry sales associated with Marcellus Shale production in Western Maryland, RESI estimated the annual extraction for a well.

As previously stated, RESI assumed that the overall EUR of a horizontal well is 1.158 bcf. Horizontal wells can continue to produce well beyond the twenty-year timeframe of this analysis, but most researchers find that a horizontal well produces the largest return in the first three years with more modest returns in subsequent years.[106] [107] However, returns vary by region, and therefore can lead to some differentiation between wells and locations.[108]

To determine the potential increase in the industry sales associated with Marcellus Shale drilling in the region, RESI created a potential decline curve given the following restrictions:

1. Wells will return 85 percent of their total EUR by the end of year three.
2. Total EUR of a well is assumed to be 1.158 bcf.
3. Production during the first three years will resemble a hyperbolic return.
4. Production after three years will resemble an exponential return with smaller incremental returns.

Hyperbolic returns exhibit very large early declines from initial production, followed by a period of smaller incremental drops. Exponential returns tend to exhibit a steadier annual decline.

substantiated-by-production-data/marcellus-reserves-and-estimates-substantiated-by-production-data-powerpoint-september-19-2013.

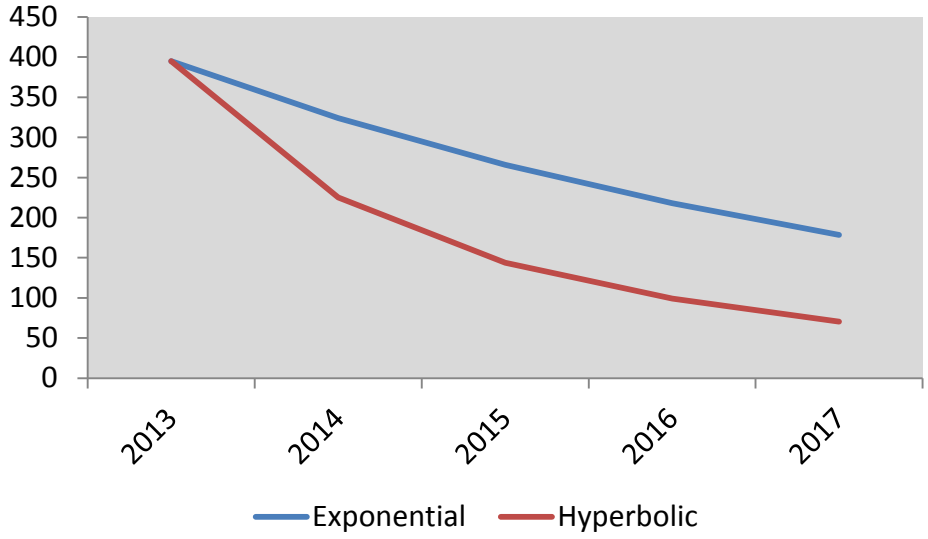
[105] Engelder, "Marcellus Reserves and Estimates Substantiated by Production Data."

[106] J. David Hughes, "Drill, Baby, Drill: Can Unconventional Fuels Usher in a New Era of Energy Abundance?," *Post Carbon Institute* (February 2013): 65, http://www.postcarbon.org/reports/DBD-report-FINAL.pdf.

[107] Engelder, "Marcellus Reserves and Estimates Substantiated by Production Data."

[108] Hughes, "Drill, Baby, Drill," 65.

Figure 12: Hyperbolic Returns versus Exponential Returns



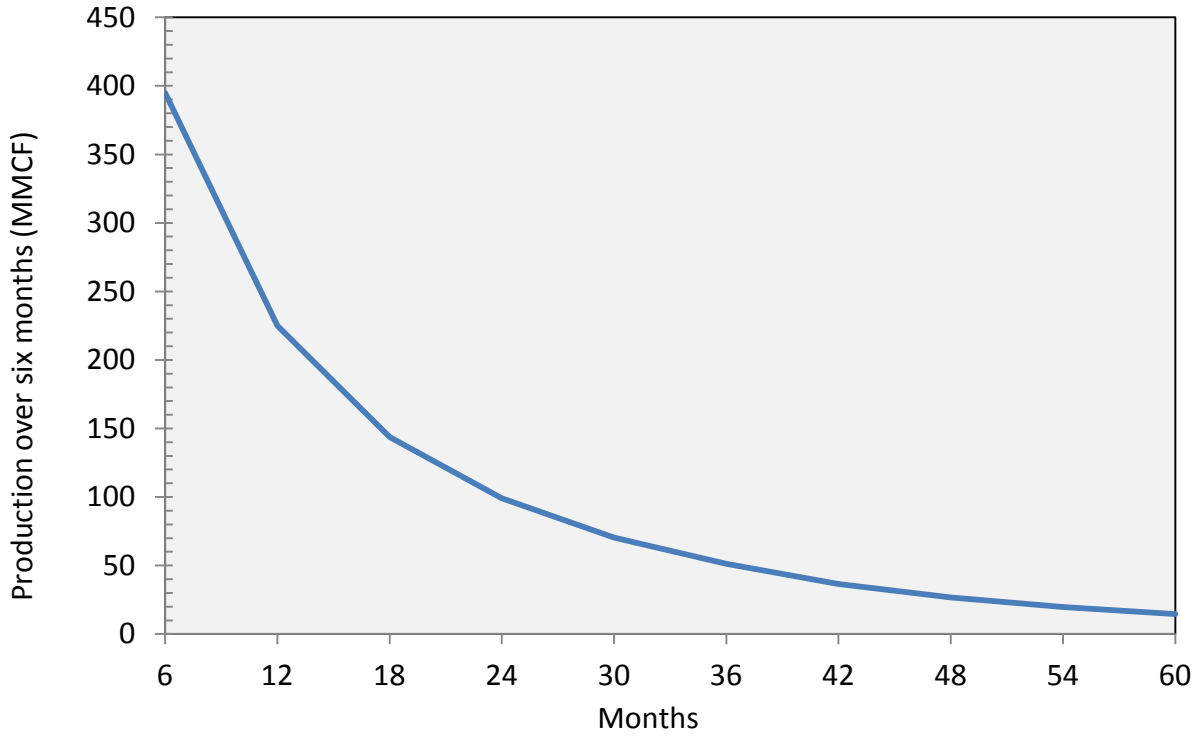
Source: RESI

Figure 12 provides an example of the difference between exponential and hyperbolic declines. In the example, the hyperbolic curve declines faster than the exponential curve from the well's initial production. Exponential curves decline at a smoother rate. In nature, the returns of a vertical well have often exhibited an exponential decline curve.[109] This exponential return indicates that vertical wells are fairly linear and consistent in regard to natural gas extraction over time. New horizontal wells, however, have larger returns earlier in their lifespans, with minimal returns and consistent decline later in their lifespans.[110]

To capture this large initial return followed by a period of consistent lower returns, RESI employed both exponential and hyperbolic return functions. Current Marcellus Shale wells in Pennsylvania have exhibited both properties at varying times. RESI used this information to create its own curve along the aforementioned parameters. The production curve used in this analysis is reported in Figure 13 for a potential Marcellus Shale well in Maryland.

[109] Hughes, "Drill, Baby, Drill," 65.
[110] Y. Shen, S. Wang, and S. He, "Improving Decline-curve Analysis of Low-permeability Gas Wells Using Type Curves," *Petroleum Science and Technology* 31 (2013): 1, http://dx.doi.org/10.2118/108176-PA.

Figure 13: Estimated Marcellus Well Production Curve for Maryland for the First Five Years



Source: RESI

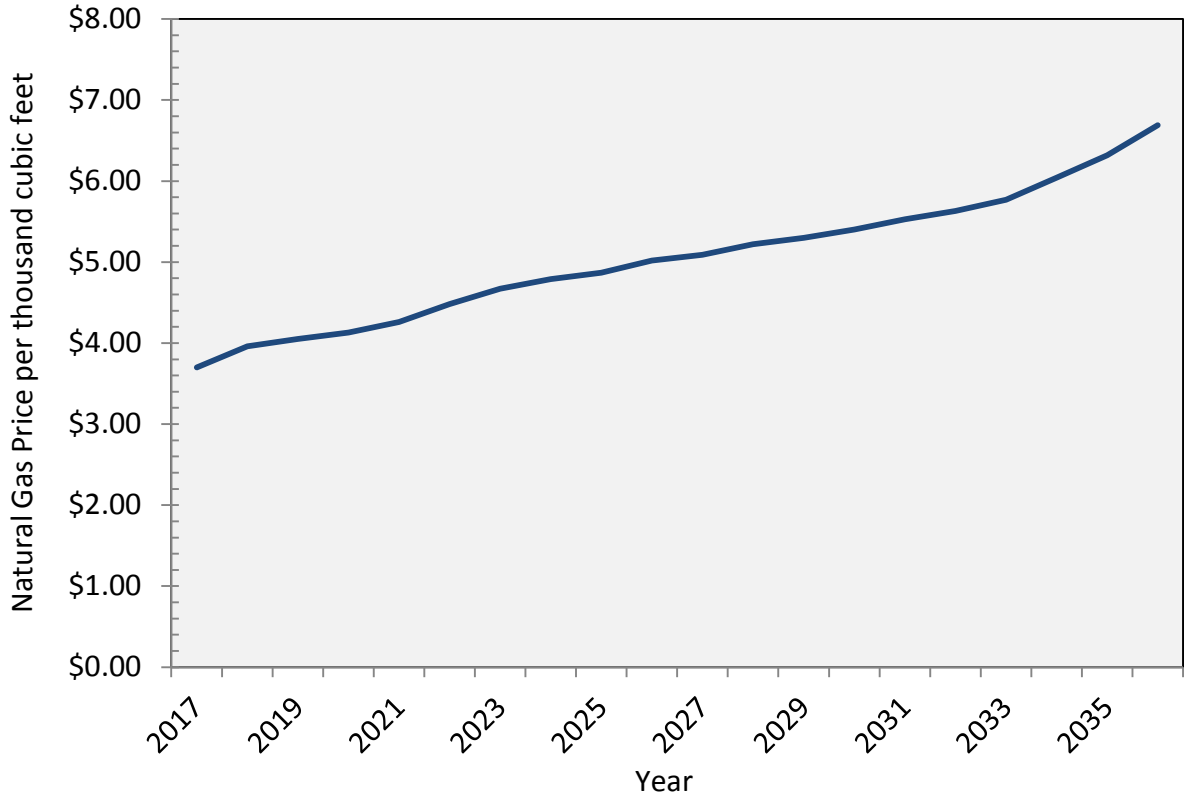
According to Figure 13, by the end of the third year, a Marcellus well in Maryland will have produced 0.9843 bcf, or approximately 85 percent of the well's total EUR. This estimate was used to formulate RESI's estimates for industry sales associated with natural gas production in Western Maryland for the REMI PI+ tool.

For more information regarding the calculation of the decline curve, please refer to Appendix C. Using the decline curve in Figure 13, RESI applied the estimated natural gas prices for 2017 through 2036 to the annual production levels to determine industry sales.

5.1.4 Industry Sales

Natural gas prices are forecasted annually by the EIA in its Annual Energy Outlook. To estimate the potential sales revenue generated by the increased level of activity within the region, RESI used the average reference case natural gas price for each year from 2017 to 2036 from the 2013 Annual Energy Outlook. The average reference case prices are reported in Figure 14.

Figure 14: Natural Gas Price Forecast[111]



Source: EIA AEO 2013

Taking the well build out for Scenario 1, at 25 percent extraction, as an example, RESI applied the ten-year production for each well against the AEO price to determine the increased industry sales for the region. RESI determined the increased level of annual industry sales using the following formula:

$$Total\ Industry\ Sales\ for\ Year\ X = (AEO\ price\ in\ year\ x * (number\ of\ new\ wells_{x} * 620{,}001\ mcf + AEO\ price\ in\ year\ x * number\ of\ new\ wells_{x-1} * 242{,}751\ mcf + AEO\ price\ in\ year\ x * number\ of\ new\ wells_{x-2} * 121{,}522\ mcf + AEO\ price\ in\ year\ x * number\ of\ new\ wells_{x-3} * 63{,}340\ mcf + AEO\ price\ in\ year\ x * number\ of\ new\ wells_{x-4} * 34{,}339\ mcf + AEO\ price\ in\ year\ x * number\ of\ new\ wells_{x-5} * 19{,}021\ mcf + AEO\ price\ in\ year\ x * number\ of\ new\ wells_{x-6} * 10{,}537\ mcf$$

[111] U.S. Energy Information Association, "Annual Energy Outlook 2013: with Projections to 2040," April 2013, accessed September 18, 2013, http://www.eia.gov/forecasts/aeo/pdf/0383%282013%29.pdf.

A detailed breakdown of industry sales by year can be found in Appendix C for each scenario. Using the results from this calculation, RESI introduced the sales data into REMI PI+ as an increase in industry sales for natural gas between 2017 and 2036.

5.2 Scenarios

To capture the full effect of the potential for drilling, RESI created high and low scenarios:

- **Scenario 1** estimated that 25 percent of Maryland's total recoverable amount would be extracted, and
- **Scenario 2** estimated that 75 percent of Maryland's total recoverable amount would be extracted.

To determine the additional impacts to employment, output, and wages associated with each scenario, RESI created a baseline forecast. The baseline forecast represents the status quo in Allegany and Garrett Counties. Detailed information on the baseline forecast for employment, output, and wages can be found in Appendix D.

Under the baseline forecast, RESI assumed that no drilling would occur in Allegany or Garrett Counties over the study period of 2017 through 2036. Using this baseline forecast, RESI then applied the change in the economic activity by adding Scenarios 1 and 2. Scenarios 1 and 2 increased the economic activity within the counties from 2017 through 2036. The results from this analysis can be found in Section 8.0 with more detailed impacts in Appendix D.

It is important to note that a scenario where 100 percent of reserves are extracted is unrealistic, if only because some owners of mineral rights will likely not lease those rights. Additionally, companies' lease holdings could be interspersed, therefore complicating the potential availability for producers.

The levels of extraction in states bordering Maryland, such as Pennsylvania and West Virginia, are likely not good indicators of the level of extraction in Maryland. Pennsylvania has leased gas rights in state forests, while Maryland's current position is not to lease those rights. Also, start-up in Maryland would be significantly different from start-up in Pennsylvania because the industry has evolved significantly since 2008 in regard to operations. The pace of drilling is affected by many factors, including the availability of pipelines, the price of gas, and the availability of drill rigs. Assuming 25 and 75 percent allowed RESI to capture both a conservative estimate and a more aggressive estimate over a ten-year period.

5.3 Comparison of Assumptions

Previous efforts have aimed to estimate various types of impacts resulting from drilling activity in the Marcellus Shale in Maryland. Analyses conducted by Samson Energy and Sage Policy Group vary in regard to their general scope as well as the assumptions made to estimate the impacts. Such assumptions included but were not limited to the total extractable gas in the

region and the total number of wells. The remainder of this subsection discusses the various assumptions made in these analyses as they compare to RESI's assumptions.

The Samson Energy calculations aimed to estimate the types of revenue and royalty payments that could be generated as a result of drilling activity in the Marcellus Shale in Allegany and Garrett Counties. These calculations assumed total extractable gas between 500 and 4,000 bcf for Allegany County and between 1,000 and 8,000 bcf for Garrett County, or a combined total of between 1,500 and 12,000 bcf of total extractable gas in the region.[112] Instead of using the estimated EUR per well to determine the number of wells, Samson Energy used total "drillable acreage" and acres per well within each county to estimate 637.5 wells for Allegany County and 1,600 wells for Garrett County.[113]

The objective of the Sage Policy Group analysis was "to help stakeholders understand the full potential of Marcellus Shale-related activity" by focusing on "the potential economic activity that could be generated by applying modern technologies to the Marcellus Shale formation in Western Maryland to produce natural gas."[114] The analysis used a low-case, a mid-case, and a high-case scenario. Sage outlined the following assumptions in its report: total extractable gas in the Maryland portion of Marcellus Shale of 1,286 bcf for the mid-case scenario; an EUR per well of 2.5 bcf for all three scenarios; and 199, 365, and 667 total wells for the low-case, mid-case, and high-case scenarios, respectively.[115]

The Samson and Sage reports generally assumed a higher total amount of extractable gas and a greater number of wells than RESI's analysis documented in this report. Sage's analysis also assumed higher extraction from each well. It is important to note that these analyses preceded USGS's 2012 revised estimates of technically recoverable Shale reserves. For more information regarding Samson Energy's and Sage Policy Group's assumptions and scenarios, please refer to the full resources.[116]

6.0 Community Impacts

Existing research on the impacts that shale drilling activity has on a community revolves around economic, environmental, housing, and infrastructure issues, some of which are discussed in Section 3.0 of this report. Ultimately, the depth of the impacts relies on the pace and scale of drilling activity. Pace is determined by the number of wells drilled in a year, and scale is the geographic area in which drilling is concentrated. The pace and scale of drilling can be

[112] Samson Energy, "Estimated Marcellus Shale Natural Gas Value," accessed May 16, 2014, http://www.mde.state.md.us/programs/Land/mining/marcellus/Documents/Economic_Value_Estimates.pdf.
[113] Ibid.
[114] Sage Policy Group, "The Potential Economic & Fiscal Impacts of Natural Gas Production in Western Maryland," March 2012, 8, accessed May 16, 2014, http://marcelluscoalition.org/wp-content/uploads/2012/03/MD-Marcellus-Study.pdf.
[115] Ibid, 24–25.
[116] Please refer to Section 10.0 of this report for the full list of references.

influenced by domestic and global industry behavior.[117] The pre-drilling conditions of an area are another major factor when considering the intensity of potential impacts, as well as that area's capacity to prevent or mitigate impacts.[118]

While economic impacts can be measured in dollars and jobs, community impacts are often difficult to quantify and are potentially undervalued. Well-managed drilling activity can bolster a community by creating job opportunities, local investment, and higher wages—all measurable impacts. However, existing research does not clearly identify how to maximize and transfer economic benefits for more equitable and sustainable growth.[119] Thus, the equity of benefits remains difficult to measure when attempting to understand the total impact of natural gas development.

Furthermore, mismanaged and misunderstood development can create lasting impacts on a community. The misconceptions regarding those impacts can stem from tangible, observable events, or the stigma and negative perceptions surrounding natural gas development. Media often play an integral role in the polarizing perceptions of drilling activity, while concurrently developing a more informed public on potential impacts of new development.

Section 6.1 summarizes some of the existing research on community impacts, particularly those stemming from the negative perceptions and stigma of energy boomtowns. Health and environmental concerns are not covered in detail in this report, as separate studies related to the Maryland Safe Drilling Initiative will cover those topics in greater detail.[120]

6.1 Existing Research on Potential Community Impacts

The Cornell Cooperative Extension's Marcellus Shale Team and Penn State's Marcellus Shale Center for Outreach and Research have contributed an abundance of data and research assessing the impacts specific to Marcellus Shale development. While research is readily available, the industry has changed over the years and has therefore created demand for a continuous supply of new studies and new findings. Phases of natural gas development, extraction, and production have been compressed to shorter timelines, impacts have varied from county to county, and companies have worked harder to improve community perceptions.

[117] Michelle Haefele and Pete Morton, "The Influence of the Pace and Scale of Energy Development on Communities," *Western Economics Forum* 8 No. 2 (Fall 2009): 3, accessed July 23, 2013, http://purl.umn.edu/92810.
[118] Susan Christopherson and Ned Rightor, "The Boom-Bust Cycle of Shale Gas Extraction Economies," Cardi Reports No. 14 (September 2011): 4, accessed June 4, 2013.
[119] Jeffrey B. Jacquet, "Risk to Communities from Shale Gas Development," South Dakota University, presentation at the National Research Council Workshop on Risks from Shale Gas Development, May 31, 2013, http://sites.nationalacademies.org/DBASSE/BECS/DBASSE_083187.
[120] "Marcellus Shale Safe Drilling Initiative," Maryland Department of the Environment, accessed February 10, 2014, http://www.mde.state.md.us/programs/land/mining/marcellus/pages/index.aspx.

The continual changes within the natural gas sector lead to difficulty in assessing its true impact.

A majority of the research on community impacts refers to the boom-bust cycles often observed in extractive industries. Literature on recent shale "booms" has drawn parallels from the decades-old boom-bust impacts of coal mining, oil production, and conventional gas extraction. The industry's workforce is massive and includes primary contractors, subcontractors, and sub-subcontractors. The impacts of rapid paces of development and unmanageable population growth are further compounded by a mixture of regulations and standards set by both public and private entities, some representing community needs and others representing industry needs.

Perceptions and Risks of Shale Development

At the National Research Council's workshop on the risks of unconventional shale development, research was presented on the benefits and risks of natural resources. Benefits were described as varying and short-term and include jobs, tax revenue, royalty income, and local investment. Four risks that were identified include industrialization, corrosion, contamination, and disruption. In contrast to the benefits, the risks are observed over the long term. In addition, physical and emotional costs continue long after production has ended.[121]

Rapid industrialization and the jobs that come with it can lead to rapid population growth that strains public services and disconnects long-term residents from their communities. During a boom cycle, local investment leads to high annual economic growth rates in once sparsely populated rural towns.[122] Corrosive communities, studied by Freudenberg and Jones in the early 1990s, are created by an imbalance of these benefits for residents and landowners—creating winners and losers.[123] Risks from contamination create lasting stigma and negative perceptions of a community, regardless of the actual presence of contamination.

If Marcellus Shale gas development moves forward, and the distribution of benefits is not shared evenly amongst residents, the effect on the community as a whole could be corrosive. Actual or perceived contamination could be one factor reducing the attractiveness of the area to visitors and new residents. In a survey conducted by RESI, over three-quarters of nearly 800 total viable survey respondents, roughly 80.6 percent of the 377 respondents not currently residing in either county, stated the presence of drilling would deter them from moving into Western Maryland.

Jeffrey Jacquet, a sociologist who has studied past and present boomtowns in the United States, surveyed nearly 1,000 landowners with or without mineral leases in the Armenia

[121] Jacquet, "Risk to Communities from Shale Gas Development."
[122] Ibid, 1–2.
[123] Ibid.

Mountain area of Bradford and Tioga Counties in Pennsylvania in 2012 to reveal their perceptions regarding whether or not natural gas development left them better off, neither worse nor better off, or worse off than five years ago.

- Of 358 cases with no lease and no development, just over 60 percent of landowners reported feeling worse off;
- Of over 50 landowners with leases and natural gas development, roughly 60 percent reported feeling better off; and
- Over 500 landowners with leases but no development reported mixed perceptions between feeling better off, worse off, or neither.[124]

In addition to landowners' possession of mineral leases and development affecting their perceptions, being employed by the gas industry appeared to have a statistically significant impact on attitudes and perceptions of the impacts of natural gas development. The imbalance of benefits and difference in perceptions of natural gas impacts can contribute to the fourth risk, known as disruption.

The Boomtown Impact Model associates rapid population growth and rapid energy development with increases in stress, changes in individuals' interactions within the community, decreased community cohesion, and poor community character.[125] When a resident can quickly identify the type of place in which he or she lives (a farm town, a resort town, etc.), what his or her role in that place is (a farmer, business owner, or community leader), and what his or her relationship is to others (a friend, partner, or employer), then that resident is strongly tied to his or her community. When those ties are disrupted, they are hard to repair.

RESI's engagement with local stakeholders and residents indicate strong ties to agriculture, tourism, construction, and existing energy activities. Based on feedback during the stakeholder engagement process, Western Maryland residents appear very clear on their roles in the community. However, the stress of potential changes to the community could already impact relationships and trust in political leadership. Stress can lead to increases in social problems (crime, substance abuse, etc.), a lowered standard of living, strained local services, and general disorganization.[126] This tendency is especially true for rural communities. Conversely, urban communities are more able to absorb rapid population growth and industrial development.[127]

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[124] Jeffrey B. Jacquet, "Landowner Attitudes toward Natural Gas and Wind Farm Development in Northern Pennsylvania," *Energy Policy* 50 (2012): 684, accessed July 25, 2013, http://dx.doi.org/10.1016/j.enpol.2012.08.011.

[125] Jeffrey B. Jacquet, "Energy Boomtowns & Natural Gas," Pennsylvania State University–The Northeast Regional Center for Rural Development, Paper No. 43 (January 2009): 4–5, accessed July 11, 2013, http://aese.psu.edu/nercrd/publications/rdp/rdp43/view.

[126] Brasier et al., "Residents' Perceptions of Community and Environmental Impacts," *Journal of Rural Social Science* 26 No.1 (2011): 37, accessed July 11, 2013, http://www.ag.auburn.edu/auxiliary/srsa/pages/Articles/JRSS%202011%2026%201%2032-61.pdf.37.

[127] Ibid.

These four risks (industrialization, corrosion, contamination, and disruption) can be more damaging than environmental risks, as residents begin to distrust government, become disconnected, and eventually disinvest physically, emotionally, and financially from their communities.[128] These four risks are dependent on the pace and scale of drilling activity, but immediate impacts to economic growth, housing, and infrastructure can be perpetuated by long-lasting negative perceptions.

6.2 Housing

Drilling for natural gas evokes major concerns over how the influx of workers will impact the housing market in Western Maryland, and, in turn, how changes in the housing market will impact the community in the short and long terms. Major concerns regarding the issue of housing include housing supply shortages, rising rents, and infrastructure capacity. Potential impacts on property values are explored in Section 8.0 of this report. RESI considered Western Maryland's unique economic, political, and social environment as well as the experience of other areas to estimate the potential for housing shortages, rent increases, and displacement of residents.

6.2.1 Nature of Impacts

The purpose of the following housing analysis was to determine each county's capacity to accommodate the potential increase in resident population caused by the added presence of drilling activity and new jobs, all else equal. Assumptions in RESI's housing analysis were based on existing research on observed community impacts where drilling has occurred in addition to estimates of location and number of wells should drilling be permitted in Western Maryland. Detailed assumptions and scenarios are explained in Section 5.0 of this report. The housing analysis considered housing needs for all of Allegany and Garrett Counties.

Exclusion of Group Quarters and Vacation and Seasonal Housing

Garrett County has a prominent tourism industry that includes resort, recreation, amusement, and outdoor sports attractions. The county, and specifically its Deep Creek Lake area, is popular for second homes and vacation rentals. The Deep Creek Lake area represented at least 74.1 percent of the county's vacation and seasonal housing units, based on census tract boundaries.[129] In Garrett County, more than 25 percent of total housing units, or 4,768 units, includes vacation and seasonal housing. The share of vacation and seasonal housing in Allegany County was considerably smaller, at just over two percent of total housing units in the county.[130] To prevent the second home market from skewing the analysis, RESI did not include vacation and seasonal homes as part of total housing supply.

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[128] Brasier et al., "Residents' Perceptions of Community and Environmental Impacts," 37.
[129] U.S. Census Bureau, "VACANCY STATUS," in *2008–2012 American Community Survey 5–year Estimates*, accessed February 7, 2014, http://factfinder2.census.gov/.
[130] U.S. Census Bureau, "VACANCY STATUS," in *2010–2012 American Community Survey 3–year Estimates*, accessed May 12, 2014, http://factfinder2.census.gov/.

The other half of Western Maryland is skewed by a large population living in group quarters, defined as institutional (e.g., nursing homes, hospitals, and prison wards) and non-institutional (e.g., military bases, group homes, and college dorms) living quarters. Allegany County has a higher number of institutionalized individuals due to the presence of two state prisons. The prison population is all male, and the majority is between the ages of 22 and 30, skewing the county's demographics.[131] The institutionalized population for each county was subtracted from total population when counting total housed population in an area.

Multifamily and Temporary Housing

Both counties have few multifamily units, most of which are used for senior housing in Cumberland or student housing in Frostburg.[132] If such housing is part of an institution, it was not included in RESI's analysis. However, if student or senior housing is outside an institution and not rented out exclusively to those two populations, it may have been included based on Census definitions of housing types. Various reports indicate that many shale workers reside in hotels, or other temporary housing, in areas where housing is in short supply and cannot be built fast enough to accommodate the influx of new residents. However, Western Maryland appears to have a sufficient housing stock, including other vacant housing, based on expected levels of natural gas extraction in RESI's analysis.

If the existing housing supply proves insufficient, Garrett County's recently closed schools could be used to soften housing impacts. For example, a school in Washington County, Pennsylvania, was converted into one-bedroom units to house workers.[133] Garrett County has at least three closed schools with potential to be similarly converted to housing. This would, however, be a temporary solution to school closures in the area due to the short-term nature of the natural gas "boom" phase.

6.2.2 Magnitude of Impacts

RESI's analysis found that overall housing availability and rental rates will not be greatly impacted by the influx of workers and additional population. Intense drilling activity—over 300 wells drilled per year—would put pressure on Western Maryland's housing market.[134] However, RESI's scenarios predicted no more than 72 wells drilled in a single year between 2017 and 2026. RESI also used a fixed housing supply in its analysis, though new housing units are likely to be built beyond 2014.

The surplus or shortage of housing based on RESI's analysis is not equivalent to the vacancy rates provided by the U.S. Census Bureau's ACS. In RESI's analysis, the number of occupied units

[131] National Center for Smart Growth, "STAR Data Brief: Population and Demographics," 4.
[132] David K. Nedved, personal communication, October 18, 2013.
[133] Ibid, 14.
[134] Partridge et al., "Final Report: Assessing the Impact of Shale Energy Boom on Ohio Local Housing Markets," Ohio State University (2013): 20, accessed October 15, 2013, https://www.ohiohome.org/research/documents/OhioStateReport-Mar12.pdf.

was increased by four percent to account for both existing residents and potential residents looking to occupy a home in Western Maryland. This four percent increase is a standard rate recommended by Jerry Knox from the Community and Regional Planning Department at Iowa State University.[135] Knox suggested that an efficient housing market provides potential residents with a variety of options for a new home.[136]

ACS data was used to distinguish the existing housing needs of each county by identifying an existing surplus or shortage of housing in either or both counties. Because both counties hold small populations, single-year estimates of occupied and vacant housing for both counties were unavailable. The U.S. Census Bureau does not calculate single-year estimates for areas with populations below 60,000, and three-year ACS data is not calculated for areas with populations below 20,000. Figure 15 summarizes the existing housing market using three-year survey estimates from the 2012 ACS.

[135] Suzette Barta and Mike D. Woods, "Constructing a Community Housing Profile: Estimating Supply and Demand in Your Local Housing Market," Oklahoma State University–Division of Agricultural Sciences and Natural Resources, Oklahoma Cooperative Extension Service AGEC-919, 2, accessed September 11, 2013, http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2185/F-919web.pdf.
[136] Ibid.

Figure 15: Existing Housing Demand and Supply, 2012

Category	Allegany County	Garrett County
Supply		
Available housing	30,105	12,932
Owned or for sale	*20,598*	*9,382*
Rented or for rent	*9,507*	*3,550*
Unavailable housing	2,515	1,220
Other vacant (not for sale or rent)	*2,515*	*1,220*
Total Supply	**32,620**	**14,152**
Demand		
To own	20,700	9,525
To rent	9,282	3,104
Total Demand	**29,982**	**12,629**
Surplus (Shortage)		
Available housing	123	303
Owned or for sale	*(102)*	*(143)*
Rented or for rent	*225*	*446*
Unavailable housing	2,515	1,220
Other vacant (not for sale or rent)	*2,515*	*1,220*
Total Surplus (Shortage)	**2,638**	**1,523**
Vacation/Seasonal Housing	**708**	**4,768**

Sources: RESI, Barta and Woods, U.S. Census Bureau

Current ACS estimates, represented in Figure 15, show an overall surplus of total housing in both Allegany and Garrett Counties, without including vacation and seasonal housing units. These findings are supportive of claims made during stakeholder interviews. The overall surplus results from surpluses in both rental and other vacant units being greater than the shortage of for-sale units.[137] [138] The shortage of for-sale-units in both counties represents households looking to own, not rent, a home in Western Maryland. The shortage may not mean that they will choose not to move to the area but may mean that they will have to rent until another vacant unit becomes available for sale. The remainder of total housing supply (classified as "other vacant" in the ACS) may represent foreclosed units or vacant units not currently for sale or rent, meaning units which physically exist but are not available. [139]

[137] U.S. Census Bureau, "HOUSING CHARACTERISTICS," in *2010–2012 American Community Survey 3–Year Estimates*, accessed May 12, 2014, http://factfinder2.census.gov/.
[138] U.S. Census Bureau, "VACANCY STATUS," in *2010–2012 American Community Survey 3-Year Estimates*.
[139] U.S. Census Bureau, "American Community Survey and Puerto Rico Community Survey 2012 Subject Definitions," 39, accessed May 14, 2014, http://www.census.gov/acs/www/Downloads/data_documentation/SubjectDefinitions/2012_ACSSubjectDefinitions.pdf.

Both Allegany and Garrett Counties have a large surplus of vacant units not currently on the market, with a combined total of nearly 4,000 unavailable and vacant housing units. Excluding vacation and seasonal housing, the total surplus for Allegany County totaled 2,638 units. Garrett County's housing surplus was smaller, with a total of 1,523 units. Drilling down further by excluding vacant units not currently for sale or rent, the two counties still have a housing surplus. Census tract level data show the western portion of Allegany County, from Cumberland to the Garrett County border, makes up just over 60 percent of the total housing surplus of the entire county.[140]

In line with observations from area stakeholders, a majority of the vacancies are off the market due to the recent housing crisis and economic downturn. Between the two counties, approximately 81.5 to 90.4 percent of the housing surplus is represented by housing not currently for sale or rent.[141] Out-migration from Allegany and Garrett Counties to nearby Washington and Frederick Counties has also opened up housing in the area.[142]

Population Changes With and Without Drilling

Existing research estimates that approximately 37 percent of gas workers will move in from out of state. Earlier research estimated a higher percentage of in-migration; however, as an increasing share of the local workforce was trained for gas sector jobs, a smaller portion of out-of-state employment was needed.[143] Maryland benefits from proximity to drilling in Pennsylvania and West Virginia in terms of employment, as firms such as Beitzel Corporation and Pillar Innovations already employ and train Maryland residents working in shale and related industries.[144] If enough Maryland residents are trained to work in the natural gas industry, fewer out-of-state workers will be needed based on the trend in other drilling communities.

Employment figures from the Bureau of Labor Statistics, cross-referenced with local data, estimate natural gas sector employment to be fewer than 300 jobs between Allegany and Garrett Counties as of 2012.[145] [146] While not all natural gas sector employees are Maryland residents, the employment of Maryland residents is expected to grow if training and employment opportunities continue in preparation for shale development in the state.

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[140] U.S. Census Bureau, "VACANCY STATUS," in *2008–2012 American Community Survey 5–year Estimates*.
[141] U.S. Census Bureau, "VACANCY STATUS," in *2008–2012 American Community Survey 5–year Estimates*.
[142] National Center for Smart Growth, "STAR Data Brief: Population and Demographics," 4.
[143] Partridge et al., "Final Report: Assessing the Impact of Shale Energy Boom on Ohio Local Housing Markets," 9.
[144] "Brief Economic Facts: Garrett County, Maryland," Maryland Department of Labor, Licensing, and Regulation, 2013, accessed May 22, 2014, http://www.choosemaryland.org/factsstats/Documents/briefeconomicfacts/GarrettBef.pdf.
[145] "Quarterly Census of Employment and Wages," U.S. Bureau of Labor Statistics.
[146] Maryland Department of Labor, Licensing and Regulation, "County Industry Series," in *Employment and wages by County*, 2012, accessed February 10, 2014, http://www.dllr.state.md.us/lmi/emppay/.

While the data show that there is room for new residents in both counties, the following figures and analyses estimate whether or not population growth will be too much, too fast for the area's housing market should drilling create a large influx of workers and new residents. To fully understand the potential changes in the housing market, RESI created a baseline of Western Maryland's housing supply and demand for a ten-year period between 2017 and 2026. The baseline represents expected population and housing changes without the presence of drilling.

Projections for the housed populations of each county were derived from total population projections from the REMI PI+ model used in RESI's analysis. Estimates from Figure 16 showing a housing surplus were followed by further analysis to determine how activity in the natural gas sector may impact housing availability. Figure 16 shows population projections based on RESI's projected drilling scenarios.

Figure 16: Projected Changes to Baseline Housed Population in Western Maryland, 2017–2026

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Allegany County										
Baseline (no drilling)	65,379	65,685	66,041	66,473	66,962	67,508	68,108	68,726	69,364	70,017
Scenario 1 (25%)	65,542	65,842	66,351	66,770	67,401	67,927	68,508	69,102	69,716	70,343
Scenario 2 (75%)	65,547	66,017	66,529	67,104	67,724	68,385	69,090	69,802	70,376	70,962
Garrett County										
Baseline (no drilling)	27,935	28,065	28,218	28,402	28,611	28,844	29,101	29,365	29,637	29,916
Scenario 1 (25%)	28,123	28,446	28,820	29,211	29,601	29,986	30,375	30,758	31,139	31,340
Scenario 2 (75%)	28,179	28,638	29,126	29,620	30,132	30,602	31,041	31,449	31,851	32,186

Sources: REMI PI+, RESI

As shown in Figure 16, Scenario 1 will add nearly 1,900 new residents to Western Maryland's baseline housed population (not including those in group quarters) within a single year based on projected employment added by drilling activity. Scenario 2 will add over 3,200 new residents to Western Maryland within a single year. For more information regarding these drilling scenarios, please refer to Section 5.0 of this report. For more information regarding employment and other impacts, please refer to Section 8.0 of this report.

Projected Housing Needs With and Without Drilling

RESI's analysis uses a fixed supply of housing units. Detailed permit data provided by both counties, in addition to estimates on the timeline from authorization to completed construction, allowed RESI to estimate housing supply in future years up to 2014. According to Census estimates, the average length of time from authorization to completed construction of a

single-family home is six months, while multifamily units can take up to one year to be constructed depending on the number of units built.[147]

For years beyond 2014, RESI assumed a fixed supply to show how much of Western Maryland's existing housing stock will be consumed by new residents as a result of projected drilling activity. Given the existing share of housing in each county, projected household sizes as determined by Maryland's Department of Planning, and REMI PI+ population projections, RESI projected growth in housing demand for Western Maryland.

Figures 17 and 18 show the housing surplus or shortage expected for both counties for the no drilling scenario as well as for drilling Scenario 1 and Scenario 2. RESI analyzed potential housing shortages broken when taking into account available housing as well as unavailable housing. As previously stated, vacation and seasonal housing and group quarters were excluded from the analysis to avoid skewing results for Allegany and Garrett Counties.

[147] "New Residential Construction: Length of Time, 1976–2012," U.S. Census Bureau, accessed February 7, 2014, https://www.census.gov/construction/nrc/lengthoftime.html.

Figure 17: Projected Housing Surplus or Shortage—Allegany County

Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Baseline (No Drilling)										
Available housing	129	85	34	(197)	(268)	(348)	(435)	(525)	(709)	(804)
Owned or for sale	*(99)*	*(124)*	*(152)*	*(282)*	*(322)*	*(367)*	*(416)*	*(466)*	*(570)*	*(623)*
Rented or for rent	*228*	*209*	*186*	*85*	*54*	*19*	*(19)*	*(59)*	*(139)*	*(181)*
Unavailable housing	2,527	2,451	2,364	1,963	1,840	1,703	1,553	1,398	1,080	915
Total Surplus (Shortage)	**2,655**	**2,536**	**2,398**	**1,765**	**1,572**	**1,355**	**1,118**	**873**	**371**	**110**
Scenario 1 (25%)										
Available Housing	105	63	(10)	(241)	(332)	(409)	(494)	(580)	(761)	(852)
Owned or for sale	*(112)*	*(136)*	*(177)*	*(307)*	*(358)*	*(401)*	*(449)*	*(497)*	*(599)*	*(650)*
Rented or for rent	*217*	*199*	*167*	*66*	*26*	*(8)*	*(45)*	*(83)*	*(162)*	*(202)*
Unavailable housing	2,487	2,413	2,287	1,888	1,730	1,598	1,452	1,303	991	832
Total Surplus (Shortage)	**2,592**	**2,475**	**2,277**	**1,648**	**1,398**	**1,189**	**959**	**724**	**231**	**(20)**
Scenario 2 (75%)										
Available housing	104	38	(35)	(289)	(380)	(476)	(578)	(681)	(857)	(943)
Owned or for sale	*(113)*	*(150)*	*(191)*	*(334)*	*(385)*	*(439)*	*(496)*	*(554)*	*(653)*	*(701)*
Rented or for rent	*217*	*188*	*156*	*45*	*5*	*(37)*	*(82)*	*(127)*	*(204)*	*(242)*
Unavailable housing	2,485	2,369	2,243	1,805	1,649	1,483	1,306	1,128	824	675
Total Surplus (Shortage)	**2,590**	**2,407**	**2,208**	**1,515**	**1,270**	**1,008**	**729**	**446**	**(34)**	**(268)**

Sources: Allegany County Land Development Services, Barta and Woods, REMI PI+, RESI, U.S. Census Bureau

Figure 18: Projected Housing Surplus or Shortage—Garrett County

Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Baseline (No Drilling)										
Available housing	402	394	384	324	310	295	277	260	198	178
Owned or for sale	*(107)*	*(110)*	*(114)*	*(138)*	*(144)*	*(150)*	*(157)*	*(164)*	*(189)*	*(197)*
Rented or for rent	*509*	*504*	*498*	*462*	*454*	*445*	*434*	*424*	*387*	*375*
Unavailable housing[148]	1,348	1,338	1,326	1,257	1,241	1,223	1,203	1,183	1,111	1,089
Total Surplus (Shortage)	**1,750**	**1,732**	**1,710**	**1,581**	**1,551**	**1,517**	**1,480**	**1,442**	**1,309**	**1,268**
Scenario 1 (25%)										
Available housing	391	369	345	270	243	218	191	166	94	81
Owned or for sale	*(111)*	*(120)*	*(130)*	*(160)*	*(171)*	*(181)*	*(192)*	*(202)*	*(231)*	*(236)*
Rented or for rent	*502*	*489*	*475*	*430*	*414*	*399*	*383*	*368*	*325*	*317*
Unavailable housing	1,333	1,309	1,281	1,195	1,165	1,135	1,105	1,075	993	977
Total Surplus (Shortage)	**1,724**	**1,678**	**1,625**	**1,465**	**1,408**	**1,353**	**1,296**	**1,241**	**1,087**	**1,058**
Scenario 2 (75%)										
Available housing	387	357	325	243	208	176	147	119	45	23
Owned or for sale	*(113)*	*(125)*	*(138)*	*(171)*	*(185)*	*(198)*	*(210)*	*(221)*	*(251)*	*(260)*
Rented or for rent	*500*	*482*	*463*	*414*	*393*	*374*	*357*	*340*	*296*	*283*
Unavailable housing	1,329	1,295	1,258	1,163	1,123	1,087	1,053	1,022	937	910
Total Surplus (Shortage)	**1,716**	**1,651**	**1,582**	**1,405**	**1,331**	**1,264**	**1,200**	**1,141**	**982**	**933**

Sources: Barta and Woods, Garrett County Permits and Inspections Services, REMI PI+, RESI, U.S. Census Bureau

[148] The U.S. Census Bureau defines available housing as any housing vacant-for-sale or vacant-for-rent housing unit. There are also vacant housing units currently not for sale or rent; these are either "other vacant" housing units or vacation and seasonal housing.

In both Scenarios 1 and 2, Garrett County will not experience a housing shortage in either available or unavailable housing units. However, the surplus will fall below 100 units by the ninth and tenth years of drilling. Allegany County will experience a shortage in available housing as early as the third year of drilling. When including vacant housing units not for sale or rent, Allegany County is not projected to experience a shortage until the ninth or tenth year under either scenario.

Affordability of Housing with Drilling Activity

Due to the relatively small number of expected wells in both scenarios and the substantial total surplus of housing in the area, RESI does not expect rental housing to become unaffordable. Maryland does not have rent control, but landlords must wait until the end of existing leases before raising the rent, especially if the lease is subject to automatic renewal.[149] If the influx of workers is relatively short-term, renters in Maryland may not be impacted if long-term leases are held, but month-to-month leases, or daily rates for temporary housing such as hotel rooms, would be more vulnerable to rising rates.

Data from the United States Housing and Urban Development office reports two-bedroom fair market rent of $699 in Garrett County and $632 in Allegany County in 2013. Rental rates in Western Maryland are similar to those reported in other rural areas where drilling has occurred, but upward pressure on rental rates is different dependent on proximity to more urbanized areas. Washington County, Pennsylvania, had relatively stagnant rental rates, around $520 to $620 per month in pre-drilling years. Demand was absorbed by nearby cities once drilling occurred.

An Ohio State University study on the subject indicates that rent was only raised modestly, if at all, in areas with a moderate amount of drilling activity. According to the University's study analyzing counties in Pennsylvania during a five-year "boom" period for drilling between 2007 and 2011, FMRs have a positive relationship with the number of gas wells in intensely drilled areas. However, the study emphasized that the relationship between oil and gas sector employment and FMR is not statistically significant, and the relationship was only observed in areas of intense drilling (Bradford, Tioga, and Lycoming Counties). The estimated breakeven point between drilling having no impact or modest impacts on FMR is between 340 to 430 wells drilled annually.[150] The number of wells predicted in RESI's Scenario 2 does not exceed more than 72 wells drilled within a single year.

Bradford County had 397 new wells drilled in 2011, for a total of 962 wells by 2011. An analysis of FMR reported by Housing and Urban Development determined a high rate of drilling activity to explain a 3.6 percent increase in FMR for Bradford County in 2011.[151] Alternatively, an

[149] "Landlords and Tenants: Tips on Avoiding Disputes," Maryland Attorney General's Office, accessed April 16, 2014, http://www.oag.state.md.us/Consumer/landlords.htm#renewals.
[150] Partridge et al., "Final Report: Assessing the Impact of Shale Energy Boom on Ohio Local Housing Markets," 20.
[151] Ibid.

analysis of drilling activities' relationship with Census-reported rental rates provided contradictory results. Both data sources for rental rates have limitations for the purpose of identifying relationships between wells drilled and rent increases.

Anecdotally, the study mentioned Williston, North Dakota, an area with the most pronounced shale boom in the nation. The area experienced an increase in two-bedroom monthly rent from $350 to $2,000 (up 471.4 percent). FMR for Williston County's one-bedroom apartments increased by 59 percent between 2003 and 2013, higher than the national average growth in FMR by 34 percent in the same period.[152] A case study of Greene County, Pennsylvania, found rents increased by 7 to 12 percent pre- and post-recession, also coinciding with an uptick in drilling activity.[153] Anecdotal evidence from Greene County also found specific cases wherein rents doubled or tripled, but the study also noted that the share of renters paying more than 30 percent of their incomes on rent increased at a slower rate than for the rest of the state due to a rise in income associated with higher paying occupations.[154]

Lycoming County, Pennsylvania, has a population of over 100,000, including the metropolitan statistical area of Williamsport.[155] Smaller communities in Lycoming County had a smaller supply of rental units, similar to the case in Allegany and Garrett Counties. One study reported that landlords in these smaller communities used rental income to supplement their primary income. Because these landlords earned other income, renting to long-term residents or workers was preferred over the cost and effort of finding new tenants between high-turnover, transient workers. In such areas, landlords hardly raised rental rates, and if they did, rents were raised by 5 to 10 percent.[156]

Impacts of Potential Housing Shortages or Rental Rate Increases

Should the pace of drilling in Allegany and Garrett Counties exceed projections, it may be necessary for housing authorities to create contingency plans for the possibility of severe housing shortages, based on the threshold provided by the Ohio State study. In counties where drilling activity was most intense, the response to increasing rental rates was to increase supply of housing, which could lead to long-term blight following a "bust" in drilling activity. While new housing was being built, workers turned to temporary housing, such as hotels. However, more creative responses such as the converted school facility in Washington County, Pennsylvania, could also be considered to reduce potential blight after the drilling industry "bust." [157]

[152] Partridge et al., "Final Report: Assessing the Impact of Shale Energy Boom on Ohio Local Housing Markets," 4.
[153] Stephen Herzenberg, Diana Polson, and Mark Price, "Measuring the Costs and Benefits of Natural Gas Development in Greene Coutny, Pennsylvania: A Case Study," Multistate Shale Research Collaborative (April 2014): 1, accessed April 18, 2014, https://pennbpc.org/sites/pennbpc.org/files/greeneCASESTUDY.pdf.
[154] Ibid.
[155] U.S. Census Bureau, "DEMOGRAPHIC AND HOUSING ESTIMATES," in *2012 American Community Survey 1-year Estimates*, accessed May 12, 2014, http://factfinder2.census.gov/.
[156] Williamson and Kolb, "Marcellus Natural Gas Developments Effect on Housing in Pennsylvania," 11.
[157] Ibid, 9.

Temporary housing is not included in this analysis, but workers' preferences for temporary housing are detailed in Section 7.0 of this report. Section 7.0 discusses tourism-related impacts and details the greater expectation of increases in hotel occupancy from an influx of workers, rather than increased homeownership or renting. One stakeholder in Washington County, Pennsylvania, speculated that continuing attempts to ban drilling activity lead to workers' uncertainty in the length of their employment within an area, adding to their preference for temporary housing, shown by the high occupancy rates of hotel rooms.[158]

Experiences of other counties with intense drilling activity indicate potential for blight and high vacancy rates in Western Maryland should drilling activity occur. In RESI's scenarios, the period between 2027 and 2036 represents the likely "bust" period of drilling activity in Western Maryland. RESI's housing analysis does not predict how many new housing units would be built in response to drilling activity.

Understanding existing and potential levels of housing stock and identifying alternative housing options for transient workers can help to avoid over-development during a boom period. Over-development in response to a short-term increase in resident population could lead to blighted communities after drilling ends. The Director of Greene County, Pennsylvania's Department of Human Services, Karen Bennett, was quoted as saying "every program I have is impacted by housing—foster, drug and alcohol, disability, [and] mental health."[159]

Inadequate housing in Bennett's jurisdiction, according to a 2014 case study, drove up rents and increased the preexisting housing shortage, which led to higher demand of foster care services and increased high school dropout rates, followed by an increase of high school dropouts applying for public assistance after being laid off by out-of-state companies.[160] The Greene County case study provides a balanced overview of the benefits and costs of the heavy drilling that has occurred in recent years. Greene County has, however, also experienced an uptick in coal extraction in addition to natural gas extraction.[161]

The differences between Greene County and Western Maryland are the level of drilling activity and the housing conditions before drilling. While Greene County had an existing shortage prior to drilling, Western Maryland has a surplus of housing. Green County had over 500 unconventional gas wells drilled within a six-year period, while Western Maryland may not see more than 350 wells in its first six years of drilling. In addition, drilling impacts in Pennsylvania and other states occurred in the midst of the most recent recession.

[158] Williamson and Kolb, "Marcellus Natural Gas Developments Effect on Housing in Pennsylvania," 9.
[159] Herzenberg, Polson, and Price, "Measure the Costs and Benefits of Natural Gas Development in Greene County, Pennsylvania," 2.
[160] Ibid, 1.
[161] Ibid, 11.

Summary

For Western Maryland, the existing conditions are an important indicator of how the community and local government will absorb the impacts of potential drilling activity. As stated throughout this report, the size of the benefits and costs of drilling are largely dependent on pace and scale; these findings are supported by a number of existing research studies.

Impacts take forms other than dollar amounts and economic impacts, though less concrete impacts are harder to quantify for purposes of comparison to economic and fiscal impacts. As such, this section uses data and existing quantitative studies on community-related impacts to create a general image of what could be. RESI then supplemented the data by qualitative research such as case studies, surveys, news articles, and interviews to fill in any gaps left by the quantitative analysis and research.

While research is readily available, the industry has changed over the years and much of the uptick in drilling activity took place concurrently with the most recent recession. As new research and studies are published, the findings may be more comparable to potential impacts for Western Maryland, though the difference in economic conditions, stages of drilling activity, and other local factors should be taken into consideration.

In addition, Western Maryland residents feel knowledgeable about the impacts drilling has had on other counties due to their proximity to drilling in bordering states. This knowledge has changed residents' perceptions and created a divide between support and opposition for drilling in Western Maryland. Divisive preconceptions of the natural gas industry before it enters a community can create problems before drilling activity takes place, thus weakening community ties and the ability to absorb impacts once drilling occurs. Perceptions and stigma while drilling activity takes place may be just as problematic for the community.

One of the most studied impacts on drilling communities has been that of housing availability and costs. RESI found that Western Maryland has a sufficient housing surplus, not accounting for construction of new units or deterioration of existing units, to handle the projected population growth from RESI's analysis. Excluding Census-defined "other vacant" housing units unavailable to own or rent from the analysis, small shortages may occur in Western Maryland's available housing. The continued shortage in for-sale units is primarily attributable to the existing shortage identified in 2012. This shortage could be reversed if more vacant housing were put back on the market to meet new demand. Both counties have a housing surplus in terms of tangible, physically existent homes, but the shortage can be traced to owners of many vacant homes who are not ready to sell or rent out their properties.

Returning more of the area's vacant housing to the sale or rental market could appease new housing demand without an immediate need for new construction. As evidenced by case studies, a high rate of new construction to meet a short-term increase in demand potentially leads to blight in the period following peak drilling years. New construction was used as a way to meet sudden and large influxes of housing demand in drilling counties outside Maryland,

though counties that could not build fast enough or had large income inequalities experienced above-average increases in rental rates.

6.3 Truck Trips

The active drilling process that is necessary to extract natural gas from the Marcellus Shale has an impact on the volume of truck activity to and from drilling sites and a direct impact on the communities, particularly the local roads, surrounding those sites. The truck traffic associated with drilling horizontal wells is often "2 to 3 times higher than the traffic associated with drilling a vertical well."[162] This increase in truck volume is mainly a result of the need for water transportation during the hydraulic fracturing of horizontal wells. Such an increase in truck traffic can adversely impact a community through increased road dust, traffic noise, and pollution. It has been noted in other states' experiences that increased truck activity is especially detrimental to the local roads surrounding wells that are not equipped or designed to handle the weight and frequency of truck traffic to and from the drilling sites.[163]

Increased truck volume attributed to drilling is a result of additional activity during site preparation and the hauling of equipment, materials, water, and supplies. The transportation of all these requires truck transport to the well pad site, particularly during early well pad development when no other infrastructure, such as water pipelines, is present.[164] In horizontal hydraulic fracturing, the primary purpose of truck trips is water delivery to the well. In addition, any wastewater that is generated during the hydraulic fracturing process is later removed by truck and either disposed or reused at other sites unless it is recycled onsite.[165]

In various studies, impacts related to increased truck traffic are generally listed among the top community complaints related to shale drilling. During RESI's stakeholder meetings, residents of Western Maryland expressed the following concerns and anecdotes regarding increased truck activity as a result of drilling:

- Access roads, long driveways, and residential roads will get worn down if repeatedly used.
- Traffic could adversely affect tourism and other industries.
- Some residents had to wait up to a half hour for a convoy of trucks to pass just to get home.
- Traffic impacts are already apparent in Oakland, Maryland, from trucks traveling through to West Virginia.

[162] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," September 7, 2011, 6-301, accessed February, 14 2014, http://www.dec.ny.gov/data/dmn/rdsgeisfull0911.pdf.
[163] Ibid, 6-311.
[164] Ibid, 6-301.
[165] Heather Cooley and Kristina Donnelly, "Hydraulic Fracturing and Water Resources," Pacific Institute (June 2012): 25, accessed March 4, 2014, http://pacinst.org/wp-content/uploads/sites/21/2014/04/fracking-water-sources.pdf.

To accurately analyze the impacts of increased truck activity directly related to Marcellus Shale drilling in Western Maryland, RESI collected research and data regarding the experiences and estimates from other areas. In particular, RESI used data for truck trips estimated by MDE using source data, MDE calculations, and several assumptions. More description of the process can be found in the methodology section below. The preliminary source used for the calculations and analysis has been widely cited and used in many different transportation studies and analyses. Using the estimates compiled by MDE for estimated truck trips as well as RESI's projections for well pad and well build out, RESI calculated figures for the potential increase in the number of truck trips in Western Maryland attributable to Marcellus Shale drilling.

6.3.1 Nature of Impacts

The active drilling process to extract natural gas from the Marcellus Shale can lead to a significant increase in truck traffic, particularly on the access and local roads surrounding well pads.[166] Although RESI's estimated number of well pads in Western Maryland is smaller than that of development expectations and actual activity for other locales in the Marcellus Shale, the expected increase in activity will still have some impact on the volume of truck traffic in the area.

According to the draft report published by the New York State Department of Environmental Conservation (NYSDEC) titled "Supplemental Generic Environmental Impact Statement (SGEIS) On the Oil, Gas and Solution Mining Regulatory Program", both light- and heavy-duty truck trips increase during development of well pads and subsequent well drilling. In the study, *early well* development is defined as the period in the development of new wells when no water pipeline infrastructure exists. During this timeframe, all water is transported by trucks to sites and has a significant impact on truck traffic. However, during *peak well* scenario, truck trips decrease significantly when water is delivered via pipelines instead of trucks, reducing the level of truck activity by as much as 30 percent.[167] However, discussion between MDE and Jim Fuller, the head of the mining program in Pennsylvania, revealed that this reduction in truck activity may be overstated according to Pennsylvania's experience. According to Mr. Fuller the majority of the water is still trucked to each individual drilling site; however, "there is an encouraged trend to centralize water from a reservoir where there is concentrated drilling and overland pipe from that but that is only 10 to 20 percent of the time and tends to be in the area of heavy concentration."[168]

Due to RESI's assumptions regarding the modest number of wells and low level of well concentration, for the purposes of this analysis, RESI assumed that there will not be a significant reduction in truck traffic as indicated in the peak well development scenario. As a result, only early well development estimates were used in the analysis.

[166] New York Municipal Insurance Reciprocal, "Protecting Our Local Roads," 2, accessed February 26, 2014, http://www.nymir.org/pdf/NYMIR%20Marcellus%20Roads%20FINAL.pdf.
[167] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," 6-302.
[168] Jim Fuller, discussion with MDE, April 3, 2014.

6.3.2 Methodology

RESI utilized the truck estimates calculated by MDE as the basis for the truck trip analysis. MDE's estimates were based on figures in a report prepared by NTC Consultants for the New York State Energy Research and Development Authority and based on several assumptions. First, their truck trip estimates were scaled from eight wells per pad to one well per pad to coincide with build out assumptions of RESI's well development scenario as discussed in Section 5.0 of this report. Second, given the assumption of the need for 5 million gallon of water-per-well in the report, the number of truck trips for water hauling was scaled up to account for the size of water-hauling trucks (5,000 gallons per truck). Finally, water disposal activity was scaled to account for the expected 30 percent in flowback volume from each site. Maintenance activities during the long term production life of a well are relatively insignificant and are limited to just weekly truck visits to empty condensate collection tanks, and the twice a year mowing of the well pad area.[169] As a result, no truck activity during this time frame is taken into account in RESI's truck trip estimates. Figure 19 defines the purpose of truck trips as well as the number of truck trips as estimated by MDE broken out by pad and well activity that can be expected during well development and drilling.

Figure 19: Estimated Number of One Way (Loaded) Trips for One Well and One Pad—Horizontal Well

Well Pad Activity	Early Well Pad Development	
	Heavy Truck	Light Truck
Drill pad construction	45	90
Rig mobilization	95	140
Non-rig drilling equipment	45	-
Completion equipment	5	-
Hydraulic fracturing equipment (trucks & tanks)	175	-
Final pad prep	45	50
Miscellaneous	0	85
Total Per Pad	**410**	**365**
Drilling fluids	45	-
Drilling (rig crew, etc.)	50	140
Completion chemicals	20	326
Hydraulic fracturing water hauling	1,000	-
Hydraulic fracturing sand	23	-
Produced water disposal	300	-
Total Per Well	**1,438**	**466**

Sources: All Consultants 2010, NTC Consultants 2011, NYSDEC 2011, MDE

[169] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," 6-300.

6.3.3 Magnitude of Impacts

The true magnitude of the impacts to truck traffic will ultimately depend on a number of factors: the number of well pads being developed, the number of wells per pad, and the total volume of water needed. The truck trip estimates in by NYSDEC assume that each well will require five million gallons of water.[170] However, the actual volume of water required can vary substantially. A typical hydraulic fracturing operation in a horizontal well could require between three and five million gallons of water per well.[171] According to an analysis by Penn State, a horizontal well uses approximately 4.2 million gallons of water on average. Given the 5 million gallon estimate for MDE's truck trip numbers, the magnitude of truck trips estimated in this study falls in line with average expectations.

Truck Trip Estimates

To estimate the total number of truck trips per year, RESI used the estimated well pad and well build out in Figures 8 and 9 in Section 5.0 of this report. RESI multiplied these estimates by the new well pad and new well estimates for both light-duty trips and heavy-duty trips depicted in Figure 20.

Figure 20 depicts the expected increase in truck trips per year as a result of Marcellus Shale well development and drilling. Figures 20 and 21 estimate the number of truck trips expected under Scenario 1 and Scenario 2.

Figure 20: Estimated One Way (Loaded) Truck Trips in Western Maryland for Horizontal Wells, Scenario 1—25% Extraction

Year	Number of New Wells	Number of New Well Pads	Heavy-Duty Truck (new well and new pad)	Light-Duty Truck (new well and new pad)	Total
2017	8	4	13,144	5,188	18,332
2018	16	4	24,648	8,916	33,564
2019	29	3	42,932	14,609	57,541
2020	22	3	32,866	11,347	44,213
2021	18	3	27,114	9,483	36,597
2022	15	2	22,390	7,720	30,110
2023	12	2	18,076	6,322	24,398
2024	12	2	18,076	6,322	24,398
2025	12	2	18,076	6,322	24,398
2026	6	0	8,628	2,796	11,424

Sources: All Consultants 2010, NTC Consultants 2011, NYSDEC 2011, MDE, RESI

[170] New York State Department of Environmental Conservation, "Supplemental Generic Environmental Impact Statement," 6-302.
[171] Arthur et al., "Water Resources and Use for Hydraulic Fracturing," 2.

The increased truck activity calculated and presented in Figure 21 amounts to an average annual increase of 22,595 trips for heavy-duty trucks and 7,903 for light-duty trucks for the ten-year drilling timeframe for Scenario 1.

Figure 21: Estimated One Way (Loaded) Truck Trips in Western Maryland for Horizontal Wells, Scenario 1—75% Extraction

Year	Number of New Wells	Number of New Well Pads	Heavy-Duty Truck (new well and new pad)	Light-Duty Truck (new well and new pad)	Total
2017	36	12	56,688	21,156	77,844
2018	72	12	108,456	37,932	146,388
2019	63	9	94,284	32,643	126,927
2020	54	9	81,342	28,449	109,791
2021	63	9	94,284	32,643	126,927
2022	42	6	62,856	21,762	84,618
2023	36	6	54,228	18,966	73,194
2024	36	6	54,228	18,966	73,194
2025	36	6	54,228	18,966	73,194
2026	12	0	17,256	5,592	22,848

Sources: All Consultants 2010, NTC Consultants 2011, NYSDEC 2011, MDE, RESI

The increased truck activity calculated and presented in Figure 21 amounts to an average annual increase of 67,785 trips for heavy-duty trucks and 23,708 for light-duty trucks for the ten-year drilling timeframe for Scenario 2.

Summary

According to various sources and anecdotal evidence, truck traffic associated with active drilling at horizontal wells is significant. Most of the increase in truck activity can be attributed to the hauling of water to and from well sites. Increased noise, pollution, and damage to local roads are all concerns that have been widely documented in previous literature and during RESI's stakeholder interviews. Although these impacts may not be present for the total lifecycle of each well pad, increased volume during well pad development and drilling is significant enough to warrant further investigation into the impacts to communities and costs to those responsible for the maintenance of impacted roadways.

7.0 Tourism Impacts and Other Impacts to the Existing Economy

RESI researched community impacts in reference to changes in availability and quality of lodging, tourism activities, and parks and recreational areas as a result of drilling activity. The scale of potential tourism impacts for Western Maryland greatly depends on the intensity of drilling activity and how drilling activity will change the landscape and perceptions of Allegany and Garrett Counties in regard to tourism.

The following subsections summarize existing research on the vulnerabilities of rural economies when presented with opportunities for energy investment. Specifically, the research focuses on the importance of economic diversity and sustainability. In addition, the analysis contains findings from RESI's survey questions regarding recreational activity and residents' and visitors' preferences, followed by quantitative and qualitative analysis of shale development's impact on the tourism industry.

7.1 Existing Research

William R. Freudenburg, a prominent researcher of rural struggles with energy development, has authored numerous studies on the subject. In a 1992 *Rural Sociology* article, Freudenburg labeled rural areas' tendency to depend on extractive industry development as an "economic addiction."[172] Areas vulnerable to such addiction are typically geographically isolated and do not influence the natural gas industry. Even though the physical drilling and production processes take place within these rural areas, the price of gas and labor is determined by the larger industry as well as national and global economic conditions. Essentially, rural areas are not in control of changes in the larger natural gas industry and become most vulnerable when they lack viable alternatives for economic prosperity or lack economic diversity.[173]

More recent literature on towns with intense shale development confirms Freudenburg's findings. A 2009 study of drilling impacts in Pennsylvania stresses the importance of a diverse economy and the tendency for rural areas to consist primarily of natural resource-dependent industries such as energy, tourism, and agriculture.[174] Drilling activity in Pennsylvania continued to grow after 2009, and cumulative impacts to other industries can change as the scale of drilling increases in a specific area. The impacts on tourism are due to either physical changes to the landscape or changes in tourists' perceptions of the area.[175]

7.2 Potential Tourism Impacts in Western Maryland

As discussed in Section 2.0 of this report, Allegany and Garrett Counties each have a few industries employing the majority of area residents. In Allegany County, nearly three quarters of its residents are employed within the Health Care and Social Assistance, Retail Trade, Accommodation and Food Services, Manufacturing, and Administrative and Waste Services industries. Garrett County is slightly more diversified, with just over half of its residents employed in these top five industries: Retail Trade, Accommodation and Food Services, Manufacturing, Construction, and Arts and Entertainment. A few of these top industries in Western Maryland rely on tourism activity. The following subsection attempts to characterize

[172] William R. Freudenburg, "Addictive Economies: Extractive Industries and Vulnerable Localities in a Changing World Economy," *Rural Sociology* 57 no. 3 (1992): 305, accessed February 18, 2013, DOI: 10.1111/j.1549-0831.1992.tb00467.x.
[173] Ibid.
[174] Timothy W. Kelsey et al., "Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009," Marcellus Shale Education & Training Center (August 2011): 38, accessed October 7, 2013, http://www.shaletec.org/docs/economicimpactfinalaugust28.pdf.
[175] Ibid.

how the presence of drilling may change tourism activity, and, in the larger report, how the entire economy is impacted.

The nature of shale development's impact on Western Maryland's tourism industry, detailed in Section 7.2.1, can be gleaned from the existing levels and types of tourism activity in the area as well as any existing perceptions of how the industry has changed or can change with the presence of drilling activity. In Section 7.2.2, to understand the magnitude of Marcellus Shale's impacts on the tourism industry, RESI compared the existing tourism and related industries with counties with similar tourism activity and the presence of gas wells.

7.2.1 Nature of Impacts

The nature of Western Maryland's economy is known to be reliant on tourism and related industries; therefore, it is important to consider how a new industry such as natural gas drilling will impact one of the area's major economic drivers. This section looks at recent studies which analyzed tourism impacts in Western Maryland followed by a summary of RESI's survey responses regarding perceptions of the quality of recreational activities in the area.

Tourism Impacts in Western Maryland

A 2010 study commissioned by the Garrett County Chamber of Commerce used non-local visitor survey responses to determine the impacts of tourism in Garrett County. The survey covered areas of interest such as the reason for visiting, the length and frequency of visits, and accommodations and activities. Most survey respondents indicated that their reason for visiting Garrett County was leisure or vacation.[176] As a resort destination, Garrett County is comparable to tourist destinations found in West Virginia and Pennsylvania.

Compared to other Maryland counties, Garrett County is estimated to see more "person-trips" than most other counties within Maryland.[177] On average, visitors stayed in Garrett County for 4.7 nights and visited the county 6.8 times in a twelve-month timespan.[178] According to survey responses, daily spending per person and total trip spending per person totaled $94 and $257, respectively.[179] Survey responses were extrapolated to estimate that Garrett County saw more than 1.1 million person-trips during the year-long survey period, and visitor spending totaled more than $243.3 million.[180]

The report estimated that visitor spending had a total economic impact of nearly $347.7 million in sales, generated more than 5,000 jobs, and contributed $193.4 million in value added.[181]

[176] Jinyang Deng, Steve Selin, and Kathryn Arano, "Travel/Tourism Related Economic Analysis for Garrett County, Maryland," Appalachian Regional Commission (January 30, 2010): 7, accessed February 28, 2014, http://www.deepcreekanswers.com/info/studies/Travel_Tourism_Related_Economic_Impact_Analysis.pdf.
[177] Ibid, 48.
[178] Ibid, 1.
[179] Ibid.
[180] Ibid, 40.
[181] Ibid, 45.

Those owning second homes in Garrett County visited most frequently, 16.8 times in a twelve-month timespan, and contributed the most to the overall economic impacts—$156.5 million in sales, nearly 2,300 jobs, and $81.5 million in value added.[182]

To represent the broad reach of the tourism industry, the Maryland Office of Tourism estimated tourism-induced sales tax revenue, which increased by 7.3 percent in Allegany County and by 6.3 percent in Garrett County between fiscal years 2012 and 2013.[183] The two counties' growth in tourism sales exceeded statewide growth rates of 1.0 percent for tourism sales tax and 0.8 percent for all sales tax collected in the same period, a promising sign of growth for a region that represents less than ten percent of the state's tourism activity.[184]

Common sources of tourism and visitor data primarily represent major hotel chains, of which there are few in smaller, rural counties. The small number of major hotels results in data being confidential or not representative of the area's entire hospitality and lodging industry. For instance, in a Maryland Office of Tourism report, Garrett County's hotel market data from Smith Travel Research is not disclosed.[185]

RESI collected data on hotel tax revenues through phone calls and secondary data collection in an effort to distinguish shale workers' impacts on hotel occupancy. However, no clear pattern emerged as the data did not distinguish shale workers share of hotel occupancy or reveal how hotel tax policy determines the impact of shale workers occupying hotel rooms. The following tourism analysis remains reliant primarily on qualitative research and reveals a need for better data in the tourism industry.

Tourism-related Stakeholder Feedback and Survey Responses

Several of Garrett County's top employers and small businesses spread throughout the county include recreation and tourism businesses that are owned and operated by local residents. A discussion with stakeholders in the tourism and recreation industries revealed a number of concerns regarding how shale development may impact these businesses. Key concerns regarding the tourism industry were the following:

- Visitor and resident perceptions of Garrett County,
- How shale development might change the local supply of labor, and
- The availability and cost of resources.

As discussed in Section 6.0 of this report, perceptions can cripple an area during and after an extractive industry "boom." A sewage leak contained within a small section of Deep Creek Lake proved enough to prompt visitors to cancel rentals and other reservations with tourism

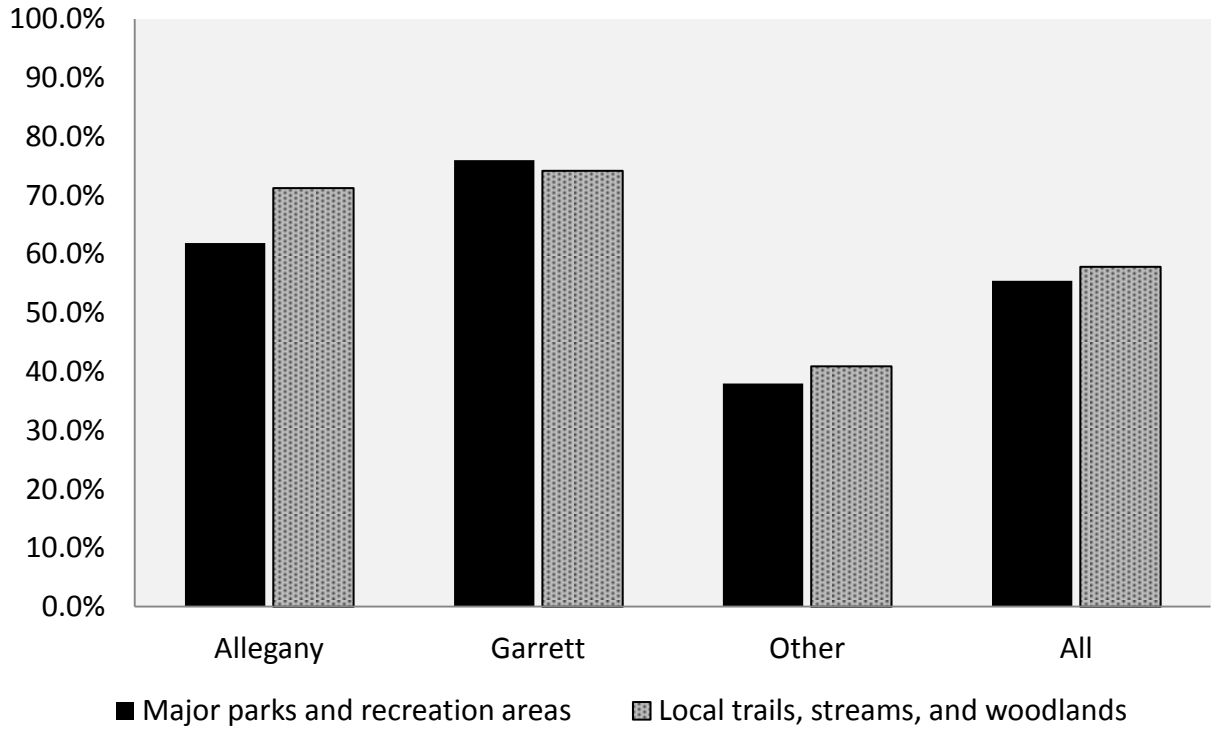
[182] Deng, Selin, and Arano, "Travel/Tourism Related Economic Analysis for Garrett County, Maryland," 9, 45.
[183] Maryland Department of Business and Economic Development's Office of Tourism, Tourism Development Annual Report Fiscal Year 2013, 6.
[184] Ibid, 5.
[185] Ibid, 12.

businesses in the area, according to stakeholders interviewed. Continued news coverage of more intense contamination from natural gas extraction elsewhere in the Marcellus Shale region raises concerns for the future of Western Maryland's tourism sector should similar events occur.

Maryland shares borders with two states that currently allow shale drilling, and storage wells and other related activity already exist in Western Maryland. RESI's survey, detailed in Appendix B of this report, reveals that approximately 40 percent of combined respondents from Allegany and Garrett Counties self-reported being extremely informed on the benefits and concerns of natural gas exploration. Nearly 54 percent of survey respondents indicated being moderately to very informed, and the remaining 6 percent felt that they were not at all or only slightly informed.

Figure 22 shows the percentage of survey respondents who participate in outdoor recreation in Western Maryland and how frequently they participate in outdoor recreation. For this particular survey question, the number of survey respondents living within Western Maryland was just over half of the total respondents, while the other half reported living elsewhere.

Figure 22: Respondents Participating in Outdoor Recreation at Least Once a Month



Source: RESI

The majority of respondents from Allegany and Garrett Counties participate in outdoor recreation at popular attractions, such as Deep Creek Lake, Swallow Falls State Park, and Wisp

Mountain Resort, at least once a month if not daily. Daily to monthly participation in outdoor recreation at smaller, local streams and attractions in the same areas was also popular among respondents in both counties. Outdoor recreation in Western Maryland was also popular among respondents from outside Allegany and Garrett Counties; a majority of nonresidents participate in outdoor recreation a few times per year.

Regarding drilling activity's impacts on recreational activities in local trails, streams, and woodlands, overall participation amongst residents is less likely to change compared to nonresident participation. Residents' use of trails, streams, and woodlands in Western Maryland is more a question of where they will recreate rather than how often. Residents may recreate in different areas within Western Maryland but farther away from tourism amenities near drilling activity.

Conversely, nonresidents may still find time to visit trails, streams, and woodlands, but may look outside Western Maryland should the quality of such amenities decline or be perceived to have declined due to drilling. Actual data to support this claim has been difficult to locate. The following source serves as anecdotal evidence of the possibility. A dissertation from the University of South Florida included interviews of residents in the Laurel Highlands of Pennsylvania, where the doctoral candidate grew up. The following excerpt from one resident's response supports how residents' recreation changes, by where and not how often, with the presence of an extractive industry:

> Personally, my recreational activities have changed…. One reason that I really enjoy living here is that I can roll out of my driveway on my road bike and ride sixty miles and pass probably six cars and ride through some of the most scenic landscapes in Southwestern Pennsylvania, and now I can tell you that my husband and I tailor the routes that we ride and the roads that we take, based on gas extraction and truck traffic.
>
> I think it left a lot of us who own small parcels of land that were carved out of farms a hundred years ago and who have well water, they're pretty vulnerable. I think that has been frustrating. There's just an edginess…My personal concerns are water contamination and disruption of my quality of life… (Resident 12).[186]

Just over half of respondents residing in Allegany County reported hiking as their primary outdoor activity; swimming and fishing were the next most popular activities. The popularity of such activities is likely due to the presence of the Great Allegheny Passage, also known as the GAP Trail. This world-class trail system crosses through many states including southwestern Pennsylvania and Western Maryland. In Garrett County, hiking was also the primary recreation activity for most respondents, with boating and fishing as other popular activities.

[186] Katherine D. Ferrari, "Rural Communities: How do Individuals Perceive Change When Industry Enters the Area?," dissertation, University of South Florida School of Social Work (October 15, 2013): 87, accessed May 21, 2014, http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=6009&context=etd.

Eighteen and 12 percent of respondents from Allegany and Garrett Counties, respectively, responded "other" when asked which activity they participate in most often. A number of those who responded "other" described primary activities such as biking, whitewater rafting, kayaking, golfing, and sightseeing. Western Maryland residents indicated that they currently enjoy diverse options for recreation, so changes to how and where they choose to recreate will depend on the number and location of wells.

7.2.2 Magnitude of Impacts

Quantifying the magnitude of tourism impacts proved challenging due to the lack of data on the impacts on tourism from drilling activities in comparable areas. However, RESI was able to develop some estimates for the possible impact to tourism's workforce and how they could impact the industry if shale drilling moves forward.

Impact on Tourism Workforce

As discussed in Section 3.0 of this report, the tourism, recreation, and entertainment industries are vulnerable to changes in labor costs and supply. Nearby drilling activity in Pennsylvania and West Virginia has already attracted commercial drivers away from Garrett County businesses and into higher paying jobs in the natural gas industry. This transfer of labor from tourism to energy can place upward pressure on labor costs at rates that some employers will simply be unable to afford.

Figure 23 compares annual salary and employment for heavy and tractor-trailer truck drivers in natural gas and tourism-related industries in the United States. RESI highlighted the heavy and tractor-trailer truck driver occupation because it was mentioned in both stakeholder interviews and existing research as an occupation found in both tourism- and natural gas-related sectors. The skills and training used to drive a truck in the tourism industry are similar enough to driving a truck in the natural gas industry. Therefore, a person with this occupation could quickly find higher paying employment in the natural gas industry.

Figure 23: Heavy and Tractor-Trailer Truck Drivers by Industry in 2012

Industry Sector (NAICS code)	Employment	Median Annual Wages
Natural Gas and Related Sectors		
Natural Gas Distribution (221200)	640	$52,390
Oil and Gas Extraction (211000)	1,040	$37,410
Support Activities for Mining (213000)	20,790	$37,330
Tourism and Related Sectors		
Performing Arts & Spectator Sports (711000)	370	$50,420
Amusement Gambling and Recreation (713000)	100	$31,310
Food Services and Drinking Places (722000)	480	$28,530
Membership and Civic Organizations (813000)	Not reported	$24,020

Sources: Bureau of Labor Statistics, RESI

Heavy and tractor-trailer truck drivers in tourism-related industries earned median annual wages up to $28,370 fewer than heavy truck drivers in the natural gas distribution sector. Employment and wages come from the Bureau of Labor Statistics' 2012 Current Employment Survey. Heavy and tractor-trailer truck drivers are paid slightly less in the extraction process but still paid up to $13,390 more than those workers in some of the tourism-related industries shown in Figure 23. The median hourly wage for a heavy truck driver in the natural gas distribution sector was $25, compared to median hourly wages of $12 to $15 per hour for tourism and related sectors.[187]

Other occupations that exist in both tourism and natural gas industries reveal similar differences in annual wages. Payroll and Timekeeping Clerks make nearly $4,000 more in median annual wages working in the natural gas industry compared to those in the tourism industry.[188] Mobile Heavy Equipment Mechanics earn nearly $13,000 more in the natural gas industry.[189] Conversely, Bureau of Labor Statistics data show that construction managers and trade workers earn less in the natural gas industry than the same occupations in the tourism industry, with median annual wages approximately $4,000 to $5,000 fewer in the natural gas industry.[190]

The Cornell University study on multiple shale plays included supportive findings regarding wage increases for existing occupations and industries, especially for trucking.[191] For general tourism employment, areas like Somerset and Fayette Counties in Pennsylvania experienced declines in employment between 2004 and 2009, representative of periods before and during drilling booms.[192] The same study found that changes in total employment, covering all industries, were not correlated with the presence of natural gas drilling in areas with a rural-urban code between 3 and 7, and tourism employment of 3.0 percent or more of total employment.[193]

The Cornell University study observed changes to tourism employment based on rural-urban classification and found severe decline in rural counties, modest decline in rural-urban counties, and modest growth in urban counties. County-level data do not, however, fully represent the varying impacts between communities within a county, and the authors recognize that impacts

[187] U.S. Bureau of Labor Statistics, "Occupation: Heavy and Tractor-Trailer Truck Drivers (SOC Code 533032)," from *Occupational Employment Statistics Query System*, May 2012, http://data.bls.gov/oes/.
[188] Ibid.
[189] Ibid.
[190] Ibid.
[191] Diaz et al., "Economic Implications of Marcellus Shale Natural Gas Development: Understanding Potential Impacts on Tourism, Agriculture and Housing," presentation, May 9, 2011, 8, http://cardi.cornell.edu/cals/devsoc/outreach/cardi/training/economic-implications-of-marcellus-shale-natural-gas-development.cfm.
[192] Ibid, 70.
[193] Ibid, 64.

are difficult to separate from other economic trends, such as the recent recession or local economic factors.[194]

Finding Comparison Cases

RESI compared counties with tourism activity and other characteristics similar to Western Maryland. Comparable counties were determined through communication with stakeholders and tourism bureaus within and outside Maryland and a comparison of the USDA rural-urban designations. A project from Cornell University also studied shale developments' impacts on tourism used the USDA rural-urban designations and tourism industry employment to compare different counties. The USDA's rural-urban designations are defined in Figure 24.

Figure 24: USDA 2013 Rural-Urban Continuum Codes

Code	Designation	Population
1	Metro	1 million or more
2	Metro	250,000 to 1 million
3	Metro	Less than 250,000
4	Nonmetro (metro adjacent), Urban	20,000 or more
5	Nonmetro (not metro adjacent), Urban	20,000 or more
6	Nonmetro, (metro adjacent) Urban	2,500 to 19,999
7	Nonmetro, (not metro adjacent) Urban	2,500 to 19,999
8	Nonmetro (urban adjacent), Rural	Less than 2,500
9	Nonmetro (not metro adjacent), Rural	Less than 2,500

Source: U.S. Department of Agriculture

As of 2013, the USDA designated Allegany and Garrett Counties by codes 3 and 6, respectively.[195] Popular tourism activities in both counties, as gleaned through RESI's survey and stakeholder interviews, include hiking, biking, whitewater rafting, and kayaking. Resort-themed activities, such as skiing, golfing, and relaxing, also proved popular. For comparison, RESI studied the tourism industry in two counties outside Maryland: Somerset County, Pennsylvania, and Lewis County, West Virginia. The counties are comparable to Allegany and Garret Counties in terms of their tourism industries but Marcellus Shale drilling has already occurred in the comparison counties. RESI also researched other counties' tourism promotion agencies for further comparison. Drilling areas with more urban settings and economic diversity were not compared to Western Maryland.

Somerset County is considered a code 4 in the rural-urban continuum and is part of the Laurel Highlands region of Pennsylvania. The Laurel Highlands Region shares the Great Allegheny Passage with Allegany County, Maryland.[196] Comparable tourism attractions include the Seven

[194] Diaz et al., "Economic Implications of Marcellus Shale Natural Gas Development," 70.
[195] U.S. Department of Agriculture, "2013 Rural-Urban Continuum Codes," updated May 5, 2013. http://www.ers.usda.gov/datafiles/RuralUrban_Continuum_Codes/ruralurbancodes2013.xls.
[196] Ibid.

Springs Mountain Resort and various biking, golfing, fishing, sightseeing, and other recreational and historical attractions. Lewis County is defined as code 7 and is home to Stonewall Jackson Lake and State Park, and the Stonewall Resort and Golf Course.[197] Lewis County is also home to a number of other scenic and protected lands, outdoor recreation areas, and historical attractions. In addition to similarities in tourism, Somerset and Lewis Counties have experienced relatively low-level drilling activity—activity similar to what is projected for Allegany and Garrett Counties in Maryland. RESI did not find reliable data to perform an independent analysis of drilling activity's impact on local tourism and recreation in comparable counties. Where available, RESI cited existing qualitative research from these comparable counties that characterizes tourism impacts based on surveys, testimony, or interviews stating perceived or observed changes to tourism where drilling has occurred.

Hotel Occupancy

Hotels became such a common choice for workers in the natural gas industry in Pennsylvania that a number of hotels began marketing directly to those working in the Marcellus Shale region. For example, the Shaner Hotel Group created a standalone website specifically marketed to the state's Marcellus Shale region, with one location in Pittsburgh and several in and around State College.[198] Many, if not all, of the Holiday Inn locations in and around the Marcellus Shale region have dedicated web pages marketed specifically toward worker accommodations. The Holiday Inn of Downtown Cumberland in Maryland had a page for the Marcellus Region before it became a Ramada Inn.[199]

In Pennsylvania, West Virginia, and Ohio, a hotel tax is collected for room stays of fewer than thirty consecutive days. After thirty consecutive days, a hotel guest is considered a resident and is no longer charged the hotel tax. This policy has kept states in the Marcellus and Utica Shale regions from fully capturing expenditures of the natural gas industry's employees who have booked rooms for six months to a year in response to housing shortages. Still, overall revenue generated from hotel taxes increased for many of the drilling counties.[200]

While a number of news articles have discussed hotel tax revenue growth as a boon for tourism in shale boomtowns, only a small minority of articles have investigated whether or not the increased revenues are from occupants in town for leisure or business. If workers comprise a majority of hotel visits in the Marcellus Shale region, tourists may be turned away from hotels. Due to increases in hotel tax revenues in some areas, TPAs are at risk of government offices reducing the share of revenues distributed to TPAs. The revenue may be used to invest in

[197] U.S. Department of Agriculture, "2013 Rural-Urban Continuum Codes."
[198] "Marcellus Shale Hotels," The Shaner Hotel Group, accessed March 10, 2014, www.marcellusshalehotels.com.
[199] "Marcellus Shale Region of PA Hotel Accommodations," Ramada Inn Cumberland-Downtown, accessed February 14, 2014, http://www.hicumberland.com/lp-marcellus-shale-region-pa/.
[200] Paula A. Duda Holoviak, "An Evaluation of Strategies and Finances of the Rural Tourism Industry," The Center for Rural Pennsylvania (April 2012): 23, accessed October 7, 2013, http://www.rural.palegislature.us/documents/reports/Evaluation_Rural_Tourism_Industry.pdf.

projects loosely defined as "tourism development," such as infrastructure investment in response to increased demand for local services.[201]

As reported in a recent article from Marietta, Ohio, the increase in hotel and motel occupancy was, during the most intense drilling phases, approximately 75 percent attributable to the transient workforce.[202] Despite the increase in occupancy, the City of Marietta splits its 6.0 percent hotel tax evenly with the Marietta-Washington County Convention and Visitors Bureau with no signs of reducing the Convention and Visitors Bureau's share of revenue unless state funding to Washington County continues to be cut.[203] Marietta is the county seat of Washington County, Ohio. The county's most intense years in terms of wells drilled were between 2005 and 2010, peaking in 2006 with thirty wells drilled that year.[204] This level of drilling activity, as well as the types of tourism activity in Marietta, is comparable to what is projected for Western Maryland.

Lodging owners and managers interviewed in the Marietta area noted the transient nature of oil and gas workers' occupation of their rooms. However, in some cases, the trend has already begun to reverse as other types of travelers increasingly occupy rooms. Conversely, one Councilperson reported a decline in tourism during the recession, with visitation only recently reversing. The influx of hotel tax revenues to the CVB are expected to improve tourism through increased marketing efforts to attract visitors to the area after shale activity subsides.[205]

Chris Richards, Executive Director of the Lewis County, West Virginia CVB described natural gas activity as "a double-edged sword."[206] While lodging businesses in the Stonewall Lake area benefit from high occupancy rates providing rooms for shale workers, a drawback has been instances when lodging facilities have turned visitors away on weekdays due to full occupancy. Visitors tend not to return on the weekends after being turned away on weekdays.[207] Hotels in Marietta described a similar scenario of full occupancy during the workweek followed by quiet weekends, when workers return to their families, until the work week began again.[208]

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[201] PATT/PRLA Room Tax Task Force, "Statewide Policy Recommendations 2013," presentation, accessed February 7, 2014, https://www.patravelandtourism.org/sites/default/files/Hotel%20Tax%20Taskforce%20-%20Statewide%20Policy%20Recommendations%202013.pptx.

[202] Evan Bevins, "Is upswing in hotel/motel tax tourism or oil and gas?" *Parkersburg News and Sentinel*, January 5, 2014, accessed February 23, 2014, http://www.newsandsentinel.com/page/content.detail/id/581858/Is-upswing-in-hotel-motel-tax-tourism-or-oil-and-gas-.html?nav=5054.

[203] Ibid.

[204] Ohio Oil and gas Association, "Summary of Ohio and Gas Activities (ODNR)," in *Downloadable Resources, 2004–2012*, accessed February 24, 2014, http://ooga.org/our-industry/ohio-oil-gas-activity/.

[205] Bevins, "Is upswing in hotel/motel tax tourism or oil and gas?"

[206] Chris Richards, Executive Director of Lewis County Convention and Visitors Bureau, personal communication, October 16, 2013.

[207] Ibid.

[208] Bevins, "Is upswing in hotel/motel tax tourism or oil and gas?"

Data on hotel tax revenues from both Lewis and Somerset Counties are not sufficient to determine impacts on tourism attributable to the presence of natural gas workers. Data are reported on an annual basis, and the coming and going of out-of-state workers appears to span weeks and months, not years. Monthly data on levels of hotel occupancy and numbers of taxable rooms may provide greater detail on how drilling activity affects tourists and other visitors. A representative from the Laurel Highlands tourism region did not have hotel tax data for the counties but did notice an increase in exempt rooms more than likely related to workers occupying rooms for more than thirty consecutive days.[209]

Impact on Water Resources

Aside from concerns about labor, the presence of drilling activity can greatly impact the availability and cost of other resources shared between related tourism and energy sectors. Water is one of the most widely used and scarce resources shared between existing businesses and residents in Western Maryland. The addition of another industry that uses significant amounts of water and other natural resources is cause for concern, based on stakeholder comments to RESI.

The impacts of increased water use will depend on whether businesses are pulling from the same sources, how intensely each is used, and how quickly the most used groundwater can recharge. Water use is an important aspect of tourism and related businesses in many ways, especially in Western Maryland, where the Youghiogheny watershed provides a prime whitewater rafting environment. Resort and recreation businesses in Garrett County's Deep Creek Lake area use water for various purposes, from drinking water for lodges and restaurants to snowmaking for over 170 acres of skiable slopes.[210] The policy of Maryland's water appropriation program is to issue permits to make reasonable use of water resources without unreasonable interference with other persons also attempting to make reasonable use of water. The permittee may not unreasonably harm water resources.[211]

The most recent data from USGS on water use at the county level reveals that industrial usage of 42.3 million gallons per day far exceeds usage by all other categories. Purposes of industrial water use are typically fabrication, processing, washing, diluting, cooling, or transportation of manufactured materials such as metals, wood and paper products, chemicals, and gasoline and oils.[212] Domestic, self-supplied use is second highest, at 9.6 million gallons per day, and public

[209] Nadine Yanarella, Vice President and Chief Financial Officer of Laurel Highlands Visitors Bureau, personal communication, October 7, 2013.
[210] "Mountain Information," Wisp Resort, accessed February 21, 2014, http://www.wispresort.com/mountain-information.php.
[211] Maryland Division of State Documents, "26.17.06.02", COMAR Online, accessed February 21, 2014, http://www.dsd.state.md.us/comar/.
[212] U.S. Geological Survey, "Industrial Water Use," The USGS Water Science School (March 17, 2014), accessed April 30, 2014, http://water.usgs.gov/edu/wuin.html.

supply ranks third, at 3.9 million gallons per day.[213] Commercial use of water was not reported in the most recent estimates from 2005.

Allegany County's major sources of public water are located in either Garrett County, Maryland, or Bedford County, Pennsylvania. Garrett County's water and sewerage plan acknowledges a lack of adequate data to determine actual usage and recharge rates, so actual usage could be higher or lower than estimated. The most recent water usage data from USGS was from 2005, indicating total withdraws of 8.4 million gallons per day in Garrett County. Public supply withdraws totaled 0.8 and 3.1 million gallons per day in Allegany and Garrett Counties, respectively.[214]

An increase in the use of water and other natural resources potentially impacts not only tourism-related businesses but also recreational users. Allegany County's water and sewerage plan lists a total of 69 impaired waterways, the majority of which were designated for aquatic life and wildlife, fishing, or recreational uses.[215] As indicated by stakeholder interviews and survey responses, residents highly value the quality of waterways for recreational use and preservation, and perceptions of impaired quality could change tourism activity in Western Maryland.

Summary

Tourism impacts alone are difficult to accurately quantify, and definitions of tourism activity can vary. Furthermore, while significant impacts have been observed and trends have been identified in mostly rural areas, the variance of impacts indicates a need for more detailed analysis. Nearly a decade after the drilling boom started in other states, existing research still does not differentiate impacts between types of tourism (entertainment, accommodation, recreation, etc.).

The lack of research is partially attributable to a lack of availability of uniform data for comparison across counties and across shale plays. State and local governments could benefit from evaluating existing hotel and amusement tax policies to ensure the full capture of expenditures from a transient workforce. RESI's research found that more accurate and robust data on tourism and visitation are necessary, including monthly, if not weekly, data on hotel tax revenues, industry-level employment, and other key indicators with which to compare the tourism and natural gas industries' coexistence over time.

Beyond identifying the need for more detailed tourism data, RESI's research did identify some potential impacts of the presence of drilling activity in Western Maryland. These impacts on

[213] U.S. Geological Survey, "Estimated Use of Water in the United States: County-Level Data for 2005," National Water Information Service, last modified February 24, 2014, accessed March 10, 2014, http://water.usgs.gov/watuse/data/2005/.
[214] Ibid.
[215] Allegany County Department of Community Services and Allegany County Department of Public Works, "Allegany County Water and Sewerage Plan 2011," November 29, 2012, 15–19.

tourism are reliant both on actual and perceived changes brought on by drilling activity. Survey responses revealed potential for changes in how and where people participate in outdoor recreation in Western Maryland. Specifically, nonresidents may have more flexibility to avoid Western Maryland if they perceive the local trails, streams, and woodlands to be of lesser quality near drilling activity, ultimately impacting the popular second-home market of Garrett County. In addition, tourists may have to compete with shale workers for hotel rooms both in terms of availability and room rates, depending on the level of drilling activity. Negative impacts on the tourism industry may be offset by increased hotel taxes in the short term, but state and local governments will need to evaluate existing hotel and amusement tax policies to fully capture the expenditures of a transient workforce, in addition to recognizing and managing impacts on tourism to sustain this long-term economic driver for Western Maryland.

For tourism businesses, annual wages in certain tourism sector occupations, such as trucking, would have to increase by up to $30,000 to compete with higher wages in natural gas and related sectors. Increased labor costs will not be limited to the tourism industry, but other industries requiring use of occupations such as heavy truck drivers will struggle to compete for qualified workers. Another cost of doing business is water use. As described by the USGS reports, industrial water use is more intensive than nonindustrial and residential uses. It is well known that new technology for natural gas extraction is water-intensive and will potentially impact water use by other users, including recreational users.

8.0 Economic and Fiscal Impacts

To analyze the economic and fiscal impacts associated with Marcellus Shale drilling in Western Maryland, RESI used several economic modeling tools including a dynamic input/output model, a WTP model, and a hedonic pricing model. Most prior studies regarding this topic have only used an input/output model. RESI expected that the inclusion of the WTP and the hedonic price models would provide more comprehensive estimates of economic and fiscal impacts.

The REMI PI+ tool, a dynamic input/output model, relies on known industry data such as forecasted natural gas prices, total EUR of a horizontal well, the level of estimated reserves in Maryland, and potential total shale gas extraction in the region. Through the research of industry-level data, RESI established input estimates for inclusion within the REMI PI+ tool. In addition to these industry specific economic and fiscal impacts, RESI sought to capture the effects associated with drilling on housing values and the value of preservation of wilderness.

To capture these effects, RESI relied on the use of industry-, state-, and local-level data as well as relevant responses to RESI's survey. These data provided estimates for elements ranging from preferences for environmental conservation to increased household disposable income due to drilling royalty payments. Additionally, GIS data regarding current well locations and recorder and assessor data for Maryland provided regional housing values and measurable attributes. Measureable attributes included the following:

- The number of bedrooms,

- The year of construction, and
- The home value.

These attributes provided RESI with data to create a hedonic model for the home values in Allegany and Garrett Counties. Through this hedonic model, RESI captured the potential impacts to home prices in the areas located within a half- to one-mile range of well locations. Royalty payments per well pad and housing value percentage change variables were then included in the model.

The following section briefly discusses the development of the REMI PI+ analysis that RESI conducted to determine the potential impacts in Western Maryland. For more information on the methodology or assumptions, please refer to Section 5.0.

8.1 Model Development

RESI reviewed the factors associated with Shale drilling using forecasted industry sales, housing price fluctuations, and royalty payments. These variables have been identified by existing research as key drivers of economic impacts from Marcellus Shale drilling.

Industry sales are often considered as the basis for economic research. Industry sales directly impact the level of employment, output, and wages created by the natural gas industry for Western Maryland. If the sales or demand for natural gas are high, then there will be an increase in the demand for labor within that industry. To meet this demand, producers may increase their production levels through expansion of existing operations.

The percentage change associated with home values located near operational wells is considered a secondary impact. RESI analyzed proximity to operational wells and determined that the closer the wells are to residential areas, the lower those property values will be. The decline in home price values may impact resale values for homeowners as well as their tax payments over time. The decline in home values may indirectly impact employment in other sectors, as governments may have fewer tax dollars to spend on public services, or affect the resale value of the home.

Royalty payments to landowners from natural gas producers can increase household income within a region. This increase in disposable income can allow residents to purchase goods they once could not afford. The increase in households' purchases could impact the economy's secondary employment in goods and services industries. These payments increase the cost to producers to do business in the region since they will pay households based on the amount extracted annually.

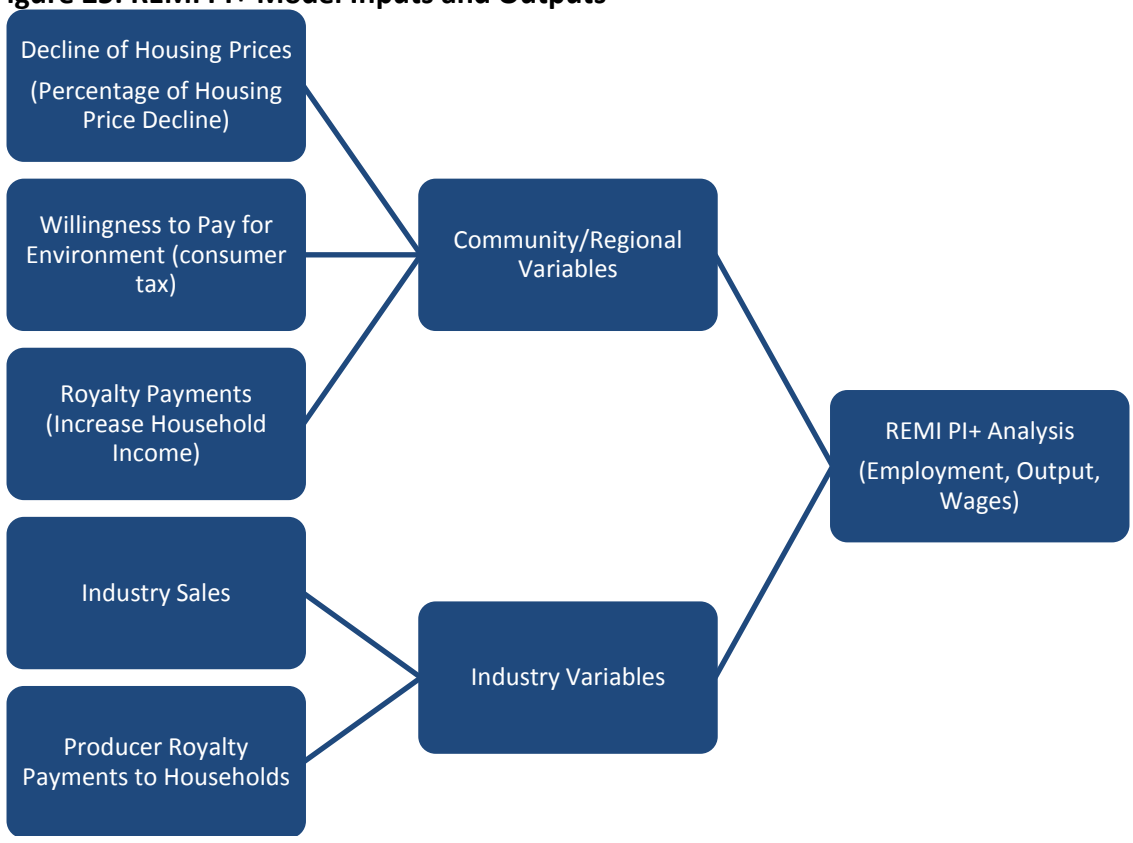
Western Maryland stakeholders expressed concern regarding the impact of Marcellus Shale drilling on the aesthetic quality of the environment in Western Maryland. Marcellus Shale drilling may deter visitors from the region if the aesthetic impacts are perceived to be

significant and apparent. However, if a conservation fund were implemented to mitigate these impacts and help maintain the aesthetic quality, this measure may help to maintain the attractiveness of the region for visitors. The WTP into the conservation fund represents a secondary impact to residents to conserve the environment. Paying into a conservation fund may ultimately reduce households' disposable income through annual personal tax increases, depending on how such payments are administered in the region. As a result, household spending on goods and services may decrease.

Of the numerous economic drivers associated with Marcellus Shale drilling, RESI identified four key drivers to include in the REMI PI+ analysis: (1) industry sales, (2) decline in housing prices, (3) royalty payments to households from producers, and (4) WTP for environment.

Figure 25 reports how the variables are captured and include within the REMI PI+ model.

Figure 25: REMI PI+ Model Inputs and Outputs



Sources: RESI, REMI PI+

RESI ran two drilling scenarios for both Allegany and Garrett Counties. Each REMI PI+ analysis reviewed the impact of Marcellus Shale drilling on each county's employment, output, and wages. Section 8.2 reports the findings from these analyses. Section 8.3 discusses the results.

For more information on the methodology (i.e., assumptions and scenarios), please refer to Section 5.0 of this report.

8.2 Potential Economic and Fiscal Impacts in Western Maryland

RESI incorporated the key economic drivers discussed in Section 8.1 into the REMI PI+ model and analyzed the results for employment, output, and wages over a twenty-year period. The following subsections detail the economic and fiscal impacts for each county for the baselines and the two drilling scenarios.

Under each scenario, RESI assumed that wells will be drilled from 2017 through 2026. No new wells are assumed to be drilled after 2026 in the region. All wells that are necessary for extraction will be completed within a ten-year timeframe. The baseline forecasts are reported first, and each scenario follows.

When reading the figures for the scenarios, note that these impacts are additional employment, output, and operation from the baseline forecasts. More detailed impacts reporting the direct, spinoff, and total impacts for employment, output, and wages for each scenario can be found in Appendix D.

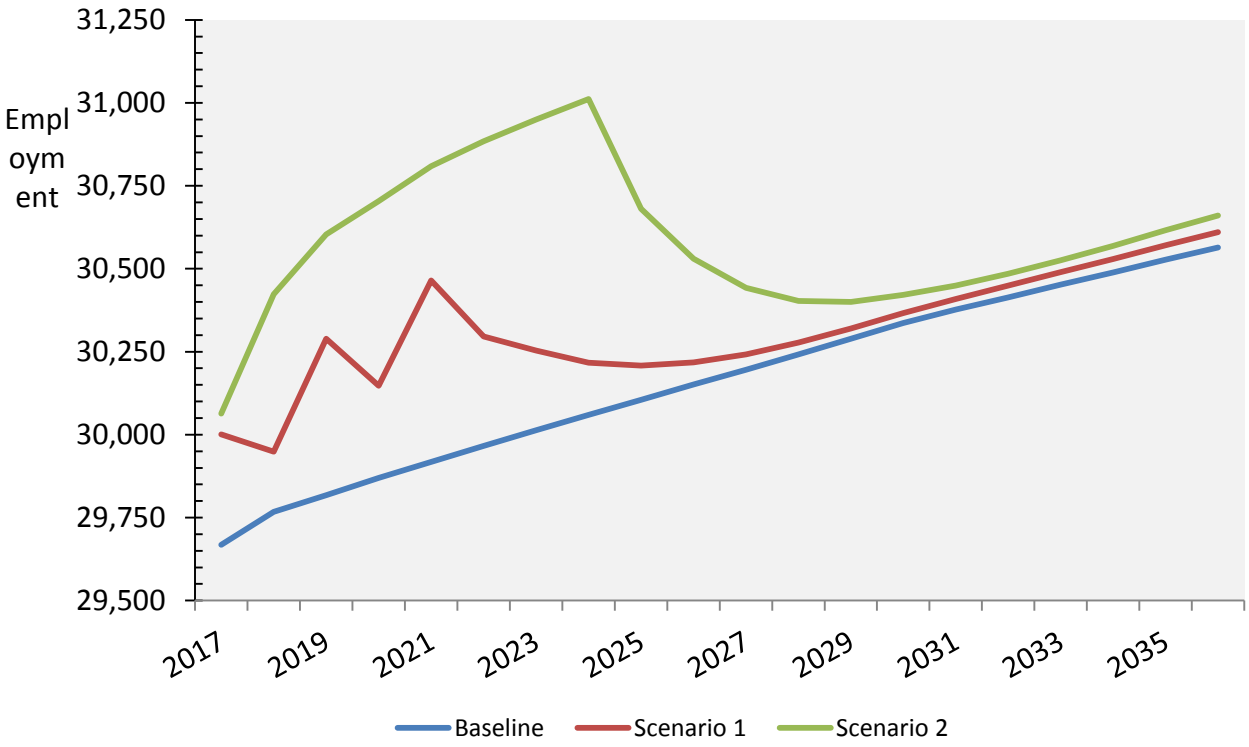
8.2.1 Economic Impacts

Allegany County

To determine the impacts on employment, output, and wages associated with Marcellus Shale drilling, RESI first created a baseline economic forecast for Allegany County's economy. The difference between the baseline and Scenario 1 (25 percent) and between the baseline and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix D of this report.

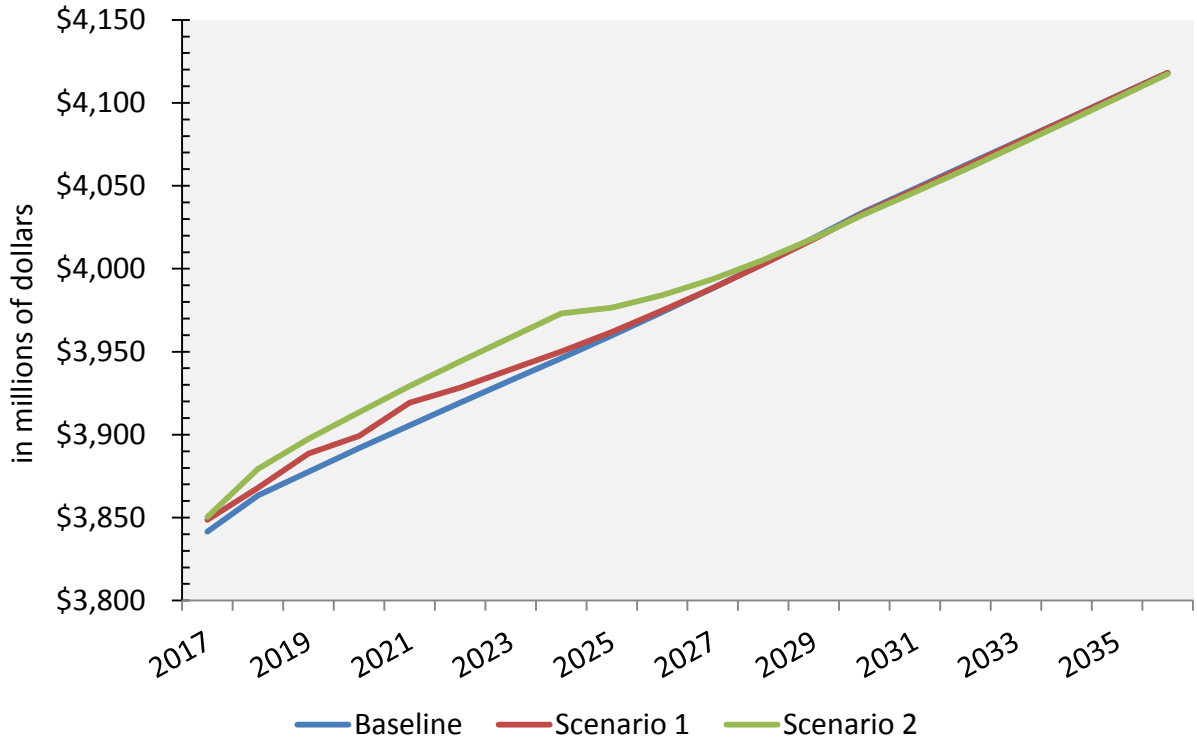
Figures 26 through 28 report the difference between the baseline and Scenario 1 (25 percent), and the baseline and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix D.

Figure 26: Employment Impacts from Shale Drilling in Allegany County



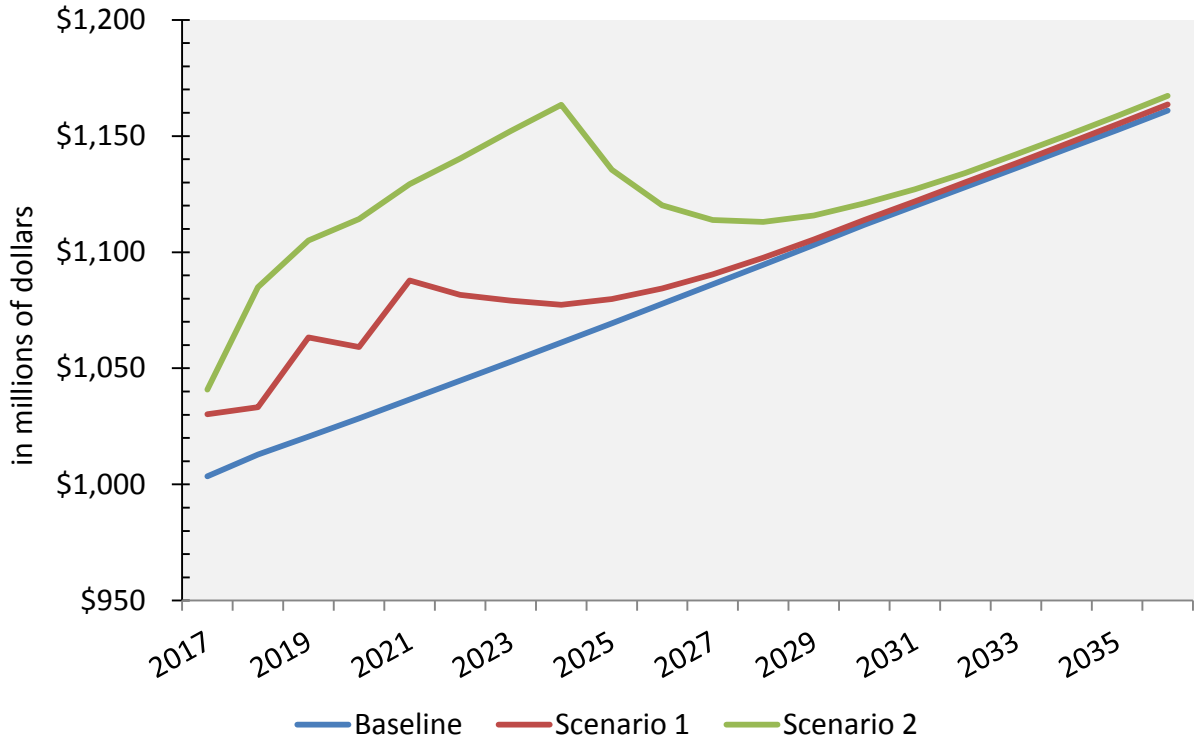
Sources: REMI PI+, RESI

Figure 27: Output Impacts from Shale Drilling in Allegany County



Sources: RESI, REMI PI+

Figure 28: Wage Impacts from Shale Drilling in Allegany County



Sources: RESI, REMI PI+

Figures 26 through 28 report the economic changes associated with Shale drilling in Allegany County. Under Scenario 1, Allegany would see minimal activity, adding only three additional well pads between 2017 and 2026. The results of this analysis can be found in Figure 29.

When comparing the baseline projections against RESI's scenarios, it is important to remember the following:

1. Wages change more slowly than output. Wages are typically tied to contracts for many employees and, although production may increase, wage levels may not increase at the same pace.
2. After the initial shock (in this case, drilling), an economy may seek to return to its initial growth after a period. Since this shock is short-lived (at approximately ten years), RESI expects that, after a period following the "bust," the economy will attempt to return to the typical steady pace of growth.

Figure 29: Economic Impacts for Allegany County—Scenario 1, 25% Extraction

Year	Number of New Wells	Employment Change	Output Change	Wage Change
2017	2	332.7	$26,733,398	$7,160,187
2018	3	181.7	$20,477,295	$4,650,116
2019	3	471.1	$42,755,127	$10,971,069
2020	3	277.4	$30,731,201	$7,358,551
2021	3	546.3	$51,208,496	$13,530,731
2022	3	329.8	$36,926,270	$9,090,424
2023	1	240.3	$26,245,117	$6,546,021
2024	0	157.3	$16,235,352	$3,971,100
2025	0	103.4	$10,437,012	$2,140,045
2026	0	66.9	$6,591,797	$843,048
2027	0	45.7	$4,333,496	-$22,888
2028	0	35.4	$3,051,758	-$499,725
2029	0	30.6	$2,319,336	-$789,642
2030	0	30.3	$2,136,230	-$823,975
2031	0	32.2	$2,014,160	-$751,495
2032	0	34.8	$2,075,195	-$633,240
2033	0	37.3	$2,136,230	-$450,134
2034	0	40.5	$2,258,301	-$251,770
2035	0	43.8	$2,441,406	-$106,812
2036	0	46.2	$2,624,512	-$38,147

Sources: REMI PI+, RESI

As reported in Figure 29, RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2021, adding 546.3 jobs, $51.2 million in output, and $13.5 million in wages. Under Scenario 1, drilling activities in Allegany County will increase employment over the baseline forecast by approximately 271 jobs on average annually between 2017 and 2026. In the period after drilling, 2027 through 2036, residual economic activity will change forecast baseline employment by an average of approximately 38 additional jobs annually. Additionally, the wages will increase over the baseline wage forecast between 2017 and 2026. During the ten-year period following no new additional drilling, the results indicate a loss of wages as the employment levels in higher wage earning sectors begin to decline.

Finally, RESI estimated Scenario 2, under which producers extract 75 percent of the total reserves in Maryland's Interior AU. Under this scenario, Allegany County would experience a more aggressive drilling atmosphere, increasing the current well pad total in the county from three to ten when compared to Scenario 1. Differences in employment, output, and wages are reported in Figure 30.

Figure 30: Economic Impacts for Allegany County—Scenario 2, 75% Extraction

Year	Number of New Wells	Employment Changes	Output Changes	Wage Changes
2017	6	395.0	$37,322,998	$8,953,094
2018	12	655.9	$72,113,037	$16,071,320
2019	9	785.3	$84,381,104	$19,851,685
2020	6	833.4	$85,784,912	$21,526,337
2021	7	890.6	$92,712,402	$23,647,308
2022	6	917.8	$95,642,090	$24,887,085
2023	6	937.0	$99,304,199	$25,978,088
2024	6	951.7	$102,416,992	$26,885,986
2025	2	576.0	$66,101,074	$16,769,409
2026	0	379.7	$42,480,469	$10,227,203
2027	0	246.1	$27,770,996	$5,428,314
2028	0	161.2	$18,493,652	$2,056,122
2029	0	111.0	$12,634,277	-$186,920
2030	0	85.3	$9,338,379	-$1,457,214
2031	0	71.9	$7,202,148	-$2,174,377
2032	0	70.7	$6,164,551	-$2,365,112
2033	0	73.9	$5,859,375	-$2,227,783
2034	0	80.0	$5,798,340	-$1,914,978
2035	0	88.9	$6,042,480	-$1,342,773
2036	0	96.7	$6,347,656	-$740,051

Sources: REMI PI+, RESI

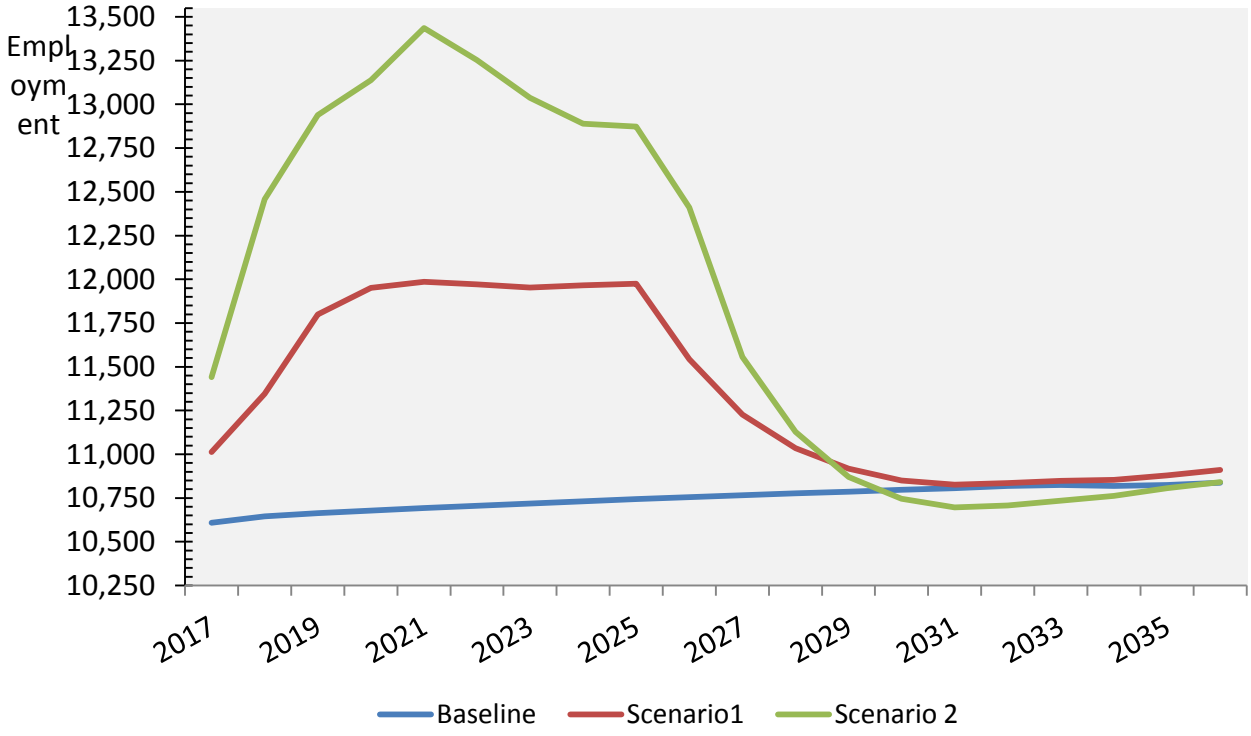
As reported in Figure 30, RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2024, adding 951.7 jobs, $102.4 million in output, and $26.9 million in wages. Under Scenario 2, drilling activities in Allegany County will increase employment over the baseline forecast by approximately 732 jobs on average annually between 2017 and 2026. In the period after drilling, 2027 through 2036, residual economic activity will change forecast baseline employment by an average of approximately 109 additional jobs annually. Additionally, the wages will increase over the baseline wage forecast between 2017 and 2026. The results indicate a decline from the initial forecasted income after 2029 as the employment levels in higher wage earning sectors begin to decline.

Garrett County

To determine the impacts on employment, output, and wages associated with Marcellus Shale drilling, RESI first created a baseline economic forecast for Garrett County's economy. The difference between Scenario 1 (25 percent) and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix D.

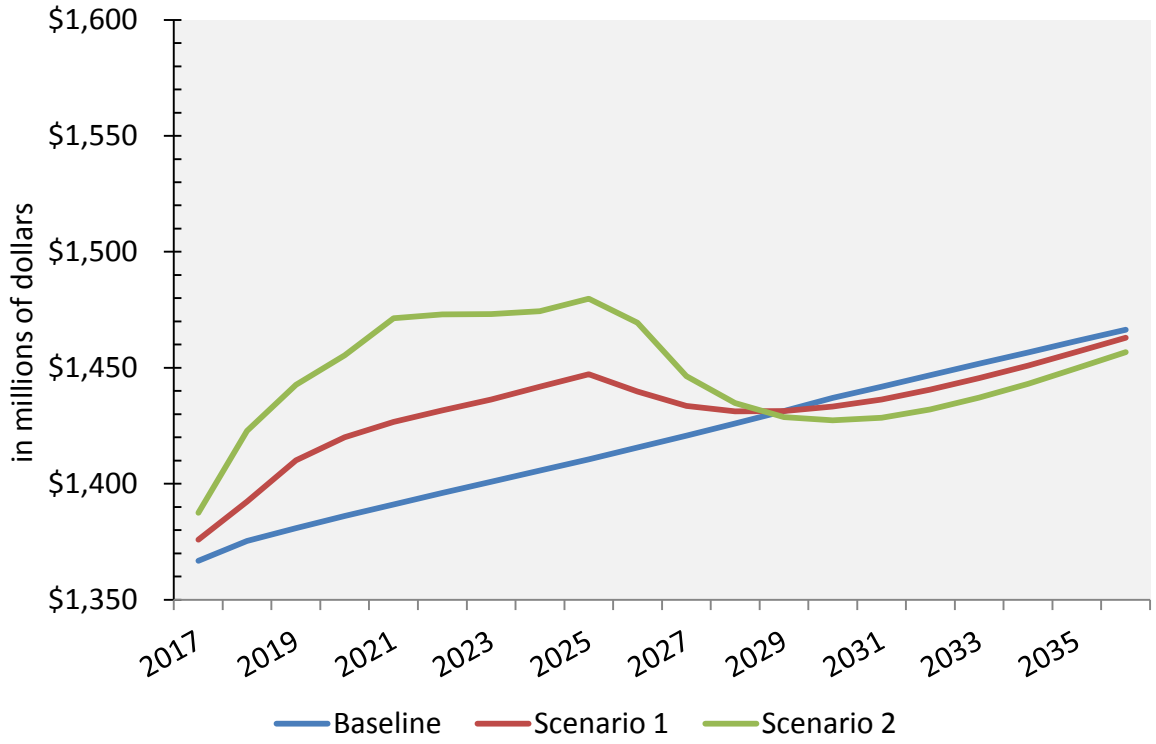
Figures 31 through 33 report the difference between the baseline and Scenario 1 (25 percent), and the baseline and Scenario 2 (75 percent) in the forecast is attributable to the amount of Marcellus Shale drilling. More detailed results from the baseline can be found in Appendix D of this report.

Figure 31: Employment Impacts from Shale Drilling in Garrett County



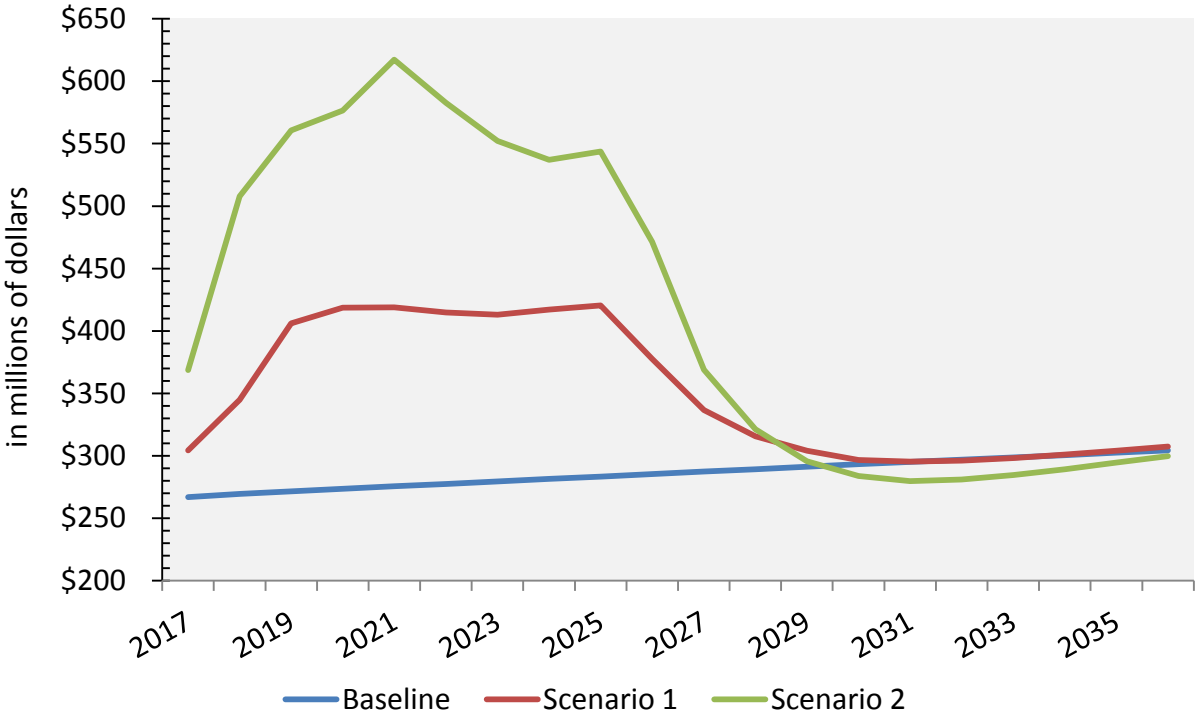
Sources: REMI PI+, RESI

Figure 32: Output Impacts from Shale Drilling in Garrett County



Sources: RESI, REMI PI+

Figure 33: Wage Impacts from Shale Drilling in Garrett County



Sources: RESI, REMI PI+

RESI first analyzed a 25 percent scenario case for drilling within the region. Under Scenario 1, Garrett would see modest increases in drilling activity, adding 22 additional well pads between 2017 and 2026. The results of this analysis can be found in Figure 34.

When comparing the baseline projections against RESI's scenarios, it is important to remember the following:

1. Wages change more slowly than output. Wages are typically tied to contracts for many employees and, although production may increase, wage levels may not increase at the same pace.
2. After the initial shock (in this case, drilling), an economy may seek to return to its initial growth after a period. Since this shock is short-lived (at approximately ten years), RESI expects that, after a period following the "bust," the economy will attempt to return to the typical steady pace of growth.

Figure 34: Economic Impacts for Garrett County—Scenario 1, 25% Extraction

Year	Number of New Wells	Employment Change	Output Change	Wage Change
2017	6	404.5	$37,506,104	$9,105,682
2018	13	701.4	$75,225,830	$16,998,291
2019	26	1,136.3	$134,582,520	$29,300,690
2020	19	1,271.3	$145,080,566	$33,931,732
2021	15	1,293.6	$143,371,582	$35,606,384
2022	12	1,265.1	$137,451,172	$35,690,308
2023	11	1,233.6	$133,544,922	$35,522,461
2024	12	1,233.4	$135,681,152	$36,167,145
2025	12	1,230.2	$137,084,961	$36,655,426
2026	6	788.5	$92,285,156	$24,253,845
2027	0	461.5	$49,316,406	$12,928,009
2028	0	257.0	$26,245,117	$5,245,209
2029	0	131.4	$12,756,348	-$64,850
2030	0	52.6	$3,417,969	-$3,757,477
2031	0	20.9	$244,141	-$5,558,014
2032	0	15.8	-$671,387	-$6,221,771
2033	0	22.9	-$427,246	-$6,130,219
2034	0	35.1	$366,211	-$5,630,493
2035	0	55.0	$1,770,020	-$4,631,042
2036	0	72.3	$3,051,758	-$3,555,298

Sources: REMI PI+, RESI

As reported in Figure 34, RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2021, adding 1,293.6 jobs, $143.4 million in output, and $35.6 million in wages. Despite no new drilling after 2027, the spinoff effects associated with drilling maintenance and initial industry boom may still linger in the region. Under Scenario 1, drilling activity in Garrett County will increase employment over the baseline forecast by an average of 1,056 jobs annually between 2017 and 2026.

The period after drilling, 2027 through 2036, will experience significantly less job retention, recording an average of approximately 113 additional jobs annually. This result is consistent with the projected experience in Allegany County. However, given the more rural nature of Garrett County and the greater intrusion by Shale operations, it is feasible that factors such as wages and output will experience a greater decline than in Allegany County.

Due to the economic climate in Garrett County, it is possible that the rural area will not be able to absorb the loss as well as the more urbanized Allegany County. Comparatively, Allegany County's baseline economic climate is nearly three times the size of Garrett County's prior to Marcellus Shale drilling. A smaller economy like that of Garrett County may have a more

difficult time absorbing the economic losses from a large operation such as Marcellus Shale drilling if activity were to suddenly cease.

Finally, RESI estimated Scenario 2, under which producers extract 75 percent of the total reserves in Maryland's Interior AU. Under this scenario, Garrett would experience a more aggressive drilling atmosphere, increasing the current well pad total in the county from 8 to 65. Differences in employment, output, and wages are reported in Figure 35.

Figure 35: Economic Impacts for Garrett County—Scenario 2, 75% Extraction

Year	Number of Wells	Employment Change	Output Change	Wage Change
2017	30	832.0	$101,867,676	$20,698,547
2018	60	1,812.0	$238,281,250	$47,500,610
2019	54	2,274.8	$289,123,535	$61,775,208
2020	48	2,458.9	$303,100,586	$69,282,532
2021	56	2,742.8	$341,796,875	$80,226,898
2022	36	2,547.7	$305,175,781	$77,075,958
2023	30	2,317.7	$272,705,078	$72,269,440
2024	30	2,156.6	$255,676,270	$68,775,177
2025	34	2,129.6	$260,437,012	$69,232,941
2026	12	1,654.4	$186,035,156	$53,909,302
2027	0	790.5	$81,481,934	$25,657,654
2028	0	350.8	$32,043,457	$8,819,580
2029	0	83.9	$4,272,461	-$2,689,362
2030	0	-51.6	-$9,338,379	-$9,605,408
2031	0	-108.9	-$15,197,754	-$13,397,217
2032	0	-111.5	-$15,808,105	-$14,739,990
2033	0	-90.9	-$14,160,156	-$14,595,032
2034	0	-57.1	-$11,291,504	-$13,526,917
2035	0	-18.3	-$7,873,535	-$11,764,526
2036	0	-2.9	-$4,516,602	-$9,750,366

Sources: REMI PI+, RESI

As reported in Figure 35, RESI expects that, during the "boom" years, the greatest change from the baseline will occur in 2021, adding 2,742.8 jobs, $341.8 million in output, and $80.2 million in wages. Under Scenario 2, drilling activity will increase employment over the baseline forecast by approximately 2,093 on average annually between 2017 and 2026. The period after drilling, 2027 through 2036, the county will experience significantly less job retention, recording an average of approximately 80 additional jobs annually when compared to the baseline forecast.

The results are consistent with the projected experience in Allegany County. However, wages will also experience a more pronounced fall in Garrett County after active drilling ceases under this scenario. Due to the economic climate in Garrett County, it is possible that the rural area

will not be able to absorb the loss as well as the more urbanized Allegany County. Discussion about the variance of these impacts can be found in Section 8.3.

Understanding the REMI PI+ Results

Figures 34 and 35 reference the differences under each scenario against RESI's baseline forecast for both counties. Under each scenario, RESI assumed that drilling will begin in 2017 and culminate in 2026. From 2027 through 2036, RESI assumed that no new wells will be drilled and that any remaining economic changes will be associated with the ongoing operation of the wells and residual impacts. Under this assumption, the wells are operational with minimal direct employment. However, royalty payments, conservation fund spending, and changes in home values remain in the region. Therefore, economic activity remains different from the baseline scenario because, without the drilling in the previous ten years, the residual economic impacts in the latter ten years would be nonexistent.

The positive growth in jobs with negative wage and output expectations is reflective of the types of jobs being gained and the losses incurred. The phenomenon can be better illustrated using an example. For instance, under the Allegany County Scenario 1 estimates, in 2036 the economy will gain 7 jobs in Retail Trade and lose 5 jobs in Construction compared to baseline projections. The net change in terms of employment appears to be a gain of 2 jobs, but these jobs offer varied median income per worker.

The Construction sector offers a significantly higher average annual wage than the Retail Trade sector. The wages lost in Construction totaled $392,900 in 2036 for Allegany County under Scenario 1. However, the wages gained in Retail Trade during that same year totaled $137,300. Taking the difference from wages gained and wages lost yields a net loss of $255,600 in wages in 2036, which is why the analysis can report net positive gains in employment with negative net wage impacts.

8.2.2 Fiscal Impacts

Allegany County

For each scenario, RESI analyzed the potential fiscal impacts associated with Marcellus Shale drilling in Allegany and Garrett Counties. Figure 36 represents the change in tax revenue impacts associated with Marcellus Shale drilling in Allegany under Scenario 1. These impacts are state tax revenues.

Figure 36: Fiscal Impacts Associated with Drilling in Allegany County—Scenario 1, 25% Extraction

Year	Property	Income	Sales	Payroll	Other[216]	Total
2017	$95,456	$67,096	$88,614	$1,785	$58,491	$311,443
2018	$333,671	$234,537	$309,753	$6,239	$204,458	$1,088,658
2019	$164,025	$115,293	$152,268	$3,067	$100,507	$535,160
2020	$407,495	$286,428	$378,286	$7,619	$249,694	$1,329,524
2021	$219,401	$154,217	$203,674	$4,102	$134,439	$715,833
2022	$187,616	$131,875	$174,167	$3,508	$114,962	$612,128
2023	$151,044	$106,168	$140,217	$2,824	$92,553	$492,806
2024	$125,029	$87,883	$116,067	$2,338	$76,612	$407,929
2025	$105,135	$73,899	$97,599	$1,966	$64,422	$343,021
2026	$91,526	$64,333	$84,965	$1,711	$56,083	$298,618
2027	$84,720	$59,550	$78,647	$1,584	$51,912	$276,413
2028	$79,338	$55,767	$73,651	$1,483	$48,615	$258,853
2029	$77,509	$54,481	$71,953	$1,449	$47,494	$252,887
2030	$75,592	$53,133	$70,173	$1,413	$46,319	$246,631
2031	$76,641	$53,871	$71,147	$1,433	$46,962	$250,054
2032	$76,230	$53,582	$70,766	$1,425	$46,710	$248,712
2033	$78,939	$55,486	$73,281	$1,476	$48,370	$257,553
2034	$82,258	$57,819	$76,362	$1,538	$50,404	$268,381
2035	$85,582	$60,155	$79,447	$1,600	$52,441	$279,225
2036	$86,063	$60,494	$79,894	$1,609	$52,736	$280,797

Sources: REMI PI+, RESI

During the height of drilling activity, RESI estimates that tax revenues will increase annually by $0.6 million on average. During the ten-year period after active drilling, tax revenues will increase by $0.3 million annually. The results shown here are additional state tax revenues associated with drilling in Allegany County only. Figure 37 reports the total, state, and local share of property and income taxes attributable to the drilling period for Scenario 1 in Allegany County.

[216] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 37: Local Income and Property Fiscal Impacts Associated with Drilling in Allegany County—Scenario 1, 25% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$67,096	$41,108	$25,988	$95,456	$9,790	$85,666
2018	$234,537	$143,695	$90,842	$333,671	$34,223	$299,448
2019	$115,293	$70,637	$44,656	$164,025	$16,823	$147,202
2020	$286,428	$175,487	$110,941	$407,495	$41,794	$365,701
2021	$154,217	$94,485	$59,732	$219,401	$22,503	$196,898
2022	$131,875	$80,796	$51,079	$187,616	$19,243	$168,373
2023	$106,168	$65,046	$41,122	$151,044	$15,492	$135,552
2024	$87,883	$53,844	$34,039	$125,029	$12,823	$112,206
2025	$73,899	$45,276	$28,623	$105,135	$10,783	$94,352
2026	$64,333	$39,415	$24,918	$91,526	$9,387	$82,139
2027	$59,550	$36,485	$23,065	$84,720	$8,689	$76,031
2028	$55,767	$34,167	$21,600	$79,338	$8,137	$71,201
2029	$54,481	$33,379	$21,102	$77,509	$7,950	$69,559
2030	$53,133	$32,553	$20,580	$75,592	$7,753	$67,839
2031	$53,871	$33,005	$20,866	$76,641	$7,861	$68,780
2032	$53,582	$32,828	$20,754	$76,230	$7,818	$68,412
2033	$55,486	$33,995	$21,491	$78,939	$8,096	$70,843
2034	$57,819	$35,424	$22,395	$82,258	$8,437	$73,821
2035	$85,582	$60,155	$79,447	$85,582	$8,778	$76,804
2036	$86,063	$60,494	$79,894	$86,063	$8,827	$77,236

Sources: REMI PI+, RESI

With the increased activity under Scenario 2, Allegany County will experience an increase to total State tax revenues over the twenty-year period.[217] These results can be found in Figure 38.

[217] These tax revenues do not include additional severance tax revenues potentially collected at the county level.

Figure 38: Fiscal Impacts Associated with Drilling in Allegany County—Scenario 2, 75% Extraction

Year	Property	Income	Sales	Payroll	Other[218]	Total
2017	$406,185	$285,507	$377,070	$7,595	$248,891	$1,325,248
2018	$491,524	$345,492	$456,291	$9,190	$301,183	$1,603,680
2019	$546,475	$384,117	$507,303	$10,218	$334,855	$1,782,967
2020	$609,624	$428,504	$565,926	$11,399	$373,550	$1,989,003
2021	$658,737	$463,026	$611,519	$12,317	$403,644	$2,149,244
2022	$706,353	$496,495	$655,722	$13,207	$432,821	$2,304,598
2023	$750,531	$527,547	$696,733	$14,033	$459,891	$2,448,735
2024	$477,225	$335,441	$443,018	$8,923	$292,422	$1,557,030
2025	$386,710	$271,818	$358,991	$7,231	$236,958	$1,261,708
2026	$316,900	$222,749	$294,185	$5,925	$194,182	$1,033,940
2027	$268,532	$188,751	$249,284	$5,021	$164,544	$876,133
2028	$233,651	$164,233	$216,903	$4,369	$143,171	$762,326
2029	$213,266	$149,904	$197,979	$3,988	$130,680	$695,816
2030	$196,580	$138,176	$182,489	$3,676	$120,455	$641,375
2031	$191,680	$134,731	$177,940	$3,584	$117,452	$625,388
2032	$189,484	$133,188	$175,901	$3,543	$116,107	$618,223
2033	$188,194	$132,282	$174,704	$3,519	$115,317	$614,016
2034	$194,180	$136,489	$180,261	$3,631	$118,985	$633,546
2035	$201,443	$141,594	$187,004	$3,767	$123,435	$657,242
2036	$207,903	$146,135	$193,000	$3,887	$127,393	$678,318

Sources: REMI PI+, RESI

During the height of drilling activity, RESI estimates that tax revenues will increase annually by $1.7 million on average. During the ten-year period after active drilling, tax revenues will increase by $0.7 million annually. The results shown here are additional state tax revenues associated with drilling in Allegany County only. Figure 39 reports the total, state, and local share of property and income taxes attributable to the drilling period for Scenario 2 in Allegany County.

[218] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 39: Local Income and Property Fiscal Impacts Associated with Drilling in Allegany County—Scenario 2, 75% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$285,507	$174,923	$110,584	$406,185	$41,660	$364,525
2018	$345,492	$211,674	$133,818	$491,524	$50,413	$441,111
2019	$384,117	$235,338	$148,779	$546,475	$56,049	$490,426
2020	$428,504	$262,533	$165,971	$609,624	$62,526	$547,098
2021	$463,026	$283,684	$179,342	$658,737	$67,563	$591,174
2022	$496,495	$304,189	$192,306	$706,353	$72,446	$633,907
2023	$527,547	$323,214	$204,333	$750,531	$76,978	$673,553
2024	$335,441	$205,516	$129,925	$477,225	$48,946	$428,279
2025	$271,818	$166,536	$105,282	$386,710	$39,663	$347,047
2026	$222,749	$136,472	$86,277	$316,900	$32,503	$284,397
2027	$188,751	$115,643	$73,108	$268,532	$27,542	$240,990
2028	$164,233	$100,621	$63,612	$233,651	$23,964	$209,687
2029	$149,904	$91,842	$58,062	$213,266	$21,873	$191,393
2030	$138,176	$84,657	$53,519	$196,580	$20,162	$176,418
2031	$134,731	$82,546	$52,185	$191,680	$19,659	$172,021
2032	$133,188	$81,601	$51,587	$189,484	$19,434	$170,050
2033	$132,282	$81,046	$51,236	$188,194	$19,302	$168,892
2034	$136,489	$83,623	$52,866	$194,180	$19,916	$174,264
2035	$141,594	$86,751	$54,843	$201,443	$20,661	$180,782
2036	$146,135	$89,533	$56,602	$207,903	$21,323	$186,580

Sources: REMI PI+, RESI

Under Scenario 2 for Allegany County, RESI found similar impacts to those for Scenario 1 over the drilling period. As reported in Figure 39, RESI expects that there will be increased tax revenues during the drilling period.

Garrett County

RESI analyzed the fiscal impacts associated with Shale drilling in Garrett County. Figure 40 represents the change in tax revenues associated with Marcellus Shale drilling in Garrett County under Scenario 1. These impacts are state tax revenues.

Figure 40: Fiscal Impacts Associated with Drilling in Garrett County—Scenario 1, 25% Extraction

Year	Property	Income	Sales	Payroll	Other[219]	Total
2017	$432,164	$303,768	$401,186	$8,081	$264,810	$1,410,008
2018	$663,325	$466,250	$615,778	$12,403	$406,455	$2,164,211
2019	$763,718	$536,816	$708,974	$14,280	$467,971	$2,491,759
2020	$820,531	$576,751	$761,715	$15,342	$502,784	$2,677,123
2021	$852,857	$599,473	$791,724	$15,947	$522,592	$2,782,592
2022	$886,743	$623,291	$823,181	$16,580	$543,355	$2,893,150
2023	$932,668	$655,572	$865,815	$17,439	$571,496	$3,042,990
2024	$974,455	$684,943	$904,606	$18,220	$597,101	$3,179,325
2025	$661,791	$465,172	$614,354	$12,374	$405,515	$2,159,205
2026	$497,605	$349,766	$461,937	$9,304	$304,910	$1,623,522
2027	$385,385	$270,887	$357,760	$7,206	$236,146	$1,257,384
2028	$306,541	$215,468	$284,568	$5,732	$187,834	$1,000,143
2029	$247,599	$174,037	$229,851	$4,630	$151,717	$807,833
2030	$212,819	$149,590	$197,564	$3,979	$130,406	$694,358
2031	$195,126	$137,154	$181,139	$3,648	$119,564	$636,632
2032	$185,682	$130,516	$172,372	$3,472	$113,777	$605,819
2033	$182,103	$128,000	$169,050	$3,405	$111,584	$594,141
2034	$189,335	$133,083	$175,763	$3,540	$116,015	$617,736
2035	$196,132	$137,861	$182,073	$3,667	$120,180	$639,913
2036	$204,710	$143,890	$190,036	$3,828	$125,437	$667,900

Sources: REMI PI+, RESI

During the height of drilling activity, RESI estimates that tax revenues will increase annually by $2.4 million on average. During the ten-year period after active drilling, tax revenues will increase by $0.8 million annually. The results shown here are additional state tax revenues associated with drilling in Garrett County only. Figure 41 reports the total, state, and local share of property and income taxes attributable to the drilling period for Scenario 1 in Garrett County.

[219] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 41: Local Income and Property Fiscal Impacts Associated with Drilling in Garrett County—Scenario 1, 25% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$303,768	$196,236	$107,532	$432,164	$43,922	$388,242
2018	$466,250	$301,200	$165,050	$663,325	$67,416	$595,909
2019	$536,816	$346,786	$190,030	$763,718	$77,619	$686,099
2020	$576,751	$372,585	$204,166	$820,531	$83,393	$737,138
2021	$599,473	$387,263	$212,210	$852,857	$86,679	$766,178
2022	$623,291	$402,650	$220,641	$886,743	$90,123	$796,620
2023	$655,572	$423,503	$232,069	$932,668	$94,790	$837,878
2024	$684,943	$442,477	$242,466	$974,455	$99,037	$875,418
2025	$465,172	$300,504	$164,668	$661,791	$67,260	$594,531
2026	$349,766	$225,951	$123,815	$497,605	$50,573	$447,032
2027	$270,887	$174,995	$95,892	$385,385	$39,168	$346,217
2028	$215,468	$139,194	$76,274	$306,541	$31,155	$275,386
2029	$174,037	$112,429	$61,608	$247,599	$25,164	$222,435
2030	$149,590	$96,636	$52,954	$212,819	$21,630	$191,189
2031	$137,154	$88,602	$48,552	$195,126	$19,831	$175,295
2032	$130,516	$84,314	$46,202	$185,682	$18,871	$166,811
2033	$128,000	$82,689	$45,311	$182,103	$18,508	$163,595
2034	$133,083	$85,972	$47,111	$189,335	$19,243	$170,092
2035	$137,861	$89,059	$48,802	$196,132	$19,934	$176,198
2036	$143,890	$92,954	$50,936	$204,710	$20,805	$183,905

Sources: REMI PI+, RESI

Finally, RESI reviewed the potential fiscal impacts associated with Shale drilling in Garrett County for Scenario 2. The increased drilling activity would result in increased additional tax revenues over the twenty-year period, as reported in Figure 42.

Figure 42: Fiscal Impacts Associated with Drilling in Garrett County—Scenario 2, 75% Extraction

Year	Property	Income	Sales	Payroll	Other[220]	Total
2017	$950,952	$668,423	$882,788	$17,781	$582,700	$3,102,644
2018	$1,209,564	$850,202	$1,122,863	$22,616	$741,165	$3,946,411
2019	$1,361,391	$956,921	$1,263,807	$25,455	$834,198	$4,441,773
2020	$1,578,684	$1,109,656	$1,465,524	$29,518	$967,345	$5,150,727
2021	$1,562,629	$1,098,371	$1,450,620	$29,218	$957,507	$5,098,345
2022	$1,531,021	$1,076,153	$1,421,278	$28,627	$938,139	$4,995,218
2023	$1,521,028	$1,069,130	$1,412,001	$28,440	$932,016	$4,962,616
2024	$1,571,783	$1,104,805	$1,459,118	$29,389	$963,117	$5,128,212
2025	$1,370,492	$963,318	$1,272,256	$25,625	$839,775	$4,471,466
2026	$820,429	$576,679	$761,620	$15,340	$502,721	$2,676,789
2027	$582,365	$409,344	$540,621	$10,889	$356,846	$1,900,064
2028	$412,266	$289,782	$382,715	$7,708	$252,618	$1,345,089
2029	$306,549	$215,473	$284,576	$5,732	$187,839	$1,000,170
2030	$238,664	$167,756	$221,556	$4,462	$146,242	$778,681
2031	$204,549	$143,777	$189,887	$3,825	$125,338	$667,377
2032	$185,691	$130,522	$172,381	$3,472	$113,783	$605,848
2033	$178,220	$125,271	$165,446	$3,332	$109,205	$581,475
2034	$183,060	$128,673	$169,938	$3,423	$112,171	$597,264
2035	$192,662	$135,422	$178,852	$3,602	$118,054	$628,592
2036	$201,798	$141,843	$187,333	$3,773	$123,652	$658,399

Sources: REMI PI+, RESI

During the height of drilling activity, RESI estimates that tax revenues will increase annually by $4.4 million on average. During the ten-year period after active drilling, tax revenues will increase by $0.9 million annually. The results shown here are additional state tax revenues associated with drilling in Garrett County only. Figure 43 reports the total, state, and local share of property and income taxes attributable to the drilling period for Scenario 2 in Garrett County.

[220] Other taxes include other forms of fees and taxes such as licenses, permits, etc.

Figure 43: Local Income and Property Fiscal Impacts Associated with Drilling in Allegany County—Scenario 1, 25% Extraction

Year	Total Income Tax	State Share	Local Share	Total Property Tax	State Share	Local Share
2017	$668,423	$431,805	$236,618	$950,952	$96,648	$854,304
2018	$850,202	$549,235	$300,967	$1,209,564	$122,932	$1,086,632
2019	$956,921	$618,177	$338,744	$1,361,391	$138,363	$1,223,028
2020	$1,109,656	$716,844	$392,812	$1,578,684	$160,447	$1,418,237
2021	$1,098,371	$709,554	$388,817	$1,562,629	$158,815	$1,403,814
2022	$1,076,153	$695,201	$380,952	$1,531,021	$155,603	$1,375,418
2023	$1,069,130	$690,664	$378,466	$1,521,028	$154,587	$1,366,441
2024	$1,104,805	$713,711	$391,094	$1,571,783	$159,746	$1,412,037
2025	$963,318	$622,309	$341,009	$1,370,492	$139,288	$1,231,204
2026	$576,679	$372,538	$204,141	$820,429	$83,383	$737,046
2027	$409,344	$264,439	$144,905	$582,365	$59,188	$523,177
2028	$289,782	$187,201	$102,581	$412,266	$41,900	$370,366
2029	$215,473	$139,197	$76,276	$306,549	$31,156	$275,393
2030	$167,756	$108,371	$59,385	$238,664	$24,256	$214,408
2031	$143,777	$92,881	$50,896	$204,549	$20,789	$183,760
2032	$130,522	$84,318	$46,204	$185,691	$18,872	$166,819
2033	$125,271	$80,926	$44,345	$178,220	$18,113	$160,107
2034	$128,673	$83,124	$45,549	$183,060	$18,605	$164,455
2035	$135,422	$87,483	$47,939	$192,662	$19,581	$173,081
2036	$141,843	$91,631	$50,212	$201,798	$20,509	$181,289

Sources: REMI PI+, RESI

8.3 Summary

The natural gas industry, like most businesses, experiences a "boom and bust" cycle. Essentially, a period of increased activity, or "boom," is followed by a period of decreased activity, or "bust." From the housing market to the stock market, most goods and services experience this trend. The natural gas industry is not an exception to the rule. The majority of the intense labor occurs during the active drilling period, with a minimal need for labor after active drilling.

A 2012 study by Weber found that counties where drilling did occur saw modest increases in their employment and wages, as did adjacent regions.[221] It has been noted in Pennsylvania that, after a well is drilled, the number of direct full-time equivalent employment drops significantly to less than one annually.[222]

[221] Jeremy G. Weber, "The Effects of a Natural Gas Boom on Employment and Income in Colorado, Texas, and Wyoming," *Energy Economics* 34 (2012): 1587, http://dx.doi.org/10.1016/j.eneco.2011.11.013.
[222] Kelsey et al., "Economic Impacts of Marcellus Shale in Pennsylvania: Employment and Income in 2009," 12.

In the case of Scenario 1, both counties will feel an economic "boom" followed by a "bust" associated with Marcellus Shale drilling. However, in Allegany County, where the number of total wells and well pads is assumed to be significantly fewer than for Garrett County, the "bust" will likely occur soon after 2027 with minimal impact on the economy from the loss of economic activity. Since Allegany County is more urbanized than Garrett County, Allegany County may be able to absorb more of the decline from the receding economic activity associated with active drilling in the region. In Garrett County, the "bust" is likely to occur much later due to the greater number of wells still producing after 2027, but will likely be greater due the more significant economic change.

Since REMI PI+ is a dynamic tool, the forecast changes continuously for wages and output based on the new level from the previous year. Therefore, the forecast for 2027 based on 2026 wages indicated a potentially higher wage level than what occurred under Scenario 1. These findings are important as they do fit with previous literature indicating a potential "boom and bust" cycle typically associated with shale drilling.

However, this "boom and bust" cycle is less pronounced for Allegany County in Scenario 2, given the increased number of wells and the increased volume of production over time. However, the size of Allegany County's baseline economy compared to the size of economic change from Marcellus Shale drilling mitigates the significant "bust" potential in Scenario 2. Despite the increased economy activity, a "bust" does appear to occur after 2029. If no new wells are drilled after 2026, at this level of drilling, Allegany County would still experience the "boom and bust" cycle of natural gas.

Additionally, Garrett County would experience a similar bust cycle in Scenario 2, much like that recorded under Scenario 1. However, the economic magnitude of Marcellus Shale drilling in Garrett County will be significantly larger than Allegany County, which is a contributing factor to the larger loss in the "bust" portion of the cycle. Garrett County, unlike Allegany County, has more opportunities for Marcellus Shale extraction. This larger area ultimately suggests more well pads to be drilled in this region.

Given the initial size of Garrett County's workforce, the size of the economic activity associated with Marcellus Shale may exceed the current economy's labor supply. As the economy grows to meet new demand, the sudden end in operations may lead to an oversupply of labor. Since the economic demand for services was initially smaller, it may be more difficult for the more rural Garrett County to absorb the new workers brought on to meet demand during Marcellus Shale drilling operations. This may provide an explanation for the decreasing impacts seen in Scenario 2 between Allegany and Garrett Counties.

Figure 35 highlights the "bust" experienced in Garrett County. However, as previously stated, the greater number of wells being drilled will increase economic activity prior to the immediate end of drilling operations. After 2026 the chance for a larger decline in economic activity is greater, as reported in Scenario 2 for Garrett County.

RESI determined from its analysis that the size of the economy prior to Marcellus Shale drilling and the amount of drilling to take place can affect how heavily the surrounding economy is affected. For more rural counties, such as Garrett County, RESI observed large build out fluctuations with an equally great economic decline when drilling operations end. For less rural areas, such as Allegany County, the same trend occurs but is less pronounced due to the economy's existing size and the lower magnitude of drilling compared to Garrett County.

9.0 Summary and Conclusion

Given the broad range of potential impacts of Marcellus Shale drilling, RESI focused on several topic areas for review: community impacts, tourism-related impacts, and economic and fiscal impacts. RESI's approach to estimating these potential impacts involved three main tasks: (1) stakeholder engagement; (2) research and data collection and analysis regarding housing, truck trips, and tourism; and (3) an input/output analysis.

Community Impacts

RESI's discussions with community members and local representatives revealed several major areas of concerns:

- Agriculture,
- Education and schools,
- Environmental protection,
- Housing availability and values,
- Infrastructure and investment,
- Economic and fiscal sustainability, and
- Property rights.

Stakeholders interviewed from Allegany County appeared more supportive of drilling compared to interviewees from Garrett County, likely due to the fact that the Marcellus Shale play underlies nearly all of Garrett County and only a small western section of Allegany County.

As well as being an area of concern for stakeholders, housing is one of the most studied impacts on drilling communities. Additional research regarding housing indicated that Western Maryland has a sufficient housing surplus, not accounting for construction of new units or deterioration of existing units, to handle the projected population growth attributable to drilling activity.

Tourism-related Impacts

While housing is a major area of study in regard to drilling activity, tourism-related impacts are less well documented. The lack of research is partially attributable to a lack of availability of uniform data for comparison across counties and across shale plays. State and local governments could benefit from evaluating existing hotel and amusement tax policies to ensure the full capture of expenditures from a transient workforce. RESI's research also indicated that more accurate and robust data on tourism and visitation are necessary, including monthly, if

not weekly, data on hotel tax revenues, industry-level employment, and other key indicators with which to compare the tourism and natural gas industries' coexistence over time.

Survey responses revealed potential for changes in how and where people participate in outdoor recreation in Western Maryland. Negative impacts on the tourism industry may be avoidable if the region is able to recognize and manage the impacts on tourism to sustain this long-term economic driver for Western Maryland.

Economic and Fiscal Impacts

RESI's findings from the economic and fiscal impact analysis supported the natural gas "boom and bust" cycle model. In the case of both scenarios modeled by RESI, both counties will feel an economic "boom" and then a "bust" associated with Marcellus Shale drilling. Factors such as housing values, industry sales, royalty payments, and WTP for wilderness conservation were determined to be key indicators of economic change associated with Marcellus Shale drilling. These indicators were included in the input/output model as they were likely to capture all the factors that could influence the impacts of shale gas drilling.

The size and scope of the economy prior to shale drilling and the amount of drilling to take place can affect how heavily a region is impacted. Garrett County is likely to experience greater build out fluctuations with an equally great economic decline when drilling ends. For Allegany County, the same trend occurs but is less pronounced due to the economy's existing size and the lower magnitude of drilling compared to Garrett County.

Conclusion

Extensive research indicates that the potential community, tourism-related, and economic and fiscal impacts—including but not limited to impacts to agriculture, schools, environmental amenities, health and safety, housing, traffic and roads, tourism and recreation—of shale gas drilling vary depending on numerous factors, ranging from well pad build out to royalty payments. Although RESI's literature review revealed that natural gas extraction activities typically follow a "boom and bust" cycle, most other states that are considering or currently allow shale gas drilling expect that such activity will generate positive economic impacts, at least during peak drilling activity.

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Appendix A—Hedonic Pricing Analysis

Indirect methodology is often used to measure individuals' desire for economic change. Methods such as hedonic price analysis are often employed to seek out the underlying preference of buyers within a region for certain items given particular attributes. The following appendix outlines the use of hedonic pricing analysis in previous shale studies and the incorporation of data used in RESI's analysis. For more detail on the analysis please refer to Appendix C of this report.

A.1 Existing Literature

The hedonic pricing analysis methodology was first employed by Rosen in 1974, where research looked at the potential implicit product differentiation in purely competitive markets.[223] A hedonic model assists in determining the implicit price associated with a good when an equation is created to determine the association of the good's price and corresponding attributes of the good.[224] With respect to home prices, a market considered to be competitive but highly differentiated, some researchers have established that hedonic models often yield more accurate reflections of the values associated with home attributes over the traditional ordinary least squares models.[225]

OLS models seek to draw direct relationships between home prices and tangible characteristics such as the number of bedrooms and bathrooms, for example. Hedonic pricing analyses seek to build on the OLS relationship by incorporating the valuations of individuals' tastes and preferences. These methods attempt to quantify a preference for a homebuyer to live close to work, or away from railroad tracks. These attributes may not be as easily quantifiable and require, in some instances, the use of spatial data analysis. Attributes may include quieter neighborhoods, better air quality, and/or better school districts.[226] These locational attributes have been noted to affect home prices, a phenomenon which may not be easily captured in property data or assessor records.[227]

Recent research in natural gas drilling has begun to bring focus to these underlying impacts through the use of hedonic pricing analysis. For example, Gopalakrishnan and Klaiber completed a study of home values in Washington County, Pennsylvania, and the effects attributed to drilling. In the study, Gopalakrishnan and Klaiber found that, using a locational

[223] Sherwin Rosen, "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *The Journal of Political Economy* 82 (1974): 1, http://www.jstor.org/stable/1830899.
[224] Ibid.
[225] Raymond Y.C. Tse, "Estimating Neighborhood Effects in House Prices: Towards a New Hedonic Model Approach," *Urban Studies* 39 (2002): 1165, DOI: 10.1080/00420980220135545.
[226] Ibid, 1166.
[227] Richard J. Cebula, "The Hedonic Pricing Model Applied to the Housing Market of the City of Savannah and Its Savannah Historic Landmark District," *The Review of Regional Studies* 39 (2009): 20, http://journal.srsa.org/ojs/index.php/RRS/article/download/182/137.

variable such as distance from a well pad, home values declined by nearly 22 percent.[228] The researchers indicated that the valuation decline occurred when homes were located within three-quarters of a mile of an existing active well location and these homes were reliant upon well water for their main water source.[229] However, the farther the distance a home was from the well pad, the less significant the impact became on home values.[230]

A 2012 study by Muehlenbachs, Spiller, and Timmins of the same county found home values for homes located near well sites and reliant on well water declined by 26.6 percent.[231] In a 2013 study, the authors analyzed property transactions from 36 counties in Pennsylvania and 7 counties in New York.[232] Similar to the findings from their study of one county, their findings indicated that properties relying on private drinking water wells were negatively affected by nearby shale gas wells whereas those properties that had access to piped water were positively affected. However, distance to the well matters—the negative effect for groundwater-dependent homes became greater the closer the well, and the positive effect for piped-water homes became smaller. For properties not in very close proximity to a well but in the general vicinity of a well (i.e., within 12 miles), property values are seen to increase.[233] Spatial parameters, such as distance from historical well locations, and other variables indicated to be statistically significant by current literature were the primary guides in data that RESI analyzed.

A.2 Data

To create a hedonic model associated with the markup, or perceived change in home values associated with Marcellus Shale drilling, RESI used a combination of historical data and spatial analysis. Variables regarding housing attributes included the following:

- Number of stories,
- Number of bathrooms,
- Square footage of building,
- Construction quality of property,
- Year property was built,
- Finished square feet of the property,
- Presence of a garage on property, and
- Housing market value.

[228] Sathya Gopalakrishnan and H. Allen Klaiber, "Is the Shale Boom a Bust for Nearby Residents? Evidence from Housing Values in Pennsylvania," *American Journal of Agricultural Economics* 96 (2014): 4, DOI: 10.1093/ajae/aat065.
[229] Ibid, 4.
[230] Ibid.
[231] Lucija Muehlenbachs, Elisheba Spiller, and Christopher Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," *Resources for the Future Discussion Paper* (2013): 29, http://www.rff.org/RFF/Documents/RFF-DP-12-40-REV.pdf.
[232] Ibid, 39.
[233] Ibid, 29.

These data were collected from DataQuick Property Data. The dataset is a combination of historical assessor and recordation data for each county. RESI used the "housing market price" variable as a dependent variable in the model. All of the remaining attributes were included as independent variables.

To determine the implicit price associated with an individual's willingness to live near a natural gas well, RESI included spatial data from County records. Water service areas and current wells were reported to RESI by Allegany and Garrett Counties. Using ArcGIS software, RESI created a map of the areas overlapped with the DataQuick Property Data. RESI then created three buffer zones to determine the homes that could potentially be impacted by proximity to a natural gas well. The buffers were the following:

- Well located within a half-mile (1 if located within a half mile, 0 otherwise);
- Well located within a mile (1 if located within a mile, 0 otherwise); and,
- Well located within two miles (1 if located within two miles, 0 otherwise).

RESI included these variables into the model along with an additional dummy variable, "pblcwater," where, if a home was serviced on a public water source, then it would have the value of 1, and 0 otherwise. The first run of the model indicated that a house's dependency on public or well water was not statistically significant at the 90 or 95 percent confidence levels. Without loss of precision, RESI dropped this variable and reran the model to determine the potential impacts with living near a natural gas well.

RESI reran the model in SAS to determine the impact multipliers associated with each variable. Taking the partial differential of the model with respect to well locations, RESI determined the implicit percentage of price variation associated with living near a natural gas well. The results for this piece are available in Appendix C of this report.

Appendix B—Contingent Valuation Analysis

B.1 Survey Background

This appendix details the results from the 2013 Marcellus Shale Survey. RESI employed two survey methods (on-site and web) to generate survey data. Both survey methods included the same questions; only the survey administration method varied. Survey participation was random through online and in-person interviews. This sample was not intended to be representative of the populations of Allegany or Garrett Counties or the state as responses were expected from outside Western Maryland.

On-site responses were collected at six locations in Allegany and Garrett Counties. RESI conducted surveys on Wednesday, August 14, 2013, and Thursday, August 15, 2013, at the following locations:

- Oakland Farmers Market,
- Cumberland Farmers Market,
- Wisp Outdoor Adventure Park,
- Garrett 8 Cinemas,
- SHOP 'n' SAVE Fresh in McHenry, and
- Swallows Falls State Park.

RESI gathered web data through the administration of an online survey. The web survey was available through the Garrett County Website[234] and promoted through the following:

- Garrett County's Twitter page;
- Garrett County's Facebook page;
- Garrett County Economic Development's Twitter page;
- GCED's Facebook page;
- GCED's LinkedIn page; and
- GCED's website, including
    - "News" page,
    - "Marcellus Shale" page, and
    - "Agriculture in the News" page.

The responses from the survey were organized according to residence status: Garrett County residents, Allegany County residents, and those residing in neither county (nonresidents). The survey had several aims:

1. To assist in engaging residents of Allegany and Garrett Counties in regard to the effects of natural gas drilling in their communities.
2. To provide residents with an opportunity to voice their opinions on the ramifications of natural gas exploration.
3. To provide nonresidents with an opportunity to voice their opinions on natural gas drilling.

[234] The survey link, which is now closed, was http://resisurvey.resiusa.org/surveydata/ContingentValuation.htm.

4. To help Maryland legislators make informed decisions about the future of natural gas exploration within the state, including current stakeholder perception of the region.

RESI analyzed survey responses to estimate the WTP for environmental protection. Responses relevant to the WTP for the purpose of conserving the aesthetic of the region from the survey respondents were used in a Tobit model to generate an estimate of the change in spending (elasticity) related to environmental amenities given the level of drilling in an area.

Survey findings are presented in figures in Section B.4 of this appendix. For each survey question and its corresponding figure, RESI discusses the findings and includes any conclusions that can be drawn from the data. RESI used the survey findings to complete a community impact analysis as well as an economic and fiscal impact analysis.

B.2 Survey Development

Prior to developing the survey, RESI performed extensive research on CVM and other survey development methods to best measure the perceived value of environmental goods.

B.2.1 Contingent Valuation Method

CVM is a proven scientific technique used to determine the WTP for a "public" good, or a good that is not bought and sold in the marketplace.[235] Environmental quality is one such good. CVM requires direct questioning of the public via survey on the value they are willing to pay in regard to specific environmental items; the amount is contingent on a hypothetical scenario.[236] Simply put, the CVM estimates the economic values that people place on the ecosystem and the environment.[237] It is also common for a CVM to ask people to identify the compensation, or willingness to accept pricing, that would be necessary for them to "give up specific environmental services." [238]

RESI sought to measure the value residents and nonresidents of Allegany and Garrett Counties are willing to pay to avoid potential environmental damage associated with shale-based oil exploration and extraction. Responses provided inputs for the valuation of streams, parks, scenic viewsheds, rental rates, and individuals' expectations should drilling take place.

B.2.2 Developing Survey Questions

To develop questions specific to its needs, RESI conducted a review of existing surveys for contingent valuation. RESI researched and reviewed several studies to design a survey that

[235] Robert Cameron Mitchell and Richard T. Carson, "Using Surveys to Value Public Goods: The Contingent Value Method," *Resources for the Future* (1989): 2, accessed July 10, 2013, http://econweb.ucsd.edu/~rcarson/papers/UsingSurveysToValuePublicGoods.pdf.
[236] "Methods, Section 6: Contingent Valuation Method," in *Ecosystem Valuation*, accessed February 13, 2014, http://www.ecosystemvaluation.org/contingent_valuation.htm.
[237] Ibid.
[238] Ibid.

elicited responses to questions relevant to the current trends associated with environmental and recreational amenity enjoyment in Allegany and Garrett Counties.

CVM contains two parts: surveying and analysis. The use of surveying for contingent valuation has been employed by many researchers to determine the WTP for other environmental recreation or goods. Through the review of the methods used by other researchers, RESI determined the appropriate measures for WTP in the hypothetical scenario.

A Duke University study, "CV to Estimate the Value of Forest Ecosystem Protection," determined that respondents' WTP for forest ecosystem protection ranged from $8 to $120 per year in higher taxes.[239] Respondents to a survey developed by University of Maryland doctoral candidate Danielle Schwarzmann were given two annual values, $40 and $60, to determine WTP for stream restoration in the Chesapeake Bay Watershed.[240] In another study, on damages related to the Exxon Valdez Oil Spill, participants were asked to pay a one-time federal tax to protect another oil spill from occurring, and the WTP dollar amount ranged from $10 to $120.[241] A Bucknell University study estimated individuals' WTP at $10.46 per month (or approximately $125 per year) to eliminate environmental damages associated with Marcellus Shale drilling.[242]

Following a thorough literature review process, RESI developed questions to determine residents' and nonresidents' WTP to protect environmental amenities and recreational attractions from potential Marcellus Shale drilling. RESI enhanced the survey questions through evaluation by a sample respondent group comprising other team members.

In addition to this review, RESI submitted the proposed survey questions to Towson University's Institutional Review Board within the Office of Sponsored Programs and Research. Upon approval of the survey from these entities, received July 18, 2013, RESI expanded its review process before releasing the survey to the public. The proposed survey was reviewed by Dr. Danielle Schwarzmann, an economist who has experience with surveys for contingent valuation, and members of the Marcellus Shale Safe Drilling Initiative Advisory Commission. RESI sought feedback regarding clarity, logic, and format. All comments and edits deemed to be relevant and that maintained the contigent valuation methodology and scope of the project were incorporated, and the survey was finalized.

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[239] Michelle Haefele, Thomas P. Holmes, and Randall A. Kramer, "Using Contingent Valuation to Estimate the Value of Forest Ecosystem Protection," 5, accessed July 10, 2013, http://fds.duke.edu/db/attachment/405.

[240] Danielle Nicole Schwarzmann, "The Environmental and Economic Benefits of Stream Restoration: An Application to Stream Restoration in Maryland," Dissertation, University of Maryland (2013): 221–222, accessed July 10, 2013, http://gradworks.umi.com/35/63/3563371.html.

[241] Richard T. Carson et al., "Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill," *Environmental and Resource Economics* 25 (March 31, 2003): 269, accessed July 10, 2013, http://are.berkeley.edu/~gh082644/Exxon%20Valdez%20Oil%20Spill.pdf.

[242] Paula Bernstein, Thomas C. Kinnaman, and Mengqi Wu, "Estimating Willingness to Pay for River Amenities and Safety Measures Associated with Shale Gas Extraction," Bucknell University (September 16, 2010): 29, accessed July 10, 2013, http://digitalcommons.bucknell.edu/cgi/viewcontent.cgi?article=1001&context=fac_pubs.

B.3 Survey Response Quality Control

A total of 1,699 surveys (1,541 web surveys and 158 on-site surveys) were submitted. Over half of the responses that were submitted via the web survey, or 896 surveys, were either answered incompletely or did not contain responses to any of the thirty-questions. A total of 865 surveys were completely unanswered, while 31 were incomplete beyond analysis. As a result, RESI analyzed a total of 802 viable surveys.

Surveys that did not contain a single a response were eliminated and not incorporated into RESI's analysis. Surveys that were incomplete were assessed to determine whether or not they could be utilized for the analysis. Incomplete surveys were deemed viable if they contained information on the respondent's place of residence and/or demographics and if they included responses to the majority of the questions in "Part C: Hypothetical Scenario."

In some cases, the surveys contained responses that were converted into numerical values for analysis purposes. Survey responses that could be extrapolated were kept and included within the initial viable response records. For example, question four (4) asked for the total mileage that the respondent was willing to drive for a day trip. Some respondents provided the number of hours that they were willing to travel rather than the number of miles.[243]

RESI also reviewed the zip codes provided for place of residence and cross-referenced with whether the respondent indicated that they resided in Allegany or Garrett Counties. There were several instances where residents of Allegheny County, Pennsylvania, indicated that they were residents of Allegany County in response to question seven (7), which asked respondents to indicate whether they resided in Allegany County, Garrett County, or neither. RESI adjusted for this based on the provided zip codes.

B.4 Survey Responses

Of the 802 viable surveys, 645 surveys were completed via the web survey, while 157 were completed on site at locations in Garrett and Allegany Counties.[244] Of the 802 viable surveys, 139 were completed by Allegany County residents, 279 were completed by Garrett County residents, and 379 were completed by respondents who indicated that they reside in neither Allegany County nor Garrett County. Several respondents provided neither their place of residence nor their zip code. Therefore, totals throughout the report may not add up exactly.

[243] RESI assumed travel at 65 miles per hour to convert the number of hours provided into mileage.
[244] More surveys were received via the web survey. However, upon review, RESI found that they were mostly incomplete and unusable in the analysis.

Figure 44: How often do you participate in outdoor recreation activities in parks and other major outdoor attractions in Garrett and Allegany Counties such as Deep Creek Lake, Swallow Falls State Park, Rocky Gap State Park, and Wisp Mountain Resort?

	All		Allegany		Garrett		Neither[245]	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Nearly everyday	127	16%	20	14%	87	31%	18	5%
Once a week	173	22%	38	27%	74	27%	60	16%
Once a month	145	18%	28	20%	51	18%	66	17%
A few times a year	201	25%	29	21%	49	18%	121	32%
Once a year	81	10%	11	8%	8	3%	62	16%
Never	52	6%	9	6%	7	3%	36	9%
Other amount	23	3%	4	3%	3	1%	16	4%
Total	**802**		**139**		**279**		**379**	

Source: RESI

The plurality of all survey respondents, or 25 percent, stated that they participated in outdoor recreational activities in Garrett and Allegany Counties a few times a year. Most often, respondents from Allegany County, 27 percent, indicated that they participate in outdoor activities once a week, while respondents from Garrett County, 31 percent, most often indicated that they participate in outdoor recreational activities nearly every day. Those respondents who reside in neither county, 32 percent, most frequently indicated that they participate in outdoor activities only a few times a year. Garrett County residents were more likely to participate in outdoor activities at a higher regularity than Allegany County residents or those respondents who reside in neither of the two counties.

A small portion of respondents indicated that they participate in outdoor recreational activities some "other amount." Those respondents who indicated that they participate in outdoor recreation with "other amount," provided responses such as the following:

- "As often as possible,"
- "Only occasionally,"
- "Not in recent years," and
- "I am a resident."

[245] Nonresident

Figure 45: How often do you recreate in local trails, streams, and woodlands in Garrett and Allegany Counties?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Nearly everyday	151	19%	36	26%	92	33%	21	6%
Once a week	186	23%	41	29%	81	29%	63	17%
Once a month	127	16%	22	16%	34	12%	71	19%
A few times a year	185	23%	18	13%	56	20%	110	29%
Once a year	65	8%	9	6%	7	3%	48	13%
Never	69	9%	12	9%	7	3%	50	13%
Other amount	19	2%	1	1%	2	1%	16	4%
Total	**802**		**139**		**279**		**379**	

Source: RESI

A plurality of respondents, or 23 percent, indicated that they recreated in local trails, streams, and woodlands in Garrett and Allegany Counties either once a week or only a few times a year. Respondents residing in Allegany County most often indicated, at 29 percent, that they recreate in the outdoors once a week, while respondents residing in Garrett County most often, at 33 percent, indicated that they recreate in the outdoors nearly every day. Those respondents residing in neither county most often, at 29 percent, indicated that they recreate in local trails, streams, and woodlands only a few times a year.

Those respondents who indicated that they recreate in local trails, streams, and woodlands with "other amount," provided responses such as the following:

- "As often as possible,"
- "Every few years,"
- "Not in recent years," and
- "I am a resident."

Figure 46: What is the main activity you participate in at the above locations?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
I don't visit any of the above locations	38	5%	2	1%	4	1%	32	8%
Camping	34	4%	7	5%	4	1%	23	6%
Hiking	320	40%	69	51%	125	45%	125	33%
Hunting	26	3%	4	3%	15	5%	6	2%
Swimming	45	6%	10	7%	15	5%	20	5%
Boating	139	17%	7	5%	41	15%	88	23%
Fishing	43	5%	10	7%	16	6%	17	5%
Bird Watching	18	2%	2	1%	11	4%	5	1%
Winter sports	36	5%	1	1%	15	5%	20	5%
Other	98	12%	24	18%	33	12%	41	11%
Total	**797**		**136**		**279**		**377**	

Source: RESI

Of all the respondents, 40 percent indicated that hiking is the main activity in which they participated at the listed locations. Hiking also received the most responses from respondents residing in Garrett County, Allegany County, and neither county. Most often, those respondents who indicated a response of "Other" participated in kayaking, biking, walking, or golfing at the listed locations.

Figure 47: When planning a day trip, what is the farthest distance one way (in miles) that you are willing to drive to participate in the previous activities?[246]

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Less than 30 miles	177	23%	36	28%	104	38%	36	10%
31–60 miles	226	30%	50	38%	92	34%	83	23%
61–120 miles	188	25%	31	24%	47	17%	109	31%
121–250 miles	149	20%	12	9%	26	10%	110	31%
More than 250 miles	23	3%	1	1%	3	1%	19	5%
Average	**99 miles**							

Source: RESI

The plurality of respondents, 30 percent, indicated that they would travel between 31 and 60 miles one way to participate in outdoor activities. The plurality of respondents residing in Allegany County, 38 percent, also indicated that they would be willing to travel between 31 and

[246] For those respondents who answered in hours rather than miles, RESI assumed an average of 65 miles per hour. RESI based this assumption on data regarding the speed limit for rural interstates in Maryland as provided by the National Motorists Association using data from the Governors Highway Safety Association. Please refer to Section 10.0 of this report for more information on this resource.

60 miles one way to participate in outdoor activities. Respondents residing in Garrett County most often, 38 percent of respondents, indicated that they would be willing to drive less than 30 miles. Respondents not residing in Allegany or Garrett Counties most often, 31 percent each, indicated that they would be willing to travel 61 to 120 miles or 121 to 250 miles.

Figure 48: Please rank the following from most to least important

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Scenic Quality								
Most Important	190	24%	38	27%	63	23%	89	23%
Moderately Important	297	37%	49	35%	120	43%	126	33%
Least Important	315	39%	52	37%	96	34%	164	43%
Abundant Wildlife								
Most Important	82	10%	16	12%	33	12%	33	9%
Moderately Important	328	41%	54	39%	102	37%	169	45%
Least Important	391	49%	69	50%	143	51%	177	47%
Clean Lakes and Waterways								
Most Important	577	72%	97	70%	199	71%	276	73%
Moderately Important	170	21%	33	24%	55	20%	82	22%
Least Important	55	7%	9	6%	25	9%	21	6%

Source: RESI

The majority of respondents valued clean lakes and waterways as the most important outdoor quality. Only 7 percent of all respondents valued clean lakes and waterways as the least important outdoor quality. Residents in Allegany County, Garrett County, and neither county believe clean lakes and waterways are most important compared to abundant wildlife and scenic quality.

Figure 49: Where do you reside?[247]

	Respondents			Respondents	
Response	**Count**	**Percent**	**Response**	**Count**	**Percent**
California	**5**	**0.60%**	Buncombe	1	
Los Angeles	1		Durham	1	
San Diego	1		Wake	2	
San Francisco	1		**Ohio**	**2**	**0.30%**
San Mateo	1		Cuyahoga	1	
Santa Barbara	1		Guernsey	1	
Colorado	**2**	**0.30%**	**Oregon**	**1**	**0.10%**
Denver	1		Clackamas	1	
Larimer	1		**Pennsylvania**	**54**	**6.80%**
Delaware	**1**	**0.10%**	Allegheny	10	
District of Columbia	**5**	**0.60%**	Bedford	5	
New Castle	1		Blair	2	
Florida	**5**	**0.60%**	Bucks	2	
Brevard	1		Cambria	2	
Lee	1		Carbon	1	
Nassau	2		Centre	3	
Palm Beach	1		Delaware	1	
Hawaii	**2**	**0.30%**	Fayette	7	
Hawaii	1		Lawrence	1	
Honolulu	1		Lehigh	2	
Idaho	**1**	**0.10%**	Montgomery	1	
Latah	1		Snyder	1	
Illinois	**3**	**0.40%**	Somerset	3	
Kane	1		Washington	1	
Madison	1		Wayne	1	
McHenry	1		Westmoreland	9	
Kentucky	**3**	**0.40%**	York	2	
Jefferson	1		**Rhode Island**	**1**	**0.10%**
Oldham	1		Washington	1	
Webster	1		**Tennessee**	**1**	**0.10%**
Maryland	**611**	**76.90%**	Williamson	1	
Allegany	139		**Virginia**	**27**	**3.40%**
Anne Arundel	18		Albemarle	1	
Baltimore	17		Arlington	4	
Baltimore City	33		Chesterfield	1	

[247] Findings in this figure are based on responses of the zip code in which the respondents' home is.

Response	Respondents Count	Percent	Response	Respondents Count	Percent
Calvert	1		Fairfax	11	
Carroll	9		Falls Church City	3	
Cecil	2		Harrisonburg City	1	
Charles	1		Loudoun	3	
Frederick	17		Prince William	1	
Garrett	279		Rockingham	1	
Harford	3		York	1	
Howard	21		**Washington**	**1**	**0.10%**
Montgomery	40		Island	1	
Prince George's	16		**West Virginia**	**50**	**6.30%**
Somerset	1		Berkeley	1	
St. Mary's	2		Jefferson	2	
Talbot	4		Kanawha	2	
Washington	6		Lewis	1	
Wicomico	2		Mineral	5	
Michigan	**3**	**0.40%**	Monongalia	16	
Washtenaw	1		Morgan	2	
Wayne	2		Preston	15	
Mississippi	**1**	**0.10%**	Randolph	1	
Warren	1		Taylor	1	
New York	**7**	**0.90%**	Tucker	4	
Chenango	2		**International**	**6**	**0.80%**
Livingston	1		Australia	1	
Oneida	1		Austria	1	
New York	2		England	1	
Ulster	1		Sweden	1	
North Carolina	**4**	**0.50%**	Switzerland	2	

Source: RESI

The majority of respondents, 77 percent, reside in Maryland. Many nonresident respondents indicated that they reside in Pennsylvania, 7 percent, or West Virginia, 6 percent. Of all respondents, 3 percent indicated that they reside in Virginia. The remaining states of residence are each home to one percent or fewer of the remaining respondents.

Of Maryland resident respondents, 68 percent indicated that they reside in Allegany or Garrett Counties. The next two top counties of residence were Montgomery County and Baltimore City, with 7 and 5 percent, respectively.

Figure 50: Do you live in Allegany County or Garrett County?

	Respondents	
Response	**Count**	**Percent**
Allegany County	139	17%
Garrett County	279	35%
Neither	379	48%
Total	**797**	

Source: RESI

More than half of the survey respondents, 52 percent, indicated their place of residence as Allegany or Garrett Counties. Many respondents, 35 percent, reside in Garrett County. The remaining 48 percent reside outside Garrett and Allegany Counties. However, as seen in Figure 46, many reside within Maryland.

Figure 51: How would you describe the location of your home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Urban	45	10%	35	26%	8	3%	2	6%
Suburban	100	22%	54	39%	31	11%	15	42%
Rural	308	68%	48	35%	238	86%	19	53%
Total	**453**		**137**		**277**		**36**	

Source: RESI

The majority of all survey respondents, 68 percent, described the location of their home as a rural setting. Many respondents in Allegany County, or 39 percent, described the location of their home as a suburban setting with rural close behind, at 35 percent. Meanwhile, 86 percent of residents in Garrett County listed their home location as a rural setting. Among all respondents, 10 percent described their home as being located in an urban area.

Figure 52: Do you rent or own your home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Rent	47	10%	24	18%	22	8%	1	3%
Own	383	85%	101	74%	246	89%	33	94%
Other	20	4%	12	9%	7	3%	1	3%
Total	**450**		**137**		**275**		**35**	

Source: RESI

Among all respondents, 85 percent stated that they own their homes. Of those residents residing in Allegany or Garrett Counties, most own their home—74 percent and 89 percent, respectively. Of those respondents residing in neither county, 94 percent stated that they own

their home. When compared to respondents residing in Garrett County or neither county, more respondents residing in Allegany County, or 18 percent, indicated that they rent.

Figure 53: What type of dwelling is your rented home considered?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Apartment or Condo	15	35%	11	48%	4	21%	0	0%
Single Family	23	53%	11	48%	11	58%	1	100%
Neither	5	12%	1	4%	4	21%	0	0%
Total	**43**		**23**		**19**		**1**	

Source: RESI

Over half of all survey respondents, or 53 percent, listed their rented property as being a single-family home, while 35 percent described their rented property as an apartment or condo. Twelve percent of all respondents described their rented property as being neither an apartment nor condo nor a single-family home.

Allegany County respondents who indicated that they rent their home were equally likely to indicate that their rented property was an apartment or condo as a single-family home, at 48 percent each. Over half of those respondents who reside in rented homes in Garrett County, or 58 percent, indicated that their rented home is considered a single-family dwelling.

Figure 54: What is your rent per month?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
$0–$500	14	35%	10	50%	3	16%	1	100%
$500–$1,000	22	55%	9	45%	13	68%	0	0%
$1,001–$1,500	4	10%	1	5%	3	16%	0	0%
$1,501–$2,000	0	0%	0	0%	0	0%	0	0%
$2,001+	0	0%	0	0%	0	0%	0	0%
Total	**40**		**20**		**19**		**1**	

Source: RESI

The majority of all respondents, or 55 percent, stated that their rent is between $500 and $1,000 per month. Among all respondents, no one indicated that they pay over $1,500 in rent per month. Residents of Allegany County indicated the lowest rent—50 percent indicated that their monthly rent was fewer than $500, while 45 percent indicated a monthly rent of $500 to $1,000.

Residents of Garrett County, on the other hand, indicated that they pay the most money for rent. While 68 percent of Garrett County residents indicated that their monthly rent is between

$500 and $1,000, 16 percent of respondents from Garrett County, as opposed to only 5 percent of respondents from Allegany County, indicated that they pay between $1,001 and $1,500 for rent per month.

Figure 55: Do you have a second home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Yes	211	29%	26	19%	69	25%	115	30%
No	590	74%	113	81%	210	75%	264	70%
Total	**801**		**139**		**279**		**379**	

Source: RESI

Most respondents, or 74 percent, stated that they do not own a second home. At 70 percent, residents from neither county had the largest percentage of second homes.

Figure 56: Is your second home in Allegany or Garrett County?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Allegany County	6	3%	6	25%	0	0%	0	0%
Garrett County	95	46%	6	25%	19	28%	70	61%
Neither	107	51%	12	50%	50	72%	44	39%
Total	**208**		**24**		**69**		**114**	

Source: RESI

Of all the respondents who indicated that they own second homes, 51 percent were located in neither Allegany County nor Garrett County.

Figure 57: What is the zip code of your second home?

	Respondents	
Response	**Count**	**Percent**
Delaware	**1**	**0.9%**
Kent	1	
Florida	**3**	**2.7%**
Broward	1	
Manatee	2	
Georgia	**1**	**0.9%**
Glynn	1	
Maryland	**96**	**87.3%**
Allegany	7	
Baltimore	1	
Baltimore City	1	
Garrett	87	
North Carolina	**2**	**1.8%**
Buncombe	1	
Hanover	1	
Pennsylvania	**1**	**0.9%**
Montgomery	1	
Virginia	**2**	**1.8%**
Fairfax	1	
Loudoun	1	
West Virginia	**2**	**1.8%**
Mineral	1	
Preston	1	
International	**2**	**1.8%**

Source: RESI

According to the provided zip codes, 87 percent of second homes owned by respondents were located within Maryland. A large portion of these second homes located in Maryland, 87 of 96 second homes, were located in Garrett County.

Figure 58: How would you describe the location of your second home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Urban	5	5%	4	33%	0	0%	1	1%
Suburban	16	16%	1	8%	4	20%	11	16%
Rural	81	79%	7	58%	16	80%	58	83%
Total	**102**		**12**		**20**		**70**	

Source: RESI

The majority of all survey respondents who indicated that they had a second home, or 79 percent, described the location of their second home as being in a rural environment. This was the most popular choice for each respondent subcategory.

Figure 59: Do you rent or own your second home?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Rent	3	3%	1	8%	1	5%	1	1%
Own	98	95%	12	92%	19	95%	67	96%
Other	2	2%	0	0%	0	0%	2	3%
Total	**103**		**13**		**20**		**70**	

Source: RESI

Of all the respondents with second homes, 95 percent indicated that they own their second home. Only 3 percent of all respondents with a second home indicated that they rent their homes, while 2 percent listed doing "other" things with their second home.

Figure 60: If you rent your second home, what type of dwelling is it considered?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Vacation Rental	0	0%	0	0%	0	0%	0	0%
Apartment or Condo	0	0%	0	0%	0	0%	0	0%
Single Family	3	100%	1	100%	1	100%	1	100%
Total	**3**		**1**		**1**		**1**	

Source: RESI

Only three respondents, all of whom listed their second home as a single family dwelling, indicated that they rent their second homes.

Figure 61: What is your rent per month?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
$0-$500	2	67%	1	100%	0	0%	1	100%
$500–$1,000	1	33%	0	0%	1	100%	0	0%
$1,001–$1,500	0	0%	0	0%	0	0%	0	0%
$1,501–$2,000	0	0%	0	0%	0	0%	0	0%
$2,001+	0	0%	0	0%	0	0%	0	0%
Total	**3**		**1**		**1**		**1**	

Source: RESI

Of all respondents who indicated that they rent their second home, 67 percent, stated that their rent is between $0 and $500 per month. The dollar values below were presented in a payment card method, where respondents were given a selection of values from which to choose.

Figure 62: How much would you be willing to pay annually into the conservation fund to protect against potential environmental damages from drilling?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
$10 per year	86	11%	15	11%	24	9%	47	12%
$40 per year	83	10%	18	13%	19	7%	46	12%
$70 per year	20	3%	6	4%	4	1%	10	3%
$100 per year	133	17%	15	11%	50	18%	67	18%
$130 per year	9	1%	2	1%	2	1%	5	1%
$160 per year	87	11%	13	9%	26	9%	48	13%
Nothing at all	380	48%	69	50%	153	55%	155	41%
Total	**798**		**138**		**278**		**378**	

Source: RESI

Nearly half of all respondents, or 48 percent, stated that they were willing to pay “nothing at all” into an annual conservation fund that would protect against environmental damages from drilling. Respondents residing in Garrett County were the least likely, at 55 percent, to be willing to pay into the fund. Respondents residing in Allegany County were not far behind; 50 percent indicated they would be willing to contribute nothing at all to the conservation fund. Respondents residing in neither Allegany County nor Garrett County were most likely, at 59 percent, to indicate a willingness to contribute some amount to the conservation fund.

Figure 63: If you answered "Nothing at all" to the previous question, please indicate why you would not support this conservation fund.

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
I don't believe drilling will have any substantial effect on the environment	38	10%	6	8%	23	15%	9	6%
I can't afford to pay any additional taxes	27	7%	10	14%	9	6%	8	5%
Funding should be on a voluntary basis or through charities	7	2%	4	6%	0	0%	3	2%
Conservation funding should be provided by the drilling and gas companies	273	72%	42	59%	107	70%	122	79%
Conservation funding should come from existing government tax revenues	22	6%	6	8%	7	5%	9	6%
There are more important uses of public funds	13	3%	3	4%	6	4%	3	2%
Total	**380**		**71**		**152**		**154**	

Source: RESI

The majority of respondents who indicated they would be willing to contribute "nothing at all" to the conservation fund, 72 percent, agree that conservation funding should be provided by the drilling and gas companies.

Figure 64: How important to you is the preservation of the environmental quality of parks, lakes, streams, and forestland?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Not at all important	12	2%	2	1%	4	1%	6	2%
Slightly important	8	1%	1	1%	5	2%	2	1%
Moderately important	32	4%	4	3%	15	5%	13	3%
Very important	88	11%	16	12%	36	13%	36	10%
Extremely important	658	82%	115	83%	218	78%	321	85%
Total	**798**		**138**		**278**		**378**	

Source: RESI

Among all respondents, 82 percent believe that the preservation of the environmental quality of parks, lakes, streams, and forestland is extremely important. Of 798 respondents, 12 respondents, or 2 percent, stated that the preservation of the environmental quality of parks, lakes, streams, and forestland was not at all important.

Figure 65: Please rank the following three at risk environmental resources by how threatened you believe them to be from drilling activity.

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Scenic Quality								
Most Threatened	107	13%	22	16%	42	15%	43	11%
Moderately Threatened	273	34%	43	31%	121	44%	107	28%
Threatened	415	52%	73	53%	114	41%	226	60%
Abundant Wildlife								
Most Threatened	82	10%	16	12%	22	8%	44	12%
Moderately Threatened	408	51%	76	55%	113	41%	217	58%
Threatened	304	38%	45	33%	142	51%	115	31%
Clean Lakes and Waterways								
Most Threatened	643	81%	112	81%	218	79%	309	82%
Moderately Threatened	77	10%	12	9%	26	9%	39	10%
Threatened	75	9%	14	10%	33	12%	28	7%

Source: RESI

Most often, clean lakes and waterways were ranked as being the environmental resource most threatened by drilling activity. Among all respondents, 81 percent believe clean lakes and waterways are the most threatened environmental resource from drilling activity. At 10 percent, respondents were least likely to indicate that abundant wildlife was most threatened.

Figure 66: Do you own land in Garrett or Allegany Counties?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Yes	388	49%	79	57%	233	84%	74	20%
No	410	51%	59	43%	45	16%	304	80%
Total	**798**		**138**		**278**		**378**	

Source: RESI

Among all respondents, 51 percent indicated that they do not own land in Garrett or Allegany Counties. Of those respondents residing in Garrett County, 84 percent indicated that they own land in Garrett or Allegany Counties, while 57 percent of respondents residing in Allegany County indicated that they own land in one of the two counties.

Figure 67: What is the approximate acreage of land that you own in Garrett or Allegany Counties?

Response	**Count**	**Percent**
Less than 1 acre	46	12%
1–10 acres	221	57%
11–25 acres	32	8%
26–50 acres	33	9%
51–100 acres	20	5%
More than 100 acres	36	9%

Source: RESI

The majority, 57 percent, of respondents who indicated that they own land in Garrett or Allegany Counties own between 1 and 10 acres of land in Garrett or Allegany Counties.

Figure 68: Suppose you could lease your land for natural gas drilling. What would you do?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Definitely lease it	50	13%	13	15%	32	14%	4	5%
Probably lease it	35	9%	8	10%	20	8%	7	9%
Not sure	27	7%	6	7%	16	7%	5	7%
Probably not lease it	26	7%	9	11%	14	6%	3	4%
Definitely not lease it	261	65%	48	57%	155	65%	57	75%
Total	**399**		**84**		**237**		**76**	

Source: RESI

Of all respondents, 65 percent stated they would definitely not lease their land for natural gas drilling, while 13 percent agreed that they would definitely lease their land for natural gas drilling. Respondents who reside outside the two counties were more likely, at 75 percent, to indicate that they would not lease their land compared to residents in Garrett and Allegany Counties, at 57 percent and 65 percent, respectively.

Figure 69: **What is the minimum value you would accept for a lease (per acre/year) to drill for natural gas on your land?**

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Fewer than $100 per year	3	2%	0	0%	3	4%	0	0%
At least $100 per year	3	2%	0	0%	3	4%	0	0%
At least $500 per year	16	12%	3	9%	10	13%	3	16%
At least $1,000 per year	39	30%	10	29%	23	31%	5	26%
At least $3,000 per year	21	16%	2	6%	16	21%	3	16%
At least $5,000 per year	48	37%	20	57%	20	27%	8	42%
Market Value	0	0%	0	0%	0	0%	0	0%
Total	**130**		**35**		**75**		**19**	

Source: RESI

Of respondents who would lease their land for natural gas drilling, 37 percent stated that they would lease their land for a minimum value of at least $5,000 an acre per year. Another 4 percent of all respondents stated that they would lease their land for some value below $500 per year. Respondents residing in Allegany County would accept no fewer than $500 per year to lease their land, while 8 percent of respondents residing in Garrett County would lease their land for under $100 per year or at least $100 per year.

Figure 70: How informed are you on the benefits and concerns of natural gas exploration in shale formations?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Not at all informed	23	3%	6	4%	5	2%	12	3%
Slightly informed	30	4%	7	5%	9	3%	14	4%
Moderately informed	159	20%	38	28%	54	19%	67	18%
Very informed	276	35%	47	34%	85	31%	142	38%
Extremely informed	309	39%	40	29%	125	45%	142	38%
Total	**797**		**138**		**278**		**377**	

Source: RESI

The plurality of respondents, or 39 percent, indicated that they were extremely informed on the benefits and concerns of natural gas exploration in shale formations, while an additional 35 percent indicated that they were very informed. Of those respondents residing in Garrett and Allegany Counties, most indicated that they were very or extremely informed on the benefits and concerns of natural gas exploration, at 63 percent and 76 percent, respectively. In all cases, fewer than 5 percent of respondents indicated that they were not at all informed on the benefits and concerns of natural gas explorations.

Figure 71: Suppose you were considering moving to a new home within the next 12 months. Would the presence of natural gas drilling deter you from moving to a residence within Allegany or Garrett County?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Yes	603	76%	96	70%	200	72%	304	81%
No	194	24%	42	30%	78	28%	73	19%
Total	**797**		**138**		**278**		**377**	

Source: RESI

Approximately 76 percent of all respondents indicated that the presence of natural gas drilling would deter them from moving to a residence within Allegany or Garrett Counties. Of respondents residing in neither county, 81 percent would be deterred from moving into a new residence due to the presence of natural gas drilling, while 19 percent indicated that they would not let the presence of natural gas drilling deter them from moving to a residence within Allegany or Garrett Counties.

Figure 72: What is your gender?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Male	425	54%	72	53%	143	52%	206	56%
Female	357	46%	63	47%	130	48%	164	44%
Total	**782**		**135**		**273**		**370**	

Source: RESI

The majority of all respondents, or 54 percent, were male. There were more male than female residents from all areas of interest who completed the survey.

Figure 73: What is your age?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
18–29 year old	92	12%	24	18%	20	7%	48	13%
30–39 years old	118	15%	36	27%	26	9%	56	15%
40–49 years old	133	17%	17	13%	43	16%	72	19%
50–59 years old	198	25%	23	17%	79	29%	96	26%
60–69 years old	180	23%	23	17%	86	31%	69	18%
70–79 years old	62	8%	11	8%	19	7%	31	8%
80 years or older	3	0%	0	0%	1	0%	2	1%
Total	**786**		**134**		**274**		**374**	

Source: RESI

A quarter of all survey respondents indicated that they were between the ages of 50 and 59 years old, followed by those between the ages of 60 and 69 years, at 23 percent. Allegany County respondents represented a slightly younger age group. Of those respondents residing in Allegany County, 27 percent were between 30 and 39 years old, compared to only 9 percent the respondents residing in Garrett County. The survey respondents residing in Garrett County were most likely, at 31 percent, to fall between 60 and 69 years of age.

Figure 74: What is the highest level of education you have completed?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Some high school	4	1%	3	2%	1	0%	0	0%
High school diploma or GED	39	5%	15	11%	14	5%	10	3%
Some college	131	17%	32	24%	47	17%	51	14%
Associate's degree	71	9%	16	12%	28	10%	27	7%
Bachelor's degree	260	33%	41	30%	87	32%	131	35%
Post-baccalaureate degree	281	36%	29	21%	96	35%	154	41%
Total	**786**		**136**		**273**		**373**	

Source: RESI

Most respondents, a combined 69 percent, indicated that they had either a Bachelor's or post-baccalaureate degree. The same was true of respondents residing in Garrett and Allegany Counties. Of the respondents residing in Allegany County, 51 percent indicated that they hold at least a Bachelor's degree, while 67 percent of those residing in Garrett County indicated that they hold at least a Bachelor's degree.

Figure 75: **Which best describes your employment situation in the past 12 months?**

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Employed full time	398	51%	64	47%	133	49%	200	54%
Employed part time	67	9%	14	10%	19	7%	34	9%
Self-employed	103	13%	11	8%	41	15%	51	14%
Unemployed	15	2%	3	2%	4	1%	8	2%
Retired	160	20%	30	22%	68	25%	59	16%
Student	17	2%	8	6%	3	1%	6	2%
Stay-at-home parental guardian	25	3%	6	4%	5	2%	14	4%
Total	**785**		**136**		**273**		**372**	

Source: RESI

Of all survey respondents, 51 percent indicated that they are employed full time. Full-time employment status was most frequently indicated by those respondents residing in Garrett and Allegany Counties as well, with frequencies of 49 percent and 47 percent, respectively. Respondents were least likely to indicate that they were unemployed—2 percent or fewer of each subcategory indicated that they were unemployed.

Figure 76: Which best fits your household income for the past 12 months?

	All		Allegany		Garrett		Neither	
Response	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**	**Count**	**Percent**
Under $10,000	25	3%	13	10%	2	1%		3%
$10,001–$25,000	53	7%	21	16%	19	7%	13	4%
$25,001–$50,000	126	17%	29	22%	50	19%	46	13%
$50,001–$75,000	143	19%	25	19%	55	21%	62	18%
$75,001–$100,000	121	16%	15	12%	40	15%	65	19%
$100,001–$125,000	88	12%	11	9%	35	13%	41	12%
$125,001–$150,000	62	8%	9	7%	22	8%	31	9%
$150,001–$200,000	69	9%	4	3%	20	8%	45	13%
Over $200,000	60	8%	2	2%	21	8%	37	11%
Total	**747**		**129**		**264**		**350**	

Source: RESI

Among all respondents, 19 percent indicated that their household income was between $50,001 and $75,000 for the previous twelve months. Most respondents, or 52 percent, indicated that their household income was between $25,001 and $100,000 for the previous twelve months.

Respondents residing in Allegany County most often, at 22 percent, indicated that their household income was between $25,001 and $50,000. This was followed closely by an income range of between $50,001 and $75,000, at 19 percent of Allegany County respondents. Respondents residing in Garrett County indicated similar household income patterns—21 percent of Garrett County respondents indicated that their household income was between $50,001 and $75,000, while 19 percent of Garrett County respondents indicated that their household income was between $25,001 and $50,000. Respondents residing in neither county indicated the highest level of household income. Of those respondents residing outside Garrett and Allegany Counties, 19 percent indicated a household income between $75,001 and $100,000.

B.5 Additional Cleaning for Contingent Valuation Analysis

RESI used the CVM to determine the WTP of individuals to preserve the environment of Allegany and Garrett Counties. Prior to running the nested model used for the analysis, RESI

first determined the level of potential bias within the data.[248] First, RESI determined the independent and dependent variables. Question 16 in the survey was used as the dependent variable, and additional questions created the list of independent variables or attributes. The following questions were included into the model as independent variables:

- Question 1, respondent's participation in outdoor activities;
- Question 4, farthest distance respondent was willing to drive to participate in outdoor activities;
- Question 7, respondent's residency;
- Question 11, whether or not respondent owned a second home;
- Question 12, location of respondent's second home, if applicable;
- Question 18, importance of preservation;
- Question 24, whether or not respondent was informed on the benefits and concerns associated with natural gas drilling;
- Question 26, gender of respondent;
- Question 27, age range of respondent;
- Question 28, highest educational attainment of respondent;
- Question 29, employment status of respondent; and
- Question 30, household income of respondent.

To determine the level of potential bias, RESI ran a correlation analysis to determine if any of the variables in the model were highly correlated with the dependent variable as well as if there may have been any potential for variables correlated with one another, which could present additional bias. RESI found a significant bias in WTP with those who stated that they were informed (Question 24) and those who owned a second home in either Allegany County or Garrett County.

To correct for this bias, RESI reviewed the data for a few factors. RESI looked at the WTP versus employment status. Individuals who were unemployed and willing to pay $160 into a conservation fund were considered potentially biased. RESI reviewed these respondents for their age ranges to determine if these respondents were possibly retired or if they were married and therefore possibly had a higher household income. RESI used factors such as these to determine if the responses were biased. RESI reviewed other questions including residency and participation in outdoor recreation. RESI dropped responses that appeared biased (26 responses) from the overall sample. Additionally, those who stated that they were very informed and responded to Question 24 with a WTP of $0 were reviewed for a potential protest bid.

Protest bids are reported WTPs that are not necessarily zero. These individuals may state that they have a WTP of zero because they do not agree with the methodology or the survey

[248] Nancy E. Bockstael and Kenneth E. McConnell, *Environmental and Resource Valuation with Revealed Preferences: A Theoretical Guide to Empirical Models.* (Netherlands: Springer, 2007), 118–119.

instrument.[249] There are typically a few methods to resolve this, including either dropping the protest bids or including them but creating more conservative estimates within the analysis. Question 17 of the survey was used to determine the potential protest bids. If individuals answered that "Conservation funding should come from existing government revenues," then RESI dropped these individuals from the sample as they exhibited disagreement with the method of payment for offsetting potential externalities associated with drilling.

However, in some cases, there was reason for the inclusion of the protest bids associated with those respondents who indicated that "Conservation funding should be provided by the drilling and gas companies," which allowed for some minimal bias. Traditionally, these bids would be dropped from the analysis, but recent literature has suggested that the exclusion of these bids may introduce significant selection bias within the model.[250] However, if a discriminant analysis for demographics regarding the groups protesting versus those who are willing to pay is conducted, it is possible to determine a set that can be included within the sample with minimal bias.[251] When running the two groups together, if analysis cannot differentiate statistically between the two groups, it is possible that the protest bidders may not be adequately registering a true "zero" bid and therefore may value the resource.[252]

Using additional econometric techniques such as treating some protest bids as "true zero bids" and dropping only those that could be classified as "true protest bids", some of the potential bias may be mitigated.[253] Protest bidders have been included in analysis by agencies such as the USDA Forest Service.[254] The inclusion of the protest bids did produce a more conservative estimate in the study.[255]

Econometricians have used techniques to mitigate and minimize the potential for bias within a model for several decades. When there is a potential for bias within a model, economists will often look for additional instrument variables that are not correlated with the dependent variable but are correlated with some of the omitted variables or those who are protest bidders.[256] RESI decided to include the variables *second_home* and *in-person* to smooth some of the bias out of the model. In-person interviews are a known method of mitigating the potential bias within a sample set since literature in sociology has suggested respondents answer differently in person than online.[257]

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[249] John M. Halstead, A.E. Luloff, and Thomas H. Stevens, "Protest Bidders in Contingent Valuation," *Northeast Journal of Agricultural Economics* 2 (1992): 163, http://purl.umn.edu/29000.
[250] Ibid, 162.
[251] Ibid, 164.
[252] Ibid, 167.
[253] Ibid, 168.
[254] J.M. Bowker et al., "Estimating the Economic Value of Lethal Versus Nonlethal Deer Control in Suburban Communities," *Society and Natural Resources* 16 (2003): 143–158, DOI: 10.1080/08941920390174256.
[255] Ibid, 155.
[256] William H. Greene, *Econometric Analysis* (New York: Pearson, 2008), 245.
[257] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," 161.

After RESI further cleaned the variables for bias, a sample size of 641 responses remained within the analysis. RESI ran another correlation analysis, and the results determined that there was no serial correlation within the model. For the results of the contingent valuation analysis, please refer to Appendix C of this report.

B.6 Survey Questions

Part A: Background

Numerous state parks and other outdoor activities have led to a strong tourism industry in Western Maryland, which includes Garrett and Allegany Counties. Specifically, Garrett County contains over 76,000 acres of parks, lakes, waterfalls, and publicly accessible forestland.

1. How often do you participate in outdoor recreation activities in parks and other major outdoor attractions in Garrett and Allegany Counties such as Deep Creek, Swallow Falls State Park, Rocky Gap State Park, and Wisp Mountain Resort? *Please choose one answer from the following:*
    a. Nearly everyday
    b. Once a week
    c. Once a month
    d. A few times a year
    e. Once a year
    f. Never
    g. Other Amount_____

2. How often do you recreate in local trails, streams, and woodlands in Garrett and Allegany Counties? *Please choose one answer from the following:*
    a. Nearly everyday
    b. Once a week
    c. Once a month
    d. A few times a year
    e. Once a year
    f. Never
    g. Other Amount_____

3. What is the main activity you participate in at the above locations? Please choose one answer from the following: *(If answered "Never" to **both** questions #1 and #2 skip to question #5)* Camping
    a. Hiking
    b. Hunting
    c. Swimming
    d. Boating
    e. Fishing
    f. Bird watching
    g. Winter sports
    h. Other_____

4. When planning a day trip, what is the furthest distance **one way** (in miles) that you are willing to drive to participate in the previous activities? *Please give a value.*
    _____

5. Please rank the following from most to least important. (From 1= most important, 2= moderately important, 3 = least important)
    a. Scenic quality_____
    b. Abundant wildlife_____
    c. Clean lakes and waterways_____

Part B: Residence

6. What is the zip-code of your home? _____

7. Do you live in…
    a. Allegany County
    b. Garrett County
    c. Neither (*If selected "Neither," skip to question #11*)

8. Would you describe the location of your home as…?
    _____Urban, _____Suburban, or _____Rural

9. Do you rent or own your home?
    a. Rent
    b. Own *(If selected "Own," skip to question #11)*
    c. Other *(If selected "Other," skip to question #11*
    (Explain_____)

10. If you answered "Rent" to **question #9**, is it considered a(n)…
    a. Apartment or Condo
        i. What is your rent per month?
            1. $0-$500
            2. $500-$1,000
            3. $1,001-$1,500
            4. $1,501-$2,000
            5. $2,001+
    b. Single-family house
        i. What is your rent per month?
            1. $0-$500
            2. $500-$1,000
            3. $1,001-$1,500
            4. $1,501-$2,000
            5. $2,001+

11. If you have a **second home**, what is the zip-code? *(If respondent does not have a second home, skip to Part C on page 4)* _____

12. Is your **second home** in…
    a. Allegany County
    b. Garrett County
    c. Neither *(If selected "Neither" skip to Part C on page 4)*

13. Would you describe the location of your **second home** as…?
    _____Urban, _____Suburban, or _____Rural

14. Do you rent or own your **second home**?
    a. Rent
    b. Own *(If selected "Own," skip to Part C on page 4)*
    c. Other *(If selected "Other," skip to Part C on page 4)*
    (Explain_____)

15. If you rent your second home, is it considered a(n)…
    a. Vacation rental
    b. Apartment or Condo
        i. What is your rent per month?
            1. $0-$500
            2. $500-$1,000
            3. $1,001-$1,500
            4. $1,501-$2,000
            5. Over $2,000
    c. Single-Family House
        i. What is your rent per month?
            1. $0-$500
            2. $500-$1,000
            3. $1,001-$1,500
            4. $1,501-$2,000
            5. Over $2,000

Part C: Hypothetical Scenario

In Pennsylvania and West Virginia, Marcellus Shale drilling has become a source of natural gas and contributed to economic growth and new jobs in those regions. If exploration of the Marcellus Shale is permitted in Maryland, the same could occur here. However, exploring for natural gas may cause negative impacts to the environment, including effects on the scenic, wildlife and water quality.

Suppose Maryland were considering creating a conservation fund, paid by all households through additional annual property taxes, to protect against potential environmental damages from shale natural gas drilling in Allegany and Garrett Counties.

16. How much would you be willing to pay annually into the conservation fund to protect against potential environmental damages from drilling? *Please choose one answer from the following:*
    a. $10 per year *(Skip to question #18)*
    b. $40 per year *(Skip to question #18)*
    c. $70 per year *(Skip to question #18)*
    d. $100 per year *(Skip to question #18)*
    e. $130 per year *(Skip to question #18)*
    f. $160 per year *(Skip to question #18)*
    g. Nothing at all *(If selected "Nothing at all," answer question #17)*

17. *If you answered "Nothing at all" to the previous question, please indicate why you would not support this conservation fund.*
    a. I don't believe drilling will have any substantial effect on the environment
    b. I can't afford to pay any additional taxes
    c. Funding should be on a voluntary basis or through charities
    d. Conservation funding should be provided by the drilling and gas companies
    e. Conservation funding should come from existing government tax revenues
    f. There are more important uses of public funds

18. How important to you is the preservation of the environmental quality of parks, lakes, streams, and forestland. (From 1 to 5 with 1 = not at all important, 2 = slightly important, 3 = moderately important, 4 = very important, 5 = extremely important)
    a. 1 2 3 4 5

19. Rank the following three at-risk environmental resources by how threatened you believed them to be from drilling activity, if it occurred? (1 = most threatened, 2 = moderately threatened, 3 = threatened)
    a. Scenic quality_____
    b. Abundant wildlife _____
    c. Clean lakes and waterways_____

20. Do you own **land** in Garrett or Allegany Counties?
    _____Yes _____No *(If selected "No," skip to question #24)*

21. What is the approximate acreage of land your own in Garrett or Allegany Counties?
    _____acre(s)

22. Suppose you could lease your land for natural gas drilling. What would you do?
    a. Definitely lease it
    b. Probably lease it
    c. Not sure
    d. Probably not lease it
    e. Definitely not lease it (*If selected "Definitely not lease it," skip to question #24*)

23. What is the minimum value you would accept for a lease of your land per acre/year?
    a. Below $100 per year
    b. At least $100 per year
    c. At least $500 per year
    d. At least $1,000 per year
    e. At least $3,000 per year
    f. At least $5,000 per year

24. How informed are you on the benefits and concerns of natural gas exploration in shale formations?
    From 1 to 5 with 1 = not at all informed, 2 = slightly informed, 3 = moderately informed, 4 = very informed, 5 = extremely informed)
    a. 1 2 3 4 5

25. Suppose you were considering moving to a new home within the next 12 months. Would the presence of natural gas deter you from moving to a residence within Allegany or Garrett County?
    a. Yes
    b. No

Part D: Demographics

26. Gender
    _____Male _____Female

27. What is your age? *(Show respondent ranges)*
    a. 18–29 years old
    b. 30–39 years old
    c. 40–49 years old
    d. 50–59 years old
    e. 60–69 years old
    f. 70–79 years old
    g. 80 years or older

28. What is the highest level of education you have completed?
    a. _____Some high school
    b. _____High school diploma or GED
    c. _____Some College
    d. _____Associate's degree
    e. _____Bachelor's degree
    f. _____Post-Baccalaureate degree

29. Which best describes your employment situation in the past 12 months?
    a. _____Employed, full-time
    b. _____Employed, part-time
    c. _____Self-employed
    d. _____Unemployed
    e. _____Retired
    f. _____Student
    g. _____Stay at home parental guardian

30. Which best fits your household income for the past 12 months?
    a. _____Under $10,000
    b. _____$10,001–$25,000
    c. _____$25,001–$50,000
    d. _____$50,001–$75,000
    e. _____$75,001–$100,000
    f. _____$100,001–$125,000
    g. _____$125,001–$150,000
    h. _____$150,001–$200,000
    i. _____Over $200,000

Appendix C—Model Development

C.1 Industry Sales

This section outlines the natural gas sales for each county under Scenarios 1 and 2. Natural gas sales were calculated using the projected EIA AEO 2013 natural gas prices and the thousands of cubic feet of natural gas that would be extracted each year from the total wells in production.[258] Scenario 1 represents a case where 25 percent of the total EUR are extracted. Scenario 2 represents a case where 75 percent of the total EURs are extracted. The timeframe of the study is 2017 through 2036.

Allegany County

Under Scenario 1, Allegany County would see minimal impact from natural gas drilling. Under this assumption, between 2017 through 2036, 18 wells would be drilled across 3 well pads. The annual industry sales are reported in Figure 77 below. Prices and volume produced are recorded in mcf.

[258] U.S. Energy Information Administration, "Annual Energy Outlook 2013 with Projections to 2040."

Figure 77: Industry Sales for Allegany County—Scenario 1, 25% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	2	$3.70	1,240,001.0	$4,588,004
2018	3	$3.96	2,345,503.7	$9,288,195
2019	3	$4.05	2,831,298.8	$11,466,760
2020	3	$4.13	3,079,501.6	$12,718,342
2021	3	$4.26	3,211,520.4	$13,681,077
2022	3	$4.48	3,283,902.4	$14,711,883
2023	1	$4.67	2,083,995.8	$9,732,260
2024	0	$4.79	1,000,702.6	$4,793,365
2025	0	$4.87	527,210.0	$2,567,513
2026	0	$5.02	285,821.8	$1,434,825
2027	0	$5.09	155,593.8	$791,972
2028	0	$5.22	83,211.8	$434,366
2029	0	$5.30	43,117.4	$228,522
2030	0	$5.40	20,907.9	$112,903
2031	0	$5.53	8,605.4	$47,588
2032	0	$5.63	1,790.8	$10,082
2033	0	$5.77	0.0	$0
2034	0	$6.04	0.0	$0
2035	0	$6.32	0.0	$0
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

Under Scenario 2, Allegany County would see more impact from natural gas drilling than under Scenario 1. Under this assumption, between 2017 through 2036, a total of 60 wells would be drilled across 10 well pads. The annual industry sales are reported in Figure 78 below. Prices and volume produced are recorded in mcf.

Figure 78: Industry Sales for Allegany County—Scenario 2, 75% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	6	$3.70	3,720,003.0	$13,764,011
2018	12	$3.96	8,896,512.6	$35,230,190
2019	9	$4.05	9,222,149.7	$37,349,706
2020	6	$4.13	7,743,069.3	$31,978,876
2021	7	$4.26	7,856,328.1	$33,467,958
2022	6	$4.48	7,244,655.1	$32,456,055
2023	6	$4.67	7,007,734.6	$32,726,121
2024	6	$4.79	6,887,709.2	$32,992,127
2025	2	$4.87	4,344,449.3	$21,157,468
2026	0	$5.02	2,099,149.9	$10,537,732
2027	0	$5.09	1,102,611.1	$5,612,290
2028	0	$5.22	586,434.1	$3,061,186
2029	0	$5.30	314,420.6	$1,666,429
2030	0	$5.40	168,214.4	$908,358
2031	0	$5.53	86,234.8	$476,878
2032	0	$5.63	41,815.8	$235,423
2033	0	$5.77	17,210.8	$99,306
2034	0	$6.04	3,581.6	$21,633
2035	0	$6.32	0.0	$0
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

Garrett County

Under Scenario 1, Garrett County would experience moderate impact from natural gas drilling. Under this assumption, between 2017 through 2036, 132 wells would be drilled across 22 well pads. The annual industry sales are reported in Figure 79 below. Prices and volume produced are recorded in mcf.

Figure 79: Industry Sales for Garrett County—Scenario 1, 25% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	6	$3.70	3,720,003.0	$13,764,011
2018	13	$3.96	9,516,513.1	$37,685,392
2019	26	$4.05	20,004,909.3	$81,019,883
2020	19	$4.13	20,051,366.5	$82,812,144
2021	15	$4.26	18,101,310.8	$77,111,584
2022	12	$4.48	15,597,578.9	$69,877,153
2023	11	$4.67	13,962,632.7	$65,205,495
2024	12	$4.79	13,837,632.8	$66,282,261
2025	12	$4.87	13,695,562.1	$66,697,387
2026	6	$5.02	9,890,132.3	$49,648,464
2027	0	$5.09	4,657,122.8	$23,704,755
2028	0	$5.22	2,432,495.9	$12,697,629
2029	0	$5.30	1,288,829.3	$6,830,795
2030	0	$5.40	690,589.5	$3,729,183
2031	0	$5.53	367,657.0	$2,033,143
2032	0	$5.63	191,751.8	$1,079,563
2033	0	$5.77	95,304.6	$549,908
2034	0	$6.04	40,887.6	$246,961
2035	0	$6.32	10,744.8	$67,907
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

Under Scenario 2, Garrett County would see more impact from natural gas drilling than under Scenario 1. Under this assumption, between 2017 through 2036, a total of 390 wells would be drilled across 65 well pads. The annual industry sales are reported in Figure 80. Prices and volume produced are recorded in mcf.

Figure 80: Industry Sales for Garrett County—Scenario 2, 75% Extraction

Year	Number of New Wells	AEO Price per mcf	Total Produced in mcf	Total Revenue
2017	30	$3.70	18,600,015.0	$68,820,056
2018	60	$3.96	44,482,563.0	$176,150,949
2019	54	$4.05	51,690,753.0	$209,347,550
2020	48	$4.13	52,060,115.4	$215,008,277
2021	56	$4.26	57,764,868.8	$246,078,341
2022	36	$4.48	47,798,511.2	$214,137,330
2023	30	$4.67	40,496,321.6	$189,117,822
2024	30	$4.79	37,287,124.6	$178,605,327
2025	34	$4.87	38,140,637.8	$185,744,906
2026	12	$5.02	24,609,452.0	$123,539,449
2027	0	$5.09	11,812,145.6	$60,123,821
2028	0	$5.22	6,170,700.8	$32,211,058
2029	0	$5.30	3,291,475.0	$17,444,818
2030	0	$5.40	1,766,660.8	$9,539,968
2031	0	$5.53	923,051.6	$5,104,475
2032	0	$5.63	475,593.0	$2,677,589
2033	0	$5.77	233,684.0	$1,348,357
2034	0	$6.04	99,683.2	$602,087
2035	0	$6.32	21,489.6	$135,814
2036	0	$6.69	0.0	$0

Sources: EIA, RESI

C.2 Home Price Value Decline

The use of indirect methodology is not uncommon to determine individuals' desire for economic change. Methods such as hedonic price modeling are often employed to determine the underlying preference of buyers within a region for certain items given particular attributes. The methodology was first employed in 1974 by Rosen, whose research explored the potential implicit product differentiation in purely competitive markets.[259] For more detail on the current existing literature of the use of hedonic modeling and shale gas on home prices, please refer to Appendix A of this report.

To determine the level of impact in Western Maryland from Marcellus Shale drilling, RESI employed a hedonic model using historical well data and property data for Allegany and Garrett Counties. Although there are no horizontal wells to date in either county, there are older vertical wells near residences in the region. The results from this analysis were used as "home price change percentage" in RESI's REMI PI+ model for each scenario.

[259] Sherwin Rosen, "Hedonic Prices and Implicit Markets," 1.

Using DataQuick Property Data and historical well locations, RESI extrapolated the current impacts associated with the wells in the region to determine the potential impacts of new well pads being constructed. In addition to the current and historical market values of the homes, RESI received data from the counties regarding public and well water services in each region. The inclusion of well and public water service data acted as a variable to capture concerns regarding well water contamination from drilling activities among residents to determine if RESI's findings are consistent with those of prior research. [260]

Using GIS and the DataQuick Property Data, RESI established three dummy variables for homes located within a half mile, a mile, or two miles of a current well. These variables equal one (1) for homes located within a given distance of a current well and zero (0) otherwise.

RESI used the public and well water data to assist in the analysis, a dummy variable was created for this purpose. Under this dummy variable, the value would equal one (1) if the home was on well water and zero otherwise (0). Well water or public water dummy variables have been a key factor in decreasing the potential rise in home values near shale drilling locations in previous research.[261] [262] According to the existing literature discussed in Appendix A, declines in home value are more noticeable in homes using well water than public water. Using the follow equation, RESI worked to determine the potential loss to home values in each county due to Marcellus Shale drilling:

$$\begin{aligned}\log(home\ market\ value)_i &= \alpha_i + \beta_{1i}\log(land\_sqft) + \beta_{2i}\log(numberbaths) \\ &+ \beta_{3i}\log(numberstories) + \beta_{4i}\log(constructionquality) \\ &+ \beta_{5i}\log(yearbuilt) + \beta_{6i}waterdummy + \beta_{7i}wellhalfdummy \\ &+ \beta_{8i}wellonemiledummy + \beta_{9i}welltwomiledummy \\ &+ \beta_{10i}\log(finishedsqfeet) + \beta_{11i}\log(garage)\end{aligned}$$

In the equation above, RESI uses the subscript i to represent the county where the home is located. Dummy variables are included within the regression to gauge the impacts from locational attributes, such as distance to an existing well or the home's water source, on the market value of the home in question, as shown below. The basis for comparison in the model above was whether or not homes were located more than two miles from a natural gas well and on well water.

$$waterdummy = 1\ if\ on\ public\ water, 0\ otherwise$$
$$wellhalfdummy = 1\ if\ well\ is\ located\ within\ a\ half\ mile, 0\ otherwise$$

[260] Muehlenbachs, Spiller, and Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," 27.
[261] Gopalakrishnan and Klaiber, "Is the Shale Boom a Bust for Nearby Residents? Evidence from Housing Values in Pennsylvania," 3.
[262] Muehlenbachs, Spiller, and Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," 29.

$welllonemiledummy = 1\ if\ well\ is\ located\ within\ a\ mile, 0\ otherwise$
$welltwomiledummy = 1\ if\ well\ is\ located\ within\ two\ miles, 0\ otherwise$

The results of the above regression are reported in Figure 81.

Figure 81: Hedonic Housing Price Regression Analysis[263]

Variable	Allegany County		Garrett County	
	Beta Coefficient Estimate	Statistically Significant?[264]	Beta Coefficient Estimate	Statistically Significant?[265]
log(land_sqft)	0.32	Yes	0.37	Yes
log(numberbaths)	0.11	Yes	0.08	Yes
log(numberstories)	0.12	Yes	0.10	Yes
log(constructionquality)	0.87	Yes	0.83	Yes
log(yearbuilt)	6.50	Yes	5.84	Yes
Wellhalfdummy	-0.06	Yes	-0.03	Yes
Wellonemiledummy	-0.05	Yes	-0.02	Yes
Welltwomiledummy	0.04	Yes	0.03	Yes
log(finishedsqfeet)	0.29	Yes	0.27	Yes
log(garage)	0.11	Yes	0.08	Yes

Sources: Eviews, DataQuick, RESI, SAS

As indicated in Figure 81, nearly all the variables were statically significant at the 95 percent confidence level. Figure 81 indicates that those living within a half mile to a mile of a current well experience some decline in property values—36 to 35 percent, respectively. Given the model's use of a log-log regression, the dummy impact multipliers are read as the following, where β is equal to the addressed reported in Figure 81:

$Difference\ between\ home\ values\ located\ within\ a\ half\ mile\ of\ a\ well\ and\ those\ not\ located\ within\ two\ miles\ of\ a\ well = \ 100 * \ e^{(\beta - 1)}$

C.3 Royalty Payments

Royalty payments are likely to positively impact housing prices near shale wells.[266] Royalty payments to landowners directly increase a landowner's disposable income within the region; indirectly, royalty payments impact the valuation of their properties as they are now income-

[263] The well dummy variable proved to be inconsistent with previous literature. After a review of the property data, RESI determined that the presence of well water homes near current well sites was few to none. Additionally, the data reported that there were more homes on public water near current or inactive well locations. Due to the low well activity within the region, RESI dropped the well water variable and reran the model.
[264] Statistical significance is reported here at the 95 percent confidence level.
[265] Statistical significance is reported here at the 95 percent confidence level.
[266] Muehlenbachs, Spiller, and Timmins, "Shale Gas Development and the Costs of Groundwater Contamination Risk," 30.

generating properties. The right for a company to drill on a property owner's land or sell the gas beneath it would require the producer and the land/mineral right owner to enter into an agreement of payment. There have been inquiries into leasing land within Allegany and Garrett Counties. However, given the current moratorium, no drilling or payments have been made to landowners in the region to date.

To counter the lack of historical data, RESI gauged the amount of payment landowners would potentially receive if Marcellus Shale drilling were to take place in the region. To gauge the potential lease or royalty payments to well owners and subsequently increased home values, RESI reviewed historical amounts associated with royalty payments in the surrounding region. To date, the minimum recorded percentage a lease holder can be paid in a royalty for shale drilling is mandated by Pennsylvania at 12.5 percent of the production value.[267] RESI applied this percentage to the production revenues previously calculated and concluded the value in annual royalties that lease holders would receive from producers.

For Allegany County, RESI used the production amounts calculated in Figures 77 and 78 to determine the potential royalties paid to landowners in Allegany County under Scenarios 1 and 2, respectively. The royalty payment amounts are reported for each scenario in Figure 82.

[267] Commonwealth of Pennsylvania Legislature, "Oil and Gas – Lease to Remove or Recover Act of July 20, 1979," P.L. 183, No. 60 (1979): 2, http://www.legis.state.pa.us/WU01/LI/LI/US/HTM/1979/0/0060..HTM.

Figure 82: Estimated Royalty Payments to Allegany County Landowners

Year	Scenario 1	Scenario 2
2017	$573,500	$1,720,501
2018	$1,161,024	$4,403,774
2019	$1,433,345	$4,668,713
2020	$1,589,793	$3,997,360
2021	$1,710,135	$4,183,495
2022	$1,838,985	$4,057,007
2023	$1,216,533	$4,090,765
2024	$599,171	$4,124,016
2025	$320,939	$2,644,684
2026	$179,353	$1,317,217
2027	$98,997	$701,536
2028	$54,296	$382,648
2029	$28,565	$208,304
2030	$14,113	$113,545
2031	$5,948	$59,610
2032	$1,260	$29,428
2033	$0	$12,413
2034	$0	$2,704
2035	$0	$0
2036	$0	$0

Sources: EIA, RESI

For Garrett County, RESI used the production amounts calculated in Figures 79 and 80 to determine the potential royalties paid to landowners in Garrett County under Scenarios 1 and 2, respectively. The royalty payment amounts are reported for each scenario in Figure 83.

Figure 83: Estimated Royalty Payments to Garrett County Landowners

Year	Scenario 1	Scenario 2
2017	$1,720,501	$8,602,507
2018	$4,710,674	$22,018,869
2019	$10,127,485	$26,168,444
2020	$10,351,518	$26,876,035
2021	$9,638,948	$30,759,793
2022	$8,734,644	$26,767,166
2023	$8,150,687	$23,639,728
2024	$8,285,283	$22,325,666
2025	$8,337,173	$23,218,113
2026	$6,206,058	$15,442,431
2027	$2,963,094	$7,515,478
2028	$1,587,204	$4,026,382
2029	$853,849	$2,180,602
2030	$466,148	$1,192,496
2031	$254,143	$638,059
2032	$134,945	$334,699
2033	$68,738	$168,545
2034	$30,870	$75,261
2035	$8,488	$16,977
2036	$0	$0

Sources: EIA, RESI

C.4 Willingness to Pay for Environment

Placing a dollar value on maintaining the status quo of scenic properties in an area is a difficult task. To determine stakeholder's WTP associated with conservation of such attractions, RESI conducted a survey, administered on site and on the web, in the region. RESI incorporated results from the survey within a contingent valuation analysis to determine the WTP to conserve the aesthetic beauty of the region.

The methodology of contingent valuation strives to determine a person's valuation of "goods" based on the attributes of the individual and his or her preferences. This method is often referred to as a "revealed preference method" since it takes information from an individual and assigns a dollar value based on a question such as "would you be willing to pay $X to offset this negative impact?" RESI assigned dollar values to nonmonetary attributes associated with environmental conservation based on characteristics and stated preferences obtained through its survey, as described in Appendix B, and determined the overall market's WTP for the environment of the counties.

In CV, a scenario indicating potentially negative impacts is described to the respondent, and users are then asked a series of questions regarding their preferred payment amounts and

valuation of the region overall. Additional attributes about the individual, such as his or her age, sex, household income, preference for traveling, and use of the outdoor goods (parks, hiking trails, streams, lakes, etc.) are revealed through the survey portion of the methodology.

RESI's survey reached nearly 1,700 respondents. However, due to incomplete responses, this number was later revised down to 802 viable responses. More information regarding the procedures used to clean the data can be found in Appendix B.

To analyze the potential WTP to maintain the aesthetic beauty of the region, RESI then reviewed the data further for any discrepancies. This included exclusion of data points where individuals stated that they were unemployed yet willing to pay a large sum into a conservation fund and where individuals reported an annual household income of fewer than $25,000. After further revision, RESI finalized its sample size to 641 surveys for the purpose of this analysis. The bid value frequencies are reported in Figure 84 below.

Figure 84: Willingness to Pay—Annual Bid Amount Frequencies

Annual Bid	Responses	Percentage
$10	73	11.4%
$40	75	11.7%
$70	16	2.5%
$100	115	17.9%
$140	9	1.4%
$160	56	8.7%
Not willing to pay	297	46.3%

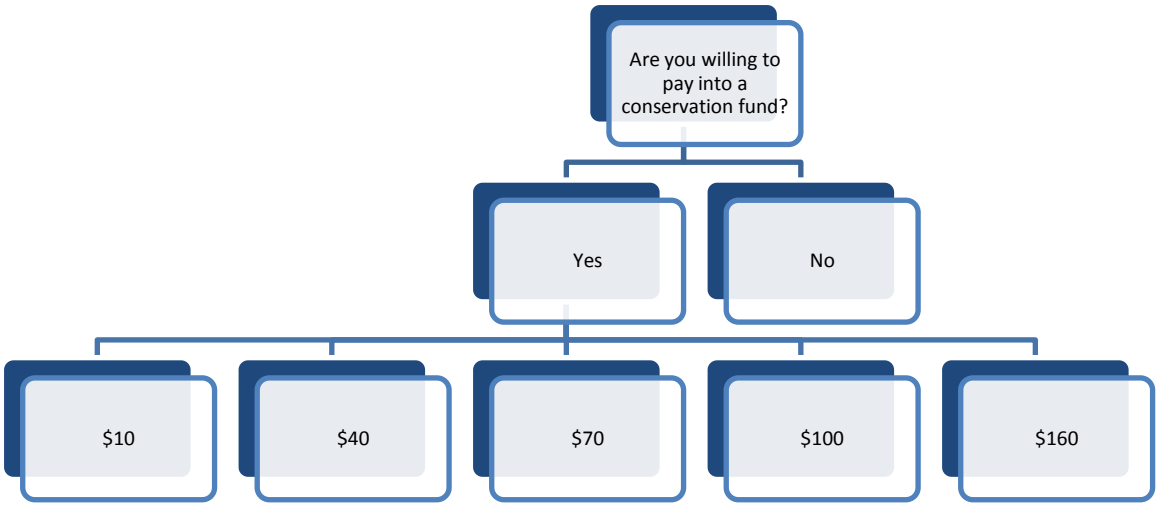
Sources: RESI, SAS

As reported in Figure 84, RESI found that approximately 46 percent of respondents stated that they were unwilling to pay into a conservation fund. Further analysis found that these individuals provided the following reasons:

- They were unable to pay that amount,
- They felt that the government should spend the funds elsewhere, or
- They felt that the production companies should pay the fees associated with offsetting the negative impacts from Marcellus Shale drilling.

Given the type of information gauged, the model can be viewed as a binary regression, or a nested model. A binary regression associates the variable being examined on only two responses, "yes" or "no," and codes those responses as "1" or "0," respectively. However, to gauge the revealed preference of maintain the scenic qualities in Western Maryland, RESI added a secondary level of analysis. The inclusion of a secondary level in the analysis changed the model into a nested Tobit model. A nested model means that the prior answer reflects the latter response. Figure 85 demonstrates the concept of a nested model.

Figure 85: Nesting within Economic Models



Source: RESI

Figure 85 demonstrates the nesting of the model through the question, "Are you willing to pay into a conservation fund?" RESI associated yes responses to those who gave a dollar value (where the values were randomly selected between $10 and $160 per year). A response of "no" or $0 was recorded and follow-up questions were asked to determine the reason an individual responded no.

To determine if the response of a survey participant was a true $0 bid, RESI conducted a series of follow-up questions. Using these questions, RESI examined potential protest bids associated with the scenario. Protest bids indicate individuals who may oppose the methodology through a nonresponse or a response of $0 despite having an underlying value for the object or policy in question.[268] Protest bids in the survey were considered to be those who felt the money should come from the drilling companies or respondents who felt the money should come from somewhere else. The remaining responses are classified for true $0 bids and examined as potential lower bounds within the analysis.

To avoid potential self-selection bias, RESI treated protest bids using two methods: (1) dropping the bids based on additional survey responses/nonresponses and (2) keeping them in as true $0 bids for those who did not focus particularly on one extreme or another in other survey questions.[269] The inclusion of the $0 bid created the lower bound used in this analysis.

[268] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," *Northeastern Journal of Agricultural and Resource Economics* 2 (1992): 160–161.
[269] Ibid, 162.

Binary choice models, such as the one described in Figure 85, are often analyzed using a series of models such as Nested Logit, Multinomial Logit, and Tobit. These models allow the dependent variable—in this case WTP into a conservation fund—to take on a binary response of "0" or "1" to be analyzed. Furthermore, the secondary analysis will then take on a lower bound, often zero, and truncate the analysis to review only the results associated with those who stated that they were willing to pay into the fund.

RESI's model included independent variables such as the following:

- Age,
- Income,
- Educational attainment,
- Visits to parks/streams/lakes,
- Distance from Allegany or Garrett County,
- Place of residency,
- Whether respondents owned second homes in Western Maryland, and
- Whether the interview was conducted on-site or via the web.

This last variable was included because, according to researchers, the methodology of the delivery of the survey can alter the responses of interviewees.[270] Adding this variable was crucial in smoothing out any potential correlation within the data to the dependent variable. The value that the respondents were willing to pay was included within the model as well.

RESI used a variety of methods to determine results. RESI finally used a Tobit model and found that individuals' WTP for conservation of scenic areas in Western Maryland was $44.05 per year. More information regarding the results of additional analyses can be found in Appendix E of this report. The dollar value assignments based on the variables included within the model are reported in Figure 86. For more information on CVM or the survey, please refer to Appendix B of this report.

[270] Christopher C. Leggett et al., "Social Desirability Bias in Contingent Valuation Surveys Administered Through In-Person Interviews," *Land Economics* 79 (2003): 574, DOI: 10.2307/3147300.

Figure 86: Willingness to Pay by Attribute

Bid	WTP
Distance	-$0.02
Frequency of Parks/Recreation	$4.87
Allegany Primary Residence	$2.87
Garrett Primary Residence	$8.19
In Person Interview	$6.41
Sex	-$1.98
Age (30-49 years old)	$4.89
Age (50-69 years old)	$3.88
Age (70 or older)	-$10.50
Education (high school diploma or less)	-$1.53
Education (Associate's Degree or some college)	$12.97
Education (Post Bachelor's Degree)	$17.99
Employed (full-time, part-time, or self)	-$11.56
Income (less than $50,000 per year)	-$5.86
Income (more than $75,001, less than $125,000)	$0.19
Income (greater than $125,000 per year)	$13.23

Sources: RESI, SAS

Using the WTP for conservation, housing price percentage changes from the hedonic model, the royalty payment estimates for increased household disposable income, and the industry sales calculated in this section, RESI calculated the impacts from Marcellus Shale drilling in Western Maryland at the 25 percent and 75 percent extraction levels. These impacts and a description of how all of the variables fit into the model can be found in Section 8.0 of this report.

Appendix D—Detailed Impacts

This appendix reports the detail impacts associated with Marcellus Shale drilling for Scenarios 1 and 2 for each county.

D.1 Detailed Baseline Results—Allegany County

To determine the economic impacts associated with Marcellus Shale drilling in Allegany County, RESI first assessed the baseline forecast for the region under the status quo. The baseline results can be found for employment, output, and wages in Figure 87.

Figure 87: Detailed Economic Forecast—Allegany County, Baseline

Year	Employment	Output	Wages
2017	29,668	$3,841,487,975	$1,003,450,532
2018	29,767	$3,863,299,620	$1,012,837,609
2019	29,818	$3,877,646,744	$1,020,585,720
2020	29,870	$3,891,879,838	$1,028,488,805
2021	29,918	$3,905,631,933	$1,036,533,974
2022	29,966	$3,919,161,296	$1,044,708,914
2023	30,013	$3,932,683,574	$1,052,859,568
2024	30,060	$3,946,141,864	$1,061,073,227
2025	30,105	$3,959,745,271	$1,069,368,615
2026	30,151	$3,973,869,178	$1,077,709,209
2027	30,196	$3,988,288,278	$1,086,131,118
2028	30,242	$4,003,191,135	$1,094,554,677
2029	30,289	$4,018,551,996	$1,103,095,417
2030	30,336	$4,034,401,379	$1,111,740,539
2031	30,377	$4,048,326,243	$1,119,879,075
2032	30,414	$4,062,311,827	$1,127,981,758
2033	30,452	$4,076,290,414	$1,136,169,026
2034	30,489	$4,090,238,066	$1,144,418,662
2035	30,527	$4,104,218,807	$1,152,627,217
2036	30,564	$4,118,171,742	$1,160,933,378

Sources: RESI, REMI PI+

D.2 Economic Impacts—Allegany County

The economic impacts for employment, output, and wages for Scenario 1 for Allegany County are reported in Figures 88 through 90. The economic impacts for employment, output, and wages for Scenario 2 for Allegany County are reported in Figures 91 through 93.

Figure 88: Detailed Employment Impacts—Allegany County, Scenario 1

Year	Direct	Spinoff	Total
2017	162.8	169.9	332.7
2018	88.4	93.3	181.7
2019	230.3	240.8	471.1
2020	135.1	142.3	277.4
2021	266.9	279.3	546.3
2022	160.4	169.4	329.8
2023	116.5	123.7	240.3
2024	76.0	81.3	157.3
2025	49.6	53.7	103.4
2026	31.7	35.2	66.9
2027	21.3	24.4	45.7
2028	16.4	19.0	35.4
2029	14.2	16.3	30.6
2030	14.2	16.2	30.3
2031	15.1	17.1	32.2
2032	16.5	18.3	34.8
2033	17.7	19.6	37.3
2034	19.4	21.1	40.5
2035	21.1	22.7	43.8
2036	22.3	23.9	46.2

Sources: RESI, REMI PI+

Figure 89: Detailed Output Impacts—Allegany County, Scenario 1

Year	Direct	Spinoff	Total
2017	$14,258,818	$12,474,581	$26,733,398
2018	$10,921,994	$9,555,301	$20,477,295
2019	$22,804,342	$19,950,785	$42,755,127
2020	$16,391,130	$14,340,072	$30,731,201
2021	$27,313,124	$23,895,372	$51,208,496
2022	$19,695,399	$17,230,870	$36,926,270
2023	$13,998,383	$12,246,734	$26,245,117
2024	$8,659,465	$7,575,887	$16,235,352
2025	$5,566,799	$4,870,213	$10,437,012
2026	$3,515,873	$3,075,924	$6,591,797
2027	$2,311,361	$2,022,135	$4,333,496
2028	$1,627,719	$1,424,039	$3,051,758
2029	$1,237,066	$1,082,270	$2,319,336
2030	$1,139,403	$996,827	$2,136,230
2031	$1,074,294	$939,866	$2,014,160
2032	$1,106,849	$968,346	$2,075,195
2033	$1,139,403	$996,827	$2,136,230
2034	$1,204,512	$1,053,789	$2,258,301
2035	$1,302,175	$1,139,231	$2,441,406
2036	$1,399,838	$1,224,673	$2,624,512

Sources: RESI, REMI PI+

Figure 90: Detailed Wages Impacts—Allegany County, Scenario 1

Year	Direct	Spinoff	Total
2017	$3,473,958	$3,686,229	$7,160,187
2018	$2,256,129	$2,393,987	$4,650,116
2019	$5,322,910	$5,648,159	$10,971,069
2020	$3,570,199	$3,788,352	$7,358,551
2021	$6,564,799	$6,965,932	$13,530,731
2022	$4,410,464	$4,679,960	$9,090,424
2023	$3,175,978	$3,370,042	$6,546,021
2024	$1,926,686	$2,044,414	$3,971,100
2025	$1,038,301	$1,101,745	$2,140,045
2026	$409,027	$434,021	$843,048
2027	-$11,105	-$11,783	-$22,888
2028	-$242,455	-$257,270	-$499,725
2029	-$383,116	-$406,526	-$789,642
2030	-$399,773	-$424,201	-$823,975
2031	-$364,608	-$386,887	-$751,495
2032	-$307,233	-$326,006	-$633,240
2033	-$218,395	-$231,740	-$450,134
2034	-$122,153	-$129,617	-$251,770
2035	-$51,822	-$54,989	-$106,812
2036	-$18,508	-$19,639	-$38,147

Sources: RESI, REMI PI+

Figure 91: Detailed Employment Impacts—Allegany County, Scenario 2

Year	Direct	Spinoff	Total
2017	193.2	201.7	395.0
2018	320.4	335.5	655.9
2019	383.6	401.8	785.3
2020	407.0	426.4	833.4
2021	434.7	455.9	890.6
2022	447.8	470.0	917.8
2023	456.9	480.1	937.0
2024	463.9	487.8	951.7
2025	279.2	296.8	576.0
2026	183.3	196.5	379.7
2027	117.8	128.3	246.1
2028	76.2	84.9	161.2
2029	52.0	59.0	111.0
2030	39.7	45.6	85.3
2031	33.2	38.8	71.9
2032	32.9	37.8	70.7
2033	34.7	39.1	73.9
2034	38.0	42.0	80.0
2035	42.6	46.3	88.9
2036	46.4	50.3	96.7

Sources: RESI, REMI PI+

Figure 92: Detailed Output Impacts—Allegany County, Scenario 2

Year	Direct	Spinoff	Total
2017	$18,125,644	$19,197,354	$37,322,998
2018	$35,021,174	$37,091,863	$72,113,037
2019	$40,979,072	$43,402,032	$84,381,104
2020	$41,660,821	$44,124,091	$85,784,912
2021	$45,025,107	$47,687,296	$92,712,402
2022	$46,447,888	$49,194,202	$95,642,090
2023	$48,226,365	$51,077,834	$99,304,199
2024	$49,738,070	$52,678,922	$102,416,992
2025	$32,101,508	$33,999,566	$66,101,074
2026	$20,630,332	$21,850,137	$42,480,469
2027	$13,486,783	$14,284,213	$27,770,996
2028	$8,981,308	$9,512,344	$18,493,652
2029	$6,135,745	$6,498,532	$12,634,277
2030	$4,535,116	$4,803,263	$9,338,379
2031	$3,497,671	$3,704,477	$7,202,148
2032	$2,993,769	$3,170,781	$6,164,551
2033	$2,845,563	$3,013,812	$5,859,375
2034	$2,815,922	$2,982,418	$5,798,340
2035	$2,934,487	$3,107,994	$6,042,480
2036	$3,082,693	$3,264,963	$6,347,656

Sources: RESI, REMI PI+

Figure 93: Detailed Wages Impact—Allegany County, Scenario 2

Year	Direct	Spinoff	Total
2017	$4,343,903	$4,609,192	$8,953,094
2018	$7,797,555	$8,273,764	$16,071,320
2019	$9,631,730	$10,219,955	$19,851,685
2020	$10,444,245	$11,082,092	$21,526,337
2021	$11,473,308	$12,174,001	$23,647,308
2022	$12,074,828	$12,812,257	$24,887,085
2023	$12,604,166	$13,373,922	$25,978,088
2024	$13,044,664	$13,841,322	$26,885,986
2025	$8,136,257	$8,633,152	$16,769,409
2026	$4,962,081	$5,265,123	$10,227,203
2027	$2,633,734	$2,794,580	$5,428,314
2028	$997,598	$1,058,523	$2,056,122
2029	-$90,691	-$96,229	-$186,920
2030	-$707,018	-$750,197	-$1,457,214
2031	-$1,054,974	-$1,119,403	-$2,174,377
2032	-$1,147,516	-$1,217,596	-$2,365,112
2033	-$1,080,886	-$1,146,897	-$2,227,783
2034	-$929,118	-$985,860	-$1,914,978
2035	-$651,493	-$691,281	-$1,342,773
2036	-$359,061	-$380,990	-$740,051

Sources: RESI, REMI PI+

D.3 Detailed Baseline Results—Garrett County

To determine the economic impacts associated with Marcellus Shale drilling in Garrett County, RESI first assessed the baseline forecast for the region under the status quo. The baseline results can be found for employment, output, and wages in Figure 94.

Figure 94: Detailed Employment Forecast—Garrett County, Baseline

Year	Employment	Output	Wages
2017	10,608	$1,366,803,593	$266,880,090
2018	10,645	$1,375,338,068	$269,488,249
2019	10,663	$1,380,849,401	$271,532,364
2020	10,679	$1,386,059,883	$273,496,274
2021	10,693	$1,391,079,225	$275,484,989
2022	10,706	$1,395,988,824	$277,454,018
2023	10,719	$1,400,862,189	$279,430,612
2024	10,732	$1,405,697,988	$281,372,544
2025	10,744	$1,410,559,652	$283,348,387
2026	10,755	$1,415,586,238	$285,321,872
2027	10,766	$1,420,706,091	$287,294,611
2028	10,777	$1,425,973,911	$289,221,698
2029	10,787	$1,431,408,517	$291,193,642
2030	10,797	$1,436,997,332	$293,170,011
2031	10,806	$1,441,904,952	$295,019,941
2032	10,819	$1,446,817,878	$296,825,786
2033	10,825	$1,451,743,391	$298,691,980
2034	10,819	$1,456,646,281	$300,559,814
2035	10,825	$1,461,547,408	$302,404,451
2036	10,838	$1,466,452,944	$304,260,557

Sources: RESI, REMI PI+

D.4 Economic Impacts—Garrett County

The economic impacts for employment, output, and wages for Scenario 1 for Garrett County are reported in Figures 95 through 97. The economic impacts for employment, output, and wages for Scenario 2 for Garrett County are reported in Figures 98 through 100.

Figure 95: Detailed Employment Impacts—Garrett County, Scenario 1

Year	Direct	Spinoff	Total
2017	198.0	206.6	404.5
2018	342.7	358.7	701.4
2019	555.3	581.0	1,136.3
2020	621.4	649.9	1,271.3
2021	632.3	661.3	1,293.6
2022	618.0	647.0	1,265.1
2023	602.3	631.3	1,233.6
2024	601.9	631.4	1,233.4
2025	600.0	630.2	1,230.2
2026	383.1	405.4	788.5
2027	222.7	238.8	461.5
2028	122.6	134.5	257.0
2029	61.1	70.2	131.4
2030	22.9	29.7	52.6
2031	7.4	13.5	20.9
2032	5.4	10.4	15.8
2033	9.1	13.8	22.9
2034	15.4	19.7	35.1
2035	25.5	29.5	55.0
2036	34.3	38.1	72.3

Sources: RESI, REMI PI+

Figure 96: Detailed Output Impacts—Garrett County, Scenario 1

Year	Direct	Spinoff	Total
2017	$18,240,423	$19,265,681	$37,506,104
2018	$36,584,737	$38,641,093	$75,225,830
2019	$65,451,801	$69,130,718	$134,582,520
2020	$70,557,339	$74,523,228	$145,080,566
2021	$69,726,205	$73,645,377	$143,371,582
2022	$66,846,919	$70,604,253	$137,451,172
2023	$64,947,184	$68,597,738	$133,544,922
2024	$65,986,102	$69,695,050	$135,681,152
2025	$66,668,819	$70,416,142	$137,084,961
2026	$44,881,235	$47,403,921	$92,285,156
2027	$23,984,152	$25,332,254	$49,316,406
2028	$12,763,843	$13,481,274	$26,245,117
2029	$6,203,822	$6,552,526	$12,756,348
2030	$1,662,268	$1,755,701	$3,417,969
2031	$118,733	$125,407	$244,141
2032	-$326,517	-$344,870	-$671,387
2033	-$207,783	-$219,463	-$427,246
2034	$178,100	$188,111	$366,211
2035	$860,817	$909,202	$1,770,020
2036	$1,484,168	$1,567,590	$3,051,758

Sources: RESI, REMI PI+

Figure 97: Detailed Wages Impacts—Garrett County, Scenario 1

Year	Direct	Spinoff	Total
2017	$4,427,635	$4,678,047	$9,105,682
2018	$8,265,414	$8,732,877	$16,998,291
2019	$14,247,451	$15,053,239	$29,300,690
2020	$16,499,294	$17,432,438	$33,931,732
2021	$17,313,593	$18,292,791	$35,606,384
2022	$17,354,401	$18,335,907	$35,690,308
2023	$17,272,785	$18,249,676	$35,522,461
2024	$17,586,263	$18,580,882	$36,167,145
2025	$17,823,689	$18,831,737	$36,655,426
2026	$11,793,425	$12,460,421	$24,253,845
2027	$6,286,240	$6,641,769	$12,928,009
2028	$2,550,481	$2,694,728	$5,245,209
2029	-$31,533	-$33,317	-$64,850
2030	-$1,827,072	-$1,930,405	-$3,757,477
2031	-$2,702,582	-$2,855,431	-$5,558,014
2032	-$3,025,334	-$3,196,437	-$6,221,771
2033	-$2,980,817	-$3,149,402	-$6,130,219
2034	-$2,737,826	-$2,892,668	-$5,630,493
2035	-$2,251,843	-$2,379,200	-$4,631,042
2036	-$1,728,762	-$1,826,535	-$3,555,298

Sources: RESI, REMI PI+

Figure 98: Detailed Employment Impacts—Garrett County, Scenario 2

Year	Direct	Spinoff	Total
2017	193.2	201.7	395.0
2018	320.4	335.5	655.9
2019	383.6	401.8	785.3
2020	407.0	426.4	833.4
2021	434.7	455.9	890.6
2022	447.8	470.0	917.8
2023	456.9	480.1	937.0
2024	463.9	487.8	951.7
2025	279.2	296.8	576.0
2026	183.3	196.5	379.7
2027	117.8	128.3	246.1
2028	76.2	84.9	161.2
2029	52.0	59.0	111.0
2030	39.7	45.6	85.3
2031	33.2	38.8	71.9
2032	32.9	37.8	70.7
2033	34.7	39.1	73.9
2034	38.0	42.0	80.0
2035	42.6	46.3	88.9
2036	46.4	50.3	96.7

Sources: RESI, REMI PI+

Figure 99: Detailed Output Impacts—Garrett County, Scenario 2

Year	Direct	Spinoff	Total
2017	$18,125,644	$19,197,354	$37,322,998
2018	$35,021,174	$37,091,863	$72,113,037
2019	$40,979,072	$43,402,032	$84,381,104
2020	$41,660,821	$44,124,091	$85,784,912
2021	$45,025,107	$47,687,296	$92,712,402
2022	$46,447,888	$49,194,202	$95,642,090
2023	$48,226,365	$51,077,834	$99,304,199
2024	$49,738,070	$52,678,922	$102,416,992
2025	$32,101,508	$33,999,566	$66,101,074
2026	$20,630,332	$21,850,137	$42,480,469
2027	$13,486,783	$14,284,213	$27,770,996
2028	$8,981,308	$9,512,344	$18,493,652
2029	$6,135,745	$6,498,532	$12,634,277
2030	$4,535,116	$4,803,263	$9,338,379
2031	$3,497,671	$3,704,477	$7,202,148
2032	$2,993,769	$3,170,781	$6,164,551
2033	$2,845,563	$3,013,812	$5,859,375
2034	$2,815,922	$2,982,418	$5,798,340
2035	$2,934,487	$3,107,994	$6,042,480
2036	$3,082,693	$3,264,963	$6,347,656

Sources: RESI, REMI PI+

Figure 100: Detailed Wages Impact—Garrett County, Scenario 2

Year	Direct	Spinoff	Total
2017	$4,343,903	$4,609,192	$8,953,094
2018	$7,797,555	$8,273,764	$16,071,320
2019	$9,631,730	$10,219,955	$19,851,685
2020	$10,444,245	$11,082,092	$21,526,337
2021	$11,473,308	$12,174,001	$23,647,308
2022	$12,074,828	$12,812,257	$24,887,085
2023	$12,604,166	$13,373,922	$25,978,088
2024	$13,044,664	$13,841,322	$26,885,986
2025	$8,136,257	$8,633,152	$16,769,409
2026	$4,962,081	$5,265,123	$10,227,203
2027	$2,633,734	$2,794,580	$5,428,314
2028	$997,598	$1,058,523	$2,056,122
2029	-$90,691	-$96,229	-$186,920
2030	-$707,018	-$750,197	-$1,457,214
2031	-$1,054,974	-$1,119,403	-$2,174,377
2032	-$1,147,516	-$1,217,596	-$2,365,112
2033	-$1,080,886	-$1,146,897	-$2,227,783
2034	-$929,118	-$985,860	-$1,914,978
2035	-$651,493	-$691,281	-$1,342,773
2036	-$359,061	-$380,990	-$740,051

Sources: RESI, REMI PI+

Appendix E—Response to Peer Reviewers

To provide the best possible estimate on economic impacts to Western Maryland from shale drilling, RESI elicited two peer reviewers to comment on the analysis. RESI would like to thank Dr. Lucija Muehlenbachs and Dr. Clifford Lipscomb for providing their detailed feedback, which provided RESI with suggestions for additional methods for determining the sensitivity of the econometric analysis. This appendix is included is to address some additional suggestions and comments that reviewers made to the draft report but that have not been addressed in other sections.

E.1 Inclusion of Protest Bids

In response to Dr. Lipscomb as well as Dr. Schwarzmann from Maryland Department of the Environment, RESI addressed the decision regarding the inclusion of some protest bids. In the survey, RESI had two potential protest bid sections as follow-ups to the WTP question. If the participant indicated that they were unwilling to pay into a conservation fund, then they were provided with a set of reasons for why they did not wish to pay into the fund. One of the responses, “Conservation funding should be provided by the drilling and gas companies” was a choice. When analyzing the results, RESI found that nearly 72 percent of respondents had stated this reasoning when choosing zero as their WTP.

The inclusion of protest bids in contingent valuation has been highly debated. Halstead, Luloff, and Stevens concluded that the inclusion of protest bids may introduce some bias; however, the exclusion of some bids may be more detrimental.[271] The exclusion of protest bids in cases where the respondent may have a valuation for the good but may also be strongly opinionated about the scenario may create a selection bias error. This error may pose a greater risk than the lesser bias introduced by inclusion.

Protest bidders can be included if, in some cases, discriminant analysis between the two groups for socioeconomic and demographic analysis fails to determine if a difference exists. RESI performed a similar analysis as Halstead, Luloff, and Stevens using a discriminant analysis function. The model produced the matrix shown in Figure 101.

Figure 101: Reclassification of Protest Bidders under Discriminate Analysis Function for WTP

Bidder	Protestor	Non-Protestor
Protestor	169	98
Non-Protestor	176	216

Sources: RESI, STATA

Under this analysis, the redistribution at the probability of .001 indicated to RESI that the difference between the two groups was potentially negligible. By not including the protest bidders, RESI would exclude 100 observations of protest bidders. The analysis indicates that, despite the respondents' answers, they do place a value on the resource and would wish to conserve it given the sociodemographic and economic characteristic similarities as those who responded as being willing to pay. Some protest bidders were then included within the model but valued as a "true zero." A "true zero" bid is someone who stated that they would not pay into a conservation fund for reasons ranging from not believing drilling would impact the environment to being unable to pay into the fund. The inclusion of the protest bidders in RESI's analysis may create a more conservative WTP estimate, but it captures those who most likely value the Western Maryland environment.

E.2 Turnbull Lower Bound Estimator

Upon reviewer suggestion, RESI dropped some estimates and reviewed the model using a Turnbull Lower Bound estimator. Using a Turnbull Lower Bound estimator, a researcher can run analysis with minor to no restrictive assumptions regarding preferences. Carson contests the use of Turnbull Lower Bound estimators due to the potential to be sensitive to the "choice of the dollar amounts used."[272] However, based on reviewer feedback, RESI ran a Turnbull Lower Bound estimator for the contingent valuation model described in Appendix C of this report.

[271] Halstead, Luloff, and Stevens, "Protest Bidders in Contingent Valuation," 155.
[272] Richard T. Carson, *Valuing Oil Spill Prevention: A Case Study of California's Central Coast* (Netherlands: Kluwer Academic Publishers, 2004), 225.

Under this analysis, RESI's results yielded an approximately $12 decline in WTP for the conservation fund. Under the Turnbull Lower Bound Estimate, RESI estimated the WTP of individuals to be approximately $32. To determine the impact this dollar amount would have on the analysis, RESI reran the REMI PI+ model at the lower WTP amount. Under the trial runs, RESI found that the change in dollar amount yielded only a .1 change in employment on average during the twenty-year drilling period.

RESI reran the Turnbull Lower Bound Estimate for all scenarios within each county to determine if economic impacts did change. Changes in economic impacts were negligible, adding between -0.3 to 0.5 additional jobs and very minimal amounts to wages and output in some instances. Given the low change in economic impacts associated with the additional runs for each county, RESI determined that the Tobit-estimated WTP of $44.05 is a valid estimate for individuals' WTP to conserve.