New Hampshire Department of Environmental Services

Alteration of Terrain Bureau

Stormwater Design Guidance for Large Solar Arrays

This document provides guidance to assist applicants in meeting the requirements of Env-Wq 1500, including assessing the impervious area of solar panels for solar array projects in order to comply with Env-Wq 1507.05 (Channel Protection Flow) and Env-Wq 1507.06 (Peak Flow Requirements). Some best management practices for sediment and erosion control during construction are also offered, and should be included as notes on design plans.

Alteration of Terrain (AoT) permits are issued pursuant to RSA 485-A:17 and Env-Wq 1500 to protect New Hampshire surface waters, drinking water supplies and groundwater by controlling soil erosion and managing stormwater runoff from developed areas. An AoT permit is required whenever a project proposes to disturb more than 100,000 square feet of contiguous terrain (50,000 square feet, if any portion of the project is within the protected shoreland), or disturbs an area having a grade of 25 percent or greater within 50 feet of any surface water.

A solar farm requires an AoT permit if the area encompassed by the solar panels, access roads and other associated features is greater than the thresholds described above.

General Requirements

1. Plans showing project design must be stamped by a NH licensed professional engineer.
2. Elevation contours must be at no more than 2 foot intervals. If LiDAR is used for the elevation data, include the source and horizontal and vertical accuracy of the data.
3. In some instances, as described below, hydrologic analysis will be required to demonstrate that the requirements of Env-Wq 1507.05 and 1507.06 are met.
4. Site specific soil mapping will be required for all sites requiring hydrologic analysis.
5. An Inspection and Maintenance Plan will be required for all solar farms, and must include the requirement to maintain 85% coverage of vegetation in good condition and repair areas of erosion.
6. A slope plan that includes a delineation of gentle, moderate and steep slopes, in accordance with the descriptions below, should be submitted. Areas where sheet flow will not occur, as described below, should also be delineated on the slope plan.

Treatment (Env-Wq 1507.03)

Treatment of the water quality volume due to the presence of the panels is not required, but treatment of access roads is required. This treatment can usually be provided through vegetated buffers.

Hydrologic Analysis Requirements

Hydrologic analysis will not be required if all of the following apply:

1. Land slopes are 5 percent or less.
2. The land cover prior to installation of the solar array is "pasture" or "open space" in good condition, as defined in the National Engineering Handbook (NEH), Chapter 9. As required by Env-Wq 1503.12(d)(1), any land disturbance in the past 10 years must be considered a land use change for the purposes of the application.
3. The width between rows of panels ("access rows") is equal to or greater than the width of the panel rows. For solar panels not installed in rows, the separation between panels must be equal to or greater than the width or length of the panel, as applicable. (See figures below for further explanation.)
4. After construction, the ground cover of the access rows and the area under the solar panels will consist of well maintained vegetation with at least 85% vegetation cover over the entire area.
5. The height of the panel drip edges will be no greater than 10 feet, and must be high enough to allow for growth and maintenance of vegetation beneath the panels.
6. Runoff will sheet flow onto and across vegetated areas. (For all land slopes, when the panel drip edges align at a right angle to the contour lines [+/- 15 degrees], it is assumed that sheet flow will not occur.)

When hydrologic analysis is required, the land use modeled in the proposed condition shall be "pasture" or "open space", in good condition, as defined by NRCS. The land cover in the existing condition must be modeled as "meadow" or "woods" in good condition, unless photographic evidence is submitted that supports an alternative land cover.

Modeling Impervious Area

Gentle Slopes (≤ 5%)

When sheet flow will not occur due to the orientation of the drip edge to the land slope, (See #6, above), the analysis must consider the impervious area of the panels. In these areas, if numbers 1 through 5, above, exist, the curve number may be adjusted in accordance with Table 1.

Moderate Slopes (>5% to 8% for Hydrologic Soil Group B, C and D Soils, and >5% to 15% for HSG A Soils)

Hydrologic analysis must be performed for all panel configurations relative to the contour lines and the analysis must account for the impervious area. In areas where conditions 2 through 5 above will apply, the curve number for the array footprint may be adjusted in accordance with the unconnected impervious method as shown in Table 1.

When drip edges align perpendicular to the land contours (+/- 15 degrees), or in other situations where sheet flow will not occur, the unconnected impervious method (Table 1) cannot be used. The hydrologic analysis must consider the area of the solar panels as impervious, with no assumption that infiltration will occur in the area under the panels.

Steep slopes (> 8% for HSG B, C and D soils, and > 15% for HSG A soils):

The hydrologic analysis must consider the area of the solar panels as impervious, with no assumption that infiltration will occur in the area under the panels. (The curve number adjustment method in Table 1 cannot be used.)

Table 1. Adjusted curve number, based on the unconnected impervious method in the National Engineering Handbook, Chapter 9, for use in gentle and moderate slope areas.[1]

Hydrologic Soil Group, with "meadow, good condition" or "open space, good condition" land cover	Curve Number associated with Land Use (No Impervious)	Adjusted Curve Number, with 30% unconnected impervious[2]
A	39	**48**
B	61	**66**
C	74	**78**
D	80	**83**

[1] This method is incorporated into many computer programs that provide TR-20 computations.

[2] The values in Table 1 are based on no more than 30% impervious area in the NEH, but DES allows this curve number adjustment method for the purposes of evaluating solar arrays, even though the ratio of impervious to pervious area is closer to 33%. (It is assumed that rainfall from the panels will infiltrate into the soil below, and into the downstream access row.). The table shows the adjusted curve number for different hydrologic soil groups with a "pasture, good" condition.

Table 2. Summary of modeling approach based on slope and flow condition

Slope	Flow Condition based on Panel Configuration*	Modeling Approach
Gentle Slopes ≤ 5%	No change in land cover, sheet flow	No hydrologic analysis required.
	Change in land cover, sheet flow	Hydrologic analysis required to evaluate the change in land cover
	Areas without sheet flow	Curve number adjustment method (Table 1) may be used to evaluate the impacts of panels.
Moderate Slopes >5% to 8 % for HSG B, C, D >5 to 15% for HSG A	Sheet flow	Curve number adjustment method (Table 1) may be used to evaluate the impacts of panels.
	Areas without sheet flow	Consider area covered by panels as 100% impervious.
Steep Slopes > 8% for HSG B, C, D > 15% for HSG A	All areas	Consider area covered by panels as 100% impervious.

* Sheet flow is not assumed to occur if panels are aligned perpendicular to the slope contours +/- 15 degrees.

Additional Considerations

Sediment and Erosion Control on Slopes Post Construction

For slopes greater than 8%, when runoff from panels will not sheet flow due to panel orientation, and when the flow path will be greater than 300 feet, level spreaders, benching, turn-outs, or other practices are recommended to prevent erosion due to concentrated flow when runoff from panels.

For slopes greater than 15% (any hydrologic soil group), those practices described above are required if the flow length exceeds 100 feet, unless it can be demonstrated through plan and calculations that flow velocities will not exceed allowable velocities for stable vegetation. If allowable velocities are exceeded, it must be demonstrated through plan and calculations that the selected practice will be capable of maintaining a stable flow condition, without soil erosion. It must also be demonstrated that the practice will remain effective over the long-term, considering the vegetation and array maintenance required.

Slopes greater than 25% must be terraced and benched as required by Env-Wq 1508.20.

Sediment and Erosion Control During Construction

To prevent sediment releases from the site during construction, plans must show the locations of temporary sediment basins, which are sized for a "newly graded" condition, utilizing the TR-20 hydrologic modeling approach. The basins must contain the 2-year, 24 hour design storm (Env-Wq 1506.12). Runoff from all areas must be captured and conveyed to the basins. On slopes of less than 5%, sediment basins will be required when the length of the flow path exceeds 200 feet.

For soils with a depth to bedrock of 12" or less, plans must show that soil will be enhanced by the addition of at least 4" of top soil. In addition, any overburden eroded during construction phases must be replaced.

Plan notes must clearly describe the construction sequence, including construction of sediment basins and conveyance swales prior to grubbing of other areas, and the placement of mulch within 72 hours of grading (or prior to a 0.25" storm, whichever is sooner). Mulch must remain in place throughout construction and maintained until final seeding is placed.

A phasing plan is required for disturbance areas over 5 acres.

When disturbance will occur within 50 feet of a waterbody (including wetlands), a double row of perimeter controls should be installed.

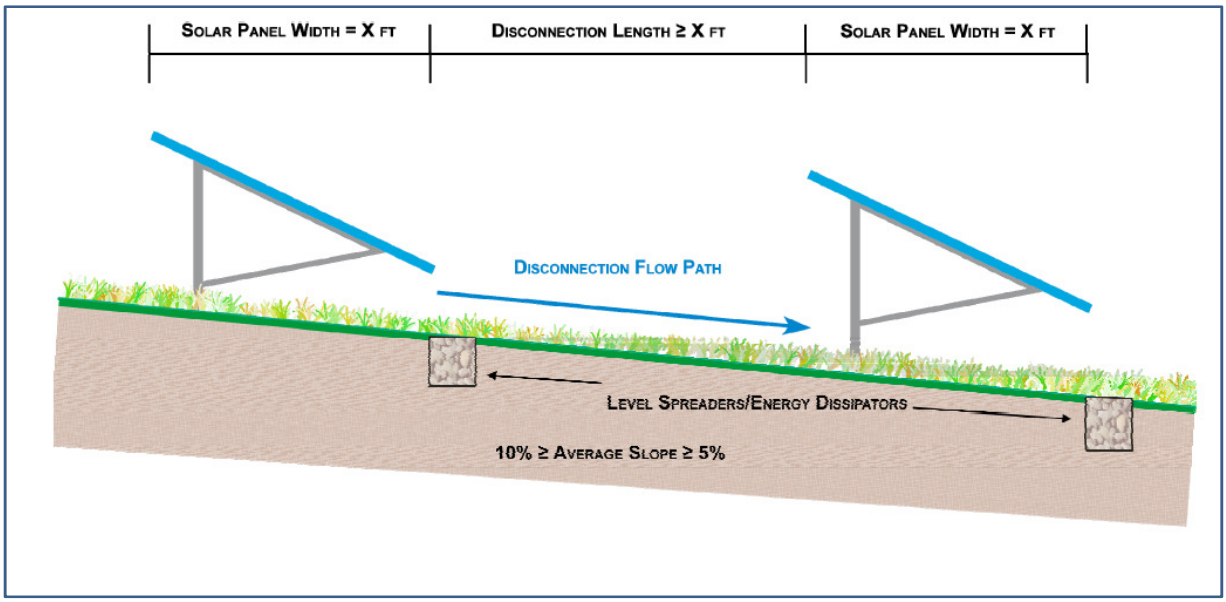

Fig. 1 Disconnected Impervious Approach for Panels

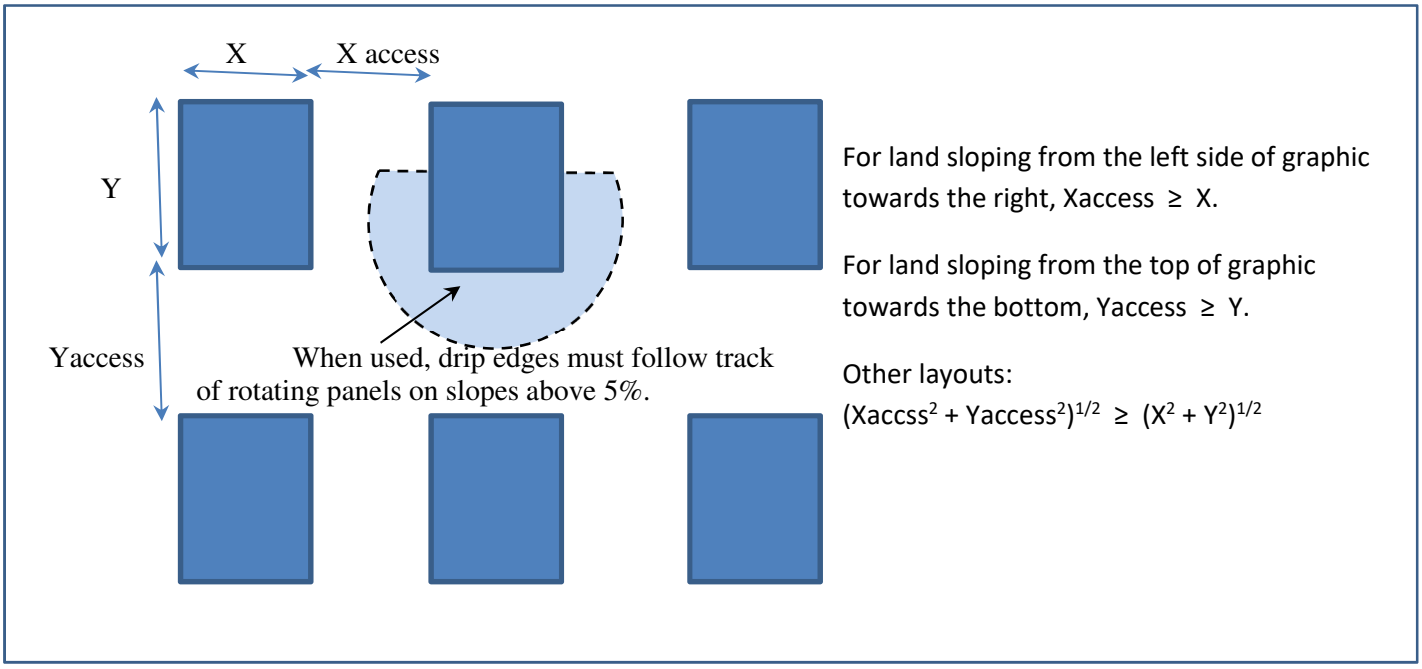

Fig. 2 Panels on Individual Stands on Slopes

References:

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