Table 2.106 - Descriptions of the Thirteen FHWA Vehicle Classification Categories (New August 2011)

Vehicle Class	Description
1	**Motorcycles**. All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle-type seats and are steered by handlebars rather than steering wheels. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles. This vehicle type may be reported at the option of the state.
2	**Passenger Cars.** All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.
3	**Other Two-Axle, Four-Tire Single Unit Vehicles.** All two-axle, four-tire vehicles other than passenger cars. Included in this classification are pickup and panel trucks, vans, and other vehicles such as campers, motor homes, ambulances, hearses, carryalls, and minibuses. Other two-axle, four-tire single-unit vehicles pulling recreational or other light trailers are included in this classification. (**Note:** Because automatic vehicle classifiers have difficulty distinguishing class 3 from class 2, these two classes may be combined into class 2).
4	**Buses.** All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. Modified buses should be considered to be a truck and should be appropriately classified.
5	**Two-Axle, Six-Tire, Single-Unit Trucks.** All vehicles on a single frame, including trucks, camping and recreational vehicles, motor homes, etc., with two axles and dual rear wheels.
6	**Three-Axle, Single-Unit Trucks**. All vehicles on a single frame, including trucks, camping and recreational vehicles, motor homes, etc., with three axles.
7	**Four or More Axle, Single-Unit Trucks.** All trucks on a single frame with four or more axles.
8	**Four or Fewer Axle, Single-Trailer Trucks.** All vehicles with four or fewer axles, consisting of two units, one of which is a tractor or straight truck power unit.
9	**Five-Axle, Single-Trailer Trucks**. All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.
10	**Six or More Axle, Single-Trailer Trucks.** All vehicles with six or more axles, consisting of two units, one of which is a tractor or straight truck power unit.
11	**Five or Fewer Axle, Multi-Trailer Trucks**. All vehicles with five or fewer axles, consisting of three or more units, one of which is a tractor or straight truck power unit.
12	**Six-Axle, Multi-Trailer Trucks.** All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.
13	**Seven or More Axle, Multi-Trailer Trucks.** All vehicles with seven or more axles, consisting of three or more units, one of which is a tractor or straight truck power unit.

Source: FHWA 2001.

Notes: In reporting information on trucks, the following criteria should be used:

- Truck tractor units traveling without a trailer will be considered single-unit trucks.
- A truck tractor unit pulling other such units in a "saddle mount" configuration will be considered one single-unit truck and will be defined only by the axles on the pulling unit.
- Vehicles are defined by the number of axles in contact with the road. Therefore, "floating" axles are counted only when in the down position.
- The term "trailer" includes both semi- and full trailers.

Not included in the FHWA Vehicle Classification Categories are farm and agricultural equipment, which are common in the rural areas. Many of the rural roads are shared by passenger traffic, truck traffic, and farm and agricultural equipment.

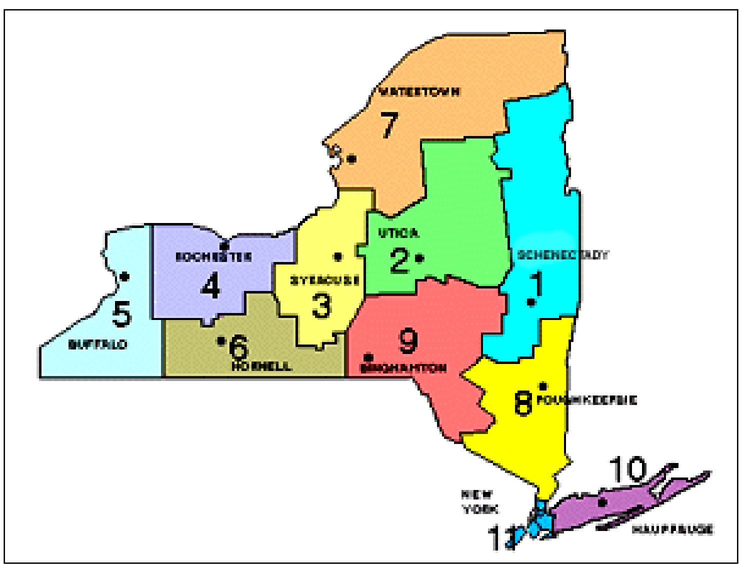
2.4.14.2 Regional Road Systems

New York State

The NYSDOT, acting through the Commissioner of Transportation, has general supervision of roads, highways, and bridges in the State of New York. The functions, powers and duties of the Commissioner of Transportation and the NYSDOT, respectively, are more fully described in Article II of the Highway Law and Article 2 of the Transportation Law. It is the mission of the NYSDOT to ensure that those who live, work, and travel in New York State have a safe, efficient, balanced, and environmentally sound transportation system.

The NYSDOT is divided into 11 regions to better manage the roadways, duties, and users (Figure 2.17).

Figure 2.17 - New York State Department of Transportation Regions (New August 2011)



Source: NYSDOT 2011a

The network of roads within New York State consists of federal, state, county, local, and private roads. Overall, there are an estimated 114,546 miles of highway roads in the state. This includes 32 interstate highways (principal arterials) totaling 1,705 miles, which are primarily maintained by the NYSDOT.

Figure 2.18 depicts the main interstate highways in New York State. The New York State Thruway, also known as the Governor Thomas E. Dewey Thruway (Interstate (I-) 90) is the main east-west route that crosses the midsection of the state, linking Buffalo, Rochester, Syracuse, and Albany. The New York State Thruway is a system of limited-access highways in New York State operated by the New York State Thruway Authority (NYSTA). It includes a total of approximately 570 miles (that is comprised of portions of I-87, I-90, I-95, I-190, and I-287). The Southern Tier Expressway, I-86, also is a major east-west route that services that southern portion of the state, connecting Jamestown, Olean, Elmira, and Binghamton. From Binghamton, I-86 runs southeast, providing access to New York City, and I-88 runs northeast providing access to Albany. Major north-south routes include I-81, which extends from Pennsylvania north through Binghamton and Syracuse to the border crossing with Canada, and I-87, which extends from New York City north to Montreal.

The state's transportation and road network also includes over 15,000 miles of state routes and 97,000 miles of county and local roads (NYSDOT 2009a). Each region examined as part of this analysis is discussed individually below.

The NYSDOT has specific, statutory authority to regulate work within the state highway rights-of-way (ROWs) (see Highway Law Section 52). This authority extends to granting, conditioning, or denying permits for, among many other things, curb cuts or breaks in access to state highways, utility work within the state ROWs that would be necessary for the operation of hydraulic fracturing facilities, and design approval for any new culverts, bridges, access roads, etc., on state ROWs that may become necessary for the construction or operation of hydraulic fracturing facilities.

Region A

Region A comprises Chemung, Tioga, and Broome Counties, which are within NYSDOT Regions 6 (Chemung) and 9 (Tioga and Broome). Table 2.107 presents a summary of the mileage of highways within each county. The Highway Mileage Report developed by NYSDOT provides current information on the public highway mileage in New York State by county (NYSDOT 2009a).

City with Year 2000 Population Greater than 25,000

Commercial Airports

Railroad

Interstate

County Boundary

State Boundary

Figure 2.18: Transportation

Source: ESRI, 2010; USGS, 2002

Table 2.107 - Region A: Highway Mileage by County, 2009 (New August 2011)

	Town or Village	County	NYSDOT Owned	Other	Total
Chemung	766.7	243.7	118.4	3.6	**1,132.4**
Tioga	823.7	141.7	155.2	0.0	**1,120.6**
Broome	1,340.1	339.1	297.3	19.6	**1,996.1**
Total Region A	**2,930.5**	**724.5**	**570.9**	**23.2**	**4,249.1**

Source: NYSDOT 2009a.

The principal arterial in Region A is the Southern Tier Expressway (I-86/NY-17), which runs east-west through the three counties that constitute Region A. This highway connects Elmira and areas west of the region with Binghamton and areas east of the region. Another major highway, I-81, intersects I-86 in Binghamton and runs north to Syracuse and south to Scranton, Pennsylvania. In addition, I-88 originates in Binghamton and runs northeast to Albany (Figure 2.18)

Numerous other arterials, collectors, and local roadways cover this region and connect smaller towns and villages. Heavy vehicles (i.e., Vehicle Classifications 04 through 13) primarily use major roadways. NYSDOT conducted a study of the road use by heavy vehicle traffic, based on 2004 to 2009 data (NYSDOT 2010a). The data for rural areas in NYSDOT Regions 6 and 9 are presented in Table 2.108.

Table 2.108 - Heavy Vehicles as a Percentage of Total Vehicles in Rural Areas in NYSDOT Regions 6 and 9, 2004-2009 (New August 2011)

Functional Classification (FC) Code	NYSDOT Region 6	NYSDOT Region 9	Statewide
01	36.0%	25.1%	25.2%
02	15.5%	13.6%	12.5%
06	10.2%	10.2%	9.5%
07	10.9%	8.7%	8.9%
08	5.7%*	6.8%	6.8%
09	-*	6.4%	7.1%

Source: NYSDOT 2010a.
* No data or insufficient data (i.e., data from <10 highway segments).

Heavy-vehicle traffic is concentrated on major roadways, with FC road classifications 01 and 02 handling 51.5% and 38.7%, respectively, of heavy-vehicle traffic in NYSDOT Regions 6 and 9. Compared to the statewide percentage (37.7%), in both Regions 6 and 9, heavy-vehicle traffic is concentrated more on principal arterial roadways and less on other roads. Since FC01 and FC02 are arterials used primarily for long-distance, high-speed travel, the majority of this traffic is assumed to pass through the counties.

Region B

Region B comprises Otsego, Delaware, and Sullivan Counties, all of which are in NYSDOT Region 9. Table 2.109 presents a summary of the mileage of highways within each county. The Highway Mileage Report developed by NYSDOT provides current information on the public highway mileage in New York State by county (NYSDOT 2009a).

Table 2.109 - Region B: Highway Mileage by County, 2009 (New August 2011)

	Town or Village	County	NYSDOT Owned	Other	Total
Otsego	1,326.2	476.6	290.4	4.2	**2,097.4**
Delaware	1,608.4	262.0	341.1	37.5	**2,248.9**
Sullivan	1,462.1	385.3	201.9	10.6	**2,059.9**
Total Region B	**4,396.7**	**1,123.9**	**833.4**	**52.3**	**6,406.2**

Source: NYSDOT 2009a.

The road network in Region B has two main roadway corridors running through different sections of the three counties. One is I-88, which runs in a southwest-northeast direction along the border of Otsego and Delaware Counties. In addition, NY-17 runs from the western portion of Delaware County to the east and southeast, along the Catskill Forest Preserve, into Sullivan County and towards New York City (Figure 2.18).

Numerous other arterials, collectors, and local roadways cover this region and connect smaller towns and villages. Heavy vehicles primarily use major roadways. A NYSDOT study used vehicle classification data from 2004 to 2009 to estimate the percentage of heavy vehicles on various road classifications in rural and urban settings (NYSDOT 2010a). The data for rural areas in NYSDOT Region 9 are presented in Table 2.110.

Table 2.110 - Heavy Vehicles as a Percentage of Total Vehicles in Rural Areas in NYSDOT Region 9, 2004-2009 (New August 2011)

Functional Classification (FC) Code	NYSDOT Region 9	Statewide
01	25.1%	25.2%
02	13.6%	12.5%
06	10.2%	9.5%
07	8.7%	8.9%
08	6.8%	6.8%
09	6.4%	7.1%

Source: NYSDOT 2010a.

Heavy-vehicle traffic is concentrated on major roadways, with FC road classifications 01 and 02 handling 38.7% of heavy-vehicle traffic in NYSDOT Region 9. Compared to the statewide percentage (37.7%), in Region 9, heavy-truck traffic is concentrated more on principal arterials and a less on other roads.

Region C

Region C comprises Chautauqua and Cattaraugus Counties, both of which are in NYSDOT Region 5. Table 2.111 presents a summary of the mileage of highways in each county. The *Highway Mileage Report* developed by NYSDOT provides current information on the public highway mileage in New York State, by county (NYSDOT 2009a).

Table 2.111 - Region C: Highway Mileage by County, 2009 (New August 2011)

	Town or Village	County	NYSDOT Owned	Other	Total
Cattaraugus	1,379.8	397.7	315.2	54.1	**2,146.8**
Chautauqua	1,531.5	551.5	353.1	47.1	**2,483.2**
Total Region C	**2,911.3**	**949.2**	**668.3**	**101.2**	**4,630.0**

Source: NYSDOT 2009a.

The two main roadway corridors in Region C run through different sections of the two counties. One is I-90, which runs northeast from the Pennsylvania border in Chautauqua County and along Lake Erie towards Buffalo, New York. The other corridor, I-86/NY-17, runs east-west through both Chautauqua and Cattaraugus Counties, crossing into Pennsylvania in western Chautauqua County. I-86/NY-17 crosses over Chautauqua Lake and runs north of the major population center of Jamestown. It also connects other cities such as Randolph, Salamanca, and Olean (Figure 2.18).

Numerous other arterials, collectors, and local roadways cover this region and connect smaller towns and villages; these include Route 16, Route 19, Route 60, and Route 219. Heavy vehicles primarily use major roadways. A NYSDOT study used vehicle classification data from 2004 to 2009 to estimate the percentage of heavy vehicles on various road classifications in rural and urban settings (NYSDOT 2010a). The data for rural areas in NYSDOT Region 5 are presented in Table 2.112.

Table 2.112 - Heavy Vehicles as a Percentage of Total Vehicles in Rural Areas in NYSDOT Region 5, 2009 (New August 2011)

Functional Classification (FC) Code	NYSDOT Region 5	Statewide
01	23.5%	25.2%
02	10.9%	12.5%
06	11.3%	9.5%
07	8.8%	8.9%
08	6.3%	6.8%
09	7.1%	7.1%

Source: NYSDOT 2010a.

Heavy-vehicle traffic is concentrated on major roadways, with FC classifications 01 and 02 handling 34.4% of heavy-vehicle traffic in NYSDOT Region 5. However, the percentages are less than the corresponding statewide percentage. This may be a result of the city of Buffalo being located in NYSDOT Region 5, where heavy-vehicle traffic may use smaller roads in industrial/manufacturing areas for pickups and deliveries.

2.4.14.3 Condition of New York State Roads

New York State reports annually on the condition of bridges and pavements. Based on data submitted to the FHWA in April 2010, about 12% of the highway bridges in New York State are classified, under the broad federal standards, as structurally deficient, and about 25% are classified as functionally obsolete. Those classifications do not mean the bridges are unsafe, rather that they would require repairs or modifications to restore their condition or improve their functionality (NYSDOT 2011b).

The condition of pavements is scored on a 10-point scale, as shown in Table 2.113. New York State road conditions are ranked 42nd in the nation (NYSDOT 2009b). This makes any impacts on road conditions an important consideration.

Table 2.113 - Ranking System of Pavement Condition in New York State (New August 2011)

9-10	Excellent	No significant surface distress
7-8	Good Surface	Distress beginning to show
6	Fair	Surface distress is clearly visible
1-5	Poor	Distress is frequent and severe
U	Under Construction	Not rated due to ongoing work

Source: NYSDOT 2010b.

2.4.14.4 NYSDOT Funding Mechanisms

The construction, reconstruction, or maintenance (including repair, rehabilitation, and replacement) of transportation infrastructure under the State's jurisdiction are performed by the NYSDOT. The state has statutorily established a number of funds that collect dedicated taxes and fees to fund NYSDOT's capital and operating activities. Most of the tax and fee sources for these funds are related to transportation and collected from transportation users. They include:

- Petroleum business tax;
- Highway use tax;
- Motor fuel tax;
- Motor vehicle fees;
- Auto rental tax; and
- Miscellaneous special revenues.

The Petroleum Business Tax (PBT) is a tax imposed on petroleum businesses operating in New York State. The tax is paid by registered distributors and is imposed at a cents-per-gallon rate on petroleum products sold or used in the State. The tax imposition occurs at different points in the distribution chain, depending on the type of petroleum product: For motor fuel, the PBT is imposed upon importation into the State; for diesel motor fuel, the PBT is imposed on the first sale or use in the State; for non-automotive diesel fuel and residual oil, the PBT is imposed on final sale or use; for kero-jet fuel, the PBT is imposed on fuel consumed on take-off from points in the State. The tax is jointly administered and collected with the State's motor fuel tax (NYSDTF 2011a).

The Highway Use Tax (HUT) is a tax on motor carriers operating certain motor vehicles on New York State public highways (excluding toll-paid portions of the New York State Thruway). The tax is based on mileage traveled on NYS public highways and is computed at a rate determined by the weight of the motor vehicle and the reporting method. A HUT certificate of registration is required for any truck, tractor, or other self-propelled vehicle with a gross weight over 18,000 pounds or for any truck with an unloaded weight over 8,000 pounds and any tractor with an unloaded weight over 4,000 pounds. An automotive fuel carrier (AFC) certificate of registration is required for any truck, trailer, or semi-trailer transporting automotive fuel (NYSDTF 2011b).

New York State has a motor fuel tax on motor fuel and diesel motor fuel sold in the State. The tax is imposed when motor fuel is produced in or imported into New York State and when diesel motor fuel is first sold or used in the State. It is jointly administered and collected with the petroleum business tax. The tax is paid by registered motor fuel and diesel motor fuel distributors (NYSDTF Finance 2011c).

Motor vehicle fees, which are collected by the New York State Department of Motor Vehicles, are another large source of income for the NYSDOT. Other taxes collected for the NYSDOT include the auto rental tax, corporation and utility tax, and other miscellaneous receipts, although the PBT, HUT, motor fuel tax, and motor vehicle fees are the main sources of revenue.

Table 2.114 shows the actual total receipts for years 2009-2010 and 2010-2011 for the NYSDOT, as well as the estimated receipts for year 2011-2012. Total receipts allotted to the NYSDOT increased from 2009 to 2011 and are expected to continue to increase through 2012.

Table 2.114 - NYSDOT Total Receipts, 2009-2012 ($ thousands) (New August 2011)

	2009-2010 Actual	**2010-2011 Actual**	**2011-2012 Estimated**
Petroleum Business Tax	612,502	605,945	614,000
Highway Use Tax	137,247	129,162	144,000
Motor Fuel Tax	401,099	407,725	404,000
Motor Vehicle Fees	626,589	813,264	827,000
Auto Rental Tax	51,726	60,032	65,000
Corporation and Utility Tax	19,641	16,400	15,000
Other Miscellaneous Receipts	635,045	467,876	578,902
Total Tax Receipts	**1,848,804**	**2,032,528**	**2,069,000**
Total Receipts	**2,483,849**	**2,500,404**	**2,647,902**

Source: Zerrillo 2011.

The actual amount of total receipts in the year 2010-2011 was $2.5 billion. Approximately $1.4 billion, or 45.7%, came from business taxes, including the motor fuel, petroleum, and highway use taxes. Approximately $813 million, or 32.5%, came from motor vehicle fees, and $544 million, or 21.8% came from auto rental and corporation and utility uses taxes and other miscellaneous receipts. In the estimated receipts for next year (2011-2012), all income related to taxes is estimated to remain relatively constant, whereas there is expected to be a $200 million increase in motor vehicle fees due to increases in fees (Table 2.114).

Collectively, revenues from these taxes flow into the state's Dedicated Highway and Bridge Trust Fund (DHBTF), which is the primary funding source for the NYSDOT highway and bridge capital program, engineering and program administration, DMV administration, as well as capital programs for transit, rail and aviation. In addition to these tax revenues, state general fund support is required to sustain the DHBTF and provide for new project commitments.

NYSDOT is implementing the final year of a two-year capital program for which approximately $1.8 billion is annually dedicated to capital rehabilitation and replacement of the state and local road and bridge system. Despite past investment, the condition of the state's highway pavements and bridges is declining. Given the age of the state's highway system, the capital program, by necessity, invests largely in safety and asset preservation projects to meet the urgent needs of the transportation system.

In addition to state investment in roads and bridges, local governments invest in local roads and bridge infrastructure maintenance and improvement, largely through local property and other local taxes.

2.4.14.5 Rail and Air Services

New York State is served by an extensive system of rail lines for passengers and freight. Amtrak, operating primarily over rail lines owned by freight railroads, is the solitary provider of intercity rail passenger service in New York State. Over approximately 782 route miles, Amtrak links downstate with upstate cities that include Albany, Utica, Syracuse, Rochester, Buffalo, and many other intermediate points. CSX Transportation, Canadian Pacific Railway, and Norfolk Southern Railway are the primary owners and operators of freight corridors in New York State. CSX Transportation is the largest among these railroads, operating 1,292 of the total 4,208 miles of freight rail in the state. Fifty-nine of New York State's 62 counties are served by one of New York's freight railroads, which connect to all adjacent states and Canadian provinces (NYSDOT 2009). The principal rail lines in New York State are shown on Figure 2.18.

Freight carried by railroad is off-loaded at rail yards and transported to specific locations from the railroads by truck. The rail network in New York State is capable of carrying much of the drill equipment that might be required, although it would still have to be moved by truck from the rail yards to the well heads.

Many of the communities in and near the gas development areas are serviced by commercial airliners, including those associated with airports in smaller cities such as Jamestown, Binghamton, and Elmira, and in larger cities such as Buffalo, Rochester, and Syracuse. Figure 2.18 shows the location of Commercial - Primary airports, which are publicly-owned airports that receive scheduled passenger service and have more than 10,000 enplaned passengers per year. A list of Commercial - Primary airports in New York State is provided below. Some airports that are not categorized as Primary airports, because they fall below the 10,000 passenger per year passenger count, also are serviced by scheduled air carriers. The Jamestown airport is one such facility that lies within the area of potential shale gas development.

- Albany International Airport;
- Greater Binghamton Airport;
- Buffalo Niagara International Airport;
- Elmira/Corning Regional Airport;
- Long Island MacArthur Airport;
- Ithaca Tompkins Regional Airport;
- John F. Kennedy International Airport;
- LaGuardia Airport;
- Stewart International Airport;
- Plattsburgh International Airport;
- Greater Rochester International Airport;
- Syracuse Hancock International Airport; and
- Westchester County Airport.

In addition to Commercial - Primary airports, there are many other public use airports that can be utilized by charter operations. None of these airports are at or near capacity and can be available to service an influx of temporary workers.

2.4.15 Community Character[58]

A community's character is defined by a combination of natural physical features, history, demographics and socioeconomics, and culture (Robinson 2005). Key attributes or features used to define community character generally include local natural features and land uses; local history and oral traditions; social practices and festivals; unique local restaurants and cuisine; and local arts. In addition, New York State's Environmental Quality Review Act acknowledges community character as a component of the environment, including existing patterns of

[58] Subsection 2.4.15, in its entirety, was provided by Ecology and Environment Engineering, P.C., August 2011 and was adapted by the Department.

population concentration, distribution or growth, and existing community or neighborhood character.

Local and regional planning are important in defining a community's character and long-term goals. In New York State, planning, zoning, and local law are implemented and enforced at the local level, through county and municipal boards or councils. The local entities set forth the community's goals and objectives through planning or zoning documents, which provide the most tangible and formal expression of a community's character. Notably, a 2007 New York State Court of Appeals decision (Village of Chestnut Ridge vs. Town of Ramapo) observed that "[t]he power to define the community character is a unique prerogative of a municipality acting in its governmental capacity" and, that, generally, through the exercise of their zoning and planning powers, municipalities are given the job of defining their own character (NYSDEC 2007).

A sense of place also is central to community character or identity. "Sense of place" can be described as those tangible and intangible characteristics which, over a period of time, have given a place its distinctiveness, identity, and authenticity (Robinson 2005). Distinctiveness can be globally, nationally, or regionally important, as well as locally or personally important. The various elements that comprise sense of place include, but are not limited to, regional and local planning, population density, transportation and access, and services and amenities.

To be a defined "place" a bounded area must be recognized by those within and without it as being a distinctive community and having a distinctive character. A sense of place and community character cannot be described for New York State as a whole due to the vast area it covers and the range of differences in communities across the state. Residents of a single place share their history, resources, and common concerns and have a similar way of life. Regions A, B, and C (Figure 2.3) were developed for the purposes of the SGEIS to generally describe representative areas of impact within the area underlain by the Marcellus Shale in New York State. Because they encompass numerous counties and municipalities with diverse land uses, planning goals, and identities, it is difficult to fully describe community character at the regional level. Each community within these regions has its own set of distinctiveness, authenticity, and identity. For the purposes of this analysis, the sense of place for a county or region was described utilizing regional, county, and local comprehensive plans, economic development plans, and Web sites. These resources were used to piece together the sense of place for the representative regions.

Region A

Region A comprises Broome, Tioga, and Chemung Counties (Figure 2.4a). It is located in the eastern portion of the Southern Tier of New York, along the New York/Pennsylvania border. The Southern Tier Expressway (Interstate 86) crosses the southern portion of Region A, providing east/west access, and connecting the cities of Elmira in Chemung County, Waverly and Oswego in Tioga County, and Binghamton, Endicott and Johnson City in Broome County. Most of the urban development occurs along this corridor. The remainder of the region is rural; the rural landscape is dominated by the hills and valleys along the Susquehanna and Chemung Rivers. Collectively, the counties within Region A comprise 38 towns/cities, 18 villages, and many unincorporated areas. There are 21 combined school districts in the Region.

Generally, Region A can be described as having relatively small urban centers and quaint villages surrounded by small, scattered, and picturesque rural communities, largely set within the hills and valleys along the Susquehanna and Chemung Rivers. The Susquehanna and Chemung River valleys are a large part of the natural landscape and create vistas important to local communities. The natural landscape is home to a variety of wildlife, which is enjoyed by residents and visitors both passively (e.g., hiking and bird watching) and actively (e.g., fishing and hunting). Rural elements include scenic drives/routes, farmland, woodlands, forests, waterways, and natural areas. Villages and towns in Region A are quaint and historic and are also home to many musicians and artisans. In Region A, officials and residents describe their communities as being friendly and having a small-town feel and their residents as hard-working and ethical. Many note their country fairs, unique shops, and overall rural characteristics as contributing to their community's character.

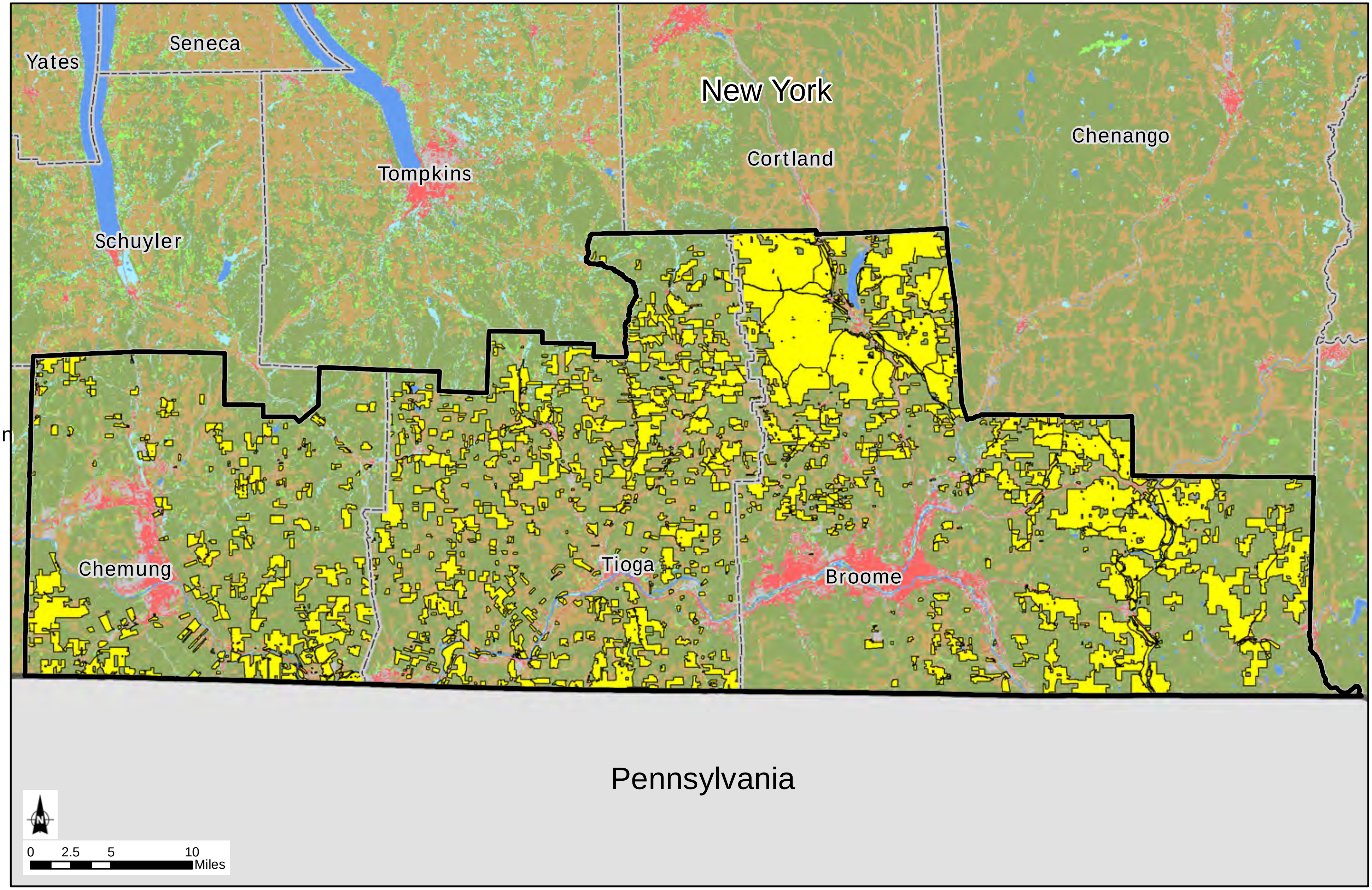
Within the counties that comprise Region A, agriculture is an important part of community character. There are over 1,500 farms within Region A, and approximately 279,000 acres of land within the Region are located within 11 state-designated agricultural districts (NYSDAM 2011). Figure 2.19 provides an overview of the agricultural districts within Region A.

Region A is rich in history and historic preservation opportunities. Chemung County and the city of Elmira are considered to be "Mark Twain Country," because it is the area where Mark Twain lived a large portion of his life and where he died. The character of Region A is influenced by numerous sites and events associated with Native American history, the Revolutionary War and Civil War, and the Underground Railroad, as well as historic villages, towns, and farms (Chemung County Chamber of Commerce 2011). The town of Owego, in Tioga County, has 151 homes that are located in historic districts (Visit Tioga 2011), and numerous Victorian homes throughout the region contribute to the historical aspect of its region's character.

The region aims to maintain a "Main Street" and small local business attitude by promoting economic growth and maintaining a rural character.

Agri-tourism in the form of petting zoos, U-pick farms, and farmers markets is a large part of the community character of the region. An abundance of outdoor recreational activities, including hiking, biking, fishing, boating, hunting, cross-country skiing, and bird-watching, contributes to the high quality of life these communities all strive for. These activities are counterbalanced by many opportunities to enjoy art, music, and other cultural amenities provided by the region's cities and towns.

Drilling for natural gas has been performed to a limited extent in Region A; in 2009 there were only 46 gas wells in the region (NYSDEC 2009). Of these, 45 active gas wells are located in Chemung County and one is in Tioga County. In addition, there are 13 underground gas storage wells in operation in Tioga County (NYSDEC 2011).



Representative Region A
County Boundary
Agricultural Districts

USGS NLCD
Developed
Open Space
Agriculture
Forest
Herbaceuous/Shrub/Scrub
Open Water
Wetlands

NOTE: Agricultural district boundaries are overlaid on the land cover data. The land cover within agricultural district boundaries includes land cover other than agriculture; however, land cover within the agricultural district boundaries is predominately agriculture.

Figure 2.1**9**:
Land Cover and Agricultural Districts
Representative Region A

Source: ESRI, 2010; NYSDAM, 2011

Broome County. Broome County is the furthest east in the region. The county has a total area of 715 square miles, including 707 square miles of land and 8 square miles of surface water (lakes, ponds, rivers, and streams). Broome County is more densely populated than the other counties in Region A, with a population density of 284 persons per square mile.

Within Broome County are 17 towns/cities and seven villages, and 12 school districts (Broome County 2011; New York Schools 2011a). The Binghamton-Johnson City-Endicott Tri-City Area is the predominant urban area of the county, which is surrounded by suburban development (Greater Binghamton Chamber of Commerce 2011). Major manufacturers located in Binghamton include Lockheed Martin (systems integration), BAE Systems (mission systems) and IBM Corporation (technology). Large healthcare facilities are also located in Binghamton, including United Health Services and Lourdes Hospital. The State University of New York at Binghamton is also a large employer within the region.

The Southern Tier Expressway (Interstate 86/NYS Route 17) crosses the southern portion of Broome County in an east-west direction, and Interstate 81 provides northern access to the cities of Cortland and Syracuse and the New York State Thruway.

The remaining land area in Broome County is largely rural. As reported by the Census of Agriculture, in 2007 there were 580 farms in Broome County, covering approximately 98,000 acres of land (22% of the total land area of the county). The average size of a farm in Broome County in 2007 was 150 acres. Principal sources of farm income include milk, cattle/calves, other crops/hay and nursery, greenhouse, floriculture, and sod. Dairy products account for approximately 70% of agricultural sales in the county (USDA 2007). As of 2011, there were approximately 153,000 acres of land within three state-designated agricultural districts in Broome County (NYSDAM 2011). Agri-tourism in Broome County focuses on farmers markets, U-pick farms, alpaca farms, apples, botanical gardens, and maple syrup (Visit Binghamton 2011).

Broome County and Tioga County are a part of the Susquehanna Heritage Area, which seeks to use the historic, cultural, and natural resources of the counties to strengthen the region's identity, enhance the local quality of life, support the local economy, and promote stewardship (Susquehanna Heritage Area 2009).

Broome County's Department of Planning and Economic Development "serves to promote the sound and orderly economic and physical growth of Broome County and its constituent municipalities…it implements projects and programs designed to improve the economy, environment and physical infrastructure of the county" (Broome County 2009). Development of comprehensive plans is generally left to the discretion of city and town zoning and planning boards, which originally adopted traditional forms of regulation in an effort to protect land use and natural resources. Local and regional development is guided by a number of open space plans, local comprehensive plans, and strategic plans. These documents broadly reflect a community's history, values, future goals, and character.

Broome County does not have a comprehensive or master plan, but many of its larger municipalities have a comprehensive/master plan, land use regulations/laws, and zoning maps. A brief review of representative local planning documents indicated that several communities in the county are concerned with protecting and maintain agricultural activities in order to preserve open space, promote historic preservation, and preserve and enhance the sense of community identities. As an example, the Town of Union's Unified Comprehensive Plan outlines the following goals and objectives: "protect and maintain agricultural activities as a land use option in order to preserve open space . . . promote a balance between the need to use and the need to preserve resources . . . [and] . . . promote historic preservation" (Town of Union 2009).

Tioga County. Tioga County is located in the Southern Tier of New York State, west of Broome County. This county has a total area of 523 square miles, including 519 square miles of land and 4 square miles of surface waters (lakes, ponds, rivers, and streams). Tioga County has the lowest population density in Region A, with 98.6 persons per square mile.

Within Tioga County are nine towns and six villages, as well as six school districts (Tioga County 2011a; New York Schools 2011b). The largest urban developments are Owego (19,883 persons in the town and 3,896 persons in the village) and Waverly (4,444 persons). The Binghamton-Johnson City-Endicott Tri-City Area also extends from Broome County into the eastern edge of Tioga County. The existing land use pattern in Tioga County has been influenced by the historic pattern of highway-oriented transportation and employment provided by IBM Corporation and later Lockheed Martin (Tioga County 2005). The presence of technologically advanced industries in the southern portion of the county, along the Southern Tier Expressway and near Owego, led to that portion of the county being more densely populated than the northern portion. There are no major roadways running east-west in the northern portion of the county.

The remaining land area in Tioga County is largely rural. As reported by the Census of Agriculture, in 2007 there were 565 farms in this county, covering approximately 106,800 acres of land (32% of the land area of the county). The average size of a farm in Tioga County in 2007 was 189 acres (USDA 2007). The principal source of farm income is dairy products, which accounted for approximately 75% of agricultural products sold in 2007. Other farming in the county includes beef cows, horses, sheep, and poultry. Hay is the largest crop grown in Tioga County, followed by oats and vegetables. Farming operations in Tioga County also produce over 800 gallons of maple syrup (Tioga County 2011a). In recent years, Tioga County has seen decreases in the number of farms, the productivity of farms, and farmed acreage (Tioga County 2005). As of 2011, there were approximately 84,000 acres of land within three state-designated agricultural districts in the county (NYSDAM 2011). Tioga County continues to encourage farm owners to enroll in and work with the NYSDAM to establish agricultural districts to preserve the agricultural character of the county (Tioga County 2005).

Tioga County's physical environment ranges from farming communities to historic town centers with charming "Main Streets" (Visit Tioga County 2011; Tioga County 2005). The county is defined as rural and suburban, but not urban (Tioga County 2011b). The portion of the Susquehanna River basin in Tioga County provides recreational and visual benefits to the county. Tioga County prides itself in its unspoiled beauty, human resources, and central geographic location (Tioga County 2011c).

Tioga County encourages local municipalities to develop their own planning documents (Tioga County 2005). Development of comprehensive plans is generally left to the discretion of village and town zoning and planning boards, which originally adopted traditional forms of regulation in an effort to protect land use and natural resources. Local and regional development is guided by a number of open space plans, local comprehensive plans, and strategic plans. These documents broadly reflect a community's history, values, future goals, and character.

Tioga County does not have a comprehensive or master plan, but many of its municipalities have a comprehensive/master plan, land use regulations/laws, and/or zoning maps. A brief review of representative local planning documents indicated that several communities in the county are concerned with promoting economic development while preserving and maintaining their small town/hometown atmosphere and rural character. The towns also emphasize the importance of conservation and preservation of natural areas and open space, including both agriculture land use and future expansion of recreational community areas. For example, the first goal of the Town of Candor Comprehensive Plan is to "attract and recruit desirable small business and light industry in order to help create a stable tax base and maintain the small town/hometown atmosphere" (Town of Candor 1999).

Chemung County. Chemung County is located west of Tioga County. The county has a total area of 411 square miles, including 408 square miles of land and 3 square miles of surface water. Chemung County has a population density of 218 persons per square mile.

Within Chemung County are 12 towns/cities and five villages, as well as three school districts (Chemung County 2011a; New York Schools 2011c). The existing land use pattern in Chemung County has been significantly influenced by the topography of the region, including the Chemung River Valley. The region's climate, topography, and soils support productive agricultural, forestry, and wood product industries (Susquehanna – Chemung 2011). The region is rural, with rolling hills, scenic farmlands, rural vistas, and outdoor recreation opportunities, which are all major contributors to the region's appeal.

The city of Elmira is the largest population center in Chemung County. Located along the Southern Tier Expressway (Interstate 86/17), the city is the historical and cultural center of the county and has numerous historical markers, museums, and tours. The city has the "largest concentration of Victorian-era homes in the State of New York" (Chemung County Chamber of Commerce 2011). Chemung County has many manufacturing industries, which make products such as subway cars, electronic equipment, structural steel products, helicopters, automotive-related products, and paper products (Chemung County 2008).

As reported by the Census of Agriculture, in 2007 there were 373 farms in the county, covering approximately 65,000 acres of land (approximately 25% of the land area of the county). The average size of a farm in Chemung County in 2007 was 175 acres (USDA 2007). Agricultural activities include the production of corn, wheat, hay silage, vegetables, poultry, eggs, beef, milk, milk products, and pork (Chemung County 2008). Approximately 42,000 acres of farmland in Chemung County are located in five agricultural districts (NYSDAM 2011). Farming operations in Chemung County have also decreased over the years, but agriculture is still a major industry in this county.

Chemung County's topography consists of hills and valleys, with the principal valley being the Chemung River valley (Chemung County 2008). The majority of the county is naturally forested and classified as woodland, but up to 18% of the land area is active agricultural land (Chemung County 2008). Described as the "Gateway to the Finger Lakes," Chemung County itself has sufficient waterways, rolling hills, scenic farmlands, and outdoor recreational resources to provide a high quality of life for residents and tourists (Susquehanna-Chemung 2011).

Chemung County's Planning Department assists local communities with comprehensive planning, land use and zoning, floodplains and watersheds, and grant proposals (Chemung County 2011b). Chemung County empowers the local municipalities to develop their own planning documents and periodically presents specialized training workshops for local planning and zoning officials (Chemung County 2011b, 2011c). Development of comprehensive plans is generally left to the discretion of village and town zoning and planning boards, which originally adopted traditional forms of regulation in an effort to protect land use and natural resources. Local and regional development is guided by a number of open-space plans, comprehensive plans, and strategic plans. These documents broadly reflect a community's history, values, future goals, and character. The Chemung County Planning Department participates actively in the Rural Leadership program of the Southern Tier Regional Planning and Development Board (Chemung County 2011b).

Chemung County does not have a comprehensive or master plan, but many of its municipalities have a comprehensive/master plan, land use regulations/laws, and/or zoning maps. A brief review of representative local planning documents indicated that several communities in the county are concerned with protecting their small town feel, maintaining a similar population size, enhancing recreational amenities, and protecting environmentally significant and/or sensitive areas while minimizing anthropogenic adverse impacts on the land and, consequently, the quality of life of the residents. For example, the Village of Horseheads Comprehensive Plan states their village "... is an inviting place where diverse residents choose to live, work, and play; it is a blend of residential neighborhoods, commercial and manufacturing businesses, parks, and open spaces. Residents and Village officials take pride in the surroundings by assuring the maintenance and beauty of homes, land, and property" (Village of Horseheads 2010).

Region B

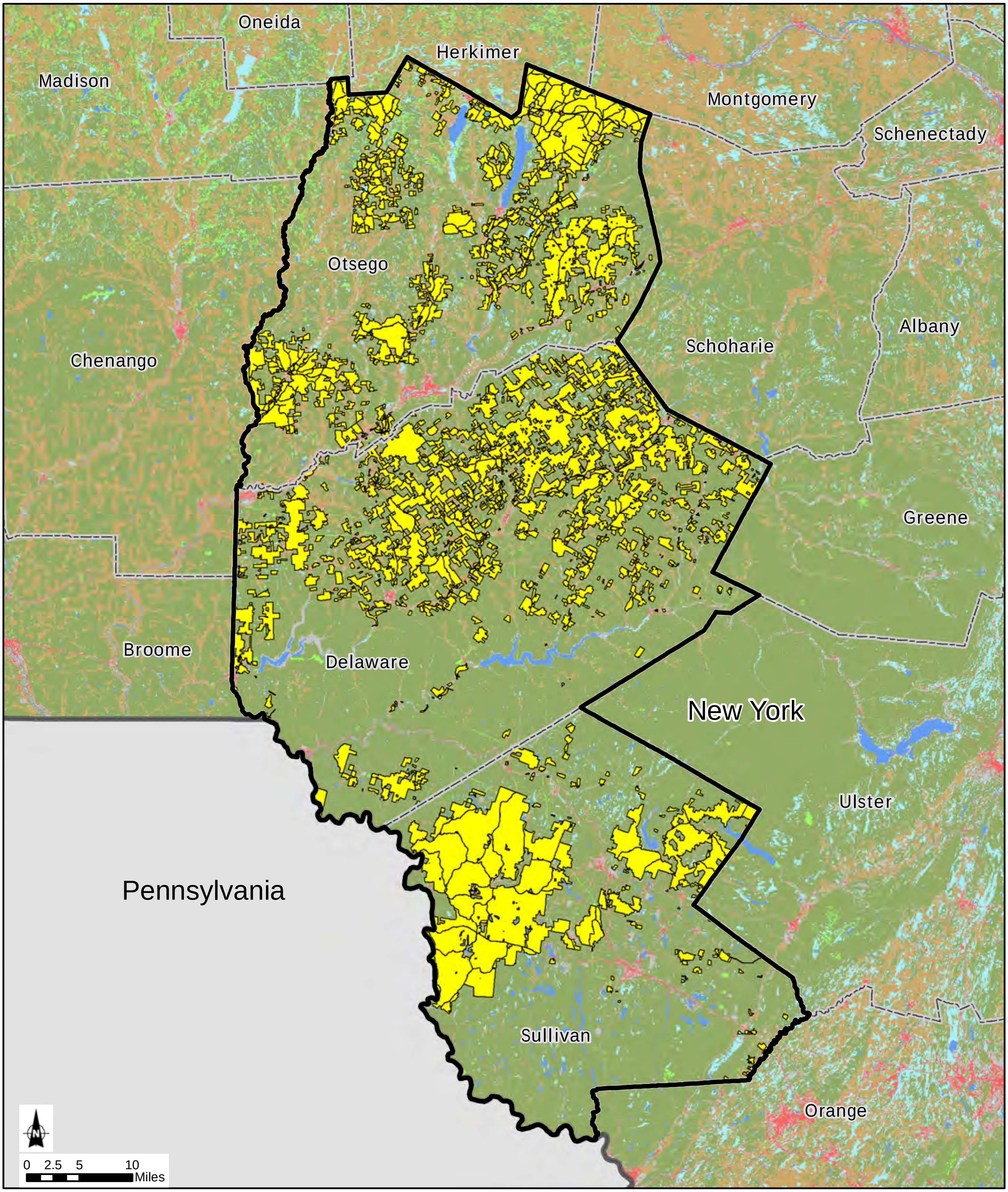
Region B comprises Delaware, Sullivan, and Otsego Counties (Figure 2.4b). Region B is located in the Catskill Mountains and the Leatherstocking region of New York and has a rich natural and human history. The National Baseball Hall of Fame is located in Cooperstown, in Otsego County, and is a destination for thousands of people annually. Glass museums, history museums, and other tourist attractions exist throughout the region. The Catskills are an attraction for outdoor enthusiasts. Various manufacturing companies are located across the region, mainly occurring in the larger towns. The region is known for manufacturing communications equipment, integrated circuits, pharmaceuticals, transportation equipment, plastic and rubber products, and food and beverages. Other large employers include insurance companies, colleges, health care facilities, and retailers. NYSEG, Verizon, and other electronics companies are located in the city of Oneonta (City of Oneonta 2011). Having manufacturing and cultural hubs surrounded by natural areas contributes to the community character of the region.

Within the region there are 60 towns, 26 villages, and over 75 hamlets; 42 combined school districts. Gas drilling is relatively new to these counties and is not an integral part of the industrial or rural landscape of the region. In 2009 there were no natural gas wells in production in Region B (NYSDEC 2009). Several exploratory wells were developed in 2007 and 2009, but no production has been reported.

Generally, Region B can be described as having relatively small urban centers and villages surrounded by numerous small, scattered, and picturesque rural hamlets within a setting of sparsely populated hills, mountains, and valleys. Some communities boast about their clean water, land, and air and panoramic views of natural beauty, while others are particularly proud of their proximity to larger metropolitan areas. Local Web sites and planning documents describe the less densely populated segments of each community as having a rural character, with few buildings, structures, or development (Catskills Region 2011). Rural elements include meandering, tree-lined streets, farmland, woodlands and forests, and natural areas. With the exception of communities immediately along state or county transportation corridors, the hamlets, villages, and towns in Region B generally are pedestrian-friendly or are in the process of revitalizing their neighborhoods to be more walkable (Sullivan County Chamber of Commerce 2011a). Within Region B, views and vistas are dominated by undeveloped open space (Town of Otsego 2005). In Delaware County, this was reinforced by the 1997 Watershed Memorandum of Agreement with NYC.

There are over 1,900 farms within the three counties that comprise Region B; consequently, agriculture is an important part of community character within the Region. Approximately 588,000 acres of land within Region B are located within 15 state-designated agricultural districts (NYSDAM 2011). Figure 2.20 provides an overview of the agricultural districts within Region B.

In Region B, many of the inhabited places are small and the pace of life is slow. Some local officials and residents describe their communities as being friendly and having a small-town feel. Many note their country fairs, specialty shops, and team sports as contributing to their community's character. Delaware and Sullivan Counties are described as rural retreats for urban tourists from NYC. The City of Oneonta, in Otsego County, describes itself as a religious community, known for its many places and worship. All of the counties in Region B describe active and passive recreational activities as being essential to their community character. Available outdoor recreational activities include hiking, fishing, boating, biking, bird-watching, hunting, skiing, and snowmobiling.



Representative Region B
County Boundary
Agricultural Districts

USGS NLCD
Developed
Open Space
Agriculture
Forest
Herbaceuous/Shrub/Scrub
Open Water
Wetlands

NOTE: Agricultural district boundaries are overlaid on the land cover data. The land cover within agricultural district boundaries includes land cover other than agriculture; however, land cover within the agricultural district boundaries is predominately agriculture.

Figure 2.**20**:
Land Cover and Agricultural Districts
Representative Region B

Source: ESRI, 2010; NYSDAM, 2010, 2011

Region B, while rural and slow-paced in some areas, also has several centers of commerce, high-quality health care facilities, institutions of higher education, and noteworthy cultural activities, including art galleries, theatre groups, and music events. These assets significantly contribute to their "sense of place." For centuries the Catskills Mountains in Delaware County have been a place where art colonies flourished. In Cooperstown, in Otsego County, the Baseball Hall of Fame, Glimmerglass Opera, art galleries, and specialty shops draw throngs of visitors each year. Sullivan County describes itself as offering value and convenience for visitors seeking an escape closer to home, with museums, antiques, boutiques and theater, as well as outdoor recreational activities. It is best known as the home of the Woodstock music festival and the Monticello Raceway. Agri-tourism also is important to Sullivan County.

Delaware County. Geographically, Delaware County is the largest county in Region B and is one of the larger counties in New York State (Delaware County Chamber of Commerce 2011a). Delaware County is located in the southeastern part of the state and is bordered to the south by the Delaware River. The Catskill Mountains are partially located in Delaware County. The county has a total area of 1,468 square miles, including 1,446 square miles of land and 22 square miles of surface water (lakes, ponds, rivers, and streams). Delaware County is one of the least populated counties in New York State, with 33 persons per square mile. The county has 19 cities/towns, 10 villages, two hamlets, and 13 school districts (Delaware County 2011; Delaware County Chamber of Commerce 2011b; New York Schools 2011d). The largest population centers are the villages of Sidney (3,900 persons), Walton (3,088 persons), and Delhi (3,087 persons). Interstate 86/Route 17 crosses the southern boundary of Delaware County.

The remaining areas in Delaware County are rural. As reported by the Census of Agriculture, in 2007, there were 747 farms in the county, covering approximately 200,000 acres (22% of the land area in the county). The average size of a farm in Delaware County in 2007 was 222 acres. The principal sources of farm income include milk, vegetables, other crops/hay and nursery, greenhouse, floriculture, and sod (USDA 2007). According to more recent data from the Delaware County Chamber of Commerce, dairy products account for approximately 80% of agricultural sales in the county, and Delaware County represents 80% of the dairy farms in the NYC watershed area (Delaware County Chamber of Commerce 2011b). As of 2011, there were approximately 237,000 acres of land within eight state-designated agricultural districts in Delaware County (NYSDAM 2011).

The existing land use pattern in Delaware County has been influenced by the historic pattern of hamlet development, highway-oriented transportation, and state land ownership. In addition, a major land-acquisition program is underway in Delaware County and other Catskills/Delaware Watershed communities that help to provide an unfiltered drinking water supply to NYC. The acquisition of this land will preclude future development in designated areas (NYC Watershed 2009).

Delaware County does not have a comprehensive plan, but it empowers its municipalities to develop their own planning documents. Development is generally left to the discretion of village and town zoning and planning boards, which originally adopted traditional forms of regulation in an effort to protect land use and natural resources. Local and regional development is guided by a number of open-space plans, comprehensive plans, and strategic plans. These documents broadly reflect a community's history, values, future goals, and character.

Delaware County does not have a comprehensive or master plan, but many of its municipalities have a comprehensive/master plan, land use regulations/laws, and zoning maps. A brief review of representative local planning documents indicated that several communities in the county are concerned with protecting and preserving agricultural land, including niche farming, forestry, and other sensitive areas; maintaining a rural character and the historical context of the communities; preserving existing development patterns and the appearance of residential development; maintaining the natural environment; and minimizing impacts on scenic transportation routes and vistas. For example, the Town of Stamford states in its Final Draft Comprehensive Plan that the town "will be a place that continues to maintain and celebrate its small town, rural character and natural beauty . . . maintain our open spaces and the pristine nature of the environment . . . [and] . . . our quality of life will be enhanced because of the Towns' strong sense of community through its caring, friendly people and the dedicated organizations and volunteers that serve us well" (Town of Stamford 2011).

Sullivan County. Sullivan County is located south of Delaware County. The county has a total area of 1,038 square miles, including 1,011 square miles of land and 27 square miles of surface water (lakes, ponds, rivers, and streams). The county's physical environment ranges from historic urban centers to farming communities nestled within an open-space network that includes the Upper Delaware Scenic and Recreation River (to the west), Catskill Park (to the north) Basherkill Watershed, and Shawangunk Ridge (Sullivan County Catskills 2011a).

Sullivan County has a population density of 76 persons per square mile. Within the county are 15 cities/towns, six villages, and over 30 hamlets; and eight school districts (Sullivan County Catskills 2011b; Sullivan County Chamber of Commerce 2011b). The largest population centers are the Village of Monticello (6,726 persons), and the Village of Liberty (4,392 persons). Interstate 86/Route 17 crosses through the middle of Sullivan County, providing access to New York City, which is approximately 60 miles southeast of Sullivan County.

The remaining portions of Sullivan County are rural and open space. According to the Census of Agriculture, in 2007 there were 323 farms in Sullivan County, covering approximately 63,600 acres (approximately 10% of the land area of the county). The average size of a farm in 2007 was 156 acres (USDA 2007). In 2007, the principal sources of farm income included poultry and eggs, milk and other dairy products from cows (USDA 2007). Poultry and eggs accounted for approximately 65% of agricultural sales in the county in 2007. In recent years, however, Sullivan County has seen a decrease in traditional dairy and livestock farms (it now has only two major egg producers and 28 dairy farms) and an increase in smaller niche and diversified vegetable and livestock farms. As of 2011, there were approximately 162,000 acres of land within two state-designated agricultural districts in Sullivan County (NYSDAM 2011).

In its Comprehensive Plan, the county describes itself as being on the verge of becoming urban, with rapid growth and development that will change its character and have an impact on its resources (Sullivan County Catskills 2005). The county's vision and community land use goals include avoiding heavy traffic, strip malls, and loss of open space and ensuring the availability of affordable housing. While development decisions are made at the local level, the county encourages collective support of a unified vision in its Comprehensive Plan (Sullivan County Catskills 2005). As stated in the Comprehensive Plan, current development patterns often mandate a separation of land uses; however, revitalization efforts are focused on mixed-used in-fill development (i.e., development within vacant or under-utilized spaces within the built environment), walkable communities, and streetscape improvements (Sullivan County Catskills 2005). The county also is committed to preserving viewsheds, natural resources, and environmentally sensitive areas through zoning. Lastly, the county encourages coordinated zoning among its municipalities and intends to provide resources to municipalities to upgrade local zoning and land use regulations every 10 years.

Otsego County. Otsego County is located in central New York State, north of Delaware County. It is situated in the foothills of the Catskill Mountains, at the headwaters of the Susquehanna River (Otsego County 2011). The County has a total area of 1,015 square miles, including 1,003 square miles of land and 12 square miles of surface water (lakes, ponds, rivers, and streams). The county has a population density of 62 persons per square mile.

Within the county are 25 cities/towns, nine villages, and 47 hamlets; and 21 school districts The city of Oneonta, the county seat, has a population of 13,901 persons, and is surrounded by suburbs, and villages, hamlets, and farm communities that stretch across the remainder of the county. Interstate 88 crosses the southern portion of Otsego County, connecting the City of Oneonta to Binghamton to the south, and the Albany area to the north.

Farming operations in Otsego County have decreased over the years, but agriculture is still a major industry in the county. Active farmland is concentrated in the mid- to northern portions of the county (Otsego County 1999). According to the Census of Agriculture, in 2007 there were 908 farms in Otsego County, covering approximately 206,000 acres (approximately 30% of the land area of the county). The average size of a farm in Otsego County in 2007 was 201 acres (USDA 2007). The principal sources of farm income include milk, cattle/calves, other crops and hay and nursery, greenhouse, floriculture, and sod. Dairy products account for approximately 70% of agricultural sales in the county (USDA 2007). As of 2011, there were approximately 189,000 acres of land within five state-designated agricultural districts in Otsego County (NYSDAM 2011).

Otsego County does not have a comprehensive or master plan, but most of its 34 municipalities have a comprehensive/master plan, land use regulations/laws, and zoning maps. A brief review of representative comprehensive plans indicated that several communities in the county are concerned with protecting sensitive areas, maintaining a low residential density, preserving existing patterns of land use in hamlets and rural areas, maintaining the natural environment, and minimizing visual blight. For example, the Town of Otsego Comprehensive Plan's vision statement states the following: "We foresee the future Town of Otsego as continuing to have a clean environment, beautiful landscape, and rural character. We foresee carefully managed growth and development, maintaining access to our natural areas. We foresee a place of safety for us and our families." (Town of Otsego 2008). According to the Otsego County Department of Planning, affordable housing and real estate is also important to the county (Otsego County 2009).

Region C

Region C comprises Chautauqua and Cattaraugus Counties (Figure 2.4c). Generally, Region C can be described as largely rural in character, with commercial/industrial hubs located along the Southern Tier Expressway and agri-tourism spread across the region. Some communities boast about their access to water bodies and the recreational opportunities they provide, while others are particularly proud of their proximity to lively cities. Local Web sites and planning documents describe the less densely populated portions of each community as having a rural character and charm. Rural elements include scenic drives/routes, farmlands, woodlands and forests, waterways, and natural areas. Hamlets, villages, and towns in the region are quaint and historic and many are home to museums and historical sites. The unique geological history of the region has endowed it with numerous natural attractions, including the deeply incised valleys of Allegany State Park, the deep gorges of Zoar Valley, and numerous lakes and rivers, all of which contribute to the region's character.

Distinct features in each county contribute to the type of agriculture they support, which in turn influences the character of each county. The floodplains of large streams such as Cattaraugus Creek support dairy farms in Cattaraugus County, whereas the climatic influences of nearby Lake Erie support grape production in Chautauqua County.

The city of Salamanca in Cattaraugus County is the only U.S. city east of the Mississippi River that is located within a Native American tribal land (Seneca Nation of Indians). The proximity to Native American tribal lands and the Native American history of the area are important to this community's character. The residents of Region C are proud of their history and work diligently to preserve and promote it. The promotion of this history is evidenced by historical sites and museums found throughout the region, including the Chautauqua Institution in Chautauqua, New York. This renowned institution opened in the late 1800s and serves as a community center and resource "where the human spirit is renewed, minds are stimulated, faith is restored, and art is valued" (Chautauqua County Chamber of Commerce 2011a). This is another example of heritage forming an important part of community character in Region C.

Region C has a vibrant and diverse agricultural industry, which can be found throughout the rolling hills, rural countryside, and woodlands. The agricultural heritage of the region includes Amish communities in both Cattaraugus and Chautauqua Counties. There are over 2,700 farms in Region C. Approximately 632,000 acres of land within Region C are located within 17 state-designated agricultural districts (NYSDAM 2011). Figure 2.21 provides an overview of the agricultural districts within Region C.

Although agriculture is an important aspect of Region C, there is a balance between rural preservation and urban development. There are numerous small villages and communities within Region C, many of which are rich in historic sites and museums. For example, Jamestown in Chautauqua County is home to the Roger Tory Peterson Institute of Natural History, the Fenton History Center, the Lucy-Desi Museum, and the Desilu Playhouse and Theater. Jamestown's unique character and Victorian heritage are echoed throughout the region.

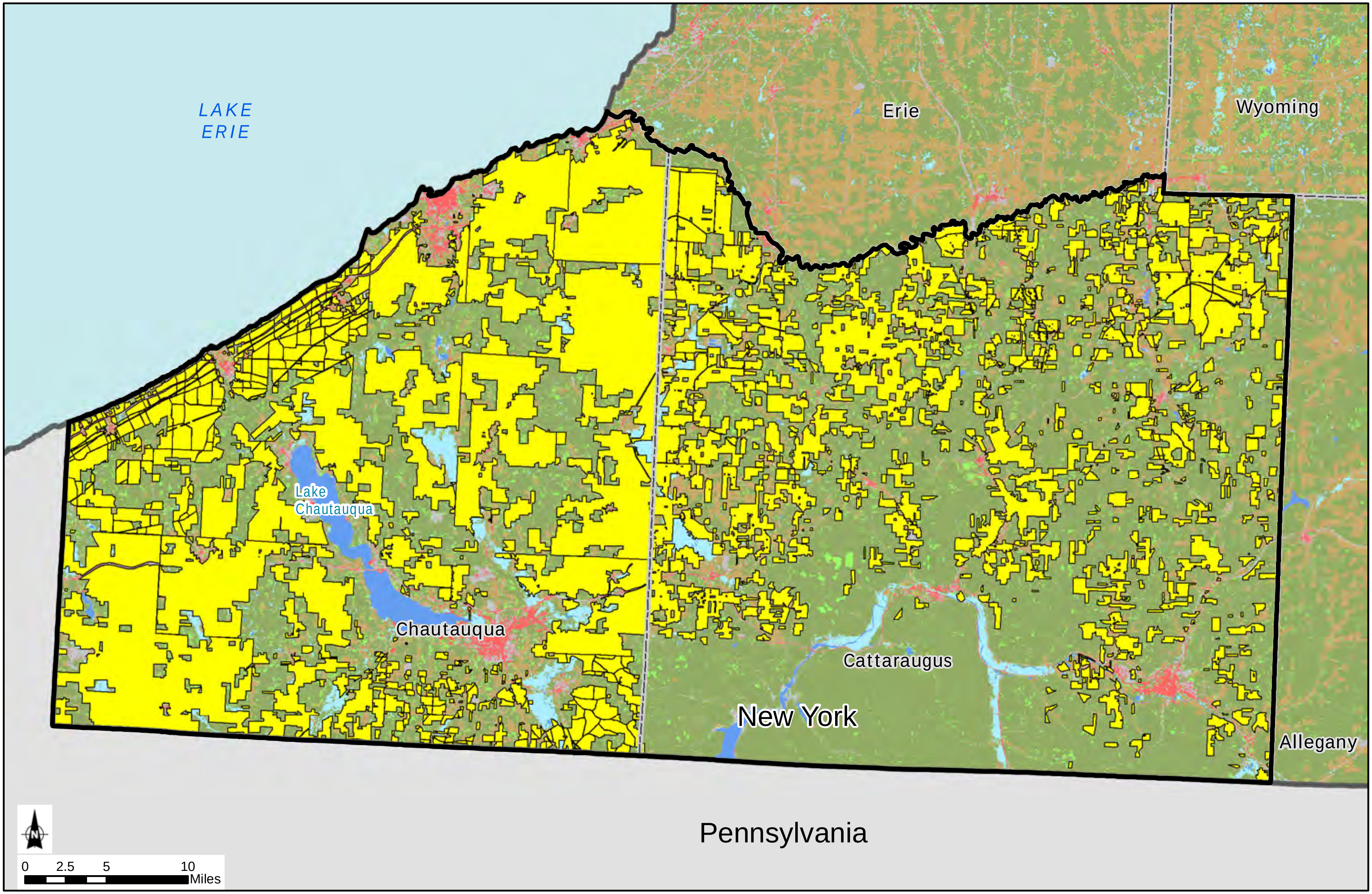
Tourism is also a large part of the community character of the region. Recreational activities that draw tourists to the region include bicycling, boating, fishing, gaming (on Native American tribal land), geo-caching (a treasure-hunting game using GPS technology), golfing, hiking, horseback riding, motor sports, scenic driving, hunting, mountain biking, downhill skiing, cross-country skiing, snowmobiling, snowshoeing, and white water rafting. This abundance of the recreational activities is a significant aspect of the community character in Region C. Within the region are 63 cities/towns, 28 villages, and other unincorporated areas, as well as 30 combined school districts.

Gas drilling is not new to Region C; in 2009 approximately 3,917 gas wells were in production in this region (NYSDEC 2009).

Chautauqua County. Located in the southwestern corner of the state, Chautauqua County is considered the western gateway to New York State (Chautauqua County 2011a). The county is bordered by Lake Erie to the northwest, Pennsylvania to the south and west, the Seneca Nation of Indians and Erie County to the northeast, and Cattaraugus County to the east (Chautauqua County 2011b). The center of the county is Chautauqua Lake; five smaller lakes are located throughout the county. The Southern Tier Expressway crosses the mid-section of the county, and the New York State Thruway crosses the county along its northern border near Lake Erie. Chautauqua County has a total area of 1,500 square miles, including 1,062 square miles of land and 438 square miles of surface water (lakes, ponds, rivers, and streams).

There are two cities within the county, Jamestown to the south and Dunkirk along Lake Erie, which are surrounded by rural areas and lakes. Due to the presence of the two cities, Chautauqua County has an average population density of 127 persons per square mile. Within the county are 29 cities/towns and15 villages, as well as 18 school districts (Chautauqua County 2011a; New York Schools 2011e).

According to the Census of Agriculture, in 2007 there were 1,658 farms in Chautauqua County, which cover approximately 235,858 acres (35% of the land area of the county) (USDA 2007). In 2007 the average size of a farm in this county was 142 acres (USDA 2007). In Chautauqua County, the principal sources of farm income are grape and dairy products (USDA 2007). Grapes and grape products account for approximately 30% of agricultural sales in the county, and dairy products account for approximately 50.5% of agricultural sales (USDA 2007). Grape growers in Chautauqua County produce approximately 65% of New York State's total annual grape harvest (Tour Chautauqua 2011a). As of 2011, there were approximately 392,000 acres of land within 11 state-designated agricultural districts in Chautauqua County (NYSDAM 2011).



Representative Region C
County Boundary
Agricultural Districts

USGS NLCD
Developed
Open Space
Agriculture
Forest
Herbaceous/Shrub/Scrub
Open Water
Wetlands

NOTE: Agricultural district boundaries are overlaid on the land cover data. The land cover within agricultural district boundaries includes land cover other than agriculture; however, land cover within the agricultural district boundaries is predominately agriculture.

Figure 2.**2**1:
Land Cover and Agricultural Districts
Representative Region C

Source: ESRI, 2010; NYSDAM, 2010, 2011

Agri-tourism in Chautauqua County focuses on wineries in the northern portion of the county and scenic drives and farmers markets in the southern and eastern portions of the county. Another large part of agri-tourism here centers on the county's Amish Country (Tour Chautauqua 2011b).

Other industries also play important roles in the community character of Region C. In Chautauqua County, tourism based on recreational opportunities and historical and cultural sites and events is important throughout the county. Dunkirk, which is strategically located along Lake Erie, is described by the Chautauqua County Chamber of Commerce as having financial and technological support networks that provide businesses with competitive opportunities for growth (Chautauqua County Chamber of Commerce 2011b). The village of Fredonia is home to the State University of New York (SUNY) Fredonia campus, and the educational industry forms a large part of the community's character (Chautauqua County Chamber of Commerce 2011c). Jamestown serves as an industrial, commercial, financial, and recreational hub for southwestern New York, and the city is home to several museums and historical resources (Chautauqua County Chamber of Commerce 2011d). The city of Salamanca is located along the Allegheny River and describes itself as filled with country charm. It is the only city in the U.S. that lies almost completely within the borders of an Indian Reservation (Seneca Nation) (City of Salamanca 2011). The city is located on the northern border of Allegany State Park and serves as a year-round access point to the park. Salamanca is a center for the forestry and wood products industry and has plentiful supplies of maple, oak, and cherry (City of Salamanca 2011).

Chautauqua County has a comprehensive plan called *Chautauqua County 20/20 Comprehensive Plan* (Chautauqua County 2011b), which is designed to assist the county government in making decisions that affect the county's future (Chautauqua County 2011b). The plan identifies strategic issues and goals and is intended to ensure that there is cooperation between municipalities to achieve these goals (Chautauqua County 2011b). The plan states that Chautauqua County has an unusually high number of natural resource assets and unique attractions, including but not limited to farms (dairy and grape), lakes, historic towns, and the Chautauqua Institution (Chautauqua County 2011b). The county considers its traditional agricultural base to have preserved its open space and rural charm, which is a significant aspect of the county's community character (Chautauqua County 2011b).

Cattaraugus County. Cattaraugus County is located directly east of Chautauqua County and is also located within the Southern Tier of New York. The county has a total area of 1,322 square miles, including 1,310 square miles of land and 12 square miles of surface water (lakes, ponds, rivers, and streams). Cattaraugus County has a much lower population density than Chautauqua County, at 61 persons per square mile. Within the county are 34 cities/towns and 13 villages, as well as 12 school districts (Cattaraugus County 2011; New York Schools 2011f).

Cattaraugus County is much more rural than Chautauqua County, with small towns and rural characteristics. There are three Native American reservations wholly or partially within Cattaraugus County. The county's geology was sculpted by glaciers during the last glacial period, and the county is drained by two significant waterways, the Allegheny River in the south and Cattaraugus Creek in the north (Enchanted Mountains 2011a).

The existing land use pattern in Cattaraugus County has been significantly influenced by the topography of the region. Glaciers and rivers have sculpted the county into a mountainous region ideal for a wide variety of outdoor recreational activities, including skiing, hiking, hunting, and camping, and the fertile valleys support productive agricultural communities.

According to the Census of Agriculture, in 2007 there were 1,122 farms in Cattaraugus County, which cover approximately 183,000 acres (USDA 2007). In 2007 the average size of a farm in the county was 163 acres (USDA 2007). The principal sources of farm income are dairy products; nursery, greenhouse, floriculture, and sod; and cattle/calves (USDA 2007). Dairy products account for approximately 68% of agricultural sales in the county (USDA 2007). However, in recent years, dairy farming has declined in Cattaraugus County, especially in areas around towns/cities where the majority of commerce is not based on agriculture, such as around Ellicottville, where tourism is the main source livelihood (Cattaraugus County 2007). As of 2011, there were approximately 240,000 acres of land within six state-designated agricultural districts in Chautauqua County (NYSDAM 2011).

Agri-tourism is an important industry in Cattaraugus County. Agri-tourism in this county centers on maple syrup production and the Amish Trail, which is located in the western portion of Cattaraugus County (Enchanted Mountains 2011b; GOACC 2011).

The city of Olean is the commercial and industrial hub of Cattaraugus County (GOACC 2011). The city has a rich commercial and industrial history and is currently home to several large corporations, including manufacturers such as Dresser-Rand and Cutco-Alcas. This regional industrial and commercial center is necessary to maintain the rural character of the rest of Cattaraugus County.

The role of the Cattaraugus County Planning Department is to assist local communities with comprehensive planning, land use and zoning, floodplains and watersheds, census data and demographics, planning for agriculture, and any downtown revitalization projects (Cattaraugus County 2011). Cattaraugus County empowers the local municipalities to develop their own planning documents (Cattaraugus County 2011). Development of comprehensive plans is generally left to the discretion of county and town zoning and planning boards, which originally adopted traditional forms of regulation in an effort to protect land use and natural resources. Local and regional development is guided by a number of open-space plans, comprehensive plans, and strategic plans. These documents broadly reflect a community's history, values, future goals, and character.

Cattaraugus County does not have a comprehensive or master plan, but many of its municipalities have a comprehensive/master plan, land use regulations/laws, and zoning maps. A brief review of representative local planning documents indicated that several communities in the county are concerned with protecting sensitive areas, promoting tourism through recreation activities, maintaining a small town/rural feel, maintaining the natural environment, and creating a balance of the rural character and protection of the environment with appropriate economic development. Affordable housing and real estate also is important to the communities. For example, the Town of Portville Comprehensive Plan outlines the following goals: "… maintain the rural character of the Town, and at the same time provide for anticipated growth and development … [and] … maintain the predominantly rural character by preserving natural woodlands and floodplains, conserving the productive farms as much as possible, encouraging open space areas as a integral part to any new residential development, and concentrating intensive residential and commercial uses into selected centers of activity" (Town of Portville 2003).

In Cattaraugus County, Allegany State Park and the Enchanted Mountains provide recreational opportunities and associated jobs. The village of Ellicottville flourishes on the tourism industry, which centers on two major ski resorts. In the city of Olean, commerce is centered on industry (GOACC 2011).

New York State

DEC

Chapter 3

Proposed SEQRA Review Process

Revised Draft
Supplemental Generic Environmental Impact Statement

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Chapter 3 - Proposed SEQRA Review Process

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Chapter 3 PROPOSED SEQRA REVIEW PROCESS

3.1 Introduction – Use of a Generic Environmental Impact Statement

The Department's regulations to implement SEQRA[1] authorize the use of a generic environmental impact statement (EIS) to assess the environmental impacts of separate actions having similar types of impacts.[2] Additionally, a generic EIS and its findings "should set forth specific conditions or criteria under which future actions will be undertaken or approved, including requirements for any subsequent SEQRA compliance"[3] such as the need for a supplemental environmental impact statement (SEIS). The course of action following a final generic EIS depends on the level of detail within the generic EIS, as well as the specific follow-up actions being considered. In considering a subsequent action such as permitting horizontal drilling and high-volume hydraulic fracturing in the Marcellus Shale and other low-permeability reservoirs, the Department must evaluate the generic EIS to determine whether the impacts from the subsequently proposed action (i.e., approval of the permit application) are not addressed, or are inadequately addressed, in the generic EIS, and, in either case, whether the subsequent action is likely to have one or more significant adverse environmental impacts. If significant adverse impacts of the subsequent action are identified, and they are not adequately addressed in the generic EIS, then a site- or project-specific SEIS must be prepared. Under the regulations, generic EISs and their findings should identify the environmental issues or thresholds that would trigger the need for a SEIS. However, if the Department determines that the final generic EIS adequately addresses all potential significant adverse impacts of the subsequently proposed action, then no SEIS is necessary. The SEQRA regulations pertaining to generic EISs (6 NYCRR §617.10[d][1]) provide that when a final generic EIS has been filed, "no further SEQRA compliance is required if a subsequent proposed action will be carried out in conformance with the conditions and thresholds established for such actions" in the generic EIS.[4]

[1] SEQR regulations are available at available at http://www.dec.ny.gov/regs/4490.html.

[2] 6 NYCRR §617.10(a). The regulations define the uses and functions of generic EISs. Frequently asked questions on the use of generic environmental impact statements are posted on the Department's website at http://www.dec.ny.gov/permits/56701.html.

[3] 6 NYCRR §617.10(c).

[4] 6 NYCRR §617.10(d)(1).

3.1.1 1992 GEIS and Findings

Drilling and production of separate oil and gas wells, and other wells regulated under ECL 23 have common types of impacts. Therefore, the Department issued the 1992 GEIS and Findings Statement to cover oil, gas and solution mining activities regulated under ECL 23. The 1992 GEIS is incorporated by reference into this document.[5] Based on the 1992 GEIS, the Department found that issuance of a standard, individual oil or gas well drilling permit anywhere in the state, when no other permits are involved, would not have a significant environmental impact.[6] See Appendix 2.

Also, in the 1992 Findings Statement, the Department found that issuance of a drilling permit for a location in a State Parkland, in an Agricultural District, or within 2,000 feet of a municipal water supply well, or for a location which requires other Department permits, may be significant and required a site-specific SEQRA determination. Under the 1992 GEIS, the only instance where issuance of an individual permit to drill an oil or gas well is always deemed significant and therefore always requires an SEIS is when the proposed location is within 1,000 feet of a municipal water supply well.

As part of the 1992 GEIS, the Department also evaluated the action of leasing of state land for oil and gas development and found no significant environmental impacts associated with that action.[7] Specifically, the Department concluded that lease clauses and the permitting process with its attendant environmental review would result in mitigation of any potential impacts that could result from a proposal to drill. See Appendix 3.

3.1.2 Need for a Supplemental GEIS

As mentioned above, the SEQRA regulations require preparation of a supplement to a final generic EIS if a subsequent proposed action may have one or more significant adverse environmental impacts that were not addressed in the 1992 GEIS.[8] In 2008, the Department determined that some aspects of the current and anticipated application of horizontal drilling and

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[5] http://www.dec.ny.gov/energy/45912.html.

[6] http://www.dec.ny.gov/docs/materials_minerals_pdf/geisfindorig.pdf.

[7] Sovas GH, April 19, 2003 (http://www.dec.ny.gov/docs/materials_minerals_pdf/geisfindsup.pdf).

[8] 6 NYCRR §617.10(d)(4).

high-volume hydraulic fracturing warranted further review in the context of a SGEIS, or Supplement. This determination was based primarily upon three concerns, as follows: (1) high-volume hydraulic fracturing would require water volumes far in excess of generic EIS descriptions (in the 1992 GEIS), (2) the possibility of drilling taking place in the NYC Watershed, in or near the Catskill Park, and near the federally-designated Upper Delaware Scenic and Recreational River, and (3) the longer duration of disturbance likely to take place at multi-well drilling sites.

1) *Water Volumes*: Multi-stage hydraulic fracturing of horizontal shale wells may require the use and management of millions of gallons of water for each well. This raised concerns about the volume of chemical additives present on a site, withdrawal of large amounts of water from surface water bodies, and the management and disposal of flowback water;

2) *Anticipated Drilling Locations:* While the 1992 GEIS does address drilling in watersheds that are major sources of drinking water supply, areas of rugged topography, unique habitats and other sensitive areas, oil and gas activity in the eastern third of the State was rare to non-existent at the time of publication. Although the 1992 Findings have statewide applicability, the revised draft SGEIS examines whether additional regulatory controls are needed in any of the new geographic areas of interest given the attributes and characteristics of those areas. For example, the 1992 GEIS did not address the possibility of drilling in the vicinity of the NYC watershed area which lies in the prospective area for Marcellus Shale drilling; and

3) *Multi-well pads:* Well operators previously suggested that as many as 16 horizontal wells could be drilled at a single well site, or pad. As stated in the following chapters, current information suggests that 6 to 10 wells per pad is the likely distribution. While this method will result in fewer well pads and thus fewer disturbed surface locations, it will also result in a longer duration of disturbance at each drilling pad than if only one well were to be drilled there, and a greater intensity of activity at those sites. ECL §23-0501(1)(b)(1)(vi) requires that all horizontal infill wells in a multi-well shale unit be drilled within three years of the date the first well in the unit commences drilling. The potential impacts of this type of multi-well project were not analyzed in the 1992 GEIS.

3.2 Future SEQRA Compliance

The 1992 Findings Statement describes the well permit and attendant environmental review processes for individual oil and gas wells. Under the 1992 Findings Statement, each application to drill a well is deemed by the Department an individual project, meaning each application requires individual review. In terms of SEQRA compliance, the Department considers itself the appropriate lead agency for purposes of SEQRA review involving such applications inasmuch as the Department is the agency principally responsible under ECL §23-0303(2) for regulating oil and gas development activities with local government jurisdiction being limited to local roads and the rights of local governments under the Real Property Tax Law. The Department does not propose to change these aspects of its review.

3.2.1 Scenarios for Future SEQRA Compliance under the SGEIS

- **FIRST SCENARIO:** Applications that conform with the 1992 GEIS and the SGEIS.

Generally, when application documents[9] demonstrate conformance with the thresholds and conditions for such actions to proceed under the 1992 GEIS and the SGEIS, SEQRA would be deemed satisfied, and no further SEQRA process would be required. Upon receipt of an application for a well permit, which will be accompanied by the detailed project-specific information described in Appendix 6, Department staff will determine based on detailed project-specific information whether the application conforms to the conditions and thresholds described in the 1992 GEIS and the SGEIS that entitle the application to be covered by the 1992 GEIS and the SGEIS. If the application conforms to the 1992 GEIS and the SGEIS, Department staff will file a record of consistency statement and no further review under SEQRA will occur in connection with the processing of the well permit application. Permit conditions will be added on a site-specific basis to ensure compliance with the requirements of the 1992 GEIS, the SGEIS, and ECL 23.

- **SECOND SCENARIO**: Proposed action is adequately addressed in the 1992 GEIS or the SGEIS but not in respective Findings Statement.

A supplemental findings statement must be prepared if the proposed action and impacts are adequately addressed in the 1992 GEIS and the SGEIS but are not addressed in the previously adopted 1992 GEIS Findings Statement or the SGEIS Findings Statement.

[9] See Appendix 4 for a copy of the Application for Permit to Drill, Deepen, Plug Back or Convert a Well Subject to the Oil, Gas and Solution Mining Regulatory Program.

- **THIRD SCENARIO**: Permit applications that are not addressed, or not adequately addressed, in the 1992 GEIS or the SGEIS.

If the proposed action and its impacts are not addressed in the 1992 GEIS or SGEIS, then additional information would be required to determine whether the project may result in one or more additional significant adverse environmental impacts not assessed in the 1992 GEIS or the SGEIS. The projects that categorically fall into this category are listed in Section 3.2.3. Depending on the nature of the action, the additional information would include an environmental assessment form or EAF; topographic, geologic or hydrogeologic information; air impact analysis; chemical information or other information deemed necessary by the Department to determine the potential for a significant adverse environmental impact. A project-specific SEQRA determination will either result in 1) a negative declaration (determination of no potentially significant impact), or 2) a positive declaration (requiring the preparation of a site-specific SEIS for the drilling application).

Examples since 1992 where such site-specific determinations have been made include the following actions: i) underground gas storage projects, ii) well sites where special noise mitigation measures are required, iii) well sites that disturb more than two and a half acres in designated Agricultural Districts, and iv) geothermal wells drilled in proximity to NYC water tunnels. As stated above, under the 1992 GEIS wells closer than 2,000 feet to a municipal water supply well would also require further site-specific review. None have been permitted since 1992.

The following sections explain how this Supplement will be used, together with the previous 1992 GEIS, to satisfy SEQRA in certain instances when high-volume hydraulic fracturing is proposed.

3.2.2 Review Parameters

In conducting SEQRA reviews, the Department will handle the topics of i) SGEIS applicability, ii) individual project scope, iii) project size and iv) lead agency as follows.

3.2.2.1 SGEIS Applicability - Definition of High-Volume Hydraulic Fracturing

High-volume hydraulic fracturing is done in multiple stages, typically using 300,000-600,000 gallons of water per stage (Chapter 5). High-volume hydraulic fracturing in a vertical well would be comparable to a single stage. Wells hydraulically fractured with less water are generally associated with smaller well pads and many fewer truck trips, and do not trigger the same potential water sourcing and disposal impacts as high-volume hydraulically fractured wells. Therefore, for purposes of the SGEIS and application of the mitigation requirements described herein, high-volume hydraulic fracturing is defined as hydraulic fracturing that uses 300,000 or more gallons of water, regardless of whether the well is vertical, directional or horizontal. Wells requiring 299,999 or fewer gallons of water to fracture low-permeability reservoirs are not considered high-volume, and will be reviewed and permitted pursuant to the 1992 GEIS and Findings Statement.

Potential impacts directly related to water volume are associated with i) water withdrawals, ii) the volume of materials present on the well pad for fracturing, iii) the handling and disposition of flowback water, and iv) road use by trucks to haul both fresh water and flowback water. The Department proposes the following methodology, applicable to both vertical and horizontal wells that will be subjected to hydraulic fracturing:

≤ 299,999 gallons of water: Not considered high-volume; 1992 GEIS mitigation is sufficient; and

≥ 300,000 gallons of water: Always considered high-volume. The applicant must complete the EAF Addendum. All relevant procedures and mitigation measures set forth in this Supplement are required to satisfy SEQRA without a site-specific determination.

3.2.2.2 Project Scope

As was the case under the 1992 GEIS, each application to drill a well will continue to be considered as an individual project with respect to well drilling, construction, hydraulic fracturing (including additive use), and any aspects of water and materials management (source, containment and disposal) that vary between wells on a pad. Well permits will be individually issued and conditioned based on review of well-specific application materials. However, location screening for well pad setbacks and other required permits, review of access road location and construction, and the required stormwater permit coverage will be for the well pad based on submission of the first well permit application for the pad.

The only case where the project scope extends beyond the well pad and its access road is when the application documents propose surface water withdrawals that have not been previously approved by the Department. Such proposed withdrawals will be considered part of the project scope for the first well permit application that indicates their use, and all well permit applications that propose their use will be considered incomplete until the Department has approved the withdrawal.

Gathering lines and pipelines are not within the scope of project review as the PSC has exclusive jurisdiction to review these activities under Public Service Law Article VII. Compressor stations associated with gathering lines and pipelines are also under the PSC's Public Service Law Article VII review authority except that the Department has jurisdiction under ECL Article 19 (Air Pollution Control) to review air emissions and ECL Article 17 for the SPDES program. The foregoing is discussed in greater detail in Chapter 3 of the GEIS and Section 1.5 of the Final Scope. Chapter 5 of this Supplement describes the facilities likely to be associated with a multi-well shale gas production site, and Chapter 8 provides details on the PSC's environmental review process for these facilities.

3.2.2.3 Size of Project

The size of the project will continue to be defined as the surface acreage affected by development, including the well pad, the access roads, and any other physical alteration necessary. The Department's well drilling and construction requirements, including the supplementary permit conditions proposed herein, preclude any subsurface impacts other than the permitted action to recover hydrocarbons. Most wells will be drilled on multi-well pads, described in Chapter 5 as likely an average of 3.5 acres in size, with larger pads possible, during the drilling and hydraulic fracturing stages of operations. Average production pad size, after reclamation, is likely to be 1.5 acres for a multi-well pad. Pads for vertical wells would be smaller. Access road acreage depends on the location, the length of the road and other factors.

In general, each 150 feet of access road adds 1/10th of an acre to the total surface acreage disturbance.

Surface water withdrawal sites will generally consist of hydrants, meters, power facilities, a gravel pad for water truck access, and possibly one or more storage tanks. These sites would generally be expected to be rather small, less than an acre or two in size.

3.2.2.4 Lead Agency

For the reasons set out in section 3.2 above, the Department would in most, if not all, instances continue to assert the lead agency role under SEQRA. If the proposed action falls under the jurisdiction of more than one agency, based, for example, on the need for a local floodplain development permit, the lead agency must in the first instance be determined by agreement among the involved agencies. Disputes are decided by the Department's Commissioner pursuant to 6 NYCRR §617.6(b)(5). Where there is an involved agency or agencies other than the Department (meaning another agency with jurisdiction to fund, approve, or undertake the action), to the extent practicable, the Department will seek lead agency designation, which is consistent with the criteria for such designation under SEQRA.

3.2.3 EAF Addendum and Additional Informational Requirements

The 1992 Findings authorized use of a shortened, program-specific environmental assessment form (EAF), which is required with every well drilling permit application.[10] (See Appendices 2 and 5). The EAF and well drilling application form[11] do not stand alone, but are supported by the four-volume 1992 GEIS, the applicant's well location plat, proposed site-specific drilling and well construction plans, Department staff's site visit, and geographic information system (GIS) - based location screening, using the most current data available. Oil and gas staff within the Department consults and coordinates with staff in other Department programs administered by the Department when site review and the application documents indicate an environmental concern or potential need for another Department permit.

[10] http://www.dec.ny.gov/docs/materials_minerals_pdf/eaf_dril.pdf . Under 6 NYCRR §617.2(m) of the SEQRA regulations, the model full and short EAFs may be modified by an agency to better serve it in implementing SEQR, provided the scope of the modified form is as comprehensive as the model.

[11] http://www.dec.ny.gov/docs/materials_minerals_pdf/dril_req.pdf.

The Department has developed an EAF Addendum for gathering and compiling the information needed to evaluate high-volume hydraulic fracturing projects (≥300,000 gallons) in the context of this SGEIS and its Findings Statement, and to identify the required site-specific mitigation measures. The EAF Addendum will be required as follows:

1) With the application to drill the first well on a pad constructed for high-volume hydraulic fracturing, regardless of whether the well is vertical or horizontal;

2) With the applications to drill subsequent wells for high-volume hydraulic fracturing on the pad if any of the information changes; and

3) Prior to high-volume re-fracturing of an existing well.

Categories of information required with the EAF addendum are summarized below, and Appendix 6 provides a full listing of the proposed EAF Addendum requirements.

3.2.3.1 Hydraulic Fracturing Information

Required information will include the minimum depth and elevation of the top of the fracture zone, estimated maximum depth and elevation of the bottom of potential fresh water, identification of the proposed fracturing service company and additive products, the proposed volume of fracturing fluid and percent by weight of water, proppants and each additive. Documentation of the operator's evaluation of alternatives to the proposed additive products will also be required.

3.2.3.2 Water Source Information

The operator will be required to identify the source of water to be used for hydraulic fracturing, and provide information about any newly proposed surface water source that has not been previously approved by the Department as part of a well permit application. The proposed withdrawal location and type of source (e.g., stream, lake, pond, groundwater, etc.) and other detailed information will be required to allow the Department to analyze potential impacts and, in the case of stream withdrawals, to ensure the operator's compliance relative to passby flow and the narrative flow standard in 6 NYCRR §703.2.

3.2.3.3 Distances

Distances to the following resources or cultural features will be required, along with a topographic map of the area showing the well pad, well location, and scaled distances from the proposed surface location of the well and the closest edge of the well pad to the relevant resources and features.

- Any known public water supply reservoir, river or stream intake, public or private water well or domestic supply spring within 2,640 feet;
- Any primary or principal aquifer boundary, perennial or intermittent stream, wetland, storm drain, lake or pond within 660 feet;
- Any residences, occupied structures or places of assembly within 1,320 feet.
- Capacity of rig fueling tank(s) and distance to:
  - Any public or private water well, domestic-supply spring, reservoir, river or stream intake, perennial or intermittent stream, storm drain, wetland, lake or pond within 500 feet of the planned location(s) of the fueling tank(s); and
- Distance from the surface location of the proposed well to the surface location of any existing well that is listed in the Department's Oil & Gas Database[12] or any other abandoned well identified by property owners or tenants within a) the spacing unit of the proposed well and/or b) within 1 mile (5,280 feet) of the proposed well location, whichever results in the greatest number of wells. For each well identified, the following information would be required, if available:
  - Well name and API Number;
  - Well type;
  - Well status;
  - Well orientation; and
  - Quantity and type of any freshwater, brine, oil or gas encountered during drilling, as recorded on the Department's Well Drilling and Completion Report.

[12] The Department's Oil & Gas Database contains information on more than 35,000 oil, gas, storage, solution salt, stratigraphic, and geothermal wells categorized under Article 23 of the ECL as Regulated Wells. The Oil & Gas database can be accessed on the Department's website at http://www.dec.ny.gov/cfmx/extapps/GasOil/.

3.2.3.4 Water Well Information

The EAF addendum for high-volume hydraulic fracturing will require evidence of diligent efforts by the well operator to determine the existence of public or private water wells and domestic-supply springs within half a mile (2,640 feet) of any proposed drilling location. The operator will be required to identify the wells and provide available information about their depth, and completed interval, along with a description of their use. Use information will include whether the well is public or private, community or non-community and the type of facility or establishment if it is not a private residence. Information sources available to the operator include:

- direct contact with municipal officials;
- direct communication with property owners and tenants;
- communication with adjacent lessees;
- EPA's Safe Drinking Water Act Information System database, available at http://oaspub.epa.gov/enviro/sdw_form_v2.create_page?state_abbr=NY; and
- The Department's Water Well Information search wizard, available at http://www.dec.ny.gov/cfmx/extapps/WaterWell/index.cfm?view=searchByCounty.

Additionally, geodata on water wells in New York State is available from the Department in KML (Keyhole Markup Language) and shape file formats. To access and download water well information, go to: http://www.dec.ny.gov/geodata/ptk.

Upon receipt of a well permit application, Department staff will compare the operator's well list to internally available information and notify the operator of any discrepancies or additional wells that are indicated within half a mile of the proposed well pad. The operator will be required to amend its EAF Addendum accordingly.

3.2.3.5 Fluid Disposal Plan

The Department's oil and gas regulations, specifically 6 NYCRR §554.1(c)(1), require a fluid disposal plan to be approved by the Department prior to well permit issuance for "any operation in which the probability exists that brine, salt water or other polluting fluids will be produced or obtained during drilling operations in sufficient quantities to be deleterious to the surrounding environment . . ." To fulfill this obligation, the EAF Addendum will require information about flowback water and production brine disposition, including:

- Planned transport off of well pad (truck or piping), and information about any proposed piping;
- Planned disposition (e.g., treatment facility, disposal well, reuse, or centralized tank facility); and
- Identification and permit numbers for any proposed treatment facility or disposal well located in New York.

3.2.3.6 Operational Information

Other required information about well pad operations will include:

1. Information about the planned construction and capacity of the reserve pit;
2. Information about the number and individual and total capacity of receiving tanks on the well pad for flowback water;
3. Indication of the timing of the use of a closed-loop tank system (e.g., surface, intermediate and/or production hole);
4. Information about any off-site cuttings disposal plan;
5. If proposed flowback vent/flare stack height is less than 30 feet, then documentation that previous drilling at the pad did not encounter H_2S is required;
6. Description of planned public access restrictions, including physical barriers and distance to edge of well pad;
7. Identification of the EPA Tiers of the drilling and hydraulic fracturing engines used, if these use gasoline or diesel fuel. If particulate traps or SCR are not used, a description of other control measures planned to reduce particulate matter and nitrogen oxide emissions during the drilling and hydraulic fracturing processes;
8. If condensate tanks are to be used, their capacity and the vapor recovery system to be used;

9. If a wellhead compressor is used, its size in horsepower and description the control equipment used for nitrogen oxides (NO_x); and

10. If a glycol dehydrator is to be used at the well pad, its stack height and the capacity of glycol to be used on an annual basis.

3.2.3.7 Invasive Species Survey and Map

The Department will require that well operators submit, with the EAF Addendum, a comprehensive survey of the entire project site, documenting the presence and identity of any invasive plant species. As described in Chapter 7, this survey will establish a baseline measure of percent aerial coverage and, at a minimum, must include the plant species identified on the Interim List of Invasive Plant Species in New York State. A map (1:24,000) showing all occurrences of invasive species within the project site must be produced and included with the survey as part of the EAF Addendum.

3.2.3.8 Required Affirmations

The EAF Addendum will require operator affirmations to address the following:

- passby flow for surface water withdrawals;
- review of local floodplain maps;
- residential water well sampling and monitoring;
- access road location;
- stormwater permit coverage;
- use of ultra-low sulfur fuel;
- preparation of site plans to address visual and noise impacts, invasive species mitigation and greenhouse gas emissions;
- adherence to all well permit conditions; and
- adherence to best management practices for reducing direct impacts to terrestrial habitats and wildlife.

3.2.3.9 Local Planning Documents

The EAF Addendum will require the applicant to identify whether the location of the well pad, or any other activity under the jurisdiction of the Department, conflicts with local land use laws, regulations, plans or policies. The applicant will also be required to identify whether the well pad is located in an area where the affected community has adopted a comprehensive plan or other local land use plan and whether the proposed action is inconsistent with such plan(s).

3.2.3.10 Habitat Fragmentation

Applicants proposing well pads in Forest or Grassland Focus Areas that involve a disturbance in a contiguous forest patch of 150 acres or more in size or a contiguous grassland patch of 30 acres or more in size should not submit the EAF or a well permit application prior to conducting a site-specific ecological assessment in accordance with a detailed study plan that has been approved by the Department. The need and plan for an ecological assessment should be determined in consultation with the Department and will consider information such as existing site conditions, existing vegetative cover and ongoing and historical land management activities. The completed ecological assessment must be attached to the EAF and must include, at a minimum:

- A compilation of historical information about use of the area by forest interior birds or grassland birds;
- Results of pre-disturbance biological studies, including a minimum of one year of field surveys at the site to determine the current extent, if any, of use of the site by forest interior birds or grassland birds;
- An evaluation of potential impacts on forest interior or grassland birds from the project;
- Additional mitigation measures proposed by applicant; and
- Protocols for monitoring of forest interior or grassland birds during the construction phase of the project and for a minimum of two years following well completion.

3.2.4 Prohibited Locations

The Department will not issue well permits for high-volume hydraulic fracturing at the following locations:

1) Any proposed well pad within the NYC and Syracuse watersheds;

2) Any proposed well pad within a 4,000-foot buffer around the NYC and Syracuse watersheds;

3) Any proposed well pad within a primary aquifer (subject to reconsideration 2 years after issuance of the first permit for high-volume hydraulic fracturing);

4) Any proposed well pad within a 500-foot buffer around primary aquifers (subject to reconsideration 2 years after issuance of the first permit for high-volume hydraulic fracturing);

5) Any proposed well pad within 2,000 feet of public water supply wells, river or stream intakes and reservoirs (subject to reconsideration 3 years after issuance of the first permit for high-volume hydraulic fracturing);

6) Any proposed well pad within 500 feet of private drinking water wells or domestic use springs, unless waived by the owner; and

7) Any proposed well pad within a 100-year floodplain.

3.2.5 Projects Requiring Site-Specific SEQRA Determinations of Significance

The Department proposes that site-specific environmental assessments and SEQRA determinations of significance be required for the high-volume hydraulic fracturing projects listed below, regardless of the target formation, the number of wells drilled on the pad and whether the wells are vertical, directional or horizontal.

1) Any proposed high-volume hydraulic fracturing where the top of the target fracture zone is shallower than 2,000 feet along any part of the proposed length of the wellbore;

2) Any proposed high-volume hydraulic fracturing where the top of the target fracture zone at any point along any part of the proposed length of the wellbore is less than 1,000 feet below the base of a known fresh water supply;

3) Any proposed well pad within 500 feet of a principal aquifer;

4) Any proposed well pad within 150 feet of a perennial or intermittent stream, storm drain, lake or pond;

5) A proposed surface water withdrawal that is found not to be consistent with the Department's preferred passby flow methodology as described in Chapter 7;

6) Any proposed water withdrawal from a pond or lake;

7) Any proposed ground water withdrawal within 500 feet of a private well;

8) Any proposed ground water withdrawal within 500 feet of a wetland that pump test data shows would have an influence on the wetland;

9) Any proposed well location determined by NYCDEP to be within 1,000 feet of its subsurface water supply infrastructure; and

10) Any proposed centralized flowback water surface impoundment.

The Department will re-evaluate the need for site-specific SEQRA determinations within 500 feet of principal aquifers two years after issuance of the first permit for high-volume hydraulic fracturing.

The Department is not proposing to alter its 1992 Findings that proposed disposal wells require individual site-specific review or that proposed disturbances larger than 2.5 acres in designated Agricultural Districts require a site-specific SEQRA determination. According to the information received to date, the drilling of all high-volume hydraulically fractured wells will create surface disturbances in excess of 2.5 acres. The Department will consult with the Department of Agriculture and Markets to develop permit conditions, best management practices (BMP) requirements and reclamation guidelines to be followed when the proposed disturbance is larger than 2.5 acres on a farm in an Agricultural District. Staff will perform the SEQRA review and publish the results in the Environmental Notice Bulletin (ENB). A large number of agricultural districts are currently located in areas where high-volume hydraulic fracturing drilling is expected to occur but many of these districts have reverted to forestlands and are no longer in agricultural production. Mineral Resources will provide guidance to gas well operators to achieve the goal of reducing or minimizing the surface disturbance to agricultural farmlands. Examples of the proposed Agricultural District requirements include but are not limited to:

- decompaction and deep ripping of disturbed areas prior to topsoil replacement;
- removal of construction debris from the site;
- no mixing of cuttings with topsoil;

- removal of spent drilling muds from active agricultural fields;
- location of well pads/access roads along field edges and in nonagricultural areas (where possible);
- removal of excess subsoil and rock from the site; and
- fencing of the site when drilling is located in active pasture areas to prevent livestock access.

Proposed projects that require other Department permits will continue to require site-specific SEQRA determinations regarding the activities covered by those permits, with one exception. Required coverage under a general stormwater permit does not result in the need for a site-specific SEQRA determination, as the Department issues its general permits pursuant to a separate process.

3.3 Regulations

The Department's oil and gas well regulations, located at 6 NYCRR Parts 550 - 559, contain permitting, recordkeeping, and operating requirements for oil and gas wells. More detailed requirements applicable to drilling operations are routinely attached as conditions to well drilling permits issued pursuant to the ECL. Additionally, the Department's regulations concerning water withdrawals, stormwater control, and the use of state lands, among others, would apply to various aspects of high-volume hydraulic fracturing operations considered in this revised draft SGEIS. Appendix 10 of this revised draft SGEIS contains proposed supplementary permit conditions for high-volume hydraulic fracturing that will be attached to well drilling permits. Although conditions incorporated into well drilling are enforceable pursuant to ECL Article 71, a number of the application requirements specific to high-volume hydraulic fracturing as well as many of the mitigation measures discussed in this revised draft SGEIS will be set forth in regulations. Accordingly, draft revisions and additions to the Department's regulations will be considered as part of the SGEIS process, pursuant to the State Administrative Procedures Act (SAPA) for agency rulemaking.

The enactment of revisions or additions to the Department's regulations relating to high-volume hydraulic fracturing would have a positive effect on the environment by mitigating or otherwise addressing potential environmental impacts from this activity. However, because these regulations would be enacted as part of an action that would authorize high-volume hydraulic fracturing the enactment of such regulatory revisions or additions will be considered in conjunction with the Department's consideration of the significant environmental impacts under SEQRA.

SAPA contains other potential impact areas for state agencies to consider, such as the impact of proposed rules on jobs, rural areas and the regulated community. Some of these types of impacts are discussed in this revised draft SGEIS, but a complete examination of those types of impacts will be evaluated within the rulemaking process. The Department will consider all information generated by the SGEIS and SAPA processes to make determinations on how high-volume hydraulic fracturing operations would be regulated.

New York State

DEC

Chapter 4

Geology

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Supplemental Generic Environmental Impact Statement

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Chapter 4 - Geology

FIGURES

TABLES

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Chapter 4 - GEOLOGY

This Chapter supplements and expands upon Chapter 5 of the 1992 GEIS. Sections 4.1 through 4.5 and the accompanying figures and tables were provided in essentially the form presented here by Alpha Environmental, Inc., under contract to NYSERDA to assist the Department with research related to this SGEIS.[1] Alpha's citations are retained for informational purposes, and are listed in the "consultants' references" section of the Bibliography. Section 4.6 discusses how NORM in the Marcellus Shale is addressed in the SGEIS.

The influence of natural geologic factors with respect to hydraulic fracture design and subsurface fluid mobility is discussed Chapter 5, specifically in Sections 5.8 (hydraulic fracture design) and 5.11.1.1 (subsurface fluid mobility).

4.1 Introduction

The natural gas industry in the US began in 1821 with a well completed by William Aaron Hart in the upper Devonian Dunkirk Shale in Chautauqua County. The "Hart" well supplied businesses and residents in Fredonia, New York with natural gas for 37 years. Hundreds of shallow wells were drilled in the following years into the shale along Lake Erie and then southeastward into western New York. Shale gas fields development spread into Pennsylvania, Ohio, Indiana, and Kentucky. Gas has been produced from the Marcellus since 1880 when the first well was completed in the Naples field in Ontario County. Eventually, as other formations were explored, the more productive conventional oil and natural gas fields were developed and shale gas (unconventional natural gas) exploration diminished.

The terms "conventional" and "unconventional" are related more to prevailing technology and economics surrounding the development of a given play than to the reservoir rock type from which the oil or natural gas resources are derived. Gas shales (also called "gas-containing shales") are one of a number of reservoir types that are explored for unconventional natural gas, and this group includes such terms as: deep gas; tight gas; coal-bed methane; geopressurized zones; and Arctic and sub-sea hydrates.

The US Energy Research and Development Administration (ERDA) began to evaluate gas resources in the US in the late 1960s. The Eastern Gas Shales Project was initiated in 1976 by

[1] Alpha, 2009.

the ERDA (later the US Department of Energy) to assess Devonian and Mississippian black shales. The studies concluded that significant natural gas resources were present in these tight formations.

The interest in development of shale gas resources increased in the late 20th and early 21st century as the result of an increase in energy demand and technological advances in drilling and well stimulation. The total unconventional natural gas production in the US increased by 65% and the proportion of unconventional gas production to total gas production increased from 28% in 1998 to 46% in 2007.[2]

A description of New York State geology and its relationship to oil, gas, and salt production is included in the 1992 GEIS. The geologic discussion provided herein supplements the information as it pertains to gas potential from unconventional gas resources. Emphasis is placed on the Utica and Marcellus Shales because of the widespread distribution of these units in New York.

4.2 Black Shales

Black shales, such as the Marcellus Shale, are fine-grained sedimentary rocks that contain high levels of organic carbon. The fine-grained material and organic matter accumulate in deep, warm, quiescent marine basins. The warm climate favors the proliferation of plant and animal life. The deep basins allow for an upper aerobic (oxygenated) zone that supports life and a deeper anaerobic (oxygen-depleted) zone that inhibits decay of accumulated organic matter. The organic matter is incorporated into the accumulating sediments and is buried. Pressure and temperature increase and the organic matter are transformed by slow chemical reactions into liquid and gaseous petroleum compounds as the sediments are buried deeper. The degree to which the organic matter is converted is dependent on the maximum temperature, pressure, and burial depth. The extent that these processes have transformed the carbon in the shale is represented by the thermal maturity and transformation ratio of the carbon. The more favorable gas producing shales occur where the total organic carbon (TOC) content is at least 2% and

[2] Alpha, 2009, p. 121.

where there is evidence that a significant amount of gas has formed and been preserved from the TOC during thermal maturation.[3]

Oil and gas are stored in isolated pore spaces or fractures and adsorbed on the mineral grains.[4] Porosity (a measure of the void spaces in a material) is low in shales and is typically in the range of 0 to 10 percent.[5] Porosity values of 1 to 3 percent are reported for Devonian shales in the Appalachian Basin.[6] Permeability (a measure of a material's ability to transmit fluids) is also low in shales and is typically between 0.1 to 0.00001 millidarcy (md).[7] Hill et al. (2002) summarized the findings of studies sponsored by NYSERDA that evaluated the properties of the Marcellus Shale. The porosity of core samples from the Marcellus in one well in New York ranged from 0 to 18%. The permeability of Marcellus Shale ranged from 0.0041 md to 0.216 md in three wells in New York State.

Black shale typically contains trace levels of uranium that is associated with organic matter in the shale.[8] The presence of naturally occurring radioactive materials (NORM) induces a response on gamma-ray geophysical logs and is used to identify, map, and determine thickness of gas shales.

The Appalachian Basin was a tropical inland sea that extended from New York to Alabama (Figure 4.1). The tropical climate of the ancient Appalachian Basin provided favorable conditions for generating the organic matter, and the erosion of the mountains and highlands bordering the basin provided clastic material (i.e., fragments of rock) for deposition. The sedimentary rocks that fill the basin include shales, siltstones, sandstones, evaporites, and limestones that were deposited as distinct layers that represent several sequences of sea level rise and fall. Several black shale formations, which may produce natural gas, are included in these layers.[9]

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[3] Alpha, 2009, p. 122.

[4] Alpha, 2009, p. 122.

[5] Alpha, 2009, p.122.

[6] Alpha, 2009, p.122.

[7] Alpha, 2009, p.122.

[8] Alpha, 2009, p. 122.

[9] Alpha, 2009, p. 123.

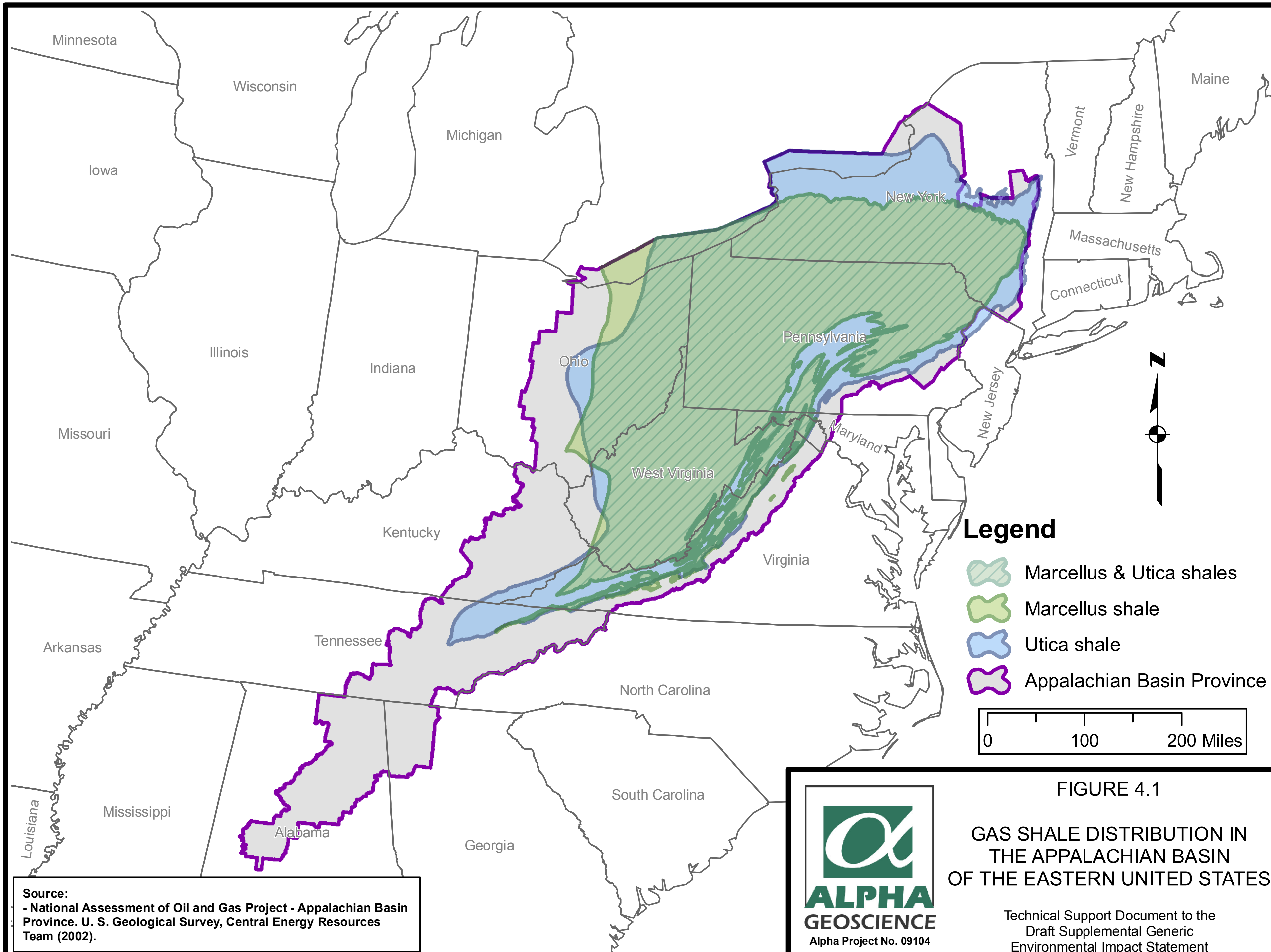

FIGURE 4.1

GAS SHALE DISTRIBUTION IN THE APPALACHIAN BASIN OF THE EASTERN UNITED STATES

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The stratigraphic column for southwestern New York State is shown in Figure 4.2 and includes oil and gas producing horizons. This figure was initially developed by Van Tyne and Copley,[10] from the analysis of drilling data in southwestern New York State, and it has been modified several times since then as various authors have cited it in different studies. The version presented as Figure 4.2 can also be found on the Department's website at http://www.dec.ny.gov/energy/33893.html. Figure 4.3 is a generalized cross-section from west to east across the southern tier of New York State and shows the variation in thickness and depth of the different stratigraphic units. This figure was initially developed by the Reservoir Characterization Group of the New York State Museum. It is important to note that the geographic areas represented in Figure 4.2 and Figure 4.3 are not precisely the same, and the figures were originally developed by different authors. For example, the Marcellus Shale is shown in Figure 4.2 as the basal unit of the Hamilton Group, but it appears as a discrete unit below the Hamilton Group in Figure 4.3 to highlight its gas-bearing potential. Similarly, the "Devonian Sandstone and Shale" of Figure 4.3 correlates to the Conewango, Conneaut, Canadaway, West Falls, Sonyea, and Genesee Groups of Upper Devonian age shown in Figure 4.2.

The Ordovician-aged Utica Shale and the Devonian-aged Marcellus Shale are of particular interest because of recent estimates of natural gas resources and because these units extend throughout the Appalachian Basin from New York to Tennessee. There are other black shale formations (Figures 4.2 and 4.3) in New York that may produce natural gas on a localized basis.[11] The following sections describe the Utica and Marcellus Shales in greater detail.

4.3 Utica Shale

The Utica Shale is an upper Ordovician-aged black shale that extends across the Appalachian Plateau from New York and Quebec, Canada, south to Tennessee. It covers approximately 28,500 square miles in New York and extends from the Adirondack Mountains to the southern tier and east to the Catskill front (Figure 4.4). The Utica Shale is exposed in outcrops along the southern and western Adirondack Mountains, and it dips gently south to depths of more than 9,000 feet in the southern tier of New York.

[10] Van Tyne and Copley, 1983.

[11] Alpha, 2009, p. 123.

The Utica Shale is a massive, fossiliferous, organic-rich, thermally-mature, black to gray shale. The sediment comprising the Utica Shale was derived from the erosion of the Taconic Mountains at the end of the Ordovician, approximately 440 to 460 million years ago. The shale is bounded below by Trenton Group strata and above by the Lorraine Formation and consists of three members in New York State that include: Flat Creek Member (oldest), Dolgeville Member, and the Indian Castle Member (youngest).[12] The Canajoharie Shale and Snake Hill Shale are found in the eastern part of the state and are lithologically equivalent, but older than the western portions of the Utica.[13]

There is some disagreement over the division of the Utica Shale members. Smith & Leone (2009) divide the Indian Castle Member into an upper low-organic carbon regional shale and a high-organic carbon lower Indian Castle. Nyahay et al. (2007) combines the lower Indian Castle Member with the Dolgeville Member. Fisher (1977) includes the Dolgeville as a member of the Trenton Group. The stratigraphic convention of Smith and Leone is used in this document.

Units of the Utica Shale have abundant pyrite, which indicates deposition under anoxic conditions. Geophysical logs and cutting analyses indicate that the Utica Shale has a low bulk density and high total organic carbon content.[14]

The Flat Creek and Dolgeville Members are found south and east of a line extending approximately from Steuben County to Oneida County (Figure 4.4). The Dolgeville is an interbedded limestone and shale. The Flat Creek is a dark, calcareous shale in its western extent and grades to an argillaceous calcareous mudstone to the east. These two members are time-equivalent and grade laterally toward the west into Trenton limestones.[15] The lower Indian Castle Member is a fissile, black shale and is exposed in road cuts, particularly at the New York State Thruway (I-90) exit 29A in Little Falls. Figure 4.5 shows the depth to the base of the Utica Shale.[16] This depth corresponds approximately with the base of the organic-rich section of the Utica Shale.

[12] Alpha, 2009, p. 124.

[13] Alpha, 2009, p. 124.

[14] Alpha, 2009, p. 124.

[15] Alpha, 2009, p. 124.

[16] Alpha, 2009, p. 124.

Figure 4.2 - Stratigraphic Section of Southwestern New York State

Period		Group	Unit		Lithology
Penn.		Pottsville	Olean		Quartz pebble conglomerate & sandstone, quartz pebble, conglomerate, sandstone & minor shale
Miss.		Pocono	Knapp		
Dev.	Upper	Conewango			Shale & sandstone, scattered conglomerates
		Conneaut	Chadakoin		Shale & siltstone, scattered conglomerates
		Canadaway	Undifferentiated[1]	O G O G	Shale & siltstone Minor sandstone
			Perrysburg[2]	O G O G	Shale & siltstone Minor sandstone
		West Falls	Java Nunda Rhinestreet	G	Shale & siltstone Argillaceous limestone
		Sonyea	Middlesex	G	Shale & siltstone
		Genesee			Shale with minor siltstone & limestone
	Middle		Tully	G	Limestone with minor siltstone & sandstone
		Hamilton	Moscow Ludlowville Skaneateles Marcellus	G	Shale with minor sandstone & conglomerate
			Onondaga	O G	Limestone
	Lower	Tristates	Oriskany	G	Sandstone
		Helderberg	Manlius Rondout		Limestone & dolostone
Sil.	Upper		Akron	O G	Dolostone
		Salina	Camillus Syracuse Vernon	S S	Shale, siltstone, anhydrite & halite
		Lockport	Lockport	G	Limestone & dolostone
		Clinton	Rochester Irondequoit		Shale & sandstone
	Lower		Sodus Reynales Thorold		Limestone & dolostone
		Medina	Grimsby Whirlpool	G G	Sandstone & shale Quartz sandstone
Ord.	Upper		Queenston Oswego Lorraine Utica	G G	Shale & siltstone with minor sandstone
	Middle	Trenton - Black River	Trenton Black River	G	Limestone and minor dolostone
	Lower	Beekmantown	Tribes Hill Chuctanunda		Limestone & dolostone
Camb.	Upper		Little Falls Galway (Theresa) Potsdam	G G	Quartz sandstone & dolostone; sandstone & sandy dolomite; conglomerate base
PreCamb.			Gneiss, Marble, Quartzite, etc...		Metamorphic & igneous rocks

1 - Includes: Glade, Bradford 1st, Chipmunk, Bradford 2nd, Harrisburg Run, Scio, Penny and Richburg.

2 - Includes: Bradford 3rd, Humphrey, Clarksville, Waugh & Porter, and Fulmer Valley.

O: Oil producing

G: Gas producing

S: Salt producing

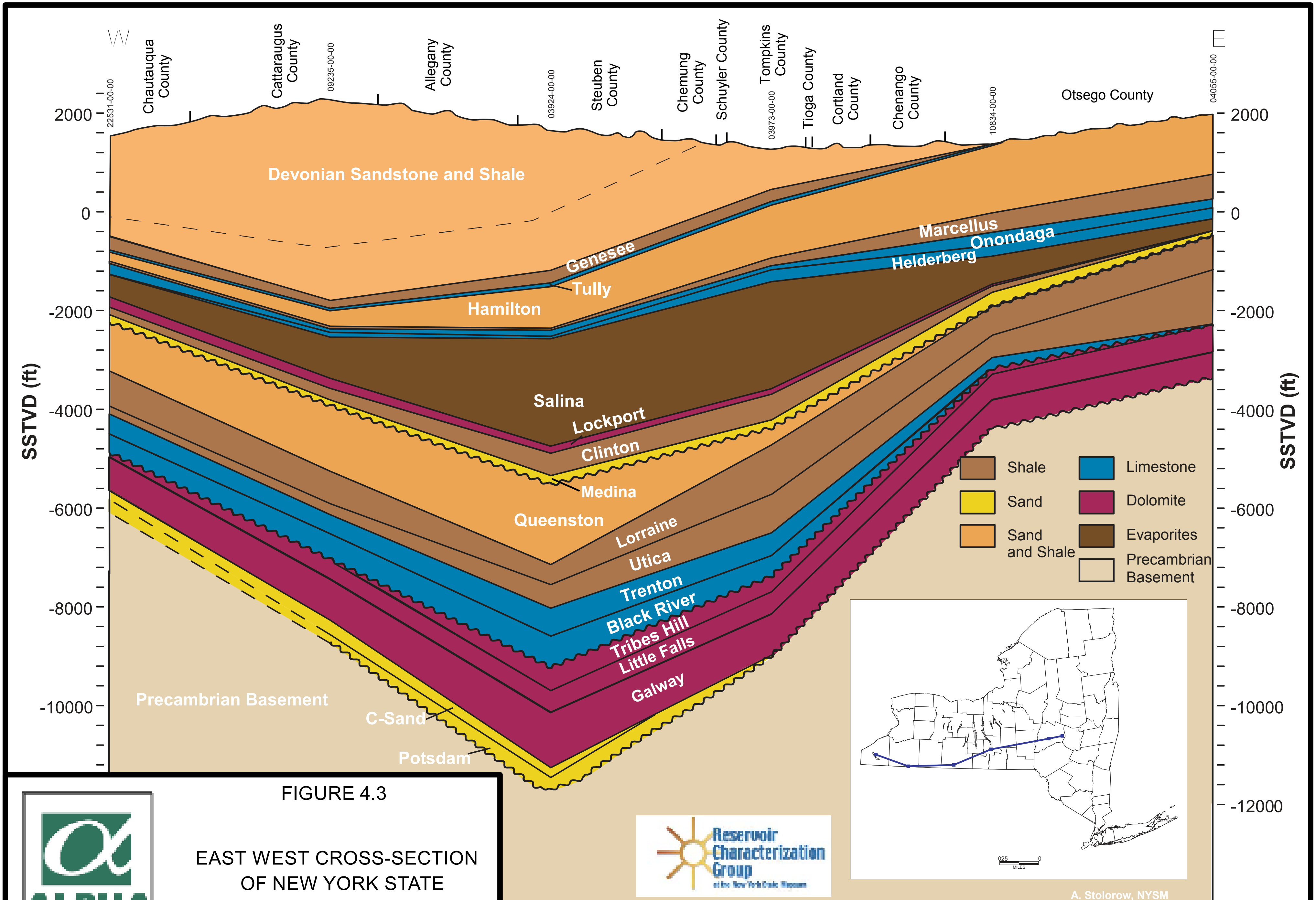

FIGURE 4.3

EAST WEST CROSS-SECTION OF NEW YORK STATE

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ALPHA GEOSCIENCE

Alpha Project No. 09104

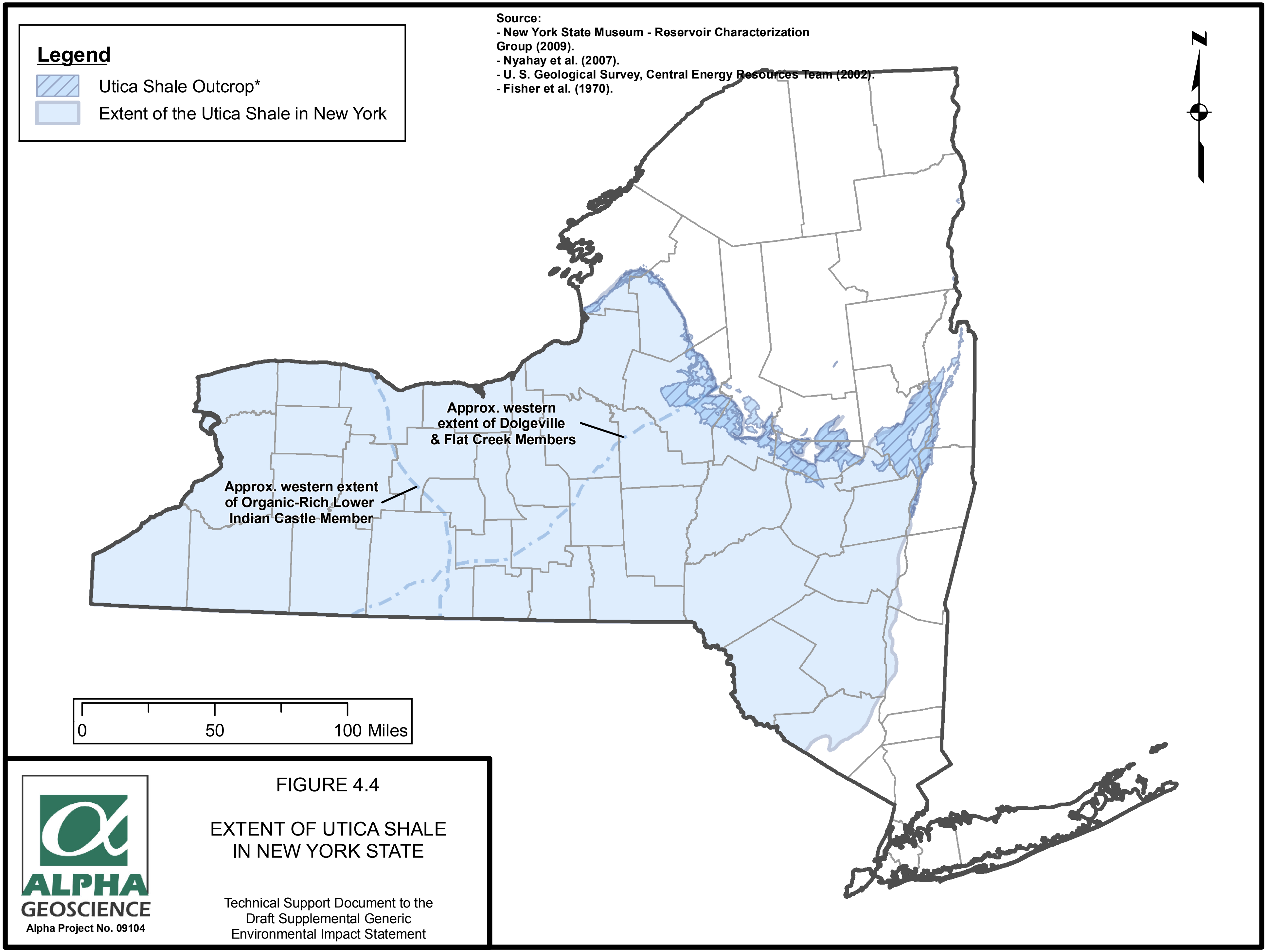

FIGURE 4.4

EXTENT OF UTICA SHALE IN NEW YORK STATE

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4.3.1 Total Organic Carbon

Measurements of TOC in the Utica Shale are sparse. Where reported, TOC has been measured at over 3% by weight.[17] Nyahay et al. (2007) compiled measurements of TOC for core and outcrop samples. TOC in the lower Indian Castle, Flat Creek, and Dolgeville Members generally ranges from 0.5 to 3%. TOC in the upper Indian Castle Member is generally below 0.5%. TOC values as high as 3.0% in eastern New York and 15% in Ontario and Quebec were also reported.[18]

The New York State Museum Reservoir Characterization Group evaluated cuttings from the Utica Shale wells in New York State and reported up to 3% TOC.[19] Jarvie et al. (2007) showed that analyses from cutting samples may underestimate TOC by approximately half; therefore, it may be as high as 6%. Figure 4.6 shows the combined total thickness of the organic-rich (greater than 1%, based on cuttings analysis) members of the Utica Shale. As shown on Figure 4.6, the organic-rich Utica Shale ranges from less than 50 feet thick in north-central New York and increases eastward to more than 700 feet thick.

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[17] Alpha, 2009, p. 124.

[18] Alpha, 2009, p. 125.

[19] Alpha, 2009, p. 125.

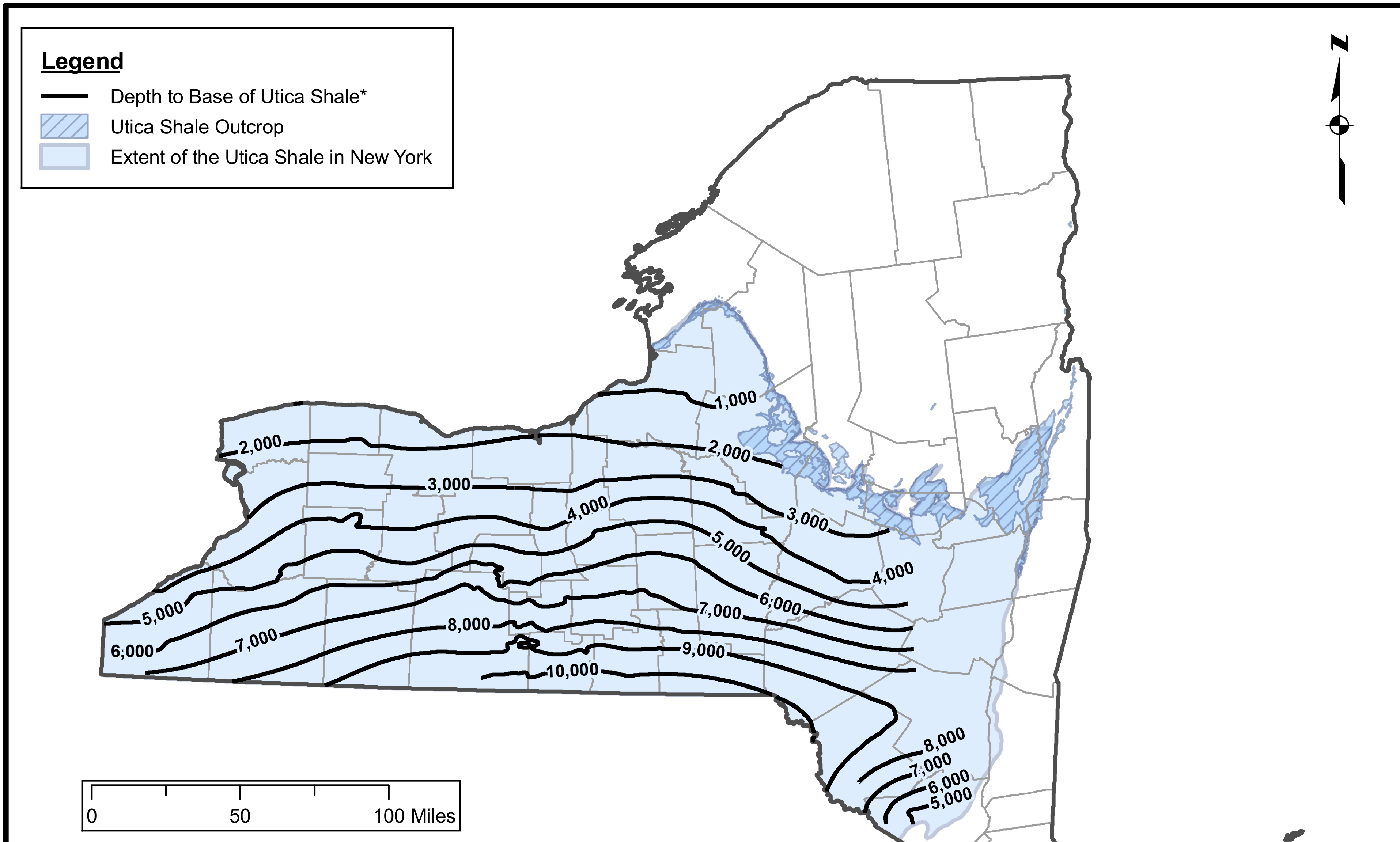

FIGURE 4.5

DEPTH TO BASE OF UTICA SHALE IN NEW YORK STATE

ALPHA GEOSCIENCE

Alpha Project No. 09104

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Notes:
- Top of the Trenton limestone approximates the base of the Utica shale (New York State Museum - Reservoir Characterization Group, 2009).
- U. S. Geological Survey, Central Energy Resources Team (2002).

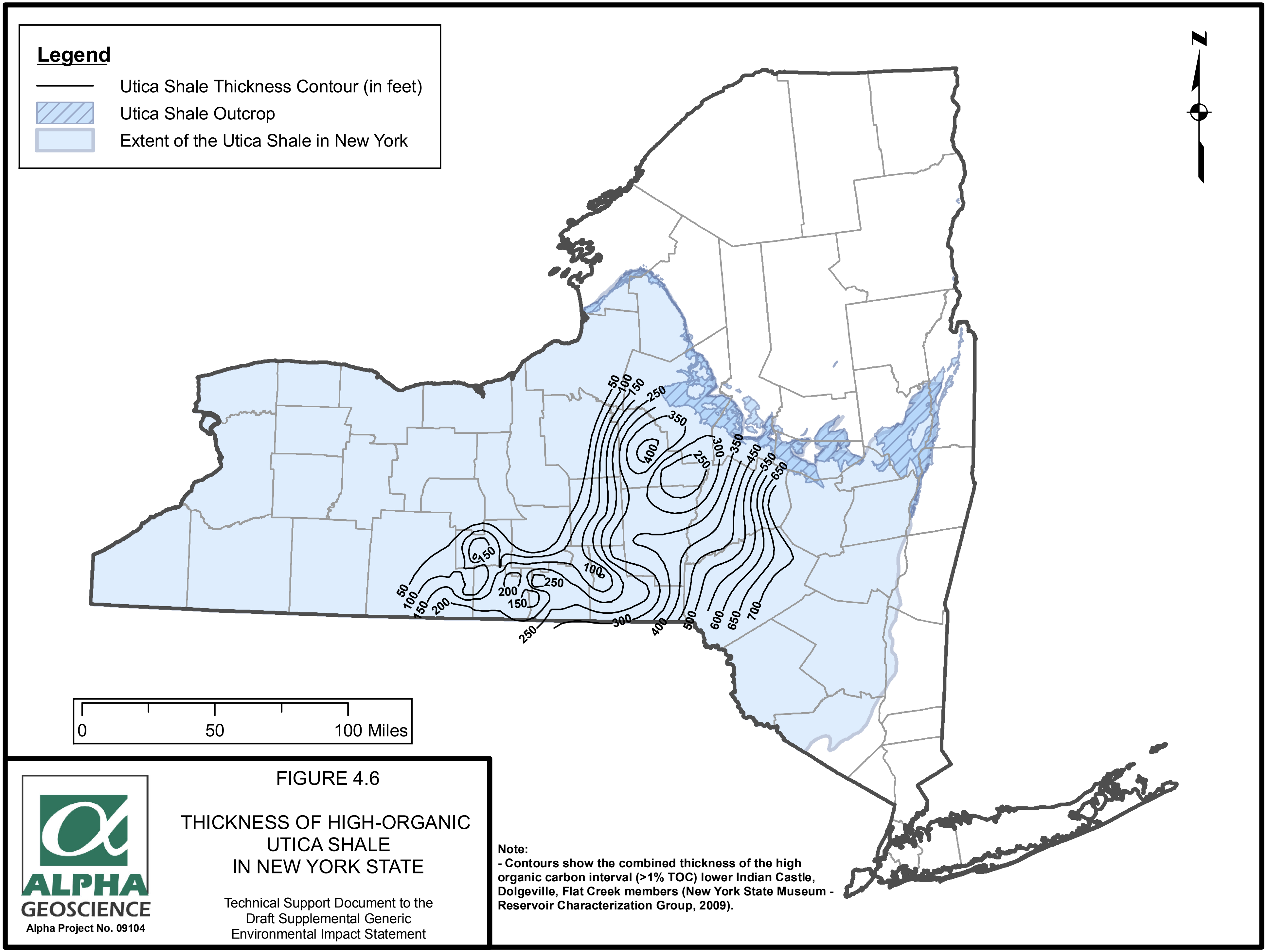

FIGURE 4.6

THICKNESS OF HIGH-ORGANIC
UTICA SHALE
IN NEW YORK STATE

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Note:
- Contours show the combined thickness of the high organic carbon interval (>1% TOC) lower Indian Castle, Dolgeville, Flat Creek members (New York State Museum - Reservoir Characterization Group, 2009).

4.3.2 Thermal Maturity and Fairways

Nyahay, et. al. (2007) presented an assessment of gas potential in the Marcellus and Utica Shales. The assessment was based on an evaluation of geochemical data from core and outcrop samples using methods applied to other shale gas plays, such as the Barnett Shale in Texas. A gas production "fairway", which is a portion of the shale most likely to produce gas based on the evaluation, was presented. Based on the available, limited data, Nyahay et al. (2007) concluded that most of the Utica Shale is supermature and that the Utica Shale fairway is best outlined by the Flat Creek Member where the TOC and thickness are greatest. This area extends eastward from a northeast-southwest line connecting Montgomery to Steuben Counties (Figure 4.7). The fairway shown on Figure 4.7 correlates approximately with the area where the organic-rich portion of the Utica Shale is greater than 100 feet thick shown on Figure 4.6.[20] The fairway is that portion of the formation that has the potential to produce gas based on specific geologic and geochemical criteria; however, other factors, such as formation depth, make only portions of the fairway favorable for drilling. Operators consider a variety of these factors, besides the extent of the fairway, when making a decision on where to drill for natural gas.

The results of the 2007 evaluation are consistent with an earlier report by Weary et al. (2000) that presented an evaluation of thermal maturity based on patterns of thermal alteration of conodont microfossils across New York State. The data presented show that the thermal maturity of much of the Utica Shale in New York is within the dry natural gas generation and preservation range and generally increases from northwest to southeast.

4.3.3 Potential for Gas Production

The Utica Shale historically has been considered the source rock for the more permeable conventional gas resources. Fresh samples containing residual kerogen and other petroleum residuals reportedly have been ignited and can produce an oily sheen when placed in water.[21] Significant gas shows have been reported while drilling through the Utica Shale in eastern and central New York.[22]

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[20] Alpha, 2009, p. 125.

[21] Alpha, 2009, p. 126.

[22] Alpha, 2009, p. 126.

No Utica Shale gas production was reported to the Department in 2009. Vertical test wells completed in the Utica in the St. Lawrence Lowlands of Quebec have produced up to one million cubic feet per day (MMcf/d) of natural gas.

4.4 Marcellus Formation

The Marcellus Formation is a Middle Devonian-aged member of the Hamilton Group that extends across most of the Appalachian Plateau from New York south to Tennessee. The Marcellus Formation consists of black and dark gray shales, siltstones, and limestones. The Marcellus Formation lies between the Onondaga limestone and the overlying Stafford-Mottville limestones of the Skaneateles Formation[23] and ranges in thickness from less than 25 feet in Cattaraugus County to over 1,800 feet along the Catskill front.[24] The informal name "Marcellus Shale" is used interchangeably with the formal name "Marcellus Formation." The discussion contained herein uses the name Marcellus Shale to refer to the black shale in the lower part of the Hamilton Group.

The Marcellus Shale underlies an area of approximately 18,700 square miles in New York (Figure 4.8). The Marcellus is exposed in outcrops to the north and east and reaches depths of more than 5,000 feet in the southern tier (Figure 4.8).

The Marcellus Shale in New York State consists of three primary members.[25] The oldest (lower-most) member of the Marcellus is the Union Springs Shale which is laterally continuous with the Bakoven Shale in the eastern part of the state. The Union Springs and Bakoven Shales are bounded below by the Onondaga and above by the Cherry Valley Limestone in the west and the correlative Stony Hollow Member in the East. The upper-most member of the Marcellus Shale is the Oatka Creek Shale (west) and the correlative Cardiff-Chittenango Shales (east). The members of primary interest with respect to gas production are the Union Springs and lower-most portions

[23] Alpha, 2009, p. 126.

[24] Alpha, 2009, p. 126.

[25] Alpha, 2009, p. 127.

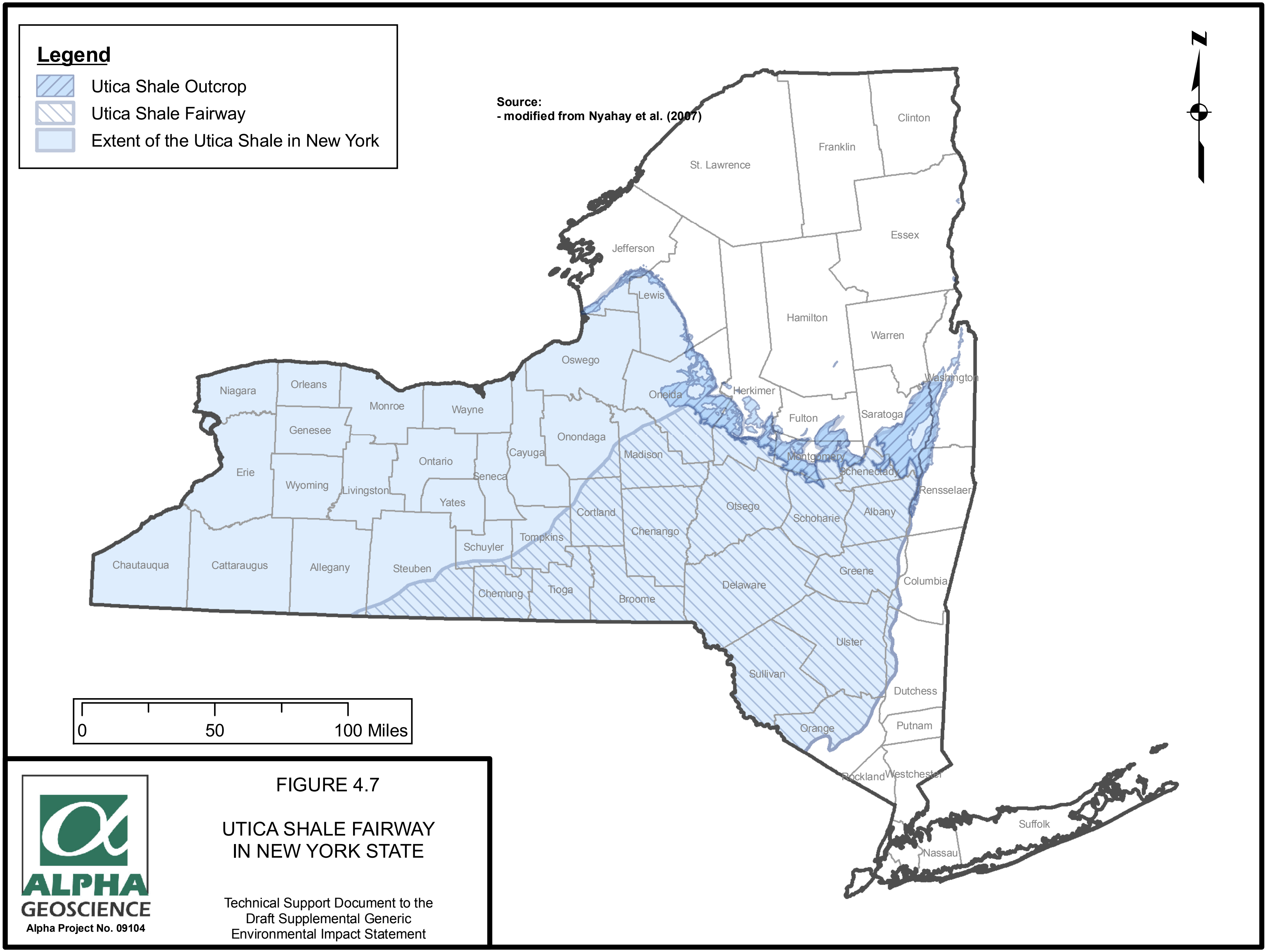

FIGURE 4.7

UTICA SHALE FAIRWAY IN NEW YORK STATE

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of the Oatka Creek Shale.[26] The cumulative thickness of the organic-rich layers ranges from less than 25 feet in western New York to over 300 feet in the east (Figure 4.9). Gamma ray logs indicate that the Marcellus Shale has a slightly radioactive signature on gamma ray geophysical logs, consistent with typical black shales. Concentrations of uranium ranging from 5 to 100 parts per million have been reported in Devonian gas shales.[27]

4.4.1 Total Organic Carbon

Figure 4.10 shows the aerial distribution of TOC in the Marcellus Shale based on the analysis of drill cuttings sample data.[28] TOC generally ranges between 2.5 and 5.5 percent and is greatest in the central portion of the state. Ranges of TOC values in the Marcellus were reported between 3 to 12%[29] and 1 to 10.1%.[30]

4.4.2 Thermal Maturity and Fairways

Vitrinite reflectance is a measure of the maturity of organic matter in rock with respect to whether it has produced hydrocarbons and is reported in percent reflection (% Ro). Values of 1.5 to 3.0 % Ro are considered to correspond to the "gas window," though the upper value of the window can vary depending on formation and kerogen type characteristics.

VanTyne (1993) presented vitrinite reflection data from nine wells in the Marcellus Shale in Western New York. The values ranged from 1.18 % Ro to 1.65 % Ro, with an average of 1.39 % Ro. The vitrinite reflectance values generally increase eastward. Nyahay et al (2007) and Smith & Leone (2009) presented vitrinite reflectance data for the Marcellus Shale in New York (Figure 4.11) based on samples compiled by the New York State Museum Reservoir Characterization Group. The values ranged from less than 1.5 % Ro in western New York to over 3 % Ro in eastern New York.

Nyahay et al. (2007) presented an assessment of gas potential in the Marcellus Shale that was based on an evaluation of geochemical data from rock core and outcrop samples using methods

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[26] Alpha, 2009, p. 127.

[27] Alpha, 2009, p. 127.

[28] Alpha, 2009, p. 127.

[29] Alpha, 2009, p. 127.

[30] Alpha, 2009, p. 127.

applied to other shale gas plays, such as the Barnett Shale in Texas. The gas productive fairway was identified based on the evaluation and represents the portion of the Marcellus Shale most likely to produce gas. The Marcellus fairway is similar to the Utica Shale fairway and is shown on Figure 4.12. The fairway is that portion of the formation that has the potential to produce gas based on specific geologic and geochemical criteria; however, other factors, such as formation depth, make only portions of the fairway favorable for drilling. Operators consider a variety of these factors, besides the extent of the fairway, when making a decision on where to drill for natural gas. Variation in the actual production is evidenced by Marcellus Shale wells outside the fairway that have produced gas and wells within the fairway that have been reported dry.

4.4.3 Potential for Gas Production

Gas has been produced from the Marcellus since 1880 when the first well was completed in the Naples field in Ontario County. The Naples field produced 32 MMcf during its productive life and nearly all shale gas discoveries in New York since then have been in the Marcellus Shale.[31] All gas wells completed in New York's Marcellus Shale as of the publication date of this document are vertical wells.[32]

The Department's summary production database includes reported natural gas production for the years 1967 through 1999. Approximately 544 MMcf of gas was produced from wells completed in the Marcellus Shale during this period.[33] In 2010, the most recent reporting year available, a total of 34 MMcf of gas was produced from 15 Marcellus Shale wells in Livingston, Steuben, Schuyler, Chemung, Chautauqua, Wyoming and Allegany Counties.

Volumes of in-place natural gas resources have been estimated for the entire Appalachian Basin. Charpentier et al. (1982) estimated a total in-place resource of 844.2 Tcf in all Devonian shales within the basin, including the Marcellus Shale. Approximately 164.1 Tcf, or 19%, of that estimated total, was attributed to the Devonian shales in New York State. NYSERDA estimates that approximately 15% of the total Devonian shale gas resource of the Appalachian Basin lies beneath New York State.

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[31] Alpha, 2009, p. 129.

[32] Alpha, 2009, p. 129.

[33] Alpha, 2009, p. 129.

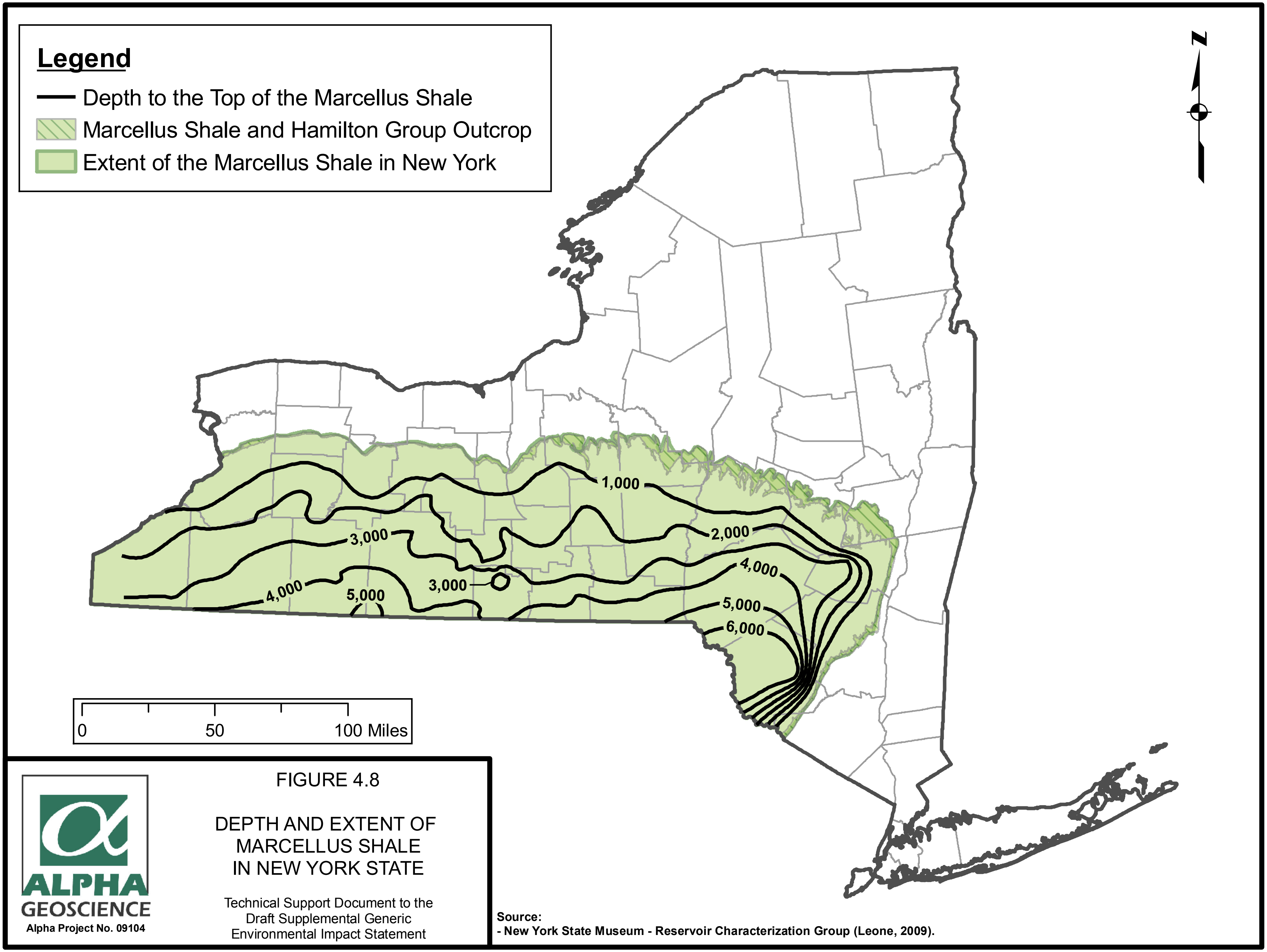

FIGURE 4.8

DEPTH AND EXTENT OF MARCELLUS SHALE IN NEW YORK STATE

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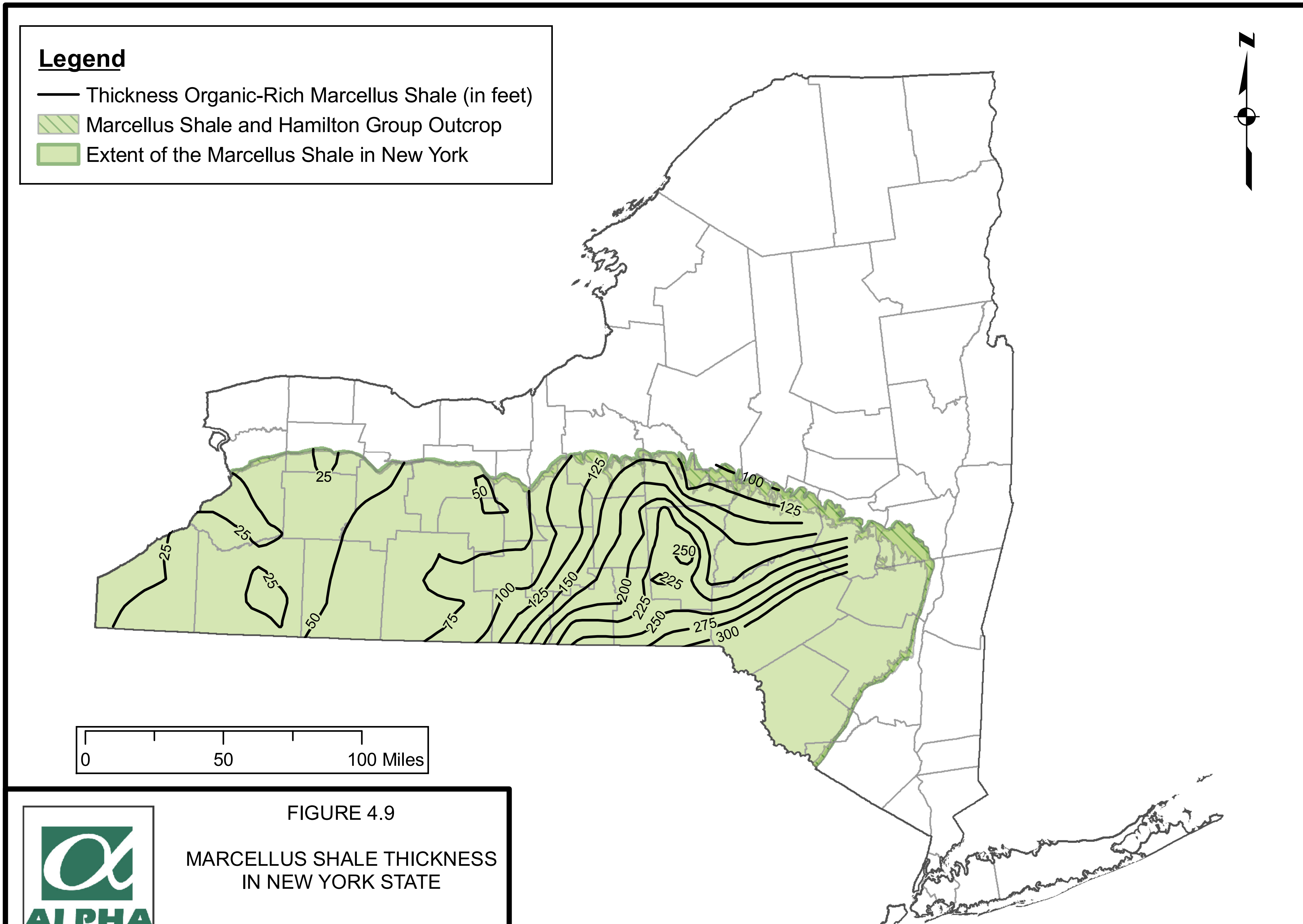

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FIGURE 4.9

MARCELLUS SHALE THICKNESS IN NEW YORK STATE

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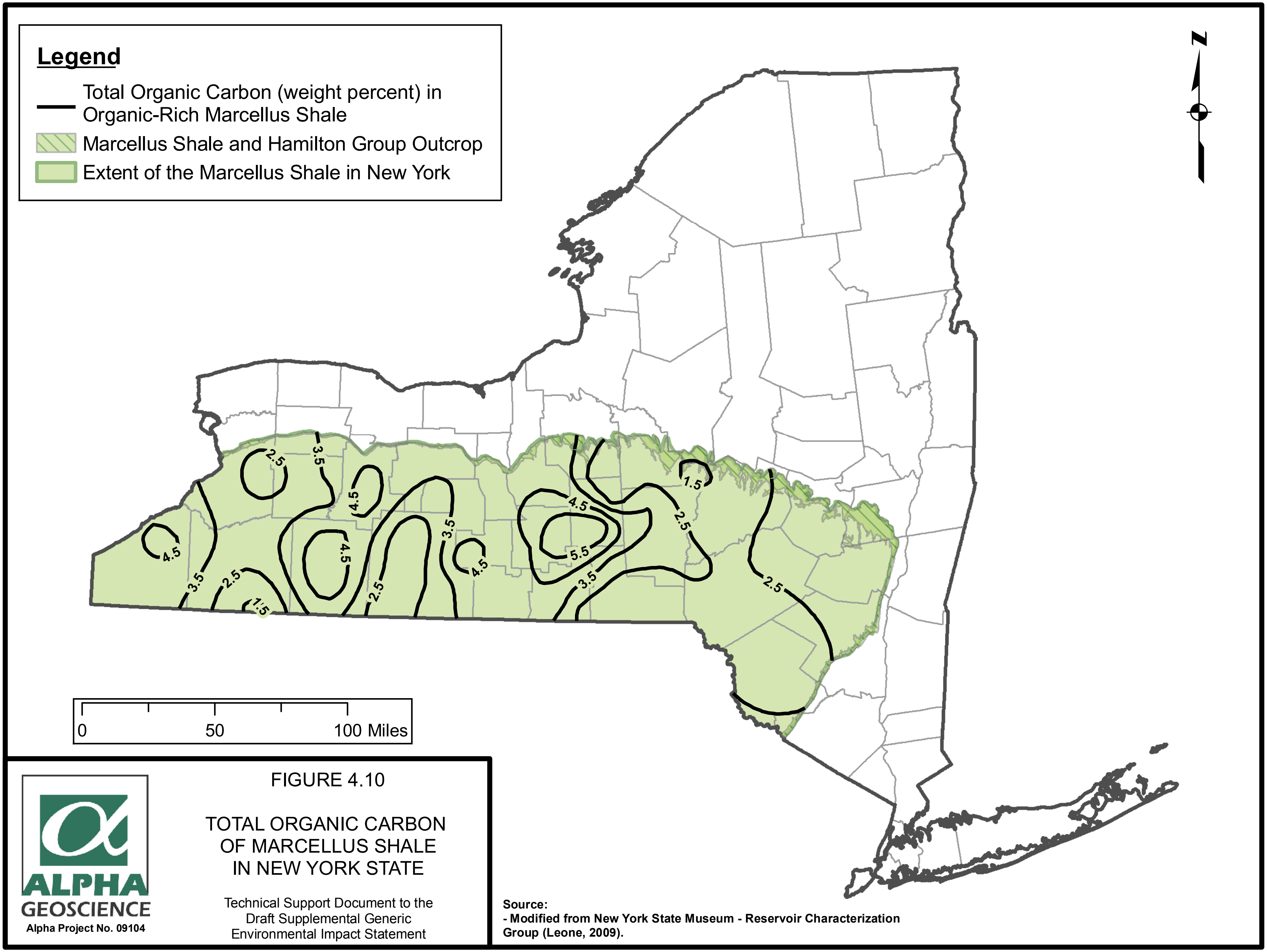
Notes:
- Source: New York State Museum - Reservoir Characterization Group (Leone, 2009)
- Organic-rich Marcellus includes Union Springs and Oatka Creek Members and lateral equivalents.



Legend
Total Organic Carbon (weight percent) in Organic-Rich Marcellus Shale
Marcellus Shale and Hamilton Group Outcrop
Extent of the Marcellus Shale in New York
N
0
50
100 Miles
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FIGURE 4.10
TOTAL ORGANIC CARBON OF MARCELLUS SHALE IN NEW YORK STATE
Technical Support Document to the Draft Supplemental Generic Environmental Impact Statement
Source:
- Modified from New York State Museum - Reservoir Characterization Group (Leone, 2009).

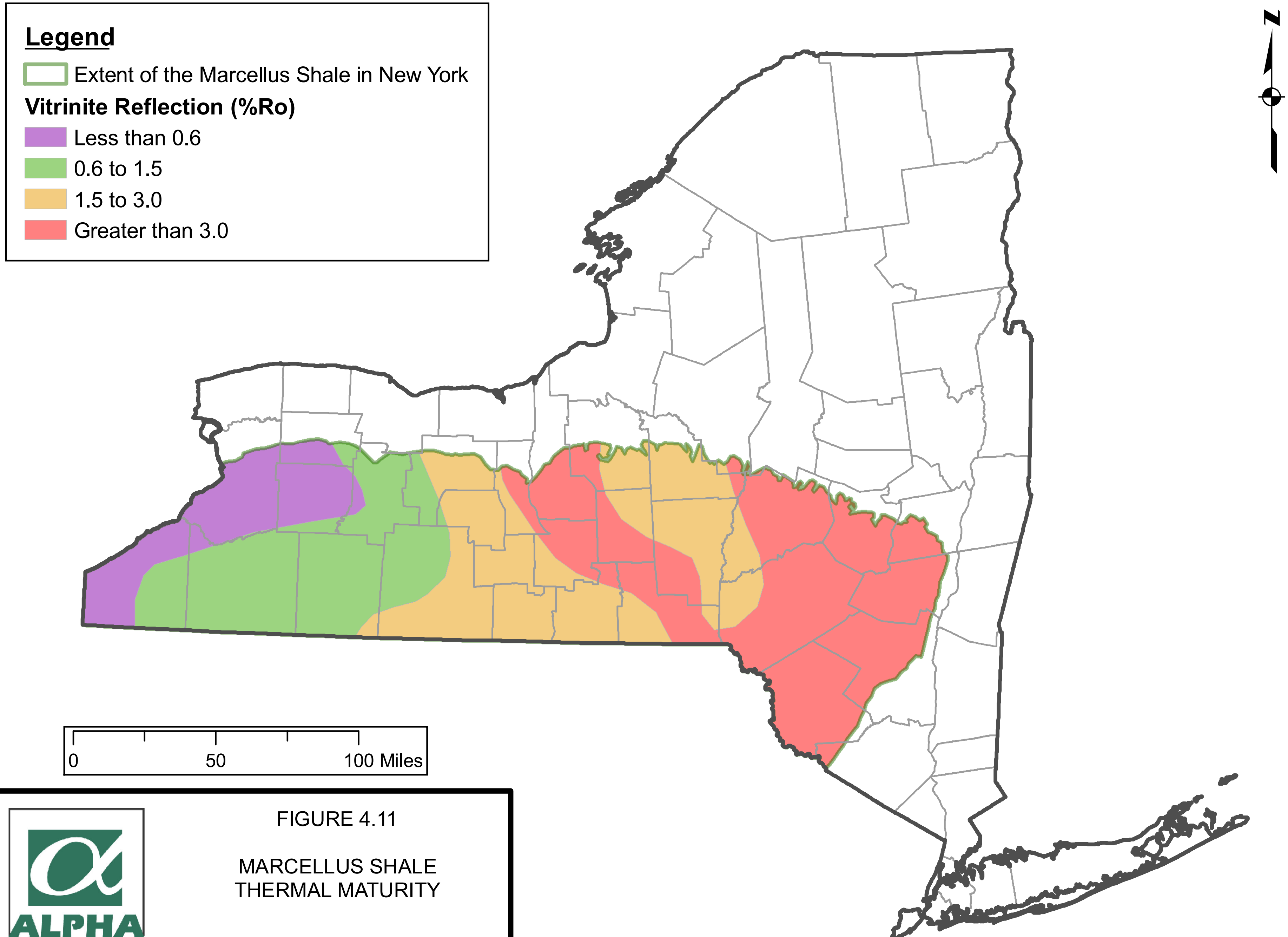

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FIGURE 4.11

MARCELLUS SHALE
THERMAL MATURITY

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Source:
- Modified from Smith & Leone (2009).

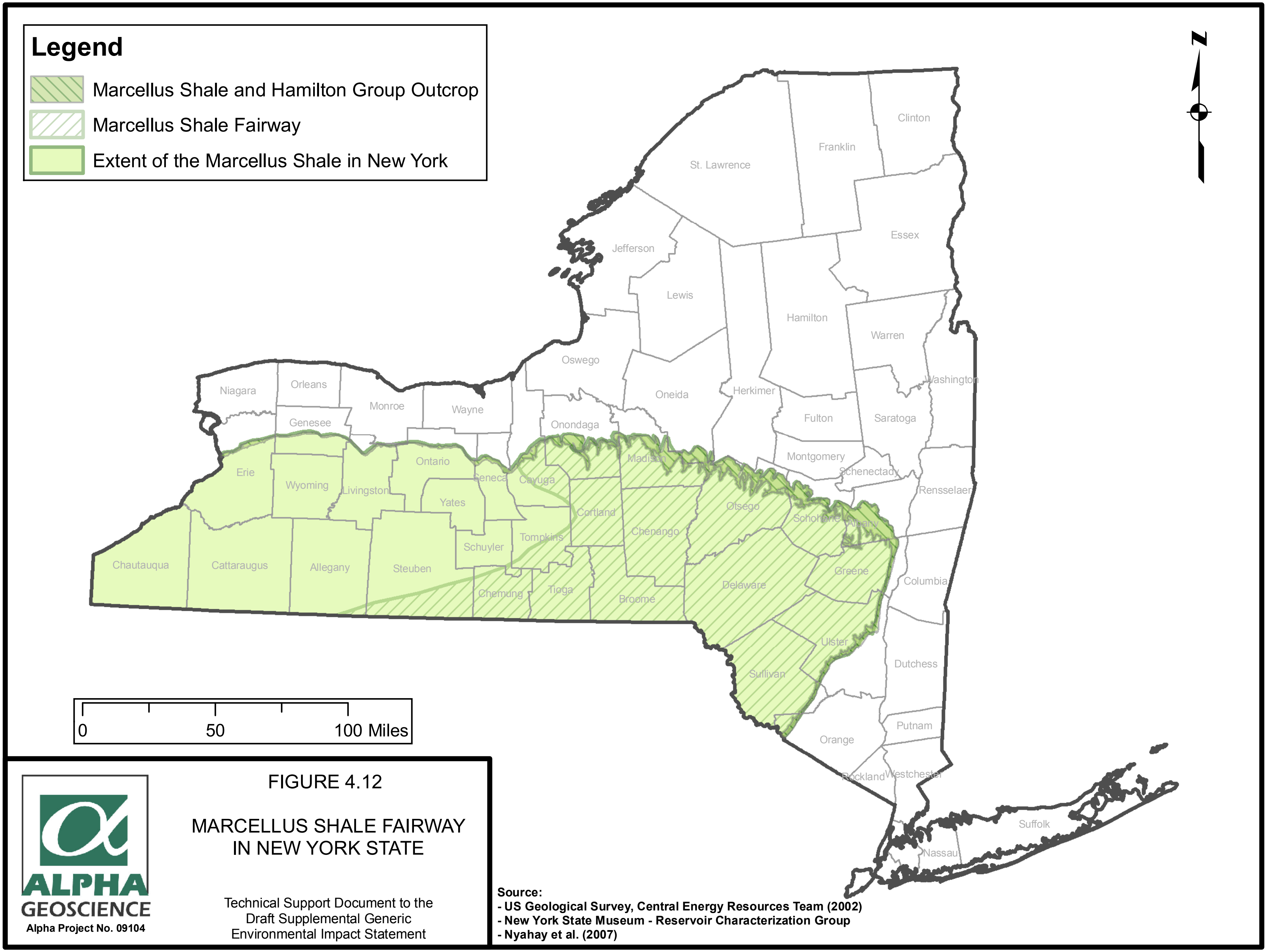

FIGURE 4.12

MARCELLUS SHALE FAIRWAY IN NEW YORK STATE

Technical Support Document to the Draft Supplemental Generic Environmental Impact Statement

Source:
- **US Geological Survey, Central Energy Resources Team (2002)**
- **New York State Museum - Reservoir Characterization Group**
- **Nyahay et al. (2007)**

In 2011, the USGS estimated a mean of 84.2 Tcf of technically recoverable undiscovered natural gas reserves in the Marcellus Shale in the Appalachian Basin, more than a 40-fold increase from its 2002 estimate of 1.9 Tcf. Engelder had previously estimated a 50% probability that 489 Tcf of gas would be produced basin-wide from the Marcellus after a 50-year decline, and assigned 71.9 Tcf of that total to 17 counties in New York.34 Engelder's basin-wide estimate appears to include both proven and undiscovered reserves. While Engelder's methodology is based on both geology and published information about initial production rates and production decline from actual wells in Pennsylvania, the USGS describes its approach as based on recognized geologic characteristics of the formation. There is insufficient information available to determine the validity of comparing these projections, but it is common for projections of these types to vary, as a function of the prevailing technologies and knowledge base associated with a given resource.

4.5 Seismicity in New York State

4.5.1 Background

The term "earthquake" is used to describe any event that is the result of a sudden release of energy in the earth's crust that generates seismic waves. Many earthquakes are too minor to be detected without sensitive equipment. Large earthquakes result in ground shaking and sometimes displacing the ground surface. Earthquakes are caused mainly by movement along geological faults, but also may result from volcanic activity and landslides. An earthquake's point of origin is called its focus or hypocenter. The term epicenter refers to the point at the ground surface directly above the hypocenter.

Geologic faults are fractures along which rocks on opposing sides have been displaced relative to each other. The amount of displacement may be small (centimeters) or large (kilometers). Geologic faults are prevalent and typically are active along tectonic plate boundaries. One of the most well known plate boundary faults is the San Andreas fault zone in California. Faults also occur across the rest of the U.S., including mid-continent and non-plate boundary areas, such as

[34] Engelder, 2009.

the New Madrid fault zone in the Mississippi Valley, or the Ramapo fault system in southeastern New York and eastern Pennsylvania.

Figure 4.13 shows the locations of faults and other structures that may indicate the presence of buried faults in New York State.[35] There is a high concentration of structures in eastern New York along the Taconic Mountains and the Champlain Valley that resulted from the intense thrusting and continental collisions during the Taconic and Allegheny orogenies that occurred 350 to 500 million years ago.[36] There is also a high concentration of faults along the Hudson River Valley. More recent faults in northern New York were formed as a result of the uplift of the Adirondack Mountains approximately 5 to 50 million years ago.

4.5.2 Seismic Risk Zones

The USGS Earthquake Hazard Program has produced the National Hazard Maps showing the distribution of earthquake shaking levels that have a certain probability of occurring in the United States. The maps were created by incorporating geologic, geodetic and historic seismic data, and information on earthquake rates and associated ground shaking. These maps are used by others to develop and update building codes and to establish construction requirements for public safety.

New York State is not associated with a major fault along a tectonic boundary like the San Andreas, but seismic events are common in New York. Figure 4.14 shows the seismic hazard map for New York State.[37] The map shows levels of horizontal shaking, in terms of percent of the gravitational acceleration constant (%g) that is associated with a 2 in 100 (2%) probability of occurring during a 50-year period.[38] Much of the Marcellus and Utica Shales underlie portions of the state with the lowest seismic hazard class rating in New York (2% probability of exceeding 4 to 8 %g in a 50-year period). The areas around New York City, Buffalo, and northern-most New York have a moderate to high seismic hazard class ratings (2% probability of exceeding 12 to 40 %g in a 50-year period).

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[35] Alpha, 2009, p. 138.

[36] Alpha, 2009, p. 138.

[37] Alpha, 2009, p. 139.

[38] Alpha, 2009, p. 139.

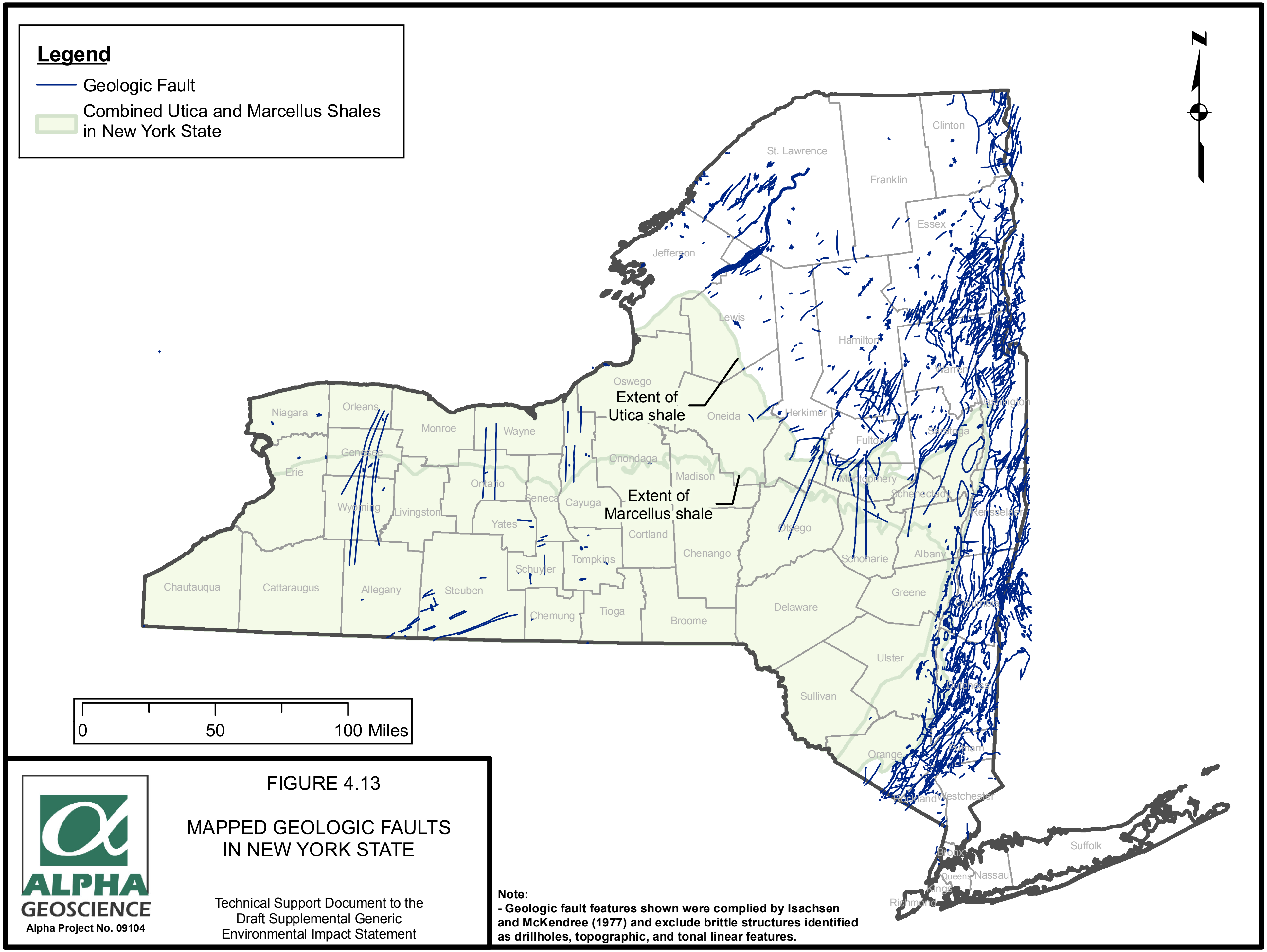

FIGURE 4.13

MAPPED GEOLOGIC FAULTS IN NEW YORK STATE

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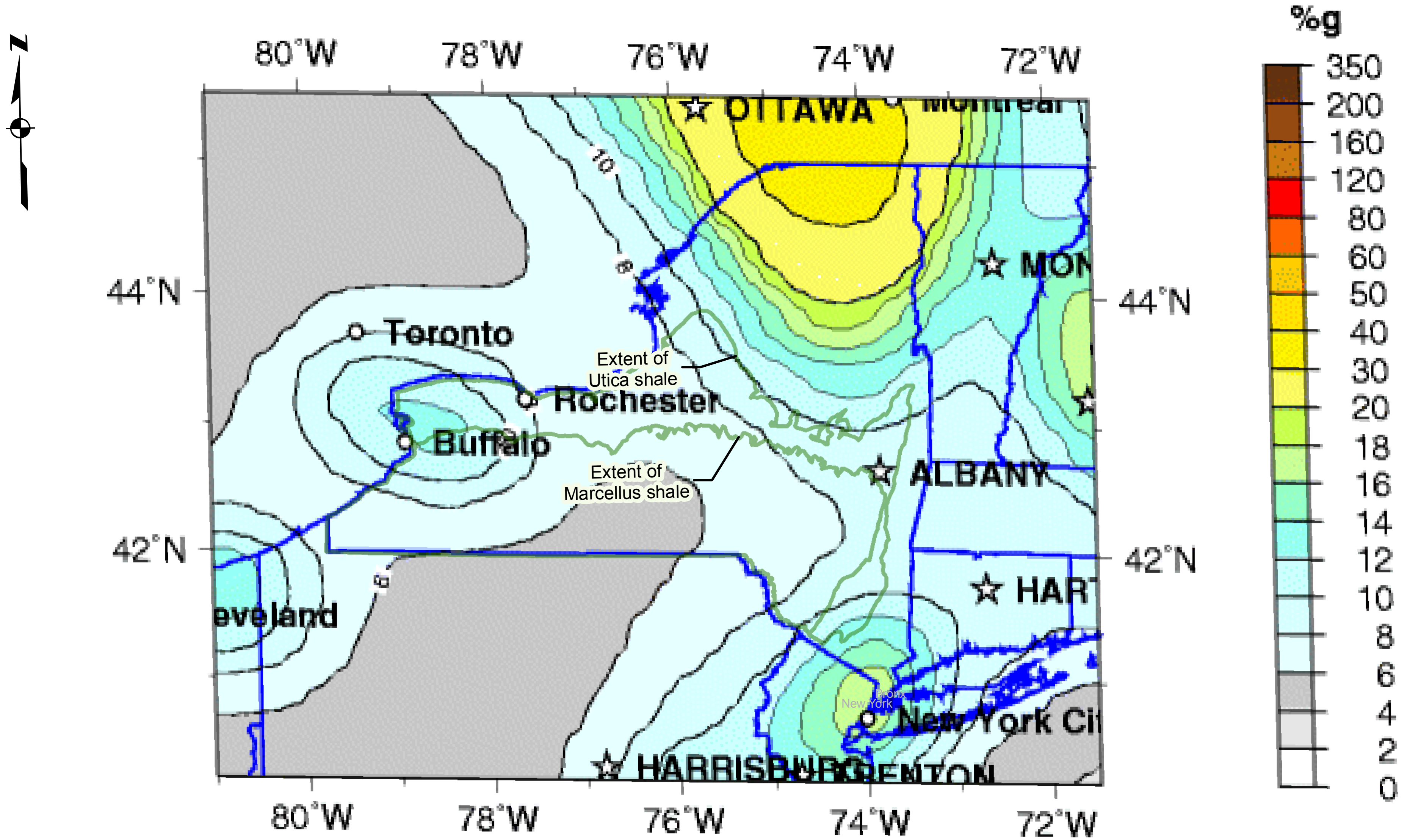
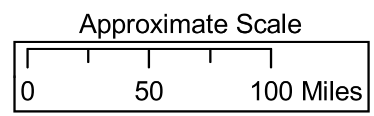
Note:

- Geologic fault features shown were complied by Isachsen and McKendree (1977) and exclude brittle structures identified as drillholes, topographic, and tonal linear features.





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GEOSCIENCE
Alpha Project No. 09104

FIGURE 4.14

NEW YORK STATE
SEISMIC HAZARD MAP

Technical Support Document to the
Draft Supplemental Generic
Environmental Impact Statement

Notes:
- Map shows peak acceleration (%g) with 2% probability of exceedence in 50 years.
- Source - USGS National Seismic Hazard Maps (2008).

4.5.3 Seismic Damage – Modified Mercalli Intensity Scale

There are several scales by which the magnitude and the intensity of a seismic event are reported. The Richter magnitude scale was developed in 1935 to measure of the amount of energy released during an earthquake. The moment magnitude scale (MMS) was developed in the 1970s to address shortcomings of the Richter scale, which does not accurately calculate the magnitude of earthquakes that are large (greater than 7) or distant (measured at a distance greater than 250 miles away). Both scales report approximately the same magnitude for earthquakes with a magnitude less than 7 and both scales are logarithmic; an increase of two units of magnitude on the Richter scale corresponds to a 1,000-fold increase in the amount of energy released.

The MMS measures the size of a seismic event based on the amount of energy released. Moment is a representative measure of seismic strength for all sizes of events and is independent of recording instrumentation or location. Unlike the Richter scale, the MMS has no limits to the possible measurable magnitudes, and the MMS relates the moments to the Richter scale for continuity. The MMS also can represent microseisms (very small seismicity) with negative numbers.

The Modified Mercalli (MM) Intensity Scale was developed in 1931 to report the intensity of an earthquake. The Mercalli scale is an arbitrary ranking based on observed effects and not on a mathematical formula. This scale uses a series of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, as summarized in Table 4.1. Table 4.1 compares the MM intensity scale to magnitudes of the MMS, based on typical events as measured near the epicenter of a seismic event. There is no direct conversion between the intensity and magnitude scales because earthquakes of similar magnitudes can cause varying levels of observed intensities depending on factors such location, rock type, and depth.

4.5.4 Seismic Events

Table 4.2 summarizes the recorded seismic events in New York State by county between December 1970 and July 2009.[39] There were a total of 813 seismic events recorded in New York

[39] Alpha, 2009, p. 140.

State during that period. The magnitudes of 24 of the 813 events were equal to or greater than 3.0. Magnitude 3 or lower earthquakes are mostly imperceptible and are usually detectable only with sensitive equipment. The largest seismic event during the period 1970 through 2009 is a 5.3 magnitude earthquake that occurred on April 20, 2002, near Plattsburgh, Clinton County.[40] Damaging earthquakes have been recorded since Europeans settled New York in the 1600s. The largest earthquake ever measured and recorded in New York State was a magnitude 5.8 event that occurred on September 5, 1944, near Massena, New York.[41]

[40] Alpha, 2009, p. 140.

[41] Alpha, 2009, p. 140.

Table 4.1
Modified Mercalli Intensity Scale

Modified Mercalli Intensity	Description	Effects	Typical Maximum Moment Magnitude
I	Instrumental	Not felt except by a very few under especially favorable conditions.	1.0 to 3.0
II	Feeble	Felt only by a few persons at rest, especially on upper floors of buildings.	3.0 to 3.9
III	Slight	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.	
IV	Moderate	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	4.0 to 4.9
V	Rather Strong	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	5.0 to 5.9
VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	
VIII	Destructive	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	6.0 to 6.9
IX	Ruinous	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	
X	Disastrous	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	7.0 and higher
XI	Very Disastrous	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.	
XII	Catastrophic	Damage total. Lines of sight and level are distorted. Objects thrown into the air.	

The above table compares the Modified Mercalli intensity scale and moment magnitude scales that typically observed near the epicenter of a seismic event.

Source: USGS Earthquake Hazard Program (http://earthquake.usgs.gov/learning/topics/mag_vs_int.php)

Table 4.2
Summary of Seismic Events in New York State
December 1970 through July 2009

County	Magnitude					Total
	< 2.0	2.0 to 2.9	3.0 to 3.9	4.0 to 4.9	5.0 to 5.3	
Counties Overlying Utica and Marcellus Shales						
Albany	27	20	3	0	0	50
Allegany	0	0	0	0	0	0
Broome	0	0	0	0	0	0
Cattaraugus	0	0	0	0	0	0
Cayuga	0	0	0	0	0	0
Chautauqua	0	0	0	0	0	0
Chemung	0	0	0	0	0	0
Chenango	0	0	0	0	0	0
Cortland	0	0	0	0	0	0
Delaware	1	2	0	0	0	3
Erie	7	5	0	0	0	12
Genesee	3	5	0	0	0	8
Greene	2	1	0	0	0	3
Livingston	1	5	1	0	0	7
Madison	0	0	0	0	0	0
Montgomery	1	2	0	0	0	3
Niagara	7	3	0	0	0	10
Onondaga	0	0	0	0	0	0
Ontario	1	1	0	0	0	2
Otsego	0	0	0	0	0	0
Schoharie	2	4	0	1	0	7
Schuyler	0	0	0	0	0	0
Seneca	0	0	0	0	0	0
Steuben	2	0	1	0	0	3
Sullivan	0	0	0	0	0	0
Tioga	0	0	0	0	0	0
Tompkins	0	0	0	0	0	0
Wyoming	8	5	0	0	0	13
Yates	1	0	0	0	0	1
Subtotal	*63*	*53*	*5*	*1*	*0*	*122*
Counties Overlying Utica Shale						
Fulton	1	2	1	0	0	4
Herkimer	4	3	0	0	0	7
Jefferson	5	3	0	0	0	8
Lewis	3	0	2	0	0	5
Monroe	1	0	0	0	0	1
Oneida	3	4	0	0	0	7
Orange	14	5	0	0	0	19
Orleans	0	0	0	0	0	0
Oswego	2	0	0	0	0	2
Saratoga	1	2	0	0	0	3
Schenectady	1	1	0	0	0	2
Wayne	0	0	0	0	0	0
Subtotal	*35*	*20*	*3*	*0*	*0*	*58*

Table 4.2
Summary of Seismic Events in New York State
December 1970 through July 2009

County	Magnitude					Total
	< 2.0	2.0 to 2.9	3.0 to 3.9	4.0 to 4.9	5.0 to 5.3	
Counties Not Overlying Utica or Marcellus Shales						
Bronx	0	0	0	0	0	0
Clinton	60	30	5	0	1	96
Columbia	0	0	0	0	0	0
Dutchess	6	4	2	0	0	12
Essex	88	64	4	1	1	158
Franklin	40	19	3	0	0	62
Hamilton	53	10	0	0	0	63
Kings	0	0	0	0	0	0
Nassau	1	0	0	0	0	1
New York	3	2	0	0	0	5
Putnam	4	2	0	0	0	6
Queens	0	0	0	0	0	0
Rensselaer	1	0	0	0	0	1
Richmond	0	0	0	0	0	0
Rockland	15	3	0	0	0	18
St. Lawrence	84	29	0	0	0	113
Suffolk	0	0	0	0	0	0
Ulster	3	0	0	0	0	3
Warren	11	5	1	0	0	17
Washington	1	3	0	0	0	4
Westchester	61	11	1	1	0	74
Subtotal	*431*	*182*	*16*	*2*	*2*	*633*
New York State Total	***529***	***255***	***24***	***3***	***2***	***813***

Notes:
- Seismic events recorded December 13, 1970 through July 28, 2009.
- Lamont-Doherty Cooperative Seismographic Network, 2009

Figure 4.15 shows the distribution of recorded seismic events in New York State. The majority of the events occur in the Adirondack Mountains and along the New York-Quebec border. A total of 180 of the 813 seismic events shown on Table 4.2 and Figure 4.15 during a period of 39 years (1970–2009) occurred in the area of New York that is underlain by the Marcellus and/or the Utica Shales. The magnitude of 171 of the 180 events was less than 3.0. The distribution of seismic events on Figure 4.15 is consistent with the distribution of fault structures (Figure 4.13) and the seismic hazard risk map (Figure 4.14).

Induced seismicity refers to seismic events triggered by human activity such as mine blasts, nuclear experiments, and fluid injection, including hydraulic fracturing.[42] Induced seismic waves (seismic refraction and seismic reflection) also are a common tool used in geophysical surveys for geologic exploration. The surveys are used to investigate the subsurface for a wide range of purposes including landfill siting; foundations for roads, bridges, dams and buildings; oil and gas exploration; mineral prospecting; and building foundations. Methods of inducing seismic waves range from manually striking the ground with weight to setting off controlled blasts.

Hydraulic fracturing releases energy during the fracturing process at a level substantially below that of small, naturally occurring, earthquakes. However, some of the seismic events shown on Figure 4.15 are known or suspected to be triggered by other types of human activity. The 3.5 magnitude event recorded on March 12, 1994, in Livingston County is suspected to be the result of the collapse associated with the Retsof salt mine failure in Cuylerville, New York.[43] The 3.2 magnitude event recorded on February 3, 2001, was coincident with, and is suspected to have been triggered by, test injections for brine disposal at the New Avoca Natural Gas Storage (NANGS) facility in Steuben County. The cause of the event likely was the result of an extended period of fluid injection near an existing fault[44] for the purposes of siting a deep injection well. The injection for the NANGS project occurred numerous times with injection periods lasting 6 to 28 days and is substantially different than the short-duration, controlled injection used for hydraulic fracturing.

[42] Alpha, 2009, p. 138.

[43] Alpha, 2009, p. 141.

[44] Alpha, 2009, p. 141.

One additional incident suspected to be related to human activity occurred in late 1971 at Texas Brine Corporation's system of wells used for solution mining of brine near Dale, Wyoming County, New York (i.e., the Dale Brine Field). The well system consisted of a central, high pressure injection well (No. 11) and four peripheral brine recovery wells. The central injection well was hydraulically fractured in July 1971 without incident.

The well system was located in the immediate vicinity of the known, mapped, Clarendon-Linden fault zone which is oriented north-south, and extends south of Lake Ontario in Orleans, Genesee, Wyoming, and the northern end of Allegany Counties, New York. The Clarendon-Linden fault zone is not of the same magnitude, scale, or character as the plate boundary fault systems, but nonetheless has been the source of relatively small to moderate quakes in western New York (MCEER, 2009; and Fletcher and Sykes, 1977).

Fluids were injected at well No. 11 from August 3 through October 8, and from October 16 through November 9, 1971. Injections were ceased on November 9, 1971 due to an increase in seismic activity in the area of the injection wells. A decrease in seismic activity occurred when the injections ceased. The tremors attributed to the injections reportedly were felt by residents in the immediate area.

Evaluation of the seismic activity associated with the Dale Brine Field was performed and published by researchers from the Lamont-Doherty Geological Observatory (Fletcher and Sykes, 1977). The evaluation concluded that fluids injected during solution mining activity were able to reach the Clarendon-Linden fault and that the increase of pore fluid pressure along the fault caused an increase in seismic activity. The research states that "the largest earthquake … that appears to be associated with the brine field…" was 1.4 in magnitude. In comparison, the magnitude of the largest natural quake along the Clarendon-Linden fault system through 1977 was magnitude 2.7, measured in 1973. Similar solution mining well operations in later years located further from the fault system than the Dale Brine Field wells did not create an increase in seismic activity.

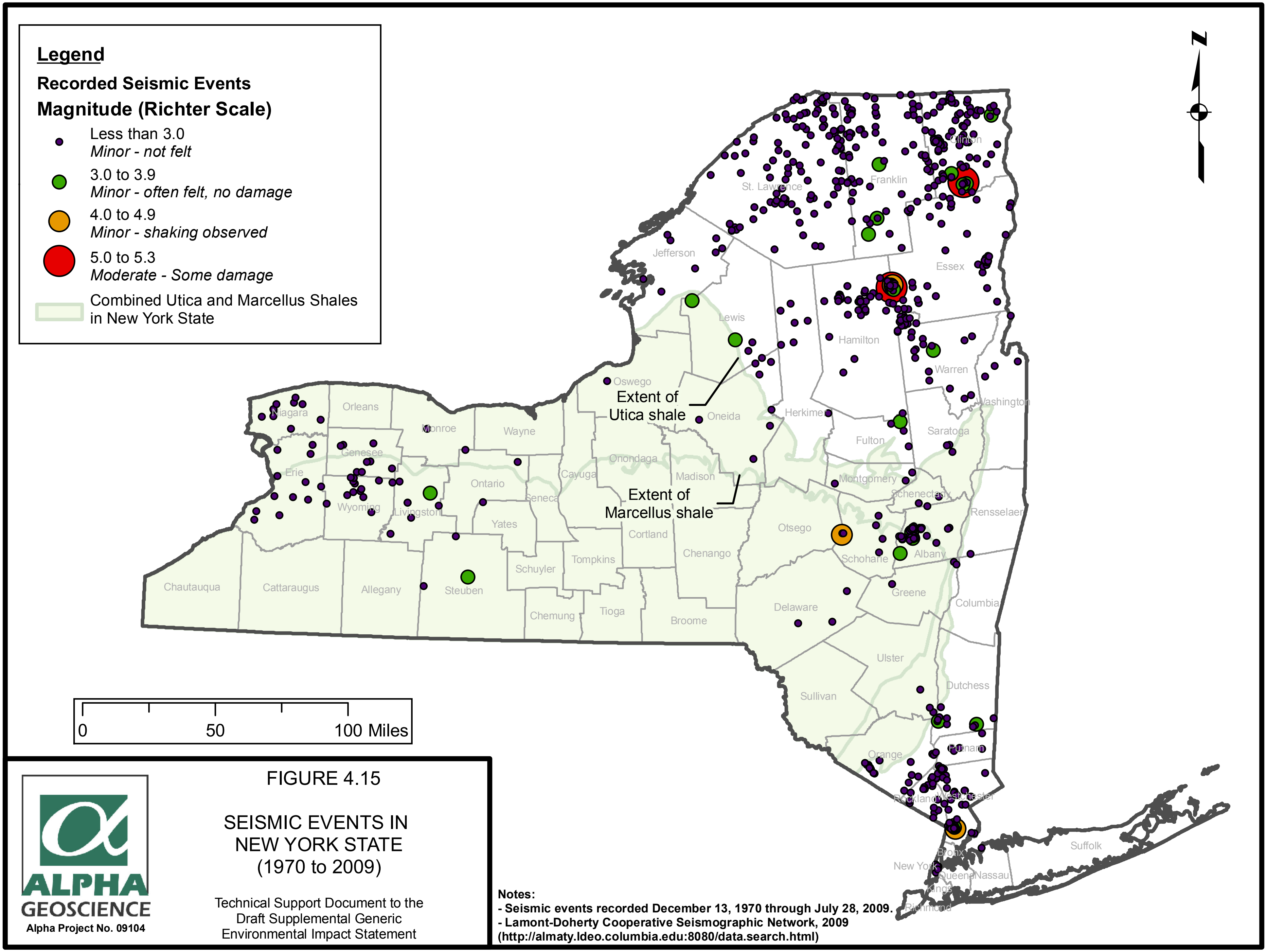

FIGURE 4.15

SEISMIC EVENTS IN NEW YORK STATE (1970 to 2009)

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Notes:
- Seismic events recorded December 13, 1970 through July 28, 2009.
- Lamont-Doherty Cooperative Seismographic Network, 2009 (http://almaty.ldeo.columbia.edu:8080/data.search.html)

4.5.5 Monitoring Systems in New York

Seismicity in New York is monitored by both the US Geological Survey (USGS) and the Lamont-Doherty Cooperative Seismographic Network (LCSN). The LCSN is part of the USGS's Advanced National Seismic System (ANSS) which provides current information on seismic events across the country. Other ANSS stations are located in Binghamton and Lake Ozonia, New York. The New York State Museum also operates a seismic monitoring station in the Cultural Education Center in Albany, New York.

As part of the ANSS, the LCSN monitors earthquakes that occur primarily in the northeastern United States and coordinates and manages data from 40 seismographic stations in seven states, including Connecticut, Delaware, Maryland, New Jersey, New York, Pennsylvania, and Vermont.[45] Member organizations that operate LCSN stations include two secondary schools, two environmental research and education centers, three state geological surveys, a museum dedicated to Earth system history, two public places (Central Park, NYC, and Howe Caverns, Cobleskill), three two-year colleges, and 15 four-year universities.[46]

4.6 Naturally Occurring Radioactive Materials (NORM) in Marcellus Shale

NORM is present to varying degrees in virtually all environmental media, including rocks and soils. As mentioned above, black shale typically contains trace levels of uranium and gamma ray logs indicate that this is true of the Marcellus Shale. The Marcellus is known to contain concentrations of NORM such as uranium-238 and radium-226 at higher levels than surrounding rock formations. Normal disturbance of NORM-bearing rock formations by activities such as mining or drilling do not generally pose a threat to workers, the general public or the environment. However, activities having the potential to concentrate NORM need to come under regulatory oversight to ensure adequate protection of workers, the general public and the environment.

Chapter 5 includes radiological information (sampling results) from environmental media at various locations in the Appalachian Basin. Radiological data for the Marcellus in New York were derived from: a) drill cuttings and core samples from wells drilled through or completed in

[45] Alpha, 2009, p. 142.

[46] Alpha, 2009, p. 143.

the Marcellus; and b) production brine from vertical wells completed in the Marcellus. Radiological data for the Marcellus in Pennsylvania and West Virginia were derived from: a) drill cuttings from wells completed in the Marcellus in Pennsylvania; and b) flowback water analyses provided by operators of wells in Pennsylvania and West Virginia. Chapter 6 includes a discussion of potential impacts associated with radioactivity in the Marcellus Shale. Chapter 7 details mitigation measures, including existing regulatory programs, proposed well permit conditions, and proposed future data collection and analysis.

4.7 Naturally-Occurring Methane in New York State

The presence of naturally-occurring methane in ground seeps and water wells is well documented throughout New York State. Naturally-occurring methane can be attributed to swampy areas or where bedrock and unconsolidated aquifers overlie Devonian-age shales or other gas-bearing formations. The highly fractured Devonian shale formations found throughout western New York are particularly well known for shallow methane accumulations. In his 1966 report on the Jamestown Aquifer, Crain explained that natural gas could occur in any water well in the area "which ends in bedrock or in unconsolidated deposits overlain by fine-grained confining material. Depth is not of primary importance because pockets of gas may occur in the bedrock at nearly any depth."[47] Upper Devonian gas bearing rocks at or near the surface extend across the southern tier of New York from Chautauqua and Erie Counties, east to Delaware and Sullivan counties (Figure 4.16).

As noted below, early explorers and water well drillers in New York reported naturally occurring methane in regions not then associated with natural gas well drilling activity. "Methane can occur naturally in water wells and when it does, it presents unique problems for water well drilling contractors. The major concern relates to flammable and explosive hazards associated with methane."[48] Gas that occurs naturally in shallow bedrock and unconsolidated sediments has been known to seep to the surface and/or contaminate water supplies including water wells. Often landowners are not aware of the presence of methane in their well. Methane is a colorless,

[47] NYSDEC, 1992, GEIS, p. 10-6.

[48] Keech, D. et al, 1982, pp. 33-36.

odorless gas, and is generally considered non-toxic but there could be an explosive hazard if gas is present in significant volumes and the water well is not properly vented.

The existence of naturally occurring methane seeps in New York has been known since the mid 1600s. In August 1669 Rene Robert Cavelier de la Salle and Rene de Brehant de Galinee, while on their way to explore the Mississippi Valley, arrived in the Bristol Hills area of Ontario County, New York. It was here where the explorers observed natural gas flowing from joint planes in the Penn Yan Shale (Upper Devonian) at the foot of a falls over the Genundewa Limestone.[49] More recent studies and investigations have provided other evidence of naturally occurring methane in eastern New York. A private well in Schenectady County was gaged at 158 MMcf/d of natural gas by the Department in 1965. The well provided natural gas for the owner's domestic use for 30 years.[50] In 1987 the Times Union reported that contaminants, including methane, were found in well water in the Orchard Park subdivision near New Scotland, Albany County. Engineers from the Department reported the methane as "natural occurrences found in shale bedrock deposits beneath the development."[51] Ten years later, in 1997, a Saratoga Lake couple disclosed to a news reporter the presence of methane gas in their water well. The concentration of gas in the well water was concentrated enough for the owners to ignite the gas from the bathtub faucet.[52] According to a September 22, 2010 article in the Daily Gazette, water wells in the Brown Road subdivision, Saratoga County became contaminated with methane gas when water wells were "blasted" (fractured) to reach a greater supply of water.[53]

Methane contamination of groundwater is often mistakenly attributed to or blamed on natural gas well drilling and hydraulic fracturing. There are a number of other, more common, reasons that well water can display sudden changes in quality and quantity. Seasonal variations in recharge, stress on the aquifer from usage demand, and mechanical failures are some factors that could lead to degradation of well water.

[49] Wells, J. 1963.

[50] Kucewicz, J. 1997.

[51] Thurman, K. 1987.

[52] Kruse, M. 1997.

[53] Bowen, K. 2010.

Recently, as part of two separate complaint investigations in the towns of Elmira and Collins, New York, the Department documented that methane gas existed in the shallow aquifers at the two sites long before and prior to the exploration and development for natural gas[54, 55]. The comprehensive investigations included the following:

- Analysis of drilling and completion records of natural gas wells drilled near the water wells;
- Evaluation of well logs to ascertain cement integrity;
- Collection of gas samples for compositional analysis;
- Inspections of the water and natural gas wells; and
- Interviews with landowners and water well drillers.

Both investigations provided clear evidence that methane contamination was present in the area's water wells prior to the commencement of natural gas drilling operations.

Drilling and construction activities may have an adverse impact on groundwater resources. The migration of methane can contaminate well water supplies if well construction practices designed to prevent gas migration are not adhered to. Chapter 6 discusses these potential impacts with mitigation measures addressed in Chapter 7.

In April 2011 researchers from Duke University (Duke) released a report on the occurrence of methane contamination of drinking water associated with Marcellus and Utica Shale gas development.[56] As part of their study, the authors analyzed groundwater from nine drinking water wells completed in the Genesee Group in Otsego County, New York for the presence of methane. Of the nine wells, Duke classified one well as being in an active gas extraction area (i.e., a gas well within 1 kilometer (km) of the water well), and the remaining eight in a non-active gas extraction area. The analysis showed minimal amounts of methane in this sample group, with concentrations significantly below the minimum methane action level (10 mg/L) to

[54] NYSDEC, 2011.

[55] NYSDEC, 2011.

[56] Osborne, S. et al, 2011.

maintain the safety of structures and the public, as recommended by the U.S. Department of the Interior, Office of Surface Mining.[57] The water well located in the active gas extraction area had 5 to 10 times less methane than the wells located in the inactive areas.

The Department monitors groundwater conditions in New York as part of an ongoing cooperative project between the USGS and the Department's Division of Water (DOW).[58] The objectives of this program are to assess and report on the ambient ground-water quality of bedrock and glacial-drift aquifers throughout New York State. In 2010 water samples were collected from 46 drinking water wells in the Delaware, Genesee, and St. Lawrence River Basins. All samples were analyzed for dissolved methane gas using standard USGS protocols. The highest methane concentration from all samples analyzed was 22.4 mg/L from a well in Schoharie County; the average detected value was 0.79 mg/L.[59] These groundwater results confirm that methane migration to shallow aquifers is a natural phenomenon and can be expected to occur in active and non-active natural gas drilling areas.

[57] Eltschlager, K. et al, 2001.

[58] http://www.dec.ny.gov/lands/36117.html.

[59] NYSDEC, 2011.

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New York State

DEC

Chapter 5

Natural Gas Development Activities & High–Volume Hydraulic Fracturing

Revised Draft
Supplemental Generic Environmental Impact Statement

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Chapter 5 - Natural Gas Development Activities & High-Volume Hydraulic Fracturing

FIGURES

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Chapter 5 NATURAL GAS DEVELOPMENT ACTIVITIES & HIGH-VOLUME HYDRAULIC FRACTURING

As noted in the 1992 GEIS, New York has a long history of natural gas production. The first gas well was drilled in 1821 in Fredonia, and the 40 Bcf of gas produced in 1938 remained the production peak until 2004 when 46.90 Bcf were produced. Annual production exceeded 50 Bcf from 2005 through 2008, dropping to 44.86 Bcf in 2009 and 35.67 Bcf in 2010. Chapters 9 and 10 of the 1992 GEIS comprehensively discuss well drilling, completion and production operations, including potential environmental impacts and mitigation measures. The history of hydrocarbon development in New York through 1988 is also covered in the 1992 GEIS.

New York counties with actively producing gas wells reported in 2010 were: Allegany, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Erie, Genesee, Livingston, Madison, Niagara, Ontario, Oswego, Schuyler, Seneca, Steuben, Tioga, Wayne, Wyoming and Yates.

Hydraulic fracturing is a well stimulation technique which consists of pumping a fluid and a proppant such as sand down the wellbore under high pressure to create fractures in the hydrocarbon-bearing rock. No blast or explosion is created by the hydraulic fracturing process. The proppant holds the fractures open, allowing hydrocarbons to flow into the wellbore after injected fluids are recovered. Hydraulic fracturing technology was first developed in the late 1940s and, accordingly, it was addressed in the 1992 GEIS. It is estimated that as many as 90% of wells drilled in New York are hydraulically fractured. ICF International provides the following history:[1]

Hydraulic Fracturing Technological Milestones [2]	
Early 1900s	Natural gas extracted from shale wells. Vertical wells fractured with foam.
1983	First gas well drilled in Barnett Shale in Texas
1980-1990s	Cross-linked gel fracturing fluids developed and used in vertical wells
1991	First horizontal well drilled in Barnett Shale
1991	Orientation of induced fractures identified
1996	Slickwater fracturing fluids introduced
1996	Microseismic post-fracturing mapping developed
1998	Slickwater refracturing of originally gel-fractured wells
2002	Multi-stage slickwater fracturing of horizontal wells
2003	First hydraulic fracturing of Marcellus Shale[3]
2005	Increased emphasis on improving the recovery factor
2007	Use of multi-well pads and cluster drilling

[1] ICF Task 1, 2009, p. 3.

[2] Matthews, 2008, as cited by ICF Task 1, 2009, p. 3.

[3] Harper, 2008, as cited by ICF Task 1, 2009, p. 3.

5.1 Land Disturbance

Land disturbance directly associated with high-volume hydraulic fracturing will consist primarily of constructed gravel access roads, well pads and utility corridors. According to the most recent industry estimates, the average total disturbance associated with a multi-well pad, including incremental portions of access roads and utility corridors, during the drilling and fracturing stage is estimated at 7.4 acres and the average total disturbance associated with a well pad for a single vertical well during the drilling and fracturing stage is estimated at 4.8 acres. As a result of required partial reclamation, this would generally be reduced to averages of about 5.5 acres and 4.5 acres, respectively, during the production phase. These estimates include access roads to the well pads and incremental portions of utility corridors including gathering lines and compressor facilities, and the access roads associated with compressor facilities. These associated roads and facilities are projected to account for, on average, about 3.95 acres of the land area associated with each pad for the life of the wells. During the long-term production phase, a multi-well pad itself would occupy about 1.5 acres, while a well pad for a single vertical well would occupy about 0.5 acre.[4,5]

5.1.1 Access Roads

The first step in developing a natural gas well site is to construct the access road and well pad. For environmental review and permitting purposes, the acreage and disturbance associated with the access road is considered part of the project as described by Topical Response #4 in the 1992 GEIS. However, instead of one well per access road as was typically the case when the GEIS was prepared, most shale gas development will consist of several wells on a multi-well pad serviced by a single access road. Therefore, in areas developed by horizontal drilling using multi-well pads, fewer access roads as a function of the number of wells will be needed. Industry estimates that 90% of the wells used to develop the Marcellus Shale will be horizontal wells located on multi-well pads.[6]

Access road construction involves clearing the route and preparing the surface for movement of heavy equipment, or reconstruction or improvement of existing roads if present on the property

[4] ALL Consulting, 2010, pp. 14 – 15.

[5] Cornue, 2011.

[6] ALL Consulting, 2010, pp. 7 – 15.

being developed. Ground surface preparation for new roads typically involves staking, grading, stripping and stockpiling of topsoil reserves, then placing a layer of crushed stone, gravel, or cobbles over geotextile fabric. Sedimentation and erosion control features are also constructed as needed along the access roads and culverts may be placed across ditches at the entrance from the main highway or in low spots along the road.

The size of the access road is dictated by the size of equipment to be transported to the well site, distance of the well pad from an existing road and the route dictated by property access rights and environmental concerns. The route selected may not be the shortest distance to the nearest main road. Routes for access roads may be selected to make use of existing roads on a property and to avoid disturbing environmentally sensitive areas such as protected streams, wetlands, or steep slopes. Property access rights and agreements and traffic restrictions on local roads may also limit the location of access routes.

Access road widths would generally range from 20 to 40 feet during the drilling and fracturing phase and from 10 to 20 feet during the production phase. During the construction and drilling phase, additional access road width is necessary to accommodate stockpiled topsoil and excavated material along the roadway and to construct sedimentation and erosion control features such as berms, ditches, sediment traps or sumps, or silt fencing along the length of the access road.

Each 150 feet of a 30-foot wide access road adds about one-tenth of an acre to the total surface acreage disturbance attributed to the well site. Industry estimates an average access road size of 0.27 acre,[7] which would imply an average length of about 400 feet for a 30-foot wide road. Permit applications for horizontal Marcellus wells received by the Department prior to publication of the 2009 draft SGEIS indicated road lengths ranging from 130 feet to approximately 3,000 feet.

Photos 5.1 – 5.4 depict typical wellsite access roads.

[7] Cornue, 2011.

Photo 5.1 Access road and erosion/sedimentation controls, Salo 1, Barton, Tioga County NY. Photo taken during drilling phase. This access road is approximately 1,400 feet long. Road width averages 22 feet wide, 28 feet wide at creek crossing (foreground). Width including drainage ditches is approximately 27 feet.
Source: NYS DEC 2007.

Photo 5.2 Nornew, Smyrna Hillbillies #2H, access road, Smyrna, Madison County NY. Photo taken during drilling phase of improved existing private dirt road (approximately 0.8 miles long). Not visible in photo is an additional 0.6 mile of new access road construction. Operator added ditches, drainage, gravel & silt fence to existing dirt road.
The traveled part of the road surface in the picture is 12.5' wide; width including drainage ditches is approximately 27 feet. Portion of the road crossing a protected stream is approximately 20 feet wide. Source: NYS DEC 2008.

Photo 5.3 In-service access road to horizontal Marcellus well in Bradford County, PA. Source: Chesapeake Energy

Photo 5.4 Access road and sedimentation controls, Moss 1, Corning, Steuben County NY. Photo taken during post-drilling phase. Access road at the curb is approximately 50 feet wide, narrowing to 33 feet wide between curb and access gate. The traveled part of the access road ranges between 13 and 19 feet wide. Access road length is approximately 1,100 feet long.
Source: NYS DEC 2004.

5.1.2 *Well Pads*

Pad size is determined by site topography, number of wells and pattern layout, with consideration given to the ability to stage, move and locate needed drilling and hydraulic fracturing equipment. Location and design of pits, impoundments, tanks, hydraulic fracturing equipment, reduced emission completion equipment, dehydrators and production equipment such as separators, brine tanks and associated control monitoring, as well as office and vehicle parking requirements, can increase square footage. Mandated surface restrictions and setbacks may also impose additional acreage requirements. On the other hand, availability and access to offsite, centralized dehydrators, compressor stations and centralized water storage or handling facilities may reduce acreage requirements for individual well pads.[8]

The activities associated with the preparation of a well pad are similar for both vertical wells and multi-well pads where horizontal drilling and high volume hydraulic fracturing will be used.[9] Site preparation activities consist primarily of clearing and leveling an area of adequate size and preparing the surface to support movement of heavy equipment. As with access road construction, ground surface preparation typically involves staking, grading, stripping and stockpiling of topsoil reserves, then placing a layer of crushed stone, gravel, or cobbles over geotextile fabric. Site preparation also includes establishing erosion and sediment control structures around the site, and constructing pits for retention of drilling fluid and, possibly, fresh water.

Depending on site topography, part of a slope may be excavated and the excavated material may be used as fill (cut and fill) to extend the well pad, providing for a level working area and more room for equipment and onsite storage. The fill banks must be stabilized using appropriate sedimentation and control measures.

The primary difference in well pad preparation for a well where high-volume hydraulic fracturing will be employed versus a well described by the 1992 GEIS is that more land -is disturbed on a per-pad basis, though fewer pads should be needed overall.[10] A larger well pad is

[8] ICF Task 2, 2009, pp. 4-5.

[9] Alpha, 2009, p. 6-6.

[10] Alpha, 2009, p. 6-2.

required to accommodate fluid storage and equipment needs associated with the high-volume fracturing operations. In addition, some of the equipment associated with horizontal drilling has a larger surface footprint than the equipment described by the 1992 GEIS.

Industry estimates the average size of a multi-well pad for the drilling and fracturing phase of operations at 3.5 acres.[11] Average production pad size, after partial reclamation, is estimated at 1.5 acres for a multi-well pad.[12] Permit applications for horizontal wells received by the Department prior to publication of the 2009 draft SGEIS indicated multi-well pads ranging in size from 2.2 acres to 5.5 acres during the drilling and fracturing phase of operations, and from 0.5 to 2 acres after partial reclamation during the production phase.

The well pad sizes discussed above are consistent with published information regarding drilling operations in other shale formations, as researched by ICF International for NYSERDA.[13] For example, in an Environmental Assessment published for the Hornbuckle Field Horizontal Drilling Program (Wyoming), the well pad size required for drilling and completion operations is estimated at approximately 460 feet by 340 feet, or about 3.6 acres. This estimate does not include areas disturbed due to access road construction. A study of horizontal gas well sites constructed by SEECO, Inc. in the Fayetteville Shale reports that the operator generally clears 300 feet by 250 feet, or 1.72 acres, for its pad and reserve pits. Fayetteville Shale sites may be as large as 500 feet by 500 feet, or 5.7 acres.

Photos 5.5 – 5.7 depict typical Marcellus well pads, and Figure 5.1 is a schematic representation of a typical drilling site.

[11] Cornue, 2011.

[12] ALL Consulting, 2010, p. 15.

[13] ICF Task 2, 2009, p. 4.

Photo 5.5 Chesapeake Energy Marcellus well drilling, Bradford County, PA
Source: Chesapeake Energy

Photo 5.6 Hydraulic fracturing operation, horizontal Marcellus well, Upshur County, WV
Source: Chesapeake Energy, 2008

Photo 5.7 Hydraulic fracturing operation, horizontal Marcellus well, Bradford County, PA
Source: Chesapeake Energy, 2008

5.1.3 Utility Corridors

Utility corridors associated with high-volume hydraulic fracturing will include acreage used for potential water lines, above ground or underground electrical lines, gas gathering lines and compressor facilities, with average per-well pad acreage estimates as follows:

- 1.35 acres for water and electrical lines;
- 1.66 acres for gas gathering lines; and
- 0.67 acre for compression (because a compressor facility will service more than one well pad, this estimate is for an *incremental* portion assigned to a single well pad of a compressor facility and its associated sales line and access roads).[14]

Gathering lines may follow the access road associated with the well pad, so clearing and disturbance for the gathering line may be conducted during the initial site construction phase, thereby adding to the access road width. For example, some proposals include a 20-foot access road to the well pad with an additional 10-foot right-of-way for the gathering line.

Activities associated with constructing compressor facility pads are similar to those described above for well pads.

5.1.4 Well Pad Density

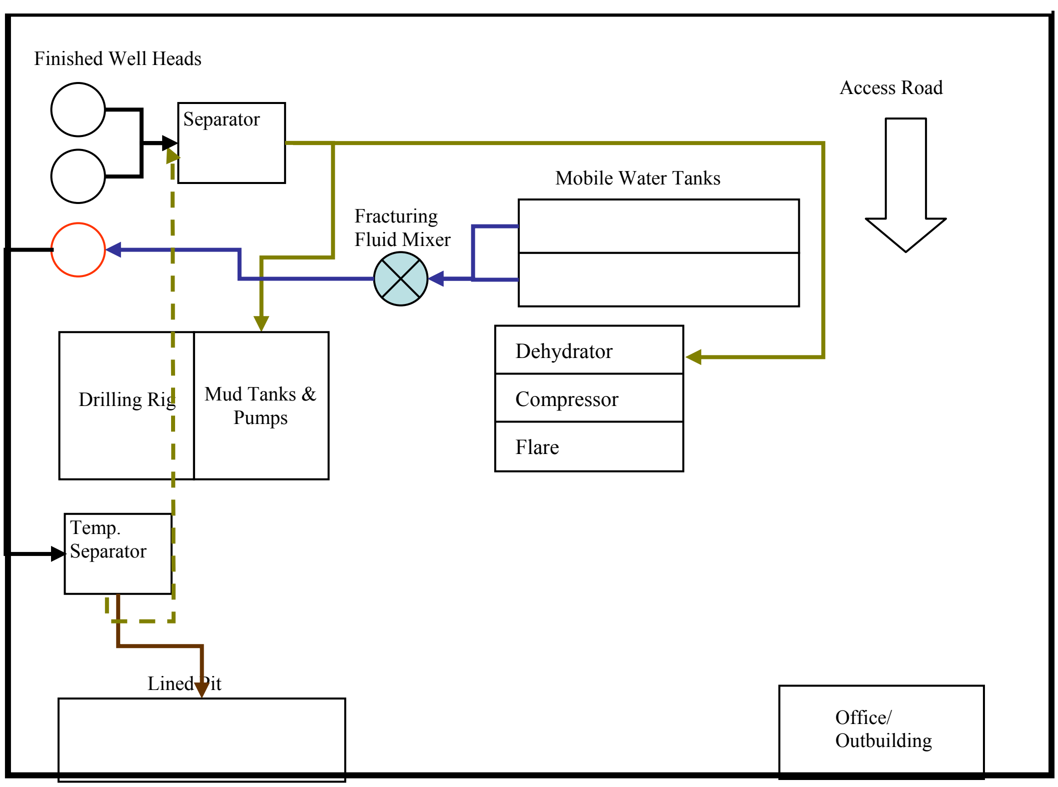
5.1.4.1 Historic Well Density

Well operators reported 6,732 producing natural gas wells in New York in 2010, approximately half of which (3,358) are in Chautauqua County. With 1,056 square miles of land in Chautauqua County, 3,358 reported producing wells equates to at least three producing wells per square mile. For the most part, these wells are at separate surface locations. Actual drilled density where the resource has been developed is somewhat greater than that, because not every well drilled is currently producing and some areas are not drilled. The Department issued 5,490 permits to drill in Chautauqua County between 1962 and June 30, 2011, or five permits per square mile. Of those permits, 62% (3,396) were issued during a 10-year period between 1975 and 1984, for an

[14] Cornue, 2011.

average rate of 340 permits per year in a single county. Again, most of these wells were drilled at separate surface locations, each with its own access road and attendant disturbance. Although the number of wells is lower, parts of Seneca and Cayuga County have also been densely drilled.   Many areas in all three counties – Chautauqua, Seneca and Cayuga – have been developed with "conventional" gas wells on 40-acre spacing (i.e., 16 wells per square mile, at separate surface locations). Therefore, while recognizing that some aspects of shale development activity will be different from what is described in the 1992 GEIS, it is worthwhile to note that this pre-1992 drilling rate and site density were part of the experience upon which the 1992 GEIS and its findings are based.

Figure 5.1 - Well Pad Schematic



Not to scale (As reported to NYSERDA by ICF International, derived from Argonne National Laboratory: EVS-Trip Report for Field Visit to Fayetteville Shale Gas Wells, plus expert judgment)

Photos 5.8 through 5.11 are photos and aerial views of existing well sites in Chautauqua County, provided for informational purposes. As discussed above, well pads where high-volume hydraulic fracturing will be employed will necessarily be larger in order to accommodate the associated equipment. In areas developed by horizontal drilling, well pads will be less densely spaced, reducing the number of access roads and gathering lines needed.

5.1.4.2 Anticipated Well Pad Density

The number of wells and well sites that may exist per square mile is dictated by gas reservoir geology and productivity, mineral rights distribution, and statutory well spacing requirements set forth in ECL Article 23, Title 5, as amended in 2008. The statute provides three statewide spacing options for shale wells, which are described below. Although the options include vertical drilling and single-well pad horizontal drilling, the Department anticipates that multi-well pad horizontal drilling (which results in the lowest density and least land disturbance) will be the predominant approach, for the following reasons:

- Industry estimates that 90% of the wells drilled to develop the Marcellus Shale will be horizontal wells on multi-well pads;[15]

- The addition to the ECL of provisions to address multi-well pad drilling was one of the primary objectives of the 2008 amendments, and was supported by the Department because of the reduced environmental impact;

- Multi-well pad drilling reduces operators' costs, by reducing the number of access roads and gathering lines that must be constructed as well as potentially reducing the number of equipment mobilizations; and

- Multi-well pad drilling reduces the number of regulatory hurdles for operators, because each well pad location would only need to be reviewed once for environmental concerns, stormwater permitting purposes and to determine conformance to SEQRA requirements, including the 1992 GEIS and the Final SGEIS.

[15] ALL Consulting, 2010, p. 7.

Vertical Wells

Statewide spacing for vertical shale wells provides for one well per 40-acre spacing unit.[16] This is the spacing requirement that has historically governed most gas well drilling in the State, and as mentioned above, many square miles of Chautauqua, Seneca and Cayuga counties have been developed on this spacing. One well per 40 acres equates to a density of 16 wells per square mile (i.e., 640 acres). Infill wells, resulting in more than one well per 40 acres, may be drilled upon justification to the Department that they are necessary to efficiently recover gas reserves. Gas well development on 40-acre spacing, with the possibility of infill wells, has been the prevalent gas well development method in New York for many decades. However, as reported by the Ground Water Protection Council,[17] economic and technological considerations favor the use of horizontal drilling for shale gas development. As explained below, horizontal drilling necessarily results in larger spacing units and reduced well pad density. Industry estimates that 10% of the wells drilled to develop shale resources by high-volume hydraulic fracturing will be vertical.[18]

[16] A spacing unit is the geographic area assigned to the well for the purposes of sharing costs and production. ECL §23-0501(2) requires that the applicant control the oil and gas rights for 60% of the acreage in a spacing unit for a permit to be issued. Uncontrolled acreage is addressed through the compulsory integration process set forth in ECL §23-0901(3).

[17] GPWC, April 2009, pp. 46-47.

[18] ALL Consulting, 2010, p. 7.

Natural Gas Wells in Chautauqua County

Year Permit Issued	Total
Pre-1962 (before permit program)	315
1962-1979	1,440
1980-1989	1,989
1990-1999	233
2000-2009	426
Grand Total	4,403

Photo 5.8 This map shows the locations of over 4,400 Medina formation natural gas wells in Chautauqua County from the Mineral Resources database. The wells were typically drilled on 40 to 80 acre well spacing, making the distance between wells at least 1/4 mile.

Readers can re-create this map by using the DEC on-line searchable database using County = Chautauqua and exporting the results to a Google Earth KML file.

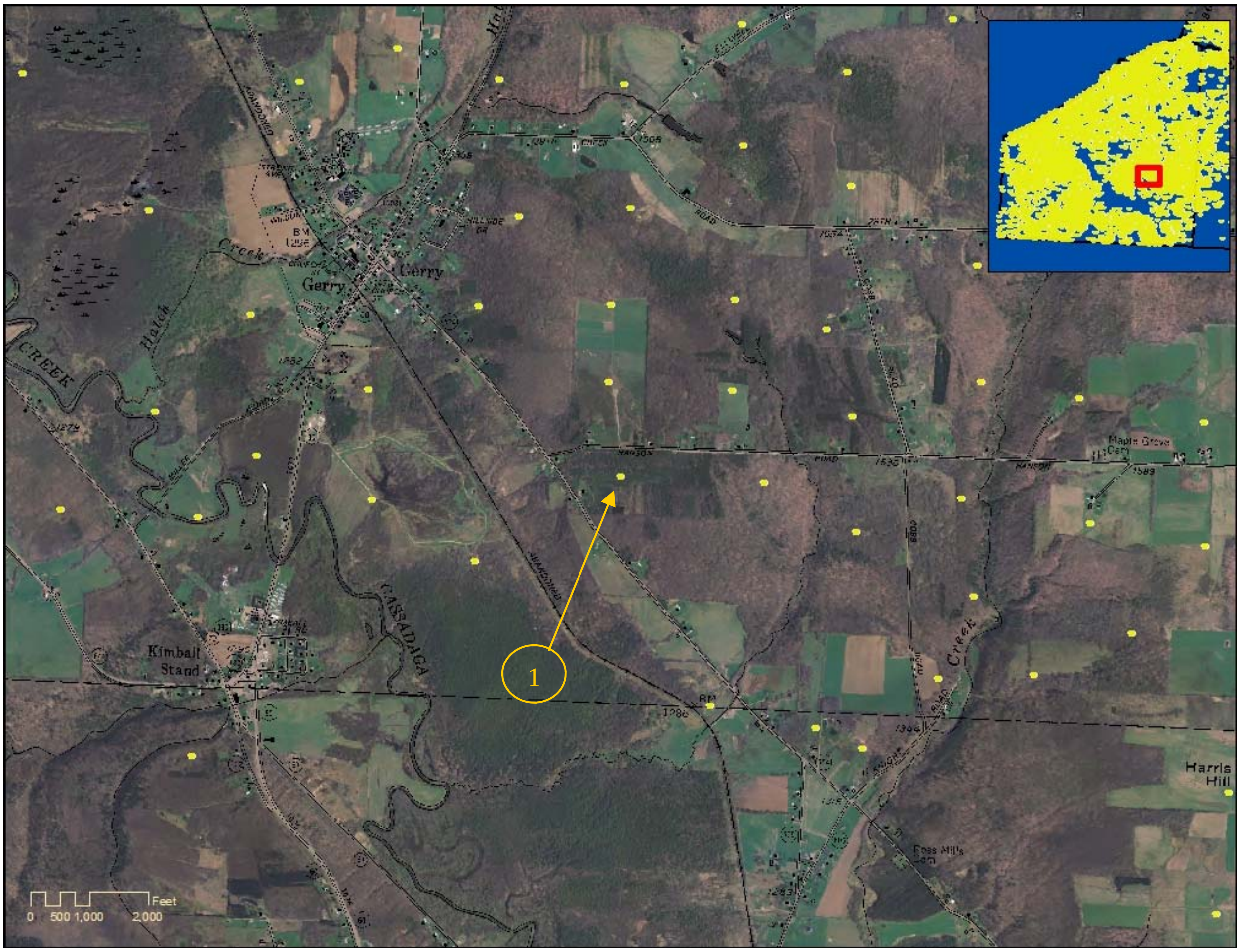


Photo 5.9 a & b The above map shows a portion of the Chautauqua County map, near Gerry. Well #1 (API Hole number 25468) shown in the photo to the right was drilled and completed for production in 2008 to a total depth of 4,095 feet. Of the other 47 Medina gas wells shown above, the nearest is approximately 1,600 feet to the north.

These Medina wells use single well pads. Marcellus multi-well pads will be larger and will have more wellheads and tanks.

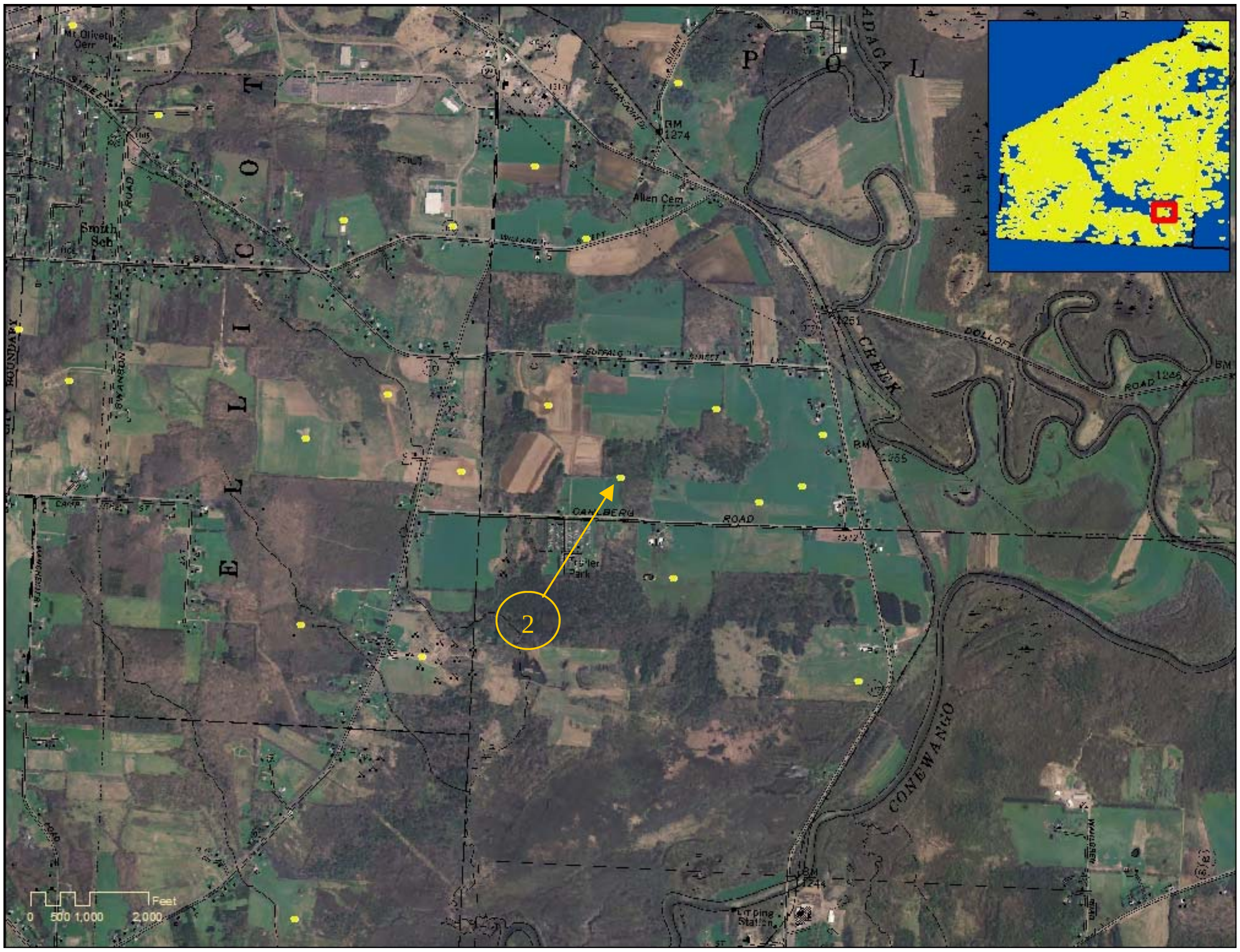


Photo 5.10 a & b This map shows 28 wells in the Town of Poland, Chautauqua County. Well #2 (API Hole number 24422) was drilled in 2006 to a depth of 4,250 feet and completed for production in 2007. The nearest other well is 1,700 feet away.