Habitat Fragmentation Analysis for the Bluestone Wind Project Broome County, New York

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Appendix A. Land Use/Land Cover for the County and Local Habitat Fragmentation Analysis for the Bluestone Wind Project in Broome County, New York.

1.0 INTRODUCTION

Bluestone Wind, LLC (Bluestone) is developing the Bluestone Wind Project (Facility Site) in Broome County, New York (Figure 1.1). The term Facility will be used to describe the locations of infrastructure (i.e., wind turbines, access roads, etc.) and the term Facility Site will be used to describe all land parcels where infrastructure will be placed. The Facility will consist of up to 33 wind turbines, with an anticipated installed generating capacity of 124 megawatts (MW).

The Facility will offer a number of environmental benefits, including generating electricity with zero carbon emissions; however, Facility construction and operation is anticipated to cause some level of direct impact of habitat through clearing and indirect impacts to areas near clearing. The objective of this habitat fragmentation analysis was to evaluate the amount of direct forested and grassland habitat lost during construction, the level of indirect impacts in forested and grassland habitats, and the potential impacts to birds and bats.

2.0 FACILITY SITE AND FACILITY COMPONENTS

2.1 Facility Site

The Facility Site is a proposed large wind energy conversion system encompassing approximately 2,287 hectares (ha; 5,652 acres [ac]) in Broome County in southcentral New York (Figure 2.1). The Facility Site lies within the Northern Allegheny Plateau Ecoregion, which is characterized by rolling hills, open valleys, and low mountains (USEPA 2010). The Facility Site also falls within the NYSDEC Central Appalachians Ecological Zone of New York (Edinger et al. 2014). Elevation within the Facility Site ranges from approximately 280 meters (m; 919 feet [ft) above sea level (ASL) in the lowest valley to 617 m (2,024 ft) ASL at the highest peak.

2.2 Facility Components

The Facility will include the construction and operation of up to 33 wind turbine generators with a nameplate generating capacity of up to 124 MW. The height of a rotating turbine to be built at the Facility, or rotor swept height (RSH), is approximately 50.5-205 m (165.7-672.6 ft) above ground level. The Facility will include access roads, underground collection lines, point of interconnection, collector substation, battery storage, and Operations and Maintenance (O&M) building (Figure 2.1). Details describing the Facility can be found in the Exhibit 3 of the Article 10 application. In general, the array of 33 turbines includes turbines distributed throughout the Facility Site in a manner that optimizes power generation and minimizes impacts to identified sensitive resources (e.g., wetlands, woodlands, etc.).

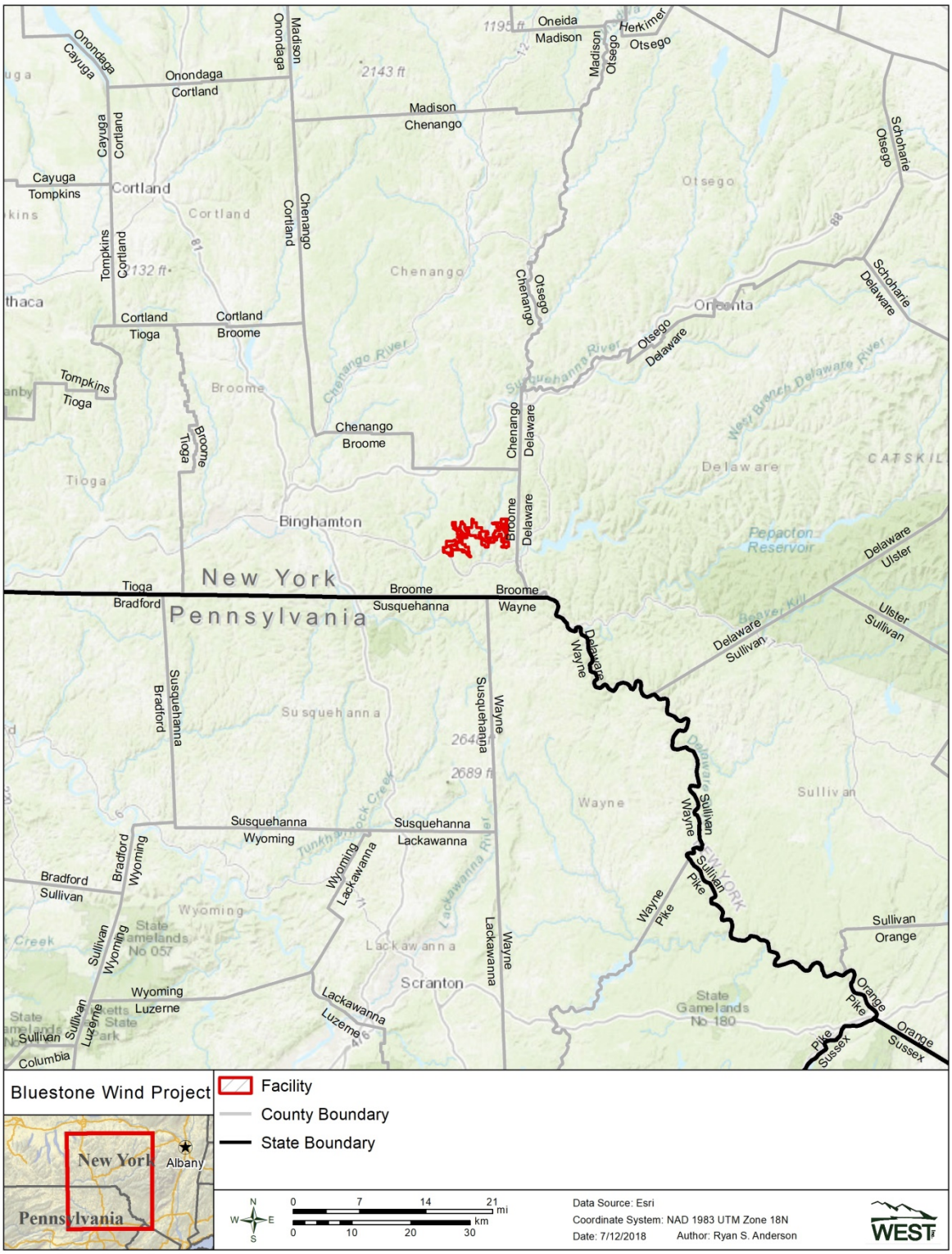

Figure 1.1. Overview of the Bluestone Wind Project, Broome County, New York.

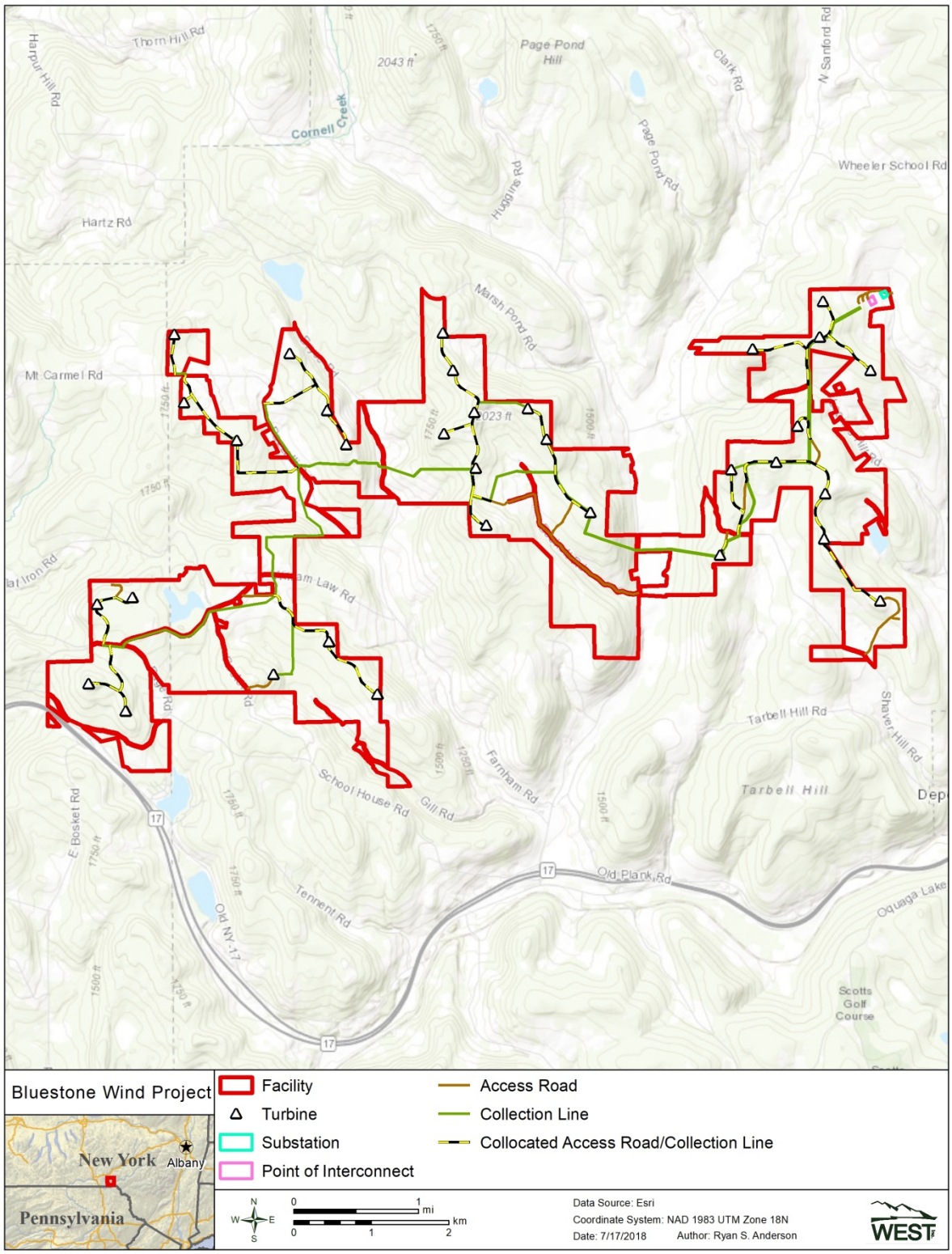

Figure 2.1. Location of the proposed Bluestone Wind Project infrastructure in Broome County, New York.

3.0 METHODS

The National Land Cover Dataset (NLCD; NLCD 2011; Homer et al. 2015) was used for land cover assessments. Forested and grassland habitat was analyzed at the landscape level using FRAGSTATS software (McGarigal et al. 2002), utilizing pre-construction land cover (NLCD raster data) and predicted post-construction land cover (NLCD raster data with disturbance areas overlaid).

FRAGSTATS is a spatial pattern analysis program that enables the user to compute statistics which quantify and describe habitat composition and configuration. The final output consists of a suite of metrics that describe the landscape in ecologically relevant terms such as habitat fragmentation and dispersion. Each habitat metric is measured for each habitat type, and each continuous piece of habitat of the same type is defined as a patch. FRAGSTATS was utilized to quantify patterns of ecological interest in relation to patch shape, edge, isolation, and connectivity in the pre-construction landscape (NLCD data) compared to predicted pre-construction disturbance.

FRAGSTAT software was run as toolbox feature within ArcGIS software (ESRI 2018). Given that user-defined inputs allows a multitude of possible metrics for any given output, only the most salient metrics for describing the landscape for the purposes of this analysis were chosen. These include, 1) the direct loss of habitat due to clearing, and 2) the secondary edge effects, specifically, habitat degradation due to increased habitat edge and division of continuous habitat. The footprint of each turbine and other Facility components were buffered by 91.4 m (300 ft) to account for both direct and indirect disturbance to the surrounding habitat. Accordingly, the sum of the footprint and other Facility component buffers represent the displaced habitat areas for the purpose of this analysis.

Landscape analysis was conducted at the county-level (defined as Broome County) and a local-level (4 kilometers (km; 2.5 miles [mi]) buffer on planned Facility components that extends into Delaware County, New York). All county-level analyses were artificially cut off at the Broome County line and at the 4 km (2.5 mi) buffer (i.e., local-level) for the local analysis.

3.1 Habitat Metric Definitions:

- Patch: Continuous area of a given habitat type.
- Total Area: Total area of a habitat type within the county- and local-level analysis.
- Mean Patch Area: Mean area of all patches within the county- and local-level analysis.
- Percent Composition: Relative composition in relation to other habitat types (Appendix A).
- Total Edge: Total length of edge for all patches of the measured habitat (forest or grassland) within the county- or local-level.
- Edge Density: The sum of the lengths of all edge segments divided by the total landscape area: m (edge)/ha (individual habitat type) within the county- or local-level analysis.

- Clumpiness: Determines if the measured habitat (forest or grassland) is randomly distributed on the landscape (value closer to zero) or clumped together (value closer to one).
- Perimeter Area Fractal Dimension: Measures the roughness of patches of measured habitat (forest or grassland). Higher values indicate uneven edges and lower values indicate smoother edges to habitat patches.
- Normalized Landscape Shape Index: This value is the relationship of the amount of linear edge of each patch of habitat and the amount of area within each patch. Values closer to one indicate patches with high linear edge compared to internal area (i.e., irregular shaped habitat patch) and values closer to zero indicate patches with lower linear edge compared to internal area (i.e., natural shaped habitat patch).

3.2 Habitat Types

3.2.1 Forested Habitat

The following NLCD habitat types were combined to form the forested patch classification for analysis: Deciduous Forest, Evergreen Forest, Mixed Forest (NLCD cover types 41, 42, and 43, respectively; Homer et al. 2015).

3.2.2 Grassland Habitat

The following NCLD habitat types were analyzed individually: Grassland/Herbaceous (NLCD cover type 71) and Pasture/Hay (NLCD cover type 81; Homer et al. 2015).

4.0 RESULTS

Results of the analysis show habitat impacts (direct and indirect) at the county- and local-level due to forest and grassland habitat conversion (Figures 4.1, 4.2, and 4.3). Impacts are described in the sections below.

4.1 Habitat Disturbance

The Facility will overlay an area of approximately 30 ha (73 ac) and a total area of disturbance (direct and indirect) of approximately 814.44 ha (2,012.53 ac; Table 4.1). At the county-level this will result in a 0.6% loss of total forested habitat and 0.3% of total grassland habitat (herbaceous and hay/pasture; Table 4.2). At the local-level, total forested habitat and total grassland habitat will be decreased by 4.2% and 3.6%, respectively (Table 4.2). Overall habitat loss for forested and grassland habitat combined will represent a 0.5% decrease at the county-level and a 4.1% decrease at the local-level.

Table 4.1. Estimated Direct and Indirect Habitat Loss at the Bluestone Wind Project, Broome County, New York.

	Direct Disturbance		Indirect Disturbance[1]	
Turbine/Infrastructure Type	**Hectares**	**Acres**	**Hectares**	**Acres**
Turbines	2.67	6.60	86.68	214.20
Access Roads/Pads	14.48	35.79	560.62	1,385.32
Collection Lines	11.48	28.38	693.33	1,713.25
Collector Substation	0.51	1.25	5.74	14.18
Point of Interconnect	0.69	1.70	6.37	15.75
Overall[2]	**29.83**	**73.73**	**814.44**	**2,012.53**

[1]91.4 meter (300 feet) buffer

[2]Dissolved total; does not represent sum of individual infrastructure disturbances

Table 4.2. Estimated Forested and Grassland Habitat (NLCD 2011, Homer et al. 2015) Loss at the Bluestone Wind Project, Broome County, New York.

		Before		After		
Habitat Type	**Spatial Scale**	**Hectares**	**Acres**	**Hectares**	**Acres**	**Change (%)**
Forest	Broome County	119,682.81	295,742.21	119,011.30	294,082.87	-0.6
Herbaceous	Broome County	1,111.77	2,747.24	1,106.64	2,734.56	-0.5
Hay/Pasture	Broome County	32,014.62	79,109.73	31,916.97	78,868.43	-0.3
Total Grassland	**Broome County**	**33,126.39**	**81,856.97**	**33,023.61**	**81,602.99**	**-0.3**
Total Forest and Grassland	**Broome County**	**152,809.20**	**377,599.17**	**152,034.91**	**375,685.86**	**-0.5**
Forest	Local[1]	15,838.65	39,138.10	15,167.16	37,478.81	-4.2
Herbaceous	Local[1]	96.57	238.63	91.44	225.95	-5.3
Hay/Pasture	Local[1]	2,797.56	6,912.91	2,699.91	6,671.61	-3.5
Total Grassland	**Local[1]**	**2,894.13**	**7,151.54**	**2,791.35**	**6,897.57**	**-3.6**
Total Forest and Grassland	**Local[1]**	**18,732.78**	**46,289.64**	**17,958.51**	**44,376.38**	**-4.1**

[1]4 kilometer (2.5 mile buffer)

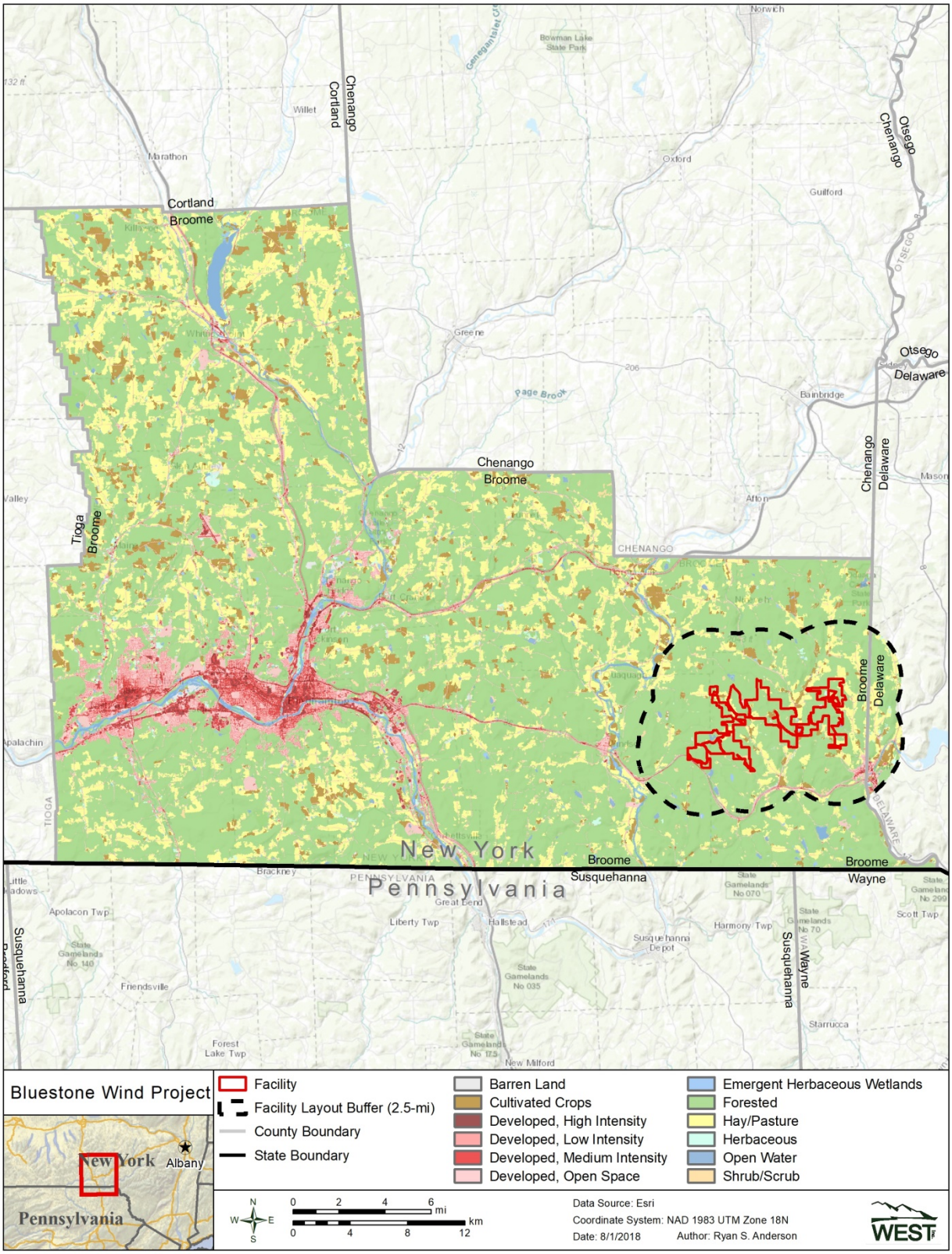

Figure 4.1. Land use/land cover at the Bluestone Wind Project within Broome County, New York (US Geological Survey National Land Cover Database 2011, Homer et al. 2015).

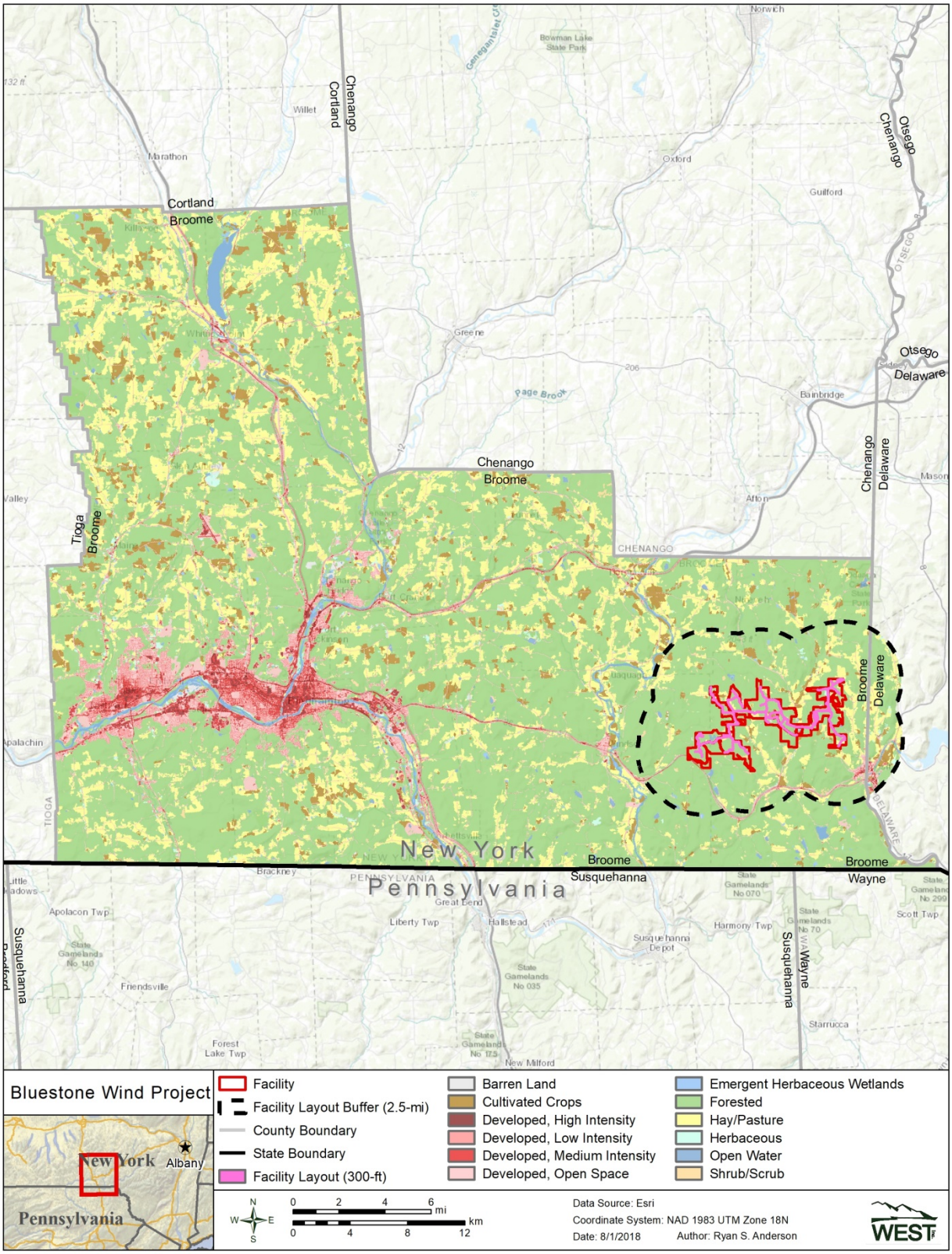

Figure 4.2. Land use/land cover with Bluestone Wind Project infrastructure in Broome County, New York (US Geological Survey National Land Cover Database 2011, Homer et al. 2015).

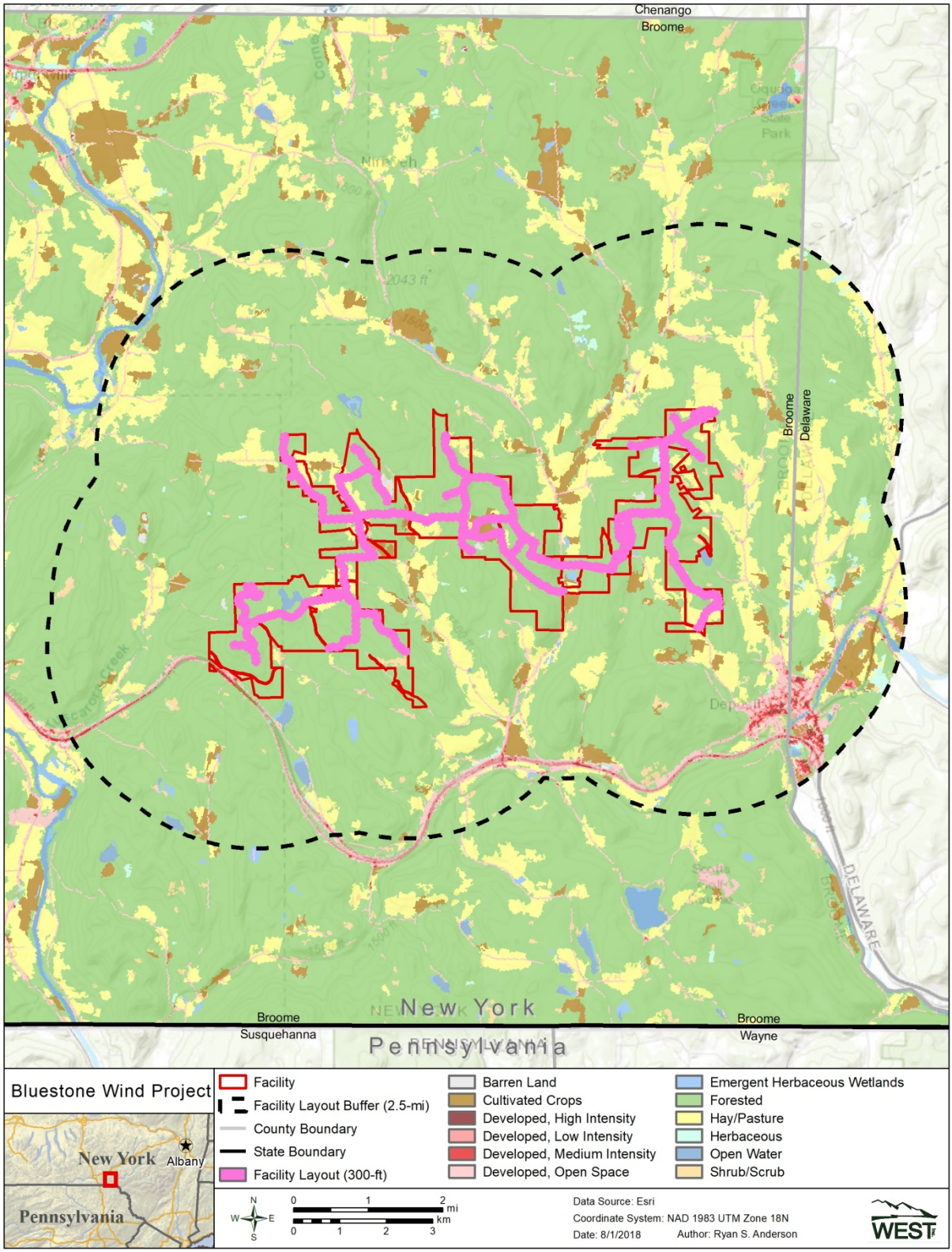

Figure 4.3. Land use/land cover and infrastructure planned for the Bluestone Wind Project, Broome County, New York (US Geological Survey National Land Cover Database 2011, Homer et al. 2015).

4.2 Forest Habitat Composition

Mean patch area for a given forested patch will decrease by 1.3% at the county-level and 12.3% at the local-level (Tables 4.3 and Table 4.4). Relative composition of forest compared to the surrounding landscape will decrease by 0.4% at the county-level and 4.2% at the local-level. Total edge will increase by 0.6% at the county-level and 7.0% at the local-level. Perimeter area fractal dimension (PAFD) decreased slightly at the county-level, while clumpiness stayed the same and edge density and normalized LSI increased slightly. At the local-level, PAFD, clumpiness, and normalized LSI all decreased slightly while edge density increased slightly.

Table 4.3. Predicted County-Level Forested Habitat (NLCD 2011, Homer et al. 2015) Landscape Changes at the Bluestone Wind Project, Broome County, New York.

Habitat Metric	Before	After	Change (%)
Total Area	119,682.81 ha (295,742.21 ac)	119,011.30 ha (294,083.33 ac)	**-0.6**
Mean Patch Area	82.83 ha (204.67 ac)	81.74 ha (201.98 ac)	**-1.3**
% Composition[1]	73.19%	72.78%	**-0.4**
Total Edge	9,350.31 km (5,810.01 mi)	9,408.88 km (5,846.41 mi)	**0.6**
Edge Density	24.93	25.08	
PAFD	1.45	1.44	
Clumpiness	0.91	0.91	
Normalized LSI	99.74	99.75	

[1]Percentage of total landscape

ha=hectare; ac=acres; km=kilometers; mi=miles; PAFD=Perimeter Area Fractal Dimension; LSI=Landscape Shape Index

Table 4.4. Predicted Local Buffer (4 kilometer [2.5 mile]) Forested Habitat (NLCD 2011, Homer et al. 2015) Landscape Changes at the Bluestone Wind Project, Broome County, New York.

Habitat Metric	Before	After	Change (%)
Total Area	15,838.65 ha (39,138.16 ac)	15,167.16 ha (37,478.87 ac)	**-4.2**
Mean Patch Area	133.1 ha (328.9 ac)	116.67 ha (288.3 ac)	**-12.3**
% Composition[1]	76.28%	73.05%	**-4.2**
Total Edge	837.99 km (520.70 mi)	896.49 km (557.05 mi)	**7.0**
Edge Density	23.19	24.81	
PAFD	1.42	1.39	
Clumpiness	0.93	0.92	
Normalized LSI	99.91	99.90	

[1]Percentage of total landscape

ha=hectare; ac=acres; km=kilometers; mi=miles; PAFD=Perimeter Area Fractal Dimension; LSI=Landscape Shape Index

4.3 Grassland Habitat Composition

4.3.1 Herbaceous Habitat

Mean patch area and percent composition did not see substantial decreases at the county- or local-levels (<0.1% and 0.6% decrease, respectively; Table 4.5). Total edge decreased by 0.3% at the county-level and 3.7% at the local-level. At the county-level, Edge density, PAFD, and normalized LSI values remained the same (Table 4.5). Edge density, clumpiness, and

normalized LSI decreases slightly at the local-level; however, PAFD increased slightly (Table 4.6).

Table 4.5. Predicted County-level Herbaceous Habitat (NLCD 2011, Homer et al. 2015) Landscape Changes at the Bluestone Wind Project, Broome County, New York.

Habitat Metric	Before	After	Change (%)
Total Area	1,111.77 ha (2,747.24 ac)	1,106.64 ha (2,734.57 ac)	**-0.5**
Mean Patch Area	1.94 ha (4.79 ac)	1.94 ha (4.79 ac)	**-<0.1**
% Composition[1]	0.67%	0.67%	**-<0.1**
Total Edge	507.15 km (315.13 mi)	505.53 km (314.12 mi)	**-0.3**
Edge Density	1.35	1.35	
PAFD	1.47	1.47	
Clumpiness	0.66	0.66	
Normalized LSI	82.19	82.19	

[1]Percentage of total landscape

ha=hectare; ac=acres; km=kilometers; mi=miles; PAFD=Perimeter Area Fractal Dimension; LSI=Landscape Shape Index

Table 4.6. Predicted Local Buffer (4 kilometers [2.5 mile]) Herbaceous Habitat (NLCD 2011, Homer et al. 2015) Landscape Changes at the Bluestone Wind Project, Broome County, New York.

Habitat Metric	Before	After	Change (%)
Total Area	96.57 ha (238.63 ac)	91.44 ha (225.95 ac)	**-5.3**
Mean Patch Area	1.78 ha (4.4 ac)	1.79 ha (4.23 ac)	**-0.6**
% Composition[1]	0.50%	0.40%	**-<0.1**
Total Edge	44.88 km (27.88 mi)	43.26 km (26.88 mi)	**-3.7**
Edge Density	1.24	1.19	
PAFD[2]	1.44	1.48	
Clumpiness	0.67	0.66	
Normalized LSI[3]	80.75	80.67	

[1]Percentage of total landscape

ha=hectare; ac=acres; km=kilometers; mi=miles; PAFD=Perimeter Area Fractal Dimension; LSI=Landscape Shape Index

4.3.2 Hay/Pasture Habitat

Mean patch area for hay/pasture decrease by 1.3% at the county-level and 13.0% at the local-level (Tables 4.7 and 4.8). Total edge decreased by 0.1% and 1.0% at the county- and local-levels, respectively. Edge density, PAFD, and normalized LSI decreased slightly at the county- and local-levels; however, there were no measurable change in the clumpiness index.

Table 4.7. Predicted County-level Hay/Pasture Habitat (NLCD 2011, Homer et al. 2015) Landscape Changes at the Bluestone Wind Project, Broome County, New York.

Habitat Metric	Before	After	Change (%)
Total Area	32,014.62 ha (79,109.72 ac)	31,916.97 ha (78,868.43 ac)	**-0.3**
Mean Patch Area	19.43 ha (48.01 ac)	19.18 ha (47.39 ac)	**-1.3**
% Composition[1]	19.60%	19.51%	**-0.1**
Total Edge	6,776.20 km (4210.53 mi)	6768.60 km (4,205.81 mi)	**-0.1**
Edge Density	18.06	18.05	
PAFD	1.52	1.51	
Clumpiness	0.83	0.83	
Normalized LSI	96.50	96.49	

[1]Percentage of total landscape

ha=hectare; ac=acres; km=kilometers; mi=miles; PAFD=Perimeter Area Fractal Dimension; LSI=Landscape Shape Index

Table 4.8. Predicted Local Buffer (4 kilometer [2.5 mile]) Hay/Pasture Habitat (NLCD 2011, Homer et al. 2015) Landscape Changes at the Bluestone Wind Project, Broome County, New York.

Habitat Metric	Before	After	Change (%)
Total Area	2,797.56 ha (6912.91 ac)	2,699.91 ha (6671.61 ac)	**-3.5**
Mean Patch Area	19.03 ha (47.02 ac)	16.56 ha (40.92 ac)	**-13.0**
% Composition[1]	13.47%	13.00%	**-0.5**
Total Edge	619.41 km (384.88 mi)	613.05 km (380.93 mi)	**-1.0**
Edge Density	17.14	16.97	
PAFD	1.56	1.52	
Clumpiness	0.82	0.82	
Normalized LSI	96.46	96.31	

[1]Percentage of total landscape

ha=hectare; ac=acres; km=kilometers; mi=miles; PAFD=Perimeter Area Fractal Dimension; LSI=Landscape Shape Index

5.0 DISCUSSION

5.1 Site-Specific Factors

Construction of the Facility is anticipated to cause impacts to forest and grassland habitats; however, most impacts will be temporary. Permanent habitat loss from construction of turbines, access roads, batch plant, staging area, collector substation, O&M building, construction laydown area, and borrow area will total approximately 29.83 ha (73.73 ac), or approximately 3.6% of the anticipated temporary habitat loss (814.44 ha [2,012.53 ac]).

Although an area centered on the turbine will be temporarily cleared of vegetation during construction, the majority of the cleared area around the turbine will be revegetated with the exception of a gravel access road accessing and encircling the base of each turbine. A total of 2.67 ha (6.60 ac) will be permanently converted to gravel pads for 33 turbines). This may ultimately increase the herbaceous habitat type in the short-term and eventually return to forested habitat in the future depending upon Bluestone's vegetation management. Forest clearing impacts can be characterized as one of three types. The first is permanent loss, where

forests would be replaced with built facilities (access roads, turbines, etc.). The second is forested conversion, where forests would be cleared and maintained as successional communities for the life of the Facility (areas under the turbines, and along collection lines or access roads). Finally, temporary impacts are those where forest would be allowed to regrow following construction (along the periphery of access roads and turbine sites). In these areas, the Applicant will only remove stumps where necessary to install underground components, will not use herbicides to prevent sprouting, and will not remove trees as part of routine vegetation management during Facility operation. Ecological succession would restore the forested condition of these areas over time if left unmanaged.

5.2 Habitat Metrics

At the county-level overall habitat disturbance is predicted to be low for forested and total grassland habitats (0.6% and 0.3% reduction, respectively). Habitat disturbance at the local-level is predicted to be slightly higher with a 4.2% reduction in forested habitat and 3.6% reduction in total grassland habitat. Details on how each habitat patch type (forested, herbaceous, and hay/pasture) is predicted to be impacted based on the measured habitat metrics are presented below (see section 3.1 for description of each metric).

5.2.1 Forest

Forested habitat composes the majority of the area at the county-level (64.6%) and local-level (76.2%; Appendix A); however, predicted forest lost due to clearing for Facility construction is expected to have limited effects to forested habitats. At the county-level there was a minimal reduction in the mean area of all forest patches (1.3% reduction) and the relative composition of forested habitat in relation to other habitat types (0.4% reduction). There was a slight increase in the total length of edge for all forest (0.6% increase) and edge density (24.93 m/ha to 25.08 m/ha). Changes in PAFD and normalized LSI were minimal (1.45 to 1.44 and 99.74 to 99.75, respectively). And clumpiness didn’t change at the county-level.

At the local-level the reduction in the mean area of all forest patches (12.3% reduction) and relative composition of forested habitat in relation to other habitat types (4.2% reduction), the increase in the total edge for all forest (7.0% increase) and increase in edge density (23.19 m/ha to 24.81 m/h) was relatively higher than at the county-level. Similar to the county-level, PAFD and normalized LSI decreased slightly at the local-level (1.42 to 1.39 and 99.91 to 99.90, respectively). Clumpiness also decreased from 0.93 to 0.92 at the local-level.

5.2.2 Grassland

Grasslands (herbaceous areas; NLCD cover type 71) are limited at both the county-level (0.6% of area) and local-level (0.5%; Appendix A) and are generally scattered on the landscape (Appendix A; Figures 4.1-4.3). Facility construction is expected to result in a limited impact to grassland as indices such as edge density, PAFD, clumpiness, and normalized landscape shape index changed slightly or remained unchanged between the pre-construction and predicted post-construction values at the local- and county-levels.

5.2.3 Hay/Pasture

Areas of hay/pasture compose the second most common habitat type at the county-level (17.3% of area) and local-level (13.5%; Appendix A). Similar to expected impacts to forested habitats discussed above, construction of Facility is not expected to have a substantial impact on hay/pasture habitat. At the county-level there was a minimal change in the measured metrics between the pre-construction and predicted post-construction values. The local-level impacts were relatively higher, but also expected to be minimal. There was a 13.0% reduction in the mean area of all hay/pasture patches, but all other measured metrics only changed slightly or remained unchanged between the pre-construction and predicted post-construction values.

5.3 Habitat Fragmentation Impacts to Birds and Bats

Habitat fragmentation occurs when large blocks of contiguous habitat (e.g., forest, grasslands) are divided into smaller segments causing reduction of the genetic or demographic viability of the population surviving in the remaining segment (USFWS 2012). There is concern that site clearing, access roads, transmission lines, and turbine tower arrays may fragment continuous habitat areas into smaller patches, which is of particular concern to species that require large expanses of habitat for breeding or foraging. There is also concern that development of wind energy infrastructure may increase edge effects to some species resulting in greater susceptibility to colonization by invasive species, increased risk of predation, and increased competition for species that favor landscapes with a mosaic of vegetation (USFWS 2012).

5.3.1 Impacts to Birds

Sensitivity to habitat fragmentation varies by species. Forest interior species require large forest areas to breed successfully and maintain viable populations (Bannerman 1998). Forest interior habitat located deep within woodlands has a more stable climatic environment, provides less nest disruption, and has fewer predators. As forests are cut, edges are created with less stable climates that are exposed to more wind, sun, and drier conditions. These areas are also more prone to disturbance and a higher number of predators. Bird species that utilize forest edge are typically habitat generalists adapted to use the variety of vegetation and food resources located in the forest edge (Bannerman 1998).

Forest interior bird species are sensitive to forest fragmentation and have shown reproductive dysfunction from fragmentation (Donovan and Flather 2002, Robinson et al. 1995). Five forest interior bird species (red-eyed vireo [*Vireo olivaceus*], ovenbird [*Seiurus aurocapilla*], scarlet tanager [*Piranga olivacea*], wood thrush [*Hylocichla mustelina*], and hooded warbler [*Setophaga citrina*]) were observed during breeding bird surveys (Table 5.1) indicating that the Facility Site has suitable nesting habitat for those species. As no large-scale changes to forested habitats are expected (Tables 4.3 and 4.4), the aforementioned species should continue to find suitable nesting habitat in the Facility Site. Ground- or open-nesting species using trees or shrub have been found to be the most sensitive to fragmentation and include several species observed during breeding bird surveys in the Facility Site (hooded warbler, black-and-white warbler [*Setophaga virens*], black-throated-blue warbler [*Setophaga caerulescens*], veery [*Catharus fuscenscens*], and ovenbird; Birds of North America 2018). As no large-scale changes to

grassland habitat are expected (Tables 4.5 – 4.8), those species should continue to find suitable nesting habitat.

Table 5.1. Observations of forest interior species during breeding bird surveys in the Bluestone Wind Project, May 16 – July 15, 2017.

Species	Observations
red-eyed vireo (*Vireo olivaceus*)	1,087
ovenbird (*Seiurus aurocapilla*)	785
veery (*Catharus fuscenscens*)	296
black-throated blue warbler (*Setophaga caerulescens*)	276
scarlet tanager (*Piranga olivacea*)	239
black-throated green warbler (*Setophaga virens*)	143
wood thrush (*Hylocichla mustelina*)	110
black-and-white warbler (*Setophaga virens*)	71
American redstart (*Setophaga ruticilla*)	55
Canada warbler (*Cardellina canadensis*)	22
hooded warbler (*Setophaga citrina*)	15
brown creeper (*Certhia americana*)	14
Total	**3,113**

While there is little information available on the effects of forest clearing for wind energy development to eastern forest birds, there is information on the effects of roads and powerline development on these species. For example, forest edge habitat that occurs adjacent to large clear-cuts, large transmission lines, or other large forest openings has decreased presence of forest interior bird species, but increased use by edge species. However, narrow openings created within larger forested areas, such as roads, appears to have a more limited effect with less reduction in use by forest dwelling species and no significant reduction in nest success (King and DeGraaf 2002, Ortega and Capen 1999, Askin 1994). The primary impact from construction of the Facility is likely an increase in predator activity along forest edges, which may result in increased nest predation and brown-headed cowbird (*Molothrus ater*) parasitism (Kroodsma 1982, Manolis et al. 2002). However, other species that use brushy habitats or edges may be positively affected by increased edge created as a result of Facility construction. Considering only 4.2% of forested habitat at the local-level is expected to be cleared for construction and that the landscape consists of a patchwork of forested and non-forested habitat, it is unlikely that the Facility will cause significant forest fragmentation impacts to bird communities.

Facility construction is also expected to result in a loss of 5.3% of grassland habitat (herbaceous) at the local-level. However, habitat fragmentation impacts to grassland birds are not expected to be significant given the limited amount of grassland habitat present (0.5% of the area at the local-level), which is generally scattered throughout the Facility and already subjected to fragmentation from development. At the landscape level, habitats similar to those within the Facility are abundant within the surrounding landscape thus allowing birds to utilize these areas during construction and operation of the Facility.

5.3.2 Impacts to Bats

Forested fragmentation effects on bats are not well understood and effects may be different between species based upon each species' ecology (e.g., preferred prey, foraging areas, roosting needs, and flight morphology). Each bat species, except northern long-eared bat (*Myotis septentrionalis*), known to occur in Broome County, New York is discussed below with potential impacts due to loss of forested habitat. Northern long-eared bat are discussed in the Net Conservation Benefit Plan (Ritzert et al. 2018a).

5.3.2.1 Eastern Red Bat

Eastern red bat (*Lasiurus borealis*) is the most commonly captured tree bat in North America (Barbour and Davis 1969, Bishop-Boros 2014), and is assumed to be common throughout all habitats where trees are present within New York State, with the exception of highly developed urban areas (Walters et al. 2007). Forest fragmentation at the Facility is unlikely to have a significant impact on the suitability of foraging or roosting habitat of this species. Based on extant research, eastern red bats show flexibility when selecting roosts and utilize a variety of foraging habitats as long as tree stands remain within the landscape. Overall, impacts to the New York eastern red bat population due to potential habitat fragmentation and edge effects resulting from the construction of the Facility are unlikely.

5.3.2.2 Silver-Haired Bat

The silver-haired bat (*Lasionycteris noctivagans*) is assumed to be common throughout forested habitats within New York State and typically roosts beneath exfoliating bark or hollows of a tree in woodlands near water sources (Barbour and Davis 1969). Based on habitat requirements of the silver-haired bats and the limited amount of forested habitat affected at the local-level, it is unlikely that Facility construction will have a direct impact on the success of the local population. Overall, impacts to the New York silver-haired bat population due to potential habitat fragmentation and edge effects resulting from the construction of the Facility are unlikely.

5.3.2.3 Hoary Bat

Hoary bat (*Lasiurus cinereus*) is physically the largest bat species in New York State and generally assumed to be common throughout all habitats within the state (Barbour and Davis 1969). Hoary bats are widespread and foraging patterns are not well known. Overall, impacts to the New York hoary bat population due to potential habitat fragmentation and edge effects resulting from the construction of the Facility are unlikely.

5.3.2.4 Little Brown Bat

As of 2013, the little brown bat (*Myotis lucifugus*) was reported to occur throughout the entire State of New York (New York Natural Heritage Program [NYNHP] 2018). Historically, the little brown bat has been one of the most common and widespread bat species in North America and New York. Between 2007 and 2012, however, the state-wide species population declined 90% (NYNHP 2018) due to the effects of white nose syndrome in its most populous hibernacula. Roosting habitat for little brown bat may be directly affected in the form of tree clearing for Facility construction; however, potential beneficial effects to this species include an increase in

foraging potential from newly formed open areas and forest edge. Overall, impacts to the New York little brown bat population due to potential habitat fragmentation and edge effects resulting from the construction of the Facility are unlikely.

5.3.2.5 Eastern Small-Footed Bat

Eastern small-footed bat (*Myotis leibii*) is a species of special concern in New York State. Eastern small-footed bats are typically found in heavily forested mountain regions up to 610 m (2,000 ft) in areas with talus slopes, cliffs, rock outgroups or other rocky features with abundant cracks/crevices that have a moderate to high level of solar exposure (Barbour and Davis 1969, Harvey et al. 1999, Boyles et al. 2009). No rocky or talus areas were identified in the Facility Site. Talus or rocky features formerly shaded by forest canopy cover that may become open and converted into potential roosting habitat with tree clearing from both construction and maintenance activities, may create artificial roosts for eastern small-footed bat. Overall, impacts to the New York eastern small-footed bat population due to potential habitat fragmentation and edge effects resulting from the construction of the Facility are unlikely.

5.3.2.6 Tri-colored bat

Tri-colored bat (*Perimyotis subflavus*) has historically been confirmed in all 62 New York State counties (NYNHP 2018). Although the tri-colored bat is common within New York State and overall region, few studies have addressed details of summer habitat requirements and behavior, especially within the state. Little is known of habitat preferences of the species in the region; however, given the extant body of knowledge of observations in other regions, it is possible that the suitability of some forested habitat, namely upland forest foraging habitat and any forested riparian habitat, may be affected by Facility construction. Though, notably, the footprint of the Facility, which overlies mostly upland areas, is unlikely to impact the forested riparian areas, which typically show the most suitability for tri-colored bat maternity roost habitat. Overall, impacts to the New York tri-colored bat population due to potential habitat fragmentation and edge effects resulting from the construction of the Facility are unlikely.

5.3.2.7 Big Brown Bat

The big brown bat (*Eptesicus fuscus*) is among the most abundant of North American bats, and as a habitat generalist, shows perhaps the greatest tolerance for human development and disturbance than any other bat species in New York State (Barbour and Davis 1969). Edge habitat has been shown to be an important habitat feature for foraging and commuting and individuals may use linear features to navigate and orient themselves within the landscape (Verboom and Huitema 1997). Overall, impacts to the New York big brown bat population due to potential habitat fragmentation and edge effects resulting from the construction of the Facility are unlikely.

5.4 Impacts to State-Listed Species

5.4.1 Henslow's Sparrow

Based on the NYNHP request, Henslow's sparrow (*Ammodramus henslowii*) is listed as threatened by the NYDEC and has been documented within 16.1 km (10 mi) of the Facility. Henslow's sparrow typically relies on weedy hayfields and pastureland for breeding habitat (Herket et al. 2002). Though initial disturbance is predicted to remove some hay/pasture habitat from the landscape, the revegetation of cleared land with planted grasses may provide breeding habitat in after initial construction disturbance at the Facility. However no Henslow's sparrows were documented during on-site breeding bird surveys (Ritzert et al. 2017) or incidentally during two years of on-site eagle use surveys (Ritzert et al. 2018b).

5.4.2 Bald and Golden Eagle

The USFWS and NYSDEC raised concerns over how the Facility may impact both the state-threatened bald eagle (*Haliaeetus leucocephalus*) and state-endangered species golden eagle (*Aquila chrysateos*), which were both identified within the Facility during surveys. Impacts to both species from the Facility are discussed in the Net Conservation Benefit Plan (Ritzert et al. 2018a).

5.4.3 Timber Rattlesnake

Based on the NYNHP data request, the state threatened timber rattlesnake (*Crotalus horridus*) has been documented within 0.8 km (1.5 mi) of the Facility. However, after additional consultation with the NYSDEC (C. Herzog, NYSDEC, pers. comm.), it was determined that the timber rattlesnake record was historical and occurred south of New York State Route 17 near the New York/Pennsylvania border. No infrastructure is planned for that area; therefore no direct or indirect habitat fragmentation impacts to timber rattlesnake are predicted.

5.4.4 Northern Long-eared Bat

The NYNHP review did not identify the state-threatened northern long-eared bat (M*yotis septentrionalis*) as occurring within or near the Facility. However, details about how the habitat fragmentation analysis affects northern long-eared bat is discussed in the Net Conservation Benefit Plan (Ritzert et al. 2018a).

5.4.5 Aquatic Species

Additionally, the NYNHP review identified the following species: green floater (threatened; *Lasmigona subviridis*), brook floater (threatened; *Alasmidonta varicose*), yellow lampmussel (unlisted; *Lampsilis cariosa*), and rapids clubtail (unlisted: *Gomphus quadricolor*). All of these species are associated with the Susquehanna River, which is adjacent to the western border of the Facility. Therefore, no direct or indirect habitat fragmentation impacts to aquatic species are anticipated.

5.5 Conclusion

Construction of the Facility has the ability to displace wildlife, either permanently or temporarily. However, permanent habitat loss is expected to be minimal. Additionally bird and bat species impacted by habitat loss during Facility construction can likely move to other suitable nearby habitat due to the preponderance of forested and grassland habitats present in the 4 km (2.5 mi) buffer of the Facility Site and Broome County.

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Appendix A. Land Use/Land Cover for the County and Local Habitat Fragmentation Analysis for the Bluestone Wind Project in Broome County, New York.

Appendix A Land Use/Land Cover (NLCD 2011, Homer et al. 2015) for the County and Local Habitat Fragmentation Analysis for the Bluestone Wind Project in Broome County, New York.

Habitat	County[1]			Local[2]		
	Hectares	Acres	% Composition	Hectares	Acres	% Composition
Forest (Deciduous, Mixed, and Evergreen)	119,682.81	295,742.21	64.6	15,838.65	39,138.10	76.2
Hay/Pasture	32,014.62	79,109.73	17.3	2,795.58	6,908.02	13.5
Cultivated Crops	8,302.68	20,516.34	4.5	740.77	1,830.48	3.6
Developed, Open Space	9,522.36	23,530.23	5.1	650.82	1,608.21	3.1
Shrub/Scrub	1,971.18	4,870.88	1.1	202.95	501.50	1.0
Developed, Low Intensity	5,355.90	13,234.70	2.9	176.75	436.76	0.9
Open Water	2,407.77	5,949.72	1.3	122.61	302.98	0.6
Herbaceous	1,111.77	2,747.24	0.6	96.3	237.96	0.5
Emergent Herbaceous Wetlands	1,097.64	2,712.32	0.6	62.16	153.60	0.3
Developed, Medium Intensity	2,642.13	6,528.84	1.4	54.4	134.43	0.3
Barren Land	327.51	809.29	0.2	23.22	57.38	0.1
Developed, High Intensity	834.75	2,062.71	0.5	10.89	26.91	0.1

[1] Facility Site, Broome County, and the 4 kilometer (km; 2.5 mile [mi]) buffer.

[2] Facility Site plus the 4 km (2.5 mi) buffer