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An Environmental Approach for Construction, Operation, and Maintenance of Floating Solar Array Renewable Energy Projects on Army Installations

January 2017

AL Miracle
JE Cabe
TD Hardy
T O'Neil
KA Wagner
TL Anderson
KA Cort
SA Liss
MJ Parker
PM Klinger
D Appriou
JP Duncan
PD Meyer
K Studarus

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Prepared by

Pacific Northwest National Laboratory, Richland, Washington
AL Miracle TL Anderson D Appriou
JE Cabe KA Cort JP Duncan
TD Hardy SA Liss PD Meyer
T O'Neil MJ Parker K Studarus
KA Wagner

U.S. Army Environmental Command, JBSA Fort Sam Houston, Texas
PM Klinger

Prepared for
the U.S. Army Office of Energy Initiatives

Abstract

The U.S. Army Office of Energy Initiatives (OEI) has primary responsibility over renewable projects to help achieve the Army's renewable energy goals. The OEI serves as the central management office for partnering with U.S. Army installations to implement cost-effective, renewable energy projects, leveraging private sector financing. Siting, construction, and operation of solar power systems on U.S. Army installations help to achieve renewable energy goals. This report provides a general framework for environmental analysis for the siting, construction, and operation of floating solar renewable energy projects on U.S. Army installations, to include joint bases managed by the Department of the Army. This report includes specific information by resource area regarding the potential environmental impacts and probable best management practices or minimization approaches that afford environmental protection. This report provides analyses and suggestions that could support a programmatic analysis or site-specific action.

Acronyms and Abbreviations

AC	alternating current
ACHP	Advisory Council on Historic Preservation
ACP	access control points
ACRP	Airport Cooperative Research Program
ACUB	Army Compatible Use Buffer
AEC	Army Environmental Command
AHPA	Archeological and Historic Preservation Act of 1974
APE	Area of Potential Effect
AR	Army Regulation
BCC	Birds of Conservation Concern
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BMP	best management practices
CAA	Clean Air Act
CAES	compressed-air energy storage
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZPM	Coastal Zone Management Programs
DA	Department of the Army
DC	direct current
DISDI	Defense Installations Spatial Data Infrastructure
DoD	U.S. Department of Defense
EA	environmental assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EITF	Energy Initiative Task Force
EMF	electromagnetic field
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 2005
ESA	Endangered Species Act
ESS	energy storage system
EUL	enhanced use lease

FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FNSI	Finding of No Significant Impact
FPPA	Farmland Protection Policy Act
GHG	greenhouse gas
HAP	hazardous air pollutants
HDPE	high-density polyethylene
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resources Management Plan
IPMP	Integrated Pest Management Plan
kV	kilovolt
LBNL	Lawrence Berkeley National Laboratory
LBP	lead-based paints
LOS	level of service
MBTA	Migratory Bird Treaty Act
MDC	Minnesota Department of Commerce
MEC	munitions and explosives of concern
MMP	Marine Mammal Protected
MMPA	Marine Mammal Protection Act
MMRP	Military Munitions Response Program
MSA	Magnuson-Stevens Fishery Conservation Management Act
MW	megawatts
MWh	megawatt hour
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act of 1966, as amended
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NWOTUS	not considered waters of the United States
O&M	operations and maintenance
OEERE	Office of Energy Efficiency & Renewable Energy
OEI	Office of Energy Initiatives
OSHA	Occupational Safety & Health Administration
PCB	polychlorinated biphenyls

PEA	programmatic environmental assessment
PPA	Power Purchase Agreement
PPE	personal protective equipment
PRPA	Paleontological Resources Preservation Act
PV	photovoltaic
RCMP	Range Complex Master Plans
RCRA	Resource Conservation and Recovery Act
REC	Record of Environmental Consideration
ROI	region of influence
RPMP	Real Property Master Plans
SAV	submerged aquatic vegetation
SDWA	Safe Drinking Water Act
SDZ	surface danger zones
SHPO	State Historic Preservation Officer
SOH	Safety and Occupational Health
SOP	standard operating procedures
SSA	sole source aquifers
SWPPP	stormwater pollution prevention plan
TCP	traditional cultural properties
THPO	Tribal Historic Preservation Officer
TMDL	total maximum daily loads
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	unexploded ordnance
WOTUS	waters of the United States

Contents

Abstract ... iii
Acronyms and Abbreviations ... v
1.0 Report on National Environmental Policy Act (NEPA) Compliant Implementation of Floating Solar Projects ... 1.1
2.0 Proposed Action ... 2.1
2.1 Description of Floating Solar Arrays ... 2.1
2.2 Ancillary Power Control Systems ... 2.4
2.2.1 Energy Storage Systems (ESSs) ... 2.4
2.2.2 Microgrid Systems ... 2.5
2.2.3 Backup Generation ... 2.6
2.3 Screening Criteria ... 2.6
3.0 Alternatives Considered ... 3.1
3.1 No Action Alternative ... 3.1
3.2 Alternative 1: Implementation of Proposed Action on Chemically Treated Water or Wastewater at an Army Installation ... 3.1
3.3 Alternative 2: Implementation of Proposed Action on a Waterbody Not Considered Waters of the United States (NWOTUS) at an Army Installation ... 3.2
3.4 Alternative 3: Implementation of Proposed Action on Waterbody Considered Waters of the United States (WOTUS) at an Army Installation ... 3.3
3.5 Other Alternatives ... 3.4
3.6 Alternatives Considered but Eliminated from This Study ... 3.4
4.0 Affected Environment and Environmental Consequences ... 4.1
4.1 Introduction ... 4.1
4.2 Approach for Analyzing Impacts ... 4.1
4.3 Land Use ... 4.3
4.3.1 Existing Conditions ... 4.4
4.3.2 Environmental Consequences ... 4.4
4.4 Air Quality and Greenhouse Gases ... 4.6
4.4.1 Existing Conditions ... 4.7
4.4.2 Environmental Consequences ... 4.8
4.5 Noise ... 4.10
4.5.1 Existing Conditions ... 4.11
4.5.2 Environmental Consequences ... 4.11
4.6 Geology and Soils ... 4.13
4.6.1 Existing Conditions ... 4.16
4.6.2 Environmental Consequences ... 4.17
4.7 Water Resources ... 4.24

4.7.1 Existing Conditions 4.27
4.7.2 Environmental Consequences 4.28
4.8 Biological Resources 4.40
4.8.1 Existing Conditions 4.43
4.8.2 Environmental Consequences 4.44
4.9 Cultural Resources 4.55
4.9.1 Existing Conditions 4.56
4.9.2 Environmental Consequences 4.57
4.10 Socioeconomics 4.64
4.10.1 Existing Conditions 4.65
4.10.2 Environmental Consequences 4.65
4.11 Transportation and Traffic 4.68
4.11.1 Existing Conditions 4.68
4.11.2 Environmental Consequences 4.69
4.12 Airspace 4.71
4.12.1 Existing Conditions 4.71
4.12.2 Environmental Consequences 4.72
4.13 Electromagnetic Spectrum 4.75
4.13.1 Existing Conditions 4.75
4.13.2 Environmental Consequences 4.76
4.14 Utilities 4.77
4.14.1 Existing Conditions 4.77
4.14.2 Environmental Consequences 4.78
4.15 Hazardous and Toxic Materials and Waste 4.80
4.15.1 Existing Conditions 4.81
4.15.2 Environmental Consequences 4.82
4.16 Human Health and Safety 4.84
4.16.1 Existing Conditions 4.84
4.16.2 Environmental Consequences 4.85
5.0 Cumulative Impacts Analysis 5.1
5.1 Significant Adverse Environmental Effects That Cannot Be Avoided 5.1
5.2 Conflicts with Federal, State, or Local Resource-Use Plans, Policies, and Controls 5.1
5.3 Energy Requirements 5.2
5.4 Depletion of Economically Viable Natural or Depletable Resources 5.2
6.0 Summary of the Potential Effects of the Evaluated Alternatives 6.1
7.0 Decision Making 7.1
8.0 References 8.1
9.0 List of Preparers 9.1
9.1 Pacific Northwest National Laboratory 9.1

9.2 U.S. Army Environmental Command 9.1
Appendix A – Suggested Environmental Checklist for Floating Solar Project(s) A.1
Appendix B – Purpose and Need for Floating Solar Arrays B.1

Figures

Figure 1. Photovoltaic Solar Resource of the United States 2.2
Figure 2. Floating Solar Farm in Japan 2.3
Figure 3. Camp Swift (TX) Wastewater-Treatment Facility 3.2
Figure 4. Sierra Army Depot (CA) 9 ac Waterbody 3.2
Figure 5. 12 ac Simmons Lake at Fort Bragg (NC) 3.3
Figure 6. 29 ac Cranberry Pond at West Point (NY) 3.3
Figure 7. Distribution of Areas from a Survey of Army Installations 4.28
Figure 8. Density of Endangered and Imperiled Species on Federal Agency Lands. 4.43
Figure 9. Reflectivity Scale (FAA 2010) 4.73
Figure 10. Solar Glare Example (Sandia 2014) 4.74

Tables

Table 1. Summary of Actions, Impacts, and Mitigation Strategies[a] for all Alternatives on Land Use 4.6
Table 2. Summary of Actions, Impacts, and Mitigation Strategies[a] for All Alternatives on Air Quality and Greenhouse Gases 4.10
Table 3. Summary of Actions, Impacts, and Mitigation Strategies[a] for All Alternatives on Noise 4.13
Table 4. Summary of Alternative 1 Actions, Impacts, and Mitigation Strategies[a] on Geology and Soils 4.20
Table 5. Summary of Alternative 2 Actions, Impacts and Mitigation Strategies[a] on Geology and Soils 4.21
Table 6. Summary of Alternative 3 Actions, Impacts, and Mitigation Strategies[a] on Geology and Soils 4.23
Table 7. Summary of Alternative 1 Actions, Impacts, and Mitigation Strategies[a] on Water Resources 4.31
Table 8. Summary of Alternative 2 Actions, Impacts, and Mitigation Strategies[a] on Water Resources 4.35
Table 9. Summary of Alternative 3 Actions, Impacts, and Mitigation Strategies[a] on Water Resources 4.39
Table 10. Summary of Alternative 1 Actions, Impacts, and Mitigation Strategies[a] on Biological Resources 4.46

Table 11. Summary of Alternative 2 Actions, Impacts, and Mitigation Strategies[(a)] on Biological Resources 4.49
Table 12. Summary of Alternative 3 Actions, Impacts, and Mitigation Strategies[(a)] on Biological Resources 4.52
Table 13. Summary of the Alternative 1 Action, Impacts, and Mitigation Strategies[(a)] for Cultural Resources 4.59
Table 14. Summary of the Alternative 2 Action, Impacts and Mitigation Strategies[(a)] for Cultural Resources 4.61
Table 15. Summary of the Alternative 3 Action, Impacts and Mitigation Strategies[(a)] for Cultural Resources 4.63
Table 16. Summary of Actions, Impacts and Mitigation Strategies[(a)] for all Alternatives on Socioeconomics 4.68
Table 17. Summary of Actions, Impacts and Mitigation Strategies[(a)] for all Alternatives on Transportation and Traffic 4.70
Table 18. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Airspace 4.75
Table 19. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Electromagnetic Spectrum 4.77
Table 20. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Utilities 4.80
Table 21. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Hazardous and Toxic Materials and Waste 4.84
Table 22. Summary of Actions, Impacts and Mitigation Strategies[(a)] for All Alternatives on Human Health and Safety 4.87
Table 23. Summary of the Potential Effects on the Evaluated Alternatives 6.2
Table 24. Summary of Best Management Practices and Environmental Protection Measures to be Adopted 6.5

1.0 Report on National Environmental Policy Act (NEPA) Compliant Implementation of Floating Solar Projects

To support future National Environmental Policy Act (NEPA) (42 USC 4321 et seq.) analyses for the implementation of floating solar projects, either programmatically or at a site-specific level, this report provides a general framework for environmental analysis for the construction and operation of floating solar renewable energy projects on Army installations, to include joint bases managed by the Department of the Army (DA). As currently envisioned, projects would average approximately 1 megawatt (MW) of power generation capability. The size of each project would depend on the installation; larger installations would generally have larger energy requirements and potentially more waterbody surface areas that could accommodate larger projects. Floating solar projects would typically be used in combination with other renewable energy projects, particularly other solar photovoltaic (PV) applications, to maximize the benefits of renewable energy to the installation and minimize the need for additional mission-constrained land that would be required for traditional ground-mounted solar PV systems. Projects could be funded by the Army, through a third-party Power Purchase Agreement (PPA), utilize a lease of land with a local utility company (Enhanced Use Lease [EUL]), or via some other relationship with a private or public entity. Appendix A provides an example of suggestions that could be included in a programmatic analysis, if one is prepared based on the framework contained in this report, to help installations determine additional site-specific NEPA information which could be required for the applicable action alternative. In the absence of a programmatic analysis, Appendix A can be used to advise installations on whether this report contains sufficient information for the development of a NEPA analysis document or whether additional analysis, based on site-specific conditions, may be needed. Appendix B also provides an example of a NEPA compliant purpose and need statement for a proposed action involving installation, operation, and maintenance of floating solar projects on Army installations.

2.0 Proposed Action

The proposed action for future NEPA analyses would be to construct, operate, and maintain floating solar arrays on Army installations to include U.S. Army Reserve facilities, Army National Guard sites, and joint bases managed by the DA (with all henceforth referred to only as “Army installations” or “installations”). To support the reliable production and distribution of floating-solar-generated electricity to the existing grid infrastructure, the proposed action also assumes the construction, operation, and maintenance of electricity transformers, transmission and distribution lines, and sub or switching stations and the installation of ancillary power control and management systems (e.g., energy storage systems [ESS], microgrid components, and backup power generation). The proposed action could also include real estate actions on Army lands and waters involving an independent power producer or a local regulated utility company (e.g., a third-party PPA, an EUL, and utility easements).

2.1 Description of Floating Solar Arrays

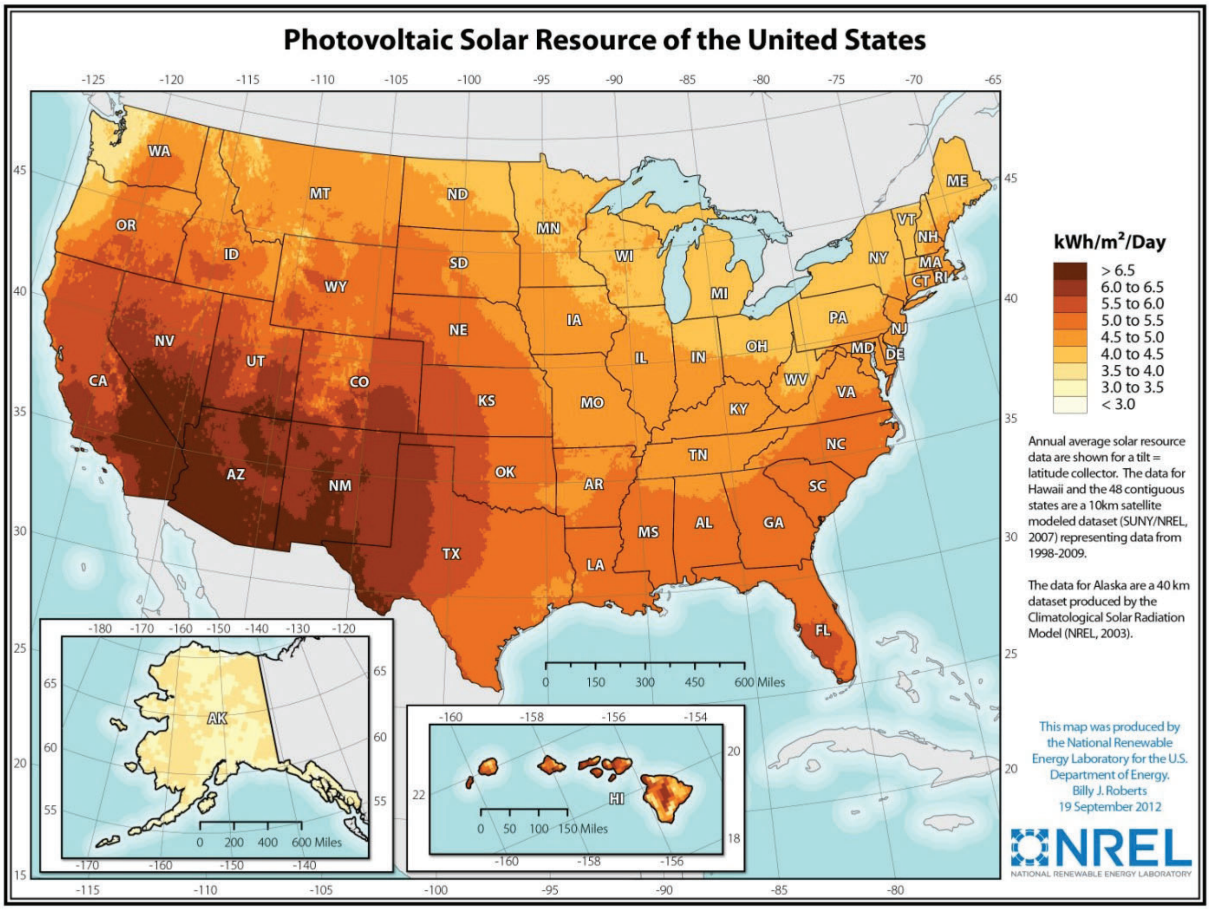
Solar PV technology converts sunlight directly into electric current through the use of semiconductors. Semiconductors are usually composed of crystalline silicon wafers—either single crystal or polycrystalline—and thin-film amorphous silicon. When exposed to light, semiconducting materials absorb light energy in the form of photons and emit electrons in the form of electricity. The direct current (DC) electricity produced is then converted to alternating current (AC) electricity through an inverter in a power-conditioning system to be compatible for use. A basic solar PV cell produces approximately 1 to 2 W on average. To produce more power, solar PV cells are wired in series and in parallel to form modules. For a floating solar array, several PV modules could be mounted on pontoons to form PV arrays as raft-like structures that rest on the surface of a waterbody. On Army installations, a number of different types of waterbodies exist on which floating solar arrays could be deployed. These waterbody types are discussed in Section 3.0.

Floating solar technology generally requires a waterbody with unobstructed views of the sun. Depending on geographic location, the potential for solar power output will vary. The National Renewable Energy Laboratory (NREL) provides information that could help installations determine the viability of potential solar arrays on Army installations. One NREL tool is the U.S. PV solar resource map (Figure 1). NREL’s evaluation of solar energy potential uses the metric of kilowatt-hours produced, per square meter, per day, or $kWh/m^2/day$.

In addition, the composition of the floating platform for the floating solar arrays may have temperature and water-quality thresholds for longevity. Waterbodies prone to freezing or located in areas with a climate that has extensive sub-freezing temperatures may not be optimal deployment areas.

One advantage floating solar might have over conventional, land-based, energy-generation systems is that construction of the arrays would typically involve a small land-use footprint and minimal ground-disturbing activities. Floating rafts with solar PV panels could be anchored to the bottom of a waterbody and/or at the shoreline, and may not require any anchoring if contained within an existing structure.

In the case of shoreline anchoring, shoreline footings or anchor sites would need to be installed, taking into consideration the amount of waterbody level fluctuation for estimating anchoring slack. For waterbody bed anchoring, surveys for bathymetry, presence of submerged aquatic vegetation (SAV), and sediment type would be required to assess an optimal anchoring configuration. In addition, bathymetry surveys would be required for optimal installation on a waterbody that could experience natural or anthropogenic dewatering and resulting change in surface-water elevation. Some additional shoreline infrastructure could be required for assembly and deployment of floating units, and access for maintenance workers.



Source: http://www.nrel.gov/gis/images/eere_pv/national_photovoltaic_2012-01.jpg (Accessed online, August 1, 2016)

Figure 1. Photovoltaic Solar Resource of the United States

Routine maintenance, equipment monitoring, and as-needed repairs would follow to ensure operation of the floating solar system, including snow removal, solar module washing, and periodic module/other equipment replacement. Water-quality monitoring for the waterbody with the deployed floating solar array could be required under state and/or local regulations, dependent upon other water uses.

In general, the floating solar arrays being considered would produce approximately 1 MW per site (Figure 2). On average, 7 ac are required to produce 1 MW of power. ESS, microgrid-based systems, distribution lines, and any accompanying backup power generation resources could require additional land acreage.

If not currently available, floating solar array sites would require the construction of security fencing to surround the floating solar system, as well as equipment shelter(s), distribution lines to the substation(s), a transformer station, and an access road for maintenance and emergency vehicles.

Power System

The power-producing components of a floating solar array system consist of the solar array field (the PV modules); the power-conditioning system, including inverters to convert the electricity produced from DC to AC for compatibility with the electrical grid; and one or more transformers to increase the line voltage when supplying electricity to the electrical grid. The power-conditioning system also contains devices that can sense grid destabilization and automatically disconnect the array system from the grid, if needed.

Figure 2. Floating Solar Farm in Japan

Contingent on the capacity of the array system, distance to the existing electrical grid, and final end-use, construction and operation of one or more substations could be required if substations or switching stations are either nonexistent or insufficient to support the proposed array system. A floating solar array substation would consist of supporting structures for high-voltage electrical structures, breakers, transformers, lightning protection, and control equipment according to regulatory requirements and specifications of the electrical provider. A substation would typically require less than 2 ac of fenced land. Personnel with specialized training would be necessary for ESS and microgrid operation, particularly at larger installations with numerous and integrated assets. Routine maintenance and monitoring of ESS and microgrid systems would also be required.

Floating solar array systems would require the construction, operation, and maintenance of distribution or transmission lines to transmit produced electricity to the existing distribution system or electrical grid. Distribution and/or transmission lines constructed in support of a floating solar array would be encased in marine-grade or other water-impermeable material that shields the lines from the water. The lines could run along the waterbed to shore or be placed above the water surface on floating walkways or other structures used for maintenance access to shore. Once onshore, the lines could be trenched to run to an aboveground transmission system.

Depending on location, existing infrastructure, capacity, and intended end-use, produced electricity could range from 5 to 35 kV if intended to be used immediately in the distribution system, or 69 to 345 kV if intended for bulk transmission. Transmission corridors have a range of required right-of-ways, depending on the line voltage and line location (overhead or buried). For example, a 115 kV overhead transmission line commonly needs a 100-ft right-of-way; the size of the right-of-way typically increases with line voltage. Burying a transmission line is typically more expensive than installing aboveground lines and requires ground-disturbing activities during construction, including opening a temporary trench, installing the insulated transmission line, backfilling the trench, and replacing topsoil and vegetation. In addition, underground transmission lines typically require the installation of large, concrete vaults to facilitate construction (line splicing) and provide access for maintenance and repair. Similar to overhead transmission lines, the higher the transmitting voltage, the larger the overall footprint needed for the larger lines, vaults, and projected right-of-way. Siting underground transmission lines also requires allowances for physical features (e.g., road/rail crossings, wetlands, and other environmentally sensitive areas). To the greatest extent possible, construction of new utility corridor(s) and any associated utility requirements for this action would be expected to use previously disturbed areas (e.g., road right-of-ways and/or existing utility easements) to minimize additional ground disturbances and reduce overall environmental impacts.

2.2 Ancillary Power Control Systems

Ancillary power storage and control systems may be developed and deployed as part of the proposed action to improve the availability, reliability, and flexibility of floating solar array-produced electricity. The use of ESS (e.g., chemical batteries, fuel cells, or compressed-air storage) may be a part of the floating solar array system, allowing any excess electricity produced beyond the immediate requirements of the system to be stored for later distribution and use. A microgrid may also be used to manage stored energy and tie in solar power with other distributed energy-generation sources. Finally, to address reliability standards and redundancy needs for the bulk electrical system, the use of backup power generation is included as part of the proposed action, where appropriate.

2.2.1 Energy Storage Systems (ESSs)

Electrical energy is typically an on-demand resource that must be transmitted or consumed at the time of generation. In the case of floating solar, without some form of energy storage, the electricity from a floating solar array could only be produced and used during times when incident solar radiation would be sufficient to produce electricity. ESSs augment this daylight-only limitation by converting solar-derived electrical energy into another form that retains its energy content for longer periods of time. The most common form of energy storage uses chemical batteries, which convert electrical energy into chemical energy (energy held in the bonds of the chemicals in the battery) and then back again as the electrical system requires. Though the oldest and most common form of chemical battery is the lead-acid battery (e.g., car batteries), ESSs deployed in microgrids typically use other chemistries (e.g., lithium-ion, sodium-sulfur, and vanadium-flow) with higher energy densities suited to the large energy exchanges utilized in microgrids.

Due to the higher energy densities, chemical ESSs do not typically have large real estate requirements. A battery set with dimensions similar to a semi-truck trailer would typically be rated at several megawatts, and 4 to 12 hours of available capacity. ESSs of this size typically come in several modules that are mounted on concrete pads and interconnected. A large portion of the total installation would be the energy storage proper, but supporting equipment (e.g., cooling systems, battery management systems, and power converters) would also be present. Further, necessary connections must be made, including connections between modules, both for energy transfer and communications, and connections to a transformer, which translates the output of the power converter to the appropriate system voltage.

Fuel cells are another commercially available electrochemical ESS. Similar to batteries, fuel cells operate by chemical conversion of fuel (typically hydrogen) in the presence of oxygen, to produce electricity. There are varieties of commercially available fuel cell configurations. When considered for stationary power applications, technology selection is typically governed by site-specific needs (e.g., physical size, electrical capacity, fuel storage limitations, and the need or desire to integrate waste heat into supporting processes such as in combined heat/power applications). Due to the variety of configurations, fuel cells can be sized to accommodate the specific needs of the application, which include not only grid-connected distributed generation and base-load power, but also backup or emergency power systems, uninterrupted power supply, and portable power supply where grid independence is required.

In stationary power applications, fuel cells have a range of potential capacity ranging from less than a kilowatt (kW), to well over a megawatt (MW) in industrial deployments where multiple fuel cells are combined in a fuel cell stack. With hydrogen as the primary fuel (or hydrogen derived from an alternative fuel source such as methane, methanol, or biogas), the production of power from a fuel cell is considered to be essentially void of harmful emissions that are common to hydrocarbon-based combustion units. Unlike batteries, which have a limit on discharge (i.e., power production capability), fuel cells continue to produce power as long as fuel (hydrogen) is supplied.

A typical commercial or industrial fuel cell application, scalable up to several MWs, requires only a modest footprint. For example, modularly designed 1 to 2 MW fuel cell system requires a site area of 4,000 to 4,500 ft^2 (372 to 418 m^2), or a total of approximately 0.1 ac (0.04 ha),[1,2] with additional space requirements expected for supporting systems (e.g., cooling, fuel storage, and switching/transmission).

Though less readily scalable, an additional form of technically feasible energy storage uses an electrically powered pump/compressor to pressurize a storage volume with air. To convert the potential energy of the compressed air into electricity, the compressed air is fed into a combustion turbine along with a fossil fuel (often natural gas), combusted, and expanded in the power turbine using the mechanical energy produced to drive an electrical generator. When turbines such as these are used without a compressed-air reservoir, approximately one-third of the gross energy output is used to drive an attached air-compressor to generate the compressed air as an integral part of the turbine operation. By using a compressor powered by excess floating solar electricity and pre-compressing the air into a storage vessel, the energy required by the combustion turbine when it is operating is reduced, effectively storing the solar energy until consumed by the turbine.

Currently, domestically deployed compressed-air energy storage (CAES) facilities utilize solution-mined subsurface salt caverns for storage. Typically sized to meet the expected output of the power plant and accompanying capacity factor, the subsurface caverns are large enough to support the volume of air and storage pressures required to make these types of systems technically and economically viable. Because of this requirement, the numbers of potential CAES installations are significantly limited in comparison to chemical energy storage technologies (e.g., batteries), which have no geologic component and smaller spatial requirements. In addition, conventional CAES facilities have traditionally been used to supplement combustion-turbine-based power generation. If no such generation exists at a candidate CAES site, including natural gas infrastructure, an additional evaluation of the viability of installing these generators must be conducted.

2.2.2 Microgrid Systems

As a complement to the installation of the floating solar array system and/or accompanying ESS, a microgrid could be installed and operated to allow for greater management and control of the electrical energy generation and consumption. Microgrids function by converting the physical electrical distribution system, which typically has only crude methods of control (e.g., manually switching breakers) to a centralized, intelligent control system with automated and dynamic control of system loads. Such a microgrid would typically entail a small or moderate control center, used to monitor the energy resource

[1] Accessed at: http://www.doosanfuelcell.com/attach_files/link/PureCell%20Model%20400%20Datasheet.pdf. August 8th, 2016.
[2] Fuel Cell Megawatt Power Generation Platform. Hydrogenics. 2013.

of the microgrid (e.g., public utility, solar PV, energy storage, diesel generation) and the current and/or projected load of the managed system. To regulate the load of the system, controllable switches connect and disconnect various loads throughout the system to ensure generation resources are not overloaded. This is particularly useful for "islanded" scenarios, where conventional utility-provided energy is unavailable and the only energy assets available are those internal to the microgrid. Without a microgrid, ensuring the system's highest priority loads were being served would be difficult and an uninterrupted transition after the loss of utility-provided electricity would likely be impossible.

Microgrid installation largely consists of installing controllable switches for load and generation management. The number of switches installed is determined by the desired level of load-control granularity and the architecture of the existing electrical distribution system. Typically, the most granular level of control allows control of individual buildings within a system. Because the cost of microgrid equipment is directly related to the size and number of switches, trade-offs can be made between granularity of load control and economics.

In addition to the microgrid switches, a microgrid requires a control center. A control center system consists of computer hardware, software for monitoring and controlling the load switches and generation assets, and hardware to interface the computers and controllable switches. Personnel with specialized training would likely be necessary for ESS and microgrid operation, particularly at larger installations that include numerous and integrated assets. ESS and microgrids also require routine maintenance and monitoring.

2.2.3 Backup Generation

The traditional electrical source of last resort is a generator driven by a reciprocating internal combustion engine. These generators are used throughout the world in a wide variety of applications from temporary on-site generation for public events or remote bases, to stationary backup generation for mission-critical buildings (e.g., medical, civil authority, and military facilities). Most commonly powered by diesel fuel, this generation technology is well established with known use-cases, limitations and ratings, and maintenance procedures. In addition, alternative fuels such as jet fuel, bio-diesel, or blends therein can be used as substitutes with little or no modification to the engine or its operation, further increasing their versatility if such fuel sources are readily available.

Backup power generators do not typically provide, nor are they intended to provide, uninterrupted or continuous service. Even in the best case, several seconds of discontinuity in electrical service occur after the electricity supply from a public utility is lost while the backup power generators start up and reach steady-state. If uninterrupted service is required, other energy sources must be used in tandem with the backup generation (e.g., a battery-based ESS).

Electrically connecting one or more backup power supplies into a floating solar array system, ESS, and/or microgrid system would allow for additional energy security when utility-supplied electricity is unavailable. Further, backup power supplies potentially reduce costs associated with reliability standards that a site would be expected to meet. A site-specific power-flow analysis coupled with an understanding of site electrical requirements during unplanned outages or imposed constraints would lead to appropriate selection of the number and size of backup generators required.

2.3 Screening Criteria

For the purposes of this report, to be considered a viable alternative and carried forward for analysis, the alternatives or location options must meet the following screening criteria:

- **Mission Compatibility:** The location must be compatible with the military missions, to include training and testing activities, occurring at the installation. Site-development and solar PV system operations and maintenance may not adversely impact current or future military training, testing, or operations activities. Site development within a range or maneuver training area may require submission of a range closure request as outlined in Army Regulation (AR) 350-19, *The Army Sustainable Range Program* (DA 2005a).
- **Grid Access and Electrical Tie-in Potential:** The location must be close to transmission facilities (substations) or have technical viability and economic justification for building the infrastructure required for interconnection to the Army installation distribution system or the grid (e.g., new electrical lines and new substation). The grid infrastructure must be capable of transporting, or being upgraded to transport, electricity generated by the floating solar array system.
- **On-Installation Energy-Generation Potential for Increased Energy Security:** If the purpose of the array system is to meet Army energy security goals, the location must allow the Army installation to have greater control of, and access to, its energy supplies while reducing the possibility of external distribution failures. Preference should be given to site locations allowing maximum use of the energy produced.
- **Array Site Factors:** The site must be on an installation body of water or treatment pond and must be under the management and control of the installation, or have installation access approval. The site area must not be overshadowed by buildings or trees that cannot be removed.
- **Aesthetic Compatibility:** The array site should be compatible with views, neighborhoods, and historic areas.
- **Environmental Factors:** The location must allow acceptable accommodation of cultural resources and sensitive natural resources and should have minimal environmental constraints, such as compliance for endangered species and migratory birds, wetlands, floodplains, protected archaeological and historic resources, or other sensitive environmental resources.
- **Safety:** The array site should involve minimized exposure to, and safety risks from, munitions and explosives of concern (MECs), including unexploded ordnance (UXOs). The location must not conflict with military training activities or jeopardize personal safety of those constructing, operating, and maintaining the facilities. Ongoing operation and maintenance needs of the floating solar system must not adversely impact traffic safety, aviation safety, or installation security.
- **Array Financeability and Use of Proven Technologies:** The floating solar array system must use proven renewable energy technologies that can be financed at reasonable rates. Factors influencing financeability include, among others, the availability of solar resources.
- **Compliance with Federal Mandates and U.S. Department of Defense (DoD) or Army Goals:** The array system must enhance compliance with government mandates and DoD and Army goals and objectives regarding renewable energy production, energy security, increased energy efficiency, water conservation, and/or greenhouse gas (GHG) emissions reduction.
- **Utility Considerations:** The array system must be reasonably acceptable to the current electric supplier and not unreasonably interfere with its ability to absorb intermittent impacts and variance in peak energy generation.

3.0 Alternatives Considered

The Army's NEPA regulation requires reasonable alternatives to be evaluated (32 CFR Part 651). The alternatives provided below build on the description of the proposed action provided in Sections 2.1 and 2.2 and provide relevant examples of potential action alternatives for future NEPA documentation. The action alternatives (Alternatives 1, 2, and 3 presented in Section 3.2, 3.3, and 3.4, respectively) meet the example purpose and need for the proposed action as described in Appendix B of this report. These action alternatives also address, at a higher level, the screening criteria detailed in Section 2.3.

Though this report focuses on high-level information, the action alternatives are designed to apply to site-specific projects. As noted previously, the goal of this report is to provide a framework for future NEPA assessments of the construction, operation, and maintenance of site-specific floating solar projects at Army installations. This report assesses the environmental impacts of floating solar projects that would occur for most resource areas at most sites. To assist installations in applying the NEPA process to proposed site-specific floating solar projects, this report also includes a suggested checklist at Appendix A to help installations determine whether additional site-specific NEPA information beyond what is assessed in this report could be required for the applicable action alternative. The checklist in this report could help an installation determine what analysis information contained in this report could be leveraged during the development of a site-specific NEPA analysis document, and what information would likely need further information to enable a complete analysis.

3.1 No Action Alternative

At a programmatic level, the no action alternative could be interpreted in a couple different ways. First, it could represent a baseline under which floating solar projects would not be constructed. This is a notional baseline, however, since the Army already decided to proceed with solar projects at some installations, and floating solar technology may be used. A second interpretation of a programmatic-level no action alternative could simply mean that this report is not adopted by the Army to assist with floating solar projects.

The no action alternative serves as a baseline against which to assess the environmental impacts of a proposed action. In accordance with CEQ regulations, the no action alternative is included to compare its impacts with the action alternatives (40 CFR § 1502.14[d]). The no action baseline in this analysis means that the Army could compare the environmental impacts of not constructing floating solar projects on Army installations with the impacts of floating solar project construction. Selection of the no action alternative would normally mean that the Army would not proceed with the proposed action, and would not consider the information presented in this report. Installations would thus not be able to apply the information contained in this report to streamline their analyses for floating solar projects, and unnecessary duplicative site-specific analyses would occur.

3.2 Alternative 1: Implementation of Proposed Action on Chemically Treated Water or Wastewater at an Army Installation

Alternative 1 includes using chemically treated water or wastewater bodies (termed "Wastewater") on an installation to install and operate a floating solar array. A Wastewater site is a constructed waterbody that contains chemically treated effluent (e.g., a water-treatment pond or lagoon). The chemical composition of wastewater varies depending on treatment processes and potential for subsequent use. Figure 3 shows a wastewater body.

Figure 3. Camp Swift (TX) Wastewater-Treatment Facility

3.3 Alternative 2: Implementation of Proposed Action on a Waterbody Not Considered Waters of the United States (NWOTUS) at an Army Installation

Alternative 2 considers installation and operation of a floating solar array on manmade waterbodies not considered waters of the United States (NWOTUS) which are not under the jurisdiction of the Clean Water Act (CWA; 33 USC § 1251 et seq.). NWOTUS waters are manmade, controlled, and/or closed water systems (e.g., artificially constructed lakes or ponds created in previously dry lands, stormwater-control features, and vehicle wash ponds) that may or may not be lined with impervious materials. Figure 4 is an example of a NWOTUS waterbody.

Figure 4. Sierra Army Depot (CA) 9 ac Waterbody

3.4 Alternative 3: Implementation of Proposed Action on Waterbody Considered Waters of the United States (WOTUS) at an Army Installation

Alternative 3 considers the installation and operation of a floating solar array on waterbodies determined to be waters of the United States (WOTUS), which are subject to the CWA (33 USC § 1251 et seq.). WOTUS can include streams, rivers, ponds, lakes, or reservoirs that are natural or manmade. Figure 5 and Figure 6 are examples of WOTUS waterbodies.

Figure 5. 12 ac Simmons Lake at Fort Bragg (NC)

Figure 6. 29 ac Cranberry Pond at West Point (NY)

3.5 Other Alternatives

Installations could use combinations of Alternatives 1, 2, and 3. For example, an installation could determine that the optimal floating solar project to meet mission requirements and minimize any negative environmental impacts would be installation of floating solar arrays on several waterbodies that fall under different alternatives. This alternative is not specifically analyzed in this report; however, the analysis for Alternatives 1, 2, and 3 in this document could be leveraged by an installation to support appropriate NEPA analysis for site-specific floating solar project alternatives covering a combination those alternatives.

3.6 Alternatives Considered but Eliminated from This Study

Analysis of renewable technologies in this report beyond floating solar was considered but dismissed from detailed evaluation because such actions are beyond the scope of this report. However, because this report analyzes the proposed action at a high level and would not remove requirements of NEPA once site-specific alternatives are known, it also means that exclusion of other renewable technologies from analysis in this report does not mean that the Army would not consider, at the installation-level, implementation of other renewable energy alternatives.

Another alternative considered but dismissed from detailed analysis in this report was to conduct site-specific analysis of all reasonably foreseeable floating solar projects on Army installations under a single NEPA analysis document. This alternative was dismissed as the majority of specific projects, whether currently envisioned or not, would be independent actions, and NEPA requirements for site-specific projects will be met, as appropriate. The intended high-level examination in this document precludes site-specific analysis. Site-specific analysis would also necessitate investigation of cumulative impacts. For example, if floating solar projects are located within close enough distance to each other that they could cause a combined impact to some resources, installations are to apply a cumulative impact analysis when analyzing the environmental impacts of their proposed projects.

4.0 Affected Environment and Environmental Consequences

4.1 Introduction

This chapter discusses aspects of the environment that could potentially be affected by the implementation of the proposed action. Because this report provides an assessment of environmental, social, and economic issues at a high level and not at the site-specific level, the descriptions of the affected environment presented in this chapter do not provide detailed information about conditions that exist at specific project sites. From a high-level perspective, the descriptions of the affected environment presented in this chapter do provide decision makers, regulatory agencies, and the public with considerations of where the floating solar arrays and power systems could affect the environment in a general sense, along with information on the socioeconomic effects potentially resulting from the implementation of a floating solar array and power system at a typical Army installation.

The following analysis may assist Army decision-maker in identifying and anticipating potential significant environmental impacts prior to implementation of the proposed action. Decision-makers may use Appendix A as an example of suggestions that could be included in a programmatic analysis, if one is prepared based on the framework contained in this report, to help installations determine additional site-specific NEPA information, which could be required for the applicable action alternative. In the absence of a programmatic analysis, Appendix A can be used to advise installations on whether this report contains sufficient information for the development of a NEPA analysis document or whether additional analysis, based on site-specific conditions, may be needed.

This report may provide installations that propose viable site-specific floating solar array alternatives with a tool for evaluating the potential environmental and socioeconomic effects that could result from implementing a floating solar project. Within an Army installation, specific locations should be considered using the screening criteria contained in Section 2.3.

Commands and/or installations would prepare site-specific analysis as necessary to: 1) examine the compatibility of the proposed project with mission needs and land/water use inside and outside of the Army installation; 2) address potential effects to environmental resource areas (e.g., air, water, biological, and cultural resources) and nearby sensitive land uses (e.g., residential areas, threatened or endangered species habitat); and 3) identify necessary and sufficient measures to ensure that a project does not interfere with the Army's mission or adversely affect environmental resources.

4.2 Approach for Analyzing Impacts

In order to enable analysis, the resource areas have been categorized in the subsequent sections as follows: land use, air quality and GHGs, noise, geological and soil resources, water resources, biological resources, cultural resources, socioeconomics, transportation and traffic, airspace, utilities, hazardous materials, and health and safety.

A region of influence (ROI) was determined for each resource area based on the potential impacts to the affected resource. The ROI may be limited to the specific location of a floating solar array and power system or could include a larger area such as an entire watershed. The ROI was generally considered to include an installation and/or a floating solar array site (the approximate area required for construction and operation of each alternative) and power system, unless otherwise noted in the specific resource of concern section.

For each resource area, context and intensity are taken into consideration in determining a potential impact's significance, as defined in 40 CFR 1508.27. Context means that the significance of an action must be analyzed in several contexts, such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant. The intensity of a potential impact refers to the impact's severity and includes consideration of the following:

- beneficial and adverse impacts
- the level of controversy associated with a project's impacts on human health
- whether the action establishes a precedent for future actions with significant effects
- the level of uncertainty about project impacts
- whether the action threatens to violate federal, state, or local laws or requirements imposed for the protection of the environment.

Quantitative and qualitative analyses have been used as appropriate in determining whether, and the extent to which, a threshold would be exceeded. Based on the results of these analyses, this report identifies whether a particular potential impact would be adverse or beneficial, and to what extent.

- **Negligible** – An environmental impact that could occur but would be less than minor and might not be perceptible.
- **Minor** – An environmental impact that would be perceptible, but clearly not significant.
- **Moderate** – An environmental impact that could occur and is not significant, but is readily detectable. Additional care in following standard procedures, or applying precautionary measures to minimize adverse impacts, could be called for. Moderate adverse impacts would not exceed limits of applicable local, state, or federal regulations.
- **Significant but Mitigable** – A significant impact is anticipated, but the Army could implement management actions or other mitigation measures to reduce the adverse impacts to less than significant.
- **Significant** – An adverse environmental impact which, given the context and intensity, violates or exceeds regulatory or policy standards, untenably alters the function or character of the resource, or otherwise exceeds the identified threshold.

Impacts can further be categorized as direct, indirect, or cumulative.

- **Direct** – Caused by the action, occurring at the same time and place.
- **Indirect** – Caused by the action and foreseeable, but occur at a later time or different place.
- **Cumulative** – The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Duration may also a factor when analyzing potential impacts.

- **Short-Term** – Transitory effects of limited duration, generally caused by construction activities or operation start-up.

- **Long-Term** – Impacts that occur or continue to occur over an extended period of time, whether they start during the construction phase, at operation start-up, or during the operations phase.

The impact level determinations in this report are based on the assumptions used herein for the design, construction, operation, and maintenance of floating solar arrays and ancillary power systems combined with a very high-level characterization of the range in environmental conditions that could be encountered at Army installations. As such, the impact levels should all be viewed as “anticipated” or “expected” until further reviewed either programmatically or through site-specific NEPA evaluations.

4.3 Land Use

General land-use patterns characterize the types of uses within a particular area and can include agricultural, residential, commercial, industrial, scenic, natural, military training and testing areas, operational ranges, and recreational. Land ownership is a categorization of land according to type of owner. Major land ownership in the United States includes federally, Tribally, state/locally, and privately/individually owned. Land ownership and real estate interest of lands adjacent to Army installations are typically required to adhere to local land-use plans, policies, and controls not applicable to Army lands. Land-management plans include those documents prepared by agencies to establish appropriate goals for future use and development of the land under the applicable agency’s jurisdiction. As part of this process, sensitive land-use areas are often identified by agencies as being worthy of more rigorous or protective management; these may include, for example, historic properties or sensitive natural areas.

For any proposed project affecting resources within a state coastal zone, the Coastal Zone Management Act of 1972 (CZMA; 16 USC §1451 et seq.) requires an evaluation of consistency with the enforceable policies of a state’s approved coastal-management program. CZMA is further discussed in Section 4.7.

Army Regulation (AR) 210-20, *Real Property Master Planning for Army Installations*, requires installations to prepare, implement, and maintain Real Property Master Plans (RPMPs) that address all lands within the installation footprint (DA 2005b). Additional guidance for incorporating holistic energy, water, and waste management and other sustainability concepts into installation RPMPs was issued by the Assistant Chief of Staff for Installation Management in November 2011. The Sikes Act (16 USC § 670 et seq.) and AR 200-1, *Environmental Protection and Enhancement*, require Army installations to prepare, implement, and maintain an Integrated Natural Resources Management Plan (INRMP) for the management of their land and biological resources (DA 2007). INRMPs are one of the contributing sources of information for RPMPs. AR 200-1 also requires Army installations to develop an Integrated Cultural Resources Management Plan (ICRMP) (DA 2007); these are another contribution source for RPMPs. AR 350-19, *The Army Sustainable Range Program* (DA 2005a), requires Army installations with a training mission to prepare Range Complex Master Plans (RCMPs). An RCMP depicts an installation’s current range and training lands, general siting of future range complex project requirements, and the installation’s requirements and constraints that could impact ranges or training lands (DA 2005a). RCMPs provide source data for installation INRMPs and RPMPs. Per Section 2.3 of this report, proposed floating solar array locations must be compatible with the military missions—to include training and testing—occurring at the installation. The Army plans to have no net loss of training or operational capability as a result of the proposed action.

Although viewsheds are not a land use, for the purposes of this report, viewsheds are discussed in this section. Viewsheds encompass the landscape visible from a specific point. A viewshed can also consist of “the sum total of the area covered by views along a road or trail, as well as the aggregate of the views visible from a specific area” (APA 2006). Topography, structures, vegetation, or other physical barriers typically are used to define the borders of a viewshed; however, a viewshed is sometimes limited by distance, changes in land use, or changes in visual character (APA 2006).

4.3.1 Existing Conditions

As of September 2015, Army installations included over 12.4 million ac of land, 57 multi-use airfields, 24 heliports, just under 800 million ft^2 of building space in the United States, over 230 million $yards^2$ of paved area (excludes road), just under 153,000 mi of roads (paved and unpaved), over 2,000 mi of railroads, and approximately 200 Army-owned and 151 privatized utility systems (e.g., electric, gas, water, and wastewater) (DA 2015a). As of that same month, the Army's remaining environmental cleanup on active sites included just over 1,300 Installation Response Program (IRP) and Military Munitions Response Program (MMRP) sites (DA 2015a). Army land-use categories include family housing, troop housing, range and training, retail, parks and recreation, schools, transportation, industrial, and natural and cultural environmental sites (DA 2012a). Existing and future use of Army installations are guided by each installation's RPMP.

Off-post land use around Army installations varies from installation to installation as does the density of development, ranging from very rural landscapes to highly developed, urban landscapes. Off-post land ownership and real estate interest also varies.

Off-post lands have been placed in the Army Compatible Use Buffer (ACUB) program, adding another layer into the categories of land use. Though the proposed action in this report does not include consideration of off-post land for solar PV arrays, an understanding of off-post land placed in the ACUB program enables analysis of potential impacts to, and/or consideration of, mitigations for on-post projects. Most military installations were originally established in rural areas far from population centers. However, land around many military installations has undergone, and continues to undergo, rapid development, which leads to habitat fragmentation, land-use conflicts, and restrictions that can compromise military training, testing, and readiness. The ACUB program is a tool to address this encroachment and achieve conservation objectives. Under 10 USC § 2684a, the Army can enter into agreements with, and provide funds to, partners with mutual conservation objectives to establish buffers around training and testing areas, within an ecosystem, or other defined area. This helps the installation, its neighbors, the community, and the region preserve habitat and limit incompatible land use. It helps prevent complaints over noise, dust, smoke, and airspace, while conserving species, habitat, and cultural resources. It provides the Army greater testing and training flexibility. Partners obtain financial support for land conservation (e.g., for endangered species and habitat), and private landowners realize financial incentives and tax benefits. The existence and extent of buffer areas under the ACUB program varies from installation to installation. More information about the ACUB program is provided in Section 4.8, Biological Resources.

4.3.2 Environmental Consequences

This section provides a discussion of the possible environmental impacts to land use that could result from the no action alternative and the proposed action. The following subsections discuss possible conflicts between the proposed action and the objectives of land-use plans, policies, and controls for potentially impacted off-post lands. Impacts to land use would be considered significant if the Army actions are 1) substantially incompatible with existing military land uses and land-use designations or have major conflicts with Army land-use plans, policies, or regulations; or 2) create a considerable land-use conflict with off-post land use. The ROI for this resource area is land use within the boundaries of an installation and immediate surrounding communities, to include regional viewsheds of an installation and project alternatives.

4.3.2.1 No Action Alternative

There would be no change to existing land use as a result of the no action alternative; therefore, there would be no new impacts.

4.3.2.2 Alternatives 1, 2, and 3: Wastewater, NWOTUS, and WOTUS

No appreciable differences exist between or among Alternatives 1, 2, and 3 that would result in assigning a different impact level with regard to land use; therefore, this section is applicable to all three alternatives.

Floating solar array and power systems that deploy solar arrays on waterbodies would only affect land use through the addition of distribution lines, ESS, substation expansion, or new substation construction, if needed. Distribution lines could require additional acreage, although this acreage would be generally linear in nature and would, to the maximum extent practicable, follow existing rights-of-way and use existing utility corridors. ESS and microgrid infrastructure could also require additional acreage and would be dependent on the storage system and optimal location for a microgrid based on related distributed energy systems. A substation, typically on less than 2 ac, could be required if existing substations are insufficient to meet the new power load.

The floating solar array and associated distribution lines and substations could affect the viewshed of an area. The installation of floating solar array and infrastructure components would create a visual impact, but lacking the height of smokestacks or wind turbines, the visual impact at water level for the floating solar array, and near ground level for the distribution system, or within neighboring buildings, would be limited. As discussed in more depth in Section 4.12, Airspace, the solar PV systems have the potential to cause glare, another type of visual impact. Near and far viewsheds could be affected by glare and result in a visual impact within neighboring buildings at elevations above ground level. Larger solar PV array fields could potentially affect a larger viewshed area than smaller array fields. As discussed in more depth in Section 4.9, Cultural Resources, some sites could be important components of viewsheds associated with cultural resources. In cases where site location has the potential to impact a viewshed associated with cultural resources, careful site design in close consultation with appropriate parties could result in adverse effects ranging from negligible to moderate. Avoidance of cultural resources and potential impacts to a viewshed is the preferred mitigation. If an installation's proposed solar PV project has the potential to result in an adverse effect to a historic property or other cultural resource, the installation may require a memorandum of agreement with a State Historic Preservation Officer (SHPO) or Tribal Historic Preservation Officer. The memorandum of agreement would document agreed-upon measures to resolve the adverse effects. As a result of this, and in spite of the fact that an operational floating solar array does not emit pollutants into the air and does not create loud noises, depending upon the conditions at a particular site, conflicts with off-post land uses could range from negligible to moderate.

Stakeholder coordination/consultation and/or consolidation of infrastructure during the scoping and design of the project could effectively avoid or minimize land-use conflicts. Careful incorporation of floating solar arrays and their power systems into the installation's RPMP would help minimize the effect of the proposed project on land use. Short-term and long-term impacts to land use would be anticipated to range from none to negligible (Table 1).

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Table 1. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for all Alternatives on Land Use

Action	Impact	Mitigation	Impact Determination
Construction	Addition of distribution lines; ESS; and, if needed, substation expansion or new substation construction could alter existing land uses	Careful siting and design and where possible co-locate new lines and facilities with existing infrastructure	None-to-negligible short- or long-term adverse impacts
Operation	NA	NA	NA
Maintenance	NA	NA	NA

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

4.4 Air Quality and Greenhouse Gases

Air quality is regulated by the U.S. Environmental Protection Agency (EPA) per the Clean Air Act (42 USC § 7401). The CAA established National Ambient Air Quality Standards (NAAQS) to protect public health and welfare and to regulate emissions of hazardous air pollutants. The NAAQS established ambient air quality regions. Air quality at a given location is a function of several factors, both naturally occurring and manmade, including the quantity and type of pollutants emitted locally and regionally, and the dispersion rates of pollutants in the region. Primary factors affecting pollutant dispersion include wind speed and direction, atmospheric stability, temperature, presence or absence of inversions, and topography.

NAAQS are established for criteria pollutants, including ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter equal to or less than 10 microns in diameter (PM_{10}), particulate matter equal to or less than 2.5 microns ($PM_{2.5}$), and lead (Pb). NAAQS represent maximum levels of background pollution that are considered safe, with an adequate margin of safety, to protect public health and welfare. Areas are classified as attainment if they meet the NAAQS for a criteria pollutant and nonattainment if they exceed the NAAQS. Army installations can be located in both attainment and nonattainment areas.

In addition to the criteria pollutants, the EPA regulates listed hazardous air pollutants (HAPs). The EPA has established National Emission Standards for HAPs. The EPA regulates emissions of listed HAPs using source categories that must meet maximum achievable control technology standards to demonstrate compliance.

According to the EPA's General Conformity Rule (40 CFR Part 51, Subpart W), any proposed federal action that has the potential to cause violations in a NAAQS nonattainment or maintenance area must undergo a conformity analysis. If net annual emissions from a proposed project remain below applicable local thresholds for conformity, a CAA conformity determination is not required. In this case, Army policy requires the preparation of a Record of Non-Applicability for CAA conformity. If management action or project emissions of one or more of the criteria pollutants were to exceed applicable local thresholds for conformity, a CAA conformity determination would be required to determine if emissions conform to the approved state implementation plan.

For project sites in nonattainment or maintenance areas, a site-specific analysis would be required to determine if local thresholds for conformity would be exceeded under the proposed action; the results of which could require a conformity determination. Failure to conform to the state implementation plan would exclude a proposed project site from further consideration.

GHGs are chemical compounds in the Earth's atmosphere that allow incoming short-wave solar radiation but absorb long-wave infrared radiation re-emitted from the Earth's surface, trapping heat in the atmosphere. Most studies indicate that the Earth's climate has warmed over the past century due to increased emissions of GHGs, and that human activities affecting emissions to the atmosphere are likely an important contributing factor. A warmer climate is expected to increase the risk of heat-related illnesses and death, worsen conditions for air quality, allow some diseases to spread more easily, and increase the frequency and strength of extreme events (e.g., floods, droughts, and storms) that threaten human health and safety (EPA 2016a).

GHGs come from both natural and human sources. Water vapor, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are examples of GHGs that have both natural and manmade sources. Other GHGs (e.g., chlorofluorocarbons) are exclusively manmade. In the United States, significant GHG emissions are attributable to energy production. Such emissions result from combustion or chemical conversion of fossil fuels when used for electricity generation, transportation, industrial purposes, heating, and other uses.

The principal GHGs that enter the atmosphere due to human activities are:

- **Carbon Dioxide (CO_2):** CO_2 enters the atmosphere through the burning of fossil fuels (i.e., oil, natural gas, and coal), solid waste, trees, and wood products, and also as a result of other chemical reactions (e.g., the manufacture of cement). CO_2 is removed from the atmosphere (or "sequestered") when absorbed by plants as part of the biological carbon cycle.
- **Methane (CH_4):** CH_4 is emitted during the production, transport, and combustion of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous Oxide (N_2O):** N_2O is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- **Fluorinated Gases:** Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful GHGs that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for O_3-depleting substances. These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as high global warming potential gases.

Certain national park and wilderness areas across the country are given special protection under the CAA. Today there are 156 protected areas designated as mandatory federal "Class I" areas of for the purposes of the visibility protection program. The EPA's visibility protection program notes that special analyses are required when a proposed new emission source could impact federally designated Class I areas and areas designated as Class I by states and Tribes. Some of these protected areas are in the vicinity of Army installations (CIRA 2016).

4.4.1 Existing Conditions

Air quality at Army installations is representative of cities and towns across the nation. Army installations have both stationary and mobile sources of air emissions. Most Army installations hold air quality permits that require routine air emissions monitoring, with 1,143 air permits held by Army installations as of October 2015 (DA 2016a). These permits may be federal, state, or local, and the type of permit is a function of the equipment and the amount of criteria pollutants and HAPs emitted. Regardless of whether an Army facility has an air permit or not, other air quality regulations (e.g., dust suppression during construction activities) may still apply.

Analysis of air quality and GHG effects considers if the proposed action would:

- increase the need for, or change the emissions profile of equipment (e.g., boilers, stationary internal combustion engines, and combustion turbine generators)
- increase ambient air pollution concentrations above any NAAQS
- contribute to an existing violation of any NAAQS
- interfere with or delay timely attainment of NAAQS
- emit HAPs
- impair visibility within any federally mandated Class I area
- trigger a conformity determination
- increase GHG emissions.

4.4.2 Environmental Consequences

This section provides a discussion of the possible environmental impacts to air quality and impacts to GHGs that could result from the no action and proposed action alternatives. Impacts to air quality and GHGs could be considered significant if the proposed action would result in a NAAQS attainment area becoming a nonattainment area or if the proposed action would generate substantial GHG emissions nationwide. The ROI for air quality analysis will be influenced by prevailing winds, weather patterns, terrain, and the nature of the pollutant being considered, to include whether an installation is in an attainment area or nonattainment area. In general, the ROI for this resource area is the airshed and the installation boundary for criteria pollutants and HAPs.

4.4.2.1 No Action Alternative

There would be no change to air quality in the region as a result of the no action alternative. The Army would fail to realize an opportunity to offset or reduce air pollutants produced from the combustion of fossil fuels, and would miss the chance to potentially reduce overall GHG emissions relative to the action alternatives.

4.4.2.2 Alternatives 1, 2, and 3: Wastewater, NWOTUS, and WOTUS

No appreciable differences exist between or among Alternatives 1, 2, and 3 that would result in assigning a different impact level with regard to air quality and GHGs; therefore, this section is applicable to all three alternatives.

The construction and operation of floating solar arrays, along with ancillary power control systems, substations, and transmission or distribution lines, could improve existing air quality conditions at an installation by allowing solar-derived energy to directly displace electricity produced from the combustion of fossil fuels, thereby reducing the accompanying fossil-fuel emissions. As proposed, the project could include the deployment of ancillary power control systems (e.g., ESS and microgrid technologies) to improve availability.

The proposed project may also include the construction, operation, and maintenance of backup power generators to meet reliability standards. As currently envisioned, backup power generation is not considered as 'additional' to existing infrastructure, but rather higher efficiency replacement generation that would be located/relocated once the floating solar, energy storage, and/or microgrid systems were designed, and a power-flow assessment confirmed the need for location-specific backup power generation. Though commonly associated with fossil-fired engines using diesel or fuel oil, more recent microgrid-based systems may incorporate low-emission/high-efficiency natural-gas-based or biogas-based equipment. Accordingly, the overall emissions profile of any site replacing older backup generators would be able to capitalize on newer machinery and realize air quality improvements. Regardless, floating solar projects including backup power generation systems would be required to determine what, if any, changes would be required to existing CAA permits, and whether any new permits would be required for any of the projects associated generator sources.

During construction, temporary short-term adverse air quality impacts would be expected as a result of vehicle exhaust from construction vehicles and equipment, as well as fugitive dust from ground-disturbing activities such as anchoring the units to land or from construction vehicles that could be required to utilize unimproved roads for site access (Table 2). The magnitude of the construction-related air emissions and fugitive dust would be influenced heavily by weather conditions and the specific construction activity occurring.

To assess the air quality impacts, it was assumed that similar constraints and attributes could be applied to a floating solar array as might be expected from a land-based solar array. Using an upper bounding estimate only as an example, to construct a 10 MW solar PV project, approximately 90 trucks carrying materials (e.g., solar modules, inverters, and racking) and vehicles to transport 40 to 80 construction workers daily would be required, over approximately 5 to 10 months for construction with variables including weather and site conditions (GroSolar 2014). Therefore, a smaller, 1 MW array would require less resources.

Higher capacity arrays or more complex projects could require proportionally more material and labor, and, therefore, a greater number of truck and/or transportation requirements. These ground-disturbing activities (i.e., grading on or for access roads to construction sites and excavation, if required, for an ESS, microgrid-based system, inverters, transformers, substation, and transmission and distribution lines) could result in the release of fugitive dust emissions.

If excavation is required for supporting structures (e.g., foundations and pilings) vehicular transportation of excavation and fill material would be minimized through site design, as the significant movement of dirt could be prohibitively expensive for these projects and contribute to increased site emissions. Air quality impacts can be mitigated with emission-control devices and by keeping vehicles and construction equipment in good working order. Dust from construction traffic and ground-disturbing activities can be controlled using standard construction practices (e.g., using dust suppression on exposed surfaces and covering disturbed areas). Dust from construction and maintenance traffic can be controlled using speed limits and limiting distances required for material transportation.

Construction-related impacts to air quality would be relatively minor, with impacts mitigated through best management practices (BMPs), some of which could be required by construction permits (Table 2). BMP examples are detailed in above paragraphs and include dust-control measures, emission-control devices, and vehicle maintenance. The nature and magnitude of these effects would vary by the project location and size. Impacts to Class I areas are also expected to be minor.

Operation and maintenance of floating solar arrays could result in minor long-term beneficial impacts to air quality and overall GHG emissions at an installation or within the region (Table 2). By offsetting a commensurate amount of electricity using floating solar produced electricity, the Army installation would consume less fossil-fuel-derived electricity attributable to an installations electrical demand. For example, a 1 MW floating solar array would save approximately 430 kilograms (kg) of CO_2 per MW hour (MWh) of solar power production and a 10 MW solar PV project would save approximately 4,300 kg of CO_2 per MWh of solar power production.

Though backup generators, when utilized as part of the power control system, would contribute to site emissions, they are anticipated to be replacement capacity for existing backup generators. With advancements in engine efficiency, coupling to ESSs and microgrid applications, and the potential to utilize bio-based fuels in all or part, net reductions from existing site emissions would be expected and subject to federal regulation and standards. Consequently, long-term adverse impacts to air quality from backup generators are anticipated to be negligible.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Table 2. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Air Quality and Greenhouse Gases

Action	Impact	Mitigation	Impact Determination
Construction	Air quality and GHG emissions from construction equipment and workers	Short-term (5-10 months) Daylight hour construction (sunrise to sunset) Obtain and follow construction permitting limitations BMP for construction practices and dust abatement	Short-term, minor, localized
Operation and Maintenance	Air quality and GHG emissions	Daylight hour maintenance (sunrise to sunset) Emission-control devices Vehicle maintenance Short-term emissions from backup power supplies subject to local, state, federal requirements Reduction in overall GHG	Short-term and long-term minor beneficial

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

4.5 Noise

Noise is any unwanted sound and it can be produced by various sources. The two key characteristics of noise are frequency (i.e., the number of pressure variations) and loudness (i.e., based on frequency, a loud noise has a large pressure variation and a quiet noise has a small pressure variation). For humans, noise is typically classified as occupational noise (i.e., at work) or environmental noise (e.g., residential, community, or domestic) (Concha-Barrientos et al. 2004). However, noise could also affect wildlife and their behaviors. How humans and wildlife respond to noise depends on several factors (e.g., frequency, distance from the source, individual sensitivity, and the time of day). Although permanent hearing loss can occur following exposure to high noise levels (OSHA 2016), noise is primarily classified as an annoyance.

In the United States, environmental noise is primarily regulated at the state and local level. States direct governmental agencies to comply with local government noise laws and regulations. This was established by the Noise Control Act of 1972 (42 USC § 4901 et seq.) and its amendments (e.g., Quiet Communities Act of 1978). Local governments have noise ordinances to control noise levels (e.g., defining sources of noise and enacting a maximum noise level). The EPA does not legislate noise control activity laws, rather it follows the regulations outlined by the Noise Control Act of 1972 (EPA 2015a). As such, the Army considers the local governmental laws and regulations when assessing noise effects. Furthermore, the recommended noise levels from established Army activities are outlined in AR 200-1 for established uses of land in regards to environmental noise (DA 2007). For transportation and industrial noise, AR 200-1 states that these cases are evaluated on an individual basis using the appropriate noise parameters (e.g., U.S. Department of Transportation guidelines) (DA 2007).

4.5.1 Existing Conditions

Army installations have similar levels and sources of noise as urban areas nationwide, except in areas of military testing and training (e.g., proving grounds and detonation sites). Noise at Army installations that are similar to civilian areas include transportation noises (e.g., road, rail, and aircraft) or environmental noises (e.g., wildlife, running water, and wind). There are three primary sources of military-related noise: transportation noise (e.g., aircraft and vehicles), firing at small-arms ranges, and impulsive noise (e.g., large-caliber weapons firing and demolition operations). Construction on- and off-post could produce temporary noise. Noise levels vary by source, and the noise created by military-related activities are typically cyclic or periodic in nature.

4.5.2 Environmental Consequences

The U.S. Department of Labor Occupational Safety & Health Administration (OSHA) has defined noise exposure standards for general industry and construction industry (29 CFR Part 1904; 29 CFR Part 1910, Subpart G; 29 CFR Part 1926, Subpart D; 29 CFR Part 1926, Subpart E). Sound levels of <90 decibels, using A-weighted sound levels (dBA) for 8 hours per day are permissible; however, exposure to sound levels of 100 dBA are permissible for only 2 hours per day (29 CFR Part 1910, Subpart G; 29 CFR Part 1926, Subpart D). However, with the use of engineering controls to reduce noise generation at its source, occupational noise exposure can be minimized. In addition, educational and prevention programs, noise assessments and controls, routine monitoring of worker hearing, and appropriate personal protective equipment (PPE) can minimize occupational noise exposure (Nelson et al. 2005).

When evaluating the impact of potential noise effects, considerations include whether land-use compatibility problems would be created (DA 2007). Other considerations include whether peak noise levels and impulsive (e.g., random blast) noise levels would cause noise-based annoyance to individuals or wildlife in incompatible land uses if these noise levels are exceeded 15 percent of the time (DA 2007). The ROI encompasses the floating solar project sites and the areas around the sites. These sites are in a proximity that would be close enough to hear noise from construction, operation, and maintenance activities.

There are three potential significant noise-related impacts: violation of applicable federal, state, or local noise laws and regulations; creation of incompatible land uses in areas containing sensitive noise receptors located outside of the installation boundary; and noise levels loud enough to threaten or harm human health.

4.5.2.1 No Action Alternative

Under the no action alternative, there would be no change in the current noise levels on or around the installation, and no beneficial or adverse impacts would occur.

4.5.2.2 Alternatives 1, 2, and 3: Wastewater, NWOTUS, and WOTUS

Noise would increase locally around the project site during construction for all three alternatives from the vehicles and equipment. During construction, there would be an increase in noise around the project site from vehicles and equipment. However, noise-related construction would be short-term and would be restricted to daylight hour operation (sunrise to sunset), when a greater amount of noise is more tolerable. The noise created by heavy construction equipment or increased vehicle use during periods of construction would also be expected to decrease with distance. Therefore, alternative sites should also take the distance from wildlife populations into consideration. Typically, the extent of relatively high construction noise levels is 400 to 800 ft from the main equipment operation location (USACE 2015). Construction noise levels rarely cause substantial negative effects at distances greater than 800 ft from the main equipment operation location.

Variables affecting construction duration could include weather, site conditions (e.g., type of anchoring system and water depth), and project size (i.e., surface coverage ratio: larger MW arrays would require proportionately longer time for construction). If the alternative site were near a noise-sensitive area (e.g., residential or school district), the construction schedule could be modified to operate some equipment (e.g., heavy equipment) during less disruptive times.

For on-site construction personnel, the primary soundscape would be construction noise. All on-site construction personnel, specifically equipment operators, would be required to wear appropriate PPE to limit noise exposure. This would include earplugs, earmuffs, or both, in compliance with federal health and safety (including OSHA) standards.

Wildlife populations, including threatened or endangered species, also need to be taken into consideration when determining how construction-related noise could affect the alternative sites (see Section 4.8, Biological Resources). Construction should be avoided during critical times (e.g., when birds are nesting, fish are spawning, and during periods of mating or parent-offspring communication). Noise levels decrease with increased distance from noise sources (McLaughlin and Kunc 2012).

When solar-derived energy replaces an alternately derived source which currently includes some noise generation, long-term minor beneficial noise impacts are anticipated; though those beneficial impacts would be in the ROI of the alternately derived energy facility.

All three alternatives would generate no noise during normal operation, with the exception of the power-conditioning unit (inverter), which converts DC electricity to AC and regulates the AC electricity. The power-conditioning unit can produce audible noise ranging from approximately 50 to 70 dBA, depending on the size of the inverter/transformer (NEMA 2000), and would be based on land. This is consistent with the range of noise levels associated with common speech. A refrigerator, dishwasher, shower, and large business office are other examples that produce noise in the 50 to 70 dBA range. Noise produced by temporary use of backup generators, when used for power control, is expected to be similar to, or less than, existing backup generator use. New backup generators replacing existing generators would produce similar noise levels or be quieter as a result of technological advances in passive controls such as acoustic barriers and insulation, vibration dampening devises, and enclosures. Where natural gas or liquefied petroleum gas fuels are available to power the backup generator, noise levels produced during generator operation can be lower than those generators powered by other fuels when operating at similar load. Siting and design of systems, including backup generators, would include consideration of distances to sensitive receptors and, when appropriate, the use of sound attenuation measures and other noise mitigation strategies.

During operations, most maintenance activities would be performed during the day (i.e., sunrise to sunset) during normal operation. Depending on the maintenance activity, it could be preferable to perform some maintenance during the night (i.e., sundown to sunrise), to reduce impact to energy production. When maintenance activities cause an increase in noise levels, impacts to aquatic organisms and the surrounding populations (human or wildlife) could be minimized if the activities are performed during the day or during weekends (human), or during non-critical times (aquatic organisms and wildlife).

Potential noise impacts from the construction of the proposed floating solar system would be minor, localized, and short-term (i.e., only occurring for the duration of construction). Noise associated with floating solar array and power systems utilizing inverters, and transformers would long-term, minor, and localized to the installation of the power inverter. Noise impacts from maintenance activities would also be minor, short-term (i.e., during yearly regularly scheduled maintenance, and localized). Execution of the floating solar proposal, regardless of the alternative, would not violate any federal, state, or local noise regulations, and would not create land-use compatibility problems. Overall, there would be no long-term environmental noise changes (Table 3).

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Table 3. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Noise

Action	Impact	Mitigation	Impact Determination
Construction	Noise from construction equipment	Short-term (1–25 weeks) Daylight hour operation (sunrise to sunset) Avoid construction during critical times for wildlife (i.e., mating) Increase distance of construction sites from human or wildlife populations	Short-term, minor, localized
Operation	Noise from power inverters	Sound attenuation, insulation, and enclosures	Long-term, minor, localized
Maintenance	Noise from construction equipment	Daylight hour operation (sunrise to sunset) Weekend hour operation for overnight maintenance Performed during non-critical times wildlife	Short-term, minor, localized

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures. Table 24 also describes the long-term minor beneficial impacts due to replacement of other energy facilities

4.6 Geology and Soils

The geology and soils of a given area refer to the topography, bathymetry, geologic settings, geologic hazards, geologic resources, and the soil types and their properties.

Discussions of topography typically include descriptions of the elevation, slope, aspect, and surface features found within a given land area. Bathymetry refers to the depths and shapes of underwater terrain. The geology of an area includes bedrock materials, mineral deposits, soils, paleontological resources, and unique geological features. Bedrock refers to consolidated earthen materials that may be made up of either interlocking crystals (i.e., igneous and metamorphic rocks) or fragments of other rocks compressed and cemented together over time by pressure and dissolved minerals that have hardened in place (i.e., sedimentary rocks).

In most areas, bedrock underlies a soil layer that consists of weathered bedrock fragments and decomposed organic matter from plants, bacteria, fungi, and other living things (see Section 4.8, Biological Resources). Soil resources are the superficial, unconsolidated, and usually weathered part of the Earth's crust and can be located above water or in areas continuously or intermittently submerged by water. The value of soil as a geologic resource lies in its potential to support plant growth, especially agriculture.

Mineral resources include metallic ores (e.g., iron, gold, silver, and uranium) and non-metallic Earth materials (e.g., sand, gravel, and gypsum) that can be extracted for useful purposes, such as iron ore that can be refined to make steel or gravel that can be used to build roads. The economic viability of a mineral resource is dependent upon supply and demand and upon the cost to extract the mineral from the ground.

Paleontological resources, as defined in the Paleontological Resources Preservation Act (PRPA, 16 USC § 470aaa), are any fossilized remains, traces, or imprints of organisms, preserved in or on the Earth's crust, that are of paleontological interest and that provide information about the history of life on Earth.

Geologic hazards refer to adverse geologic conditions that could threaten life and property (e.g., highly erodible soils, landslides, seismic hazards, and volcanic hazards). The principal geologic hazards influencing the resiliency of a structure are soil stability, seismic activity, and secondary phenomena triggered by seismic activity (e.g., seismic seiches, tsunamis, liquefaction, or landslides).

Aspects, laws, and regulations considered when analyzing the potential impacts of the proposed action on geological and soils resources are identified and briefly described below:

- **Topography and Bathymetry:** To assess a site's suitability for construction and anchoring, the topography and bathymetry should be characterized prior to construction. The topography of a proposed project site can be determined using topographic maps published by the U.S. Geological Survey (USGS) and the Bureau of Land Management (BLM) or through information from Geographic Information System datasets available online. If the proposed project involves waterbody bed anchoring, bathymetric data could be needed to determine bottom slopes, irregularities, and roughness so the anchoring system could be properly designed. In addition, bathymetry surveys also would be necessary before installing a floating solar facility on a waterbody that could experience natural or anthropogenic dewatering and the resulting change in surface-water elevation. For this specific case, the waterbody bed would need to be relatively flat to accommodate the deployment of the floating solar arrays. Bathymetric data are less likely to be available in published sources, and bathymetric surveys could be required to obtain the information necessary for siting.

  The CZMA (16 USC § 1451) and its implementation through Coastal Zone Management Programs (CZPM) in coastal states could be applicable if a floating solar system is deployed on coastal waters (Alternative 3). The intent of a CZPM is to protect natural resources, including wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitats within the coastal zone (see Section 4.7, Water Resources, and Section 4.8, Biological Resources).
- **Soils Types and Properties:** Land soil information, including soil surveys and soil classifications, is available through the Natural Resources Conservation Service (NRCS). In addition, maps and inventories of subaqueous or submerged soils, if available, can be accessed through the NRCS.

  The composition, characteristics, and mechanical properties of soils at a project site also should be characterized prior to construction to assess their suitability for construction, capacities for anchoring, and potential for erosion. Soil erosion potentially impacts soils, air quality, water resources, and vegetation growth (see Section 4.4, Air Quality; Section 4.7, Water Resources; and Section 4.8, Biological Resources). The degree of erodibility is determined by physical factors (e.g., drainage, permeability, texture, structure, and surface slope). The rate of erodibility is a function of the amount of vegetative cover, climate, precipitation, proximity to waterbodies, and land use. Disruptive activities accelerate the natural erosion process by exposing erodible soils to precipitation and to wind and surface runoff. Highly erodible land is defined by the Sodbuster, Conservation Reserve, and Conservation Compliance parts of the Food Security Act of 1985 (Public Law 99-198) and the Food, Agriculture, Conservation, and Trade Act of 1990 (Public Law 101-624). Erodibility is one of the soil classification characteristics identified by the NRCS. Soil erosion prevention and control, particularly during construction activities, associated with storm discharges are regulated by the EPA under sections of the CWA (33 USC § 1251 et seq.) through the National Pollutant Discharge Elimination System (NPDES) Program (Section 402). Section 404 of the CWA established a permit program that regulates the discharge of dredged and fill material into WOTUS. Discharge of dredged or fill material into WOTUS is prohibited unless the action is exempted or is authorized by a permit issued by the U.S. Army Corps of Engineers (USACE) or by the state. Section 401 requires that the state in which an activity requiring a federal license or permit would occur must confirm that the activity would not violate state water-quality standards. Section 4.7, Water Resources, provides further details regarding the CWA requirements. Installation stormwater-management plans provide requirements for minimizing soil erosion that could affect sedimentation in streams and other waterbodies. In addition, some Army installations may have a fugitive dust-control plan that includes measures to minimize fugitive dust emissions and to avoid exceeding the exceedance of threshold levels dictated by state regulations; wind-borne soil is a form of fugitive dust.

Hydric soils are one of the three indicators of a wetland and, therefore, should be considered during site-selection and the project-design phase. According to the National Technical Committee for Hydric Soils, hydric soils are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation (USDA 2016). The potential impacts to wetlands are discussed in Section 4.7, Water Resources, and Section 4.8, Biological Resources.

The U.S. Department of Agriculture defines prime farmland as land that can be used in the production of the nation's food supply. Prime farmland is protected under the Federal Farmland Protection Policy Act (FPPA, 7 CFR Part 658). Under the FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements may not currently be used for cropland, but can be forestland, pastureland, cropland, or other land, but not water or urban built-up land. However, acquisition and use of farmland soils by a federal agency for national defense purposes are exempted by Section 1547(b) of the FPPA.

In addition, AR-200-1 requires each Army installation to develop and maintain an INRMP. The INRMP is the mechanism by which applicable environmental laws and regulations intended to protect natural resources, including soil resources, are integrated and implemented at Army installations (DA 2007). In addition, state and local erosion- and sediment-control programs may be applicable on Army installations.

- **Mineral Deposits, Paleontological Resources, and Unique Geological Features:** Site conditions should be reviewed to determine if economically viable mineral deposits, scientifically significant paleontological resources, or unique geological features are present or expected in the project area. For proposed project sites located on Army installations, the potential for the presence of such mineral deposits, paleontological resources, and geological features may be known from previous activities. Mineral exploration and extraction on Army-controlled lands are regulated by AR 405-30, *Mineral Exploration and Extraction* (DA 1984).

The BLM and/or state repositories of fossil finds are sources of information about paleontological resources in a region. Paleontological resources have been protected on federal lands by the PRPA since March 30, 2009 (16 USC § 470aaa). However, the PRPA is applicable to U.S. Department of Interior and U.S. Forest Service lands, but not to DoD lands. AR 200-1 (DA 2007) requires Army installations to maintain an ICRMP that serves as the guide of compliance with applicable federal laws and regulations, including the Archeological and Historic Preservation Act of 1974 (AHPA; 54 USC § 312501_312508). The AHPA specifically states that paleontological resources must be addressed for impact and loss in any NEPA documentation (42 USC § 4321 et seq.) (see Section 4.9, Cultural Resources, for more information).

The Antiquities Act of 1906 (54 USC § 320301-320303) has resulted in significant paleontological sites in the United States being identified as national monuments and requires that permits must be obtained prior to examining, excavating, or gathering, among other items "… *objects of …. scientific interest*" on Army lands, which includes paleontological resources. The Antiquities Act and its associated regulation, Preservation of American Antiquities (43 CFR Part 3), also limits who may obtain such permits and for what purpose (see Section 4.9, Cultural Resources). Regarding geological features, the Historic Sites Act of 1935 (54 USC § 320101-320106) establishes a national registry of natural landmarks and protects "… outstanding examples of major geological features." Topographic and geologic features also may be protected under state regulations (e.g., California Environmental Quality Act [California Public Resources Code 21000-21189]).

- **Geologic Hazards:** Geologic hazards encompass Earth processes such as seismic activity, volcanic activity, erosion, and their related processes. Potential geologic hazards would be identified in a geotechnical investigation of any proposed project site. The geotechnical study should describe existing geological conditions, and design and construction recommendations, that address potential geological hazards at a site. Army Regulation 525-2, *Army Emergency Management Program* (DA 2012b), requires installations to prepare, implement, and maintain an Emergency Management Program for the planning, execution, and management of response efforts to mitigate the effects of an all-hazard incident to include, but not limited to, natural disasters. Because geologic hazards distribution varies across the United States, state and local regulations may apply in areas subject to higher risks.

4.6.1 Existing Conditions

Existing conditions with respect to geology and soils on Army installations are representative of geological and soil resources across the United States and would vary by specific location.

Geologic formations present significant variations in age and lithology from installation to installation. Depending on the location, formations may consist of sedimentary rock (e.g., sandstone, shale, and limestone); igneous rock (e.g., basalt); metamorphic rock (e.g., gneiss); glacial features such as tills, moraines, and outwash plains; and alluvial deposits.

The actions of climate, living organisms, topography, and parent material over time produce soil. For these reasons, soil series at Army installations across the United States vary widely in characteristics, properties, and distributions, with some locations including hydric soils, highly erodible soils, and prime or unique farmland soils.

The presence and the type of mineral resources on Army installations and in the surrounding areas vary depending on the geological setting. Some Army installations are located in regions where mineral resources have been identified or have been mined and/or extracted in the past. The presence of paleontological resources and unique geological features varies significantly across the United States depending on geological settings, and the occurrence of these resources will vary from installation to installation.

Similarly, the distribution of geologic hazards will differ significantly from location to location, ranging from areas where few to no hazards exist, to areas subject to seismic activity because of proximity to active geological fault zones (e.g., Ring of Fire and New Madrid Zone) or to volcanic activity (e.g., Hawaii).

Geological features that should be considered during site selection include, but are not limited to, areas with low topographic relief, the absence of unique geological features, and soil properties with minimal construction and stability issues, and exposure to geologic hazards. The Army, through the Defense Installations Spatial Data Infrastructure Program, maintains geospatial information for its installations (AT&L 2016) and, therefore, may be able to take geological conditions, soil, and mining information into account when reviewing potential sites for floating solar array deployment.

4.6.2 Environmental Consequences

Impacts on geological and soil resources from installation of floating solar at each of the alternatives, and whether existing geologic or soil conditions might affect elements of the proposed action were evaluated. This evaluation assessed and distinguished by degree to which the impact would 1) impair the ability of the geological resources of the Army installation to sustain effective training grounds and range, and 2) conflict with existing federal, state, or local statutes or regulations. In general, the ROI would be localized and restricted to the floating solar array and power system footprint and its immediate surroundings.

Impacts to geological and soil resources would be considered significant if the proposed action induced wind-borne- or storm-water-related soil erosion exceeding the amount of soil loss at which quality of a soil can be maintained to sustain existing vegetation. In addition, impacts could also result in a violation of federal or state air quality laws; induce soil erosion resulting in sedimentation issues that violate federal or state water-quality laws; or adversely affect the conversion of farmland to nonagricultural uses.

4.6.2.1 No Action Alternative

There would be no change to geological and soil resources on the installation as there would be no construction activity under the no action alternative.

4.6.2.2 Alternative 1: Wastewater

Soils would be directly impacted during construction of a floating solar array. Floating solar projects that deploy solar arrays on chemically treated or wastewater ponds/lagoons would involve ground-disturbing activities through the addition of anchoring systems, security fencing, access roads, equipment shelter(s), distribution and transmission lines, and if needed, substation expansion or new substation construction. Similar disturbances might occur if a floating solar array is coupled to an energy storage or microgrid-based system. These ground-disturbing activities could include removing vegetation, excavating, grading, trenching, and basic earthmoving. These construction activities would increase the potential for soil erosion and permanent topsoil loss.

Floating solar arrays could be anchored to the waterbody bed and/or the shoreline, or may not require anchoring if contained within an existing structure. If anchoring is needed, the system design could increase the extent of ground disturbances as some systems could require excavation or ground penetration (e.g., percussive driven Earth anchors and helical screw anchors) and others may not (e.g., concrete block). Waterbodies considered for Alternative 1 are manmade structures that contain chemically treated effluents. The floating solar array anchoring system design would need to ensure that geo-membranes, or any containment equipment or structures not damaged during construction, operation, and maintenance activities. Waterbody bed anchoring would likely not be appropriate unless a suitable bottom anchoring system design that does not jeopardize the integrity of the waterbody bed or containment structure is proposed. Installation of a bottom anchoring system on manmade structures would have no direct impact on geologic and soil resources because the area is already disturbed; however, such an installation could lead to a variety of impacts on water and biological resources such as submerged aquatic vegetation and algae (see Section 4.7, Water Resources, and Section 4.8, Biological Resources). If on-shore anchoring is required, shoreline footings or anchor sites would need to be installed with a design adapted to the type and properties of soils or manmade structures encountered at the banks of the waterbody and also adapted to the size of the floating solar array system. A site-specific geotechnical study should identify existing geological conditions, and design and construction recommendations that address the suitability of site soils for construction and anchoring, if applicable. However, it is likely that, for floating solar arrays located on chemically treated waterbodies or wastewater bodies, the anchoring systems would be installed on existing manmade structures (e.g., edges) and would not result in any soil-disturbance or soil-stability issues.

Ground-disturbing activities associated with construction activities can lead to increased erosion and sedimentation that can degrade the land and water. Soil erosion that could result from these ground-disturbing activities could be controlled by implementing appropriate environmental protection measures, including BMPs to prevent soil erosion. Methods used to minimize soil erosion could include, but are not limited to, the following:

- minimizing ground-disturbing activities
- placing barriers and sedimentation devices around drainage and wetlands (e.g., sandbags, silt fences, earthen berms, fiber trolls, and sediment traps)
- minimizing land disturbance in natural drainage systems and the groundwater aquifer
- avoiding areas with unstable slopes and soils
- considering use of appropriate construction techniques in areas of steep slopes, erodible soil, and drainage ways
- considering phasing the construction activities to minimize the areas of exposed and unstabilized soils
- restoring native plant communities as soon as practicable after completion of the activities in disturbed areas through natural revegetation or by seeding and transplanting.

Environmental protection measures identified in stormwater pollution prevention plans (SWPPP) and fugitive dust-control plans prepared for installations and in the state-issued construction permits (e.g., NPDES permit) should be considered. In addition, soil conservation and stormwater-management regulations require the use of appropriate BMPs to minimize/eliminate site-specific erosion concerns. BMPs also would help minimize soil compaction issues related to construction activities. If no visible dust requirements exist, frequent construction site watering or other dust-mitigation options may be used to meet the requirements. For floating solar array and power system projects that require new transmission lines, the lines should be placed, to the greatest extent possible, along existing road-disturbance limits and within existing utility easements to minimize ground disturbance. Negligible, long-term, adverse impacts would be anticipated as a result of increase to impervious surfaces (e.g., from equipment shelters and access roads). If appropriate mitigation measures are implemented, adverse impacts from ground-disturbing activities associated with construction of a floating solar system are anticipated to be short-term, moderate / less than significant, and long-term minor to moderate.

During construction and maintenance activities, potential soil contamination resulting from spills of hazardous materials could occur (e.g., fuel spills from vehicles and equipment). With environmental protection measures, to include BMPs and standard operating procedures (SOPs) for preventing and responding to potential contamination, impacts are anticipated to be negligible.

During operation and maintenance activities, natural processes (e.g., wind and rain) or the passage of vehicles or operators could lead to soil erosion. System operators would monitor the floating solar array and associated support infrastructure to identify any soil erosion. Highly eroded soil and sediment reaching streams and other waterbodies would be investigated, and appropriate remediation actions would be taken. Installation of floating solar arrays could result in beneficial impacts by reducing silt accumulation in the waterbody where the installation is located (Ferrer-Gisbert et al. 2013). Soil erosion during operation and maintenance activities would result in negligible long-term adverse effects.

Conversion of prime farmland also could occur if such land occurs on the project site, which would be applicable to land-based power control system structures and transmission corridors. An assessment of the presence of the same soil type within the project area could be conducted to evaluate the significance of the loss of prime farmland and determine if avoidance of such impact would be feasible. However, depending on the site selected for the proposed project, soil disturbance could be limited because the location had been disturbed in the past. In addition, acquisition of farmland for national defense purposes is exempt by Section 1547(b) of the FPPA (7 CFR Part 658). Therefore, it is anticipated that loss of prime farmland would have negligible-to-moderate impact.

Depending on the geology of a specific installation and the amount of soil disturbance, scientifically significant paleontological resources, if present, could be impacted by ground-disturbing activities associated with construction, and long-term direct adverse effects would be expected. This type of soil disturbance would be applicable to land-based power control system structures and transmission corridors. Though the Paleontological Resources Preservation Act of 2009 (16 USC §§ 470aaa et seq.) does not apply to DoD lands, if the construction contractor inadvertently discovers scientifically significant paleontological resources, construction work should stop and the installation's environmental management office should be notified. Such resources must be located and assessed for their potential value. ICRMPs developed for Army installations serve as guides for managing and protecting cultural resources and for complying with applicable laws and regulations (Section 0, Cultural resources). Adherence to the guidance provided in ICRMPs would minimize the potential impacts on paleontological resources. Careful siting and avoidance of areas that are known or likely to contain fossils could reduce adverse impacts to negligible-to-minor levels.

Similarly, the proposed action would not be anticipated to directly or indirectly destroy a scientifically significant paleontological find if careful site design and avoidance of the resource were undertaken.

In a limited number of installations, the presence, extent, quantity, and quality of mineral resources could affect or be affected by the construction and operation of the proposed action. Careful siting and avoidance of known resources could reduce the impact on mineral resources of implementing Alternative 1. Adverse effects associated to the proposed action would be considered to be negligible to minor.

Methods to minimize geologic hazard concerns, if applicable, mainly involve building project structures in accordance with design-basis recommendations provided in the project-specific geotechnical report. Special siting, design, and engineering strategies would be taken into consideration in areas subject to geologic hazards.

Implementation of Alternative 1, with deployment of mitigation strategies, to include BMPs, would be anticipated to have negligible-to-moderate impacts on soil and geologic resources (Table 4).

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Table 4. Summary of Alternative 1 Actions, Impacts, and Mitigation Strategies[(a)] on Geology and Soils

Action	Impact	Mitigation	Impact Determination
Construction	Erosion, sedimentation, and turbidity	Careful site design Erosion-control BMPs	Short-term, minor to moderate
	Ground-disturbing activities	Avoidance of resources Careful site design	Short-term, less than significant to moderate Long-term, minor to moderate
	Spills of hazardous materials	BMPs and SOPs	Negligible
	Conversion of prime farmland	Careful site design, avoidance of known resources	Long-term, minor to moderate
	Soil compaction	BMPs and SOPs	Negligible to moderate
	Damaged liners	Avoid bottom anchoring when a liner is present, careful site and anchoring design	Negligible with mitigation
	Soil stability	Careful site selection and design, BMPs and SOPs	Negligible with mitigation
	Geologic hazards	Careful site selection and design	Negligible to moderate
	Destruction of Paleontological resources	Careful site selection and design, avoidance	Negligible to minor
	Deterioration of unique geologic features	Careful site selection and design, avoidance	Negligible to minor
	Mineral resources removal or deterioration	Careful site selection, avoidance of resources	Long-term, negligible to minor
Operation	Soil erosion	Monitoring by the system operator in sensitive areas	Long-term, negligible
	Geologic hazards	Careful site design	Negligible to moderate
Maintenance	Soil erosion	Monitoring by the system operator in sensitive areas	Long-term, negligible
	Spills of hazardous materials	BMPs and SOPs	Negligible

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

4.6.2.3 Alternative 2: NWOTUS

Construction, operation, and maintenance of the floating solar array system on NWOTUS are anticipated to have consequences similar to those of Alternative 1. However, because the possibility of pre-existing constructed structures is lower, more attention should be given to potential soil stability and erosion issues during construction activities.

Similar to Alternative 1, direct impacts to soils would occur from the construction of a floating solar system. Constructing the floating solar array system to include power infrastructure would involve ground-disturbing activities through addition of an anchoring system, security fencing, access roads, equipment shelter(s), distribution and transmission lines, and if needed, substation expansion or new substation construction. Waterbodies considered in Alternative 2 would likely have less available existing infrastructure than Alternative 1. Hence, additional consideration should be given to the impacts of implementing either a bottom anchoring system and/or a shoreline anchoring system. Placement of a bottom anchoring system could require removal of SAV (see Section 4.8, Biological Resources) and could require soil excavation or penetration. Implementing waterbody bed anchoring systems could lead to a temporary increase of water turbidity from soil-disturbing activities with attendant direct impacts on the aquatic life (see Section 4.8, Biological Resources) and could also affect soil stability. Careful anchoring system design and siting based on soil, geotechnical, and bathymetric surveys would help minimize the adverse impacts of the construction activities. Similarly, implementing a shoreline anchoring system could alter stability conditions of the waterbody embankments, change vegetation removal practices, and lead to increased erosion and sedimentation.

Implementation of Alternative 2 would require careful siting, design, and construction efforts to minimize the impacts of ground-disturbing activities that could degrade water and air quality. Soil erosion resulting from ground-disturbing activities could be controlled by implementing appropriate environmental protection measures, such as erosion-control BMPs similar to those described for Alternative 1. Additional attention should be given to adopting mitigation methods that would arrest or prevent slope failure and surface erosion. If not controlled, surface erosion and shallow slope failures could lead to larger issues (e.g., landslide conditions with potential consequences for structures). Soil stabilization methods could include, but would not be limited to, avoiding areas with unstable slopes and soils; considering use of special construction techniques in areas where steep slopes, erodible soils, and drainage ways exist; and implementing bioengineering methods (e.g., slope stabilization using vegetation). Any other environmental protection measures specified in the installation's SWPPP and fugitive dust-control plan, and in the state-issued construction permit (e.g., NPDES permit) would also be taken into consideration.

A site-specific geotechnical study should provide existing geological conditions, and design and construction recommendations, that address suitability of soils for construction and anchoring.

Regular operation and maintenance of the floating solar array system on NWOTUS would be expected to have impacts similar to those expected for Alternative 1.

Short-term, less than significant-to-moderate and long-term minor, adverse impacts to soils would be anticipated as a result of construction activities. Negligible, long-term, adverse impacts would be anticipated as a result of increase to impervious surfaces (e.g., equipment shelters and access roads). Soils identified as prime farmland would require special consideration during construction.

Programmatically, development and operation of floating solar systems on NWOTUS would be anticipated to result in negligible-to-moderate impacts to geologic and soils resources with mitigation strategies (e.g., BMPs and SOPs) described in Table 5.

Table 5. Summary of Alternative 2 Actions, Impacts and Mitigation Strategies[(a)] on Geology and Soils

Action	Impact	Mitigation	Impact Determination
Construction	Erosion, sedimentation, and turbidity	Careful site design, erosion-control BMPs	Short-term, moderate with mitigation
	Ground-disturbing activities	Avoidance of resources, careful site design	Short-term, negligible to moderate, Long-term, minor to moderate
	Spills of hazardous materials	BMPs and SOPs	Negligible
	Turbidity	Careful anchoring system design	Short-term, negligible
	Conversion of prime farmland	Careful site design, avoidance of known resources	Long-term, negligible to moderate
	Soil compaction	BMPs/ SOPs	Negligible to moderate

Table 5. (contd)

Action	Impact	Mitigation	Impact Determination
Construction (contd)	Damaged liners	Careful site and anchoring design	Negligible with mitigation
	Soil stability	Careful site selection and design, BMPs	Negligible with mitigation
	Geologic hazards	Careful site selection and design	Negligible to moderate
	Geological resources removal or deterioration	Careful site selection, avoidance of resources	Long-term, negligible to minor
Operation	Soil erosion	Monitoring by the system operator in sensitive areas	Negligible
	Geologic hazards	Careful site design	Negligible to moderate
Maintenance	Soil erosion	Monitoring by the system operator in sensitive areas	Negligible

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

As with Alternative 1, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.6.2.4 Alternative 3: WOTUS

Construction, operation, and maintenance of the floating solar array system on WOTUS could result in impacts greater than those anticipated for Alternatives 1 and 2. The reasons for the greater anticipated impacts are the nature of the waterbody type and the possible absence of existing infrastructure, which would require more construction activities. Additional consideration should be given to reducing and minimizing impacts caused by uncontrolled erosion, sedimentation, and soil-stability issues during the construction activities and to ensure compatibility with any requirements related to air and water quality (see Section 4.4, Air Quality and Section 4.7, Water Resources).

Direct impacts to soils would occur from the construction of the floating solar array and power system. Construction under this Alternative 3 would involve ground-disturbing activities related to the addition of an anchoring system; security fencing; access roads; equipment shelters; distribution and transmission lines; and, if needed, substation expansion or new substation construction. As with Alternatives 1 and 2, siting, design, and construction efforts must minimize the impacts of ground-disturbing activities that could degrade water and air quality. Soil erosion that could result from these ground-disturbing activities could be controlled by implementing appropriate environmental protection measures (e.g., erosion-control BMPs similar to those described for Alternatives 1 and 2) to be compliant with federal, state, and local regulations. Because of the nature of the waterbody, more consideration should be given to any mitigation methods that will arrest or prevent slope failure and surface erosion. Floating solar systems installed on coastal waters also could require additional mitigation measures to prevent soil erosion and stability issues.

Short-term, negligible-to-significant, adverse impacts to soils would be anticipated as a result of construction activities. Minor, long-term, adverse impacts would be anticipated as a result of grading, and a negligible increase to impervious surfaces (e.g., equipment shelters and access roads) would be anticipated.

Unlike Alternatives 1 and 2, a floating solar array system deployed on WOTUS could be exposed to currents and/or be subject to tide, wave, and wind actions that could induce motion of the floating rafts and could strain the anchor systems. Depending on the type of waterbody considered for the floating solar array, the water level also could experience natural (e.g., tides, seiches, harbor oscillations, and tides) or man-controlled fluctuations. Implementation of Alternative 3 would require careful siting and anchor system design to ensure that the floating structure could withstand such conditions.

Army installations located on a coastal environment or near enclosed or partially enclosed waterbodies (e.g., a lake or bay) in areas subject to seismic activity could also experience secondary hazard impacts from tsunami inundations and/or seismic seiches. Exposure to geologic hazards must be considered when siting and designing a floating solar system to ensure that it could withstand bedrock acceleration during a seismic event and the floating solar rafts move on the waterbody surface in the instance of tremor. Seiche or landslide events induced by earthquakes could lead to a heave of the waterbody surface, which also could strain anchor systems. Special siting, design and engineering strategies would need to be considered in areas subject to high seismic activity and related hazards.

Geological and soil characterization should be conducted prior to construction, and bathymetric survey would be required if a bottom anchoring system is proposed.

For floating solar systems deployed on WOTUS, impacts similar to those anticipated for Alternatives 1 and 2 would be anticipated for paleontological and mineral resources and also for unique geological features.

Development and operation of floating solar systems on WOTUS would be anticipated to result in negligible-to-significant impacts to geologic and soil resources, but the impacts would be mitigatable using strategies described in Table 6 (e.g., BMPs and SOPs).

Table 6. Summary of Alternative 3 Actions, Impacts, and Mitigation Strategies[a] on Geology and Soils

Action	Impact	Mitigation	Impact Determination
Construction	Erosion, sedimentation, and turbidity	Careful site design, erosion-control BMPs	Short-term, minor to significant
	Ground-disturbing activities	Avoidance of resources, careful site design	Negligible to moderate
	Spills of hazardous materials	BMPs and SOPs	Negligible
	Conversion of prime farmland	Careful site design, avoidance of known resources	Long-term, minor to moderate
	Soil stability	Careful site selection and design, BMPs	Minor to significant
	Soil compaction	BMPs/SOPs	Negligible to moderate
	Conversion of prime farmland	Careful site design, avoidance of known resources	Long-term, minor to moderate
	Geologic hazards	Careful site selection and design	Negligible to significant
	Destruction of Paleontological resources	Careful site selection and design, avoidance	Negligible to minor
	Deterioration of unique geologic features	Careful site selection and design, avoidance	Negligible to minor
	Mineral resources removal or deterioration	Careful site selection, avoidance of resources	Long-term, negligible to minor
Operation	Soil erosion	Monitoring by the system operator in sensitive areas	Negligible
	Geologic hazards	Careful site design	Negligible to moderate
Maintenance	Soil erosion	Monitoring by the system operator in sensitive areas	Negligible
	Spills of hazardous materials	BMPs and SOPs	Negligible

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

As with Alternatives 1 and 2, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.7 Water Resources

Water resources as defined in this assessment are sources of water available for use by humans, flora, or fauna. They are important for economic, ecological, recreational, and human health reasons. The use of water resources is affected by their quantity, availability, and quality. Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. Water resources include surface waterbodies (e.g., streams, rivers, ponds, lakes, and estuaries), groundwater, coastal near-shore waters, and wetlands. Water resources may be naturally occurring or manmade (e.g., stormwater-management ponds, reservoirs, and constructed wetlands).

Surface-water systems are typically defined in terms of watersheds or drainage basins. A watershed is a land area that drains to a common waterway (e.g., a stream, lake, estuary, wetland, aquifer, or ocean). A drainage divide defines the boundary between watersheds. For a stream, the drainage divide is the highest topographic ridgeline around the stream and its tributary streams. The downstream watershed boundary for a stream is the point where the stream flows into a larger stream or river, a lake, or an ocean, commonly referred to as the mouth of the stream. Year-round presence of water in surface-water features varies, falling into the categories of perennial (continuous), intermittent (seasonal), and ephemeral (water present only in response to rainfall).

Groundwater is any source of water beneath the ground surface; accessible groundwater occurs in aquifers, which are commonly used for potable water, agricultural irrigation, and industrial applications. Groundwater aquifers may discharge to and/or recharge from streams, lakes, or wetlands.

Coastal near-shore waters can be directly affected by human activity, and are important for human recreation and subsistence.

Wetlands are habitats subject to permanent or periodic inundation or prolonged soil saturation, and include marshes, swamps, and similar areas. They may be tidal or nontidal. Areas described and mapped as wetland communities may contain small streams or shallow ponds. Wetlands often occur in the floodplains of streams and along the margins of lakes and ponds. Floodplains are relatively flat areas adjacent to rivers, streams, watercourses, bays, or other bodies of water, that are subject to inundation during flood events.

Aspects of water resources relevant to the proposed floating solar arrays include:

- **Watershed:** Any activity that affects water quality, quantity, or rate of movement at one location within a watershed has the potential to affect the characteristics of locations downstream. In June 2005, to assist DoD installations in understanding and managing operations from a watershed perspective, the DoD issued the *Department of Defense Installation Watershed Impact Assessment Protocol – a Water Resources Management Guide* (AEC 2005).
- **Surface-Water Quality:** Surface-water quality is regulated under the CWA (33 USC § 1251 et seq.). Section 303(c) of the CWA requires states to adopt and periodically review water-quality standards to support the designated uses of waterbodies, which include public water supply; propagation of fish and wildlife; recreation, agricultural, and industrial purposes; navigation; and other uses. Section 303(d) of the CWA requires states to identify and develop a list of impaired waterbodies where technology-based and other required controls have not provided attainment of water-quality

standards. For impaired waterbodies, states are required to identify the pollutant(s) causing the impairment and develop Total Maximum Daily Loads (TMDL) for these pollutants of concern. The TMDL process establishes allowable pollutant loadings or parameters for a waterbody and allows water-quality controls to be developed to reduce pollution and to restore and maintain water quality to the level required by the waterbody's designated use. The allowable load established by a TMDL suggests stream water quality would improve over time. Section 305(b) of the CWA requires states to assess and report the quality of their waterbodies. These water-quality reports are available from the individual states or from the EPA (2015b). Additional regulatory requirements may also exist for surface waters under the Safe Drinking Water Act (SDWA; 42 USC § 300f) for those surface waters that are sources of potable drinking water. In 1999, to assist Army installations that operate, own, or partially own a drinking water-treatment system, the Army published the *User's Guide for Source Water Assessment and Protection at U.S. Army Installations* (AEC 1999).

CWA Section 401 requires that any activity requiring a federal license or permit that might result in a discharge into WOTUS receive state certification that the discharge will comply with state water-quality standards. Federal permits that may require state certification include those under CWA Section 402 (NPDES) and CWA Section 404 (discharge of dredged or fill material) when the state is not authorized to issue these permits, and those under Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 USC § 401 et seq.) for construction and dredging in navigable waters.

Regulated Army installation discharges into surface waters include those from wastewater, cooling water, and stormwater. CWA discharge permits are issued by the EPA or authorized state agencies under the NPDES. NPDES permits may be issued for point source discharges—including stormwater discharges—to WOTUS, and establish the site-specific compliance requirements for the permitted facility (e.g., effluent limits and monitoring and reporting requirements). Army installations that have indirect discharges into municipal wastewater-treatment plants may have similar pretreatment requirements.

Army stormwater-management practices are also required to comply with Section 438 of the Energy Independence and Security Act of 2007 (EISA; Public Law 110-140), which directs federal agencies sponsoring development or redevelopment of over 5,000 ft^2 in size to use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of water flow. This requirement is further emphasized by Army policy which states development projects of 5,000 ft^2 or greater must be planned, designed, and constructed to manage any increase in stormwater runoff (i.e., the difference between pre- and post-project runoff) within the limit of disturbance (DA 2013a).

In addition, as part of the stormwater permitting process, Army installations prepare SWPPPs that include implementation of BMPs, performing frequent visual inspections, and conducting benchmark monitoring to determine BMP effectiveness (DA 2007). Monitoring results are analyzed in relationship to the identified water-quality objectives and if the benchmarks are not being reached, the BMPs would be modified.

- **Waters of the United States (WOTUS):** The CWA's jurisdiction applies to WOTUS, which are defined in 40 CFR 122.2. By rule, WOTUS consist of traditional navigable waters (including all waters subject to tides), interstate waters (including interstate wetlands), the territorial seas, tributaries of these three types of waters, impoundments of WOTUS, and all waters adjacent to these WOTUS (including wetlands, ponds, lakes, oxbows, impoundments, and similar waters). In addition, other specific waters are WOTUS if a case-specific analysis establishes a significant nexus to a water identified by rule as a WOTUS. This includes waters within the 100-year floodplain, or within 4,000 ft of the high-tide line or ordinary high water mark, of a WOTUS. Definitions for "tributary," "adjacent," "significant nexus," and other terms are provided in the regulation.

Waters specifically identified as not WOTUS include manmade waterbodies used for waste treatment that were neither created in WOTUS nor resulted from impoundment of WOTUS, ditches unrelated to WOTUS, artificial constructed lakes and ponds created in dry land, water-filled depressions created in dry land incidental to mining or construction activity, stormwater-control features created in dry land, wastewater-recycling structures (including detention/retention basins, groundwater recharge basins, percolation ponds, and associated distribution structures), and groundwater.

Some states define "waters of the state" more broadly than the CWA, in which case there may be waters that are not WOTUS, but that are nonetheless subject to state regulatory controls. For example, artificial waterbodies and groundwater are excluded from the definition of WOTUS, but may fall under the jurisdiction of state water-control boards.

- **Navigable Waters of the United States:** Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 USC § 401 et seq.) provides for USACE regulation of structures or work in or affecting navigable waters, including any obstructions to navigation (33 USC § 403). Jurisdiction under Section 10 applies to navigable waters, which are defined in 33 CFR Part 329. There may also be state requirements for in-water construction and structures affecting navigation and recreational activities such as boating and fishing. These state requirements may apply to waterbodies that would not be included in navigable waters of the United States.
- **Groundwater and Aquifers:** Some Army installations use groundwater as a source for potable water, which is regulated under the SDWA, and/or for other uses, such as irrigation. Aquifer recharge areas also exist on some Army installations. Land uses in such areas may be restricted, especially for aquifers serving as the sole or principal source of drinking water. Such aquifers may be designated by the EPA as sole source aquifers (SSAs) when the aquifer supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer, and when there are no reasonably available alternative sources of drinking water in the event the aquifer is contaminated. Regulations are authorized for SSAs under Section 1424(e) of the SDWA (EPA 2015c). Some of the 77 designated SSAs in the United States occur beneath or near Army installations. The previously mentioned *User's Guide for Source Water Assessment and Protection at U.S. Army Installations* addresses groundwater aquifers and recharge areas, in addition to surface-water sources (AEC 1999).
- **Wetlands and WOTUS:** If a formal wetland delineation has already been determined for the Army installation for the proposed project area, this can be used to determine the occurrence of jurisdictional wetlands (WOTUS) that might be affected by any proposed new facilities. If no previous delineation has been performed, available Army and other federal agency data would be used to determine the potential for jurisdictional wetlands within the proposed project footprint. These include aerial photographs, U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory maps, and NRCS soil classification maps (which identify the presence of hydric soils, one of the components of a wetland). Even if these sources do not provide evidence of potential wetlands, previously undeveloped sites may be inspected by a wetland biologist to determine if unmapped jurisdictional wetlands are present. If there are indications that jurisdictional wetlands may be located within the proposed project footprint, then formal wetland delineation would be conducted according to the *USACE Wetlands Delineation Manual* (USACE 1987) and any regional supplements. A wetland delineation report would then be prepared and submitted to USACE, which would make a determination whether a wetland is jurisdictional and therefore subject to CWA Section 404 permitting requirements. As described above, some states regulate waters more broadly than WOTUS, and in some cases include non-jurisdictional wetlands in the definition of "waters of the state".
- **Floodplains:** The Federal Emergency Management Agency's (FEMA) flood maps (FEMA 2016a) can be used to determine if the proposed project area is located within a FEMA-designated 100- or 500-year floodplain. The 100-year floodplain is a Special Flood Hazard Area and this area has a 1 percent or greater chance of flooding each year. The 500-year floodplain has a 0.2 percent chance of

flooding each year and is considered a moderate flood hazard area (FEMA 2016b). If a project site is determined to be located within a 100-year floodplain, any federal development at that site is subject to Executive Order (EO) 11988, *Floodplain Management* (EO 11988). This EO requires federal agencies to avoid, whenever possible, the long- and short-term adverse effects associated with the occupation and modification of flood plains. Federal agencies should also avoid direct and indirect support of floodplain development wherever there is a practicable alternative. On January 30, 2015, EO 11988 was amended by EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input* (EO 13690). EO 13690 provides three approaches that federal agencies can now use to establish the flood elevation and hazard area for consideration in decision making: 1) a climate-informed science approach, 2) adding 2 to 3 ft of elevation to the 100-year floodplain, and 3) using the 500-year floodplain. Guidelines for implementing EOs 11988 and 13690 were published on October 8, 2015 (FEMA 2015).

- **Coastal and Great Lake Waters:** Areas bordering the Atlantic, Pacific, and Arctic Oceans, Gulf of Mexico, Long Island Sound, and Great Lakes are affected by additional requirements under the CZMA (16 USC § 1451 et seq.), which is concerned with the degradation of coastal waters, to include degradation from nonpoint source pollution. Under the CZMA, federal agency actions within or outside the coastal zone that affect any land or water use, or natural resource, of the coastal zone shall be carried out in a manner that is consistent, to the maximum extent practicable, with the enforceable policies of a state's approved coastal-management program. Currently, 34 coastal states participate; Alaska withdrew in 2011 (NOAA 2014).

AR 200-1 provides guidance to ensure the availability, conservation, and protection of water resources, to include potable water, and enables Army compliance with the CWA, CZMA, SDWA, and applicable state and local regulations implementing these federal laws (DA 2007).

4.7.1 Existing Conditions

Existing water resources on Army installations are representative of water resources across the United States. U.S. Army installations are often large enough that they cover multiple watersheds and contain various types of natural and manmade waterbodies. Natural surface waterbodies at Army installations include ponds, lakes, streams, and rivers. A recent survey identified over 650 man-made or natural lakes on or adjacent to 56 Army installations, with surface water areas ranging from about 10 ac to more than 11,000 ac (PNNL 2016). Approximately 50 percent of the waterbodies in the survey had an area between 10 and 20 ac, and 95 percent of the lakes had an area less than 300 ac (see Figure 7). Wetlands are common at Army installations and many have been formally delineated: 1.3 million ac of wetlands have been identified on 12.4 million ac of Army land (DA 2016a). A few Army installations abut near-shore marine waters and water resources protected by the CZMA. Some installations have impaired waters, as defined by the CWA, on or adjacent to the installation. Groundwater resources include confined and unconfined aquifers that may provide drinking water, and/or industrial, landscaping, and agricultural water to the installation and/or surrounding communities, depending on the groundwater aquifer's quality and quantity. At some installations, potable water comes from surface-water sources.

In general, construction in a floodplain is to be avoided; however, there is a process for constructing in a floodplain when no other practicable alternatives are available. Floating solar projects with associated infrastructure located in whole or in part within a floodplain must undergo the process outlined in EO 11988, as amended by EO 13690, which may result in a Finding of No Practicable Alternative (FONPA). For projects located in a floodplain, EO 11988 requires identification of the impacts of the project on lives, property, and the natural and beneficial values of the floodplain. If the project results in harm to or within the floodplain, EO 11988 requires that harm be minimized and natural and beneficial values of the floodplain be restored and preserved.

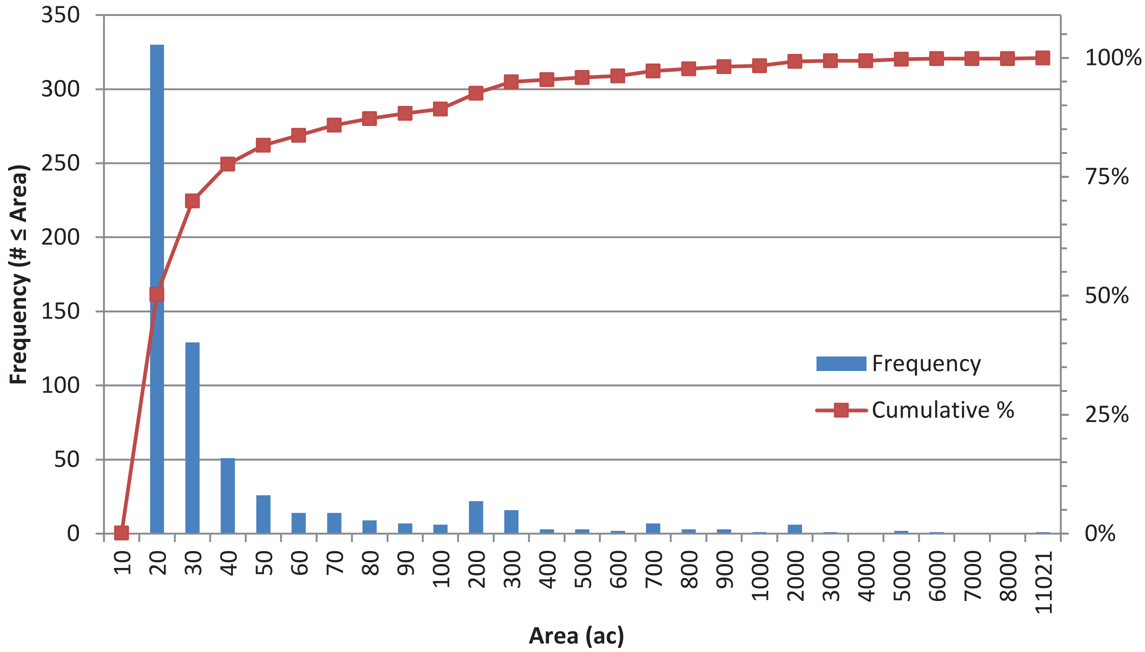


Figure 7. Distribution of Areas from a Survey of Army Installations

Manmade surface waterbodies at Army installations include stormwater-management features, ponds, reservoirs, and water/wastewater-treatment facilities. Some Army installations operate their own wastewater-treatment plants (regulated under their site-specific permit), whereas other Army installations discharge to the surrounding community's municipal treatment plant. These 'indirect' discharges to the municipal wastewater-treatment plant may also be regulated under site-specific 'pretreatment' permits. Based on data from 2015, Army installations held a total of 778 CWA permits (DA 2016a).

For surface waterbodies that are WOTUS (or waters of the state), the state will have designated water uses that may include public water supply, protection and propagation of fish, shellfish, and wildlife, recreation, and other uses (e.g., agriculture, industrial, and navigation). Some manmade waterbodies may have other specific uses, such as stormwater management, water treatment, and Army mission uses (e.g., training and vehicle washing).

4.7.2 Environmental Consequences

Factors considered when determining whether an alternative would have a significant effect on water resources were evaluated and distinguished by the degree to which the construction and operation of a floating solar array would impact physical, chemical, or biological measures of water quality, and would impact the availability of water for current and future uses. The potential effect of an alternative on flooding was also considered, but determined to be negligible for a floating solar array. In general, the ROI encompasses the watershed in which the proposed floating solar array would potentially be located, and the aquifer(s) beneath the installation which could potentially be impacted by the project. The largest potential for impacts would be to the waterbody on which the floating solar array is located and any connected waterbodies, including adjacent wetlands and the surficial aquifer.

A significant impact to water resources would occur if the proposed action resulted in a detrimental change in surface-water impairment status, a detrimental change impacting potable groundwater, or an impairment to the existing designated use(s) of surface waterbodies or groundwater aquifers. A significant impact would also occur if the proposed action resulted in unpermitted direct impacts to jurisdictional wetlands or other WOTUS.

4.7.2.1 No Action Alternative

There would be no impacts to water resources as a result of the no action alternative because there would be no construction activities.

4.7.2.2 Alternative 1: Wastewater

Alternative 1 is the construction and operation of a floating solar array on a waterbody used for treating water quality, typically a wastewater-treatment pond or lagoon (also known as a stabilization pond). These waterbodies are manmade and relatively shallow (typically 1 to 15 ft in depth), with controlled discharges subject to water-quality and water-monitoring requirements, as specified by state- or locally issued permits (DA and USAF 1988; EPA 2011). Wastewater-treatment ponds may be aerobic, anaerobic, or a combination of the two (facultative), with waste stabilization provided primarily by bacteria and algae in the pond. Ponds may be aerated and/or mixed, and may be lined to limit seepage.

Construction of a floating solar array on a water/wastewater pond or lagoon would likely involve use of temporary structures adjacent to the waterbody for storage and assembly of floating solar array components and some temporary, near-shore, in-water structures for deploying the assembled system. A variety of storage, assembly, and deployment structures could be used. The type of structures and the area disturbed during construction would depend on the site-specific nature of the shoreline and the waterbody, and on the size of the assembled floating solar array. It is expected that floating solar array assembly and deployment procedures would result in a disturbed area that is much smaller than the area of the final assemble array. A chemically treated water/wastewater pond or lagoon may have specific features to consider, such as a “shoreline” that consists of a berm, and a bottom liner, both of which would need to remain undamaged during construction. Vehicle access to the construction area would be required for transportation of personnel and delivery of system components. Boat access could be required for towing array components to the final location.

Construction activities for a floating solar array would likely require near-shore vegetation removal and possibly some grading, excavation, and road construction. Vegetation removal could result in altered drainage patterns, runoff, erosion, and sedimentation. Ground disturbance from any grading, excavation, road construction, and related construction traffic could also alter drainage patterns, increase erosion, and result in runoff and sediment reaching nearby surface waters. These impacts would be expected to be localized to the vicinity of the construction area. During construction, water could be required for dust control in the area of disturbed ground. Using methods from BLM-DOE (2010), the daily rate of water use for this purpose is expected to be less than 3 gal/100 ft^2. Actual water use would depend on the weather during construction, but would be expected to be minor due to the relatively small disturbed area.

Near-shore in-water structures would likely rest on the bottom of the pond or lagoon without requiring any dredging, pile driving, or other in-water construction methods. Sediments would be disturbed during construction of the in-water structures and during removal of the structures following deployment of the floating solar array. These impacts would be expected to be localized to the area of the in-water structures. Appropriate installation and removal procedures for the in-water structures would likely be used to avoid damage to banks and the pond liner, if present.

Removal of vegetation and disturbance of surface soils during construction could alter the volume and rate of water infiltrating into the ground, and potentially affect recharge of the surficial aquifer. These impacts would likely be negligible, however, because of the small area affected. In addition, EISA and

Army policy require that site development for all projects of 5,000 ft^2 or greater retain the predevelopment site hydrology.

Surface-water and groundwater quality could potentially be impacted during construction by inadvertent spills of liquid contaminants (e.g., inadvertent spills of gasoline or oil from construction vehicles and boats), turbidity from installation activities involving sediment disturbance, or from fugitive dust from nearby land-based construction activities.

A floating solar array would need to be anchored to either the bottom of the waterbody or to land along the banks of the waterbody. The specific type of anchoring would depend on the soils/rock at the bottom and on the banks of the waterbody (see Section 4.6, Geology and Soils), the depth of water, the geometry of the banks, and the presence of a liner. If the waterbody is lined, shoreline anchoring would be required. Bottom anchoring would disturb sediments in the vicinity of the anchor points. The extent of the disturbance would depend on the specific design of the anchor. Shoreline anchoring would result in ground disturbance in the vicinity of the anchor. Any resulting erosion, runoff, or sedimentation would likely be minor due to the small area disturbed.

Electrical connections must be made from a floating solar array to land-based facilities. Cables could be supported by floats or allowed to rest on the bed of the waterbody. Some trenching could be required at the point where the cables transition from water to land. This could involve minor near-shore dredging and excavation immediately adjacent to the waterbody. Erosion and sedimentation could occur as a result, but this impact would be localized to the area of the trenching. Installation of ancillary power control systems and transmission may occur in a floodplain. Methods to minimize, restore, and preserve floodplain function should be considered (EO 11988; EO 13690). Other design components that should be considered include elevation of land-based structures at or above the 100-year water surface elevation, meeting safety requirements related to electrical components, and meeting safety and structural requirements related to ancillary structures (FEMA 2015). Consequently, impacts to floodplains as a result of the proposed action are anticipated to range from none to minor.

For a fixed volume of water in a wastewater-treatment pond, the buoyancy of a floating solar array would displace some of the water and raise the average water level in the pond. Assuming each array module and the associated floats, hardware, and electrical components weighs 100 lb, an array module would displace about 1.6 ft^3 of water per panel. A 1 MW array with about 3,500 panels would displace about 0.22 in. of water over the 7 ac required. The average water level change over the entire pond would be less than this depending on the fraction of the pond area covered by the floating solar array. The impact of this change in water level would be negligible.

Impacts to water resources from construction of a floating solar array are anticipated to be negligible to minor by designing the site to minimize the size of disturbed areas, implementing environmental protection measures, such as BMPs to reduce or eliminate sedimentation and manage stormwater, keeping vehicles, boats, and construction equipment in good working condition (e.g., to prevent spills or leaks), and adhering to construction permit requirements (Table 7). Methods and procedures described in the applicable SWPPP and spill-prevention, control, and countermeasures plan would be followed, as required. Site design applies to the array field and, if needed, supporting infrastructure such as an ESS, microgrid-based systems, transmission and distribution lines, and sub or switching stations. Impacts resulting from construction activity would be short-term. Following deployment of the floating solar array, the temporary structures used for construction could be removed and the disturbed ground surface could be revegetated to mitigate ongoing erosion and sedimentation.

Table 7. Summary of Alternative 1 Actions, Impacts, and Mitigation Strategies[(a)] on Water Resources

Action	Impact	Mitigation	Impact Determination
Construction	Altered drainage, erosion, runoff, sedimentation, and floodplain alteration	Timing (avoid rainy/windy season); revegetation management; SOPs/BMPs; avoidance or minimization of floodplain fills, grading, and compaction (FEMA 2015)	Moderate; minor with mitigation
	Disturbance of sediments	Limit area affected; careful site and anchoring design; use BMPs for any required dredging or trenching	Moderate; minor with mitigation
	Degradation of water quality from inadvertent spills	Vehicle and boat maintenance; BMPs	Moderate, minor with mitigation
	Damaged liner	Avoid bottom anchoring when a liner is present; use appropriate procedures near-shore for in-water structures and boat launch	Moderate; negligible with mitigation
	Change in water depth from buoyancy of floats	None	Negligible
	Change in infiltration and groundwater recharge	None	Negligible
Operation	Shading – alterations in water treatment	Modify operation of wastewater-treatment plant components and processes; may not be appropriate for all treatment ponds/lagoons	Significant; possibly moderate or minor with mitigation, if practical
	Reduction in water temperature – alteration in water treatment	Modify operation of wastewater-treatment plant components and processes	Moderate; possibly minor with mitigation, if practical
	Reduction in air flow at water surface and water surface area exposed to air – alters mixing and oxygen diffusion	Modify operation of wastewater-treatment plant components and processes	Significant; possibly moderate or minor with mitigation, if practical
	Alter discharge water quality	Meet conditions of discharge permit; alter permit conditions if needed	Moderate; minor with adherence to permit conditions
	Materials leach contaminants	Use nonhazardous PV panels and floats; maintain in good repair	Moderate; minor or negligible with mitigation
Maintenance	Ground disturbance, erosion, and sedimentation	BMPs	Moderate; negligible with mitigation
	Degradation of water quality from inadvertent spills	Vehicle and boat maintenance; BMPs	Moderate, negligible with mitigation
	Damaged liner or banks	Use appropriate procedures to avoid damage	Moderate; negligible with mitigation
	Degradation of water quality from cleaning floating solar arrays	Use only water from pond on which array is installed, or clean water from an external source; no chemical use	Negligible with mitigation
	Water use for cleaning floating solar arrays	Use water from waterbody on which the array is floating, if applicable	Minor to moderate; negligible with mitigation

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Potential water-resources impacts from operation and maintenance of a floating solar array on a water/wastewater pond or lagoon may result from interference with water-treatment processes. A floating solar array would significantly shade the water surface, reducing photosynthesis by algae. This would have effects on the algal growth, nutrient uptake, and oxygen production. The bacterial/algal pond ecosystem could be altered as a result, which might impact the overall efficiency of the pond's water treatment. The significance of this effect would depend on the fraction of the pond that is covered by the solar array. The shading caused by a floating solar array could reduce the water temperature beneath the array, which could affect temperature-dependent water-treatment processes. The significance of this effect would depend on the particular processes affected, the magnitude of cooling, the depth of the pond, and the amount of mixing in the pond. A floating solar array would block or reduce air flow at the water surface over the area of the array and in the downwind vicinity of the array. This would reduce wind-driven mixing and the diffusion of oxygen into the water from the air. Surface transfer of oxygen from air to water would also be reduced by a floating solar array due to the reduction in water surface area exposed to the air from the presence of the floats. The significance of impacts to water-treatment processes would have to be estimated using knowledge of the specific processes operating at a site.

Operation of a floating solar array on a wastewater-treatment pond would not alter the permit requirements for the water quality of the discharge, which would still have to be met. A pond would typically be one component of a wastewater-treatment plant, and it could be possible to adjust other component processes to compensate for the water-treatment process impacts resulting from the floating solar array operation. The operation of a floating solar array could trigger changes in the discharge permit, such as additional monitoring and reporting requirements and changes to the schedule or rates of discharges. If the discharge water quality were altered by the operation of the floating solar array, changes in the use of the treated water could be required.

Traditional silicon panels in good repair would be unlikely to leach any contaminants that would adversely affect water quality. These panels are generally considered nonhazardous during recycling or disposal and would pose a small risk to water quality if damaged. Thin-film PV panels contain hazardous materials that could contaminate water if released. This report assumes that thin-film PV panels would not be used in a floating solar array.

Floats are expected to be made of durable plastic, such as high-density polyethylene (HDPE). Plastics are commonly used in drinking water distribution pipes and in food packaging, and have generally been considered non-toxic. However, various chemicals are added to the plastics to improve mechanical characteristics and resist degradation. These chemicals have been shown to leach from the plastic pipes into water, and could pose a health risk at sufficiently high concentrations (Stern and Lagos 2008). Endocrine disrupting chemicals are of the greatest concern for plastics in contact with food and drinking water. Leaching of chemicals is often accelerated when plastics are exposed to stresses such as ultraviolet radiation in sunlight (Yang et al. 2011). Among the various types of plastics, HDPE is thought to be of low risk (Halden 2010). Compared to food containers or drinking water pipes, the ratio of water volume to plastic surface area is much larger for the floating solar array, which would tend to reduce the average concentrations of any leached chemicals. With floats kept in good repair, leaching from the plastic would have a minor effect on water quality (Table 7).

Maintenance activities for a floating solar array include periodic inspection and repair of float components for misalignment, wear, and buoyancy; PV panels for alignment and damage; anchor points and anchoring cables; and electrical cables and connections. Potential effects of floating solar array maintenance activities include ground disturbance from maintenance vehicles servicing the facility, and spills or leaks from maintenance vehicles and equipment. Environmental protection measures, including BMPs, would mitigate these potential impacts. Maintenance vehicles would avoid shorelines and, where feasible, stay on hard surface or gravel roads. If boats are used to access the solar array island, launch locations and procedures would be chosen to minimize damage to banks and pond liners. Maintenance vehicles and equipment, including boats used to access the solar array island, would be maintained in good working condition. By implementing these environmental protection measures, impacts would be negligible to minor. Repairs completed on the floating solar island would not likely involve the use of any potential water contaminants and would not result in any impacts on water resources.

Floating solar array panels must be cleaned periodically. Water obtained from the waterbody on which the array was operating could be used for cleaning, if suitable. For floating solar arrays on wastewater-treatment ponds, however, the water quality may not be suitable, for example, due to excessive total suspended solids. In this case, an external source of water would have to be used for cleaning panels. It is anticipated that panel washing would generally use only water and no cleaning chemicals, in which case impacts on water quality from cleaning the solar panels would be negligible to minor. If specific circumstances required additives to be used to achieve panel cleaning, the effects on water quality would have to be evaluated on a case-by-case basis.

Panel washing frequency would be a function of local precipitation frequency, dust levels, and degree of air pollution; but, on average, modules could be washed one to four times a year. Estimates of water use for washing floating solar arrays include 16,000 gal/MW/yr (BLM-DOE 2010), a range of 0 to 30 gal/MWhr (Klise et al. 2013), and 20 gal/MWhr (SEIA 2010). Using the latter estimate and information on the range of capacity factor values for solar PV projects (Bollinger, et al. 2016), 1 MW of installed floating solar generating capacity (DC) would use about 27,000 to 39,000 gal of water annually for cleaning (i.e., about 10 gal/panel). This is comparable to the average individual's home water use in the United States (i.e., about 100 gal [379 L] per day per person [EPA, 2008]), and would be equivalent to about 0.2 in. of precipitation over the array area (assuming 7 ac/MW). Larger solar PV facilities would require a corresponding increase in the volume of water used for washing. For example, a 10 MW facility generating 24,000 MWh per year would require approximately 480,000 gal (1.8 million L) of water annually for washing. Water use for the typical Army installation is measured in millions of gallons per day, so the water needed for washing solar PV modules would be comparatively small, even for a large floating array. Therefore, the impact of panel washing on the availability of water is anticipated to be minor in most cases, even when the water for cleaning the modules is not obtained from the waterbody on which the solar array is floating. For installations in areas where water resources are limited or constrained by existing uses and water for washing must be trucked in, impacts on water availability may range up to moderate, particularly for a large solar facility, and may require mitigation as appropriate. If water for panel washing is obtained from the waterbody on which the solar array is floating, the impact of panel washing on the availability of water would be negligible (Table 7).

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.7.2.3 Alternative 2: NWOTUS

Alternative 2 is the construction and operation of a floating solar array on a waterbody that is not a WOTUS (and also does not fall into the Alternative 1 category). As described above, such waterbodies would include various types of artificial lakes and ponds constructed or created in dry land. These would include stormwater-management ponds (created in dry land) and ponds or basins used for infiltration of treated wastewater. Vehicle wash ponds on Army installations would be included in this alternative (unless they were not created in dry land). Waterbodies in Alternative 2 are manmade, of varying depth (but likely to be relatively shallow), and might be periodically dry. Discharges from Alternative 2 waterbodies would be subject to some degree of control (e.g., by design). Discharges from some of these waterbodies (e.g., some stormwater-management ponds and wastewater-recycling ponds) would be subject to water-quality and water-monitoring requirements, as specified by state- or locally issued permits. These waterbodies may be lined or unlined.

Construction of a floating solar array on a waterbody that is not WOTUS would involve the same set of activities as described for Alternative 1, including construction of ancillary power systems. Construction would likely involve use of temporary structures adjacent to the waterbody for storage and assembly of floating solar array components and some temporary, near-shore, in-water structures for deploying the assembled array. Near-shore vegetation removal and possibly some grading, excavation, and road construction would be required. Vehicle access to the construction area would be required for transportation of personnel and delivery of system components. Boat access could be required for towing array components to the final location. Anchoring of the floating solar array would be needed, either to the bottom of the waterbody or to land along the banks of the waterbody. If the waterbody is lined, shoreline anchoring would be required. Electrical connections from the floating solar array to land-based facilities could require minor near-shore dredging and excavation immediately adjacent to the waterbody. Ground disturbance from vegetation removal, grading, excavation, road construction, and related construction traffic could alter drainage patterns, increase erosion, and result in runoff and sediment reaching nearby surface waters, but these impacts are expected to be localized to the vicinity of the construction area and mitigated by the use of environmental protection measures, including BMPs. Near-shore, in-water structures would disturb sediments locally, but are not expected to require any dredging, pile driving, or other in-water construction methods. Appropriate installation and removal procedures for the in-water structures are expected to be used to avoid damage to banks and the waterbody liner, if present. As with Alternative 1, impacts to infiltration and groundwater recharge are expected to be negligible because of the small land area affected by construction. Surface-water- and groundwater-quality impacts from inadvertent spills of liquid contaminants would be mitigated by maintenance of vehicles and boats and adherence to environmental protection measures. Turbidity impacts from anchor installation, either sediment disturbance for bottom anchors or erosion from shoreline anchoring, would be minor due to the small area disturbed. Similarly, erosion and sedimentation resulting from near-shore dredging and excavation for the electrical connection to land-based facilities would be localized to the area of the trenching and further minimized through the use of BMPs. Impacts resulting from construction activity would be short-term because the temporary structures used for construction would be removed and the disturbed ground surface would be revegetated to mitigate ongoing erosion and sedimentation. As discussed for Alternative 1, the impact of a floating solar array on the water level of a closed waterbody would be negligible (Table 8). Similar to Alternative 1, installation of ancillary power control systems and transmission may occur in a floodplain. Methods to minimize, restore, and preserve floodplain function should be considered (EO 11988; EO 13690). Other design components that should be considered include elevation of land-based structures at or above the 100-year water surface elevation, meeting safety requirements related to electrical components, and meeting safety and structural requirements related to ancillary structures (FEMA 2015). Consequently, impacts to floodplains as a result of the proposed action are anticipated to range from none to minor.

Potential water-resources impacts from operation and maintenance of a floating solar array on a waterbody that is not WOTUS would arise from similar factors as discussed for Alternative 1. A floating solar array would significantly shade the water surface, reducing the water temperature beneath the array. The floating array would also block or reduce air flow at the water surface over the area of the array and in the downwind vicinity of the array, and reduce the water surface area exposed to the air due to the presence of the floats. The effects of these alterations would be similar to those described for Alternative 1: reduced photosynthesis, changes in biochemical processes and the waterbody ecosystem, reduction of wind-driven mixing, and reduction of the surface transfer of oxygen from the air into the water. It is also expected that the reductions in temperature, air flow, and surface area would reduce the average evaporation rate from the waterbody, which would likely be a beneficial impact in most cases. The magnitude of these effects would depend on a number of factors, such as the size of the floating solar array, the degree of shading caused by the array, the depth of the waterbody, and the existing waterbody ecosystem (Table 8).

Table 8. Summary of Alternative 2 Actions, Impacts, and Mitigation Strategies[a] on Water Resources

Action	Impact	Mitigation	Impact Determination
Construction	Altered drainage, erosion, runoff, sedimentation, and floodplain alteration	Timing (avoid rainy/windy season); revegetation management; SOPs/BMPs; avoidance or minimization of floodplain fills, grading, and compaction (FEMA 2015)	Moderate; minor with mitigation
	Disturbance of sediments	Limit area affected; careful site and anchoring design; use BMPs for any required dredging or trenching	Moderate; minor with mitigation
	Degradation of water quality from inadvertent spills	Vehicle and boat maintenance; BMPs	Moderate, minor with mitigation
	Damaged liner	Avoid bottom anchoring when a liner is present; use appropriate procedures near-shore for in-water structures and boat launch	Moderate; negligible with mitigation
	Change in water depth from buoyancy of floats	None	Negligible
	Change in infiltration and groundwater recharge	None	Negligible
Operation	Shading – reduction in photosynthesis and temperature leading to water-quality changes	Monitor changes in water quality; meet conditions of discharge permit, when applicable; alter permit conditions if needed	Moderate; minor with adherence to permit conditions
	Reduction in air flow at water surface and water surface area exposed to air – alters mixing and oxygen diffusion leading to water-quality changes	Monitor changes in water quality; meet conditions of discharge permit, when applicable; alter permit conditions if needed	Moderate; minor with adherence to permit conditions
	Materials leach contaminants	Use nonhazardous PV panels and floats; maintain in good repair	Moderate; minor or negligible with mitigation
Maintenance	Ground disturbance, erosion, and sedimentation	BMPs	Moderate; negligible with mitigation
	Degradation of water quality from inadvertent spills	Vehicle and boat maintenance; BMPs	Moderate, negligible with mitigation
	Damaged liner or banks	Use appropriate procedures to avoid damage	Moderate; negligible with mitigation
	Degradation of water quality from cleaning floating solar arrays	Use only water from pond on which array is installed, or clean water from an external source; no chemical use	Negligible with mitigation
	Water use for cleaning floating solar arrays	Use water from waterbody on which the array is floating, if applicable	Minor to moderate; negligible with mitigation

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Because a waterbody in Alternative 2 would not be used as an active component of a wastewater-treatment train, the use of water would be less sensitive to the effects of a floating solar array. In most cases a waterbody in Alternative 2 would be used primarily for storing water for subsequent release to surface waters (in the case of stormwater management), groundwater (in the case of wastewater recycling), or specific Army installation uses, such as vehicle washing. Operation of a floating solar array on a stormwater-management or wastewater-recycling pond would not alter any permit requirements for the water quality of the discharge, which would still have to be met. However, additional monitoring and reporting could be required to verify that the operation of a floating solar array does not alter discharge water quality. Water used for Army activities (e.g., vehicle washing) has some practical water-quality requirements, but because these waterbodies are not WOTUS, they would not be subject to CWA requirements. As noted above, however, some states may regulate waters more broadly than defined under WOTUS. With the use of nonhazardous materials, and adequate maintenance to keep solar panels and floats in good repair, leaching of contaminants from the array and its components would have a minor effect on water quality.

Maintenance activities for a floating solar array would be the same as those described for Alternative 1, namely, periodic inspection and repair of all system components and periodic cleaning of the floating solar arrays. In addition, larger surface water areas may need episodic inspections following extreme weather events that may damage the array or its components. Potential effects of floating solar array maintenance activities include ground disturbance from maintenance vehicles servicing the facility and spills or leaks from maintenance vehicles and equipment. Environmental protection measures, including BMPs, would mitigate these potential impacts. Maintenance vehicles would avoid shorelines and, where feasible, stay on hard surface or gravel roads. If boats are used to access the solar array island, launch locations and procedures would be chosen to minimize damage to banks and pond liners, if applicable. For waterbodies that might be periodically dry, maintenance access could be over the dry bed of the waterbody. BMPs to minimize ground disturbance would still be applied in this case. Maintenance vehicles and equipment, including boats used to access the solar array island, would be maintained in good working condition. By implementing these environmental protection measures, impacts are anticipated to be negligible to minor. Repairs would not likely involve the use of any potential water contaminants and would not result in any water-resource impacts. Module washing would generally occur using water obtained from the waterbody on which the array is operating; in some cases, an external source of water could be required. It is anticipated that no cleaning chemicals would be used, so impacts on water quality from cleaning the solar panels would be negligible to minor. If specific circumstances required additives to be used to achieve panel cleaning, the effects on water quality would have to be evaluated on a case-by-case basis. As discussed for Alternative 1, floating solar arrays require small volumes of water for module washing relative to the typical water use of Army installations; therefore, the impact of module washing on the availability of water is anticipated to be negligible to minor in most cases (Table 8). For installations in areas where water resources are limited or constrained by existing uses and water for washing must be trucked in, impacts on water availability may range up to moderate, particularly for a large solar facility, and may require mitigation as appropriate.

As with Alternative 1, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.7.2.4 Alternative 3: WOTUS

Alternative 3 is the construction and operation of a floating solar array on a waterbody that is a WOTUS as defined in 40 CFR 122.2. As described above, WOTUS include all traditional navigable waters, tributaries, and impoundments of WOTUS, and adjacent waters, including wetlands (essentially all waters not included in Alternatives 1 or 2). Waterbodies in Alternative 3 are generally natural, but may be constructed (e.g., impoundments and some wetlands). They are of varying depth and might be periodically dry. They may include stormwater-management features when these are not created in dry land. WOTUS have designated uses and are subject to related water-quality standards. Alternative 3 waterbodies would generally be open, with discharges that are relatively uncontrolled. Discharges from some of these waterbodies (e.g., stormwater-management ponds) may be subject to water-quality and water-monitoring requirements, as specified by state- or locally issued permits. WOTUS waterbodies would not typically be lined. Unlike Alternatives 1 and 2, WOTUS include flowing waters (e.g., streams and rivers). WOTUS also include near-shore coastal waters, estuaries, and the Great Lakes. Construction and operation of a floating solar array on these coastal waters may be subject to requirements of state coastal-management programs established under the CZMA (16 USC § 1451 et seq.).

For this report it was assumed that operation of a floating solar array on wetlands would be infeasible due to the relative lack of open water and restrictions on wetlands development. However, potential impacts to wetlands adjacent to a WOTUS should be considered during construction of a floating solar array. If possible, construction facilities should be located on a WOTUS shoreline where wetlands would not be affected. If construction of a floating solar array would result in the discharge of fill to any wetlands, this activity would require a CWA Section 404 permit. Stormwater discharges to wetlands would be regulated as part of an NPDES permit.

Deploying a floating solar array on a stream or river would be feasible, but would need to consider additional factors. The anchoring system would need to accommodate the additional forces generated by the flowing water. Depending on the design of the anchors and floats, there would be some practical upper limit on water velocity to allow for safe operation of a floating solar array. In addition, the width of the solar array island would need to be a small fraction of the width of the river to avoid impeding flow. There are also related design factors that would apply to all Alternative 3 waterbodies. The floating solar array would need to be designed to withstand the effects of wind-driven waves. Tidal effects and storm surge would be additional considerations for some waterbodies. Construction and operation of a floating solar array on a WOTUS would also be subject to state and/or federal permits for structures that affect navigation and desired recreational activities (e.g., boating and fishing). These permits would likely cover the installation of anchors and mooring lines. Permits could restrict the area, dimensions, and location of an array and the type and location of anchors to reduce or prevent impacts to navigation.

Construction of a floating solar array on a waterbody that is WOTUS would involve the same set of activities as described for Alternative 1. Construction would likely involve use of temporary structures adjacent to the waterbody for storage and assembly of floating solar array components and some temporary, near-shore, in-water structures for deploying the assembled array. Near-shore vegetation removal and possibly some grading, excavation, and road construction would be required. Vehicle access to the construction area would be required for transportation of personnel and delivery of system components. Boat access could be required for towing array components to the final location. Anchoring of the floating solar array would be needed, either to the bottom of the waterbody or to land along the banks of the waterbody. Very deep waterbodies could require special anchor designs. Electrical connections from the floating solar array to land-based facilities could require minor near-shore dredging and excavation immediately adjacent to the waterbody.

Ground disturbance from vegetation removal, grading, excavation, road construction, and related construction traffic could alter drainage patterns, increase erosion, and result in runoff and sediment reaching nearby surface waters. These construction activities could be subject to NPDES permitting requirements for stormwater discharges. Impacts would be localized to the vicinity of the construction area and mitigated by the use of environmental protection measures, including BMPs. Near-shore in-water structures would disturb sediments locally, but are not expected to require any dredging, pile driving, or other in-water construction methods. These activities could be subject to state approval. Appropriate installation and removal procedures for the in-water structures would be used to avoid damage to banks and the waterbody liner, if present. Impacts to infiltration and groundwater recharge would be negligible because of the small land area affected by construction. Surface-water and groundwater-quality impacts from inadvertent spills of liquid contaminants would be mitigated by maintenance of vehicles and boats and adherence to environmental protection measures. Turbidity impacts from anchor installation, either sediment disturbance for bottom anchors or erosion from shoreline anchoring, would be minor due to the small area disturbed. As discussed above, anchor installation and floating solar array mooring could require state and federal approval. Some waterbodies may have been used in the past for disposal of various Army installation waste, which could be disturbed during bottom anchor installation. Bathymetric studies and surveys of the waterbody bed could be needed to ensure that uncontaminated areas are used for anchor placement. Erosion and sedimentation resulting from near-shore dredging and excavation for the electrical connection to land-based facilities would be localized to the area of the trenching and further minimized through the use of environmental protections measures, including BMPs. This construction activity would also be included in the NPDES permit for the project. Dredging could also require a permit from the appropriate state authority. Impacts resulting from construction activity would be short-term because the temporary structures used for construction would be removed and the disturbed ground surface would be revegetated to mitigate ongoing erosion and sedimentation. As discussed for Alternative 1, the impact of a floating solar array on the water level of a closed waterbody would be negligible, and would be nonexistent on the open waterbodies of Alternative 3 (Table 9).

Similar to Alternatives 1 and 2, installation of ancillary power control systems and transmission may occur in a floodplain. Methods to minimize, restore, and preserve floodplain function should be considered (EO 11988; EO 13690). Other design components that should be considered include elevation of land-based structures at or above the 100-year water surface elevation, meeting safety requirements related to electrical components, and meeting safety and structural requirements related to ancillary structures (FEMA 2015). Consequently, impacts to floodplains as a result of the proposed action are anticipated to range from none to minor.

Waterbodies in Alternative 3 include streams, rivers, ponds, lakes, reservoirs, and near-shore coastal waters. Designated uses for these waterbodies could include water supply (including drinking water), propagation of fish, shellfish, and wildlife, recreation, navigation, and possibly other uses (e.g., aesthetics) as determined by the states. Water-quality standards, specified by the states, would depend upon the designated uses for the waterbodies. Potential water-resources impacts from operation and maintenance of a floating solar array on a waterbody that is WOTUS would arise from similar factors as discussed for Alternatives 1 and 2. Impacts of a floating solar array would correspond to the extent to which the operation of the array degraded water quality. During normal operation of a floating solar array, no discharges of contaminants to water are expected. A floating solar array would significantly shade the water surface, which could reduce the water temperature beneath the array. This would generally be considered a beneficial effect for a WOTUS. A floating solar array would block or reduce air flow at the water surface over the area of the array and in the downwind vicinity of the array and reduce the water surface area exposed to the air due to the presence of the floats. The effects of these alterations would be similar to those described for Alternatives 1 and 2: reduced photosynthesis, potential changes in biochemical processes and the waterbody ecosystem, reduction of wind-driven mixing, and reduction of the surface transfer of oxygen from the air into the water. These biochemical effects could moderately impact the use of WOTUS for water supply and propagation of fish and wildlife. The magnitude of these impacts would depend on a number of factors, such as the size of the floating solar array relative to the size of the waterbody, the degree of shading caused by the array, the depth and velocity of the waterbody, and the existing waterbody ecosystem. Compared to Alternative 2, these impacts could be less significant for WOTUS because the larger flow velocities and water circulation expected in the open WOTUS waterbodies would tend to increase mixing and reduce temperature and biochemical gradients. It could be possible to alter float design or array location to mitigate some of the water-quality effects. Monitoring could be required to verify that the operation of a floating solar array does not alter water quality. The effects of floating solar array operation on water quality would likely not be large enough to affect other designated water uses. The reductions in temperature, air flow, and surface area from the operation of a floating solar array would reduce the average evaporation rate from the waterbody, which would likely be a beneficial impact for WOTUS. With the use of nonhazardous materials, and adequate maintenance to keep solar panels and floats in good repair, leaching of contaminants from the array and its components would have a minor effect on water quality (Table 9).

Table 9. Summary of Alternative 3 Actions, Impacts, and Mitigation Strategies[(a)] on Water Resources

Action	Impact	Mitigation	Impact Determination
Construction	Discharge to wetlands	Avoid construction near wetlands; adherence to CWA Section 404 and NPDES permit requirements; SOPs/BMPs	Significant if construction occurs in wetlands; moderate to minor with mitigation
	Altered drainage, erosion, runoff, sedimentation, and floodplain alteration	Timing (avoid rainy/windy season); revegetation management; adherence to NPDES permit requirements; SOPs/BMPs; and avoidance or minimization of floodplain fills, grading, and compaction (FEMA 2015)	Moderate; minor with mitigation
	Disturbance of sediments	Limit area affected; bathymetric and water bed surveys used to site anchors in uncontaminated areas; adherence to state permit requirements; use BMPs for any required dredging or trenching	Moderate; minor with mitigation
	Degradation of water quality from inadvertent spills	Vehicle and boat maintenance; BMPs	Moderate, minor with mitigation
	Change in water depth from buoyancy of floats	None	Negligible
	Change in infiltration and groundwater recharge	None	Negligible
Operation	Shading – reduction in water temperature	None	Generally beneficial
	Reduction in photosynthesis, water surface air flow, and water surface area exposed to air – alters mixing and oxygen diffusion leading to water-quality changes	Modify float design or array location; monitor changes in water quality	Moderate to minor depending on site-specific conditions and designated water uses
	Materials leach contaminants	Use nonhazardous PV panels and floats; maintain in good repair	Moderate; negligible with mitigation
	Impeding water flow	Design array to limit flow blockage. Inspect array and remove debris	Moderate; minor with mitigation
	Interference with navigation	Locate array outside navigation channels; adherence to state or federal permit requirements	Significant to minor with mitigation
	Interference with recreation	Locate array outside recreation areas; adherence to state permit requirements	Significant to minor with mitigation
Maintenance	Ground disturbance, erosion, and sedimentation	BMPs	Moderate; negligible with mitigation
	Degradation of water quality from inadvertent spills	Vehicle and boat maintenance; BMPs	Moderate, negligible with mitigation
	Damaged liner or banks	Use appropriate procedures to avoid damage	Moderate; negligible with mitigation
	Degradation of water quality from cleaning floating solar arrays	Use only water from pond on which array is installed, or clean water from an external source; no chemical use	Negligible with mitigation
	Water use for cleaning floating solar arrays	Use water from waterbody on which the array is floating, if applicable	Minor to moderate; negligible with mitigation

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Maintenance activities for a floating solar array would be similar to those described for Alternatives 1 and 2, namely, periodic inspection and repair of all floating solar components, including inspection of floats for accumulated debris, episodic inspections following extreme weather events, and periodic cleaning of the floating solar arrays. Potential effects of floating solar array maintenance activities include ground disturbance from maintenance vehicles servicing the facility, and spills or leaks from maintenance vehicles and equipment. Environmental protection measures, including BMPs, would mitigate these potential impacts. Maintenance vehicles would avoid shorelines and, where feasible, stay on hard surface or gravel roads. If boats are used to access the solar array island, launch locations and procedures would be chosen to minimize damage to banks and pond liners, if applicable. Maintenance vehicles and equipment, including boats used to access the solar array island, would be maintained in good working condition. By implementing these environmental protection measures, impacts to water quality are anticipated to be negligible to minor. Repairs would not likely involve the use of any potential water contaminants and would not result in any water-quality impacts. Module washing is anticipated to occur using water obtained from the waterbody on which the array is operating except in rare cases where an external source of water would be used. It is anticipated that no cleaning chemicals would be used, so impacts on water quality from cleaning the solar panels would be negligible to minor. If specific circumstances required additives to be used to achieve panel cleaning, the effects on water quality would have to be evaluated on a case-by-case basis and their use would be included in a discharge permit. As discussed for Alternative 1, floating solar arrays require small volumes of water for module washing relative to the typical water use of Army installations; therefore, the impact of module washing on the availability of water is anticipated to be negligible to minor in most cases (Table 9). For installations in areas where water resources are limited or constrained by existing uses and water for washing must be trucked in, impacts on water availability may range up to moderate, particularly for a large solar facility, and may require mitigation as appropriate.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.8 Biological Resources

Biological resources refer to living attributes of the environment, including native and non-native plants, animals, and microorganisms and their associated habitats. Biological resources on Army installations are protected by federal laws and regulations, such as the Sikes Act (16 USC § 670 et seq.), CZMA (16 USC § 1451 et seq.), Endangered Species Act (ESA; 16 USC § 1531 et seq.), Magnuson-Stevens Fishery Conservation Management Act (MSA; 16 USC § 1801 et seq.), Marine Mammal Protection Act (MMPA; 16 USC § 1361 et seq.), Migratory Bird Treaty Act (MBTA; 16 USC § 703 et seq.), and the Bald and Golden Eagle Protection Act (BGEPA; 16 USC § 668 et seq.). State laws and regulations governing biological resources may apply to some floating solar installation projects and activities and should be considered when evaluating impacts and considering mitigation strategies. On Army installations, AR 200-1 is the primary Army Regulation for environmental responsibilities, including management of biological resources. AR 200-1 provides guidance to ensure the sustainability, conservation, and protection of biological resources on Army installations to enable compliance with applicable federal and state statutes and regulations and support military missions and operations (DA 2007). Laws and regulations considered when analyzing the potential impacts of the proposed action on biological resources include the following:

- **The Sikes Act** (16 USC § 670 et seq.)**:** Under the Sikes Act, all DoD installations that hold land with significant natural resources are required to have an INRMP. INRMPs are prepared in cooperation with the USFWS and state fish and wildlife agencies to ensure proper consideration of fish, wildlife, and habitat needs. INRMPs must be reviewed annually and modified as needed. In addition, if circumstances have changed, the Sikes Act requires INRMPs to be reviewed every five years by the USFWS and the corresponding state agency. Public input is requested during this 5-year review. This regulation may be applicable to all alternatives discussed.

- **The Coastal Zone Management Act** (16 USC § 1451 et seq.): The CZMA was passed in 1972 to preserve, protect, develop, and where possible restore or enhance coastal zone resources, including the Great Lakes. Resources include, wetlands, floodplains, estuaries, beaches, barrier islands, coral reefs and associated fish and wildlife and their habitats within the coastal zone. The CZMA requires that activities of federal agencies that are likely to affect coastal zones to adhere to applicable state-approved coastal-management plan(s) to the maximum extent practical. See Section 4.7, *Water Resources* for further discussion. This regulation is likely only applicable for Alternatives 2 and 3, NWOTUS and WOTUS, respectively.
- **The Endangered Species Act** (16 USC § 1531 et seq.): The ESA was passed in 1973 to protect and recover animal and plant species in danger of extinction and their associated habitats. Under ESA, take of a listed species (i.e., threatened or endangered) is not allowed without an incidental take permit. "Take" is broadly defined to include harassing, killing, and habitat modification. Federal agencies are prohibited to authorize, fund, or carry out actions that are likely to jeopardize the continued existence of listed species or modify their critical habitat. Candidate species are identified when a petitioned species is actively being considered for listing as endangered or threatened. ESA is administered jointly by the USFWS and the National Marine Fisheries Service (NMFS), with USFWS having primary responsibility for terrestrial and freshwater organisms and NMFS having primary responsibility for marine wildlife and anadromous fish (e.g., salmon). This regulation will be applicable to all alternatives discussed.
- **The Magnuson-Stevens Fishery Conservation Management Act** (16 USC § 1801 et seq.**)**: The purpose of the MSA is to conserve and manage coastal and anadromous fishery resources, including finfish, mollusks, crustaceans, and all other marine animal and plant life but excluding marine mammals and birds, and to promote the protection of Essential Fish Habitat (EFH). EFH refers to habitat (waters and substrate) necessary for managed fish species to complete their life-cycle (i.e., spawning, breeding, feeding, and maturation). Federal agencies are prohibited from authorizing, funding, or carrying out an action that may adversely affect EFH- or MSA-managed species and must consult with NMFS. A fishery management plan must be used to manage EFHs. This regulation is likely only applicable to Alternative 3, WOTUS.
- **The Marine Mammal Protection Act** (16 USC § 1361 et seq.): All marine mammals, including cetaceans, pinnipeds, sirenians, sea otters, and polar bears, are protected under the MMPA, a law that prohibits the "take" of marine mammals in WOTUS. Under the MMPA, certain exceptions exist for select Alaska Native practices and scientific research, which is regulated by the NMFS. This regulation is likely only applicable to Alternative 3, WOTUS.
- **The Migratory Bird Treaty Act and Migratory Birds** (16 USC § 703 et seq.): Under the MBTA, it is unlawful to "pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported … any migratory bird…or any part, nest, or egg of any such bird" without a federal permit. The migratory bird species protected by the MBTA are listed in 50 CFR 10.13. In addition to the MBTA requirements, federal agencies are directed under EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, to conserve migratory birds and to assess effects of their actions on migratory bird populations. Also, a 2006 memorandum of understanding between the DoD and USFWS (DoD and FWS 2006) requires DoD to review power line guidelines published by USFWS and the Avian Power Line Interaction Committee, respectively, and consult with USFWS as needed, in considering potential effects on migratory birds in proposals for locating power lines on military lands. This regulation is applicable to all alternatives discussed.

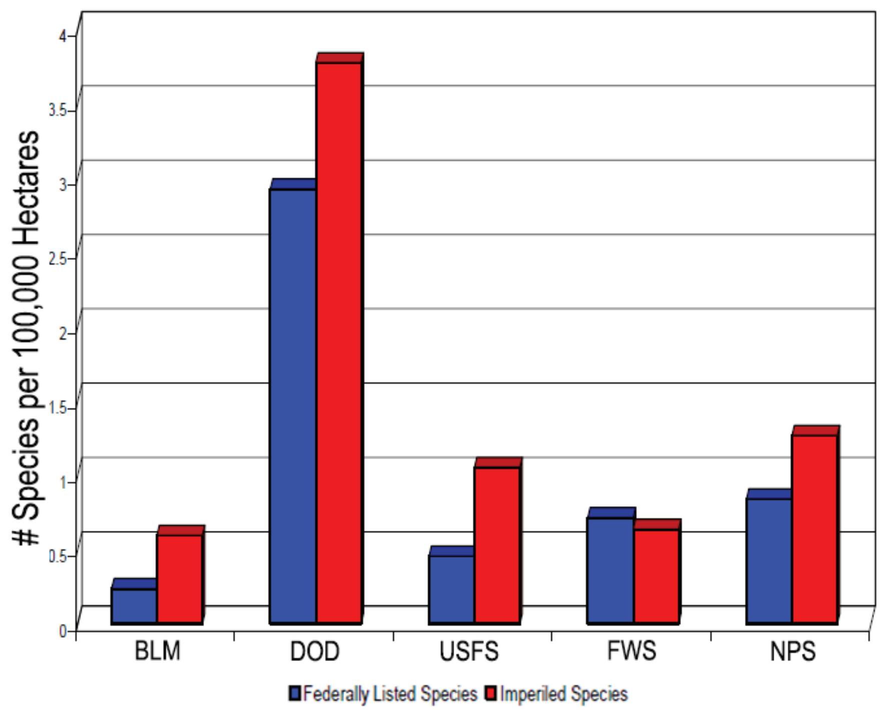
- **The Bald and Golden Eagle Protection Act** (16 USC § 668 et seq.): Under the BGEPA, taking, possessing, or selling an eagle or eagle part, is prohibited without a federal permit. Under BGEPA, "take" includes molest and disturb. As with MMPA, there are a few limited exceptions (e.g., for scientific research, exhibition, or Native American religious purposes). For bald eagles, the recommended nest avoidance zone is 330 to 660 ft (100.58 to 201.17 m) depending on the terrain and type of activity, according to the National Bald Eagle Management Guidelines implemented by USFWS (2007). For golden eagles, Army consultation with USFWS resulted in a recommended avoidance zone of 2,640 ft (804.67 m). This regulation and recommended avoidance zones are applicable to all alternatives discussed.
- **Birds of Conservation Concern (BCC):** The 1988 amendment to the Fish and Wildlife Conservation Act (16 USC § 2901 et seq.) mandated that the USFWS identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the ESA. BCC (USFWS 2008) was developed to carry out this mandate. The list consists of 147 species and includes some non-MBTA-protected species because of their conservation status and efforts of concern to the USFWS (2008). This regulation is applicable to all alternatives discussed.
- **Noxious, Invasive, and Pest Species:** Management practices for biological resources are influenced by noxious, invasive, and pest species. A noxious plant is any plant designated by a federal, state, or local government as injurious to public health, agriculture, recreation, wildlife, or property; is often growing out of place; and is competitive, persistent, and pernicious. Invasive species are organisms introduced into a non-native ecosystem and that cause, or are likely to cause, harm to the economy, environment, or human health. Invasive species degrade, change, or displace native habitats and compete with native wildlife and are thus harmful to fish, wildlife, and plant resources. Invasive species—whether insect, plant, or animal—often out-compete native species and upset the ecological balance. Invasive species may also directly impact military missions by "infesting open space needed for military operations; rendering training grounds hazardous with dense, spiny, flammable, or otherwise noxious vegetation; and reducing the extent of realistic training areas" (MSU, 2013-). The U.S. Department of Agriculture Animal and Plant Health Inspection Service defines a pest species as any biotic agent (any living agent capable of reproducing itself) that is known to cause damage or harm to agriculture of the environment. EO 13112, *Invasive Species*, defines an invasive species as a non-native species whose introduction does or is likely to cause economic, environmental, or human health harm. EO 13112 includes federal agency responsibilities to prevent the introduction of invasive species and to control populations of such species in a cost-effective and environmentally sound manner. The DA memo "Army Policy Guidance for Management and Control of Invasive Species" (DA 2001) provides guidance on implementing this EO. In addition, management of noxious, invasive, and pest species is in accord with each installation's Integrated Pest Management Plan (IPMP). This regulation is applicable to all alternatives discussed.
- **Wildland Fires:** Wildland fires may be initiated by natural events (e.g., lightning) or human activities (e.g., camp fires, hot vehicle mufflers, arson, and select military training activities) and are capable of causing loss of life, loss of property, or detrimental impacts to biological resources. The fire-management programs of federal land-holding agencies includes containing and responding quickly to wildland fires and, as appropriate, using prescribed fires and fire breaks to reduce potential fuel loads and thus the chances of catastrophic wildland fires, as specified in AR 200-1 (DA 2007). This regulation is applicable to all alternatives discussed.
- **Wetlands:** Wetlands are vital habitat for many plant and animal species. In addition, they play a role in water purification and flood control. Wetland protection measures, governed under the CWA (33 USC § 1251 et seq.) protect species that directly or indirectly depend on wetlands for all or part of their life cycle. Section 4.7, Water Resources, covers water quality for additional discussions on

wetlands and potential impacts. This regulation is likely only applicable for Alternatives 2 and 3, NWOTUS and WOTUS, respectively.

- **Areas of Conservation Importance:** Management practices for biological resources on Army installations may also be influenced by proximity to areas designated by local organizations to be of conservation importance, such as local parks, refuges, or Audubon-designated Important Bird Areas. This would be state- and installation-specific. This regulation is applicable to all alternatives discussed.

4.8.1 Existing Conditions

Army installations are located across the entire United States, including Hawaii and Alaska, thus biological resources are representative of those across the nation. Some wildlife species have a year-round presence on an installation while others are present only temporarily (e.g., for nesting or stopover on a migration route). Installations have planning-level surveys for many of the biological resources present, and more detailed surveys are completed as necessary for particular species or sites.



Source: NatureServe, 2008
BLM – Bureau of Land Management; DoD – Department of Defense; USFS – U.S. Forest Service; FWS – U.S. Fish and Wildlife Services; NPS – National Park Service

Figure 8. Density of Endangered and Imperiled Species on Federal Agency Lands.

On military lands, access limitations exist because of security and safety concerns. These access limitations have sheltered many habitats from development pressures and large-scale habitat loss. As a result, DoD lands contain a higher density of endangered and imperiled species than other federal lands (Figure 8), as well as some of the finest remaining examples of rare wildlife habitats (DoD 2015). As of February 2016, Army installations collectively had 223 federally listed species protected by the ESA (16 USC § 1531 et seq.) on 118 installations and 13 candidate species that may impact the military's mission on 20 installations (DA 2016a). Management of biological resources, including ESA-protected species and habitat, on each Army installation is guided by an INRMP. As a general matter, INRMPs prepared under the Sikes Act (16 USC § 670 et seq.) avoid designation of critical habitat under ESA; however, there are a few Army installations with designated critical habitat. Some installations have species recovery plans for specific protected species as part of their INRMP. The INRMP for each installation takes into account the specific requirements for species protection and the installation's military mission.

Off-post activities also may affect the management of biological resources on Army installations. Under 10 USC § 2684a and the ACUB program (AEC, undated), DoD is authorized to work with non-federal governments and private organizations to establish buffers around installations to limit encroachments and other pressures on military training, testing, and operations. Under ACUB, the Army can work with others to identify mutual objectives of land conservation and prevent development of critical open areas. These partnerships preserve high-value habitat and limit incompatible development in the vicinity of military installations. Potential sites for development of floating solar systems could include critical habitat, ESA-listed species, or nesting grounds for migratory birds or bald or golden eagles. Careful site selection (including conducting pre-disturbance surveys) could help to avoid biological resources critical to maintain installation compliance with applicable laws, regulations, and EOs and stewardship responsibilities. As of February 2016, 36 Army installations had ACUB partnerships that collectively protected over 307,179 ac of habitat (DA 2016a). Though the proposed action for this report does not include consideration of off-post land for floating solar PV arrays, understanding an installation's benefits from land placed in the ACUB program enables analysis of potential effects to and/or consideration of mitigations for biological resources for on-post projects.

4.8.2 Environmental Consequences

Multiple factors are considered when determining whether an alternative would have a significant effect on aquatic or terrestrial biological resources. These factors are evaluated by the degree to which the effect would 1) result in loss of habitat or adverse effects to threatened or endangered species or species at risk and 2) conflict with existing federal, state, or local statutes or regulations. In general, the ROI for biological resources encompasses the aquatic and terrestrial habitat or ecosystem in which a proposed floating solar system would be located and the connected habitats, and for migratory birds or fish species, the habitat supporting the species presence on the installation (e.g., breeding/spawning grounds, wintering areas, migratory routes, and total range).

A significant impact to biological resources would occur if the proposed action resulted in any of the following outcomes:

- unauthorized take of a protected species (e.g., under ESA, MBTA, BGEPA, or MMPA)
- local extirpation of rare or sensitive species not currently listed under the ESA
- long-term loss or degradation of diversity within unique or high-quality plant communities
- unacceptable loss of critical habitat as determined by the USFWS or NMFS, including EFHs; non-compliance with policies, regulations, and permits related to wetlands conservation and protection
- high probability of increasing the frequency and intensity of wildfires, especially in sensitive ecological areas

4.8.2.1 No Action Alternative

Under the no action alternative, there would be no new anticipated change to aquatic or terrestrial biological resources on the installation. However, the Army would lose an opportunity to reduce its use of fossil fuels.

4.8.2.2 Alternative 1: Wastewater

Development and operation of floating solar arrays on closed chemically treated or wastewater ponds/lagoons could have some biological impacts. However, previous use and development of the site would likely result in reduced impacts on biological resources compared to Alternatives 2 and 3, NWOTUS and WOTUS, respectively.

Construction of floating solar arrays on chemically treated water or wastewater ponds/lagoons and supporting power infrastructure on the land around the array would involve ground-disturbing activities. These activities could include vegetation removal and soil movement needed for construction of an anchoring system, security fencing, access roads, equipment shelters, ESSs, transmission and distribution lines, and if needed, sub or switching stations. As described in Section 4.6, Geological and Soil Resources, and Section 4.7, Water Resources, ground-disturbing activities could lead to increased soil erosion and siltation that could degrade the land and water, thus reducing the ability to support vegetation (Pimentel 2006) and aquatic life, including algae necessary for waste processing in some systems (Newcombe and MacDonald 1991; EPA 2011). Furthermore, vegetation removal would provide an opportunity for the colonization of pioneer species (i.e., species to first colonize a disrupted ecosystem), including noxious and invasive plant species. Wind, animals, or construction equipment could spread noxious or invasive plant propagules (e.g., seeds and spores). Construction during dry conditions creates a potential for wildfires. An installation's designated Wildland Fire Manager determines wildland fire risk level based on data and models. When wildland fire risks are high, construction operators should take measures to minimize the potential for wildland fire, including, having fire extinguishers readily available, construction vehicles and equipment properly maintained to prevent sparks, and working spark arrestors, where applicable (USFS 2016), and prohibiting parking in dry vegetation. In addition, construction operators should be prepared, in coordination with the appropriate fire-fighting organization, to respond rapidly to wildland fire risks. Timing limitations, when appropriate, could minimize impacts to vegetation and soil due to seasonal rainy, windy, or dry conditions. Managed revegetation and dust suppression could reduce erosion and support native plant communities to reduce or compete with noxious or invasive plant species. Cleaning construction vehicles prior to use on the floating solar system construction site could also reduce the spread of noxious and invasive plant species. The construction contractor would be responsible for maintaining construction vehicles and equipment and implementing BMPs and SOPs (e.g., as a result of regulation, contract, or legally-binding agreement) to comply with federal, state, local, and installation-specific laws and regulations to help minimize impact to biological resources (Table 10).

Construction activities, vehicles, and equipment could reduce or disturb available habitat for local and migratory terrestrial wildlife, which could affect food and water availability, and movement and migration. Impacts to aquatic wildlife on a chemically treated or wastewater site would be minimal because the presence of aquatic species would be limited or nonexistent and likely no sensitive species would be present. The impact or level of concern for habitat reduction or displacement varies with the installation. Potential areas for development of floating solar systems could include critical habitats (no EFHs), habitats of concern limited-use areas, off-limit areas, ESA-listed species (though likely no aquatic ESA species), or nesting grounds for migratory birds or bald or golden eagles. Careful site design and selection (including conducting pre-disturbance surveys) could help to minimize or avoid disturbance to biological resources critical for maintaining installation compliance with applicable laws, regulations, and EOs, and meeting appropriate stewardship responsibilities. Ideally, sites selected for the floating array system and supporting infrastructure would have no sensitive or important biological areas. Examples of elements that should be characterized to help inform the site-selection process include the following:

- surveys for protected species (including state-listed species)
- set-back requirements or use restrictions for sensitive habitats
- buffer distances established through consultation with the regulatory agency to avoid an "incidental take" by disturbance or harassment of protected species (e.g., those protected under ESA, MMPA, and BGEP)
- nesting grounds of migratory birds, nest locations of bald and golden eagles, and any additional ESA-related mitigation requirements (e.g., translocation, or acquisition and protection of compensatory habitat).

Table 10. Summary of Alternative 1 Actions, Impacts, and Mitigation Strategies[(a)] on Biological Resources

Action	Impact	Mitigation	Impact Determination
Construction	Erosion and siltation	Timing (avoid rainy/windy season); revegetation management; SOPs/BMPs	Moderate; minor, with mitigation
	Establishment of noxious or invasive species	Revegetation management; SOPs/BMPs	Moderate; minor with mitigation
	Habitat fragmentation or removal	Avoidance of sensitive areas or species	Moderate, minor with mitigation
	Wildlife disturbance	Careful site selection; seasonal restrictions; SOPs/BMPs	Moderate; negligible to minor and short-term with mitigation
	Wildfire	Timing (SOPs/BMPs)	Moderate; negligible with mitigation
	Damaged liners or change in wastewater depth (wastewater migration)	Careful site and anchoring design	Moderate; negligible with mitigation
Operation	Shading – alterations in wastewater treatment	May not be appropriate for all treatment ponds/lagoons	Minor, long-term
	Biofouling	Anti-biofouling coating (if necessary)	Minor, long-term
	New nesting habitat	Wildlife deterrents and BMPs/SOPs	Moderate; minor with mitigation
	EMF-related behavioral impacts	NA	Negligible to minor
Maintenance	Hazardous material introduction	Washing equipment in designated location	Moderate; negligible with mitigation
	Wildlife disturbance	BMPs and SOPs	Moderate; negligible to minor and short-term with mitigation
	Disturbance in treatment processes	Minimize time, use filtered water when possible	Minor; negligible with mitigation
	Mowing and vegetation control – wildlife fatalities	Seasonal restrictions	Negligible
	Insect, pest, weed, and invasive plant control	Adherence to IPMP and INRMP	Negligible
	Wildfire	BMPs and SOPs	Moderate; negligible with mitigation

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

The Army would leverage INRMPs as potential sites are considered for the construction of a floating solar array. Under the Army's ACUB program, buffer zones could be established in public or private lands surrounding the installation to provide additional habitat for threatened and endangered species. Taking advantage of existing infrastructure or other installation activities and priorities associated with the chemically treated water and wastewater ponds/lagoons could help to minimize biological resource disturbance. New transmission lines, if necessary, would be placed along existing roads within existing utility easements, when appropriate, and overhead lines would be constructed in accordance with avian protection guidelines, as described in *Suggested Practices for Avian Protection On Power Lines: The State of the Art in 2006* (APLIC 2006). In addition, seasonal limitations for construction activities could minimize impacts on species during migration or nesting (Table 10).

A floating solar array would require an anchoring system. Site-specific assessments could be necessary to identify substrate type for an appropriate anchor type and its placement (see Section 4.6, Geology and Soils). The anchoring design would need to ensure the integrity of pond liners or barriers, if applicable, so the water quality of aquifers would not be affected during construction. For chemically treated or wastewater sites, a waterbody bed anchoring system would likely not be appropriate, but a shore anchoring system could be considered.

Potential impacts from regular operation and maintenance of floating solar systems could result from shading; electromagnetic field (EMF) emissions in water; water runoff from rainfall, snow melt, and module washing; and ground and wastewater disturbance from maintenance vehicles and equipment. In addition, the floating solar array and anchoring system equipment could encourage wildlife use by providing new habitat areas for nesting birds and for plants, animals, and microorganisms, which could lead to biofouling issues. New biofouling habitats could increase the potential for establishment of invasive species (Glasby et al. 2007). Wildlife deterrents, avoidance of structures that promote nesting (such as lattice type structures), reduced lighting for ancillary structures that attracts insects, and anti-biofouling coatings, if necessary, could be considered to reduce possible nesting and biofouling habitat on equipment, although habitat on a chemically treated wastewater pond is not optimal nesting or foraging habitat and may not be an issue for birds. BMPs and SOPs should include regular maintenance activities to remove any nest construction prior to establishment (Table 10). Depending on the type of chemically treated or wastewater-treatment pond/lagoon, shading could indirectly disrupt or slow treatment processes by reducing the amount of sunlight penetrating the water for photosynthetic organisms or by altering the water temperature. Some wastewater ponds rely on photosynthetic organisms for wastewater processing (e.g., facultative wastewater ponds) (EPA 2011), and many processes are affected by light availability and water temperature.

Transmission cables could be deployed on the floor of the chemically treated or wastewater ponds/lagoons, suspended in the water column, or attached to the floating solar array. When energized, these cables have the potential to create EMFs. Though research is limited, EMFs may alter the behavior of electro-sensitive aquatic species, such as salmon (Fisher and Slater 2010). However, in chemically treated water and wastewater ponds/lagoons, EMFs might not be an issue as the presence of aquatic species is limited or nonexistent.

Annual maintenance of the floating solar array would be required, but could be more frequent depending on the amount of dust, snow, etc., that needs to be removed from panels. Water would be sufficient to clean solar panels; however, a source of clean or filtered water would be required at chemically treated water or wastewater sites. The use of an external water source could temporarily alter the chemical characteristics of the waterbody (e.g., pH), thereby altering waste treatment processes. Water runoff from the floating solar array system components could result in increased soil erosion. As discussed in Section 4.6, Geological and Soil Resources and Section 4.7, Water Resources, the implementation of BMPs and SOPs would help to mitigate the potential soil erosion impacts during regular operation and maintenance activities. During routine maintenance, operators would inspect the system for soil erosion resulting from maintenance or natural causes, and remediate as appropriate. Vegetation and/or a gravel cover could be maintained around the land-based system components. Maintenance activities to control insects, other pests, noxious weeds, and invasive plants would be implemented in adherence to the installation's IPMP and INRMP and may include the use of pesticides and herbicides. With adherence to installation management and wastewater-treatment management plans, impacts are anticipated to be negligible. Maintenance activities related to mowing and brush removal could lead to some occasional, accidental small wildlife fatalities, but the impact would not be perceptible (Table 10). Seasonal restrictions on maintenance could be applied to reduce potential impacts to migratory birds. When wildland fire risks are high, measures to minimize the potential for wildland fire during maintenance would be similar to those related to construction activities, as described above.

Programmatically, implementing Alternative 1 with environmental protection strategies such as BMPs and SOPs would have negligible-to-moderate impacts on biological resources if no sensitive species are on or near the proposed site, either permanently or temporarily (e.g., migratory birds; Table 10). Depending on the amount of existing infrastructure that could be utilized, there would be negligible-to-moderate long-term impacts to wildlife due to displacement from habitat loss. Negligible-to-moderate, short-term impacts would occur due to disturbance during construction and maintenance. Most impacts associated with operation and maintenance would be negligible to minor and short term, except shading, EMFs, biofouling, and availability of new nesting habitat, which would be negligible-to-moderate and long term for the duration of the life of the floating solar array. The availability of aquatic biological resources would be minimal for Alternative 1; thus, potential impacts on aquatic biological resources would be much reduced compared to terrestrial impacts.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Site-specific analysis should assess the occurrence of resources of concern and their vulnerabilities. Input from state and local agencies or nongovernmental organizations (e.g., National Audubon Society) should be sought as part of the site-specific analysis. In addition, any required informal or formal consultation under ESA, MBTA, BGEPA, and other applicable species-related laws and regulations would be required to be completed prior to implementing the proposed action.

4.8.2.3 Alternative 2: NWOTUS

Construction, operation, and maintenance of the floating solar system on NWOTUS (see Section 4.7, Water Resources, for a description) could result in impacts to terrestrial biological resources, similar to those for Alternative 1. However, potential impacts to aquatic biological resources would be greater due increased aquatic biological resources and possibly less existing infrastructure within the waterbody. In NWOTUS, fish species present are likely to have been introduced and not be protected species.

Similar to Alternative 1, construction activities, to include waterbody bed and on-shore anchoring, have the potential to increase turbidity, move soils, and reduce plant cover. This could lead to increased soil erosion and siltation that, in turn, could degrade the land and water, including fringe wetlands, and reduce the ability to support vegetation and aquatic species (Newcombe and MacDonald 1991; Pimentel 2006). Waterbody bed anchoring systems, including helical anchors or anchors (e.g., concrete weights) that rest on the sediment, could require removal of SAV and woody structures, which may be habitat for aquatic wildlife, though likely not EFHs. In addition, placement of the anchor could increase turbidity temporarily and damage the waterbody floor. Anchor placement could be performed by divers to minimize damage to the waterbody floor. If pneumatic installation were required for floating solar array anchors, any impacts would be short-term and only occur during anchor placement. On-shore anchoring could require some vegetation removal. Site-specific studies could be necessary to identify sediment type (see Section 4.6, Geological and Soil Resources), bathymetry, and presence of SAV to determine the most appropriate anchoring system for the site. Local terrestrial wildlife species could be impacted through disturbance or loss of habitat, habitat fragmentation, and changes in water availability, similar to Alternative 1. Fish species present in NWOTUS, would likely be introduced and not federally listed, though other federally listed wildlife that use aquatic habitats (e.g., alligators and frogs) could be present. There would be potential for loss of aquatic habitat, including spawning and nesting habitat, from the alteration of the shoreline. Alteration of the shoreline, including armoring to reduce erosion or improve water access or water surface rise due to water displacement from the floating solar array (although anticipated impacts would be negligible; see Section 4.7, Water Resources), could alter the amount of shallow water habitat and SAV, which could reduce invertebrate prey availability (Sobocinski et al. 2010) and increase predator density (Tabor et al. 2011) (Table 11).

Table 11. Summary of Alternative 2 Actions, Impacts, and Mitigation Strategies[(a)] on Biological Resources

Action	Impacting Factor	Mitigation	Impact Determination
Construction	Erosion, siltation, and turbidity	Timing (avoid rainy/windy season); revegetation management; SOPs/BMPs	Moderate, minor with mitigation
	Establishment of noxious or invasive species	Revegetation management cleaning construction equipment	Moderate, minor with mitigation
	Habitat Fragmentation/Removal	Avoid ESA species and habitats, fringe wetlands, etc.	Significant to moderate long-term with mitigation
	Wildlife disturbance	Careful site selection; seasonal restrictions; SOPs/BMPs	Significant to negligible and short-term with mitigation
	Wildfire	Timing (SOPs/BMPs)	Moderate; negligible with mitigation
	Damage to sea floor	Careful site selection; avoid SAV and sensitive habitat	Moderate; negligible to minor with mitigation
	Change in shoreline	Careful site selection; avoid sensitive habitat	Moderate; negligible to minor with mitigation
	Noise due to waterbody bed anchoring	NA	Negligible to minor
Operation	Shading – reduced SAV, food availability, habitat, altered thermocline	Avoid areas with sensitive species and SAV; maximize floating solar array light penetration (e.g., grating)	Moderate; negligible to minor with mitigation
	Biofouling	Anti-biofouling coating	Moderate; negligible to minor with mitigation
	New nesting habitat	Wildlife deterrents and BMPs/SOPs	Significant to moderate with mitigation
	EMF-related behavioral impacts	EMF threshold set below 0.5 V/m	Moderate; negligible to minor with mitigation

Table 11. (contd)

Action	Impacting Factor	Mitigation	Impact Determination
Maintenance	Hazardous material introduction	BMPs and SOPs	Minor; negligible to minor with mitigation
	Wildlife disturbance	BMPs and SOPs	Moderate; negligible to minor with mitigation
	Mowing and vegetation removal – wildlife fatalities	Seasonal restrictions	Negligible
	Insect, pest, weed, and invasive plant control	Adherence to IPMP and INRMP	Negligible
	Wildfire	BMPs and SOPs	Moderate; negligible with mitigation
(a) See Table 24 for comprehensive list of BMPs and environmental protection measures			

Regular operation and maintenance of the floating solar system on NWOTUS, would have similar impacts on terrestrial biological resources as Alternative 1; however, there could be greater adverse impacts on aquatic resources due to shading from the floating solar array platform and EMF fields in the water from transmission cables. Shading would reduce the amount of available light for penetration by up depending on the raft or support structures used (Gayaldo and Nelson 2006). One study reported approximately a tenfold decrease in light availability beneath overwater structures such as a dock or pier with plank spacing averaging 0.4 in. (Garrison et al. 2005). Reduced light penetration could alter water temperature, which would have the potential to alter the plant species assemblage and richness and reduce the abundance of SAV and biomass beneath and adjacent to the structure (Garrison et al. 2005; Vasilas et al. 2011). Shading impacts could extend beyond the footprint of the floating solar array depending on the height of the structure and the water depth as habitat impact zones have been estimated to be at least 8 m beyond the footprint for recreational overwater structures in shallow waters (Radomski et al. 2010; Lepore 2013). A decrease in SAV could destabilize soft sediments and increase turbidity (Garrison et al. 2005), and also could reduce available refuge, foraging, and spawning habitat, likely altering the assemblage fish species (Kahler et al. 2000;

Garrison et al. 2005; Sobocinski et al. 2010; Ono and Simenstad 2014). In addition, shading has been shown to alter fish migration patterns (Ono and Simenstad 2014). The overall level of impact due to shading would be dependent upon available light, water quality, distance of the structure platform to the water surface and the shade tolerance of the species present (Garrison et al. 2005; Vasilas et al. 2011). Besides light penetration, altered water temperature could also affect aquatic biological resources through altered hatching and growth rates, thereby affecting reproduction success of some fishes (Tabor et al. 2011). During operation, EMFs have been found to cause behavioral alterations in salmon species (Fisher and Slater 2010) and could have similar impacts on other electro-sensitive species such as eels and elasmobranchs.

Mitigation efforts would be similar to Alternative 1, including careful site-specific selection and design to avoid areas with biological resources critical toward maintaining compliance, such as wetland areas, careful timing of construction activities, and implementation of BMPs and SOPs (Table 11). However, additional consideration should be given to aquatic habitats during site selection to avoid critical habitats and minimize areas with SAV. Impacts from shading could be lessened by orienting the platform in the north/south direction that does not compromise the maximum sunlight exposure for the arrays, and using grating in the platform to maximize the amount of available light (Gayaldo and Nelson 2006). If electro-sensitive species were present, thresholds for EMF should be kept below 0.5 V/m to avoid behavioral changes (Fisher and Slater 2010). BMPs and SOPs should be used to reduce the introduction of chemical contaminants from vehicle/equipment washing and runoff and reduce disturbance of the shoreline. For example, boats could be cleaned on a boat launch to ensure water returns to its original water source and soil disturbance is minimized, or in a designated area to collect runoff.

Programmatically, development, operation and maintenance of floating solar systems on NWOTUS would result in negligible-to-moderate impacts to biological resources with the implementation of mitigation strategies (Table 11). Negligible-to-moderate impacts to biological resources would result if the action does not impact any critical or listed biological resources such as SAV. Moderate impacts could result if sensitive biological resources are present on or near the site, whether annually or temporarily, even though mitigation measures to avoid or minimize impacts would be applied. Depending on the amount of existing infrastructure that could be utilized, there would be negligible-to-moderate long-term impacts to wildlife due to displacement from habitat loss. Negligible-to-moderate, short-term impacts would occur due to disturbance during construction and maintenance. Most impacts associated with operation and maintenance would be negligible-to-moderate and short-term, except shading, EMFs, biofouling, and availability of new nesting habitat, which would be negligible-to-moderate and long-term for the duration of the life of the floating solar array.

As with Alternative 1, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Site-specific analysis should assess the occurrence of resources of concern and their vulnerabilities. Input from state and local agencies or nongovernmental organizations should be sought as part of the site-specific analysis. In addition, any informal or formal consultation under Section 7 of the ESA, MBTA, BGEPA, and other applicable species-related laws and regulations would be required to be completed prior to implementing the proposed action.

4.8.2.4 Alternative 3: WOTUS

Construction, operation, and maintenance of the floating solar system on WOTUS would result in impacts similar to Alternative 2. However, possible WOTUS sites could have a greater potential for impact on aquatic organisms because of more connections with other waterbodies. Alternative 3 would include 1) ponds, lakes, and reservoirs; 2) streams and rivers, and 3) coastal waters. Impacts between the three waterbody types would be similar, but would vary due to water flow, connections to other waterbodies, and regulatory agencies with jurisdiction.

Unlike Alternatives 1 and 2, Alternative 3, WOTUS, could have flowing water. Construction and operation of the floating solar array could disrupt or restrict flow, which could create eddies that alter fish behavior and habitat (see Section 4.7, Water Resources). The frequency of maintenance activities could need to be increased as flow could increase the accumulation of debris buildup on the floating solar arrays and/or platform as well as damage to the system. Depending on the maximum flow, a floating solar array may not be feasible because of the increased damage potential from waves and debris.

Similar to Alternative 2, mitigation efforts would include careful site selection and design, careful timing of construction activities, and implementation of BMPs and SOPs. However, additional consideration should be given to aquatic habitats during site selection to avoid critical habitats, including EFHs, and minimize areas with SAV. In addition, state-specific regulations and permits that require further mitigation (e.g., percentage of light penetration to maintain SAV habitats) or restrictions to protect sensitive biological resources may exist.

Programmatically, development, operation, and maintenance of floating solar systems on WOTUS waterbodies, with the implementation of mitigation strategies, would result in negligible-to-moderate impacts to biological resources if no SAV or sensitive species are on or near the proposed site, either permanently or temporarily (e.g., migratory birds; Table 12). Moderate impacts could result if sensitive biological resources are present on or near the site, whether annually or temporarily, even though mitigation measures to avoid or minimize impacts would be applied. Depending on the amount of existing infrastructure that could be utilized, there would be negligible-to-moderate long-term impacts to wildlife due to displacement from habitat loss. Negligible-to-moderate, short-term impacts would occur due to disturbance during construction and maintenance. Most impacts associated with operation and maintenance would be negligible-to-moderate and short-term, except shading, EMFs, flow alteration, biofouling, and availability of new nesting habitat, which would be negligible-to-moderate and long-term for the duration of the life of the floating solar array.

Table 12. Summary of Alternative 3 Actions, Impacts, and Mitigation Strategies[(a)] on Biological Resources

Action	Impact	Mitigation	Impact Determination
		Ponds, Lakes, Reservoirs	
Construction	Erosion, siltation, and turbidity	Timing (avoid rainy/windy season); revegetation management; SOPs/BMPs	Moderate, minor with mitigation
	Establishment of noxious or invasive species	Revegetation management cleaning construction equipment	Moderate, minor with mitigation
	Habitat fragmentation or removal	Avoid ESA and MBTA species and habitats, fringe wetlands, etc.	Significant to moderate long-term; moderate to minor with mitigation
	Wildlife disturbance	Careful site selection; seasonal restrictions; SOPs/BMPs	Significant to negligible short-term; moderate to negligible with mitigation
	Wildfire	Timing (SOPs/BMPs)	Moderate; negligible with mitigation
	Damage to waterbody floor	Careful site selection; avoid SAV and sensitive habitat	Moderate; minor with mitigation
	Change in shoreline	Careful site selection; avoidance of sensitive species and habitat	Moderate; negligible to minor with mitigation
	Noise due to anchoring		Negligible to minor and short-term
Operation	Shading – reduced SAV, food availability, habitat, altered thermocline	Avoid areas with sensitive species and SAV; maximize floating solar array light penetration (e.g., grating)	Significant to moderate; negligible to moderate with mitigation
	Biofouling	Anti-biofouling coating	Moderate; negligible to minor with mitigation
	New nesting habitat	Wildlife deterrents and BMPs/SOPs	Significant; moderate with mitigation
	Flow alteration and debris accumulation	NA	Negligible to minor
	EMF-related behavioral impacts	EMF threshold set below 0.5 V/m	Negligible to moderate; negligible to minor with mitigation

Table 12. (contd)

Action	Impact	Mitigation	Impact Determination
Maintenance	Hazardous material introduction	BMPs and SOPs	Minor; negligible to minor with mitigation
	Wildlife disturbance	BMPs and SOPs	Moderate; negligible with mitigation
	Mowing and vegetation control – wildlife fatalities	Seasonal restrictions	Negligible
	Insect, pest, weed, and invasive plant control	Adherence to IPMP and INRMP	Negligible
	Wildfire	BMPs and SOPs	Moderate; negligible with mitigation
Streams and Rivers			
Construction	Erosion, siltation, and turbidity	Timing (avoid rainy/windy season); revegetation management; SOPs/BMPs	Moderate, minor with mitigation
	Establishment of noxious or invasive species	Revegetation management cleaning construction equipment	Moderate; minor with mitigation
	Habitat fragmentation	Avoid ESA and MBTA species and habitats, fringe wetlands, etc.	Significant to moderate long-term; moderate to minor with mitigation
	Wildlife disturbance	Careful site selection; seasonal restrictions; SOPs/BMPs	Significant to negligible short-term; moderate to negligible with mitigation
	Wildfire	Timing (SOPs/BMPs)	Moderate; negligible with mitigation
	Damage to river bed	Careful site selection; avoid SAV and sensitive habitat	Moderate; minor with mitigation
	Change in shoreline	Careful site selection; avoidance of sensitive species and habitat	Moderate; negligible to minor with mitigation
	Noise due to anchoring	NA	Negligible to minor and short-term
	Flow disruption and debris accumulation	Careful site selection	Moderate; minor and long-term with mitigation
Operation	Shading – reduced SAV, food availability, habitat, altered thermocline	Avoid areas with sensitive species and SAV; maximize floating solar array light penetration (e.g., grating)	Significant to moderate; negligible to moderate with mitigation
	Biofouling	Anti-biofouling coating	Moderate; negligible to minor with mitigation
	New nesting habitat	Wildlife deterrents and BMPs/SOPs	Significant; moderate with mitigation
	Flow disruption and debris accumulation	Careful site selection; routine maintenance	Moderate; minor and long-term with mitigation
	EMF-related behavioral impacts	EMF threshold set below 0.5 V/m	Moderate; negligible to minor with mitigation
Maintenance	Hazardous material introduction	BMPs and SOPs	Minor; negligible to minor with mitigation
	Wildlife disturbance	BMPs and SOPs	Moderate; negligible to minor with mitigation
	Mowing and vegetation control – wildlife fatalities	Seasonal restrictions	Negligible

Table 12. (contd)

Action	Impact	Mitigation	Impact Determination
	Insect, pest, weed, and invasive plant control	Adherence to IPMP and INRMP	Negligible
	Wildfire	BMPs and SOPs	Moderate; negligible to minor with mitigation
		Coastal Waters	
Construction	Erosion, siltation, and turbidity	Timing (avoid rainy/windy season); revegetation management; SOPs/BMPs	Moderate, minor with mitigation
	Establishment of noxious or invasive species	Revegetation management cleaning construction equipment	Moderate, minor with mitigation
	Habitat fragmentation or removal	Avoid ESA, MBTA, and MMPA species and habitats, fringe wetlands, etc.	Significant to moderate long-term; moderate to minor with mitigation
	Wildlife disturbance	Careful site selection; seasonal restrictions; SOPs/BMPs	Significant to negligible short-term; moderate to negligible with mitigation
	Wildfire	Timing (SOPs/BMPs)	Moderate; negligible with mitigation
	Damage to sea floor	Avoidance of SAV and sensitive habitat	Moderate; minor with mitigation
	Change in shoreline	Careful site selection; avoidance of sensitive species and habitat	Moderate; negligible to minor with mitigation
	Noise due to anchoring	NA	Negligible to minor and short-term
	Flow disruption and debris accumulation	Careful site selection	Moderate; minor and long-term with mitigation
Operation	Shading – alterations SAV, food availability, habitat, reduced water temperature	Avoid areas with sensitive species and SAV; maximize floating solar array light penetration (e.g., grating)	Significant to moderate; negligible to moderate with mitigation
	Biofouling	Anti-biofouling coating	Moderate; negligible to minor with mitigation
	New nesting habitat	Wildlife deterrents and BMPs/SOPs	Significant; moderate with mitigation
	EMF-related behavioral impacts	EMF threshold set below 0.5 V/m	Moderate; negligible to minor with mitigation
	Flow disruption and debris accumulation	Careful site selection; routine maintenance	Moderate; negligible to moderate with mitigation
Maintenance	Hazardous material introduction	BMPs and SOPs	Minor; negligible to minor with mitigation
	Wildlife disturbance	BMPs and SOPs	Moderate; negligible to minor with mitigation
	Mowing and vegetation control – wildlife fatalities	Seasonal restrictions	Negligible
	Insect, pest, weed, and invasive plant control	Adherence to IPMP and INRMP	Negligible
	Wildfire	BMPs and SOPs	Moderate; negligible with mitigation

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

As with Alternatives 1 and 2, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Site-specific analysis should assess the occurrence of resources of concern and their vulnerabilities. Input from state and local agencies or nongovernmental organizations should be sought as part of the site-specific analysis. In addition, any informal or formal consultation under Section 7 of the ESA, MBTA, BGEPA, and other applicable species-related laws and regulations would be required to be completed prior to implementing the proposed action.

4.9 Cultural Resources

Cultural resources can be defined as physical location(s) or object(s) that evidence past human activity. Past and present cultures attach cultural meaning based on the association of that cultural resource with that culture's history, beliefs, traditions, rituals, and lifeways. Cultural resources include prehistoric and historic era archaeological sites, historic districts, and buildings, as well as any site, structure, object, or landscape that may be considered eligible for listing in the National Register of Historic Places (NRHP or National Register). Cultural resources also include traditional cultural properties (TCPs), which are places that not only have past traditional cultural and historic importance to a living community of people, but also have continued importance today as part of the perpetuation of that community's culture (e.g., sacred sites and traditional resource gathering areas). Cultural resources can also include places that contain human remains (e.g., burial grounds). Although cemeteries are not necessarily cultural resources as defined by the National Historic Preservation Act (NHPA; 54 USC § 300101 et seq.), for the purposes of this report, cemeteries will be included in the cultural resources section.

As mandated by law, all federal installations and personnel must participate in the preservation and stewardship needs of archaeological and cultural resources and must consider potential impacts to these resources prior to any installation undertaking. Several laws and regulations define cultural resources and establish requirements for the Army in managing cultural resources, including the following:

- The Antiquities Act of 1906 (54 USC 320301-320303)
- The National Historic Preservation Act of 1966, as amended (54 USC 300101 et seq.)
- The American Indian Religious Freedom Act of 1978 (42 USC 1996)
- The Archeological and Historic Preservation Act of 1974, as amended (54 USC 312501_312508)
- The Archaeological Resources Protection Act of 1979 (16 USC § 470aa et seq.)
- The Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) (25 USC § 3001 et seq.)
- 36 CFR Part 79, *Curation of Federally Owned and Administrated Archaeological Collections* (36 CFR Part 79)
- Executive Order 13007, *Indian Sacred Sites* (EO 13007)
- Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments* (EO 13175)
- Abandoned Shipwreck Act of 1987 (43 USC § 2101-2106).

Per NHPA Section 106 regulations promulgated by the Advisory Council on Historic Preservation (ACHP) under 36 CFR Part 800, the Army is required to take into account the effects of its undertakings on historic properties located within the Area of Potential Effect (APE). In addition, NHPA Section 106 requires federal agencies to appropriately consult with the SHPO and/or applicable federally recognized

Native American Tribe(s), Alaska Native Tribe(s), and Native Hawaiian Organization(s) (collectively referred to as "Tribes" herein), as well as interested parties. The term "historic property" is defined in the NHPA Section 300308 as: "any prehistoric or historic district, site, building, structure, or object included on, or eligible for inclusion on, the National Register, including artifacts, records, and material remains related to the district, site, building, structure, or object" (54 USC § 300101 et seq.). In order for cultural resources to be eligible for the National Register, that resource "must possess integrity of location, design, setting, materials, workmanship, feeling and association" (NPS 2002). It must also have significance under at least one of the following four criteria:

1. associated with events that have made a significant contribution to the broad patterns of our history
2. associated with the lives of persons significant in our past
3. embodies the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction
4. yields, or may be likely to yield, information important in prehistory or history (NPS, 2002:2).

The APE—as defined by the Army once a specific proposed project is identified and a site recommended—constitutes the affected environment for cultural resources. The information from the NHPA Section 106 process typically helps to inform any associated NEPA assessment. The APE, as defined for the NHPA undertaking, would constitute the ROI in support of the NEPA environmental review.

AR 200-1 enables installations to make informed decisions regarding the environment, including cultural resources under their control in compliance with public laws, in support of the military mission, and consistent with sound principles of cultural resources management (DA 2007). AR 200-1 requires Army installations to maintain an ICRMP that serves as a guide for compliance with NHPA and other applicable federal laws and regulations, including identification and preservation of cultural resources and historic properties (DA 2007). Installation-specific ICRMPs are the framework for managing and protecting cultural resources as well as compliance with cultural resources laws and regulations. Consultation requirements for an undertaking are directed by NHPA Section 106 or by an existing agreement between the Army and the consulting entity.

The Army is authorized to use the Army Alternate Procedures, a streamlined procedure Army installations can elect to follow, to satisfy NHPA consultation requirements. Army Alternate Procedures approach an installation's management of historic properties programmatically, instead of on a project-by-project review basis. This allows installations with Historic Properties Component Plans certified by ACHP to operate under SOPs developed in consultation with their stakeholders. A few Army installations have received ACHP certifications and use the Army Alternate Procedures.

4.9.1 Existing Conditions

The scope and extent of cultural resources that might be present at each Army installation will vary by specific location. The identification of specific consulting parties (e.g., Tribes, SHPOs, and interested parties) to support NHPA Section 106 consultation will also vary by location.

As of February 2016, Army installations collectively had the following known cultural resources (DA 2016a):

- 58,887 buildings or structures over 50 years old that would be subject to NHPA;
- 82,605 recorded archaeological sites on Army lands.

As of February 2015, Army installations collectively had the following known cultural resources (DA 2015b):

- 109 Native American Sacred Sites;
- Native American collections protected under NAGPRA.

4.9.2 Environmental Consequences

In general, the ROI and the APE for cultural resources encompasses the proposed floating solar array and ancillary power systems and infrastructure , as well as viewsheds that could be indirectly affected by the proposed action. NHPA Section 106 specifically analyzes both direct and indirect effects to historic properties. Effects can be determined to be adverse or not adverse. An adverse effect occurs when project impacts either directly or indirectly alter aspects of the integrity of the historic property (i.e., location, design, setting, materials, workmanship, feeling, and association) or alter those any of the four criteria (listed above) that make the historic property significant and therefore NRHP-eligible. Under NEPA, a significant impact to cultural resources would occur if the proposed action resulted in irretrievable or irreversible commitment of resources, such as a historic property listed or eligible for listing on the NRHP.

The types of direct and indirect effects that could occur from project activities associated with the installation of the floating solar system will vary by cultural resource type (i.e., archaeological site, historic building, TCP). Examples of direct and indirect effects to cultural resources include the following:

- An example of a direct adverse effect to a significant archaeological site includes ground disturbance that alters an intact significant subsurface or surface archaeological feature that has the potential to yield information about our historic and prehistoric past.
- An example of direct adverse effects to an important historic building includes modifications that are not in keeping with its historic character or age.
- Examples of indirect adverse effects to an important historic building, a significant TCP, or archaeological site that could occur as a result of construction of a floating solar installation include alterations in the setting accessibility, use, or economic viability of that resource.
- Alterations in the visual setting in particular could result in indirect effects to historic buildings or important TCPs where setting is an important characteristic of that resource.
- Alterations in accessibility could occur when public access to an historic property is either enhanced or restricted.
  - Enhanced access could indirectly result in increased opportunities for destruction of an archaeological site, historic building or TCP through looting or vandalism.
  - Restricting access to cultural resources could indirectly affect a TCP if access to that TCP is important in maintaining the cultural identity of the community that uses and values that TCP. Restrictions on access could also affect the ability of a community to use an historic building for tourism purposes or a TCP for subsistence purposes resulting in indirect effects to the economic viability of that community.

Adverse effects under NHPA would require the installation to resolve adverse effects through consultation with the SHPO/Tribes and other interested parties. Consultation is documented in a memorandum of agreement, which outlines agreed-upon measures that the installation will take to avoid, minimize, or mitigate the adverse effects. In some cases, the consulting parties may agree that no such measures are possible, but that the adverse effects must be accepted in the public interest (ACHP 2013)

While cultural resource impacts are required to be mitigated under NHPA, because cultural resources are nonrenewable, the NHPA Section 106 finding is not reduced as a result of mitigation because the cultural resource is permanently altered and effects are irretrievable. A finding of adverse effect on a historic property does not necessarily require an EIS under NEPA (36 CFR 800.8(a)(1)). Adverse effects can be resolved through consultation and an executed memorandum of agreement. Examples of significant impacts to cultural resources from a proposed action include the creation of conditions that would stop the traditional use of sacred or ceremonial sites or resources. A significant impact to cultural resources would occur if the proposed action resulted in a violation of compliance with NAGPRA or irretrievable or irreversible damage to human burials (particularly unmarked or poorly marked cemeteries) or an NRHP-eligible archaeological site.

Consultation with the SHPO, Tribes, and interested parties would be pursued by Army installations, as appropriate per NHPA Section 106 requirements and other local historic preservation requirements, during site-specific NEPA analysis for floating solar arrays and ancillary power systems.

4.9.2.1 No Action Alternative

Under the no action alternative, there would be no impacts to cultural resources on an Army installation because there would be no construction activities associated with floating solar array projects.

4.9.2.2 Alternative 1: Wastewater

Under Alternative 1, there would be the potential for impacts to occur to cultural resources on an Army installation.

Construction of floating solar arrays on existing chemically treated water or wastewater ponds/lagoons would involve ground-disturbing activities. These activities could include vegetation removal and soil movement necessary for construction of an anchoring system, security fencing, access roads, equipment shelter(s), ESS, transmission (underground and/or above ground) and distribution lines, and if needed sub or switching stations. During construction, there would be potential for wildfires if activities take place during dry conditions. Timing limitations, when appropriate, could minimize impacts to vegetation and soil due to seasonal rainy, windy, or dry conditions.

Floating solar arrays require an anchoring system. Site-specific assessments could be necessary to identify the appropriate anchor type and placement (see Section 4.6, Geology and Soils). However, on-shore anchoring, which could involve ground-disturbing activities, would likely be used to minimize disturbance to pond liners. It would be rare that an existing wastewater pond or lagoon would be at least 50 years of age and considered eligible for listing in the NRHP.

There would be potential for floating solar arrays to cause a visual impact to cultural resources within the ROI. Direct impacts to cultural resources as a result of ground-disturbing activities associated with installation of the required floating solar array anchoring system and its supporting infrastructure would need to be considered to minimize impacts. The pond or lagoon could require fencing and access roads, which could either enhance or restrict accessibility to historic properties.

Depending upon the cultural resource type (i.e., archaeological site, TCP, or building), enhanced access could lead to a greater degree of direct effect to the historic property by creating more opportunities for destruction (e.g., looting of archaeological sites or vandalism of historic buildings and structures).

Restricting access to cultural resources (e.g., TCPs) where the community's access and ongoing use of the resource is a significant component of that resources' NRHP-eligibility could result in both direct and indirect effects to that TCP and to the communities for which that TCP is important in the perpetuation and protection of their cultural identity. Access restrictions could also result in indirect and direct effects to cultural resources including destruction and vandalism, if access and use are essential components of the cultural resource's ongoing economic viability such as an historic building that is part of heritage tourism in the area of a TCP contains subsistence resources that a community relies upon.

Maintenance activities (e.g., on access road and transmission line rights-of-way) associated with the floating solar array and supporting infrastructure could have similar impacts on cultural resources as construction activities, but to a much lesser degree.

Implementing Alternative 1 with mitigation strategies (e.g., installation-specific ICRMPs) would have negligible-to-moderate impacts to cultural resources if no historic properties, TCPs, or sacred sites are known to be on or near the proposed site within the ROI (Table 13). Due to the nature of cultural resources in general, there is the possibility that significant resources could still be present at the Alternative 1 site location and the installation ICRMP would serve as the guide for cultural resource compliance.

Table 13. Summary of the Alternative 1 Action, Impacts, and Mitigation Strategies[(a)] for Cultural Resources

Action	Impact	Mitigation	Impact Determination
Construction	Erosion and siltation	Timing (avoid rainy/windy season) revegetation management.	Negligible to moderate
	Wildfire	Timing (SOPs/BMPs).	Negligible to moderate
	Ground-disturbing activities	Avoidance of known resources. Careful site design. Monitoring by archaeologist in sensitive areas.	Negligible to moderate
	Visual impacts	Careful site design and complying with NHPA Section 106 process.	Negligible to minor
	Modification of waste water pond/lagoon structures >50 years of age	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Enhanced access due to new access roads	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Restricted access due to new security	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
Operation	Visual impacts	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Enhanced access due to new access roads	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Restricted access due to new security	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
Maintenance	Minor ground disturbance	Avoidance of known resources. Careful site design. Monitoring by archaeologist in sensitive areas.	Negligible to moderate
	Wildfire	BMPs and SOPs	Negligible to moderate

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Installation-specific ICRMPs are the framework for managing and protecting cultural resources as well as compliance with laws and regulations. Consultation requirements for an undertaking are directed by NHPA Section 106 or by an existing agreement between the Army and the consulting entity.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

If careful application of the checklist to the proposed project at an installation requires a “yes” or “maybe” response to any cultural resources checklist item, then additional environmental analysis of potential impacts to cultural resources could be required and should be conducted as part of an installation-level, site-specific NEPA process. If the installation concluded that additional NEPA analysis for impacts to cultural resources was necessary, this must occur before the proposed action was implemented. To comply with NHPA Section 106, the Army would be required to conduct a site-specific cultural resources impact analysis to assess the effect of the Army’s undertaking on historic properties and to consult with the appropriate SHPO, Tribes, and interested parties. NHPA Section 106 consultation for the undertaking would also be required to be completed prior to implementing the proposed action in order to ensure cultural resources are considered and avoided, prior to construction.

4.9.2.3 Alternative 2: NWOTUS

Construction, operation, and maintenance of the floating solar array and power infrastructure on NWOTUS (see Section 4.7, Water Resources, for a description) has the potential to impact cultural resources, similarly to those for Alternative 1. Impacts to cultural resources for Alternative 2 would be similar because the waterbodies would be manmade, controlled, and closed.

Construction of floating solar arrays on existing or constructed NWOTUS and supporting power infrastructure on the land around the array would involve ground-disturbing activities. These activities could include vegetation removal and soil movement necessary for construction of an anchoring system, security fencing, access roads, equipment shelter(s), ESSs, transmission (underground and/or above ground) and distribution lines, and, if needed, sub or switching stations. These construction activities should be planned in a way to avoid known cultural resources in order to minimize impacts. During construction, there would be potential for wildfires if activities take place during dry conditions. Timing limitations, when appropriate, could minimize impacts to vegetation and soil due to seasonal rainy, windy, or dry conditions.

Floating solar arrays would require an anchoring system. Site-specific assessments could be necessary to identify the appropriate anchor type and placement (see Section 4.6, Geology and Soils). It would be rare that an existing NWOTUS would be at least 50 years of age and considered eligible for listing in the NRHP.

There would be the potential for floating solar arrays to cause a visual impact to cultural resources within the ROI; however, the impact would be negligible to minor if constructed on an existing NWOTUS.

The floating solar array on NWOTUS would also require supporting infrastructure that would need to be considered during siting and construction periods to ensure cultural resources are avoided or impacts are minimized. The floating solar array on NWOTUS would require fencing and access roads. Effects due to accessibility could occur when access to historic properties is either enhanced or restricted.

Enhanced access could lead to a greater degree of direct effect to the historic property by creating more opportunities for destruction (e.g., looting of archaeological sites or destruction of historic buildings and structures). Restricting access to cultural resources could indirectly affect the communities to which they are important for their cultural identity (e.g., limiting access by Tribal communities to TCPs, limiting access by local communities to churches or other historic buildings important to their identity). Restrictions on access could indirectly affect the use and economic viability of cultural resources, which could lead to their eventual destruction or demolition.

Maintenance activities associated with the floating solar array and supporting power infrastructure would have the potential to impact cultural resources similarly to activities associated with construction, but to a much lesser degree. It was assumed that access roads and transmission line rights-of-way would be maintained.

Implementing Alternative 2 with mitigation strategies (e.g., installation-specific ICRMPs) would have negligible-to-moderate impacts on cultural resources if no historic properties, TCPs, or sacred sites are known to be on or near the proposed site within the ROI (Table 14). Due to the nature of cultural resources in general, there would be the possibility that significant resources could still be present at the NWOTUS alternative site location and the installation ICRMP would serve as the guide for cultural resource compliance.

Table 14. Summary of the Alternative 2 Action, Impacts and Mitigation Strategies[(a)] for Cultural Resources

Action	Impact	Mitigation	Impact Determination
Construction	Erosion/siltation	Timing (avoid rainy/windy season) revegetation management.	Negligible to moderate
	Wildfire	Timing (SOPs/BMPs).	Negligible to moderate
	Ground-disturbing activities	Avoidance of known resources. Careful site design. Monitoring by archaeologist in sensitive areas.	Negligible to moderate
	Visual impacts	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Modification of NWOTUS structures >50 years of age	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Enhanced access due to new access roads	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Restricted access due to new security	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
Operation	Visual impacts	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Enhanced access due to new access roads	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
	Restricted access due to new security	Careful site design and complying with NHPA Section 106 process.	Negligible to moderate
Maintenance	Minor ground disturbance	Avoidance of known resources. Careful site design. Monitoring by archaeologist in sensitive areas.	Negligible to moderate
	Wildfire	BMPs and SOPs	Negligible to moderate

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Installation-specific ICRMPs are the framework for managing and protecting cultural resources and complying with laws and regulations. Consultation requirements for such an undertaking are directed by NHPA Section 106 or by an existing agreement between the Army and the consulting entity.

As with Alternative 1, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

If careful application of the checklist to the proposed project at an installation requires a “yes” or “maybe” response to any cultural resources checklist item, then additional environmental analysis of potential impacts to cultural resources could be required and should be conducted as part of an installation-level, site-specific NEPA process. If the installation concluded that additional NEPA analysis for cultural resources was necessary, this must be prepared before any irreversible and irretrievable commitments of resources occurs on the proposed action, should it be implemented. Site-specific analysis in support of NHPA Section 106 would be required and would assess the Army’s undertaking on historic properties as well as seek consultation with the appropriate SHPO, Tribes, and interested parties.

4.9.2.4 Alternative 3: WOTUS

Construction, operation, and maintenance of the floating solar array and power infrastructure on WOTUS would result in similar impacts to cultural resources as Alternative 1 and 2, but has the potential to have greater impacts to cultural resources due to the nature of this waterbody type and possible lack of existing infrastructure. WOTUS are defined in Section 4.7, Water Resources, and include streams, rivers, ponds, lakes, reservoirs, and coastal waters. Using WOTUS sites for floating solar would have a greater potential for affecting cultural resources due to the potential for significant cultural resources to be present at these locations. Significant archaeological sites, TCPs and buildings tend to be located near natural waterways as this is where humans have settled to access important resources.

Construction of floating solar arrays on WOTUS, and supporting power infrastructure on the land around the arrays, would involve ground-disturbing activities. These activities could include vegetation removal and soil movement necessary for construction of an anchoring system, security fencing, access roads, equipment shelter(s), ESSs, transmission (underground and/or aboveground) and distribution lines, and, if needed, sub or switching stations. During construction, there would be a potential for wildfires if activities take place during dry conditions. Timing limitations, when appropriate, could minimize impacts to vegetation and soil due to seasonal rainy, windy, or dry conditions.

Floating solar arrays would require an anchoring system. Site-specific assessments could be necessary to identify the appropriate anchor type and placement (see Section 4.6, Geology and Soils). There would be the potential for underwater cultural resources to exist within WOTUS or perhaps on the shoreline of WOTUS that would need to be considered when siting the anchoring system.

There would be the potential for floating solar arrays to cause indirect visual impacts to cultural resources especially TCPs and historic buildings that are located within the WOTUS ROI. Because of their co-location with natural waterways, it would be likely that the integrity of the natural setting associated with such a TCP or historic building would also associated with its’ historic significance.

The floating solar arrays and supporting facilities and infrastructure would require fencing and access roads. Effects due to accessibility could occur when access to historic properties is either enhanced or restricted.

Enhanced access could lead to a greater degree of direct effect to the historic property by creating more opportunities for destruction (e.g., looting of archaeological sites or destruction of historic buildings and structures). Restricting access to cultural resources could indirectly affect the communities to which they are important for their cultural identity (e.g., limiting access by Tribal communities to TCPs, limiting access by local communities to churches or other historic buildings important to their identity). Access restrictions could indirectly affect the use and economic viability of cultural resources that could lead to their destruction or demolition.

Maintenance activities associated with the floating solar system and supporting infrastructure have the potential to impact cultural resources similarly to activities associated with construction, but in a much lesser degree. It was assumed that access roads and transmission line rights-of-way would be maintained.

Implementing Alternative 3 with mitigation strategies (e.g., installation-specific ICRMPs) would have negligible-to-moderate impacts on cultural resources if no historic properties, TCPs, or sacred sites are known to be on or near the proposed site within the ROI. The potential exists for impacts to be greater and potentially to be significant due to the presence of historic properties, TCPs, or sacred sites within the ROI (Table 15). Due to the nature of cultural resources in general, there would be the possibility that significant resources could still be present at the WOTUS alternative site location and the installation ICRMP would serve as the guide for cultural resource compliance.

Table 15. Summary of the Alternative 3 Action, Impacts and Mitigation Strategies[a] for Cultural Resources

Action	Impact	Mitigation	Impact Determination
Construction	Erosion/siltation	Timing (avoid rainy/windy season) revegetation management.	Negligible to moderate
	Wildfire	Timing (SOPs/BMPs).	Negligible to moderate
	Ground-disturbing activities	Avoidance of known resources. Careful site design. Monitoring by archaeologist in sensitive areas.	Negligible to significant
	Visual impacts	Careful site design and complying with NHPA Section 106 process.	Negligible to significant
	Enhanced access due to new access roads	Careful site design and complying with NHPA Section 106 process.	Negligible to significant
	Restricted access due to new security	Careful site design and complying with NHPA Section 106 process.	Negligible to significant
Operation	Visual impacts	Careful site design and complying with NHPA Section 106 process.	Negligible to significant
	Enhanced access due to new access roads	Careful site design and complying with NHPA Section 106 process.	Negligible to significant
	Restricted access due to new security	Careful site design and complying with NHPA Section 106 process.	Negligible to significant
Maintenance	Minor ground disturbance	Avoidance of known resources. Careful site design. Monitoring by archaeologist in sensitive areas.	Negligible to moderate
	Wildfire	BMPs and SOPs	Negligible to moderate

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Installation-specific ICRMPs are the framework for managing and protecting cultural resources and complying with laws and regulations. Consultation requirements for such an undertaking are directed by NHPA Section 106 or by an existing agreement between the Army and the consulting entity.

As with Alternatives 1 and 2, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

If careful application of the checklist to the proposed project at an installation requires a "yes" or "maybe" response to any cultural resources checklist item, then additional environmental analysis of potential impacts to cultural resources could be required and should be conducted as part of an installation-level, site-specific NEPA process. If the installation concluded that additional NEPA analysis for cultural resources was necessary, it would be required to be prepared before any irreversible and irretrievable commitments of resources occurs on the proposed action, should it be implemented. Site-specific analysis in support of NHPA Section 106 would be required and would assess the Army's undertaking on historic properties as well as seek consultation with the appropriate SHPO, Tribes and interested parties.

4.10 Socioeconomics

Socioeconomics is defined as the basic attributes and resources associated with the human environment, particularly population and economic activity. Economic activity is typically affected by sales, income, employment, and population. Effects on these fundamental socioeconomic components can influence other issues such as housing availability and the provision of public services. The principal factors affecting socioeconomics at Army installations are construction project expenditures; population changes as a direct result of Army growth or reduction actions; salaries (i.e., soldier, civilian, and contractor); and procurement of goods and services locally and regionally by soldiers, civilians, and their family members.

As the Army manages its natural resources, some of those resources may be placed under the Army's forestry, agricultural, or grazing programs. These programs, tied to socioeconomic indicators, are only permitted if compatible with the installation's INRMP (16 USC § 670a). Through the forestry program, for example, revenues supporting installation natural resources management activities are generated by the sale of forest products, such as saw timber, firewood, pulp wood, and pine straw. The agricultural and grazing out-lease program, executed in accordance with 10 USC § 2667, supports natural management resources and minimizes Army costs to maintain the land, roads, and fences associated with the program (e.g., a hay lease may be a viable alternative for contract mowing).

For the purposes of this report, recreational activities will be included in the socioeconomic section. On Army installations, in addition to the normal, recreational activities that take place in outdoor, urban environments (e.g., on ball fields or playgrounds), hunting and fishing activities are often available in accordance with 16 USC § 670a(b). Hunting and fishing programs provide recreational opportunities for soldiers and their family members, civilians, and the general public in controlled environments while supporting the installation's natural resource conservation and rehabilitation goals. Opportunities made available are done so within the constraints of the military mission, safety, and fish and wildlife resource needs.

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, requires federal agencies to assess the potential for disproportionate occurrence of effects of federal projects on minority and low-income populations. For the purposes of this analysis, those groups are defined as follows:

- **Minority Population:** Persons of Hispanic origin of any race, blacks, American Indians, Eskimos, Aleuts, Asians, or Pacific Islanders.

- **Low-Income Population:** Persons living below the poverty level, according to income data collected in U.S. Census 2010.
- **Youth Population:** Children under the age of 18 years.

In addition, EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, requires federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children. Such risks to health and safety are attributable to products or substances that a child would be likely to come in contact with or ingest.

Socioeconomic effects for any proposed site should be evaluated in terms of their locality, duration, intensity, and whether they would be beneficial or adverse. Construction effects would likely be local, short-term, negligible, and beneficial.

4.10.1 Existing Conditions

As of October 2014, the Army had 156 installations around the world (not including forward operating bases used in contingency operations) (DA 2015a). These installations included over 198,000 permanent party barracks spaces and over 100,000 family housing units (i.e., 16,009 Army-owned units, 6,433 leased units, and 86,531 privatized units). The installations supported a population of 508,210 active Army, 195,438 Army Reserve, and 354,072 Army National Guard military personnel; 248,947 Civilian employees; and 926,827 retired military personnel. More than 55 Army installations have forestry programs; 40 have hunting and fishing programs; and 35 have agricultural/grazing programs (AEC 2016). In fiscal year 2012, the forestry program generated $16 million in proceeds, of which $12.1 million was returned to installations to support program execution; hunting and fishing programs generated $1.8 million; and the agriculture and grazing out-lease program revenues were approximately $3.5 million (AEC 2016). When located in more rural areas or near smaller communities, an Army installation may be the largest employer and contributor to the surrounding economy. In larger urban areas, the percent of contribution from the installation may be less but still substantial. In addition to direct socioeconomic impacts, Army installations can influence the type and availability of off-post housing, employment and educational opportunities, community services and related infrastructure, industrial operations, and commercial activities.

In the United States, the solar industry has grown, adding workers at a rate nearly 12 times faster than the overall economy in 2015 and increasing 123 percent from 2010 to 2015. As of November 2015, the U.S. solar industry employs nearly 209,000 solar workers and accounted for 1.2 percent of all jobs created in the United States in 2015. Approximately 7,430 MW of solar energy capacity was installed in 2015 (TSF 2016).

4.10.2 Environmental Consequences

Multiple factors are considered in determining the extent to whether the proposed action would affect the socioeconomic structure, including the extent or degree to which its implementation would 1) change the local housing market or vacancy rates, particularly when compared to the availability of affordable housing; 2) increase student enrollment beyond the capacity of the local schools; 3) change any social, economic, physical, environmental, or health conditions so as to disproportionately affect low-income or minority populations; or 4) disproportionately endanger children.

Impacts to socioeconomics would be considered significant if the proposed alternatives caused 1) a substantial change to the sales volume, income, employment, or population on the installation and in the communities and counties in the immediate area; 2) substantial disproportionate adverse economic, social, or health impacts on minority or low-income populations; 3) substantial disproportionate health or safety risks to children; 4) long-term substantial loss or displacement of recreational opportunities and resources relative to the baseline; or 5) a substantial increase in demand for public services (e.g., fire protection, police enforcement, and education). The ROI for this resource area is within the boundaries of the installation and the immediate surrounding communities and counties.

4.10.2.1 No Action Alternative

Under a no action alternative, there would be no change to socioeconomics or environmental justice. Implementing the no action alternative would result in a negligible, short-term adverse economic impact because no construction activity would be realized. Consequently, impacts to socioeconomics as a result of the no action alternative are anticipated to be negligible, short-term, with no long-term impacts.

4.10.2.2 Alternatives 1, 2, and 3: Wastewater, NWOTUS, and WOTUS

Short-term, beneficial impacts on the economy would occur as the result of construction activities (Table 16). A 1-MW array would require construction workers to be on-site for several months. A larger array would likely take longer to complete. Compared to the 10,000-plus full-time permanent workers on most major Army installations, this short-term impact would be minor.

Some long-term operation and maintenance will be required during operation of a floating solar installation. On-site labor is required to support operation, routine maintenance, and various levels of non-routine maintenance. Publically available empirical cost data related to solar power operations and maintenance (O&M) is limited. Based on the data available, Lawrence Berkeley National Laboratory (LBNL) estimates the average O&M expenses for utility-scale land-based solar PV installations to be approximately $15 per kW (installed capacity) per year, where overall O&M expenses vary based on the size and hours of operation of the installation (LBNL 2016). Although some of the routine and non-routine O&M activities for a floating solar installation would be distinct from land-based solar installation, it is reasonable to assume the level of O&M expenses would be in a similar range to land-based estimates and that they would vary by the size of the installation. The operator of two co-located solar PV facilities in California reported that the combined 479 MW facility required 15 full-time, on-site workers, and up to 25 additional intermittent and/or part-time jobs on an annual basis (SunPower 2016). Scaling this employee and cost data by the capacity of the facility, it is estimated that one full-time, on-site O&M worker would be required for every 40 MW of installed solar PV capacity, with up to two workers required on a part-time and/or intermittent basis throughout the year. Thus, based on these estimates, the O&M requirements for a 1 MW solar installation would be less than one full-time worker required on a full-time and/or part-time intermittent basis. Consequently, the long-term economic impact as a result of workforce growth is anticipated to be none to negligible and no substantial increase in demand for public services would be required.

While impacts to utility rates and local or regional plans for utility or power generating infrastructure upgrades are unlikely as a result of the proposed action, it is possible that a large solar PV project on an Army site that is connected to the off-post power grid could indirectly impact the local or regional economy. For example, a large project could affect utility rates, influence a local power provider's decision(s) to seek other renewable or nonrenewable power sources, or otherwise affect other energy-related decisions by government or private parties regarding power generation. These impacts are speculative and difficult to anticipate or analyze programmatically; nevertheless, no significant economic impacts are anticipated as a result of proposed action.

The siting of a floating solar PV system would consider impacts to outdoor recreation, such as hunting and fishing programs, as well as any other forestry programs, and the agricultural/grazing out-lease programs. Access to recreational resources and programs may be affected under Alternatives 1, 2, and 3. Revenues lost as a result of removing land or access to bodies of water from a conservation reimbursable or fee collection program would be proportionately small, with short- and long-term negative impacts anticipated to range from none to negligible. Lessees who have long-term expectations for out-leases due to the specification contained in 10 USC § 2667 may not be able to use the affected area for the life-cycle of the solar PV project. Lost recreational opportunities would be a factor of the location and size of the solar PV system relative to the baseline of available opportunities. Recreational impacts should also consider the impacts of fencing on paths taken by current recreational users. Impacts may be minimized through site selection to avoid or reduce the area of the proposed project or the size of the system. Impacts to recreational activities as a result of Alternatives 1, 2, and 3 are anticipated to range from none to moderate both in the short- and long-term. Siting of a proposed floating solar PV system would also need to consider whether the site of the proposed project is disproportionately affecting low-income or minority populations. With proper site planning, disproportionate adverse impacts to low-income or minority populations as a result of construction, operation, and maintenance could be avoided; thus, these impacts are anticipated to be none to negligible.

Construction of a floating solar system on a chemically treated or wastewater pond or lagoon would likely involve use of temporary structures adjacent to the waterbody for storage and assembly of floating solar array components and some temporary, near-shore, in-water structures for deploying the assembled system. A variety of storage, assembly, and deployment structures could be used. The type of structures and the area disturbed during construction would depend on the site-specific nature of the shoreline and the waterbody, and on the size of the assembled floating solar system. A chemically treated water/wastewater pond or lagoon may have specific features to consider, such as a "shoreline" that consists of a berm, and a bottom liner, both of which would need to remain undamaged during construction. Vehicle access to the construction area would be required for transportation of personnel and delivery of system components. Boat access could be required for towing array components to the final location. These impacts would be localized to the vicinity of the construction area (Table 16).

Floating solar arrays and power systems adjacent to or in the viewshed of off-post residential areas could reduce residential or other land-use property values; however, a review of the literature found no research specifically aimed at quantifying impacts to property values based on solely on proximity to utility-scale PV facilities (MDC 2015). Consequently, the impact to the value of one particular off-post property based solely on its proximity to a PV facility on Army land would be difficult to determine. Widespread negative impacts to off-post property values would not be likely (Table 16). The extent to which an existing site was used as a recreational resource or in proximity to a recreational resource would affect the potential socioeconomic impact of the alternative. A 1 MW array with about 3,500 panels would cover approximately 7 ac of water.

Maintenance activities for a floating solar array would include periodic inspection and repair of float components, solar panels, anchor points, anchoring cables; and electrical cables and connections. Floating solar arrays would be cleaned periodically. It was assumed that array washing would occur using only water and no cleaning chemicals. Potential effects of floating solar array maintenance activities include ground disturbance from maintenance vehicles servicing the facility, and spills or leaks from maintenance vehicles and equipment. BMPs would mitigate these potential impacts (Table 16).

Table 16. Summary of Actions, Impacts and Mitigation Strategies[a] for all Alternatives on Socioeconomics

Action	Impact	Mitigation	Impact Determination
Construction	Environmental Justice impacts should be evaluated for each site	Any disproportionate impacts to minority, low-income, or youth populations should be mitigated	Short-term, negligible with mitigation
	Economy – Increased number of workers	Additional workers on-site would benefit the area economically	Short-term, moderate and beneficial
	Aesthetic and recreational resource disruption	Careful site design, Avoidance of known resources	Short-term, negligible to moderate
Operation	Environmental Justice impacts should be evaluated for each site	Any disproportionate impacts to minority, low-income, or youth populations should be mitigated	Long-term, negligible with mitigation
	Economy	Negligible impact expected for economy in long-term, but would be dependent on size and scale of installation	Long-term, negligible
	Aesthetics and Recreational Resources	Careful site selection and design, BMPs	Long-term, negligible to moderate
Maintenance	Aesthetics and Recreational Resources	BMPs/SOPs	Negligible

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

The impacts of this alternative would not have disproportionate adverse impacts on children, because no aspect of the proposed action as currently envisioned would increase the risks described in EO 13045. If the floating solar array and power system site were located within reasonable walking or bicycling distance of children, with no existing security measures restricting access to the proposed site, a security fence and gate would be erected to preclude children from having access to the site and around construction staging areas. If the proposed project included construction of ESSs, microgrid facilities, or a substation, a permanent security fence would be erected around these assets.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.11 Transportation and Traffic

Transportation is the movement of people and goods from one location to another. It is accomplished by a variety of modes, such as road, rail, air, water, and in some cases pipeline, and there are different systems within those modes. Examples of principal transportation systems include vehicular systems (e.g., highways and streets); aviation system (e.g., commercial air carriers), waterway and maritime systems, and rail systems (e.g., railroads). Traffic is related to the congestion of the applicable system being able to handle traffic flow during peak volumes. Vehicular traffic is rated on level of service (LOS), a qualitative measure graded on a letter scale from A to F, with A being the highest LOS and F being the lowest. At LOS F, traffic flow is forced, the traffic volume has exceeded the capacity of the roadway to handle it, and there are no passing opportunities.

4.11.1 Existing Conditions

Army installations are like small cities, with adjoining rural areas, and have highways and streets throughout. Roadways and traffic are concentrated in areas where there are buildings, such as in cantonment areas. Many Army installations have expansive training areas with limited roadways and traffic only in support of training exercises or, at some installations, testing exercises. Some Army installations support rail transportation and a number of installations have multi-use airfields and heliports. As of September 2015, Army installations collectively had over 152,000 lane miles of paved and unpaved roads; 2,171 mi of railroads; over 28,000 linear ft of bridges; 57 multi-use airfields; and 24 heliports (DA 2015a). Transportation planning is part of the real property master planning efforts on installations.

At most installations, the main gate is the most heavily used vehicular access gate, with peak flows associated with the start and end of the average employee's work day. The number of additional access control points (ACPs) varies at installations and may include ACPs to support temporary construction traffic.

At most installations, roads serving the cantonment area are paved whereas roads serving the training and testing areas are mostly unpaved. The condition of unpaved roads varies, with erodibility factors primarily influenced by soil type and weather.

Military vehicles use a combination of public roads, installation roads, and military vehicle trails. Vehicle convoys using public roads typically are limited in size and have requirements governing the spacing between each vehicle in the convoy. Convoy procedures reduce noise levels and prevent the convoy vehicles from dominating local traffic flow for long periods of time.

Airfields and helipads on Army installations support training of military aircraft and their crew. Army aviation systems also support air transportation of soldiers and equipment.

4.11.2 Environmental Consequences

Impacts to transportation and traffic would be considered significant if the Army actions cause a reduction by more than two LOSs at roads and intersections within the ROI. The ROI for this resource area is within the boundaries of the installation and on nearby, off-post public transportation networks (e.g., roadways).

4.11.2.1 No Action Alternative

There would be no change to transportation and traffic as a result of the no action alternative.

4.11.2.2 Alternative 1: Wastewater

There would be an increase in vehicle traffic associated with construction of the floating solar project, but no perceptible increase in vehicle traffic associated with the operation and maintenance of the floating solar array and support infrastructure.

A 1 MW floating solar array would require multiple trucks carrying material (e.g., solar modules, inverters, and racking) and vehicles would be required to transport construction workers to the site daily. During equipment delivery, there could be weekly truck deliveries. A 1 MW array would require several months for construction, with variance based on weather and site conditions. Mitigation measures to minimize traffic impacts during construction could include limiting what ACP(s) would be permitted to be used by the construction vehicles and scheduling deliveries to avoid poorly rated roads (e.g., LOS E or F) and intersections during peak usage times.

Construction of a floating solar array on a chemically treated or wastewater pond or lagoon would likely involve use of temporary structures adjacent to the waterbody for storage and assembly of floating solar array components and some temporary, near-shore, in-water structures for deploying the assembled system. Vehicle access to the construction area would be required for transportation of personnel and delivery of system components. Boat access could be required for towing array components to the final location.

To the extent possible, floating solar arrays would be sited on waterbodies with access to existing roads. Depending on the location of the floating solar array and power system, the construction of unimproved roads to access the site for construction and maintenance activities could be required. If new roads were necessary, BMPs would be implemented to ensure that the road would not adversely affect surface runoff. In addition, BMPs would be implemented to ensure that appropriate features such as rolling dips or flat land drains would be implemented as necessary to remove stormwater from unimproved roads in a way that minimized erosion and preserves the driving surface. Intersections of new improved or unimproved roads with existing roads would be appropriately signed to enable safe passage at the intersection.

Site locations proposed near or adjoining airfields have the potential for the proposed project to impact air traffic and military aircraft operations; potential impacts are discussed in Section 4.12.2 of this report. The anticipated impact to vehicular transportation and traffic would be short-term and minor for construction of the floating solar array and power system, and negligible for floating solar array O&M. Impacts to other transportation systems, to include rail and air, would not result from the implementation of the proposed action (Table 17).

4.11.2.3 Alternative 2: NWOTUS

Alternative 2 potential impacts would be similar to those of Alternative 1, although construction of floating solar array systems on some NWOTUS could generally have fewer effects to transportation and traffic if the proposed site had and retains remnants of a relatively extensive transportation network within the site (Table 17).

4.11.2.4 Alternative 3: WOTUS

Alternative 3 potential impacts would be similar to Alternative 2; though construction-related impacts to traffic would be moderate if the proposed site selection were in proximity to a recreational resource with adjoining roads already in use (Table 17). Adjoining roads could need to be temporarily closed and traffic diverted during construction.

As with Alternatives 1 and 2, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Table 17. Summary of Actions, Impacts and Mitigation Strategies[(a)] for all Alternatives on Transportation and Traffic

Action	Impact	Mitigation	Impact Determination
Construction	Increased traffic and trucks on roads	Use and improve existing roads when available. Use BMPs and ACPs when necessary. Encourage carpooling for workers	Short-term, negligible to moderate
Operation and Maintenance	Increased traffic accessing floating solar installation	Careful site selection and design, BMPs	Long-term, negligible

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

4.12 Airspace

The Federal Aviation Administration (FAA) manages all airspace within the United States and its territories. The FAA recognizes the military's need to conduct certain flight operations and training within airspace that is separated from that used by commercial and general aviation. The FAA has established various airspace designations to protect aircraft while operating near and between airports and while operating in airspace identified for defense-related purposes. Due to the unique nature and frequency of military operations, the airspace over Army installations is generally a form of restricted use or a special use airspace. The Army manages airspace in accordance with DoD Directive 5030.19, *DoD Responsibilities on Federal Aviation* (DoD 2013). The Army implements these requirements through AR 95-2, *Air Traffic Control, Airfield/Heliport, and Airspace Operations* (DA 2016b). Use of military airspace on Army installations is typically scheduled through the installation's Directorate of Plans, Training, Mobilization, and Security.

Expanding the production and transmission of renewable energy and ensuring a modern and resilient commercial electrical grid can impact military readiness and operations, including the Army's research, development, test, and evaluation activities. In 2011, Congress endorsed and empowered the DoD Siting Clearinghouse to coordinate a comprehensive mission compatibility evaluation process to ensure the robust development of renewable energy sources and the increased resiliency of the commercial electrical grid in the U.S., while minimizing or mitigation any adverse impacts on military operations and readiness (Public Law 111-383 § 358). The DoD Siting Clearinghouse coordinates and oversees the military's review of project applications submitted for permitting through the FAA's Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) process (49 USC § 44718). One evaluated airspace consideration examines whether solar power towers and electrical transmission towers sited in or under designated low-altitude military training routes and special use airspace present a serious collision hazard to military aircraft. Another airspace consideration examines whether the momentary "glint" or longer duration "glare" reflecting off of solar systems presents a hazard to aircraft and air traffic control tower operations. These are just two of many airspace considerations examined.

Equipment using the airspace over Army installations may include helicopters, planes, and unmanned aerial vehicles. Training activities which may require special use airspace designation by the FAA include firing of certain artillery and mortars; unmanned aerial system operations; military specific aircraft maneuvers; some types of laser training activities; and some types of research, development, testing, and evaluation efforts.

4.12.1 Existing Conditions

As of September 2015, Army installations included over 12.2 million ac of U.S. land, all with airspace above. This airspace supports military training and testing operations, which includes operations at 57 multi-use airfields and 24 heliports (DA 2015a).

PV solar modules use silicon to convert sunlight to electricity and silicon is naturally reflective. To mitigate this natural reflectivity, solar modules use a layer of anti-reflective material that still allows sunlight to pass through to the silicon. Recent modules include the anti-reflective material on the outer surfaces of the glass and use a roughened protective glass surface to further limit glint (a momentary flash of light) and glare (a more continuous source of excessive brightness relative to the ambient lighting) [referred to henceforth as just glare]. The area of the aluminum frame is very thin and, therefore, reflection from the aluminum is not a concern (TRB 2011).

4.12.2 Environmental Consequences

Impacts to airspace would be considered significant if Army actions lead to a violation of FAA regulations that affect aviation safety, result in substantial infringement of private or commercial flight activity, or substantially impact military aviation missions. The ROI for this resource area is the airspace above the installation and surrounding aviation assets.

4.12.2.1 No Action Alternative

There would be no change to airspace use at an installation under the no action alternative.

4.12.2.2 Alternative 1: Wastewater

Floating solar arrays deployed on waterbodies would only affect airspace through the addition of distribution lines, ESS, substation expansion or construction (if needed), and the aforementioned glare.

Floating solar arrays would be less than a single-story structure. Distribution lines, although possibly more than one story in height, would be generally linear in nature and would, to the maximum extent practicable, follow existing rights-of-way using existing utility corridors. If lines were of sufficient height in some locations, additional lighting of poles could be required. Site design of permanent nighttime lighting to support operations should be set at the lowest height possible and shielded so that it would be directed only toward areas needing illumination. Coordination with installation aviation organizations and/or the Test Center Commander would be required during design to minimize or eliminate potential impacts to low-level aviation training and testing. ESS and microgrid infrastructure would typically be no more than one story in height, but could require additional acreage and, based on related distributed energy systems, would be dependent on the storage system and optimal location for a microgrid. A substation, typically on less than 2 ac and one story in height, could be required if existing substations are insufficient to meet the new power load. In general, smaller installations would likely to be able to site smaller floating solar arrays and power systems and conversely, larger installations could be able to site larger floating solar arrays and power systems. At these heights, the proposed project would not result in a request for the FAA to change any airspace designations unless the location of new transmission lines or needed infrastructure conflicted with ongoing airspace operations. Under such circumstances, it was assumed that the location of these elements of the proposed action would be modified or their designs altered to avoid any such conflicts

Anti-reflective crystalline solar PV modules possess reflectivity properties from 2 to 7 percent, meaning 93 to 98 percent of the light from the sun's rays are absorbed into the solar module and not reflected out. As shown in Figure 9, these reflectivity levels are much lower than those of water, wood shingles, bare soil, and vegetation (TRB 2011). Nevertheless, solar PV systems have the potential to cause glare from various solar energy components,

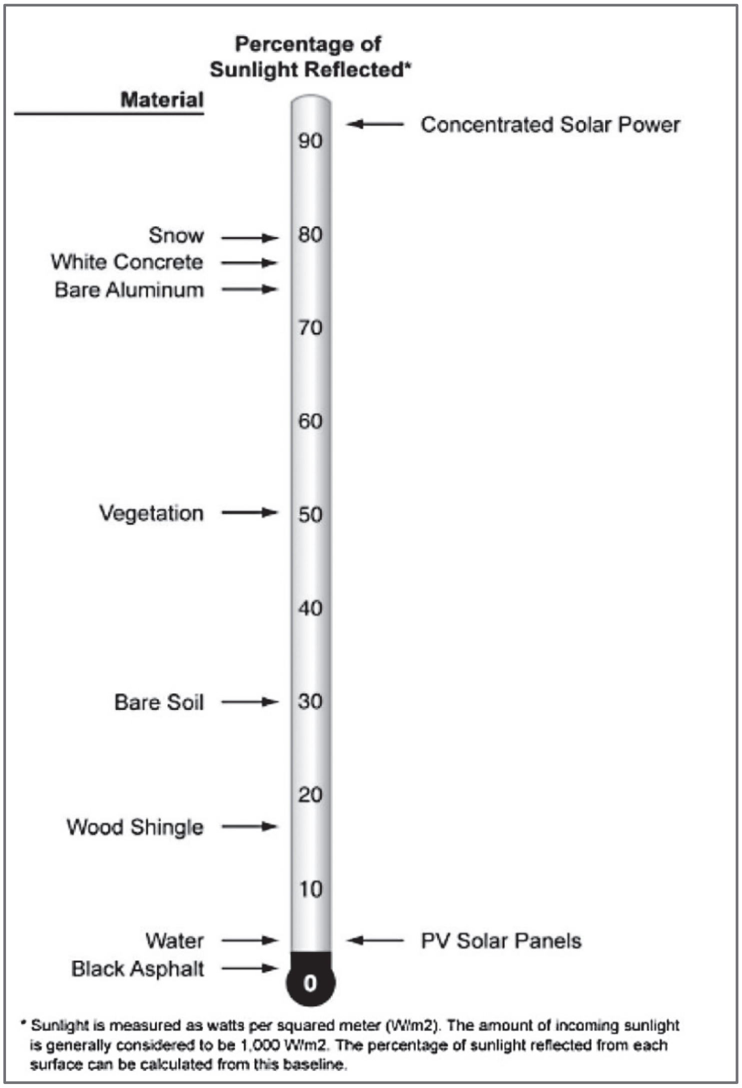


Figure 9. Reflectivity Scale (FAA 2010)

Impacts of glare on eyesight can include discomfort, disability, veiling effects, after image, and retinal burn (Ho 2013). Figure 10 provides an example of glare from a rooftop array. Glare intensity and size are impacted by the size and orientation of reflective surfaces relative to the observer, atmospheric humidity levels, and particulates in the air. Because of the potential risk of glare to aircraft safety, codes and regulations seek to prevent unwanted glare from impacting airports and aviation operations (OEERE 2016). In 2010, the FAA issued the *Technical Guidance for Evaluating Selected Solar Technologies on Airports* (FAA 2010) and in 2013, the FAA issued an interim policy—still in effect as of 2016—replacing some sections of the 2010 guidance with new information based on more recent field experience (FAA 2016). The results of one study, conducted to support analysis of a large solar array system at Nellis Air Force Base in Nevada, indicated that "under the worst case scenario, there would be a slight potential for an after image or flash glare resulting from reflected direct sunlight. This after image or flash glare is similar to the potential for flash glare due to water and less than that due to weathered, white concrete and snow" (USAF 2011). Mitigation of glare includes selecting materials that reduce reflectivity, ensuring proper design and siting of floating solar arrays to minimize or eliminate impacts to aviation traffic and training activities, and having pilots use glare shields and sunglasses. Glare shields and sunglasses typically reduce radiation by approximately 80 percent (USAF 2011).

Figure 10. Solar Glare Example (Sandia 2014)

For any potential floating solar array on an Army installation, the potential hazard of solar glare would need to be evaluated. When the proposed project requires approval by the FAA (e.g., potential impacts to airports and safe flight operations), the FAA review process includes coordination with, and review by, the DoD Siting Clearinghouse. Sandia National Laboratories, for example, offers a Solar Glare Hazard Analysis Tool, Empirical Glare Analysis Tool, and Analytical Glare Estimation Tool available online from https://share.sandia.gov/phlux. For all large-scale renewable energy projects, the Army has established a review process through the Office of Energy Initiatives, which includes glare hazard determinations. This process, together with application of siting and design criteria, would assist in the identification of any potential impacts to flight operations, ensuring compatibility with air/ground operations, training, testing, and operational mission requirements. As a result, there would be no significant effect on airspace.

The design and construction of any floating solar array power distribution lines needed to connect the floating solar array to an installation electrical distribution system or the grid could impact low-level training routes used by military aircraft within the installation boundaries. Coordination with installation aviation organizations would be required to minimize or eliminate potential impacts to low-level aviation training.

Site-specific studies and coordination with the installation air operations; air traffic; and airspace managers, range managers, and users would occur for each floating solar array site. FAA coordination would also be needed for arrays where glare could affect federal airspace.

The impact of construction, operation, and maintenance of floating solar arrays and supporting power infrastructure on airspace resources would be negligible (Table 16).

4.12.2.3 Alternative 2: NWOTUS

Similar consequences as Alternative 1 would occur for Alternative 2 because the same types of airspace impacts would occur to connect a floating solar array to the base distribution system, substation, ESS, and microgrid components regardless of the type of waterbody utilized (Table 18). Careful siting and design would minimize airspace use impacts and ensure compatibility with any regulatory requirements.

4.12.2.4 Alternative 3: WOTUS

Similar consequences as Alternatives 1 and 2 would occur for Alternative 3 because the same types of airspace impacts would occur to connect a floating solar array to the base distribution system, substation, ESS, and microgrid components regardless of the type of waterbody utilized (Table 18). Careful siting and design would minimize airspace impacts and ensure compatibility with any regulatory requirements.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Table 18. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Airspace

Action	Impact	Mitigation	Impact Determination
Construction	Transmission line poles and any facilities that might be more than one story could affect air space uses	Minimize height of supporting infrastructure buildings and poles and add marker lighting if required	None-to-negligible adverse impacts, both short- and long-term
Operation	Glare from solar arrays	Select solar arrays that generate the minimum amount of glare and where feasible orient solar arrays to prevent glare interference with airspace	None-to-negligible adverse impacts, both short- and long-term
Maintenance	NA	NA	NA

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

4.13 Electromagnetic Spectrum

The electromagnetic spectrum is the entire range of electromagnetic radiation, characterized by frequency and wavelength. The electromagnetic spectrum extends from radio waves, which have the longest wavelengths and lowest frequencies; to gamma rays, which have the shortest wavelength and highest frequencies. Most commonly deployed communication platforms operate within these ranges, including short-wave radio, microwave, and fiber optics.

Communication systems interference includes negative impacts on radar, satellite, navigation aids, and infrared instruments due to a variety of reasons. Radar or satellite interference occurs when objects are placed too close to a radar antenna or satellite communication device, reflecting or blocking signal transmission between the generation point and the receiver. Impacts to radar or satellite communications can result from adjacent or structural interferences such as overhead transmission lines or unintentional constraints (e.g., competing or congested radio frequencies). Specific to solar facilities, impacts to infrared communication systems can occur in cases where retained heat from the solar panel is released into the surrounding environment, and picked up by infrared communications in aircraft causing an unexpected signal. The DoD Siting Clearinghouse review, discussed in Section 4.12, also considers electromagnetic interference impacts on aircraft safety operations and critical test activities. This review is required for renewable energy projects which require an FAA permit through the FAA's OE/AAA process (49 USC § 44718).

Spectrum-related activities associated with the military are subject to the policies and procedures of several federal agencies. At the highest level, communication spectrum management and inventory falls under the authority of the National Telecommunications and Information Administration, as part of the U.S. Department of Commerce. The policies and procedures for spectrum use by federal agencies are contained in the *Manual of Regulations and Procedures for Federal Radio Frequency Management* (NTIA 2015), more commonly referred to as the *National Telecommunications and Information Administration Manual*. In addition to the manual, DoD has well-established and detailed policies and procedures for the use of the electromagnetic spectrum by DoD agencies. Finally, DA has its own policies and procedures guiding the spectrum-dependent activities of Army entities. Regulations and procedures relevant to Army spectrum management issues are addressed in AR 5-12, *Army Use of the Electromagnetic Spectrum* (DA 2013b).

4.13.1 Existing Conditions

Military mission operations include communications, navigation, and targetry using radar, satellite, and infrared instruments. Some installations have a higher degree of mission-related activities involving radio frequency and spectrum use. In addition to using the electromagnetic spectrum to accomplish training activities, some installations have missions that involve the testing of communications and electronic equipment utilizing the Military Electromagnetic Range; this frequency coordination zone is protected for use by federal mandate.

Safe operations of private and commercial aviation also depend on many similar communication components, and some Army installations are adjacent to, or near, non-military airfields.

4.13.2 Environmental Consequences

Impacts to radio frequency and the communications spectrum use would be considered significant if Army actions were to cause mission failure, including those activities related to training and testing requirements. The ROI for this resource area is the installation and adjoining communities.

4.13.2.1 No Action Alternative

No impacts on radio frequency and the communication spectrum use would occur because no construction activities would occur under the no action alternative.

4.13.2.2 Alternatives 1, 2, and 3: Wastewater, NWOTUS, and WOTUS

No appreciable differences exist between or among Alternatives 1, 2, and 3 that would result in assigning a different impact level with regard to the electromagnetic spectrum; therefore, this section is applicable to all three alternatives.

Under the proposed action, the construction and operation of a floating solar array and power system would lead to the collection of solar radiation from the electromagnetic spectrum, including visible wavelengths, to produce an electric current.

All electrical generation systems produce electric and magnetic fields, and could potentially cause electromagnetic interference. Typically, small-scale systems (e.g., solar-powered street signs and lights) generate a negligible amount of electromagnetic interference. Larger systems (e.g., the floating solar arrays envisioned in the proposed action, along with ancillary power control systems such as ESS and microgrid components) have a greater potential to generate electromagnetic and radar interference that could adversely affect mission-critical testing and training operations.

In addition, the metallic components of floating solar arrays would have the potential to cause reflection of radar transmissions. To reduce the potential for impacts to ongoing and future missions and/or training, project siting factors would need to consider the location of signal-generation points (e.g., radar transmission facilities) and receivers. For example, the solar fields at Oakland International Airport and Meadows Field Airport, both in California, were required to meet set-backs from transmitters of 500 and 250 ft, respectively (TRB 2011). Due to their low profiles, however, most solar modules, including those in the proposed action, represent little risk of interference with radar transmissions (FAA 2010). In addition, the floating solar modules would not emit electromagnetic waves over distances that could interfere with radar signal transmissions (FAA 2010). However, to appropriately avoid or minimize potential impacts, stakeholder coordination would be critical during the scoping, design, and siting of the proposed floating solar array and power system. For proposed sites in proximity to off-post airfields, coordination may be required with the FAA to ensure aviation communications and safety is maintained.

Communications between physical assets is typically a significant part of energy storage and microgrid-based systems operations. Such communications could be carried out through a variety of methods, almost all of which involve incidental (wired) to intentional (wireless) electromagnetic radiation. Communications between a centralized control center and the ancillary power control system assets is necessary to ensure safe and reliable operation, particularly during the onset of emergency events, or the islanding of the microgrid system itself.

Construction activities are not anticipated to provide any short-term, adverse impacts to the electromagnetic spectrum. O&M of the proposed solar PV project is not anticipated to be a significant source of electromagnetic interference nor are any major impacts to electromagnetic spectrum use anticipated.

If the proposed project includes the construction of aboveground transmission lines, siting consideration would need to be taken to ensure the location of signal-generation points and receivers would not impact mission-critical systems. Potential long-term impacts to operations that are not mission-critical may range from none to moderate/less than significant. If the proposed project included the construction and operation of ancillary power control systems, the locations of the signal-generation points and receivers must not affect mission-critical systems. With the implementation of appropriate mitigation measures in the siting and design of the ESS, impacts would be to be negligible (Table 19).

Table 19. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Electromagnetic Spectrum

Action	Impact	Mitigation	Impact Determination
Construction	NA	NA	Negligible short-term and long-term impacts
Operation and Maintenance	Communications interference	Identify signal generating and receiving devices Follow Army guidelines and regulations for telecommunications and EMF/radio frequency transmission Meet minimum set-back requirements	Negligible short-term and long-term impacts

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.14 Utilities

Utilities furnish an everyday necessity to the public at large, including provisions of electricity, natural gas, water, telecommunications, wastewater-management services, solid-waste-management service (nonhazardous), and other essentials. Utility operators and maintenance personnel are required to comply with applicable federal, state, local, or host-nation certification requirements. Further, relative to the service provided, specific facilities such as a wastewater-treatment plant, will also have specific statutory and regulatory requirements governing their design and operation.

4.14.1 Existing Conditions

Army policy is to provide safe, reliable, efficient, and life-cycle cost-effective utility services that promote the health and welfare of soldiers, civilians, family members, contractors, and retirees and that provide the capability for garrisons to accomplish assigned missions (DA 2012a). The primary regulation guiding utilities management on Army installations is AR 420-1, *Army Facilities Management* (DA 2012c), with environmentally related components also addressed in AR 200-1 (DA 2007).

Some installations have their own facilities for electricity generation, potable drinking water production, wastewater treatment and discharge, solid waste management, and natural gas provision including distribution and/or collection systems. Installations commonly rely on utility services from the nearby community, or privatized on-site utility providers. As of September 2015, 203 Army-owned and 151 privatized utility systems on Army installations support electric, natural gas, water, and wastewater services (DA 2015a).

Installation potable water consumption and potable water consumption intensity (i.e., gallons of water used per gross square foot of facility space) continue to be reduced, having dropped 24.3 and 26.6 percent respectively from FY 2007 to FY 2013 (DA 2014a). Actions are also underway to reduce non-potable water use. In FY 2013, installations reused or recycled 43 percent of nonhazardous solid waste and 75 percent of construction and demolition debris instead of landfilling (DA 2014a). In addition, the Army is generating less waste, in part through informed decisions in the procurement process, which resulted in 2.23 million tons less waste generated in FY 2013 than in FY 2012 (DA 2014a).

4.14.2 Environmental Consequences

Impacts to utilities would be considered significant if the Army actions were to cause long-term or frequent impairment of utility service to local communities, homes, or businesses. The ROI for this resource area is the installation and immediate surrounding communities.

4.14.2.1 No Action Alternative

There would be no change to existing utilities under the no action alternative. The Army would miss an opportunity to reduce reliance on fossil-fuel power generation.

4.14.2.2 Alternatives 1, 2, and 3: Wastewater, NWOTUS, and WOTUS

No appreciable differences exist between or among Alternatives 1, 2, and 3 that would result in assigning a different impact level with regard to utilities; therefore, this section is applicable to all three alternatives.

Construction and operation of a floating solar array and ancillary power control system would be intended to displace a commensurate amount of electrical energy used on the installation, with electricity produced by solar, thereby reducing the installation's reliance on fossil fuels. The proposed action may also improve energy security for the installation. On average, a 10 MW solar array would be capable of generating approximately 24,000 MWh per year,[3] although energy generation of the solar array would be impacted by the location of the array and solar radiation. For comparative purposes, if the same solar PV panels are used, then there are no estimated differences in capacity or capacity factors between traditional land-based solar arrays and the proposed floating solar array. The Solar Energy Industries Association estimates that 164 homes on average are capable of being supplied by 1 MW of solar PV.[4] When scaled to meet minimum objectives of 10 MW, an estimated 1,600+ houses could utilize a single 10 MW floating solar array. The percent reduction in the use of gas- and fossil-fuel-derived electrical energy would therefore be a function of the location of the installation, the size of the floating solar array, and the energy use of the installation.

The floating solar array project would produce and supply electricity to the existing electrical grid owned by the Army, an on-post third-party utility provider, or a nearby utility provider. In any configuration, the

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[3] Calculated with EIA 2014/2015 average solar PV capacity factor of 27%. Accessed at https://www.eia.gov/. June 13, 2016.
[4] Accessed June 13, 2016 at https:/www.seia.org.

project would have to be designed and operated to be compatible with the existing grid system. With additional components/configurations (e.g., ESS and microgrid-based systems) intended to have the ability to execute seamless connection and disconnection with the local electrical grid, equipment designed to support integrated operations, coordination, and communications will be required between the installation and the local electrical utility. If connecting to a local utility's transmission or distribution system, the installation would have to negotiate the arrangement.

Some Army installations would use a grant or land lease with the local utility company. For example, at Fort Benning, the Army set up a 35-year utilities easement with the local power company. In this case, the utility company executed the build, own, and operate portion of the agreement, and the 30 MW solar PV array on the installation provided electricity directly into the utility company's grid (AEC 2014a). For projects connecting only inside the installations' distribution grid, a floating solar array could provide meaningful contributions to energy security.

Some potable or near-potable water is required for maintenance of the solar PV project to wash the modules. A 10 MW PV array has about 35,000 modules. Washing frequency is a function of local precipitation frequency, dust levels, and degree of air pollution. Estimates of water use for washing floating solar arrays include 16,000 gal/MW/yr (BLM-DOE 2010), a range of 0 to 30 gal/MWhr (Klise et al. 2013), and 20 gal/MWhr (SEIA 2010). Therefore, 1 MW of installed floating solar generating capacity (DC) would use about 27,000 to 39,000 gal of water annually for cleaning (about 10 gal/panel). This is comparable to the average individual's home water use in the United States (about 100 gal per day per person [EPA, 2008]), and would be equivalent to about 0.2 in. of precipitation over the array area (assuming 7 ac/MW). A larger 10 MW facility that generates 24,000 MWh per year would require approximately 480,000 gal of water per washing. For comparison, an Olympic-sized swimming pool holds around 660,000 gal of water.

Compared to the volume of water used by a typical Army installation on an annual basis, the water needed for washing solar modules is minimal. Therefore, the anticipated impact to water utility systems would be negligible to minor. This minimal impact would also occur at locations where the wash water must be purchased and trucked in from off-post, or in more remote locations that may require use of a fill and/or discharge station (Table 20). For potential impacts to water availability, see Section 4.7, Water Resources.

Short-term negligible impacts to wastewater would occur during the construction period to support the estimated 40 to 80 construction workers that would be utilizing restroom facilities while on the job site (Table 20). Additional facilities or accommodations (e.g., outhouses or portable restrooms) and associated disposal services would be the responsibility of the project's contractor.

No significant impacts to landfills are anticipated. Contractors, who would be responsible for properly disposing of construction-related waste and debris, would be required to have waste management plans for system construction (DA 2012c). The construction contractor's waste management plan should support the Army's 50 percent minimum diversion of waste, by weight, from landfill disposal. For construction, packaging material of the solar PV system's component parts would generate solid waste under all three alternatives. A construction contractor's BMP to reduce waste could include estimating the packaging materials generated and noting whether the supplier can eliminate or recycle packaging. Smaller floating solar projects using less acreage (e.g., 1 MW system on 7 ac [2.8 ha]) would generate substantially less solid waste and debris than a substantially larger project but still remain subject to Army waste reduction objectives. Floating solar systems have no moving parts and also have relatively extended service lifetimes, typically ranging from 10 to 30 years, with some minor performance degradation over time (CRS 2015). Some of the equipment for construction, operations, and maintenance activities would come in packaging that would subsequently be disposed of in a landfill. Overall, it was assumed that negligible-to-minor impacts would occur at landfills as a result of construction and operation of a floating solar array and power system for all three alternatives (Table 20).

No impacts to other utility systems (e.g., natural gas and telecommunications) and services are anticipated as a result of the proposed action.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

Table 20. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Utilities

Action	Impact	Mitigation	Impact Determination
Construction	Potable water consumption and wastewater production Waste and debris production	Follow site-specific permitting and construction BMP practices Follow site/Army-specific plans for waste reduction and recycling where applicable	Short-term negligible to minor
Operation and Maintenance	Chemicals used to wash solar arrays	Follow site-specific environmental health and safety plans Follow permitting requirements Material safety data sheets Follow OSHA standards	Short-term negligible to minor

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

4.15 Hazardous and Toxic Materials and Waste

Hazardous and toxic materials are substances that are hazardous to health and/or the environment (e.g., combustible and flammable substances, compressed gases, and oxidizers). Health hazards associated with these materials, which also include toxic agents, carcinogens, and irritants, can cause acute or chronic reactions.

Hazardous materials (including chemicals), hazardous substances, toxic chemicals, toxic pollutants, and hazardous waste are regulated under applicable federal laws to include the CAA (42 USC § 7401 et seq.); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; 42 USC § 9601 et seq.; also known as Superfund); Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA; 7 USC § 136 et seq.); Occupational Safety and Health Standards (OSHA; 29 USC § 651 et seq.); Resource Conservation and Recovery Act (RCRA; 42 USC § 6901 et seq.); Solid Waste Disposal Act (42 USC Ch. 82) as amended by RCRA; and Toxic Substances Control Act (TSCA; 15 USC § 2601 et seq.); all, as amended. Army installations and their service providers who use, handle, and dispose of hazardous and toxic materials and waste may also be subject to state and local government requirements. Various agencies also include lists of the material and waste which they regulate. In addition, the EPA maintains a "List of Lists" which is a consolidated list of chemicals subject to the Emergency Planning and Community Right-to-Know Act (EPCRA; 42 USC § 11001 et seq.), CERCLA, and Section 112(r) of the CAA. The generation, transportation, treatment, storage, and disposal of hazardous wastes are regulated under RCRA (42 USC § 6901 et seq.). Businesses and agencies are required to adhere to applicable regulations to minimize the possibility of harm to humans and the environment by use of this type of material and the disposal of any associated waste.

As a result of past practices and activities, hazardous and toxic materials and wastes are present in some of the lands and waters of the United States and overseas. The two primary laws governing cleanup activities for these lands are CERCLA and RCRA. One method to properly dispose of hazardous and toxic materials and waste that has been removed from the environment is through landfilling with liners and caps. Liners and caps create a barrier between the contaminated media and the adjoining soils, water, and air, thereby shielding humans and the environment from the harmful effects of the contaminated site and limiting the migration of the content. In addition to promulgating regulations and guidance to enable cleanup of contaminated lands and prevent contamination from hazardous and toxic materials and waste, the EPA has a RE-Powering America's Land Initiative (EPA 2016b) which encourages development of renewable energy systems on current and formerly contaminated lands, landfills, and mine sites.

In general, the solar PV industry does use hazardous and toxic materials. However, one constituent of solar modules is silicon, which while non-toxic can have respiratory effects at high concentrations, and lead, also a health hazard is often used in solar PV electronic circuits for wiring, solder-coated copper strips, and some lead-based printing pastes. In addition, small quantities of silver and aluminum are used to make the electrical contacts on the cell. As discussed in Section 2.2.1, larger battery systems may include use of lithium-ion, sodium-sulfur, and vanadium-flow chemistries that are well suited to the large energy exchanges of microgrids and have higher energy densities than smaller lead-acid batteries. However, the health hazards of these battery systems is during the manufacturer of the batteries, and there are relatively low risks to workers during the construction or operations of a floating solar array.

4.15.1 Existing Conditions

Hazardous and toxic material use on Army installations is representative of hazardous and toxic material use across the United States and across the municipal, services, commercial, and industrial sectors. Typical hazardous materials used on Army installations include cleaning and disinfecting supplies, antifreeze, gasoline, diesel fuel, oil, lubricants, degreasers and other industrial compounds, batteries, pesticides, and explosive and pyrotechnic devices. Toxic substances include asbestos, polychlorinated biphenyls (PCBs), and lead-based paints (LBP). Many of the current uses of these materials are associated with routine maintenance of buildings, grounds, and equipment common to public and private sector operations. Some uses are associated with military training and testing activities. Residual hazardous materials generated during routine maintenance should be recovered for reuse, recycling, or proper disposal. Some hazardous materials (e.g., pesticides and fuel) are consumed in the process of performing operations and/or training. Handling, use, and storage of these hazardous materials are subject to federal and state regulations, in addition to Army and DoD regulations, including: AR 200-1 (DA 2007); AR 385-10, *The Army Safety Program* (DA 2013c); AR 710-2, *Supply Policy Below the National Level*) (DA 2008); AR 700-141, *Hazardous Materials Information Resource System* (DA 2015c); DA Pamphlet 700-16, *The Army Ammunition Management Program* (DA 1982); and AR 700-143, *Joint Service Regulation – Packaging of Hazardous Material* (DLA 2015). If hazardous and toxic material become hazardous waste, management practices would in accordance with the laws and regulations governing hazardous waste (e.g., RCRA and AR 200-1 [DA 2007]).

Army installations maintain, as appropriate and needed, less than 90- or 180-day storage areas and/or satellite accumulation points, permitted by the appropriate regulatory agency, to facilitate the collection of hazardous wastes and to ensure that the wastes are properly managed in accordance with applicable federal, state, and DoD regulations. Transportation offsite is accomplished by appropriately licensed waste management and transportation companies. Transporters must have an EPA identification number and comply with manifest management requirements.

Alternative 1 includes using chemically treated water or wastewater on an installation to construct and operate a floating solar array. A wastewater site is a constructed waterbody that contains chemically treated effluent such as a water-treatment pond or lagoon. The chemical composition of the wastewater varies depending on treatment processes and potential for subsequent use.

The Army also has sites on many of its installations that are managed under the Army's Environmental Restoration Program. The mission of this program is to return Army lands to usable condition and protect human health and the environment by performing appropriate, cost-effective cleanup of contamination resulting from past practices. It is part of DoD's Defense Environmental Restoration Program, which was established in 1986 to address hazardous substances, pollutants, contaminants, and military munitions remaining from past activities at active military installations and formerly used defense sites. Cleanup actions have been completed on many sites and, as of February 2015, the Army had 1,309 cleanup sites on active installations and 1,851 formerly used defense sites (DA 2016a). Army cleanup policy is detailed in AR 200-1 (DA 2007).

4.15.2 Environmental Consequences

Factors considered in determining whether hazardous and toxic material and waste associated with an individual project would result in a significant effect include the extent or degree to which the implementation would:

- expose military or civilian personnel, family members, or the public to areas potentially containing unexploded ordinance (UXO) or other hazardous substances without adequate protection
- cause a spill or release of a hazardous substance (as defined by 40 CFR Part 302 [CERCLA regulation], or 40 CFR Parts 110, 112, 116, and 117 [CWA regulations])
- expose the environment or public to any hazardous condition through release or disposal (e.g., exposure to toxic substances including pesticides/herbicides or open burn/open detonation disposal of unused ordnance)
- adversely affect contaminated sites or the progress of IRP, MMRP or compliance related cleanup remediation activities
- cause the accidental release of friable (easily crumbled by hand pressure) asbestos or LBP during the demolition or renovation of a structure
- generate either hazardous or acutely hazardous waste, resulting in increased regulatory requirements over the long term.

Impacts from hazardous material and waste would be considered significant if the Army actions were to result in substantial additional risk to human health or safety, to include direct human exposure; substantial increase in environmental contamination; or a violation of laws and regulations governing the management of hazardous material and waste, to include non-compliance with an installation's hazardous waste permit, if applicable. The ROI for this resource area is the installation and immediate surrounding communities.

4.15.2.1 No Action Alternative

There would be no change to hazardous material usage nor the generation of hazardous waste under the no action alternative.

4.15.2.2 Alternative 1: Wastewater

Solar PV panels are almost entirely benign in operation, and potential environmental hazards occur primarily at the production and disposal stages which would be done offsite. Solar PV modules may contain small amounts of hazardous materials that would pose no threat under normal circumstances. However, if damaged, those materials could potentially release hazardous substances into the environment. Operation of the solar modules would not generate any hazardous waste. ESSs containing chemical energy storage devices would pose additional risks as the chemicals used in these devices are frequently toxic and/or hazardous. Most battery-based storage devices use high-strength acids, and the specific chemistry of the device could also include smaller amounts of other toxic and/or hazardous materials. The volume of the toxic and/or hazardous materials would depend on the size of the energy storage device. If a spill were to occur, procedures established in the Installation Spill-Prevention, Control, and Countermeasure Plan or equivalent document would be implemented, and contaminated soil and other hazardous waste would be disposed of properly.

Most solar PV panels have long service lifetimes, typically ranging from 10 to 30 years, with some minor performance degradation over time (CRS 2015); therefore, the disposition of any hazardous material contained in any components of a floating solar array would have no near-term impacts. The rapid evolution of the solar PV industry, along with the diverse, innovative, and complex technologies involved, make it very difficult to assess all end-of-life hazards related to floating solar arrays. As solutions evolve and regulations are issued related to the management of hazardous waste from the operation and maintenance of floating solar arrays, the Army would continue to comply with applicable requirements.

Under Alternative 1, the solar arrays would be installed on wastewater bodies that could have existing contamination of hazardous or toxic materials or hazardous wastes presenting potential risk to workers or the solar equipment installed in such a waterbody. For workers, this risk is discussed further under Section 4.16, Human Health and Safety. The risk to the solar equipment would have to be assessed by the system operator prior to installation, to confirm that the waste waterbody's characteristics would fall within the compatibility requirements of the solar equipment.

The proposed action also includes risk of accidental spills and leaks from construction and maintenance vehicles. The construction contractor would be responsible for properly maintaining construction vehicles and equipment, along with any hazardous and toxic materials used in their operation, in compliance with applicable laws and regulations. The system operator would be responsible for similar activities, as related to maintenance vehicles and equipment. The contractor would also be responsible for the appropriate disposal of all hazardous wastes generated during construction in compliance with applicable laws and regulations. The system operator would be responsible for the appropriate disposal of hazardous waste generated during maintenance activities, to include, for example, broken parts and packaging material of replacement parts. All hazardous and regulated materials or substances would be handled according to safety data sheet instructions. With environmental protection measures, including BMPs and SOPs for preventing and responding to potential contamination, short-term impacts are would be minor and long-term impacts would be negligible (Table 21).

The Army follows strict SOPs for storing and using hazardous materials and disposing of hazardous waste. No new procedures would need to be implemented to comply with current requirements applicable to storing or using construction-related or operation and maintenance related hazardous or toxic materials (Table 21). Likewise, no new procedures would be needed to dispose of any hazardous waste associated with the proposed action (e.g., used oil from maintenance vehicles).

4.15.2.3 Alternative 2: NWOTUS

Under Alternative 2, the potential risk to workers or solar equipment installed in a waste waterbody under Alternative 1 would not occur. However, as under Alternative 1, installation personnel would have to confirm that any proposed waterbody would not pose unacceptable risk to workers or equipment. The remaining impacts described under Alternative 1 would also apply under Alternative 2 (Table 21).

4.15.2.4 Alternative 3: WOTUS

Under Alternative 3 the potential risk to workers or solar equipment installed in a waste waterbody under Alternative 1 would not occur. However, as under Alternative 1, installation personnel would have to confirm that any proposed waterbody would not pose unacceptable risk to workers or equipment. The remaining impacts described under Alternative 1 would also apply under Alternative 3 (Table 21).

Table 21. Summary of Actions, Impacts, and Mitigation Strategies[(a)] for All Alternatives on Hazardous and Toxic Materials and Waste

Action	Impact	Mitigation	Impact Determination
Construction	Generation of hazardous waste could impact workers or equipment	Apply BMPs, and comply with existing procedures controlling the generation, handling, storage and disposal of hazardous wastes	Negligible
Operation	NA	NA	NA
Maintenance	Cleaning of solar arrays could introduce hazardous materials affecting the environment or workers	Select nonhazardous cleaning agents to the extent possible, apply BMPs, and comply with existing procedures controlling the generation, handling, storage and disposal of hazardous wastes	Negligible

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

4.16 Human Health and Safety

A primary purpose of NEPA is to promote the "health and welfare of man" (42 USC § 4321 et seq.). The analysis of the impacts of the proposed action on human health and safety is presented throughout Chapter 4. These impacts may be more evident in some sections (i.e., hazardous and toxic materials) than in other sections. The intent of this section is to provide the public and decision makers with a more comprehensive understanding of the potential impacts of the proposed action on human health and safety. Human health and safety encompasses occupational workers (OSHA) standards and regulations (29 CFR Part 1904), and the general public. The goal of addressing human health and safety is to mitigate the risk of exposure to immediate injury and long-term health problems for workers.

4.16.1 Existing Conditions

Conditions affecting human health and safety on Army installations are similar to the conditions affecting human health and safety nationwide. Adult populations working within Army installations have occupations that include construction, education, facilities and equipment, health care, managerial and administrative, repair, services, and other related professions found nationwide. Regardless of the occupation, workplaces within Army installations must comply with OSHA and Army health and safety-related regulations (e.g., AR 385-10 [DA 2013c]).

More specifically related to the DoD, adult populations working within Army installations have occupations that provide direct tactical training support to the mission of the U.S. military. In particular, surface danger zones (SDZs) are a safety concern. A SDZ encompasses an area on the Earth and the atmosphere above it in which personnel and/or equipment may be endangered by events such as ground weapons firing or demolitions. SDZs are in place to minimize health and safety risks to facilities/equipment, installation personnel, property, and the public. Army installations comply with several safety requirements (e.g., AR 385-10 [DA 2013c]; AR 385-63, *Range Safety* [DA 2014b; DoD 2014]). The *Range Safety* pamphlet (DA 2014b; DoD 2014) gives detailed guidance for range safety standards and procedures.

MECs pose safety concerns on numerous Army installations. Because of this, ground-disturbing events must follow specific procedures to minimize MEC-related safety risks (e.g., UXO). Site-specific surveys for MECs could be necessary prior to ground-disturbing events, depending on the site in question and its past uses.

As previously mentioned in Section 4.15, Hazardous and Toxic Materials and Waste, many Army installation sites are managed under the Army's Environmental Restoration Program. Health and safety may be affected by site disturbance, which can be caused by remediation, cleanup, or other activities. EPA and Army rules and regulations exist to minimize potential adverse effects to health and safety at these sites.

Not only do Army installations have adult populations, many installations also have family housing areas with child populations. In addition, installation facilities (e.g., development centers, schools, and youth services) support these child populations. These facilities are operated in compliance with federal, state, and Army, and DoD regulations (e.g., AR 608-10, *Child Development Services* [DA 1997]; DoD Instruction [DoDI] 6055.01, *DoD Safety and Occupational Health (SOH) Program* [DoD 2014]; DoDI 6055.04, *DoD Traffic Safety Program* [DoD 2009]; and DoDI 6055.07, *Mishap Notification, Investigation, Reporting, and Record Keeping* [DoD 2011]).

Army installations provide on-site health and safety services. The LOS offered is partially dependent on the size of the installation's population. Larger installations may provide full-service hospitals, while smaller installations may only provide clinics with more complex injuries and illness treated at facilities that are off-post. All Army installations house on-site fire safety and police response services.

4.16.2 Environmental Consequences

There are three potential significant impacts to health and safety: 1) if Army actions resulted in substantial additional risk to human health and safety, 2) if Army actions included direct human exposure to activities that may threaten health or safety, or 3) if Army actions were in violation of human health and safety laws and regulations. The ROI encompasses the floating solar array and power system sites on Army installations, and the communities immediately surrounding the installations.

The proposed floating solar array alternative site must take current and potential future range SDZs into consideration. A floating solar array system would not be permitted within SDZs without waivers of safety regulations for explosives safety approvals. SDZs are site-specific and there would be no adverse impacts to public health or safety within SDZs. As such, SDZs do not warrant detailed analysis in this report.

4.16.2.1 No Action Alternative

Under the no action alternative, there would be no change to the current human health and safety status on or around the installation. The Army would fail to meet DoD requirements of reducing the negative impacts caused by dependence on fossil fuels.

4.16.2.2 Alternative 1: Wastewater

During construction, there would be minor, short-term effects on human health and safety. Construction activities would be limited to authorized personnel only, and access to the construction site would be limited. Human health risks at the construction site would be comparable to any construction site, and would include slips, trips, and falls, working in extreme weather conditions (e.g., heat, cold, rain, or wind), shocks from electrical equipment, and leaks from construction equipment. Additional risks at these alternative sites during construction, operation, and maintenance could include risks associated with boating, diving (e.g., to install bottom anchors depending on the depth of the waterbody), and water (e.g., drowning and hypo- and hyperthermia). Human health and safety could also be at risk from exposure to the chemicals or pathogenic microorganisms in water/wastewater. Comprehensive health and safety plans would focus on site-specific health and safety issues to minimize potential human health risk during construction, operation and maintenance. These health and safety plans would include the appropriate PPE that should be worn, and specific emergency response services, procedures, and evacuation measures. Extra precautions would be outlined regarding the chemicals used in the chemically treated water/wastewater, using safety data sheets, and following OSHA standards. Risks are also discussed in further detail under Section 4.15, Hazardous and Toxic Materials and Waste.

There are two potential types of maintenance for floating solar arrays: preventative and curative maintenance. Preventative maintenance could include floating solar array components (e.g., cleaning, debris removal, and panel connections or repair) or anchoring components (i.e., shore or bottom). Clean or filtered water would be used to wash and rinse the panels. Curative maintenance could include floating solar array component replacement or disassembly (i.e., float replacement or removal). Risks to workers conducting these maintenance activities could include water hazards, inhalation of aerosolized materials or water, and use of tools. In addition, there would be risks associated with transmission line or other electrical conductivity components. Power distribution lines could be overloaded (i.e., by switching equipment failure or unintentional activation), which could pose a fire hazard during dry periods. These risks would be minimized through comprehensive maintenance health and safety plans. These plans would include site-specific health and safety issues to minimize potential human health risk (e.g., appropriate safety requirements and proper tool and equipment maintenance), the appropriate PPE that should be worn, and specific emergency response services, procedures, and evacuation measures. Regularly scheduled maintenance activities would likely be minimal (i.e., would likely occur on a once-per-year basis), but could be more frequent depending on the amount of dust, snow, etc. that needs to be removed from panels.

Depending on the location of the chosen site, workers could encounter wildlife during construction or maintenance. PPE may be required to minimize exposure to insects. However, cComprehensive health and safety plans would focus on specific emergency response services, procedures, and evacuation measures if threatening wildlife-human interactions occur. To further minimize potential risk, workers should maintain a safe distance from the animal(s) and should not interact with wildlife.

The proposed action would reduce fossil-fuel emissions, resulting in fewer air quality issues, lower GHG production, and ultimately a long-term beneficial effect on human health and safety. Specifically, air quality has a direct impact on human health. There are documented effects of particulate matter in the air on cardiovascular and respiratory health, and particulate matter in the air may aggravate existing conditions (e.g., asthma or allergies). GHGs occur naturally; however, the increase in the production and concentration of GHGs has been of concern since the 1950s (Revelle and Suess 1957; Marland and Rotty 1985). One outcome of increased GHGs includes the potential to warm the Earth (Wang et al. 1976; Marland and Rotty 1985; Lal et al. 1995). A warmer climate may threaten human health and safety through an increase in heat-related illnesses and death, air pollution, spread of some diseases, and the incidence and severity of extreme weather events (e.g., storms, floods, droughts; EPA 2016c). Energy from renewable energy sources (e.g., floating solar arrays) improves human health and safety because, in contrast to other energy sources, its production creates very little air pollution and emits no GHGs. The continued threat to human health and safety would be negligible during normal operation (e.g., not during installation or maintenance).

Programmatically, the effects of construction, operation, and maintenance activities of a floating solar array system on chemically treated water/wastewater to human health and safety would be minor and short-term (Table 22). Effects from construction would be similar to any construction site and would only exist for the duration of construction. During regular operation there would be no negative effects on human health and safety. Maintenance activities, preventative and curative, would only exist for the duration of the activity. Over the long-term, floating solar panels could benefit human health and safety by reducing GHG production.

Table 22. Summary of Actions, Impacts and Mitigation Strategies[(a)] for All Alternatives on Human Health and Safety

Action	Impact	Mitigation	Impact Determination
Construction	Construction site and activities	Limited to authorized personnel Limited site access	Short-term, minor
	Slips, trips, falls Extreme weather conditions Boating, diving, water activities	Follow site-specific comprehensive health and safety plans (addresses health and safety issues, appropriate PPE, emergency response services, procedures, and evacuation measures)	Short-term, minor
	Chemicals used to treat wastewater (Alternative 1 only)	Follow site-specific health and safety plans Safety Data Sheets Follow OSHA standards	Short-term, minor
	Encounter wildlife	Remain a safe distance from wildlife Follow site-specific health and safety plans Careful site selection to injurious species (particularly for Alternative 3)	Short-term, minor (Alternatives 1, 2, & 3) to moderate (Alternatives 2 & 3 only)
Operation	NA	NA	Negligible
Maintenance	Preventative maintenance (cleaning, debris removal, panel connections or fixing, anchoring components)	Use clean or filtered water Follow site-specific comprehensive health and safety plans	Short-term, minor
	Curative maintenance (replacement or disassembly)	Follow site-specific health and safety plans	Short-term, minor
	Transmission lines/electrical conductivity	Follow site-specific health and safety plans	Short-term, minor
	Encounter wildlife	Remain a safe distance from wildlife Follow site-specific health and safety plans	Short-term, minor (Alternatives 1, 2, & 3) to moderate (Alternatives 2 & 3 only)

(a) See Table 24 for comprehensive list of BMPs and environmental protection measures

4.16.2.3 Alternative 2: NWOTUS

Potential health and safety risks resulting from the implementation of Alternative 2 would be to be similar to those of Alternative 1. One difference between Alternative 1 and Alternative 2 includes the use of chemicals. Chemicals would not be used to treat the waterbodies in Alternative 2, and thus, would minimize human health and safety risks. Another difference includes potential interactions with wildlife. Alternative 2 would be more likely at a location with close proximity to wildlife. As such, potential interactions with wildlife would likely pose a greater risk compared to Alternative 1 sites. However, comprehensive health and safety plans could minimize risk to workers, and sites would be carefully selected to avoid dangerous wildlife. All other human health and safety effects in Alternative 2 for construction, operation, and maintenance would be the same as Alternative 1. In addition, the two alternatives share similar human health and safety benefits (i.e., the reduction of GHG emissions).

Programmatically, the effects from construction, operation, and maintenance would be short-term and minor for Alternative 2 (Table 22). The risks would only occur for the duration of construction or maintenance activities and would be negligible during operation. With the proper comprehensive construction and maintenance health and safety plans, and appropriate PPE, potential risks could be mitigated.

4.16.2.4 Alternative 3: Waters of the United States (WOTUS)

Potential health and safety risks resulting from the implementation of Alternative 3 would be similar to those of Alternatives 1 and 2. One difference between Alternative 1 and Alternative 3 includes the use of chemicals. As with Alternative 2, chemicals would not be used to treat the waterbodies in Alternative 3, which would minimize human health and safety risks. Another difference between Alternative 1 and Alternative 3 would be potential interactions with wildlife. Alternative 3 would be more likely at a location with close proximity to wildlife. As such, potential interactions with wildlife would likely pose a greater risk compared to Alternative 1. However, similar comprehensive health and safety plans would be in place to minimize risk to human health and safety, and sites would be carefully selected to avoid dangerous wildlife. Another difference between Alternative 3 and Alternative 2 would be the size of the site and of the potential for boater traffic. On a larger body of WOTUS water, there could be an increase in boater traffic compared to NWOTUS. This would also increase waves and make boating conditions more difficult. Comprehensive health and safety plans would be in place, as well as additional training requirements for boat operators.

The other human health and safety effects in Alternative 3 for construction, operation, and maintenance would be the same as Alternatives 1 and 2. Also comparable to Alternatives 1 and 2, human health and safety could benefit from floating solar installations at Alternative 3 through the reduction of GHGs.

The effects from construction, operation, and maintenance would be short-term and minor for Alternative 3 (Table 22). The risks would only occur for the duration of construction or maintenance activities and would be negligible during operation. With the proper comprehensive construction and maintenance health and safety plans, and appropriate PPE, potential risks could be mitigated.

Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

5.0 Cumulative Impacts Analysis

Cumulative impacts result from the incremental effect of separate past, present, and reasonably foreseeable future actions on the environment, regardless of what natural event occurs, or agency or person undertakes those actions. They can accrue from individually minor but collectively significant actions taking place over an extended period of time. Taken individually, environmental damage is incremental, occurring one action at a time; however, determining the significance of the collective actions requires an understanding of their effect on the larger environment.

This cumulative impact analysis is prepared at a level of detail that is reasonable and appropriate to assist with an informed decision by the Army and takes into consideration the impacts of a proposed action as characterized in this analysis report. Installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed.

The cumulative impacts on a resource become significant when the total impacts from separate past, present, and reasonable foreseeable future actions are greater than the identified significance criterion for that resource. In analyzing cumulative impacts, it is determined that the siting, deployment, and operation of floating solar systems on chemically treated water or wastewater, NWOTUS, and WOTUS would not have significant, adverse, cumulative impacts. Positive, cumulative impacts, however, would be possible as the Army uses floating solar systems to generate more of its electricity and reduces reliance on fossil fuels. This conclusion is supported in the following sections.

5.1 Significant Adverse Environmental Effects That Cannot Be Avoided

Significant adverse environmental effects could be avoided as a result of the siting, construction, and operation floating solar system alternatives, as analyzed in this report. Federal, state, and local environmental laws and regulations, would require similar types of analyses for nearby off-post projects, and thus would adversely affect resources within a ROI. The Army's implementation of floating solar technology would not result in significant adverse cumulative impacts to environmental resources in the ROIs of specific installation floating solar arrays and power systems as a result of the proposed action.

5.2 Conflicts with Federal, State, or Local Resource-Use Plans, Policies, and Controls

Floating solar arrays and power systems could preclude other water and land uses within the project footprint on the installation and could alter the character of largely rural areas. Depending on the proposed site location, hydrology, waterbody bathymetry, and area topography, a proposed floating solar system array and power system could impact the viewshed of neighboring communities; however, the site-selection process should ensure no conflicts with federal, regional, state, or local hydrological and land-use plans, policies, or controls. Implementation of the alternatives would comply with existing federal and other applicable statutes and regulations, while maintaining the Army's mission. Cumulative impacts to water quality and use and land use as a result of the proposed action would be negligible.

5.3 Energy Requirements

To successfully implement specific floating solar arrays and power systems, fuel and electricity would be needed to power vehicles and equipment during construction and for periodic maintenance activities. In addition, fuel and electricity would be used by other existing and reasonably foreseeable future facilities and operations in and around Army installations. Resources to meet energy requirements are currently available and in adequate supply, although the specific sources of fuel and electricity vary and are dependent, in part, on market conditions and technology. BMPs and SOPs are already used as standard practice by government agencies, private industry, and organizations to ensure operations use energy safely and minimize potentials for spills, regardless of whether the primary driver is due to safety concerns, environmental stewardship ethics, economic factors, or regulatory requirements. Cumulative impacts related to energy for all resource areas analyzed in this report would be negligible for the proposed action.

5.4 Depletion of Economically Viable Natural or Depletable Resources

Construction of specific floating solar arrays and power systems would include the consumption or conversion of resources that would not subsequently be able to be retrieved. This includes, for example, the use of fuel, oil, and lubricants consumed by construction and maintenance vehicles and equipment; a small amount of concrete, metals (i.e., steel), and wood used for pilings or poles; and the consumption of food products by construction and maintenance workers. Water resources would be covered wholly or in part by floating arrays, and thus make surface water unavailable for other uses. In addition, land would be used for the development of specific floating solar system components such as shoreline anchoring, transmission, and microgrid infrastructure. The use of land for floating solar system ancillary power components would eliminate the potential to be use of such lands for farmland, grazing, or timber harvesting; though it would be possible to bring that use back, if the land had ever been viable for those uses previously. As the alternative sites are waterbodies on Army installations, some of these uses, if viable, may not be current due to conflicts with the military mission. Globally, as populations increase, more resources may be allocated for additional anthropogenic development. Cumulatively, there is a moderate impact to natural and depletable resources, with fewer resources being available over time; however, the incremental contribution of the proposed action would be negligible.

6.0 Summary of the Potential Effects of the Evaluated Alternatives

No significant impacts would result from the no action alternative, nor any of the three action alternatives for land use, air quality, noise, geological and soil resources, socioeconomics and environmental justice, traffic and transportation, airspace, electromagnetics, utilities, hazardous and toxic waste, or human health and safety. The action alternatives could have up to a significant adverse impact to some resource areas, as summarized in Table 23. Impacts could be minimized through avoidance and through the implementation of BMPs and SOPs, as summarized in Table 24. Avoidance could be a result of the selection of proposed site locations, how the project site was designed, and when construction activities were scheduled. BMPs and SOPs would include, for example, implementing erosion and stormwater-control measures during construction, maintaining construction vehicles and equipment, ensuring adequate and ecosystem-appropriate vegetation and/or gravel cover at the post-construction site, and ensuring safety equipment was appropriately used by construction and maintenance workers. No new mitigations would be required.

Significant impacts could occur to water and biological resources, for each of the three action alternatives proposed in this report and to cultural resources for the WOTUS alternative. Significant impacts could be reduced to moderate or minor through siting and effective use of BMPs and mitigation (Table 24).

As discussed in Section 3.0, in considering the implementation of a specific proposed floating solar array and power system, installations may use the checklist in Appendix A of this report to determine whether the information contained in this report is sufficient for developing the appropriate NEPA documentation or if additional NEPA analysis is needed. Therefore, the checklist in this report could help an installation determine what analysis information contained in this report could be leveraged during the development of a site-specific NEPA analysis document, and what information would likely need further information to enable a complete analysis.

Table 23. Summary of the Potential Effects on the Evaluated Alternatives

Resource Area	No Action Alternative	Alternative 1: Wastewater	Alternative 2: NWOTUS	Alternative 3: WOTUS
Land Use	No impacts	None-to-negligible short- or long-term adverse impacts	None-to-negligible short- or long-term adverse impacts	None-to-negligible short- or long-term adverse impacts
Air Quality and GHG	No impacts; missed opportunity for minor beneficial impacts	Short-term minor adverse impacts; Long-term minor beneficial impacts	Short-term minor adverse impacts; Long-term minor beneficial impacts	Short-term minor adverse impacts; Long-term minor beneficial impacts
Noise	No impacts; missed opportunity for minor beneficial impacts	Short-term, localized, minor adverse impacts; Long-term negligible-to-minor localized impacts; Long-term minor beneficial impacts when solar-derived energy replaces an alternately derived method which currently includes some noise generation	Short-term, localized, minor adverse impacts; Long-term negligible-to-minor localized impacts; Long-term minor beneficial impacts when solar-derived energy replaces an alternately derived method which currently includes some noise generation	Short-term, localized, minor adverse impacts; Long-term negligible-to-minor localized impacts; Long-term minor beneficial impacts when solar-derived energy replaces an alternately derived method which currently includes some noise generation
Geological and Soil Resources	No impacts	Short-term negligible-to-moderate adverse impacts; Long-term negligible-to-moderate, adverse impacts	Short-term negligible-to-moderate adverse impacts; Long-term negligible-to-moderate adverse impacts	Short-term negligible-to-significant adverse impacts; Long-term negligible-to-moderate adverse impacts
Water Resources	No impacts	Negligible-to-significant adverse impacts, both short- and long-term	Short-term negligible-to-moderate adverse impacts; Long-term negligible-to-moderate adverse impacts	None-to-significant short-term adverse impacts; Long-term significant adverse impacts
Biological Resources	No impacts; missed opportunity for minor beneficial impacts	Negligible-to-moderate adverse impacts, both short- and long-term	Negligible-to-significant adverse impacts, both short- and long-term	Negligible-to-significant adverse impacts, both short- and long-term
Cultural Resources	No impacts	Negligible-to-moderate adverse impacts, both short- and long-term	Negligible-to-moderate adverse impacts, both short- and long-term	Negligible-to-significant adverse impacts, both short- and long-term

Table 23. (contd)

Resource Area	No Action Alternative	Alternative 1: Wastewater	Alternative 2: NWOTUS	Alternative 3: WOTUS
Socio-economics	No impacts; missed opportunity for minor short-term beneficial impacts	Short-term moderate beneficial for economy and short-term negligible to moderate adverse for aesthetics; no long-term impacts	Short-term moderate beneficial for economy and short-term negligible to moderate adverse for aesthetics; no long-term impacts	Short-term moderate beneficial for economy and short-term negligible to moderate adverse for aesthetics; no long-term impacts
Transp. and Traffic	No impacts	Short-term negligible-to-moderate adverse impacts; Long-term negligible, adverse impacts	Short-term negligible-to-moderate adverse impacts; Long-term negligible, adverse impacts	Short-term negligible-to-moderate adverse impacts; Long-term negligible, adverse impacts
Airspace	No impacts	short-term and long-term none-to-negligible adverse impacts	short-term and long-term none-to-negligible adverse impacts	short-term and long-term none-to-negligible adverse impacts
Electro-magnetic Spectrum	No impacts	short-term and long-term negligible adverse impacts	short-term and long-term negligible adverse impacts	short-term and long-term negligible adverse impacts
Utilities	No impacts; missed opportunity for minor beneficial impacts	Short-term negligible-to-minor impacts	Short-term negligible-to-minor impacts	Short-term negligible-to-minor impacts
Hazardous and Toxic Materials and Waste	No effect	short-term and long-term negligible adverse impacts	short-term and long-term negligible adverse impacts	short-term and long-term negligible adverse impacts
Human Health and Safety	No impacts	Minor adverse impacts, both short- and long-term	Moderate adverse impacts, both short- and long-term	Moderate adverse impacts, both short- and long-term
Cumulative	Less than significant	Less than significant	Less than significant	Less than significant

Table 24. Summary of Best Management Practices and Environmental Protection Measures to be Adopted

Resource Area	Best Management Practices / Environmental Protection Measures
Land Use	• Stakeholder coordination/consultation and/or consolidation of infrastructure during the scoping and design. • Incorporation of floating solar arrays into the installation's RPMP. • Site designed for compatibility with regulatory requirements (Alternative 3).
Air Quality and GHG	• Site design to minimize movement of large amounts of dirt (e.g., excavation and fill). • Dust-control measures on the project site and unpaved roads used during construction. • Emission-control devices and vehicle maintenance of construction and maintenance vehicles and equipment.
Noise	• Scheduling of construction activities to minimize impacts to noise-sensitive receptors. • Personal hearing protection by appropriate construction personnel. • If maintenance activities would create noise impacting sensitive receptors, maintenance performed at a time to minimize impacts.
Geological and Soil Resources	• Site design to minimize grading requirements and avoid unique geological features and soils for which there are substantial construction issues. • Site design to consider shoreline and sediment stability (Alternatives 2 and 3). • Site design of transmission lines, when part of project, to maximize placement along existing road-disturbance limits and within existing utility easements. • Construction permits obtained, as required, and permit requirements adhered to. • Erosion- and stormwater-management control measures on the project site during construction. • Fugitive dust-control plan for construction developed and implemented, as required. • Minimize unnecessary soil compaction during construction. • Minimize import or export of earthen material to/from the site. • Monitor, by system operator, soil erosion, and investigate and remedy as appropriate.
Water Resources	• Site design to maximize avoidance of important water features and minimize the size of disturbed areas. • Spill-prevention and -response measures in place for construction and maintenance activities. • Site design of transmission lines, when part of project, to maximize placement along existing road-disturbance limits and within existing utility easements. • Construction permits obtained, as required, and permit requirements adhered to. • Erosion- and stormwater-management control measures on the project site during construction. • Pond liners not impacted during construction (Alternative 2). • Maintenance of construction and maintenance vehicles and equipment. • Monitor soil erosion (by system operator) and investigate and remedy as appropriate. • Module cleaning water not anticipated to include chemicals. • Module washing scheduling such that washing does not cause noticeable changes in water quality. • Maintenance vehicles should avoid the shoreline and, where feasible, stay on hard surface or gravel roads (Alternatives 2 and 3).

Table 24. (contd)

Resource Area	Best Management Practices / Environmental Protection Measures
Biological Resources	• Site selection to avoid biological resources critical toward maintaining installation compliance. • Site selection to minimize impacts to biological resources critical toward maintaining installation stewardship responsibilities. • Site design incorporates set-back requirements to sensitive habitats and protected species. • Site design to minimize the size of disturbed areas. • Site design of transmission lines, when part of project, to maximize placement along existing road-disturbance limits and within existing utility easements. • Scheduling of construction activities to minimize impacts to protected species and sensitive habitats. • Erosion- and stormwater-management control measures on the project site during construction. • Minimize unnecessary soil compaction during construction. • Dust-control measures on the project site and unpaved roads used during construction. • Emission-control devices and vehicle maintenance of construction and maintenance vehicles and equipment. • Spill-prevention and -response measures in place for construction and maintenance activities. • Appropriate monitoring and/or cleaning of equipment and vehicles to avoid transportation of noxious, invasive and pest species and minimize spread of non-native noxious, invasive, or pest pioneer species. • Pond liners not impacted during construction (Alternative 2). • Construct overhead transmission lines in accordance with avian protection guidelines. • Observe migratory bird nesting activity during construction and maintenance activity and avoid active nesting areas. • Replace and re-vegetate top soil removed for grading. • Post-development vegetation and/or gravel cover appropriate for the ecosystem and which, for vegetation covers, shouldn't require watering once established; preference in plant selection should be for native plants and take into consideration the wildlife species they support. • Monitor, by system operator, soil erosion, and investigate and remedy as appropriate. • Avoid accidental fatalities to small wildlife when mowing, to the extent practicable. • Apply seasonal restrictions to mowing, if appropriate.
Cultural Resources	• Stakeholder coordination/consultation during the scoping and design. • Site selection to ensure adverse effects to cultural resources are avoided or minimized. • If proposed site hasn't been surveyed for cultural resources, complete survey and Section 106 Consultation. • Site design to minimize the size of disturbed areas. • Site design to minimize the effect of potential impacts to historic properties. • Site design to avoid substantive direct impacts to cemeteries. • Site design incorporates appropriate set-back requirements, if any, for affected cultural resources. • For sites adjacent to a cemetery, off-limit criteria should be established for floating solar array and power system construction and maintenance workers and preconstruction access abilities to the cemetery for visitation and maintenance would be maintained. • Complete appropriate pre-disturbance surveys for cultural resources. • Execute appropriate data recovery for archaeological resources impacted as a result of construction. • Stormwater-management control measures on the project site during construction.

Table 24. (contd)

Resource Area	Best Management Practices / Environmental Protection Measures
	• During construction, if any human remains or possible cultural resources are found, then stop work, notify the cultural resource manager, and adhere to applicable legal and regulatory requirements. • Archaeologist monitor construction activities for sensitive cultural resources, if construction activities take place in a culturally sensitive location.
Socio-economics	• If the project site is located within reasonable walking or bicycling distance of children, with no existing security measures restricting access to the proposed site, erect a security fence and gate. • If the proposed project includes construction of a substation, erect a permanent security fence around the substation.
Transportation and Traffic	• Potential limitations of what ACPs construction vehicles could be permitted to use. • Potential scheduling limitations to avoid use of poorly rated roads and intersections by construction vehicles during peak usage times. • Erosion- and stormwater-management control measures. • Coordination with installation low-level aviation trainers when aboveground power distribution lines are part of the proposed project.
Airspace	• Completion of a solar glare hazard evaluation. • Site design features to select material to minimize potential solar glare. • Coordination with installation aviation organizations.
Electromagnetic Spectrum	• Stakeholder coordination during the scoping and design. • Site selection and site design to avoid or minimize electromagnetic interference between signal-generation points and receivers.
Utilities	• Project design to be compatible with existing grid system. • Temporary restroom facilities provided for construction workers include disposal services to a permitted wastewater-treatment facility (contractor responsibility).
Hazardous and Toxic Materials and Waste	• Spill-prevention and -response measures in place for construction and maintenance activities, to include plans, if appropriate, for other hazardous material encounters. • Maintenance of construction and maintenance vehicles and equipment. • Proper disposal of all waste generated during construction, in compliance with applicable laws and regulations (contractor responsibility). • Use of protective gear and equipment by construction and maintenance workers to minimize potential impacts from hazardous material.
Human Health and Safety	• Site design appropriate considers the type, scope, and extent of the contaminant, if any (Alternative 1). • No project permitted within SDZs without explosives safety approvals for a waiver of safety regulations. • Installation of wiring is protected against shock hazards. • As appropriate, MEC survey completed. • If any evidence of MECs are encountered on the site during construction or operation, cease work immediately and remain stopped until the appropriate military office has been notified and appropriate clearance procedures have been completed. • Limit access to the construction site to authorized personnel. • Develop and implement comprehensive construction health and safety plan which addresses site-specific health and safety issues, including specific emergency response services and procedures and evacuation measures (contractor responsibility).

Table 24. (contd)

Resource Area	Best Management Practices / Environmental Protection Measures
	• Maintain and use safety tools and equipment for appropriate construction and maintenance activities. • Use of protective gear and equipment by construction and maintenance workers to minimize potential health hazards and accidents and potential impacts from hazardous material.

7.0 Decision Making

A possible application of this report could be the development of a site-specific NEPA assessment (leveraging the analysis contained in this report and using the checklist in Appendix A to identify other information likely needed for inclusion in the analysis document) or a programmatic environmental assessment (PEA).

A PEA would serve to inform the federal decision-maker and the public of the potential environmental consequences of the proposed action and alternatives, programmatically. For this programmatic, overarching floating solar environmental analysis, the decision to be made is whether there would be significant environmental impacts anticipated in implementation of the proposed action, in general, and whether to continue to pursue floating solar projects as a general matter on Army installations. A PEA would facilitate decisions on DA actions that precede site- or project-specific decisions and actions. The Army decision-maker is the Assistant Secretary of the Army for Installations, Energy and Environment.

A PEA process, which would include the analysis and public and stakeholder comments received as a result of the public review period, would provide the Army decision-maker with the information necessary to evaluate the potential environmental and socioeconomic impacts associated with the proposed action. The decision-maker would take into account technical, economic, environmental, and social issues, as well as the ability of each alternative to meet the purpose and need. If no significant environmental impacts were to be determined based on the evaluation of impacts in a PEA and public and stakeholder comments, a Finding of No Significant Impact would be signed by the Assistant Secretary of the Army for Installations, Energy and Environment. If it were determined that the proposed action would have significant environmental impacts, the action would either not be taken, or a Notice of Intent to prepare an environmental impact statement would be published.

Regardless of the generation of a PEA, each Army installation will have to consider site-specific conditions on whether to construct the projects, where they are located, and/or the size of the floating solar project(s). A PEA and subsequent decision document would provide information and analysis that could be incorporated by reference in future NEPA reviews. Should a PEA process be completed an where it is determined that a site-specific project requires further analysis, tiered from a PEA, the appropriate NEPA documentation would be completed prior to implementation decisions. Generally, the garrison commander would be the federal decision-maker concerning subsequent environmental analyses for site-specific floating solar proposals on Army installations.

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9.0 List of Preparers

9.1 Pacific Northwest National Laboratory

Team Member	Contribution
Ann Miracle	Team Lead, Proposed Action, Alternatives, Cumulative
Jim Cabe	Air Quality, Electromagnetics, Utilities
Karen Studarus	Grid and Energy Systems
Trevor Hardy	Grid and Energy Systems
Tom Anderson	Land Use, Hazardous & Toxic Waste, Airspace
Tara O'Neil	Cultural Resources
Philip Meyer	Water Resources
Katie Wagner	Ecological Resources
Stephanie Liss	Human Health & Safety, Noise
Katie Cort	Socioeconomics, Environmental Justice, Transportation & Traffic
Delphine Appriou	Geology & Soils
Mike Parker	Editor
Joanne Duncan	References

9.2 U.S. Army Environmental Command

Team Member	Contribution
Pamela Klinger	Project Manager, Reviewer (also Lead Author for Army Installation NEPA Documentation for the Nov 2016 Solar PV PEA, used to help inform aspects of this report)

Appendix A

Suggested Environmental Checklist for Floating Solar Project(s)

Appendix A

Suggested Environmental Checklist for Floating Solar Project(s),

Should the Army develop a programmatic NEPA analysis document, the suggested checklist (below) could be used to support the development of this effort. The environmental checklist, if included with a programmatic NEPA analysis document, could facilitate the consideration of environmental effects for floating solar projects and provides a framework for identifying site-specific NEPA requirements.

Were a programmatic NEPA analysis completed and the decision incorporated use of this checklist, installations could use this checklist to determine whether the use of Categorical Exclusions and reliance on existing NEPA documents would be appropriate, or whether additional NEPA analysis would be needed for a specific proposed floating solar project(s).

If the installation could respond "no" to each of the statements in the checklist below, the idea would be that no further NEPA analysis would be required and the action would likely qualifies for a Record of Environmental Consideration (REC). The installation REC would then cite any applicable documents, such as the programmatic NEPA analysis and resulting decision (for which this report may inform), any applicable installation-level NEPA analyses, and any applicable Categorical Exclusion(s).

If careful application of this checklist to the proposed project at an installation would require a "yes" or "maybe" response to any checklist item, then additional environmental analysis may be required (should a programmatic analysis have been completed, informed, in part, by this report) and would need to be conducted as part of an installation-level, site-specific NEPA process.

If the installation concludes that additional NEPA analysis is necessary (should a programmatic analysis have been completed, informed, in part, by this report), the site-specific NEPA process could be streamlined by using information in the related programmatic NEPA analysis, and focusing analysis on those resource areas of the proposed action where site-specific considerations require NEPA analysis of potential impacts. Additionally, if the installation were to conclude that additional NEPA analysis would be necessary (again, assuming a programmatic analysis exists from which to be tiered), it would be required to be prepared before any irreversible and irretrievable commitments of resources occurs on the proposed action, should it be implemented.

Suggested Environmental Checklist for Floating Solar Projects, as proposed to be covered under a programmatic NEPA analysis

[Insert description of installation's proposed action to include location(s) and installation name, size of floating solar array(s), ESS and microgrid infrastructure, details on the connection to the electrical grid, construction requirements, and proposed dates.]

Land Use	
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed project, to include associated infrastructure, if any, on the installation is in conflict with the real property master plan.
Air Quality	
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction activities associated with the proposed project would contribute to a change in the air quality compliance status in the region (e.g., from attainment to nonattainment).
Noise	
☐ *No* ☐ *Maybe* ☐ *Yes*	Noise generated during construction of the proposed project would have a significant negative impact on sensitive noise receptors (e.g., residential areas, hospitals, and schools).
☐ *No* ☐ *Maybe* ☐ *Yes*	Noise generated during construction of the proposed project would have a significant negative impact on sensitive wildlife populations, to include threatened and endangered species.
Geological and Soil Resources	
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed solar project is anticipated to include construction activities on highly erodible soils.
Water Resources	
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction or operation of the proposed project would result in unpermitted direct impacts to waters of the U.S., regulated recharge zones, and/or ground water aquifers.
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed project is anticipated to include construction activities on jurisdictional wetlands or require additional surveys to identify and delineate jurisdictional wetlands.
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed project is anticipated to include construction activities in a coastal zone regulated by the Coastal Zone Management Act.
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed project, to include associated infrastructure, if any, would require substantial modification of the installation's storm water discharge prevention plan.
☐ *No* ☐ *Maybe* ☐ *Yes*	Operation of the proposed project is expected to adversely affect the designated use(s) of a waterbody.

Biological Resources (including Threatened and Endangered Species)	
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction or operation of the proposed floating solar project is likely to result in an unpermitted "take" of a protected species (e.g., under the Endangered Species Act, Migratory Bird Treaty Act, Marine Mammal Protection Act, or Bald and Golden Eagle Protection Act) and/or construction activity is anticipated to be in critical habitat, as designated by the U.S. Fish and Wildlife Service under the Endangered Species Act.
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed floating solar project is anticipated to include construction activities on jurisdictional wetlands or require additional surveys to identify and delineate jurisdictional wetlands.
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed floating solar project is anticipated to include construction activities in biological sensitive areas other than those mentioned above.
☐ *No* ☐ *Maybe* ☐ *Yes*	All or part of the proposed construction area needs to be surveyed for one or more protected species, such as threatened or endangered species protected under the Endangered Species Act (a YES means that the appropriate biological resource survey does not exist for all or part of the construction area).
☐ *No* ☐ *Maybe* ☐ *Yes*	All or part of the proposed construction area needs to be surveyed for bathymetry, sediment type and/or presence of submerged aquatic vegetation (a YES means that the appropriate surveys do not exist for all or part of the construction area).
Cultural Resources	
☐ *No* ☐ *Maybe* ☐ *Yes*	All or part of the proposed construction area needs to be surveyed for cultural resources (a YES means that a cultural resources survey does not exist for all or part of the construction area).
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed floating solar project is anticipated to have adverse effects on NRHP-listed and/or -eligible historic properties and those effects are unlikely to be able to be avoided or mitigated. (Note: Appropriate SHPO and Tribal consultation must be completed prior to commencing with the proposed project.)
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction and operation of the proposed project will prevent the traditional use of sacred or ceremonial sites or resources by federally recognized Native Americans, Alaska Natives, or Native Hawaiians. (Note: NHPA Section 106 consultation with SHPO, Tribes, and interested parties must be completed prior to commencing with the proposed project.)
Socioeconomics	
☐ *No* ☐ *Maybe* ☐ *Yes*	Only one or two of all the residential areas bordering the installation are primarily occupied by low-income and/or minority populations, and the site of the proposed project is adjacent to that low-income/minority population area.

Airspace	
☐ *No* ☐ *Maybe* ☐ *Yes*	The glint/glare report on the proposed project indicates a likely significantly negative impact on air operations at or near the installation.
Utilities	
☐ *No* ☐ *Maybe* ☐ *Yes*	The proposed project is designed so that it is not compatible with the existing nearby electrical grid system or is located such that there is no use for the generated electricity.
Hazardous and Toxic Material and Waste	
☐ *No* ☐ *Maybe* ☐ *Yes*	The installation would need to build, or significantly modify, facilities necessary to store waste petroleum, oil, and lubricant products associated with the construction and operation of the proposed project, in accordance with local/state/federal regulations.
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction of the proposed project would require substantial modification for the installation's Spill-Prevention, Control and Countermeasures Plan.
Human Health and Safety	
☐ *No* ☐ *Maybe* ☐ *Yes*	Construction or operation of the proposed floating solar project would require substantial modification of the installation's health and safety plan.
☐ *No* ☐ *Maybe* ☐ *Yes*	During construction or operation of the proposed project, humans would come into contact with dangerous wildlife species.
☐ *No* ☐ *Maybe* ☐ *Yes*	Chemicals encountered at the proposed project site would require substantial modification of the installation's health and safety plan.
Cumulative Effects	
☐ *No* ☐ *Maybe* ☐ *Yes*	Other actions are underway, or proposed, that when combined with the potential effects of construction and operation of the proposed project, could have a significant cumulative effect on human health or the environment.

Appendix B

Purpose and Need for Floating Solar Arrays

Appendix B

Purpose and Need for Floating Solar Arrays

The following are examples of a Background and Purpose and Need statements in support of either a programmatic environmental assessment (PEA) or site-specific environmental assessment (EA) for installation, operation, and maintenance of a floating solar array system with supporting energy infrastructure.

The proposed action being evaluated for a PEA or site-specific EA is the construction and operation of floating solar photovoltaic (PV) renewable energy (floating solar) projects on Army installations, to include joint bases managed by the Department of the Army (DA). The projects would generally range around 1 MW of power generation capability. The size of each project would depend on the conditions at the installation. In general, larger installations may have larger energy requirements and potentially more waterbody surface areas that could accommodate larger projects. Floating solar projects will typically be used in combination with other renewable energy projects, particularly other solar PV applications, to maximize the benefits of renewable energy to the installation and minimize the need for amount of mission-constrained land that would be required for traditional ground-mounted solar PV systems. The projects could be funded and constructed by the Army, funded through a third-party Power Purchase Agreement (PPA) and utilizing a lease of land with a local utility company (an “Enhanced Use Lease” or EUL), or via some other relationship with a private or public entity.

B.1 Background

B.1.1 Basis of Analysis

The National Environmental Policy Act of 1969 (NEPA; 42 U.S. Code [USC] Section [§] 4321 et seq.) establishes procedural requirements for all federal government agencies for proposed agency action. The Council on Environmental Quality (CEQ) regulations (Title 40 of the Code of Federal Regulations [CFR] 1500-1508) and the Army’s NEPA regulation (32 CFR 651), Environmental Analysis of Army Actions, provide the Army regulatory guidance for implementing NEPA. NEPA directs federal agencies to evaluate and incorporate an understanding of the environmental impacts of its proposed actions into its decision-making processes, and to disclose the effects of its proposed actions to the public and officials who must make decisions concerning the proposal.

From a programmatic perspective, in accordance with 32 CFR 651, “Army agencies are encouraged to analyze actions at a programmatic level for those programs that are similar in nature or broad in scope.” CEQ regulations encourage the use of programmatic documents, when appropriate, accompanied by "tiered" supplemental documents that focus on the site-specific issues, eliminating unnecessary duplication. A programmatic level of analysis would eliminate repetitive discussions of the same issues and focus on key issues at each appropriate level. Supporting this concept, CEQ issued its final *Effective Use of Programmatic NEPA Reviews* guidance on December 18, 2014 (CEQ 2014).

B.1.2 Army and Renewable Energy

The Office of Energy Initiatives (OEI) has primary responsibility over large-scale renewable projects to help achieve the Army’s renewable energy goals. OEI, initially known as the Energy Initiatives Task Force, was established in September 2011 by the Secretary of the Army. The OEI serves as the central

Figure B.1. 2012 Ceremony at Fort Bliss, TX

Figure B.2. Solar PV Module

management office for partnering with U.S. Army installations to implement cost-effective, large-scale renewable energy projects, 10 MW or greater, leveraging private sector financing. Smaller projects are generally managed by installations.

Over the past several years, the Army has developed considerable experience analyzing environmental impacts of various renewable energy technologies. Although solar PV is considered one of the most environmentally friendly and efficacious of the proven renewable energy technologies available, the construction and operation of floating solar array systems does have some environmental impacts. As many Army installations expect to continue to pursue additional proposed solar PV projects, the Army has determined that analysis of solar PV technology construction and operation—more detailed than that analyzed in the *Programmatic Environmental Assessment Army Net Zero Installations* (Net Zero PEA) dated July 2012 (DA 2012a)—may be required either at the programmatic or site-specific level.

This report uses the specific information and analysis from both the Army PV PEA and Net Zero PEA and adds more information and analysis about possible floating solar projects on installations, to include providing updated information, if applicable. Additional information includes that gained from several site-specific EAs analyzing impacts of PV projects prepared by U.S. Army Environmental Command (AEC) and other Army organizations for various installations, to include Fort Benning, Georgia (AEC 2014a); Fort Carson, Colorado (Fort Carson and AEC 2012); Fort Gordon, Georgia (Fort Gordon and AEC 2014); Fort Hood, Texas (AEC 2014b); and others. The information obtained from various completed EAs analyzing site-specific PV projects across the Army, and the associated and signed Findings of No Significant Impact, informs and supports this programmatic analyses. Figures B.1 and B.2 provide visual examples of solar PV modules being used by the Army.

This floating solar environmental analysis report does not eliminate NEPA requirements for specific floating solar projects planned for execution on Army installations. Each Army installation would have to consider site-specific conditions, such as where the projects would be constructed and operated, where they would be located, and/or the size of the floating solar project(s). Site-specific considerations would require an appropriate level of supplemental NEPA analysis and documentation. In some cases, it may be determined that a Record of Environmental Consideration (REC) would be appropriate, citing other installation NEPA documents, and/or one or more Army Categorical Exclusions. In other cases, the Army anticipates further analysis would be required to meet site-specific NEPA requirements; and, if so, using the framework of this report for the site-specific environmental analysis is expected to enable development of a site-specific EA focused on those resource areas at the proposed site(s) where site-specific considerations require additional analysis of potential impacts. To that end, this report includes a checklist in Appendix A to assist installations in identifying site-specific NEPA requirements.

As of April 2014, less than 2.1 percent of the energy consumed by the Army comes from renewable energy sources. In 2005, the Energy Policy Act of 1992 (EPAct; 42 USC § 13201 et seq.) mandated federal facilities use at least 5 percent renewable energy by 2010 and 7.5 percent in 2013 and thereafter. On March 19, 2015, the White House released a new Executive Order (EO)—EO 13693, *Planning for Federal Sustainability in the Next Decade*—which includes requirements for federal agencies to ensure that they increase how much of their building electric energy and thermal energy is derived from renewable electric energy; the EO establishes specific and increasing percentages by fiscal year. In general, this new EO covers the same areas as the revoked EO 13423 and EO 13514, to include environmental performance and federal sustainability, reducing energy use and cost, and renewable or alternative energy solutions.

B.1.3 Army Consideration of Renewable Energy Technologies

The purpose of this report is to provide a framework that analyzes anticipated impacts of solar PV installation and operation; use of this analysis assumes that Army installations are considering various renewable energy technologies as installations studies options for meeting their renewable energy goals and energy needs. This report assumes installations will analyze alternative technologies along with solar PV, or have determined that these alternative technologies are not feasible to meet that particular installation's need. Installations must carefully consider all reasonable alternatives, including other renewable energy technologies, to meet their particular needs. The Army recognizes the many benefits of solar PV, including the fact that it is a proven, time-tested, and energy- and cost-efficient technology with relatively few potential adverse environmental impacts in most proposed locations. For all of these reasons, solar PV is frequently choses as the best technology to meet a given site-specific need. This report is intended to expedite either programmatic or site-specific analyses of most issues commonly associated with solar PV. It is not intended to replace thoughtful consideration of other renewable technologies, other alternatives to meet a particular installation's needs, or to express any agency preference for one renewable technology over another, in any situation.

B.2 Example Statement of the "Purpose" of the Proposed Action

The following text is an example of a Purpose statement that could be used in a NEPA analysis of floating solar:

The purpose of the proposed action is to allow for the design, construction, operation, and maintenance of floating solar projects within the boundaries of Army installations, to include joint bases managed by DA. To fulfill the purpose, the proposed action may involve a third-party PPA, entail a EUL, require utility easements, or involve some other related real estate action on Army lands.

The Army is preparing this PEA/EA to identify, evaluate, and compare the potential environmental effects of implementing the proposed action. This PEA/EA is prepared in accordance with NEPA (42 USC § 4321 et seq.); the CEQ regulations that implement NEPA (40 CFR Part 1500-1508); and Army NEPA regulations (32 CFR Part 651). In general, CEQ regulations require that prior to implementing any major action; the federal agency must evaluate the proposal's potential environmental effect as well as notify and involve the public in the agency's decision-making process.

B.3 Example Statement of the "Need" for the Proposed Action

The following text is an example of a Need statement that could be used in a NEPA analysis of floating solar:

The need for advancing floating solar, as it is for other renewable technologies, is to: (a) achieve renewable energy production on Army land in accordance with 10 USC § 2911, which requires the U.S. Department of Defense to produce or procure not less than 25 percent of the total quantity of facility energy it consumes within its facilities during fiscal year 2025 and each fiscal year thereafter from renewable energy sources; (b) contribute to the Army's goal of generating 1 GW of renewable electrical energy on Army land by 2025; and (c) contribute to compliance with the EPAct of 2005 (42 USC § 13201 et seq.) requiring the Army's consumption of not less than 7.5 percent of the total quantity of facility electrical energy it consumes within its facilities during fiscal year 2013 and each fiscal year thereafter from renewable energy sources. These projects could also improve installation energy security by generating electricity on-site, may reduce total utility costs to the Army, and would reduce generation of greenhouse gas. A summary of renewable energy goals, some of which can be met, in part, through solar PV technology, is contained in Appendix D of DA's ES^2 Strategy (DA 2015d).

If used for a PEA, the Need statement could include the following text:

The need for this programmatic analysis is to comply with CEQ and Army regulations encouraging the use of programmatic NEPA analyses (respectively, 40 CFR 1502.20 and 32 CFR 651.14(c)), as well as the recent CEQ guidance entitled *Effective Use of Programmatic NEPA Reviews* (CEQ 2014). Responding to this need avoids unnecessary duplicative site-specific analyses and eliminates repetitive discussions of the same issues; in this case, the similar environmental impacts of solar PV for most resource areas at most sites.

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