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To: Technical Services Department, Development & Review Section

From: Elias Archuleta, P.E., Deputy County Manager for Public Works

Date: May 05, 2023

Subject: Stormwater Management Guidance in Large Scale Ground-Mounted Solar Arrays

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With the passage of the 2019 New Mexico Energy Transition Act, and subsequent Community Solar Act in April 2021, interest in development of large-scale solar facilities in rural areas of Bernalillo County (County) is growing. The County encourages development of renewable energy technology, including solar facilities, to strengthen and diversify our energy resources. This guidance establishes County Public Works criteria for evaluating grading & drainage submittals for ground-mounted Photovoltaic (PV) arrays that are constructed over a pervious surface. This guidance cannot be used for earth-mounted PV arrays, where any part of the panel touches the ground. Earth-mounted PV arrays shall generally be treated as impervious surfaces and requirements will be addressed during the conceptual design as part of the special use permit process.

Stormwater quality in the County is regulated by the EPA National Pollutant Discharge Elimination System (NPDES), including the Construction General Permit (CGP), Multi-Sector General Permit (MSGP), and the Municipal Separate Storm Sewer (MS4) Permit. This guidance addresses stormwater runoff mitigation, including MS4 Permit post-construction requirements, which are distinct from CGP requirements.

The County Public Works objective is to protect soils from the erosive conveyance of stormwater, to mitigate the magnitude of peak flow rates during heavy precipitation events, protect stormwater quality, and create a transparent permitting environment that encourages solar development within the County's jurisdiction. This guidance supplements the County Technical Standards (Technical Standards) and the County Green Stormwater Infrastructure (GSI) / Low Impact Development (LID) Standards (GSI/LID Standards). The agreement to integrate these practices shall be a condition of approval for solar project special use permits.

1. Stormwater Management Guidance and Best Management Practices (BMPs) for PV Array Projects

Applicants must comply with the MS4 Permit and County Stormwater Quality Ordinance, which require stormwater BMPs to manage the stormwater quality design volume (SWQV) onsite for all development and redevelopment projects with land disturbances equal to or greater than one acre. This includes sites

which disturb less than one acre but are part of a larger common plan of development. Projects must also evaluate for opportunities to implement GSI/LID BMPs, with submission of the required Stormwater Post-Construction GSI/LID BMP Evaluation form. Calculating the SWQV for PV arrays is described below in Section 2 of this guidance memo. Guidance and BMPs for PV array developments in the County include:

1.1. ***Slopes*****:** Site slope is a contributing factor to increased runoff and potential erosion, particularly on projects proposing development on steeper sloped sites.

1.1.1. Sites with slopes less than 5% are preferred for PV array development.

1.1.2. For moderate slopes of 2% to 8%, consider BMPs, such as level spreaders, terraces, berms, or equivalent method of energy dissipation, to promote sheet flow conditions within the project area.

1.1.3. Sites with steep slopes of 8% to 15% may be allowed for PV array development upon evaluation of soil conditions and the proposed grading & drainage plan, which should provide slope protection and energy dissipation at the dripline edge of each row of panels. Where sheet flow is unfeasible, swales shall be designed to minimize runoff velocity. Vegetated swales that allow for infiltration are preferred.

1.1.4. Sites, and portions of sites, with slopes greater than 15% are not suitable for PV array development in the County.

1.1.5. More frequent post-construction BMP inspections (refer to Section 1.8) may be required in the special use permit for sites with steeper slopes.

1.2. ***Existing Soil Conditions*****:** Development on soils with high erosive potential per NRCS is discouraged unless mitigation strategies are implemented. Soil sampling data is required for hydrology calculations, as described in Section 3 of this guidance memo.

1.2.1. Submit a Slope and Soil Analysis Sheet showing the Natural Resource Conservation Service (NRCS) soil boundaries, hatching for the slope classes described in Sections 1.1.2, 1.1.3, and 1.1.4 above, and offsets from all water courses and surface water bodies, superimposed over the proposed layout and existing contours. NRCS data, including the hydrologic soil groups must be keyed off on the sheet. Soil texture data shall be supplemented by site-specific soil analysis, see below.

1.2.2. The following soils analysis and testing methods are required for PV arrays. Results must be submitted with the grading and drainage submittal. Collect soil samples for analysis at locations across the site using a stratified random sampling plan, that can be correlated to sample locations shown on a Slope and Soil Analysis Sheet.

- Gradation analysis for composite sample for top six (6) inches of existing soils:
  - Sieve analysis (ASTM C117-04/C136-06), Hydrometer analysis (ASTM D7928), or alternative analysis method approved by the County.
- Bulk density (also referred to as dry density) soil test for top six (6) inches of existing soils, ASTM D7263-21 (only required if using PV-SMaRT Calculator, see Section 3.1.1).
- In-situ infiltrometer, Modified Philip Dunne infiltrometer test (ASTM D8152) or double-ring infiltrometer test (ASTM D3385); required if <u>not</u> using PV-SMaRT Calculator to develop curve numbers, see Section 3.

1.2.3. A minimum of 3 soil samples is required for all sites up to 64 acres in size. Additional samples are needed for larger sites at a rate of 1 sample per every 64 acres. The County may request additional soil samples depending on site specific conditions. Additional soil types, as mapped by NRCS, within the site limits shall be a justification for requiring additional soil samples.

1.2.4. Geotechnical borings used for foundation design may also be used to support hydrology calculations (if using PV-SMaRT Calculator, see Section 3.1.1).

1.2.5. More frequent post-construction BMP inspections (refer to Section 1.8) may be required in the special use permit for sites with erosive soils.

1.3. ***Buffer or Set Back from Natural Arroyos or Watercourses*****:** Setback requirements should be clearly labeled on the Slope and Soil Analysis Sheet. Per the Technical Standards, Chapter 4, Required Easement Widths for Drainage Conveyance Systems, PV arrays shall not be constructed within Special Flood Hazard Areas (SFHA) as identified by FEMA except where those limits are analyzed and reduced with a FEMA Letter of Map Revision (LOMR). Constructed features shall be set back 50 feet from unnumbered Zone A SFHA. The County Engineer may require an analysis and revision to the FIRM for unnumbered Zone A SFHA within PV project limits. To meet requirements of the 2022 CGP Section 2.2.1, applicants must provide and maintain natural buffers and/or equivalent erosion and sediment controls for discharges to any receiving waters that are located within 50 feet of the site's earth disturbances.

1.4. ***PV Panel Orientation:*** The preferred panel orientation is on contour (i.e., parallel to slope). Panels not installed on contour will be evaluated for slope and soil type to determine the need for additional flood control detention and BMPs to mitigate erosive stormwater conveyance.

1.5. ***Disconnection of Impervious Areas:*** PV panels should be configured to provide permeable space between PV array rows so that runoff from the panel rows remains hydrologically disconnected. The PV array design configuration should promote sheet flow conditions and natural infiltration, minimizing concentrated runoff. At a minimum, the vegetated length between panels in adjacent rows (disconnection length) should be equal to or greater than the average panel width (refer to Section 2, Figure 1, dimension Y).

1.6. ***Erosion Control at Panel Driplines:*** Erosion control at driplines for the panels is required for steep slopes and may be required for moderate slopes, depending on soil conditions. Limiting the vertical distance between the lowest edge of the panels and ground surface to no greater than 10 feet is preferred (refer to Section 2, Figure 1, dimension X).

1.7. ***Construction Practices:*** Minimize earth disturbance and site compaction during construction by avoiding mass grading, full blading, and soil removal. Existing vegetation should be retained, undisturbed wherever possible. Designate protected areas in the design plans to help ensure that the contractor identifies these in the CGP stormwater pollution prevention plan (SWPPP). Soil stabilization measures (temporary and permanent) should be taken following CGP guidelines, typically 7 to 14 days following the disturbance. Stock piling and reusing the existing topsoil onsite is encouraged. Remediate soil compaction following construction, consider post-construction bulk density testing to inform soil remediation techniques to improve post-construction compaction and infiltration.

1.8. ***Vegetation:*** Establish low growing site-appropriate groundcover that is native, drought-adapted, and preferably pollinator friendly. Consider NMDOT regional seed lists as well as the City of Albuquerque seeding guidelines in choosing vegetation. The grading & drainage submittal package should identify required re-seeding/post-construction vegetation/ remediation for soil compaction, and the CGP SWPPP must include a plan for the post-construction vegetation establishment period and maintenance. The owner shall be responsible for implementing the post-construction maintenance plan and the site will be evaluated during the post-construction BMP inspections, conducted annually for the first 3 years, then a minimum of every 3 years afterwards, depending on site conditions.

2. Calculating Stormwater Quality Volume for Solar Projects

Stormwater quality volume (SWQV) calculations must be provided with the grading and drainage plan with the designated ponding areas depicted on the plan (see the Technical Standards, Section 4.4, for SWQV submittal requirements, including definitions of Land Treatments C and D). The County uses a simple formula to calculate SWQV for new development. The equation for SWQV for new development (cubic feet, ft^3) is:

SWQV = [(0.615 in.) x (Land Treatment D areas in sq. ft.) + (0.52 in.) x (Land Treatment C areas in sq. ft.)]/12

To account for disconnection of PV panel pervious area and variability in the panel angle, a calculation is needed to determine the area of panels to be included as Land Treatment D in the SWQV calculation. The panel area calculation (source: Minnesota Stormwater Manual) assumes that the surface between panels will be vegetated per the CGP final stabilization requirements and the design plans for the site. If there are compacted soils or other impervious surfaces on the site in addition to the panels, such as paved roads, footings outside of the footprint of the panel area, and accessory structures, those areas must also be included as Land Treatment D in the SWQV calculation.

The average horizontal pervious length beneath panels (refer to Figure 1), adjusted for change in the panel angle (α), is Z. If the panels rotate to follow the sun, H = Z since the panel orientation when a storm occurs cannot be know. Z is calculated using the following equation:

$$Z = [\cos(\alpha_{max})H + \cos(\alpha_{min})H]/2$$

Use Z to calculate the total impervious area for the PV panels:

Impervious area = Number of panels * Z * panel width

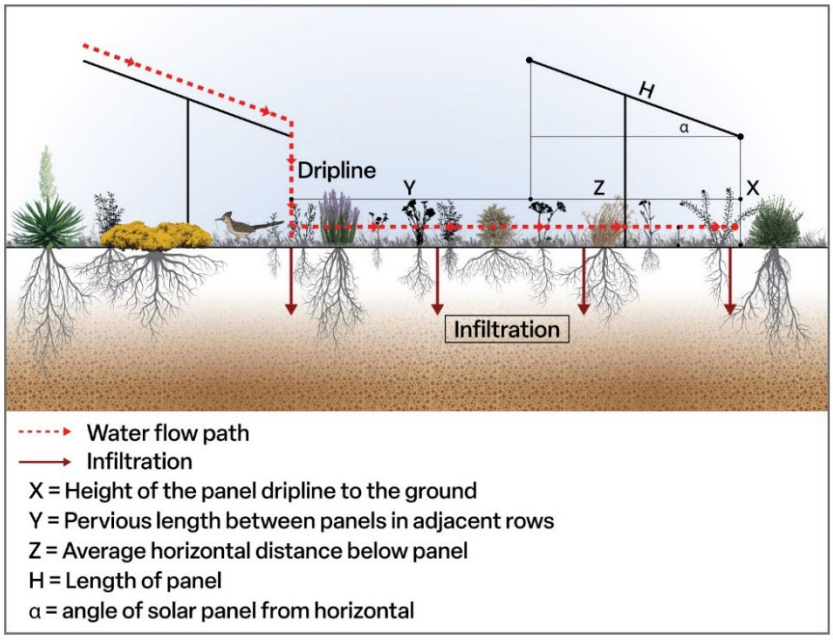

Figure 1: Variables for Calculating the Impervious Area for PV Panels

3. Hydrologic Analysis for Solar Projects

The permittee should conduct a hydrologic analysis that meets the criteria below. Acceptable methods include those listed in the NRCS *Technical Release 55: Urban Hydrology for Small Watersheds* (TR-55) and the NMDOT *Drainage Design Manual* (2018). Other hydrologic analysis methods may be permitted at the discretion of the County Engineer or designee. The hydrologic analysis must:

- Evaluate the 2-year, 6-hour and 100-year, 24-hour return period storms' pre- and post-construction stormwater runoff;
- Offsite hydrologic analysis will be required in accordance with the Technical Standards;
- Account for the reduction in infiltration capacity of soil due to construction activities related to the installation of the solar panels;
- Consider slope gradient, surveyed soil type (see soils guidance in Section 1.2 above), infiltration rate, length of slope, occurrence of bedrock, and change in drainage patterns; and
- Demonstrate no net increase in peak runoff or volume, erosion potential, or adverse impacts to downstream properties for the PV array installation.

3.1. ***Rainfall Losses and Curve Number:*** Multiple methodologies exist for developing rainfall losses. This guidance memo covers the use of runoff curve number to represent rainfall losses. Other methodologies may be approved at the discretion of the County. Two methods for curve number development are discussed below: 1) using the Photovoltaic Stormwater Management Research and Testing (PV-SMaRT) Calculator developed by the University of Minnesota and 2) adapting the process outlined in Section 402 of the NMDOT *Drainage Design Manual* (2018).

3.1.1. PV SMaRT Calculator

The PV-SMaRT Solar runoff calculator can be used to generate runoff curve numbers for ground-mounted PV arrays as a land use. Projected post-construction curve numbers calculated by the PV-SMaRT Calculator shall not be less than 55. If the calculator determines a curve number less than 55, the curve number will be set to 55 for hydrologic calculations.

Parameters within PV-SMaRT Calculator require information from site-specific soil analysis (refer to guidance in Section 1.2.2 above). Additional PV-SMaRT Calculator parameter guidance includes:

- Soil texture parameter shall be determined based on one of the following:
  - The Unified Soil Classification System outlined in ASTM D2487-17.
  - Evaluation of percent sand, clay, and silt based the gradation analysis (see Section 1.2.2), then applied to the USDA Soil Texture Calculator.
  - Soil texture parameter shall not be determined by the NRCS field guide to estimate soil texture by feel.
- Soil depth parameter shall be determined based on:
  - The soil depth parameter used in the PV-SMaRT Calculator shall be set to a maximum depth of 9 inches, unless additional data demonstrating a rooting zone depth greater than 9 inches is present based on existing vegetation.

- Soil profiles developed from borings, if available, may be used to support the soil depth parameter.

- Bulk density parameter for projected post-construction conditions shall be:
  - Based on management activities, as documented in the PV-SMaRT User's Manual. Use of compaction mitigation values for projected post-construction bulk density must be supported by mitigation methods in the project grading and drainage plans.
  - Post-construction bulk density will be greater than or equal to the existing condition bulk density.
  - Vegetation shall be only set to Bare Earth, Gravel, or Row Crop (Straight Row, Poor Management). Use of other vegetation types in PV-SMaRT Calculator may be permitted by the County based on the specific project.

3.1.2. NMDOT Drainage Design Manual Method

Section 402 of the NMDOT *Drainage Design Manual* (2018) describes a method of developing curve number losses for watersheds in New Mexico. The method listed in the Manual may be used with the following adjustments:

- Earth-mounted panels, where any of the solar panel touches the ground, must be considered 100% impervious with a curve number of 98.
- Hydrologic soil group must be determined by using the infiltrometer test results (refer to Section 1.2 above). Results from infiltrometer tests can be used to determine hydrologic soil group based on the NRCS *National Engineering Handbook, Part 630 Hydrology*, Chapter 7: Hydrologic Soil Groups.
- For post-construction conditions, the hydrologic soil group must be increased by one (Group A becomes Group B, Group B becomes Group C, etc.) to account for compaction caused by construction activities.
- For post-construction conditions, land uses with ground cover conditions of "good" must be supported by mitigation methods shown in the project grading & drainage plans.
- Existing curve numbers must be area weighted based on the combination of land uses and soils found in the area.
- Post-construction curve numbers must be adjusted to account for the increased imperviousness caused by the panels. This should be in the range of 40-60 percent based on panel orientation.

3.2. ***Other Hydrologic Parameters:*** To determine peak flow rates and total runoff volumes for the 2-year, 6 hour and 100-year, 24-hour storm events, either TR-55 or the NMDOT *Drainage Design Manual* (2018) methodology is acceptable. The PV-SMaRT Calculator cannot be used to determine peak flow rates. Both pre- and post-construction hydrologic conditions must be analyzed to demonstrate no increase in peak flow rates or runoff volumes caused by the development of the site.

4. **References:**

Bernalillo County Technical Standards (Technical Standards)
Bernalillo County Green Stormwater Infrastructure (GSI) / Low Impact Development (LID) Standards
Best Practices: Photovoltaic Stormwater Management Research and Testing (PV-SMaRT), January 2023
NMDOT Drainage Design Manual, July 2018
NRCS National Engineering Handbook, Chapter 7: Hydrologic Soil Groups
PV-SMaRT Calculator Download and User's Manual
Soil Texture Calculator | Natural Resources Conservation Service (usda.gov)

Within 30 calendar days from May 8, 2023, all new solar development projects that meet the disturbance conditions described above will be evaluated using the standards described herein.

Concurrence:

Elias Archuleta (May 5, 2023 16:34 MDT)

Elias Archuleta, P.E., Deputy County Manager of Public Works

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