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Chapter 9 ALTERNATIVE ACTIONS

Chapter 21 of the GEIS and the 1992 Findings Statement discussed a range of alternatives concerning oil and gas resource development in New York State that included both its prohibition and the removal of oil and gas industry regulation. Regulation as described by the GEIS was found to be the best alternative. Regulatory revisions recommended by the GEIS have been incorporated into permit conditions, which have been continuously improved since 1992.

The following range of alternatives to use of high volume hydraulic fracturing for Marcellus shale and other low permeability gas reservoirs have been reviewed for the purpose of this SGEIS:

- The prohibition of development of Marcellus Shale and other low permeability gas reservoirs by horizontal drilling and high-volume hydraulic fracturing.
- The use of a phased-permitting approach to developing the Marcellus Shale and other low permeability gas reservoirs, including consideration of limiting and/or restricting resource development in designated areas.
- The required use of green or non-chemical fracturing technologies and additives.

9.1 Prohibition of Development

The prohibition of development of Marcellus Shale and other low permeability gas reservoirs by horizontal drilling and high-volume hydraulic fracturing would be contrary to New York State

and national interests. It would also contravene Article 23-0301 of the Environmental Conservation Law where it is stated:

> *It is hereby declared to be in the public interest to regulate the development, production and utilization of natural resources of oil and gas in this state in such a manner as will prevent waste; to authorize and to provide for the operation and development of oil and gas properties in such a manner that a greater ultimate recovery of oil and gas may be had, and that the correlative rights of all owners and the rights of all persons including landowners and the general public may be fully protected, and to provide in similar fashion for the underground storage of gas, the solution mining of salt and geothermal, stratigraphic and brine disposal wells.*

As more fully described in Chapter 2, the Marcellus Shale formation, which extends from Ohio through West Virginia and into Pennsylvania and New York, is attracting attention as a significant new source of natural gas production. In New York, the Marcellus Shale is located in much of the Southern Tier, stretching from Chautauqua and Erie counties in the west to the counties of Sullivan, Ulster, Greene and Albany in the east. According to Penn State University, the Marcellus shale is the largest known shale deposit in the world. Engelder and Lash (2008) first estimated gas-in-place to be between 168 and 500 trillion cubic feet with a recoverable estimate of 50 tcf.[1] While it is very early in the productive life of Marcellus shale wells, the most recent estimates by Engelder (2009) using well production decline rates indicate a 50% probability that recoverable reserves could be as high as 489 trillion cubic feet.[2]

The Draft 2009 New York State Energy Plan recognizes the potential benefit to New York from development of the Marcellus Shale natural gas resource:

> Production and use of in-state energy resources – renewable resources and natural gas – can increase the reliability and security of our energy systems, reduce energy costs, and contribute to meeting climate change, public health and environmental objectives. Additionally, by focusing energy investments on in-state opportunities, New York can reduce the amount of dollars "exported" out of the State to pay for energy resources.[3]

[1] Considine et al., 2009, p. 2
[2] Considine et al., 2009, p. 2
[3] NYS Energy Planning Board, August 2009

The Draft Energy Plan further includes a recommendation to encourage development of the Marcellus Shale natural gas formation with environmental safeguards that are protective of water supplies and natural resources.[4]

The New York State Commission on Asset Maximization recommends that "Taking into account the significant environmental considerations, the State should study the potential for new private investment in extracting natural gas in the Marcellus Shale on State-owned lands, in addition to development on private lands." The Final report concludes that an increase in natural gas supplies would place downward pressure on natural gas processes, improve system reliability and result in lower energy costs for New Yorkers. In addition, natural gas extraction would create jobs and increase wealth to upstate landowners, and increase State revenue from taxes and land-owner leases and royalties. Development of State-owned lands could provide much needed revenue relief to the State and spur economic development and job creation in economically depressed regions of the State.[5]

Although total prohibition of natural gas development using high volume hydraulic fracturing of the Marcellus has been recommended by some, such a prohibition is contrary to New York statute and State policy advocating development of this resource. A prohibition would also deny owners of mineral interests an opportunity to realize the benefit of mineral rights ownership. It is not a reasonable alternative to development as set forth in this draft SGEIS.

9.2 Phased Permitting Approach

The use of a phased-permitting approach to developing the Marcellus Shale and other low permeability gas reservoirs, including consideration of limiting and restricting resource development in designated areas, was evaluated. Phased permitting as a means to mitigate regional cumulative impacts is not practical or necessary given the inherent difficulties in predicting gas well development for a particular region or part of the State. The mitigation proposed in the SGEIS that focuses on the siting of well pads based on Best Practices will lessen

[4] NYS Energy Planning Board, August 2009

[5] NYS Commission on Asset Maximization, June, 2009

or eliminate potential impacts. The 1992 GEIS found that the negative impacts associated with gas development were short term and could be mitigated with siting restrictions and setback requirements. This is also true for multi-well pads; therefore the mitigation techniques discussed in the 1992 GEIS and set forth in this SGEIS should be utilized.

Given the extended time period involved in fully developing a multi-well pad, control of the impacts, while still temporary, is essential. As stated in 1992, many of the potential negative impacts of gas development hinge on the location chosen for the well and the techniques used in constructing the access road and well site. Before a drilling permit can be issued, DEC staff must ensure that the proposed location of the well and access road complies with the Department's spacing regulations and siting restrictions. To assist in this process, DEC staff now has access to Policy Guidance Documents DEP-00-1, "Assessing and Mitigating Noise Impacts" and DEP-00-2, "Assessing and Mitigating Visual Impacts". If the guidance provided in these documents is applied where appropriate to multi-well pad applications along with a proposed site plan and design guidelines, it will be possible to avoid significant site-specific cumulative impacts. Additionally, the applicant should also be encouraged to review any applicable land use policy documents with the understanding that the New York State Department of Environmental Conservation (NYSDEC) retains authority to regulate gas development.[6]

The level of impact on a regional basis will be determined by the amount of development and the rate at which it occurs. Accurately estimating this is inherently difficult due to the wide and variable range of the resource, rig, equipment and crew availability, permitting and oversight capacity, leasing, and most importantly economic factors. This holds true regardless of the type of drilling and stimulation utilized. Historically in New York, and in other plays, development has occurred in a sequential manner over years with development activity concentrated in one area then moving on with previously drilled sites fully or partially reclaimed as new sites are drilled. As with the development addressed in 1992, once drilling and stimulation activities are completed and the sites have been reclaimed, the long term impact will consist of widely spaced

[6] NTC, pp. 28-31

and partially re-vegetated production sites and fully reclaimed plugged and abandoned well sites.[7]

The statewide spacing regulations for vertical shale wells of one single well pad per 40-acre spacing unit will allow no greater density for horizontal drilling with high volume hydraulic fracturing than is allowed for conventional drilling techniques. This density was anticipated in 1992 and areas of New York, including Chautauqua, Cayuga and Seneca Counties, have experienced drilling at this level without significant negative impacts to agriculture, tourism, and other land uses.

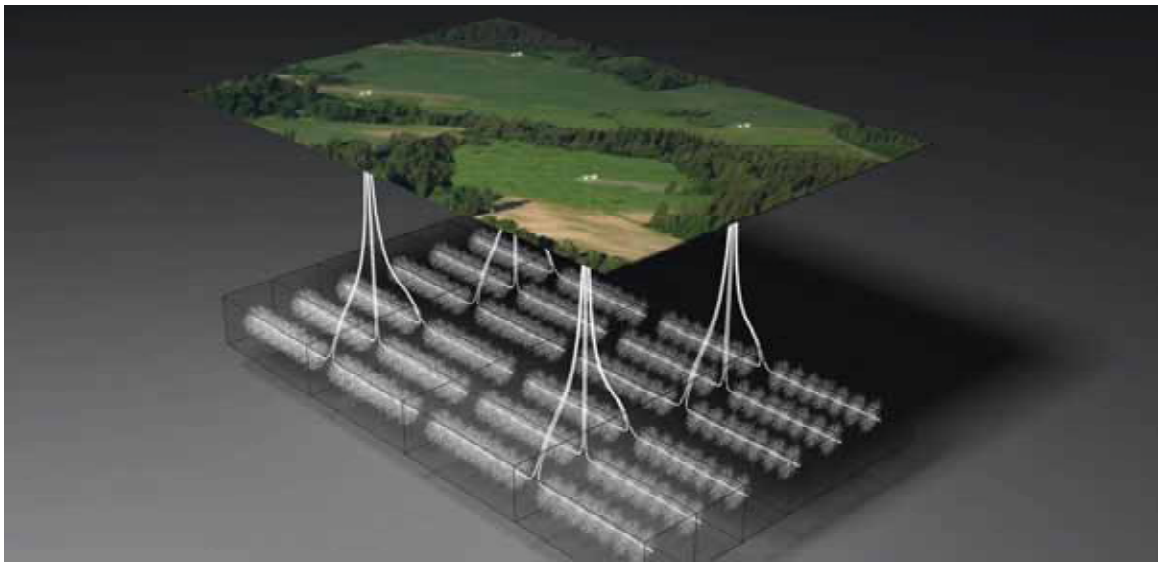
As discussed earlier, the density for multi-well pads, one per 640-acre spacing unit, is significantly less than for single well pads reducing the total number of disturbances to the landscape. While multi-well pads will be slightly larger than single well pads the reduction in number will lead to a substantial decrease in the total amount of disturbed acreage providing additional mitigation for long term visual and land use impacts on a regional basis. The following table provides an example for a 10 square mile area (i.e., 6,400 acres), completely drilled, comparing the 640 acre spacing option with multi-well pads and horizontal drilling to the 40 acre spacing option with single well pads and vertical drilling.

Spacing Option	**Multi-Well 640 Acre**	**Single Well 40 Acre**
Number of Pads	10	160
Total Disturbance - Drilling Phase	50 Acres (5 ac. per pad)	480 Acres (3 ac. per pad)
% Disturbance - Drilling Phase	.78	7.5
Total Disturbance - Production Phase	30 Acres (3 ac. per pad)	240 Acres (1.5 ac. per pad)
% Disturbance - Production Phase	.46	3.75

The reduction in sites should also allow for more resources to be devoted to proper siting and design of the pad to mitigating the short term impacts that result during the drilling and stimulation phase.[8] Some in industry have indicated that units much larger than 640 acres, possibly approaching 1280 acres, are being evaluated for future development from single, multi-

[7] NTC, pp. 28-31
[8] NTC, pp. 28-31

well pads. This would reduce the overall and regional gas well development footprint even further.



Source: Chesapeake Energy

9.2.1 Rate of Development and Thresholds

In response to questioning, a representative for one company estimated a peak activity for all of industry at 2,000 wells per year ± 25% in the New York Marcellus play. Other companies did not provide an estimate, listing the variables mentioned above as the reason. In Pennsylvania, where the Marcellus play covers a larger area and development has already occurred, the number of permits issued has increased in recent years as indicated in the following table. The source data provides information on the number of permits issued and is not indicative of the number of wells drilled.[9]

Year	**Marcellus Permits Issued**
2007	99
2008	510
2009 (Through 8/31)	1127

SOURCE: http://www.dep.state.pa.us/dep/deputate/minres/oilgas/RIG09.htm

[9] NTC, pp. 28-31

Recent development in the Barnett play in Texas, which utilizes the same horizontal drilling with high volume hydraulic fracturing that will be used in New York, has occurred at a rapid rate over the last decade. It is an approximately 4,000 square mile play located in and around the Dallas – Fort Worth area. In the eight year period from 2002 to 2008 approximately 10,500 wells were drilled.

The final scoping document summarizes the challenge of forecasting rates of development as follows:

"The number of wells which will ultimately be drilled cannot be known in advance, in large part because the productivity of any particular formation at any given location and depth is not known until drilling occurs. Changes in the market and other economic conditions also have an impact on whether and how quickly individual wells are drilled."

Additional research has identified that "Experience developing shale gas plays in the past 20 years has demonstrated that every shale play is unique." Each individual play has been defined, tested and expanded based on understanding the resource distribution, natural fracture patterns, and limitations of the reservoir, and each play has required solutions to problems and issues required for commercial production. Many of these problems and solutions are unique to the play.[10]

"The timing, rate and pattern of development, on either a statewide or local basis, are very difficult to accurately predict." As detailed in Section 2.1.6 of the Final Scoping Document "overall site density is not likely to be greater than was experienced and envisioned when the GEIS and its Findings were finalized and certified in 1992."[11]

The rate of development cannot be predicted with any certainty based on the factors cited above and in the Final Scoping Document. Additionally, the threshold at which development results in adverse impacts to the topics studied in this report cannot be determined since it would be

[10] NTC, pp. 28-31
[11] NTC, pp. 28-31

subjective.[12] Research has not found any scientifically backed or measurable threshold that could be used for the topic areas discussed in this report. As a result, any limit to rate of development, or setting of thresholds, would be purely subjective and indefensible.[13]

9.2.2 Regional Cumulative Impacts Conclusion/Recommendation

The approach for addressing regional cumulative impacts is to focus on the proactive siting of well pads as discussed in previous sections of this SGEIS. If the location and construction of each well pad is based on 'Best Practices' (See Appendix A, NTC) then the potential impacts will be lessened and/or eliminated. When applications are reviewed, it is recommended that DEC examine any negative issues that have occurred on adjacent spacing units to determine if there is a potential problem in the area that needs further scrutiny.[14]

9.3 Green or non-chemical fracturing technologies and additives

Hydraulic fracturing operations involve the use of significant quantities of additives/products, albeit in low concentrations, which potentially could have an adverse impact on the environment if not properly controlled. The recognition of potential hazards has motivated investigation into environmentally-friendly alternatives for hydraulic fracturing technologies and chemical additives.[15]

It is important to note that use of 'environmentally friendly' or 'green' alternatives may reduce, but not entirely eliminate, adverse environmental impacts. Therefore, further research into each alternative is warranted to fully understand the potential environmental impacts and benefits of using any of the alternatives. In addition, the 'greenness' needs to be evaluated in a holistic manner, considering the full lifecycle impact of the technology or chemical.[16]

URS reports that the following environmentally-friendly technology alternatives have been identified as being in use in the Marcellus Shale, with other fracturing/stimulation applications or under investigation for possible use in Marcellus Shale operations:

[12] NTC, pp. 28-31
[13] NTC, pp. 28-31
[14] NTC, pp. 28-31
[15] URS, pp. 6-1 - 6-7
[16] URS, pp. 6-1 - 6-7

- Liquid carbon dioxide alternative – The use of a liquid carbon dioxide and proppant mixture reduces the use of other additives [19]. Carbon dioxide vaporizes leaving only the proppant in the fractures. The use of this technique in the US has been limited to demonstrations [20].

- Nitrogen-based foam alternative – Nitrogen-based foam fracturing was used in vertical shale wells in the Appalachian Basin until recently [21]. Nitrogen gas is unable to carry appreciable amounts of proppant and the nitrogen foam was found to introduce liquid components that can cause formation damage [22].

- Liquefied Petroleum Gas (LPG) – The use of LPG, consisting primarily of propane, has the advantages of carbon dioxide and nitrogen cited above; additionally, LPG is known to be a good carrier of proppant due to the higher viscosity of propane gel [55]. Further, mixing LPG with natural gas does not 'contaminate' natural gas; and the mixture may be separated at the gas plant and recycled [55]. LPG's high volatility, low weight, and high recovery potential make it a good fracturing agent. This technology is in limited use in Canada, and has not yet been used in the US.

- Horizontal and directional wells – These techniques are already in use in the Marcellus Shale. While these techniques require larger quantities of water and additives per well, horizontal and directional wells are considered to be more environmentally-friendly because these types of wells provide access to a larger volume of gas/oil than a typical vertical well [20, 23].[17]

The use of alternative chemical additives in hydraulic fracturing is another facet to the 'environmentally- friendly' development in recent years.

9.3.1 Environmentally-Friendly Chemical Alternatives

There are several US-based chemical suppliers who advertise 'green' hydraulic fracturing additives. For example, Earth-friendly GreenSlurry system from Schlumberger used in both the U.K. North Sea and the Gulf of Mexico [29]; Ecosurf EH surfactants by Dow Chemicals; or

[17] URS, pp. 6-1 - 6-7

'Green' Chemicals for the North Sea from BASF. USEPA has published the twelve principles of green chemistry and a sustainable chemistry hierarchy [30], yet these do not provide a common measure of environmental-friendliness to assess 'green' hydraulic fracturing additives.[18]

The 'environmentally-friendly' aspect of hydraulic fracturing of deep shale formations presently stem from drilling techniques, like horizontal drilling and mutli-well pads with smaller overall footprint, and from the use of environmentally-friendly chemicals.[19] Several US-based chemicals suppliers advertise 'green' chemicals, but there does not seem to be a US-based metric to evaluate the environmental-friendliness of these chemicals.[20] The most significant environmentally conscious hydraulic fracturing operations and regulations to date are likely in the North Sea. Several countries have established criteria that define environmental-friendliness, and utilize models and databases to track chemicals' overall hazardousness against those criteria. Similar to NYSDEC, the regulatory authorities in Europe request proprietary information from chemicals suppliers, and do not release any proprietary information into the public domain. The proprietary recipes for chemical additives are used to assess their potential hazard to the environment, and regulate their use as necessary. [21]

If applicable, New York could choose to adopt the criteria used in Europe, or New York might choose to adapt the European criteria, as appropriate, or the US might choose to set up an independent scientific entity to evaluate all chemicals proposed for use within US territories. However, at this time, it may not be feasible to require the use of 'green' chemicals because presently there is no metric or chemicals approvals process in place in the US. The evaluation of the 'greenness' of a chemical needs to consider the life-cycle impacts associated with that chemicals; and setting up a metric that provides a comprehensive evaluation is difficult. It is important to note that several products manufactured by US-based companies, and used or proposed for use in the Marcellus Shale in New York, may be found in the European approved chemicals lists.[22]

[18] URS, pp. 6-1 - 6-7
[19] URS, pp. 6-1 - 6-7
[20] URS, pp. 6-1 - 6-7
[21] URS, pp. 6-1 - 6-7
[22] URS, pp. 6-1 - 6-7

9.3.2 Summary

As the Marcellus Shale and other shale plays across the United States are developed, the development and use of ‘green chemicals’ will proceed based on the characteristics of each play and the potential environmental impacts of the development. While more research and approval criteria would be necessary for the requirement of ‘green chemicals,’ this SGEIS contains thresholds, permit conditions and review criteria to reduce or mitigate potential environmental impacts for development of the Marcellus Shale and other lowpermeability gas reservoirs using high volume hydraulic fracturing. These requirements may be altered as the use of ‘green chemicals’ begin to provide reasonable alternatives and the appropriate technology and processes are in place.