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Conceptual Retention and Grading Study

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NEXTERA ENERGY RESOURCES

CONCEPTUAL RETENTION AND GRADING STUDY

SYNOPSIS

This report is prepared for NextEra Energy Resources and is undertaken as part of the **Beacon Solar Energy Project**.

PROJECT - BEACON SOLAR ENERGY PROJECT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
2	Issued for Use	B Anders	J Foster		19-Jun-09	N/A	

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1. INTRODUCTION

The Beacon Solar Energy Project is a concentrated solar electric generating facility proposed on an approximately 2,012-acre site in Kern County, California. The Project will use well-established parabolic trough solar thermal technology to produce electrical power using a steam turbine generator (STG) fed from a solar steam generator (SSG). The SSG receives heated heat transfer fluid (HTF) from solar thermal equipment comprised of arrays of parabolic mirrors that collect energy from the sun.

The Project site is located adjacent to State Route 14 and north of the town of California City, California. The site is bounded by undeveloped land to the north, south, east, and State Route 14 to the west. A Southern Pacific Railroad track bisects the western portion of the site. The solar collection arrays will encompass an area of approximately 1,275 acres within the site boundary.

Off site storm flows pass through the site from two basic locations. The first is Pine Tree Creek that passes through the central portion of the site running from South-West to North-East. Pine Tree Creek gets drainage from an 83.2 square mile watershed within the El Paso Mountains to the South-West. The planned design is to reroute the dry wash around the site along the southern and eastern property boundaries. Design considerations for this channel are prepared separately by AECOM.

The second location of offsite flow originates in a drainage shed west of State Route 14. The flows from this drainage shed pass through the site and discharge to Pine Tree Creek within the site boundary. The flows within this drainage shed pass under State Rout 14 and under a Railroad line and enter the site at a distinct location.

2. PURPOSE

The purpose of this study is to provide a basis for the retention design at the Beacon Solar Energy Project. The intent is to describe the rational that will be implemented during the detailed on site grading and drainage design, and to provide a preliminary layout of this concept. The on site grading and drainage design are directly interrelated, and adjustments to each can and should be made during the detailed design to provide for the most efficient engineering solutions that provide for storm water quality control and treatment in compliance with the LORS.

3. DESIGN BACKROUND

The preliminary conceptual grading plan was prepared by Carlton Engineering and included in the Conceptual Drainage Study for Beacon Solar Energy Project, dated February 2008. This plan and study provided for the release of all on-site generated flows (within the solar array) into the re-routed wash. This design indicated that post development flows from the developed site into the re-routed wash will be less than or equal to pre development flows from the site into the Pine Tree Creek watershed. A small detention pond was provided near the North-East corner of the site to maintain this goal. The concern with this approach is that there are portions of the site that drain directly into the re-routed wash without the opportunity for treatment though retention facilities.

Additionally, the Carlton design included preliminary grades for the re-routing of Pine Tree Creek. Subsequent work has been completed by AECOM including flood mapping, hydrologic studies, sediment and scour analysis, and revised grades for the re-routed wash. The work completed by AECOM determined the “top of bank” elevation for the re-routed wash channel on the edge of the project along the south and east sides of the site.

The conceptual design approach included herein uses the Carlton Grading, the AECOM re-routed channel grades, and incorporates retention to provide for storm water quality treatment.

Using the top of bank grades prepared by AECOM, the Carlton grades across the site were adjusted slightly to match these grades along the south and east edges of the site. The grades across the site provide an overall gradual slope of the final graded surface ranging from approximately 0.5% to 1.6%. This overall gradual slope can be accomplished via the use of a uniform slope (as shown on the drawings in the appendix), terracing, or a combination of both. The site grades can and should be adjusted as necessary during final design to accommodate adjustments in cut/fill; however, the channel grades and the top of bank channel grades need to be set by the design of the channel prepared by AECOM. Adjustments of the grades in the solar array can be made during the detailed design process to accommodate larger retention facilities, to provide for adjustments in cut/fill volume, to allow an adjustment in the locations of the retention facilities, and to accommodate the detention required.

The following criteria should be considered during the final detailed grading and drainage design:

1) Maintain retention volumes at or above the values indicated herein
2) Adjust grades to balance the volume of cut and fill on site. Design the site so that import or export of material is averted.

3) Comply with the detention and retention requirements of Kern County, Division Four, “Standards for Drainage”, and the Kern County Hydrology Manual.
4) Provide site grades that match the final top of bank grades within the AECOM report, and that contain the Pine Tree Creek re-routed wash without creating a levy situation on the north and west sides of the re-routed wash (along the south and east sides of the site).
5) Maintain the off site flow that enters the site from under the railroad track as a “pass though” flow, so that this flow does not mingle the on site storm water runoff with this flow (this can be done in a drainage ditch as shown on the attached plan sheets, or can be piped through to the re-routed Pine Tree Creek location).
6) A location specific percolation test will be required to be performed by a properly licensed Geotechnical Engineer to confirm that the rain volume captured in each retention pond will infiltrate within (72 hours) Additional infiltration surface can be added by including French drains or gravel filled holes to the retention areas.

4. RETENTION METHOLOGY

The proposed design is based upon the retention basin sizing included in the Kern County Division Four Standards for Drainage. The Kern County guideline for retention basins require the storage volume to be based on the 10 year 24 hour depth of rainfall. Based on this approach, storm flow runoff volume in excess of the runoff volume produced from the 10 year 24 hour rainfall depth will overflow into the Pine Tree Creek dry wash channel.

Per Kern County Division Four, "Standards for Drainage", Chapter VIII, "Retention Basin Design", Section 408-1, "Design Volume", the runoff volume is calculated as follows:

Runoff Volume = $0.12(D_{10})(a_i)(\text{Area})$

Where:	D_{10}	=	10 year 24-hour depth of rainfall (in)
	a_i	=	Average percentage of impervious area
	Area	=	Drainage area of total development

The D_{10} is determined from the Carlton drainage study, and the rainfall intensity duration frequency curves from NOAA Atlas 14 Point Precipitation Frequency Estimates. The value used is 1.97 inches.

The average percentage of impervious area is somewhat subjective for this type of development. A very small percentage of the site can be considered truly impervious (asphalt, buildings, or concrete surfaced), and some areas will contain 100% of the rainfall in that area (no runoff). Mr. Munir Haddad of Kern County was contacted (661-862-5100) to confirm the units of the equation, and to discuss the application to a project such as the Beacon Solar Energy Project. The anticipated finish surfacing of the site was discussed wherein the percentage of impervious area is not certain. Mr. Haddad indicated that in a situation such as the Beacon Solar Energy Project, the impervious area determination will be left to the design engineer and that the assumptions would be subject to review by the applicable authority for confirmation of the calculations and rational for determination of impervious areas, and therefore the retention volume.

Per the SCS, the highest impervious value for dirt roads is 85%. The approach used looked at each block of solar panels. Each block of solar panels is 59 feet wide and will include a maintenance road between each panel of approximately 12 feet in width. Using the 85% and the 12 feet, the equivalent width of a road that is 100% impervious is 10.2 feet (12'*0.85=10.2 feet). The impervious percentage for the dirt roads can then be estimated as 17.2% (10.2'/59'=17.2%).

There are support footings that also contribute to the impervious area of the surface. For the support footings estimation, each solar block is divided up into “design cubes”. Each design cube is 2,050 linear feet by 1,180 linear feet (2,419,000 square feet). Within each design cube there are eighty, 489 foot long solar panels. Each solar panel has thirteen support footings, measuring an estimated two feet in diameter (3.1415 square feet). Therefore each design cube contains 3,270 square feet of impervious solar panel footings, making each design cube approximately 0.14% impervious. % impervious = 3,270/2,419,000 = 0.14%.

This provides a total estimated percentage of impervious area of 17.34%.

After determining the percentage of impervious area the Retention Volume was calculated for each separate design cube based on the above formula.

The total estimated retention volume calculated is 58.5 acre feet. The Preliminary Retention Pond Plan View and Plan Details show the incorporation of 58.5 acres of pond area that are 12” in total depth. The depth of retention can be increased, adjusted, or modified during the detailed design. However, the depth should be kept below 18” within the solar arrays, as the Kern County regulations require freeboard, and other requirements if the depth of the pond is greater than 18”.

The retention volume is meant to provide treatment control for storm water leaving the site. In order to provide an alternate analysis of the water quality control aspects of the above volumetric determination, the methodology used in the California Storm Water Quality Association (CASQA) BMP Handbook for New Development and Redevelopment, the “Urban Runoff Quality Management Approach” was reviewed.

Per the California BMP Handbook for New Development and Redevelopment, the “Urban Runoff Quality Management Approach”, the Maximized Detention Volume (Po) is determined as follows:

$Po = (a)(C)(P_6)$ - in watershed-inches

$C = 0.858i^3 – 0.78i^2 + 0.774i + 0.04$

i = the watershed imperviousness ratio (0.1734 from above)

Therefore; C = 0.0045 – 0.0234 + 0.1342 +0.04 = 0.1553

Per the same section 5.5.1 of the BMP Handbook, a = 1.582 (for 24 hour draw down, and 1.963 for a 48 hour draw down). For this estimate, the 48 hour drawdown is included.

P_6 = 0.5" (per BMP Handbook table Victorville is 0.47, Bakersfield is 0.50, and per calculation on-line, 0.5 is correct)

Thus:

Po = (.1553)(0.5)(1.963) = 0.1524"

To get the "capture volume of the BMP", Po is multiplied by the drainage area

= (1,275 Acres)(0.1524") = 194 acre-inches **=** 16 acre-feet

This CASQA BMP Handbook method of retention capture shows that the site designed for 58.5 acre-feet of retention will provide adequate volume, and indicates that the Kern County methodology can be followed for the detailed design of the retention for the site for management of storm water quality.

5. DETENTION CONSIDERATIONS

Detention must be considered in the final design of the facility for flow control. The Carlton "Conceptual Drainage Study for Beacon Solar Energy Project" provided for a detention facility to reduce the overall project peak post development flows to pre-development runoff rates. The volume of the detention facility outlined in the Carlton study is 12.6 acre-feet. However, the impervious area considered in the Carlton report is less than 17.34% of the total drainage area, as used in the retention calculation above.

The retention facilities, depicted at a total of 58.5 acre-feet on the drawings in the appendix can be designed to provide this reduction in the overall peak post development flows. Given the potential to increase the depth or size of the individual retention areas, it follows that these areas will provide adequate capacity to support the detention needs of the site, including the estimated impervious area and the potential increase in the runoff coefficient. An increase in the runoff coefficient may be caused by the application of dust suppressants as indicated in the study "Hydrologic Impacts of Disturbed Lands Treated with Dust Suppressants", and can be accounted for in the final determination of the detention requirements.

6. STORM WATER MANAGEMENT APPROACH

Storm water management for the completed facility will be provided through the use of source control, site design, and treatment control best management practices (BMPs) consistent with the typical and appropriate requirements for storm water management at both construction and industrial sites. A summary of a sampling of these BMPs was presented in the draft Storm Water Pollution Prevention Plan (SWPPP) and in the Application for Certification submitted to the CEC; however, detailed descriptions of appropriate and relevant BMPs for anticipated and potential pollutants during construction and operation will be provided in the appropriate SWPPP documents to be prepared and finalized prior to construction.

Locations within the power block for the potential of chemical or oil releases will be fully contained. Rainfall within the containment areas will be allowed to evaporate or will be drained through an oil water separator. Locations within the power block where “contact” storm water may occur will be contained within a system of curbs or trenches. Drains from these curbed areas or containment trenches will be directed to an oil water separator. The oil separated and captured within the oil water separator will be trucked off-site to a licensed disposal/recycling facility. Clean water discharged from the oil water separator will be used on site by discharging it to the cooling tower or to the raw water storage tank. The water discharge from the oil water separator will not be discharged to the storm water system.

Off site storm flows will be separated from on site storm flows. This will allow for treatment control of the flows from the Plant Site, and ensure that off site flows do not come into contact with the solar collector array area (locations where the potential for storm water to contact the HTF exist). Pine Tree Creek will be re-routed around the solar collector field to the south and east. The off site flows from under the railroad track will be passed though the site within a drainage channel or through a pipe.

The storm flows from the solar collector arrays will be treated through the use of multiple retention ponds. These retention ponds will be linked via shallow, gradually sloped swales that will enhance the treatment of the storm flows.

7. REFERENCES

1) Conceptual Drainage Study for Beacon Solar Energy Project, prepared by Carlton Engineering, Dated February 2008

2) Hydrologic Impacts of Disturbed Lands Treated with Dust Suppressants, Published in the Journal of Hydrologic Engineering, September/October of 2003

3) California BMP Handbook for New Development and Redevelopment, the “Urban Runoff Quality Management Approach”

APPENDIX 1

APPENDIX 1

Preliminary Conceptual Retention Pond Plan – Plan View, Sketch No. FPLS-0-SK-112-716-001, Rev A

NEXTERA ENERGY RESOURCES

CONCEPTUAL RETENTION AND GRADING STUDY

APPENDIX 2

APPENDIX 2

Preliminary Conceptual Retention Pond – Plan Details, Sketch no FPLS-0-SK-112-716-002, Rev A

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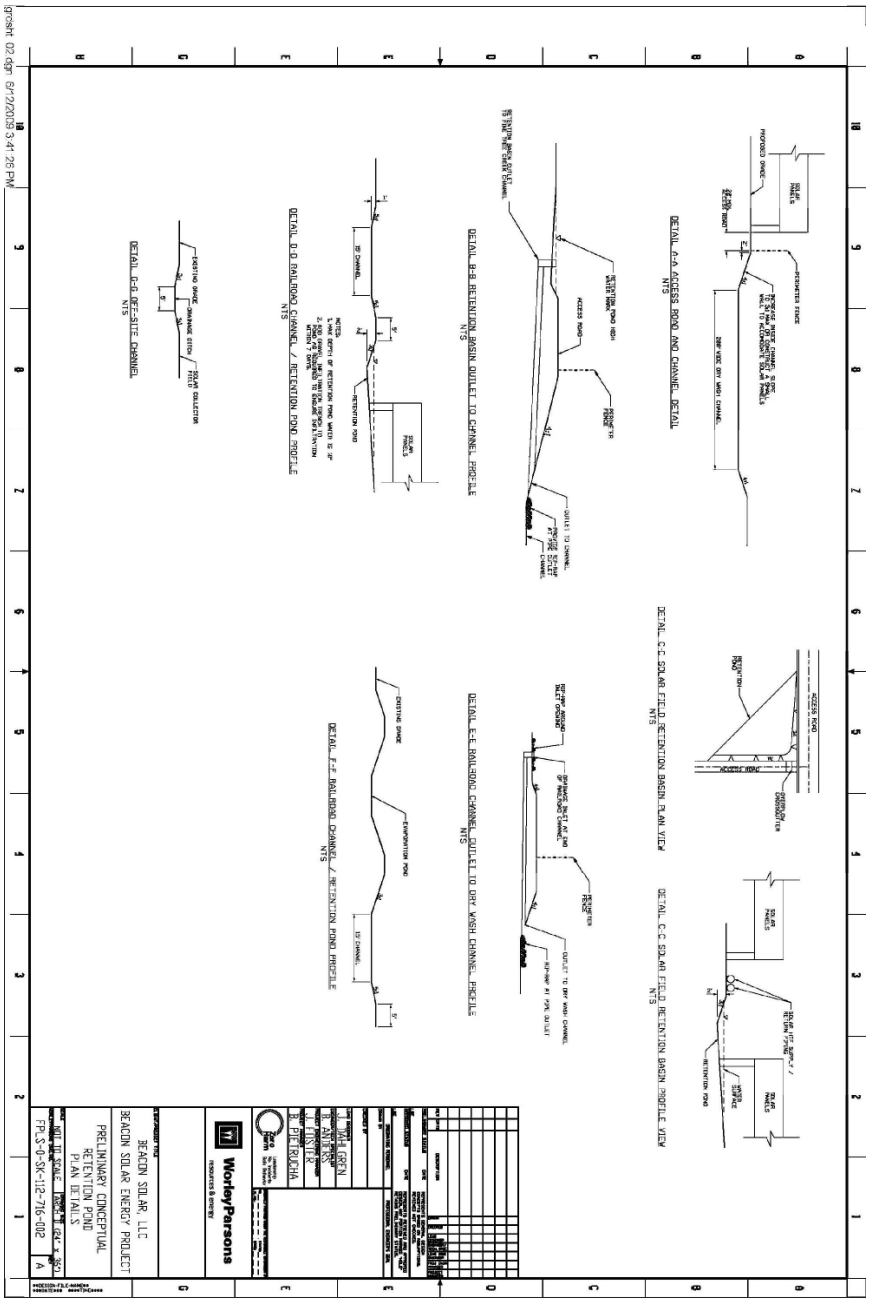
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