Redington Wind Farm Project

Basis of Design for the Roadways to Access Wind Turbines

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1.0 Introduction

DeLuca-Hoffman Associates, Inc. is one of several consultants who have been retained by Endless Energy Corporation of Yarmouth, Maine to prepare designs and portions of the permit applications for a series of wind turbines proposed to be sited on the Redington and Black Nubble Mountain ranges in Redington Township, Maine. DeLuca-Hoffman Associates, Inc. has been retained to select a preliminary roadway alignment to access the wind turbines from existing roadway systems, prepare a basis of design for the roadways, and to prepare the basis of design for the stormwater and erosion control issues attendant with the access roads. DeLuca-Hoffman Associates, Inc. has also been retained to assist with the preparation of road maintenance, solid waste, and blasting narratives associated with access roads and construction of turbine sites as well as assistance with preparation of the erosion and sedimentation control plan for transmission lines. The work of DeLuca-Hoffman Associates, Inc. is summarized in seven reports, which accompany the MeDEP and LURC application and are titled:

- Erosion and Sedimentation Control Plan for Roadway Construction;
- Basis of Design for the Roadways to Access Wind Turbines;
- Basis of Stormwater Management for Access Roadways;
- Access Road Maintenance;
- Blasting;
- Erosion and Sedimentation Control Plan for Transmission Line Corridor Connection; and
- Solid Waste

The reports are supported by a series of drawings prepared by DeLuca-Hoffman Associates, Inc. and include the following:

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The designs and reports prepared by DeLuca-Hoffman Associates, Inc. rely upon baseline information provided for this project by other consultants of Endless Energy Corporation. The baseline data prepared by other consultants to Endless Energy Corporation include the following:

- The identification and location of wetlands and other natural resources by Woodlot Alternatives.
- Surficial Soils Surveys and narratives prepared by Al Frick.
- Base topographic mapping prepared by Aerial Survey.
- Geotechnical evaluations and recommendations for Roadway Construction prepared by S. W. Cole.
- Information for the basis of Roadway Design "Narrow Road" specification established by Endless Energy Corporation, revision E, dated December 14, 2005, included with this report in Appendix 2.6.

Note: Transportation guidelines for Vestas V90 are not yet available; therefore, review of this Basis of Design for Roadways by Vestas and DeLuca-Hoffman Associates, Inc. is required once the V90 guidelines are available. Transportation guidelines for Vestas V80 are included in Appendix 8.4 as an example of what may be updated for the V90.

LURC Chapter 10, Rules and Standards, defines three roadway classifications with minimum roadway widths ranging from 8 to 18 feet. In an effort to design the roadway to meet the specific requirements of this project, a minimum gravel travelway width of 12 feet is proposed for access roads and 32 feet for mountaintop summit roads. A wider travel width up to 20 feet is required at the tightest curves of the proposed access roadways and at wide-outs for passing of equipment.

The roadways have been designed to minimize the use of ditching and to fit the natural topography of the land such that cuts and fills are minimized while preserving the scenic qualities of the surrounding land to the extent possible.

There are other physical elements of the project such as the electrical power transmission lines, staging area, small buildings, and the actual wind turbines, with attendant construction areas, which are being designed by other consultants and discussed in separate portions of the application.

A portion of the access to the proposed wind turbines will use existing roads. These roads are shown as a red line on the Base Map and have the following lengths:

Table 1 - Access to Wind Turbines		
Existing Road Segment	**Distance (ft)**	**Distance (miles)**
I.P. Road from Route 16 to tee intersection just beyond the Maintenance Building Lot.	26,928	5.1
Road segment from tee intersection to Lower Black Nubble (includes portion of RE2).	16,896	3.2
Road segment from tee intersection to log yard at base of Redington Mountain (includes portion of RE6b).	16,896	3.2
TOTALS	**60,720**	**11.5**

2.0 Seasonal Restrictions

The roads from State Route 16 to the maintenance center, approximately 4.5 miles in from Route 16, including the parking lot, will be plowed through the winter to allow for normal automobile access. This is the only portion of the access road which will be used by normal automobile access year round.

During snow months, the roads from the maintenance building to the turbine sites will not be plowed but “groomed,” as ski areas do, to allow access to the turbine sites by snowcat, snowmobile, ATV or tracked vehicles. During snow months it will not be suitable for heavy vehicles to travel on these sections of the roadway; hence they will not have access to the turbines during this period. Only small ATVs will be allowed to use these roads during the spring thaw to prevent damage to the roadway.

3.0 Basis of Roadway Design

The basis for the design of new roads, as well as upgrades to existing roads, is discussed in this narrative. This report and the accompanying plans provide a preliminary horizontal alignment and the basis of the vertical alignment. However, the baseline data available for design is limited to 5' contours developed with aerial topographic surveys, much of which is subject to the limitations of obscured ground conditions.

The roadway construction will need to proceed in an uphill direction. Completed roadway sections will be used to access the next roadway construction area (the erosion and sedimentation control plan for the roadways is presented in a separate section of this application, but requires construction of the roadway by segments which are completed prior to moving to the next segment). This requirement is stipulated to minimize the size of denuded areas exposed to erosion during adverse weather conditions.

This basis of design for the roadways integrates the technical load bearing and geometric criteria with site-specific observations including additional challenges of construction of roadways in the higher elevations (above elevation 2,700). The design intent for roadway construction is to use naturally occurring materials supplemented by manufactured products that will enhance the performance and design. A list of the manufactured materials which will be used includes:

- **Filter Cloth:** Native materials that can be layered to meet geotechnical filter criteria are difficult to obtain in this area and require relatively large section thicknesses. This is because there are several layers of materials required and each layer needs to be at least 6" in thickness to be practical to install. A synthetic material which can provide this filtering and material separation in a very thin, single layer is geotextile filter cloth.

- **Geotextile Fabrics:** Bridging soft subgrades and maintaining the separation between soils can be achieved with geotextile fabrics. These fabrics have some tensile strength not found in native materials and can be very effective when placed over weak subgrade areas. Native cover is placed over the geotextile cloth to help disperse the load over the weak subgrade area. Fabric placement with overlaps and avoidance of excessive creasing is necessary.

- **Reinforced Turf and Erosion Control Meshes (ECM):** There are numerous grades of materials for reinforced turf and ECMs. Some are intended merely to resist wind from dislodging the cover material (netting), while others permit the slope to be increased or the erosion control resistance to be increased.

- **Geogrids:** Geogrids provide lateral reinforcement to the soil, thereby increasing the natural angle of repose.

These synthetic materials are proposed as tools to supplement the constructed roadway section, to permit an increase in the angle of cut and fill slopes, and to stabilize the surface of disturbed areas. These same materials are integrated with the erosion control plan for the roadways.

The roadway is designed for construction and long-term access to the wind turbines. The design is illustrated on the typical details, profiles, and plan views of the drawings which accompany this application.

The following are the design parameters for the roadway and a description of how the proposed roadway alignment shown on the plan conforms to these design criteria.

3.1 Longitudinal Grades

The basis of the vertical alignment for the access roads is as follows:

- The maximum longitudinal grade is 14%, based upon limitations of the equipment which will transport the project equipment to the summits of the mountains for fabrication and erection at the wind turbine sites.

- A K-value of 15 is desirable for vertical curves, with a K of 10 acceptable when deemed necessary. This parameter is based upon the need to provide for a maximum vertical crown or sag of 30 inches in a 50-foot distance for existing and proposed access roads and to provide for a maximum vertical crown or sag of 6 inches in a 50-foot distance for proposed mountaintop roads.

The application submission includes profiles of the roadway, which illustrate the existing vertical alignment along the centerline. A graphic tool is included on the profile sheets to illustrate 5, 10, and 14% grades. The effective existing grade has been computed at 200-foot intervals and is noted near the bottom of the profile sheets. These computed grades demonstrate the roadways follow a route wherein the existing centerline profile is generally within the design criteria. Therefore, the roadway centerline profile can be constructed closely paralleling existing grades. Limited softening of the profile grades through minor cuts and fills will be required to address the unevenness of the profile and to provide the parabolas for vertical curves between grade changes. Cuts and fills will be attendant principally with the existing transverse grades. The transverse grade varies from being gentle on the mountain ridge tops to being extremely steep on portions of the access roads. The slope maps, which accompany this report in Appendix 2.5, illustrate the side hill slopes that the roadways will traverse.

Flexibility to adjust the vertical profile grade based on field conditions has been provided by selecting a route where the existing grade is generally less than the maximum permissible grade. The most likely field condition which would require an upward adjustment be considered will occur in areas where wet conditions or springs are encountered. An upward adjustment will permit the road contractor to reduce the depth of cut for roadway back slopes into wet seeps and increase the cover thickness over weak subgrade areas. In rock areas, the contractor may want to lower the profile to gain additional material and to reduce the size of the fill slope.

A description of the roads citing areas where the proposed alignment is not anticipated to parallel the existing vertical alignment is described below:

3.1.1 Redington Access Road

Two different access road routes were evaluated for access to the Redington Mountaintop, one from the north and one from the west. The route from the north extended from the end of RE6a at the location of an existing log yard. This route would have required installation of up to two bridge crossings and a number of locations where cut and fill slopes on the order of 20 to 30 feet would have been required due to the steep terrain. This northern route, which was not selected, is shown on the project Base Map.

The western Redington Access Road is located in more moderate terrain than that encountered to the north of Redington. The colored slope maps, which accompany this report in Appendix 2.5, illustrate the terrain for this access road. Different alignments were evaluated before the alignment shown on Drawing C-5, with the attendant profile shown on Drawing C-17, C-18 and C-18 was selected (see Appendix 2.4). The alignment was selected after considering the various design elements described in this report.

Near the beginning of the Redington Access Road between stations 1406+00 and 1409+00 a cut on the order of 12 feet is required to allow for a switchback in this area.

Between stations 1434+00 and 1440+00, a fill of approximately 7 feet will be required to maintain the 14% maximum grade.

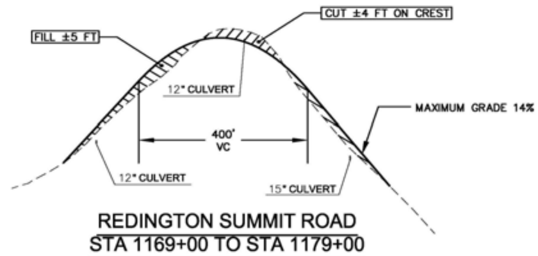
The most difficult segment of this proposed access road is encountered between station 1481+00 and 1488+00, where a major fill of up to 20 feet and a cut of up to 18 feet will be necessary to turn the alignment of the roadway in an area where existing grade exceeds 33%.

This 9,596-foot roadway ends at station 1495+96 at the start of Redington Summit Roadway.

3.1.2 Redington Summit Roadway

The Redington Summit Roadway continues from the end of the Redington Access Road and, including spurs, has a length of about 19,000 feet. The profile for this roadway is shown on drawings C-14, C-15 and C-16 (see Appendix 2.4). The alignment of the roadway can mirror the existing topography except in the following areas:

- The Redington Summit Road will reach its highest point near station 1174+00 at an elevation of 3,905 feet. A cut on the order of 4 feet will be required at this location to meet the basis of design criteria. This excess material may be rock but could be "lost" in a widened section either side of the crest. The tools include the provision for a steep back slope of 1:6 (near vertical), which will reduce excavation into rock across this crest. This section is illustrated in the figure below.



- There is an area between stations 1193+00 and 1198 where it will be necessary to elevate the road slightly to allow the profile to remain within the maximum basis of design grade coming down from the ridge at station 1174+00. The excess fill placement in this area is expected to be on the order of 4 feet and should be obtainable by widening the "cut side" of the roadway.

- The spur out to turbines 8 through 11 also crosses a ridge. Work within the design limits will likely require cuts and fills along this area. Excess material could be wasted in the sag area and could have near vertical cut slopes and 1-1/4 to 1 fill slopes to avoid excessive earthwork. This section can be seen on profile sheet C-16 (see Appendix 2.4). Here is an example where the outside turn radius could be reduced to 115 feet to stay out of steeper terrain and reduce cuts and fills. Once again, the design is intended to retain flexibility to allow the final layout to blend more harmoniously with the topography of the slopes.

3.1.3 Upper Black Nubble Access Road

The Upper Black Nubble Access Road starts at about elevation 2,660 and ascends to elevation 3,310. The profiles are shown on drawings C-11 and C-12 (see Appendix 2.4). The access road is nearly a continuous uphill grade over its length of about 6,275 feet. It appears that the first 4,700 feet of the road can essentially mirror the existing profile with a minor fill of up to 3 feet on centerline between stations 2027+00 and 2029+00. Between stations 2047+00 and 2059+00, it is anticipated cuts will be required in order not to exceed the maximum 14% design grade. These cuts are expected to be shallow except for about a 200-foot section where cuts on the order of 20 feet are likely.

3.1.4 Upper Black Nubble Summit Roadway

The Upper Black Nubble Summit Road is about 9,328 feet including spurs. The profile is shown on drawings C-9 and C-13 (see Appendix 2.4). The Upper Black

Nubble Summit Road starts at elevation 3,310 and ascends to near elevation 3,700 in one area. The vertical alignment will require minor cuts and fills along much of its route to smooth irregularities, which are prevalent in these upper elevations.

3.1.5 Lower Black Nubble Access Road

The Lower Black Nubble Access Road is fairly short, being about 500 feet in length. The vertical alignment of this section should closely mirror the existing profile.

3.1.6 Lower Black Nubble Summit Roadway

The Lower Black Nubble Summit Road is about 16,300 feet in length including spurs. The profiles are shown on Drawings C-8, C-9 and C-10 (see Appendix 2.4). The summit road elevation varies from elevation 2,875 to 3,130. However, this 255 feet of elevation change is gradual, which permits the vertical alignment to be very close to paralleling the existing profile. The first fourteen hundred feet appears as if the proposed profile can closely mirror the existing grade. Between station 2814+00 and 2821+00 is a 700-foot area where vertical parabolas will be used to smooth the alignment and may involve cuts or fills of up to 5 feet on centerline. The next 2,900 feet of the roadway appears to permit the profiles to be paralleled. Smoothing the alignment between stations 2850+00 and 2854+00 will eliminate a sag area and require a fill on the order of 12 feet with a cut of 4 feet ± on centerline. The main summit road will crest at about station 2662+00 and begin a descent. Some fill is expected at the terminus, but the rest of the 2,100 feet along this summit road can closely parallel the existing contour. The main summit road is about 8,700 feet in length.

The main spur of the Lower Black Nubble Mountain Summit Road begins at station 2900+00 and is about 5,800 feet in length. Some cutting is anticipated crossing the first summit with cuts on the order of 10 to 12 feet. From station 2918+00 to the terminus at station 2958+00, some cuts and fills are anticipated to improve the vertical shape. Cuts and fills in this area are anticipated to be less than 5 feet in height, except for deeper fills of about 10 to 12 feet on centerline near stations 2920+00 and 2935+00.

3.2 Horizontal Alignment

The horizontal alignment for proposed access roads is currently shown with a minimum centerline radius of 150 feet. Because of the slow travel speed anticipated, there was no specific tangent distance between compound or reverse curves. The minimum design standards in Appendix 2.6 indicate that a minimum outside radius of 115 feet can be used. This tighter radius has been used in areas where wetlands are present, along existing roads requiring widening as shown in inset area drawings included with this submission. With the ability to reduce the 150-foot centerline radius to a 115-foot outside edge of roadway radius, the locations of the switchback curves could be adjusted based upon the field conditions encountered to reduce deep cuts and fills required at switchbacks.

The horizontal alignment was selected to permit the route to stay within permissible vertical limits with a preference for areas of mild transverse grades and to avoid the natural resource constraints identified by Woodlot Alternatives to the extent practicable. Because meeting the vertical limitations requires an alignment across the contours, it is necessary to periodically introduce a switchback curve. These locations were selected to occur in areas of mild topography to the extent possible and will require an increase in roadway width up to 20 feet.

The location of the roadway relative to topographic constraints and the attempt to site it within the milder topographic areas of the route corridor will permit the road to achieve its function while being constructed to set harmoniously within the existing conditions found along the corridors.

It is possible that actual field elevations or conditions may not be accurately reflected on the baseline due to obscured ground conditions (noted on the mapping) and the limitations of the contour interval (5 feet). This could be adjusted in the field. For example, if the actual elevations were three feet higher than anticipated and the existing transverse slope was 15%, a 20-foot down slope adjustment would result in a relative vertical alignment mirroring that which was anticipated during the preliminary design. Caution will be needed with any horizontal adjustment to check and make sure that any resultant shortening of the route length can be accommodated with the final vertical alignment. This caution regarding shortening the route length will be especially important in areas where the switchback curve radius is reduced below 150 feet. The design tools also provide the ability to increase cut or fill volumes.

The horizontal alignment results from the skewing across steep contours to maintain a profile up to or below the 14% maximum grade. A procedure referred to as compass routing is used for the selection of the initial alignment. This technique does not permit vertical curves to be evaluated but creates an initial alignment which can be refined using the profiles. Periodically, it is necessary to introduce a switchback in the alignment. The locations for the switchbacks are areas where the topography flattens out somewhat. Otherwise, the vertical alignment goal is exceeded and deep cuts result. While some relatively deep cuts in the switchbacks cannot be avoided, the siting of these on the flatter area of the hillside minimizes the depth of the cut.

Intersections are also shown with the horizontal alignment. These are generally “T” intersections (which join to be a curved equilateral triangle in the optimum case) to provide access using summit spurs, or for turnarounds for the large vehicles which will transport the turbines and blades to the tower sites for erection. There are certain areas where turn-around is not practicable, which will necessitate the large haul vehicles either back up the last roadway segment, or that the vehicles are picked up and turned around by the crane. The most notable area where turnarounds are not practicable is at the northern turbine sites on Upper Black Nubble.

The horizontal alignment of the Redington Access Road has 4 switchbacks. The vertical alignment through the switchbacks at stations 1482+00 and 1487+00 has the most substantial cut/fills reflecting the lack of a natural flat area shallow enough for these curves. The Redington Summit Road has 2 switchbacks, both at the beginning of the summit road.

The horizontal alignment of the Upper Black Nubble Access Road is a series of small curves which lengthen the roadway, thereby allowing the ascent up the hill to be made generally paralleling the existing grades. The horizontal alignment of the Upper Black Nubble Summit Road has an immediate switchback to sweep around the ridgetop and head northerly to other turbine sides. There are several spurs at the end of the summit road to gain access to individual turbines. Turnarounds are not practicable to construct near this northerly terminus. The Lower Black Nubble Road is fairly smooth in alignment reflecting gentler topography. The Lower Black Nubble Summit Road is also quite regular in alignment, except for a switchback to access wind turbines on the easterly end of the summit. The approach to the curve at station 2939+00 to 2947+00 requires fill in the 600 feet preceding this curve. An alternate route to avoid this area is shown on Drawing C-3 (see Appendix 2.1) and profiled on Drawing C-12 (see Appendix 2.4).

3.3 Roadway Width

The access roadway width for road segments leading up to the mountaintops in tangent sections is 12 feet in width. Shoulders should be 2 feet on the uphill side to aid in some snow storage. A four-foot shoulder is used for the downhill side except where the fill height is less than 4 feet and a 3:1 or flatter slope can be constructed. In these areas the shoulder will be reduced to 2 feet. Wide-outs 20 feet in width and 200 feet in length for passing will be constructed along existing and proposed incoming access roads. Locations of wide-outs will be selected to avoid wetland areas. Field notes, which identify potential locations for wide-outs along existing access roads, from a site visit the week of October 4, 2004 by Dwight Anderson, P.E. of DeLuca-Hoffman Associates, Inc. and Michael Johnson of Woodlot Alternatives are included in Appendix 2.7.

The roadway width increases in curve sections, especially the switchback areas. The plans include a schedule for increasing the roadway width in non-tangent areas. Additional details including vegetation clearing requirements noted on the Redington Wind Power Project's "Narrow Road" specifications are included in Appendix 2.6.

The summit and mountaintop spur roadways width is 32 feet. Shoulder requirements will be the same as that for other access roadways noted above.

3.4 Transverse Grades

A roadway with a shoulder and travel lane section width of 18 feet and a one-foot wide by two-foot-deep ditch on the uphill side with 3:1 side slopes will have a grade differential across the 31 foot wide transverse section of the following:

Table 2 - Transverse Slope

Transverse Slope (%)	Differential from Uphill Side of Ditch to Edge of Outside Shoulder
1	0.31'
3	0.93'
10	3.10'
20	6.20'
25	7.75'
33	10.23'
50	15.50'

Actual construction widths will be wider depending upon the respective cut or fill height relative to existing grade, fill slopes, and back slopes.

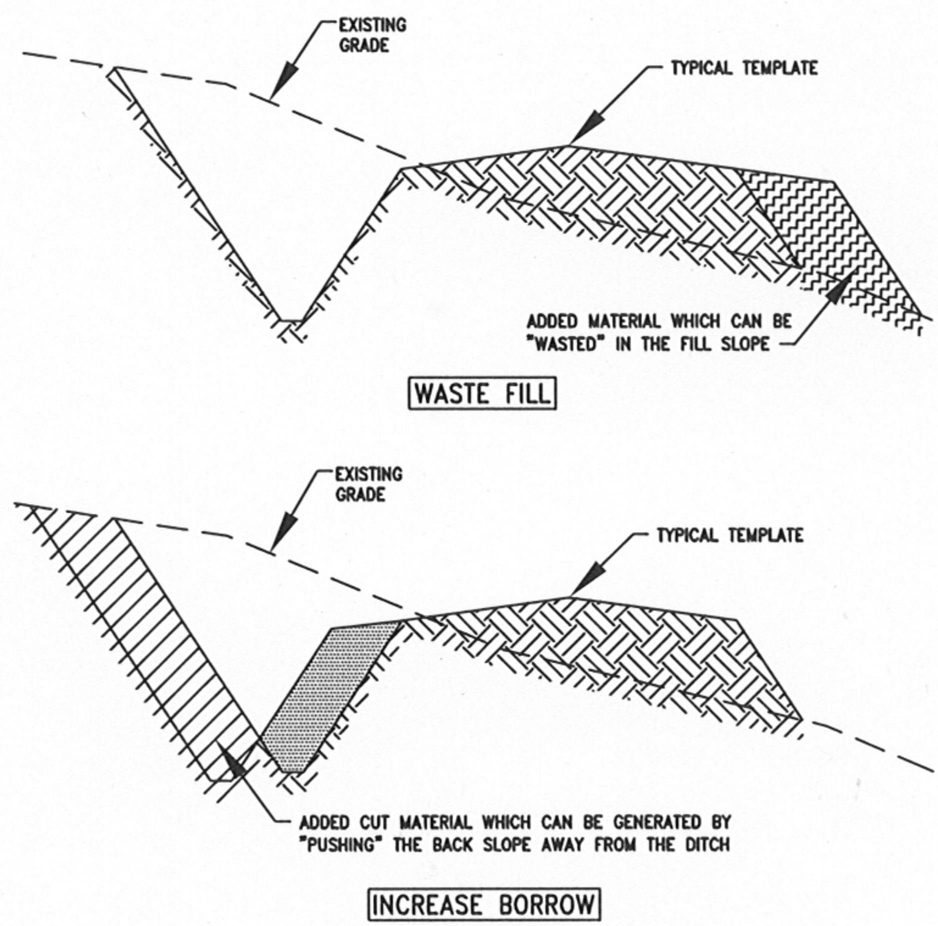
The design tools allow the selection of materials to steepen either the back slopes or the fill slopes. These tools are illustrated in the roadway section options that accompany the submission. As shown, it is possible for fill and back slopes to be constructed nearly vertically. However, the near-vertical construction requires special construction techniques, is very labor intensive, and requires special equipment. Therefore, while tools are available for slope construction of over 1H:6V slopes, it is anticipated that most of the roadway will be constructed with back and fill slopes of

1-1/4H to 1V and flatter. In fact, most areas are expected to employ slopes in the 2H:1V to 3H:1V range. This is possible since the alignment allows the profile to nearly mirror the existing conditions, thereby reducing the width of the disturbed area when compared to an alignment with substantial cuts and fills.

3.5 Cuts and Fills

The roadway alignment was selected with the idea that material would be cut from the high side and used for subgrade fill on the low side. The exceptions to this would be in the locations listed in 3.1.1 to 3.1.6 of this report.

Where necessary, the cut amount can be increased or the excess fill wasted. The ability to gain or waste fill across the section is illustrated in the figure below:



METHOD TO ADJUST ROADWAY TEMPLATE TO INCREASE CUT OR FILL

3.6 Roadway Surface Treatment

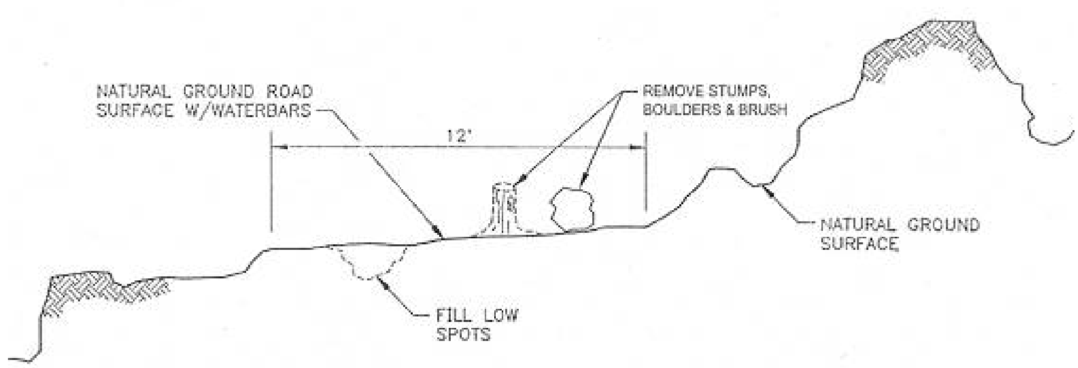
The proposed access roads have steep grades. Runoff across the roadway has a propensity to erode the surface. Over time, the roadway unravels and becomes rutted. Two options are available:

- Regrading and leveling of the roadway surface after any significant rainfall.
- Treating the surface to reduce the erosion potential of the roadway surface.

This will need to be an applicant-selected option. DeLuca-Hoffman Associates, Inc. recommends the second option be selected. This would be accomplished using either an asphalt/chip seal or asphalt/gravel mix-in-place application. If this option is adopted, the final design of the asphalt/aggregate mix should be performed by the geotechnical engineer.

3.7 Temporary Construction Roads

Temporary upland construction road will be cleared to a minimum width to allow passage of construction equipment and will require no other improvements than removal of large rocks, stumps, and brush and limited earth cutting and filling to facilitate vehicular passage, as shown on the figure below. Previously used logging roads will follow the natural ground contours when practical and standard erosion control measures described in the Erosion and Sediment Control Plan will be utilized



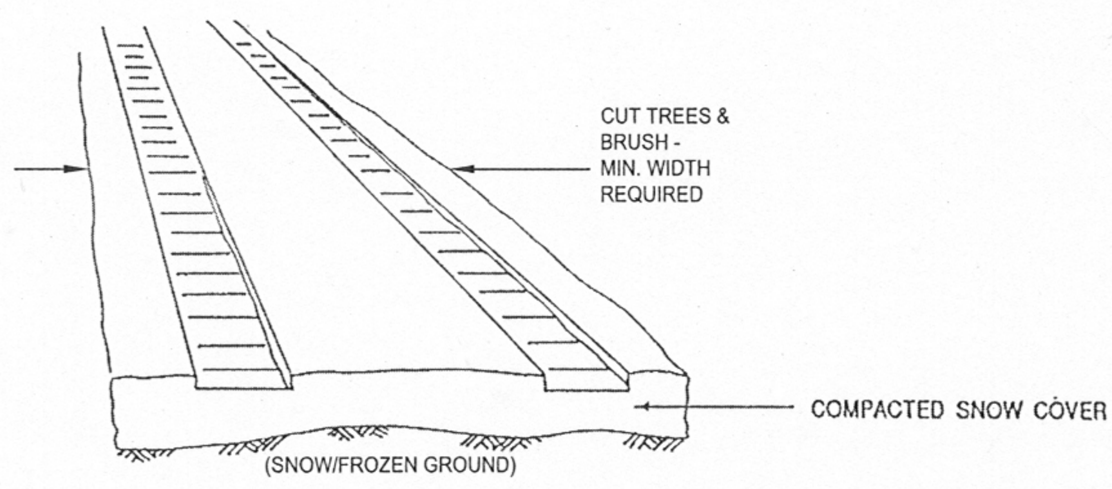
TEMPORARY UPLAND CONSTRUCTION ROAD

along these areas. Corduroy road and geotextiles may be used in areas where poor soil conditions exist.

When temporary upland construction roads are constructed along the proposed roadway alignment, the alignment will be cleared to a 40-foot width and constructed as described above. This will allow for advancement of construction activities along the route and slight horizontal shifts or vertical adjustments to the final roadway alignment prior to completing clearing activities.

3.8 Temporary Wetland Construction Roads

Wetland temporary light duty roads shall be constructed only when no other practical means are available to access roads through a wetland. All wetland roadway construction and use will occur during winter months when the ground is frozen or snow covered. No ground disturbance is anticipated, except that trees and brush will be cut off at ground level for the minimum width required. It is expected that temporary roads in wetland will be in place a maximum duration of six months. Following is a typical detail of a temporary wetland access road.



TEMPORARY WETLAND CONSTRUCTION ROAD

3.9 Visual Corridor Areas

The selection of the type of roadway section will be affected by whether or not the roadway segment is considered to be within a sensitive view corridor. To the extent practical, slope treatments in these areas will be chosen to minimize visual impact. For example, this may result in a recommendation for a different cover material for the re-establishment of vegetation. A discussion of these areas is provided in the visual assessment.

3.10 Natural Resource Areas

The alignment of the roadway has been selected to minimize impacts to the natural resource areas which have been identified by Woodlot Alternatives, principally by avoidance. The bridge crossings of the major streams are detailed separately and show how impacts have been minimized.

4.0 Anticipated Improvements to Existing Roads

Access to the wind turbines will use approximately 60,720 feet (11.5 miles) of existing gravel roadways identified as the IP (International Paper) Road, RE2 and RE6b and as shown in red on the base map.

Improvements to existing roads would include strengthening any bridge crossings to accept the wheel loads required for the project, widening of the roadway surface where necessary, and geometric improvements. Two types of improvements will require realignment of the existing roadway in a new location:

- Realignment to reduce vertical grade; and
- Realignment of the roadway to eliminate corners with insufficient radii.

4.1 Areas with Insufficient Turn Radii

The existing roadways are depicted on the Base Map. The known areas of deficient horizontal geometry are identified on the base drawing as C1 through C10. The anticipated remedial measures are discussed below.

C1 is located at the intersection of IP Road and Route 16. This is a relatively flat area where minimal widening of corner radii may be necessary. The existing travel width of the road is 23 feet at this location.

C2 is located just after the second bridge crossing on IP Road about 2.7 miles from Route 16. This is a tight corner with inadequate radii located on terrain with moderate slope. The outside edge will need to be widened to a 115-foot radius. The existing road travel width is 16 feet at this location. No wetlands were observed in this area during an October 2004 site visit. Field notes from the site visit are included in Appendix 2.7.

C3 is located just after the third bridge crossing on IP Road about 3.1 miles from Route 16. This will require similar improvements to C2, but is located on flatter terrain. The existing road travel width is 13 feet at this location. Again, no wetlands were observed in this area during the October 2004 site visit.

C4 is located just before the proposed Maintenance Building Lot about 4.0 miles from Route 16. Grade in this area is approximately 10 percent and a limited amount of outside curve widening is expected to be required. The existing road travel width is 15 feet at this location. No wetlands were observed in this area during the October 2004 site visit.

C5 is located just after the proposed Maintenance Building Lot and is also the intersection which splits the route to either Redington or Black Nubble Mountain. The turn toward Redington will require widening of approximately 400 feet of roadway. Wetlands exist in the area of C5; therefore, Inset Area 3 has been prepared to show the limits of the roadway improvements in this area.

C6 and C8 are located approximately 2,000 feet each side of C5 and both are expected to require limited roadway widening to improve their alignments. The existing roadway travel width at C6 is 15 feet and C8 is 12 feet. No wetlands at C6 or C8 were observed during the October 2004 site visit.

C7 is located just after Bridge Crossing #1 leading up to Lower Black Nubble (the southwestern portion). Existing grades are moderate in this area and improvements are required. Wetlands exist in the area of C7; therefore, Inset Area 5 has been prepared to show the limits of roadway improvements in this area.

C9 is located just after Bridge Crossing #3 leading up to Redington Mountain. Existing grade in this area is very steep and this section of road is known to have failed by sloughing when first constructed in the 1970s. Typical logging trucks currently track their back wheels within 1 to 2 feet of the steep downgradient slope. Structural measures would have been required in this area if Route RE6a was selected. Photos of this area taken on October 17, 2003 are shown on this page. This area helps to justify why Route RE6b was selected over RE6a.

C9

C10 is located at Bridge Crossing #4 where the road turns to go up a steep slope toward Redington. Again, roadway widening would have been required in this area in conjunction with bridge or culvert improvements if Route RE6a was selected.

4.2 Vertical Realignment

The vertical grade along the existing roadways has not been formally measured by ground survey. However, the areas where the existing vertical alignments are steep are identified on the base drawing as V1 through V6, and the approximate grades in these areas were visually estimated in the field with the use of an inclinometer.

V1 is located just after the turn to go to Black Nubble after the Maintenance Building Lot. Grades in this area have been estimated at 13% and the road is stable in its current location; therefore, realignment should not be required to lengthen the roadway.

V2 is located along RE2 after the shale pit. Many dips exist in this area due to culvert crossings which have been removed. Installation of culverts and filling of dips is anticipated in this area.

V3 is located along the existing route leading up to Lower Black Nubble after Bridge Crossing #1. Grades in this area have been estimated at 14% and short sections of existing road grade up to 18% are allowed by the "Narrow Road" specification; therefore, realignment of this road section is not required.

V4 is located along the existing route leading to Redington Mountain just before Bridge Crossing #2. This is a steep section with an estimated grade of 17%, just under the 18% max for existing roads. A photo looking downgradient toward Bridge Crossing #2 is shown here.

V4

V5 with an estimated grade of 17% is located after Bridge Crossing #3 off of the selected route.

V6 with an estimated grade of 19% is located after Bridge Crossing #4 and would require a significant roadway shift to the south starting west of Bridge Crossing #4 to reduce vertical grades if Route RE6a had been selected. A photo looking upgradient from Bridge Crossing #4 is shown here.

V6

The improvements to the existing roads would be required to meet the same erosion control provisions and basis of design as the new roads, except that short sections of existing roads will be allowed to have grades of up to 18%. Details for the erosion control provisions are provided in the project drawings.

5.0 Materials of Construction

The materials for construction of the roadway section are discussed in the geotechnical narrative that accompanies the application and are illustrated on the detail drawings.

6.0 Other Tools for Construction of the Roadway

Other tools are available to the contractor, including the use of under drain and trap-rock in the pavement subgrade to address subgrade drainage, the use of synthetic materials, and other opportunities which will result in a roadway section which is appropriate for the actual conditions encountered.

If conditions were found which were not reflected on the baseline data, it would also be possible to make minor changes to the location of the centerline for the roadway, provided the basis of design criteria is not violated and the roadway remains within the permissible roadway corridor shown on the roadway drawings.

7.0 Implementation

The erosion and sedimentation control plan requires the roadway be constructed in segments. It is recommended that the area of construction be staked and a corridor of at least 40’ feet be cleared ahead of the construction crews. Subsequently, this area should be staked out at 50-foot centers and walked by the design team, the geotechnical engineer, and the contractor to agree on the following:

- Confirmation or recommended adjustment of horizontal and vertical alignment;
- Selection of cross section to be used in the area;
- Locations for cross culverts; and
- Other tools to be employed.

It will be necessary for this effort to precede construction by a sufficient period of time in order that adjustments can be made and the contractor can have final clearing, blasting, and proper materials on hand.

8.0 Closure

The basis of roadway design allows third parties to understand the requirements for the roadway, define the basis of how the alignment was selected, and provide a description of the flexibility for construction, which has been reserved for implementation.

As required by LURC Chapter 10, Rules and Standards, the roadways have been designed to minimize the use of ditching and to fit the natural topography of the land such that cuts and fills are minimized while preserving the scenic quality of the surrounding land to the extent possible.

APPENDIX 2.1

APPENDIX 2.2

APPENDIX 2.4

APPENDIX 2.5

APPENDIX 2.6

APPENDIX 2.7

APPENDIX 8.4