Appendix O

Conceptual Solar PV Layout Technical Memorandum

Technical Memorandum

July 19, 2021

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From	Jordan King, PE	**Ref. No.**	11205607
Subject	Conceptual Solar PV Layout and Production Estimate for Nordic Aquafarms		

Introduction

GHD has prepared a Conceptual Solar Photovoltaic (PV) Layout and supporting production estimate for Nordic Aquafarms California (NAFC) to establish the potential size and capacity of a roof mounted system at the planned Eureka, CA facility. The project is currently in the planning phase and this conceptual layout is intended to serve as a visual representation of the potential roof area available for a solar PV power system. This Conceptual Layout does not include detailed structural, permitting, or technology analysis, and is intended to guide further planning.

System Sizing

The Conceptual Solar Layout is included as an attachment to this technical memorandum, shown on drawings provided by SMRT Architects and Engineers. The system was sized to cover the available roof space of Building 1, Building 2, and Building 3 based on the current NAFC facility layout. PV modules are flat mounted parallel to the roof surface to minimize wind loads with minimum gaps between panels and spacing of gaps between panels, in accordance with ASCE 7-16, Section 29.4.3 minimum design standards.

The PV module dimensions used for the conceptual layout are based on a Tier 1 product that is currently available with panel dimensions of 39.45" x 79" and maximum power capacity of 410 Watts per unit (STC, Jinko Solar Product Number: JKM410M-72HL-V). The solar array layout includes estimated minimum interior access pathways and perimeter pathways in accordance with 2019 California Fire Code Section 1204.3 and the proposed Tier 1 PV module. Pathways include a six-foot perimeter and eight-foot interior pathways at intervals not less than 150 feet throughout the length and width of the roof. The location of roof obstructions such as vent pipes, conduits, and mechanical equipment have not been fully identified during the Concept Layout. Roof obstructions identified for installation in the location of the proposed solar PV array during the design process will require removal of solar PV modules. Removal of solar PV modules to accommodate roof obstructions is anticipated to slightly reduce the overall solar array footprint. Large areas where roof vent equipment is currently identified on Buildings 1 through 3 is shown on the concept drawing with consideration for setbacks from the proposed array locations to minimize shading.

Based on the above assumptions, GHD estimates that NAFC could install an approximate 4,845 kW (Standard Test Conditions) PV module array across Buildings 1, 2, and 3. This is the maximum system size under this configuration. Installation of the proposed solar system is anticipated to be implemented in phases, with Buildings 1 & 3 being constructed first, followed by Building 2. Table 1 below shows the anticipated system sizes for each building and phase.

Table 1: Estimated Solar PV Energy System Size by Building and Development Phase

Building Description	Number of Modules	System Size (kW)	Development Phase
Building 1	5,069	2,078	1
Building 3	1,216	498	1
Building 2	5,536	2,269	2
Total:	**11,821**	**4,845**	**N/A**

Electricity Production Estimate

GHD used the National Renewable Energy Laboratory's PVWatts Calculator to estimate the energy production of the Conceptual Solar Layout. Tables 2 below shows the site-specific insolation data (amount of solar radiation reaching a given area), and Table 3 shows the above system information used as inputs for the production model in PVWatts. Figure 1 shows the estimated Monthly Production from the PVWatts Simulation for the 4,845 kW system by Building.

Table 2: Average Daily Insolation for NAFC Project Site

Average Daily Insolation for Arcata, CA (latitude 40.85°N, longitude 124.1°W, from PVWatts)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Average Insolation ($kWh/m^2/day$)	1.69	2.42	3.53	4.88	5.74	6.27	6.03	5.09	4.36	3.26	1.92	1.54	3.89

Table 3: Summary of PV System Inputs and Assumptions for PVWatts Production Simulation

NAFC PV System Production Model Inputs			
Building	1	3	2
DC System Size (kW):	2,078	498	2,269
Module Type:	Standard	Standard	Standard
Array Type:	Fixed (roof mount)	Fixed (roof mount)	Fixed (roof mount)
System Losses (%):	11.42	11.42	11.42
Tilt (deg):	0	0	0
Azimuth (deg):	195	182	183
DC to AC Size Ratio:	1.2	1.2	1.2
Inverter Efficiency (%)	96	96	96
Ground Coverage Ratio	0	0	0

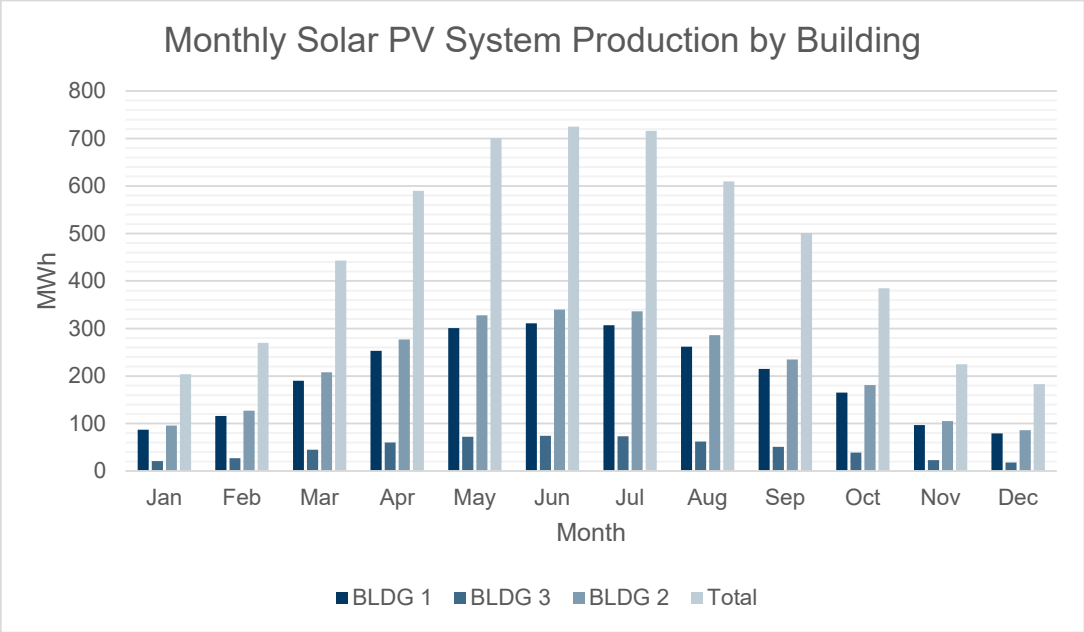

Figure 1: Estimated Monthly Production from PVWatts Simulation

The summary of monthly and annual estimated electricity production (MWh) by building is summarized in Table 4.

Table 4: Summary of Estimated Solar PV Production for NAFC Project Site

Estimated Monthly and Annal Electricity Production from PVWatts Simulation for NAFC Site (MWh)													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Building 1	87	116	190	253	301	311	307	262	215	165	97	79	2,383
Building 3	21	27	45	60	72	74	73	62	51	39	23	18	565
Building 2	96	127	208	277	328	340	336	286	235	181	105	86	2,605
Total	204	270	443	590	701	725	716	610	501	385	225	183	5,553

Based on the conceptual system sizing and assumptions used in the PVWatts Calculator simulation, the total solar system size potential for a roof mounted system on NAFC's Buildings 1, 2, and 3 is 4,845 kW with an estimated annual production of 5,553 MWh.

As mentioned in the introduction, the Conceptual Layout does not attempt to include all formal code requirements or make technology and design decisions that are required for the most accurate calculations of system size and production. Please let us know if you have follow up questions.

Attachments: Conceptual Solar PV Site Layout

NOTES:

SOLAR PV MODULES ARE FLAT MOUNTED PARALLEL TO ROOF SURFACE WITH MINIMUM GAPS BETWEEN PANELS AND SPACING OF GAPS BETWEEN PANELS IN ACCORDANCE WITH ASCE 7-16, SECTION 29.4.3.

SOLAR PV MODULE DIMENSIONS ARE BASED ON A TIER 1 PRODUCT THAT IS CURRENTLY AVAILABLE WITH PANEL DIMENSIONS OF 39.45"X79" AND 410 WATT (STC) MAX POWER CAPACITY (JINKO SOLAR JKM410M-72HL-V).

ARRAY LAYOUT INCLUDES MINIMUM ACCESS PATHWAYS AND PERIMETER PATHWAYS IN ACCORDANCE WITH 2019 CFC SECTION 1204.3. PATHWAYS SHOWN INCLUDE A 6 FOOT PERIMETER PATHWAY AND 8 FOOT INTERIOR PATHWAYS AT INTERVALS NOT LESS THAN 150 FEET THROUGHOUT THE LENGTH AND WIDTH OF THE ROOF.

THE LOCATION OF ROOF OBSTRUCTIONS SUCH AS VENT PIPES, CONDUITS, OR MECHANICAL EQUIPMENT HAVE NOT BEEN FULLY IDENTIFIED AT THIS POINT IN THE DESIGN PROCESS, AND WILL NEED TO ACCOMMODATED BY PANEL REMOVAL IN DEPENDING ON FINAL BUILDING DESIGN. ROOF VENT EQUIPMENT THAT HAS BEEN IDENTIFIED ON BUILDINGS 1-3 ARE SHOWN ON PLANS WITH CONSIDERATION FOR APPROPRIATE CLEARANCE FROM THE PROPOSED ARRAY LOCATIONS.

OVERALL SOLAR PV SYSTEM SIZE (STC):
PHASE 1 (BLDG 1 & 3): 2,576 KW
PHASE 2 (BLDG 2): 2,269 KW
TOTAL: 4,845 KW

BUILDING 1:
APPROXIMATE ROOF AREA: 265,025 SF
MODULES: 5,069
APPROXIMATE SYSTEM SIZE: 2,078 KW (STC)
DEVELOPMENT PHASE: 1

NO SOLAR PLACED IN THIS AREA DUE TO POTENTIAL SHADING FROM LARGE ROOFTOP EQUIPMENT, AND SIGNIFICANT CHANGES IN ROOF ELEVATION.

1000.0'

264.2'

1

5

BUILDING 3:
APPROXIMATE ROOF AREA: 105,085 SF
MODULES: 1,216 APPROXIMATE SYSTEM SIZE: 498 KW (STC)
DEVELOPMENT PHASE: 1

542.0'

SOLAR PV ARRAY, TYP.

NO SOLAR PLACED IN THESE AREAS DUE TO POTENTIAL SHADING FROM LARGE ROOFTOP EQUIPMENT, AND SIGNIFICANT CHANGES IN ROOF ELEVATIONS.

4

192.3'

3

BUILDING 2:
APPROXIMATE ROOF AREA: 286,887 SF
MODULES: 5,536
APPROXIMATE SYSTEM SIZE: 2,269 KW (STC)
DEVELOPMENT PHASE: 2

NO SOLAR PLACED IN THIS AREA DUE TO POTENTIAL SHADING FROM LARGE ROOFTOP EQUIPMENT, AND SIGNIFICANT CHANGES IN ROOF ELEVATION.

264.2'

2

1095.2'

KEY PLAN
N.T.S. F0

REV	DESCRIPTION	DATE

CURRENT ISSUE STATUS:

N

PROJECT NORTH:

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NORDIC AQUAFARMS

CONCEPTUAL SOLAR LAYOUT

SHEET TITLE:

0 50' 100'

SCALE: AS NOTED

PROJECT MANAGER:	JCK	PROJECT NO:	19120
A/E OF RECORD:			
JOB CAPTAIN:			
DRAWN BY:	NPS		
SMRT FILE:		SHEET No.	

36x48