Dedicated to Building a Sustainable Future

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# Passaic Valley Sewerage Commission
# Solar Energy and Battery Energy Storage System Feasibility Study

Commissioned by:

**Passaic Valley Sewerage Commission**
**600 Wilson Ave, Newark, NJ 07105**

For:

**The New Jersey Department of Environmental Protection**
**401 E State St, Trenton, NJ 08608**

As required in:

**NJDEP Air Pollution Control Operating Permit Significant Modification**
**Program Interest Number: 07349**
**Permit Activity Number: BOP210002**

Date: June 30, 2025

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## 1. Introduction and Purpose

This feasibility study was commissioned by the Passaic Valley Sewerage Commission for the New Jersey Department of Environmental Protection (NJDEP) in order to comply with the requirements of the NJDEP Environmental Justice Decision of July 18, 2024 and the similar requirements of the NJDEP Air Pollution Control Operating Permit Significant Modification (Air Permit), for Program Interest Number: 07349, Permit Activity Number: BOP210002. Specifically, the feasibility study is a Submittal/Action Requirement of GR2 EJ Special Conditions No. 8 (solar) and No. 9 (battery storage) in the Air Permit. The conditions as stated in the Air Permit are repeated below.

*Install the maximum feasible and no less than five (5) MW of solar panels at the PVSC Facility by December 31, 2026, unless a written extension request is submitted to and approved by the Department. [N.J.S.A. C.13:1D-160(d)].*

*Install the maximum feasible and no less than five (5) MW of battery storage capacity at the PVSC Facility by December 31, 2026, unless a written extension request is submitted to and approved, in writing, by the Department. [N.J.S.A. C.13:1D-160(d)]*

The feasibility studies required under Special Condition No. 8 and under Special Condition No. 9 of the Air Permit are significantly interrelated, since the solar power and energy storage systems will function together in an integrated fashion to provide backup power to the PVSC facility, as required under Special Condition No. 1.e. Therefore, the solar and battery feasibility studies are combined in this document.

## 2. About PVSC

Created in 1897, the Passaic Valley Sewerage Commission is a New Jersey state agency and public utility that owns and operates the largest wastewater treatment facility in New Jersey.

Based in Newark, PVSC is the 5th-largest treatment plant in the United States, serving approximately 1.6 million residents in the 48 cities/ municipalities of Bergen, Essex, Hudson, Passaic and Union Counties in Northeastern New Jersey.

The facility treats 25% of all wastewater generated in New Jersey and 20% of the biosolids produced by the New York City Department of Environmental Protection. PVSC also accepts liquid waste from customers located in the northeast via truck or marine vessel.

The site is also the largest single consumer of electricity in the state, with average load of approximately 22 megawatts (“MW”) and expected peak electric load of about 34 MW when the resiliency improvements are completed

## 3. History of PVSC's Solar Energy and Battery Energy Storage System Efforts

In 2012, before Superstorm Sandy occurred, PVSC conducted a plant-wide study of the potential for solar energy to provide an emission-free source of energy for the plant, including PVSC ownership options as well as third-party ownership (PPA) options. At the time, installation of solar energy was not economically feasible.

In 2020, in response to the adoption to New Jersey's 2019 Energy Master Plan, PVSCs Board of Commissioners directed the technical staff to start the development of a strategic plan for the purpose of identifying opportunities to reduce PVSC's plant-wide air emissions and dependence on electricity derived from fossil fuels. This effort, along with others described below, ultimately led to the PVSC Energy Sustainability Roadmap. The Roadmap provides a three-phase timeline of a number of activities designed to reduce environmental stressors in the local community as well as reduce overall greenhouse gas emissions, while continuing to provide uninterrupted wastewater treatment services.

In 2021, and in response to concerns raised by the community, the Board directed PVSC's technical team to re-evaluate the 2012 solar feasibility study and other renewable energy technologies for potential use with the SPGF. This included an investigation of solar power, wind power, and battery energy storage.

In 2022, PVSC issued an award for the proposal of Advanced Solar Products, which included the development, design, construction, and operation of solar power systems and a battery energy storage system.

## 4. Solar Energy and Battery Energy Storage System Concept

### a. Challenges to Overcome

Challenges to achievement of a solar energy and battery energy storage system include:

1. The amount of space available:

Space within the PVSC facility for resiliency measure is very limited. The facility is very compact for its functional capacity, so the great majority of space is used for equipment, traffic, storage of material, and other uses, or is reserved for near-term future uses. Where there is open ground, some are unusable due to being wetlands or buffer areas, a stream corridor, or high slopes.

2. Technology limitations:

Technology limitations are important, including availability of a particular technology; efficiency or other performance limitations; and lack of track record or reliability commensurate with the critical nature of the intended function.

3. Source of funds:

PVSC's primary source for infrastructure investment is the New Jersey Infrastructure Bank, and there are restrictions that can prevent its use for some potential measures. Third-party ownership by private entities is a common option for public projects since Solar and Batteries are specialty systems that the public owners do not have the capabilities to operate and maintain these systems and can facilitate the monetization of federal tax credits, However, it is restricted to measures that can produce enough net revenue for an adequate rate of return for the third-party investors, and that feature low levels of risk. There are state incentive funds for some measures, but they may not be available at the scale needed or for some technical configurations.

4. Potential for conflict with ongoing operations:

Conducting construction measures within the facility can be curtailed due to interference with ongoing operations or with construction within the facility, or proximity to potential hazards.

5. Regulatory limitations:

Some technically feasible technologies or measures may not be allowed under current regulatory structures. Examples of current regulatory structures that may interfere with otherwise feasible measures include:

a. NJBPU rules in the Administratively Determined Incentive (ADI) program for solar (a different program than the Transition Incentive program under which the solar project was originally approved by NJBPU) now has a 5 MW cap for total solar capacity on a given site.

Although waivers to these rules could be sought, success in obtaining such waivers is uncertain.

**b. Description of the Renewable Energy Generation System (REGS) Concept**

Battery energy storage is the most effective clean energy measure in providing reliable backup power. The duration of backup power that can be provided by batteries is limited, however, as will be discussed in detail below. Like solar energy, battery energy storage can generate revenue in amounts sufficient to avoid significant negative rate impacts and possibly even to have positive rate impacts. However, most of that revenue depends on market-based price that can fluctuate wildly from year to year, making reliance on that revenue to cover debt obligations, or to provide a return to third-party owners, a risky proposition. For that reason, it will be of key importance to secure eligibility for state energy storage incentive programs to maximize the battery size.

The capability of a solar power system is expressed in terms of its rated power generation capacity in kilowatts (KW) or megawatts (MW). On the other hand, battery energy storage systems have *two* ratings, a *power rating* and an *energy rating*. Its power rating is determined by the size of its inverter(s), and is expressed in KW or MW, like solar power. Its energy rating is determined by the size of its batteries and is expressed in kilowatt-hours (KWH) or megawatt-hours (MWH).

The concept as proposed by ASP relies primarily on a battery energy storage system whose inverter power rating is large enough and whose battery energy rating is large enough to operate at that power level for as long as possible.

It is important to note that the cost of a battery energy storage system is embodied almost entirely in the battery aspects of the system, whereas the cost of the inverter is a small percentage of the system cost – as a rule of thumb, often only approx. 5%. Therefore, achieving the power rating needed to run the PVSC plant is relatively easy (in technical and economic terms), while achieving longer hours of duration is a challenge.

The other part of the concept, solar power, is to be maximized to extend the duration of the battery. However, there are limitations to how much solar power can be connected to the PVSC facility. Moreover, solar power capacity cannot necessarily be relied upon to deliver during a power outage. First, the solar systems will only deliver power during the daytime, whereas a power outage may be all or partially at night. Furthermore, a power outage may occur during very cloudy weather, or when snow covers the solar panels.

The role of the solar part of the concept is still important, because it *increases the probability* that the microgrid will continue to support the PVSC facility for the full duration of a power outage.

## 5. Description of Feasibility Study Approach

The determination of the maximum feasible size of solar power generation and battery energy storage that can provide standby power to the facility during power outages is a requirement of Air Permit Special Condition No. 8 (solar) and No. 9 (battery storage).

Assessing the maximum feasible size first requires a definition of feasibility for solar and batteries. Then the feasibility work proceeds to assess the factors that determine the limits of rated size and function of solar power and battery storage.

### a. Definition of "Feasible"

To define feasibility for solar power, ASP primarily relied on an assessment of the available and appropriate space that can support solar panels.

"Available" means that a space is not already required for other activities, including plant operations, vehicle traffic, and foot traffic, and that it is not anticipated for future use for such incompatible purposes.

"Appropriate" means that a candidate space has enough load-bearing capacity; that there is a way to support and fasten solar panels in their required orientation while resisting wind loads, snow loads, and seismic loads; that there are not corrosive or hazardous conditions present; that the surface is in proper condition (e.g., roof surfaces) and can be expected to remain so for more than 20 years; and that there is not excessive dust in the location that would frequently cover the solar panels and block light from them. In addition, if any activity takes place underneath or near the solar panels, that appropriate clearance and safety can be maintained.

The same factors apply to battery energy storage, but some factors are much less important for batteries, and some are much more important. In particular, load bearing capacity of a space is more important for batteries. Solar panels are relatively lightweight, but large, utility-scale batteries are extremely heavy (dozens of tons per unit), so load-bearing capacity and the ability to assess old, sub-surface conditions is of vital importance. On the other hand, dust is less of a concern for batteries than it is for solar panels.

Of secondary importance, a location might be considered not feasible if the cost of building solar at the proposed location there could not be done with commercially available methods or would be inordinately expensive to build, <u>and</u> it was so small that it would not contribute meaningful or significant capacity.

In the case of rooftops, a particular rooftop, even though it might not be in adequate condition for a solar array, was still considered feasible if the roof surface or other parts of the roof assembly could be repaired, upgraded, or replaced within the required time frame and at a reasonable cost. No roofs were rejected because of disrepair or lack of a warranty.

### b. Procedures Followed for Determining System Sizes

There were many different locations within the PVSC facility that offered the potential for the construction of solar systems, and a small number of locations that had the potential for large-scale battery systems. The following outline describes the major activities that were conducted to determine system size:

i. Planning

ASP and PVSC personnel met to discuss each potential location to identify any factors that would prevent the use of the location for solar or batteries.

ii. Site investigation

Site visits were made to all potential locations, and all available drawings and other relevant documents were located.

iii. Structural analysis

Licensed structural engineers from the engineering firm of French & Parrello Associates were engaged to assess the ability of the buildings and their rooftops to support solar systems on their roofs, including identification of any areas of a given roof that could not.

The clarifier walkways and floodwalls were similarly assessed for their ability to support the loads imposed by canopies fastened into them.

iv. Solar system design

ASP engineers performed system designs for each of the potential locations. This included solar panel layouts, generally with several alternative layouts; racking design, design of safety devices such as module-level rapid shutdown devices; design of DC wiring, conduit, and combiners; inverter design; design of AC wiring, conduit, and combiners; routing of circuits within the facility; and point of interconnection design.

For the floodwall canopies, clarifier walkway canopies, and ground mounts, design included structural design (with assistance from French & Parrello and the racking manufacturer's engineers) of supporting structures, foundations (including the walkways and floodwalls themselves), and methods for fastening the structures to the foundations.

a. Environmental assessment

b. Utility interconnection applications and approval

c. Assessment of special requirements for PVSC conditions

d. Permitting

e. Re-design as necessary

v. Battery preliminary design

Site suitability for a large BESS includes the size of any location within the facility, and whether the space is required for other functions taking place in the facility.

In addition, available data regarding subsurface conditions is reviewed for a preliminary assessment of the site's load bearing capacity to support the weight of the battery energy storage systems.

Routing of medium-voltage (13.8 kilovolt) electric power from a given site to the PVSC substation is assessed, in terms of distance of the run, and the type of conductor and conduit, and potential methods for carrying the circuit (below ground, overhead, etc.).

BESS system preliminary engineering design includes battery system and inverter layout and basic design; transformer design, preliminary electrical diagram; switchgear design; design of instrumentation and controls; and more.

## 6. Solar Power Maximum Feasible Size

Exhibit A provides an overview of the proposed solar energy system at the PVSC site.

### a. Rooftop

The following rooftops were found to be able to support solar power systems:

**TABLE 1 - ROOFTOP PV SYSTEMS**

| SYSTEM LOCATION | MW DC |
|---|---|
| VEHICLE MAINTENANCE | 0.39 |
| ADMIN | 0.04 |
| 02 PRODUCTION | 0.09 |
| WAREHOUSE | 0.39 |
| OEM | 0.08 |
| SLUDGE THICKENER | 0.12 |
| OLD CENTRIFUGE | 0.12 |
| TOTAL | **1.23** |

All of the rooftop systems have been completed.

### b. Clarifier Walkway Canopies

Based on custom-engineered designs, it was found to be feasible to construct canopies over the walkways within the final clarifier system without significantly impacting the conduct of normal work on the walkways. The walkway system size is shown below:

**TABLE 2 - CLARIFIER WALKWAY CANOPY PV SYSTEMS**

| SYSTEM LOCATION | MW DC |
|---|---|
| FINAL CLARIFIER POND 1 | 0.64 |
| FINAL CLARIFIER POND 2 | 0.64 |
| TOTAL | **1.27** |

Construction will commence on the clarifier walkway canopy systems in July 2025.

### c. Floodwall Canopies

Also based on custom-engineered designs, it was found to be feasible to construct canopies on top of the floodwalls in many areas without significantly impacting the conduct of normal work or traffic adjacent to the floodwalls within the facility, or adjacent to the floodwalls in the areas immediately outside the facility. The floodwall system sizes for various locations along the floodwall are shown below:

**TABLE 3 - FLOODWALL PV SYSTEMS**

| SYSTEM LOCATION | MW DC |
|---|---|
| LAB | 0.19 |
| 02 SCRUBBER | 0.10 |
| SUPERNATANT TREAT. PLANT | 0.19 |
| FINAL CLARIFIER 1 | 0.08 |
| SLUDGE THICKENER | 0.25 |
| DECHLORINATION | 0.16 |
| FILTER PRESS | 0.12 |
| SLUDGE HEAT TREAT. | 0.3 |
| TOTAL | **1.39** |

The first location listed above has been completed. The others are ready to enter the construction phase.

### d. Ground Mounts

It was found that there are three locations within the PVSC facility that can support ground-mounted solar systems. These locations have soil, subsurface, and terrain conditions that require geotechnical evaluation and custom-engineered design.

**TABLE 4 - GROUND MOUNT PV SYSTEMS**

| SYSTEM LOCATION | MW DC |
|---|---|
| NUTLEY BERM | 0.74 |
| HADER HILL | 0.25 |
| CHLORINE CONTACT TANK AREA | 0.32 |
| TOTAL | **1.31** |

The ground mount systems are currently in the development and design phase of work.

In conclusion, the solar maximum feasible within the plant boundaries is summarized below.

**TABLE 5 - SOLAR MAXIMUM FEASIBLE**

| SYSTEM TYPE | MW DC |
|---|---|
| ROOF MOUNTED | 1.23 |
| FLOOD WALL MOUNTED | 1.39 |
| CANOPY MOUNTED | 1.27 |
| GROUND MOUNTED | **1.31** |
| TOTAL | **5.19** |

## 7. Solar Preliminary Installation Schedule

The following tables are preliminary installation schedules for the solar energy system at the PVSC site. As noted previously, installation of the rooftop systems is now complete.

**TABLE 6 – PRELIMINARY SCHEDULE FOR CLARIFIER WALKWAY SOLAR SYSTEM**

| No. | Milestone – Clarifier Walkways | Est. Completion Date |
|---|---|---|
| 1 | Notice to Proceed to Submission of Purchase Orders | complete |
| 2 | Commence Construction | 6/30/2025 |
| 3 | Mechanical Completion | 12/8/2025 |
| 4 | Commercial Operation | 1/5/2026 |
| 5 | Substantial Completion | 1/19/2026 |
| 6 | Final Completion | 1/29/2026 |

**TABLE 7 – PRELIMINARY SCHEDULE FOR FLOODWALL AND GOURND MOUNT SOLAR SYSTEMS**

| No. | Milestone - Floodwalls & Ground Mounts | Est. Completion Date |
|---|---|---|
| 1 | Notice to Proceed | 7/1/2025 |
| 2 | Receive All AHJ Approvals | 10/21/2025 |
| 3 | Submit Purchase Orders | 10/26/2025 |
| 4 | Receive Equipment Deliveries | 2/15/2026 |
| 5 | Commence Construction | 2/20/2026 |
| 6 | Mechanical Completion | 9/18/2026 |
| 7 | Commercial Operation | 10/9/2026 |
| 8 | Substantial Completion | 10/23/2026 |
| 9 | Final Completion | 11/1/2026 |

## 8. Battery Maximum Feasible Size

There are currently unusually long lead times for major electrical power equipment, including grid-scale battery systems, transformers, switchgear, and more. The causes of unusually long lead times include a worldwide boom in the demand for new electric generating capacity, and the disruption and uncertainty caused by new U.S. tariffs.

In addition, the efforts to develop sources of funding to support a very large BESS system have been underway for a long period of time and are expected to take substantially more time to complete before orders for long lead time equipment can be made.

In view of these factors, the maximum size that PVSC can be confident of completing by the required 12/31/26 date is 5 MW of battery storage. PVSC is exploring further the ability to expand the BESS to a 35MW x 2 hour system but it is expected to require more time to develop and fund.

The primary factor limiting the technical maximum feasible size of the battery is space.

ASP is currently using the Tesla Megapack 2XL as its basis of design.

Each of the battery system modules is very heavy – they weigh about 84,000 pounds each. The transformers and pads contribute substantial additional weight. Therefore, the battery system must be placed in a location where PVSC can be very confident in the bearing capacity of the soil. Some of the locations in the facility that were assessed for the battery system have subsurface conditions that are unsuitable for supporting the weight of the battery system. One location was identified that appears to be suitable. Exhibit B provides an overview of the proposed battery energy storage system at the PVSC site.

**9. Battery Preliminary Installation Schedule**

The battery energy storage system includes some very long lead time equipment – principally the battery systems themselves, and the transformers.

Condition no. 9 to the air permit, and the EJ decision, require that at least 5 MW of battery capacity be completed by the end of 2026. A preliminary schedule for the completion of this system is shown below in Table 7.

**TABLE 8 – PRELIMINARY SCHEDULE FOR BATTERY ENERGY STORAGE SYSTEM**

| No. | Milestone - Battery Energy Storage System | Est. Completion Date |
|---|---|---|
| 1 | Notice to Proceed | 10/1/2025 |
| 2 | Submit Purchase Orders for Long Lead Time Equipment | 10/12/2025 |
| 2 | Receive All AHJ Approvals | 1/16/2026 |
| 4 | Commence Construction | 1/26/2026 |
| 5 | Receive Long Lead Time Deliveries | 10/15/2026 |
| 6 | Mechanical Completion | 11/10/2026 |
| 7 | Commercial Operation | 11/28/2026 |
| 8 | Substantial Completion | 12/10/2026 |
| 9 | Final Completion | 12/30/2026 |

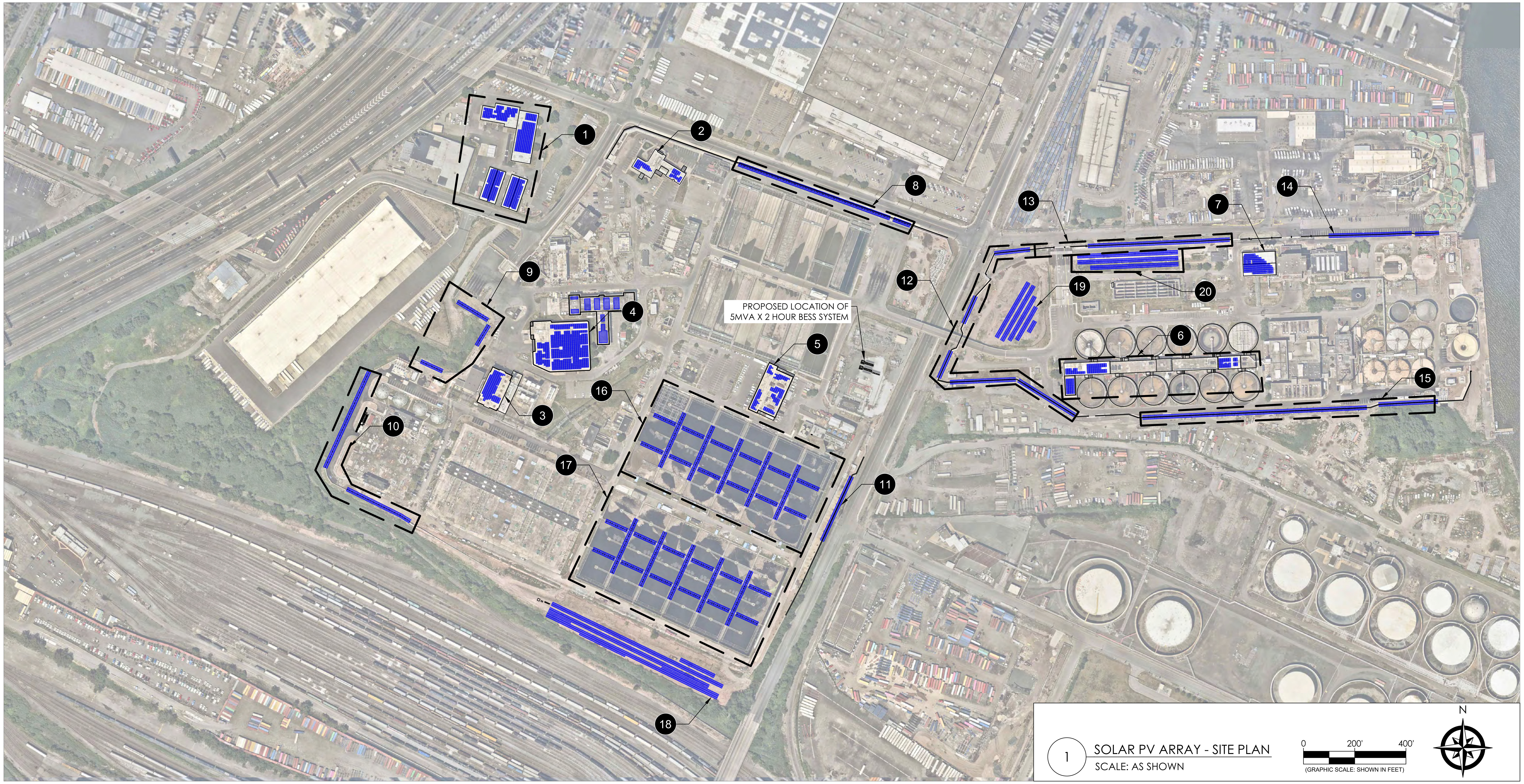
**10. Summary**

The potential for a clean energy microgrid serving the PVSC facility is substantial. PVSC’s goal is to utilize solar power and battery energy storage to provide as many hours of standby power as possible, keeping the facility fully functional.

The maximum feasible solar power that can be built onsite is rated at 5.2 MWdc, which corresponds to an AC power output of 4.2 MWac. This capacity can be completed by December 31, 2026.

As of this date, 1.4 MW of solar panels have been installed, including all of the feasible on-site rooftop locations and one section of floodwall-mounted canopies. Work continues on several additional solar systems within the facility. These include solar on canopies over the walkways over the final clarifiers, which are ready to commence on-site construction in July 2025.

A large battery energy storage system (BESS) is feasible at the PVSC. The required minimum of 5 MW of battery power capacity can be completed by December 31, 2026. The BESS is the primary feature of a Renewable Energy Generation System, in order to provide short-term resilient power.




## ROOFTOP PV SYSTEMS

| ID | SYSTEM | KW DC |
|---|---|---|
| 1 | VEHICLE MAINTENANCE | 388.80 |
| 2 | ADMIN | 38.88 |
| 3 | O2 PRODUCTION | 87.48 |
| 4 | WAREHOUSE | 398.52 |
| 5 | OEM | 77.76 |
| 6 | SLUDGE THICKENER | 116.64 |
| 7 | OLD CENTRIFUGE | 116.64 |
| | | |
| TOTAL | | 1,224.72 |

## FLOODWALL PV SYSTEMS

| ID | SYSTEM | KW DC |
|---|---|---|
| 8 | LAB | 194.40 |
| 9 | O2 SCRUBBER | 90.72 |
| 10 | SUPERNATANT TREAT. PLANT | 194.40 |
| 11 | FINAL CLARIFIER 1 | 77.76 |
| 12 | SLUDGE THICKENER | 246.24 |
| 13 | DECHLORINATION | 155.52 |
| 14 | FILTER PRESS | 116.64 |
| 15 | SLUDGE HEAT TREAT. | 311.04 |
| TOTAL | | 1,386.72 |

## CANOPY PV SYSTEMS

| ID | SYSTEM | KW DC |
|---|---|---|
| 16 | FINAL CLARIFIER POND 1 | 635.04 |
| 17 | FINAL CLARIFIER POND 2 | 635.04 |
| TOTAL | | 1,270.08 |

## GROUND MOUNT PV SYSTEMS

| ID | SYSTEM | KW DC |
|---|---|---|
| 18 | NUTLEY BERM | 737.10 |
| 19 | HADER HILL | 252.72 |
| 20 | CHLORINE CONTACT TANK | 322.92 |
| TOTAL | | 1,312.74 |

ALL PV SYSTEM TYPES TOTAL = 5,194.260 KW DC

PRELIMINARY - NOT FOR CONSTRUCTION

REVISIONS

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

PROJECT TITLE:
PVSC
SOLAR PHOTOVOLTAIC SYSTEM

SITE:
OVERALL SITE PLAN

OWNER:


ADVANCED SOLAR PRODUCTS
Dedicated to Building a Sustainable Future
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lyle@advancedsolarproducts.com


NJ CERTIFICATE OF AUTHORIZATION
LICENSE NO.: 24GA28102500

| DRAWN: AS | DATE: 3/12/2025 |
|---|---|
| CHECKED: | DATE: |
| SCALE: AS SHOWN | |

ANTHONY TIMOTHY LOMMA, P.E.
NJ PROFESSIONAL ENGINEER
LIC #24GE04553700

DRAWING TITLE: SITE PLAN

DWG. NO.: E-2


1 SOLAR PV ARRAY - SITE PLAN

SCALE: AS SHOWN

0 200' 400'

(GRAPHIC SCALE: SHOWN IN FEET)

N

PRELIMINARY - NOT FOR CONSTRUCTION

REVISIONS

| NO. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |

PROJECT TITLE:
PVSC
SOLAR PHOTOVOLTAIC SYSTEM

SITE:
OVERALL SITE PLAN

OWNER:


ADVANCED SOLAR PRODUCTS
Dedicated to Building a Sustainable Future

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NJ CERTIFICATE OF AUTHORIZATION
LICENSE NO.: 24GA28102500

DRAWN: AS
DATE: 3/12/2025
CHECKED:
DATE:
SCALE: AS SHOWN

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NJ PROFESSIONAL ENGINEER
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DRAWING TITLE: SITE PLAN

DWG. NO.: E-2