# Black Nubble Wind Farm Project

# Stormwater Management for Primary Access Roads and Summit Road

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## 1.0 Introduction

DeLuca-Hoffman Associates, Inc. was retained to prepare designs and portions of the permit applications for a series of wind turbines proposed to be sited on Black Nubble. DeLuca-Hoffman Associates, Inc. designed the primary access roads and summit roads, which will be used to access the wind turbines from existing roadway systems; and also prepared the Stormwater Management Report, Erosion and Sedimentation Control Plans, Road Maintenance Plan, Solid Waste Narrative, and Blasting Narrative associated with the primary access roads and summit roads. Note that the term "summit road" is synonymous with "ridgeline road" within this application. The work of DeLuca-Hoffman Associates, Inc. is summarized in a series of reports as follows:

- Basis of Design for Primary Access Roads and Summit Roads;
- Erosion and Sedimentation Control Plan for Roadway Construction;
- Stormwater Management for Primary Access Roads and Summit Roads;
- Road Maintenance;
- Blasting Narrative;
- Erosion and Sedimentation Control Plan for Transmission Line Corridor Construction; and
- Solid Waste Narrative.

The narratives prepared by DeLuca-Hoffman Associates, Inc. are supported by the project Civil Engineering Design Drawings included with this submission. Please refer to Cover Sheet C-1 for a complete list of the project drawings.

The designs and reports prepared by DeLuca-Hoffman Associates, Inc. rely upon baseline information provided for this project by other Project consultants.

Civil Engineering Design Specifications for the project are provided in Appendix 2.11.

DeLuca-Hoffman Associates, Inc. has prepared the following Stormwater Management for Summit Roads, Primary Access Roads, Turbine Sites and the Substation for the Black Nubble Wind Farm Project.

Limited areas where culvert installation is required along existing roadways has also been addressed.

The project is not in a lake, river, stream or brook most at risk from development.

## 2.0 Existing Site Conditions

The project has remained consistent with the preliminary development plan submitted last year with only minor changes to roadway alignment and turbine locations as a result of ground truthed survey data; therefore, the findings in the stormwater report previously submitted remain valid and only revised calculations to support actual proposed culvert locations has been necessary. After the submission of the original application, Woodlot Alternatives and Albert Frick, a certified soil scientist, walked the proposed roadway corridors to identify drainage courses, seeps, and wetlands. This information is shown on the design drawings included with this submission and proposed drainage elements have been cited based upon these existing features.

## 3.0 Existing and Proposed Drainage Features

The stormwater management report provides the basis for the size and placement of most culverts. However, placement will also rely on field judgment. Stationing for culvert placement is provided on the project design drawings based upon field reconnaissance by the project's wetlands and soils experts, identification of drainage features, and stormwater calculations. Flagging has been provided in the field to demark these drainage features. There will be instances where adjustments to the culverts location to better align with existing drainage features will be appropriate.

Monitoring of the culvert outlets after construction will be necessary to confirm the culvert discharges are not causing erosion in downstream areas. If erosion is observed, the following corrective alternatives are available:

- Placement of non-erodible material or geotextiles to re-disperse the flow.
- Adding Culverts – For example, if a problem area was observed, and it appeared to be fed by 200 feet of runoff intercepted in the uphill ditch, a second culvert placed midway back of the ditch line would reduce the flow by 50%. Therefore, follow-up monitoring of the outlets will occur to verify discharge stability.

The existing roadways have existing culverts and bridges, which will be retained. If lengthening of culverts is required along existing roadways, the size will be matched. If culvert replacement were required, the replacement for small culverts would be increased by one size. (For example, a 15-inch culvert would be replaced with an 18-inch culvert.) Larger culverts would be checked for size before replacement using the procedures described in the stormwater management report for roadways.

There are instances where culverts along existing access roads have been removed in the final design because they are not necessary. The locations of these missing culverts are shown on Drawing C-BN56. Culvert sizing calculations for the installation of alternative culverts at these locations are provided in Attachment B.

## 4.0 References


- HydroCAD Version 6.10 – Used for SCS-TR-20 Comparison Analysis to Rational Method.
- IDF Curve – Town of Rangeley – MDOT Highway Design Manual, Figure 12-14.
- Culvert Design Form – MDOT Highway Design Manual, Figure 12-20.

- Chart 1 – Headwater Depth for Concrete Pipe Culverts with Inlet Control – MDOT Highway Design Manual, Figure 12-21.
- Appendix D-1 – (SCS) One Day Precipitation Values – MeDEP Stormwater BMPs.
- Rainfall Factor "RF" (BPR 1021 Series Method), MDOT Highway Design Manual, Figure 12-5.
- Peak Runoff Rates (BPR 1021 Series Method), MDOT Highway Design Manual, Figure 12-6 (a), (b), and (c).
- Appendix D-12: Runoff Coefficients for the Rational Formula by Hydrologic Soil Group and Slope, MeDEP Stormwater Management BMPs.
- Appendix D-13: Runoff Curve Numbers for Use in TR-55, MeDEP Stormwater Management BMPs.
- Buffer Removal Efficiencies; Addendum to Stormwater Management for Maine: Best Management Practices, December 12, 1996.
- Stone Size for Rip Rap (USDA Soil Conservation Service), MeDEP BMPs for Construction, Figure 70.1, March 1991.

These reference figures and tables are appended to this report as Attachment A.

## 5.0 Overview of Stormwater Runoff Modeling

The proposed wind turbines will be sited on Black Nubble. The topography is relatively is steep except for relatively mild topography on the very crest.

Black Nubble is not located in a mapped 100-year floodplain.

## 6.0 Method of Analysis – Stormwater Quantity

The hydrologic analyses for the evaluation of roadway culverts have been conducted based upon simple methods that are easy to employ in the field to check culvert capacity and placement. The methods include the rational method, BPR series method, and the USDA Soil Conservation

Service's Method used by MDOT. These methods generate a peak flow needed for culvert and ditch design. Four catchments were previously analyzed using the methodology contained in the USDA Soil Conservation Service's Technical Releases No. 20 and 55 (SCS TR-20 and TR-55) as modified for special site conditions. For Franklin County, Maine, a 24-hour SCS Type III storm distribution was used for the analysis using the following storm frequencies and rainfall amounts:

| **Storm Rainfall Amounts** | |
|---|---|
| **Storm Event** | **24-Hour Rainfall (inches)** |
| 2-Year Storm | 2.9 |
| 10-Year Storm | 4.2 |
| 25-Year Storm | 4.9 |
| 100-Year Storm | 5.9 |

The rational method requires a time of concentration to be determined from which a peak rainfall intensity is selected, a land cover coefficient, and the watershed area. The intensity and land cover coefficient for the analysis are based upon references outlined in Section 4.

The four catchments mentioned above were also analyzed using the BPR 1021 series method. The BPR 1021 series method requires the following input: a rainfall factor, land cover factor, frequency factor, runoff index, and watershed area. The rainfall, land cover and frequency factors for the analysis are based upon figures 12-5, 12-6(a), 12-6(b) and 12-6(c) from the MDOT.

The HydroCAD computer program was used for the watersheds analysis with the SCS methodology. Input parameters for this were based upon the watersheds delineated from the base mapping. This program determines the critical points of the project watershed and uses SCS TR-20 methodology for evaluation of the anticipated conditions at these points. Drainage areas are defined with runoff curve numbers, times of concentration, and travel time data based on methods outlined in the USDA TR-55 manual. To assess storage and kinematic effects of runoff, the model uses reservoirs and pipes to imitate actual conditions. Specific hydrologic characteristics, including travel times, storage capacity, and the effects of hydraulic head, are considered for analysis with this program.

To model any watershed, the drainage system is represented by a system network consisting of four basic components:

- Subcatchment: A relatively homogenous area of land that drains into a single reach or pond. Each subcatchment generates a runoff hydrograph.
- Reach: A uniform stream, channel, or pipe which conveys water from one point to another reach or pond. The outflow of each reach is determined by a hydrograph routing calculation.
- Pond: A pond, swamp, dam, or other impoundment which fills with water from one or more sources and empties in a manner determined by a weir, culvert or other device(s) at its outlet. A pond may empty into a reach or into another pond. The outflow of each pond is also determined by a hydrograph routing calculation.
- Link: A multi-purpose mechanism for introducing a hydrograph from outside the diagram, by either manual entry, file import, or linkage to another diagram. A link also allows the diversion and/or scaling of hydrographs.

After identifying each of the components, the system may be represented by a routing diagram.

To calculate the outflow for each structure, HydroCAD automatically performs these steps:

1. If there is more than one inflow, the inflows are summed together to produce a single hydrograph. If a pipe is being re-sized, its diameter will be calculated to handle the peak inflow.
2. The inflow is routed through the structure using the description and method previously specified. For a subcatchment, the specified storm type and rainfall are used.

3. For a reach, the peak depth, peak velocity, contact time, etc. are calculated.
4. For a pond, the peak elevation, peak storage, etc. are calculated.
5. Any warning messages are displayed.
6. For the inflow and outflow, the peak flow and time of peak are calculated by interpolating between the three highest points.
7. The total volume of inflow and outflow are calculated.
8. The results are stored in a database for subsequent calculations or to be examined at any time.

The process is automatically repeated for each structure until the design point is reached. HydroCAD is a hydrograph routing model. It is specifically designed to handle time varying flows, as required for pond design and other volume-sensitive calculations. As such, HydroCAD routes completely through one structure at a time. Only after determining the outflow hydrograph from a given structure does it consider the next structure downstream.

Ditch scour protection was based upon methods outlined in the Maine Erosion Control BMP Handbook. A nomograph was used which provides a d50 stone size for a given ditch flow and velocity.

Land use, cover, delineation of watershed subcatchments, hydraulic flow paths and hydrologic soil types were obtained using the following data:

1. 7.5 minute Quadrangles Maps.
2. Franklin County, USDA Medium Intensity Soils Survey.
3. Onsite Topographic Survey with 5' contour intervals prepared by Aerial Survey, Inc. (Note: Many areas are annotated with the note "ground obscured" indicating the accuracy of the contours is limited.)

4. The Class D Medium Intensity Soil Survey for the site prepared by Al Frick closely mirrors the Medium Intensity Soil Survey available from the Soil Conservation Service.

The traditional SCS methodology and BPR 1021 series methodology were used to check the simple method computations for the larger watersheds. They were also used to compare one of the smaller watersheds for the preliminary development plan submitted last year. The results are as follows:

| Sample | Storm Event | Access Roadway | Culvert Station | Drainage Area (Acres) |
|---|---|---|---|---|
| 1 | 100-Year | Redington Access | 1440+23 | 22.66 |
| 2 | 100-Year | Redington Access | 1444+63 | 16.94 |
| 3 | 100-Year | Redington Summit | 1212+70 | 12.20 |
| 4 | 25-Year | Redington Summit | 1221+28 | 4.17 |

| Methodology | Storm Event | Culvert Station | Peak Flow (cfs) | Culvert Size Selected based upon Rational Method (Inches) |
|---|---|---|---|---|
| SCS<br>Rational<br>BPR | 100-Year | 1440+23 | 38.49<br>35.35<br>24.05 | 36” |
| SCS<br>Rational<br>BPR | 100-Year | 1444+63 | 30.17<br>26.43<br>19.77 | 36” |
| SCS<br>Rational<br>BPR | 100-Year | 1212+70 | 22.95<br>19.03<br>15.48 | 30” |
| SCS<br>Rational<br>BPR | 25-Year | 1221+28 | 5.74<br>5.33<br>5.45 | 18” |

This check verifies that although the simple methods employed to compute the watershed flows do not yield a hydrograph, good values are provided for peak flow values. As these verified the basis of design in the preliminary submission last year, the same methods have been used in the attached calculations updated for this submission. Stormwater flow and culvert sizing computations are appended to this report in Attachment B.

## 7.0 Site Specific Predevelopment Conditions Considered in the Analysis

The specific site conditions considered in establishing the basis of design include:

- The presence of seeps and subterranean water flows;
- The high elevations, topography, and the respective short growing seasons;
- The lack of alternate access; and
- The flow regimes observed during limited site reconnaissance.

These specific conditions have been addressed as follows:

### 7.1 Groundwater Seeps and Subterranean Water Flow

The basis of design is to minimize disruption of current drainage flow regimes. The entire corridor has been walked with the State Soils Scientist and areas with seeps and subterranean flow have been identified. However, when the initial corridor is cleared, evidence of additional seeps and subterranean flow will be recorded and a decision made to address these in one of the following ways:

- Raising the roadway profile slightly to reduce the depth of cut on the uphill side of the road.
- Installing a drainage blanket on the cut slope: Options include a Miraweb drainage fabric behind soil nail walls, the use of a drainage aggregate below the surface cover, a stone and fabric behind gabion walls, and the use of a stone backslope. The details in the plans illustrate these options.
- In the event that the existing surface is wet, the area will be identified and a sandwich of stone between filter fabric will be provided.

- If subterranean flow is heard and identified, the disruption will be minimized and trap rock sandwiched between geotextiles will be employed. The geotechnical engineer should monitor excavations in this area.
- The use of an underdrain on the uphill side to protect the base and subgrade of the road.

### 7.2 The High Elevations and Steep Topography

Will require winter measures to be employed earlier in the season, vegetation to reestablish these areas has been selected for harsher climates, and the period between disturbance and restoration of the roadway has been reduced for these areas. The steep topography has been considered by including methods which can be employed to steepen fill and backslopes, thereby reducing the changes in land cover.

### 7.3 The Lack of Alternate Access

To protect the road from damage from timber blowdowns, the edges of the roadway will be selectively cleared a minimum of 20 feet on either side of the edge of clearing for the roadway. Culverts 24 inches diameter and larger will have armor stone over the fill to help protect the roadway from washout in the event of a culvert failure.

### 7.4 Existing Flow Regimes

The drainage patterns, particularly in the higher elevations near the summits, are poorly defined and principally sheet and shallow concentrated flow. For this reason, the basis of design employs closely spaced small diameter culverts spaced in most cases a maximum of 200 feet apart with flow dispersion lips on the outlet side of the culvert except where an established drainage swale is identified when the roadway corridor is cleared. The culvert location would then be field adjusted.

## 8.0 Watershed Characteristics

The current cover for the predevelopment watersheds tributary to the roadway culvert is not materially different than will exist after the project is constructed. Culverts are intended to be placed in existing drainage swales and low areas to the extent these can be identified after initial clearing. Many of these have already been identified by field work to support the final design. In general, the watershed shapes will not be significantly altered, except at the lower edge where runoff will be collected in a ditch and directed through a culvert. Therefore, the shape of the pre and postdevelopment watersheds is essentially the same. The watersheds are provided on the plans which accompany this submission.

## 9.0 Postdevelopment Conditions

The postdevelopment conditions consider the proposed culvert locations and the attendant tributary watersheds. These watersheds are shown on the drainage maps and are summarized in the appended computations.

## 10.0 Roadway Drainage System

The drainage system for the roadways includes design and consideration of the following:

- Culvert Placement
- Culvert Sizing
- Ditch Capacity
- Ditch Lining
- Culvert Inlet and Outlet Aprons
- Flow Dispersion

This section of the narrative describes the basis design for these elements of the roadway system.

***Culvert Placement***

The drawings which accompany the application are based upon aerial photogrammetry which has been ground truthed with survey section along the road corridor. Most drainage features have been identified in the field and are shown on the project drawings. In some instances culvert locations may require field adjustment.

The field procedure to adjust the culvert locations should be as follows:

- Field locate the proposed culvert based upon the project drawings after the narrow corridor for reconnaissance of the roadway has been cleared;
- Review the conditions to determine if the culvert location should be adjusted;
- If an adjustment is needed, identify the location by the station shown on the drawings;
- Recheck the tributary drainage area and confirm the culvert size is acceptable;
- Confirm the basis of design as annotated on the profiles is appropriate;
- Determine the culvert length based upon the final field elevations and anticipated profile grade; and
- Notify the contractor of the adjusted culvert station, length, and size.

LURC Standards indicate that for roads constructed at 11 to 15 percent grades, ditch relief culverts are to be placed at a minimum spacing of 127 to 136 feet. In some instances the culvert spacing proposed for this project exceeds this minimum spacing; however, is supported by calculations and provides a margin of safety on the order of 2 and a number of design tools to help convey stormwater and soil hydrology.

***Culvert Sizing***

The culvert sizes have been based upon a ratio of one for the headwater to culvert diameter. Because the culverts are depressed below the shoulder, additional culvert capacity is provided. This added capacity is intended to provide for a margin of safety to help offset the database accuracy issue of obscured ground which may result in some error in the watershed size. A comparison between the culvert capacity at an HW/D of one and the available HW/D is provided in the following table:

| Table 7 – Flow Through Culverts with Inlet Control | | | |
|---|---|---|---|
| **Culvert Size** | **Flow at HW/D Ratio of 1** | **HW/D to Roadway** | **Shoulder Elevation** |
| 12 | 2.4 cfs | 4.00 | 8.00 cfs |
| 15 | 4.2 cfs | 3.20 | 12.00 cfs |
| 18 | 6.8 cfs | 2.67 | 17.25 cfs |
| 24 | 13.6 cfs | 2.00 | 28.00 cfs |
| 30 | 24.0 cfs | 1.80 | 45.00 cfs |
| 36 | 37.0 cfs | 1.67 | 72.00 cfs |

It is also noted that while the culverts have been sized not to exceed an HW/D ratio of 1; actual HW/D ratios are frequently less as shown in the appended computations. This provides an additional margin of safety in the design.

The culvert sizing also considered the distance of the roadway from the ridge of the mountain ranges. In the ridge areas the drainage regime is poorly defined with sheet and shallow concentrated flow being predominant. In these areas the design uses small, frequently placed 12-inch culverts to reduce the discharge volumes at the culvert locations.

As the roadway descends, the tributary areas are larger, drainage patterns are more discernable and larger culverts are proposed.

The locations and sizes of the culverts are shown on the design drawings included with this submission.

***Ditch Sizing***

All ditches have been sized to be a minimum of 12 inches wide with 3:1 sideslopes on the roadside and variable sideslopes on the cut side. The depth of flow in the ditches will vary with the longitudinal grade and ditch treatment. The capacity of the ditch flowing 12-inches deep with stone surface material and different grades are as follows:

| **Table 8 – Ditch Capacity and Velocity** | | |
|---|---|---|
| **Stone Lined Ditches Longitudinal Grade (%)** | **Velocity (fps)** | **Flow (cfs)** |
| 14 | 8.57 | 21.43 |
| 12 | 7.94 | 19.84 |
| 10 | 7.24 | 18.11 |
| 8 | 6.48 | 16.20 |
| 6 | 5.61 | 14.03 |

The ditch lining material is to prevent erosion by the flow conveyed by the ditch. The ditch lining stone size is based upon the maximum flow in the ditch based upon the flow to the cross culvert. Ditch riprap stone sizing is provided with the project details and supported by appended calculations included in Attachment C.

***Culvert Inlet and Outlet Aprons***

The culvert inlet and outlet aprons have been provided to:

- Lower the Ditch to the Culvert Inlet Elevation
- Block Water from Bypassing the Culvert
- Disperse the Culvert Discharge

The apron sizes are based upon culvert flow velocities and volumes. The details are shown on the project drawings that accompany this submission and supported by the appended computations.

***Flow Dispersion***

The flow dispersion beyond the outlet aprons of the culvert is intended to re-disperse the flow if no apparent receiving channel or swale is evident. The length of the dispersion berm should be at least six times the rated culvert capacity such that flows in a 25-year storm would not exceed a depth of six inches when crossing the flow dispersion berm.

This flow dispersion berm is a variation of the level lip spreader, but designed to hold the level of the berm somewhat better than some commonly used lip spreaders. These are only proposed to be used for 12-inch culverts and in most instances an apron with a 6-inch depression and stone lip will be used.

## 11.0 Requirement for Stormwater Management

Stormwater management is intended to provide either:

- Control of Peak Discharge Rates; or
- Measures to address Non-Point Runoff and Stormwater Quality

The need for Stormwater Management to control discharge rates can be determined by comparing the predevelopment (or current) flows with postdevelopment flows. The proposed roadway system is linear in nature, resulting in only minor land cover changes within a given watershed.

A comparison of pre and post development conditions provided in the preliminary development plan submitted last year demonstrated that stormwater detention is not warranted for the project and impacts associated with new access roads and summit roads has been reduced from last year's preliminary plan; therefore, stormwater detention remains unwarranted.

## 12.0 Phosphorous Impact Evaluation

The Black Nubble Wind Farm Project area is tributary to Flagstaff Lake, Redington Pond and a number of streams and rivers. The northerly portion of the project area discharges to Nash Stream, flows to the South Branch of the Dead River, and continues to Flagstaff Lake. The outlet is the Dead River, which flows to the Kennebec River at the West Forks. The southerly portion of the project area discharges to Redington Pond, flows to Orbeton Stream, and continues to the Sandy River, which also enters the Kennebec River at Starks._Ultimately, all of the site is tributary to the Kennebec River north of Norridgewock. None of these water bodies are in the watershed of a lake most at risk from development, of rivers, streams, or brooks most at risk from development, and are not coastal wetlands most at risk from development, as listed in Chapter 502 of the Maine Department of Environmental Protection regulations effective December 31, 1997.

Because the project will create a disturbed area of more than one acre in the direct watershed of a body of standing water 10 acres or greater in size, phosphorous control standards must be met in accordance with LURC Chapter 10 Rules and Standards. Provisions are required to limit the export of phosphorus from the site following completion of the development so that the project will not exceed the allowable per-acre phosphorus allocation for the water body, determined by the Commission according to "Phosphorus Control in Lake Watersheds: A Technical Guide for Evaluating New Development" (Maine Department of Environmental Protection, 1992).

DeLuca-Hoffman Associates, Inc. met with Jeff Dennis of the Maine Department of Environmental Protection Watershed Planning and Management Department to review water quality requirements for the proposed Black Nubble Wind Farm Project. Mr. Dennis verified that the project is required to meet the phosphorus control standard noted above for portions of the project tributary to Flagstaff Lake, as well as portions of the project tributary to Redington Pond. Minutes from this meeting with Jeff Dennis are included in Attachment D.

## 13.0 Compliance with Phosphorous Export Requirements

Representatives from DeLuca-Hoffman Associates, Inc., Endless Energy, the Maine Department of Environmental Protection (MeDEP), and LURC met on December 1, 2005 to discuss water quality requirements relating to the Black Nubble Wind Farm Project. The results of this meeting are summarized in Meeting Minutes contained in Attachment D. MeDEP’s 1992 Phosphorus Control Technical Guide will apply to this project and phosphorus standards will need to be met for Flagstaff Lake and Redington Pond.

Based upon a phosphorus export of 1.75 lbs/acre for gravel road surfaces and 0.50 lbs/acre for riprap ditches, the phosphorus export to Flagstaff Lake without treatment was calculated at 29.28 lbs. in last year’s preliminary development plan and 18.36 in this updated preliminary development plan. The allowable phosphorus export based upon the developable area of the Black Nubble parcel tributary to Flagstaff Lake is 17.81 lbs. Buffer areas are depicted on the buffer area figure contained in Attachment D, these buffers have been calculated to reduce the phosphorus export to Flagstaff Lake by 0.76 lbs, based upon buffer treatment factors provided in Table 5-3 of MeDEP’s Phosphorus Control Technical Guide for hydrologic group C soils (category 2). Some hydrologic group A soils exist within the parcels; however, the C soils buffer factor was selected as a conservative value. With this treatment, the phosphorus export to Flagstaff Lake is reduced to 17.60 lbs and is below the allowable phosphorus export.

Based upon a phosphorus export of 1.75 lbs/acre for gravel road surfaces and 0.50 lbs/acre for riprap ditches, the phosphorus export to Redington Pond without treatment has been calculated at 2.42 lbs. The allowable phosphorus export based upon the developable area of the Black Nubble parcel tributary to Redington Pond is 3.39 lbs. Therefore, the phosphorus export to Redington Pond is 0.97 lbs less than the allowable and additional treatment is not required. However, some natural buffering to Redington Pond will occur.

Detailed calculations associated with access roadways, turbine sites, and the project’s substation and maintenance building site providing a breakdown of phosphorus export to Flagstaff Lake and Redington Pond are included in Attachment D. Note that the Redington Parcel has not been considered in these calculations and would result a greater allowable phosphorus export for the project.

No additional water quality measures are proposed for the proposed roadway system.

## 14.0 Thermal Provisions

The proposed roadways have a narrow width; by selecting an alignment which closely follows the natural profile, the need for large clearings for major cuts and fills is minimized. The adjacent forest will provide shade in many areas and the roadway surfaces will be gravel with less tendency to act as a heat sink than bituminous concrete pavement. No special provisions have been made for thermal impacts since the impact is not anticipated to be significant.

## 15.0 Maintenance of Stormwater System

### 15.1 Overview

The proposed storm drainage system is the portion of the project which intercepts the stormwater and runoff from the uphill side of the roadway and delivers it to the downgradient side. The proposed surface restoration, ditch linings, and culvert sizing are designed under the assumption that the stormwater management system will be maintained such that the runoff reaches the areas intended by the basis of design. In addition, there are provisions to adjust this system to reflect field conditions not identifiable on the base maps from which the plan has been prepared, since the plan accuracy is limited to five-foot form lines and existing vegetative cover which obscured the ground and the related accuracy of the base maps.

This portion of the narrative addresses the maintenance of the drainage system.

Key permits issued (or applied for) on the project include:

- MeDEP Site Location of Development and Natural Resources Protection Permits (Carrabassett Valley Portion)

- Land Use Regulation Commission Final Development Plan Approval

The application for this permit contains the basis of design information for the roadways and stormwater management system within separate sections of this application.

A copy of these permits and applicable sections of the application should be appended to this manual. The Permittee/Operator of the stormwater management system should review these permits for a general description and background of the project, as well as any specific permit conditions or requirements of the project.

DeLuca-Hoffman Associates, Inc. has been the consultant who was engaged to prepare the basis of design for the stormwater management facilities and may be contacted at:

DeLuca-Hoffman Associates, Inc.
778 Main Street, Suite 8
South Portland, Maine 04106
(207) 775-1121

It is recommended the preparer of the plan be contacted with any particular questions on the design intent or similar issues.

The maintenance provisions contained herein are intended for general guidance. However, any substituted deviations from the manual should be reviewed by the applicant.

The following narratives have been prepared to describe the recommended maintenance of the stormwater systems for the roadway portion of this project.

## 15.2 Standard Inspection/Maintenance Descriptions

***Sediment in Forebay***

Preface: The culvert inlets and outlets will be constructed with a small sump constructed with riprap. The purpose of this sump is to collect and detain sediment void of the riprap which may exit the area.

Inspection: During periods of quiescent water surface it should be possible to inspect the forebay sump and to observe the sediment accumulation. Heavy sediment is likely to be a sign of upgradient erosion and needs to be identified and repaired.

Maintenance: If a significant accumulation of sediment is recorded in the sump above stone level or to obstruct flow from the inlet pipe it should be removed. Depending on the size of the sump, the amount of sediment collected, and its location, the sediment may be removed manually, by a vacuum truck or other methods. The material removed from the sump should be disposed of in accordance with local practice.

Frequency: The forebay sump should be inspected annually if possible, preferably in the early spring after spring runoff. During the first two to three years of operation, a more frequent (3-4 times per year) inspection is recommended. The frequency of sump cleaning will depend on the rate of sediment buildup. Cleaning on a 1-to-2-year basis is likely. It is noted that cleaning of the forebay sump will lengthen the time between culvert cleanings.

The rate of sediment buildup will depend on the tributary drainage facilities, road gradient, and road treatment (i.e., faster buildup with long open ditch transport systems, runoff from steeply graded roads, especially if the optional asphaltic penetration is not used).

Comments: None.

**This sediment sump also functions as an outlet plunge pool to provide protection and reduce velocities prior to discharge to forested areas.**

***Stormwater Inlets and Culverts***

Preface: The success of any stormwater facility relies on the ability to intercept stormwater runoff at the design locations. Stormwater inlets for the roadways of this project are principally open culverts. Inlets exist along the entire roadway, except bridge crossings, typically at a 100-to-200-foot spacing. It is recommended the culvert locations be marked with a highway delineator for ease of location. This section is directed at maintenance of the actual inlet point. A later section addresses more substantive maintenance of the conveyance facilities.

Inspection: The inspection of inlet points will need to be coordinated with other maintenance items described in this section.

The key elements of the inspection are to assure the inlet entry point is clear of debris and will allow the intended water entry and to inspect the inside of the culvert for debris accumulation.

Maintenance: The key maintenance is the removal of any blockage or accumulated sediment in the culvert which restricts the entry of stormwater to the inlet. The material should be taken out of the area of the inlet and tributary ditches and placed where it will not reenter the runoff collection system.

Frequency: All inlets and culverts should be inspected on a quarterly basis, and after/during significant storm events.

Maintenance/Inspection Responsibility:

Maintenance Personnel: The maintenance personnel will perform the normal maintenance/inspections of the inlets and culvert crossings.

Comments: Maintenance of inlets is critical on this project.

**Poorly stabilized inlet allows entrance of debris and reduced capacity.**

**Stabilized inlets reduce debris accumulation and maintain design capacity.**

***Tributary Drainage System***

Frequency: It is recommended vegetated swales be inspected quarterly until vegetation is established and a year after installation. Thereafter, if no problems have been noticed, the frequency can be increased to one year.

Design Guidelines: The vegetated swale should consider channel cover at the time of construction as well as several years after construction.
Design computations state the assumed channel dimension and provide the basis for the Manning's or other roughness coefficient used for design.

Applicability: The vegetated swales are limited due to the gradients of the ditches. Most are stone lined.

**Vegetated swale with hay bale check dam to reduce velocities under construction.**

**A well-stabilized vegetated swale shows little sign of erosive velocities or flows.**

***Sorbent Booms***

Preface: During construction, sorbent booms should be installed ahead of the culvert inlet in any roadway area which receives the asphaltic treatment. The intent of these is to absorb oil and runoff from new pavement surfaces. These will be removed when construction of the project is complete.

Recommendation: It is recommended the applicant have three of these sorbent booms or pillows onsite in the event of an unexpected spill or if oil sheen is observed frequently on any inlet.

## 16.0 Conclusions

The proposed roadways are linear in nature resulting in only small changes in overall land use cover within the various project watersheds. The use of frequently placed culverts and efforts to maintain any subterranean flow is intended to avoid any significant alteration of flow regimes in the proposed roadway area. Since the land area affected by the roadway is small in comparison to the attendant project area, there is little difference anticipated between pre and postdevelopment flows. Formal detention is therefore not proposed and is unwarranted in the opinion of DeLuca-Hoffman Associates, Inc. This report and the accompanying plans provide the basis of design, culvert sizing, and describe the procedure to field adjust the locations of the culverts. This procedure is necessary since the accuracy of the baseline data is limited to aerial photogrammetry with five-foot form lines and obscure ground conditions in many areas. Therefore, swales may exist and, if found, should be used for culvert discharge locations.

The discharge from the roadway culverts provides for dispersion of flow to the forest buffers beyond the fill slopes of the roadway. These downhill areas will act as buffers. The most important water quality element of the roadways is the need to phase the construction and minimize the amount of area denuded at any time. This requirement is discussed in detail in the accompanying erosion and sedimentation control report for the roadways.

The stormwater management system for the roadways will consist of ditches, culverts, and measures to disperse the flows. The culvert locations will be marked for ease of location during maintenance. A roadway maintenance checklist including ditches and culverts is included in a separate section of this application.

# ATTACHMENT A

Reference Figures and Tables

## ATTACHMENT B

Stormwater Flow Culvert Sizing Calculations

# **ATTACHMENT C**

Ditch Riprap Stone Sizing Calculations

# **ATTACHMENT D**

Time of Concentration Flow Paths and Inset Area Discharge Figures

# ATTACHMENT E

Water Quality Calculations and Meeting Minutes

# **ATTACHMENT F**

Water Quality Buffer Drawing

# APPENDIX 2.3

## Mountain Drainage Analysis Maps (C-BN56 to C-BN58)