Programmatic Environmental Assessment

Army Net Zero Installations

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Chapter 1 – Purpose of and Need for Proposed Action

1.1 Introduction

This programmatic Environmental Assessment (PEA) analyzes the potential environmental impacts of implementing Net Zero at Army installations. The proposed Net Zero Installation program would direct Army installations to make every fiscally prudent effort to reduce their installation's overall consumption of energy and water resources and disposal of solid waste in landfills to an effective rate of zero. This will require an examination and balancing of resource requirements against the increased constraints on energy and water supplies and disposal methods. While achieving absolute "Net Zero" may not be achievable at all installations with currently available technology, the process of each installation evaluating itself against this benchmark will identify opportunities for reduction, repurposing, recycling and composting, and energy recovery.

The PEA will evaluate the various behaviors, processes, and technologies that can be used to achieve Net Zero and the associated environmental impacts and mitigation. The decision to be made is whether to implement Net Zero Army-wide, to strategically implement Net Zero based on mission needs and return on investment, or to not implement Net Zero. Installations will be able to draw on this analysis as they explore measures and processes that can be used in their site-specific analyses.

1.2 Purpose and Need

The U.S. Army faces significant near-and-long-term threats (e.g., terrorist, manmade, natural disasters, climate change), both home and abroad, that can affect its access to energy and water resources in the quantity, quality, and cost needed to carry out its national defense mission. Ensuring uninterrupted supplies of energy and water to support installation missions is increasingly challenging. "Energy and Water Security" means the capacity to ensure that energy and water of suitable quality are provided at a sustained rate sufficient to support all current and future Army missions. Similarly, materials must be managed throughout their life-cycle to maximize the material's utilization and minimize its disposal, ensuring the Army obtains its full resource value, while reducing disposal costs and preserving land for military use versus future landfills. The Army also has numerous legal and policy requirements related to conservation of resources and sustainability. The Army's Net Zero Installation program would address these needs.

Addressing energy security and sustainability is operationally necessary, financially prudent, and essential to mission accomplishment. The Army seeks to apply sustainability principles to ensure that the Army of tomorrow has the same access to energy, water, land, and other natural resources as the Army of today through the reduction of demand/consumption, the diversification of the energy supply with a greater reliance on renewable sources, and the expansion of self-sufficiency. The Army's goal is to manage appropriately our natural resources with a goal of creating and sustaining Net Zero installations.

The purposes of the proposed action are, to the maximum extent practicable, to: (1) improve the Army's energy security posture, (2) improve the Army's water security posture, (3) minimize solid waste generation and disposal, (4) improve the management of natural and fiscal resources in order to sustain the Army's operational capability in support of its mission, (5)

incorporate sustainability and security considerations into installation management decisions, and (6) enable the Army to achieve Federal and Department of Defense (DoD) sustainability goals for energy, water, and waste.

1.2.1 By becoming effectively self-sufficient, the Army can insulate itself from potential disruptions to its energy supplies. The Army proposes to reduce reliance on energy infrastructure susceptible to disruptions and logistical mechanisms that add risk to installation missions through application of Net Zero approaches across the Army.

1.2.2 The Army's water security would be enhanced because the Army will be better prepared to address both short and long term variations in water supply and quality (due to drought conditions, increased water usage by the community, etc.). The Army proposes to reduce reliance on water infrastructure susceptible to disruptions and logistical mechanisms that add risk to installation missions through application of Net Zero approaches across the Army. In addition, reduced water use, and thus need, increases the ability of the Army to continue its mission uninterrupted.

1.2.3 Identifying and pursuing opportunities for waste avoidance in the Army's procurement processes will minimize or eliminate the unnecessary use, and eventual disposal, of raw materials. More aggressive material utilization also preserves raw materials for future use. Similarly, minimizing the volume of solid waste to be disposed of will reduce the land space that is occupied by landfills and preserve this space for critical military operational needs.

1.2.4 Improving the Army's energy and water usage, and minimizing waste generation and disposal will reduce operating costs, which will help maintain mission operations during periods of constrained fiscal resources or access to natural resources, or uncertain future constraints. In addition, it will reduce the demand for services provided by off-Post service providers (e.g., utility companies), which in turn could extend the Army's ability to continue operations during potential service interruptions.

1.2.5 Incorporating sustainability and security considerations into installation management decisions ensures that the access to, and the lifecycle cost of, energy, water, and material/waste are evaluated during decision-making. Consideration of the total life-cycle cost of actions, materiel, and services will improve the Army's ability to make informed decisions.

1.2.6 The Army will meet Federal energy, water, and waste mandates and goals, including goals to reduce the total ownership cost of facilities, improve energy efficiency and water conservation, increase use of renewable energy, provide sustainable buildings, increase recycling and waste diversion, and promote environmental stewardship. Additionally, DoD and the Army have their own energy, water and waste requirements and initiatives, including the DoD Strategic Sustainability Performance Plan, Army Sustainability Campaign Plan, Army Energy Security Implementation Strategy, and numerous policies for energy, water, and waste. These plans, policies, and strategies include requirements for projects to integrate the principles and practices of sustainability into project design and to ensure that the Army provides safe, secure, reliable, environmentally compliant and cost-effective energy and water services on Army installations. Appendix A provides a list of energy and sustainability laws, executive orders and policies that the Army intends to meet under the Net Zero Installation program.

1.3 Scope and Content of the Environmental Assessment

This PEA has been prepared by the Department of the Army in accordance with the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] Parts 1500-1508), and the Army's Federal NEPA regulation (32 CFR Part 651) – Environmental Analysis of Army Actions. NEPA is a Federal environmental law that establishes procedural requirements for all Federal government agencies for proposed agency actions. 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.

In accordance with 32 CFR Part 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. The programmatic level of analysis will eliminate repetitive discussions of the same issues and focus on key issues at each appropriate level.

This PEA evaluates potential direct, indirect, and cumulative effects of the Net Zero Installation program at Army installations. Potential environmental effects resulting from the Proposed Action and alternatives, including the No Action Alternative, are identified in this PEA. Installation-specific actions to implement Net Zero will require an appropriate level of supplemental NEPA analysis and documentation.

Chapter 2 – Proposed Actions and Alternatives

2.1 Introduction

The Net Zero Installation program is a holistic approach to addressing energy, water, and solid waste management at Army installations. The Army Net Zero hierarchy is comprised of five interrelated steps: reduction, re-purpose, recycling and composting, energy recovery, and disposal. Each step is a link toward achieving Net Zero. Reduction includes maximizing energy efficiency in existing facilities, implementing water conservation practices, and eliminating generation of unnecessary solid waste. Re-purpose includes capturing various waste energy, water, or other waste streams and reusing them for a secondary purpose with limited processes. Recycling or composting includes management of the solid waste stream, development of closed-loop systems to reclaim water, or cogeneration where two forms of energy (heat and electricity) are created from one source. Energy recovery can occur from converting unusable waste to energy, renewable energy or geothermal water sources. Disposal is the final step and last resort after the last drop of water, the last bit of thermal energy and all other waste mitigation strategies have been fully exercised.

2.2 Proposed Action

The Net Zero Installation program would require Army installations to evaluate the feasibility of and then implement to the maximum extent practicable and fiscally responsible: (1) producing as much renewable energy on the installation as it uses annually, (2) limiting the consumption of freshwater resources and returning water back to the same watershed so as not to deplete the groundwater and surface water resources of that region in quantity or quality, and (3) reducing, reusing, and recovering waste streams, converting them to resource values with zero solid waste disposed in landfills.

2.2.1 **Proposed Energy Action:** The Net Zero energy program seeks to have each installation produce at least as much energy on the installation from renewable sources as it uses annually. The first step is to reduce energy demand in the most cost-effective manner, through changes in behavior and by maximizing energy efficiency and conservation in existing facilities. Next, installations must look for opportunities to divert energy to a secondary purpose with limited processes, such as using boiler stack exhaust, building exhaust or other thermal energy streams for a secondary purpose. Next, installations should explore converting unusable waste to energy, and determine whether cogeneration (where two forms of energy, heat and electricity, are created from one source) is feasible. The final step, after energy capture has been fully exercised, is to develop options for generation of renewable energy to meet the reduced energy demand. Each step in the process will be evaluated against the regulatory and policy drivers in Appendix A to ensure they are incorporated into the decision-making process.

Potential energy initiatives include:

- **Reduction through behavior change, followed by maximizing energy efficiency and conservation:** The terms energy conservation and energy efficiency have two distinct definitions. Energy conservation is any behavior that results in the use of less energy, whereas energy efficiency is the use of technology that requires less energy to perform the same function. Energy reduction starts with changes in

behavior to conserve energy. Energy awareness campaigns and use of mock billing can effectively change behavior. Sustainable master planning concepts (e.g., compact, walkable communities) will also help to reduce energy demand. Energy conservation and energy efficiency projects may include: replacing conventional lighting with energy-efficient models (e.g., compact fluorescent lights (CFLs), light-emitting diodes (LEDs)) and installing dimmers, motion detectors, and timers; replacing aging/inefficient heating, ventilation, and air conditioning (HVAC) systems with more energy-efficient HVAC equipment; replacing aging appliances and office equipment with Energy Star-rated equipment; replacing aging process equipment with more energy-efficient models; improving the building envelope (e.g., replacing older building windows with energy efficient windows; increasing the amount or R-factor of insulation in walls and roofs).

- **Re-purposing:** This includes capturing waste energy for a secondary purpose with limited processes. Projects may include using boiler stack exhaust, building exhaust or other thermal energy streams for a secondary purpose.

- **Recycling:** Recycling includes cogeneration where two forms of energy (heat and electricity) are created from one source. Projects may include converting unusable waste to energy where that is feasible.

- **Energy recovery through renewable energy generation:** Renewable energy generation may be small-scale or large- (utility) scale. Appendix B includes more detailed descriptions of each type of renewable energy technology described below.

  – Small-scale renewable energy efforts may include fuel cells (depending on the fuel source) and installation of photovoltaic (PV) and/or solar hot water panels on existing buildings or installation of ground source heat pumps.

  – Large-scale renewable energy projects could include PV systems (including flat plat arrays and concentrating solar power), wind turbines, geothermal systems, waste-to-energy (WTE), biomass systems, landfill gas recovery, and hydroelectric power. Development of supporting infrastructure (e.g., new transmission lines, roads) may also be required for these systems. Microgrids may be implemented in conjunction with these systems to improve energy security.

2.2.2 **Proposed Water Action:** The Army Net Zero water program seeks to limit the consumption of freshwater resources and return water back to the same watershed so as not to deplete the groundwater and surface water resources of that region in quantity or quality. The first step is to implement water efficiencies through low-flow/waterless plumbing fixtures and improving distribution system integrity. Installations must look for opportunities to capture 'waste' water for a secondary purpose with limited processes, such as using greywater generated from showers and sinks. Installations should identify opportunities to develop closed-loop systems to reclaim and/or treat water. Installations should also determine whether there are opportunities to capture waste water. Each step in the process will be evaluated against the regulatory and policy drivers in Appendix A to ensure they are incorporated into the decision-making process.

Potential Water Initiatives include:

- **Reduction through behavior change, followed by maximizing water efficiency and conservation:** As with energy, water efficiency and conservation have two distinct definitions. **Water efficiency** is the use of technology that requires less water to perform the same function, whereas **water conservation** is any behavior that results in the use of less water. Water efficiency measures provide greater reductions in water use than conservation. Together they provide key components of integrated water resources management including comprehensive reductions in use. Examples of specific actions that could be taken include:

  - Education initiatives to change behavior to use water more efficiently and conserve it when it is used. This would include changes in installation policies to manage Soldier, civilian, and contractor behavior in support of Net Zero goals.
  - Water balance assessments to determine who the water users are and how much water they use, both of which are needed to determine a baseline of water use for an installation. This helps to strengthen water management decision-making.
  - Meters installed along the water distribution system to monitor how much the system may be leaking.
  - Meters installed on the facilities where the largest water uses are located.
  - Meters and/or sub-meters installed on all facilities and spaces within those facilities where tenant organizations are located so that tenant water use can be correctly determined and then billed.
  - Water distribution system leak detection surveys and subsequent repair/replacement of the leaking distribution system segments.
  - Replacement of existing systems with more water-efficient systems, such as low-flow plumbing fixtures, air handling units, and irrigation controls.
  - Incorporation of low impact development criteria in facility designs.
  - Replacement of traditional landscaping with xeriscaping or low water demand landscaping.
  - Use of pervious surfaces to increase water infiltration and reduce runoff.
  - Use of closed-loop or recirculation systems to reduce the freshwater demand.

- **Re-purposing through greywater recycling:** Greywater recycling is the reuse (for other non-potable uses) of water from sinks, showers, washing machine and dishwashers. Greywater typically contributes 75% of total wastewater flow to domestic sewers.

- **Development of alternate water supplies:** Ensuring current and future water supplies to an installation may require construction of new infrastructure or modification of existing infrastructure. New infrastructure could include rainwater retention systems as well as new groundwater or surface water supply connections.

2.2.3 **Proposed Waste Action:** The Army's Net Zero waste program seeks to reduce, reuse, and recover waste streams, converting them to resource value with zero solid waste disposed in landfills. The first step is considering the waste stream when purchasing items to avoid or eliminate generation of unnecessary waste (e.g., packaging waste). In the second step, installations will look for opportunities to divert waste to a secondary purpose with limited processes. Third, installations will maximize the reclamation of recyclable and compostable materials. Fourth, installations may explore opportunities to convert unusable waste to energy. The final step after thermal energy has been salvaged and all other waste mitigation strategies have been fully exercised, is disposal of any remaining waste in a landfill. Each step in the process will be evaluated against the regulatory and policy drivers in Appendix A to ensure they are incorporated into the decision-making process.

Potential waste initiatives include:

- **Reduction through modification of purchasing practices**:
  - At a minimum, installation procurement specialists and contracting officers would include existing Federal Acquisition Regulations (FAR) clauses for sustainable procurement, and would favorably weight those FAR clauses when making purchases and issuing contracts. Sustainable procurement is generally defined as purchasing products, goods, and services that use materials that are less toxic or free of hazardous materials, and are recyclable or contain recycled content materials. Examples include recycled-content copier/printer paper, non-toxic copier/printer inks, chlorine-free and/or non-toxic cleaning products, rechargeable batteries, re-writable CDs/DVDs, recycled-content carpets, etc. Sustainable procurement also includes efforts to minimize or eliminate packaging waste and switch to bulk dispensing versus smaller or single-serving items.
  - More proactive sustainable procurement actions may include implementation of 'take-back' provisions in furniture and equipment purchases. Examples include modular furniture purchasing agreements that have provisions to return worn, out-dated, and/or damaged components to the manufacturer/distributer, or appliance purchasing agreements where the manufacturer/distributor takes possession of the old appliance when delivering the new/replacement appliance.
  - Other actions may include contracts or management actions to refurbish or extend the lifecycle of furniture, equipment, and other goods. Examples include barracks mattress refurbishing (versus the purchase of new mattresses), extending the replacement cycle for equipment and appliances (including computers, fax machines, phones, barracks kitchen appliances), and use of replaceable carpet tiles versus wall-to-wall carpeting.

- **Re-purposing**: Installations may implement actions to divert waste to a secondary purpose with limited processes. Examples include chipping waste wood (including damaged pallets) for use in landscaping and soil cover, grinding brick and concrete debris from building demolition for use as roadway aggregate, grinding waste drywall for use as a soil stabilizer (e.g., for trails within a training range), and recovery of wood, steel, windows, fixtures or other building elements to retro-fit for use in other buildings. Other actions may include increased diversion of usable items for free

redistribution to on-Post government organizations, through the servicing Defense Logistics Agency Disposal Services (DLADS) office, in on-Post 'reuse shops', or through donation to non-profit veterans organizations (e.g., AMVETS).

- **Waste diversion through recycling and composting**: At a minimum, installations will endeavor to increase their solid waste diversion rates through more aggressive recycling and/or composting.

  - Recycling efforts may use single-stream collection or sorting in designated bins/containers, and may include a combination of curb-side collection and centrally-located recycling 'centers'. More aggressive recycling may include collection of recyclable materials previously not recycled by an installation, or identification of new options/markets for materials previously not thought to be readily recyclable.
  - Food waste and other organic material may be segregated for composting at on-Post or off-Post facilities. The resulting compost may be used for landscaping and soil amendments, or sold to off-Post users. Depending on state and local regulations, the composting may be conducted at smaller decentralized sites or at larger centralized facilities.

- **Energy recovery**: Installation waste that cannot be cost-effectively 'avoided', re-purposed, recycled, or composted could be disposed of via WTE technologies so that, after treatment, there is very little remaining waste. Volumes of remaining waste are expected to be significantly smaller than volumes generated prior to waste avoidance, re-purposing, recycling, and composting efforts were implemented. Therefore, a smaller scalable WTE treatment facility may be constructed on Post (using government funding or leveraging a public-private partnership), or a larger-scale commercial off-Post facility may be used. Many states regulate WTE processes as "incineration" even when other technologies are used. Note that WTE technologies still generate small quantities of resulting waste, and an end-use for that waste must be identified to achieve true Net Zero Waste. Current waste-to-energy technologies include:

  - **Mass Burn** – is the most proven technology, using standard combustion techniques. In the furnace, the waste is either combusted on a grate or in a fluidized bed to release energy in the form of heat. The gaseous and particulate products of the combustion reaction pass through several stages of emissions controls to meet U.S. Environmental Protection Agency (USEPA) air emissions standards. The heat released from the combustion of the fuel is transferred to water in the boiler and converted to steam which drives a steam turbine to produce electricity or is used for various heating applications.

  - **Pyrolysis** – is a form of incineration that chemically decomposes organic materials by heat in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures above 430 ºC (800 ºF). In practice, it is not possible to achieve a completely oxygen-free atmosphere. Because some oxygen is present in any pyrolysis system, a small amount of oxidation occurs. If volatile or semi-volatile materials are present in the waste, thermal desorption will also occur. Organic materials are transformed into gases, small quantities of liquid, and a solid residue containing carbon and ash. The off-

gases may also be treated in a secondary thermal oxidation unit. Particulate removal equipment is also required.

- **Gasification** – is a process that converts organic or fossil-based carbonaceous materials into carbon monoxide, hydrogen, carbon dioxide and methane. This is achieved by reacting the material at high temperatures (>700°C), without combustion, with a controlled amount of oxygen and/or steam. The resulting gas mixture is called *syngas* (from *synthesis gas* or *synthetic gas*) or *producer gas* and is itself a fuel. Syngas may be burned directly in gas engines, used to produce methanol and hydrogen, or converted into synthetic fuel. Gasification can also begin with material which would otherwise have been disposed of such as biodegradable waste. In addition, the high-temperature combustion refines out corrosive ash elements such as chloride and potassium, allowing clean gas production from otherwise problematic fuels.

- **Anaerobic Digestion** – is an emerging technology using biologic methods to process waste materials. The feedstock collection and processes for anaerobic digestion are the same as discussed for mass burn and gasification. The organic materials are placed into a digester, where microorganisms break down the material and release a biogas high in methane. The resulting biogas is captured and can used for several purposes (e.g., combusted for steam to drive a turbine; conditioned to serve as fuel for engines; stored for later use).

2.3 Alternatives Considered

2.3.1 Alternative 1: No Action

Under the No Action alternative, the Army would not pursue Net Zero initiatives to reduce overall consumption of energy and water resources and disposal of solid waste in landfills beyond those policies and procedures that are currently in place. The increasing costs of centralized utility provided energy and potential disruption of installation energy and water supplies would hinder efforts to effectively address installation energy and water security. Not minimizing the volume of solid waste to be disposed of will increase the land space occupied by landfills and may affect the installation's mission.

2.3.2 Alternative 2: Implement Net Zero Installation Program across the Army

As part of this alternative, the Army would implement policies, procedures and best management practices at all Army installations to maximize resource utilization and identify opportunities for reduction, repurposing, recycling, composting and energy recovery.

2.3.3 Alternative 3: Strategically implement Net Zero after evaluation of mission needs, consumption, and existing resource constraints while still achieving existing environmental mandates.

Implementing Net Zero at every Army installation may not be achievable due to available funds. Under this alternative, the Army would assess mission needs and return on investment to determine where resources should be concentrated. For example, investing in Net Zero initiatives at Fort Bliss (a high population

installation that has a corresponding high energy and water consumption and waste generation rate) will have a larger return on investment than that of Camp Atterbury (a small, low resident population National Guard site with a corresponding lower energy and water consumption and waste generation rate). In addition, critical mission considerations should be assessed when implementing measures to improve energy and water security.

Chapter 3 – Affected Environment and Environmental Consequences

3.1 Introduction

This chapter of the PEA discusses aspects of the environment that may potentially be impacted by the implementation of the Proposed Action. Because this PEA provides an assessment of environmental, social, and economic issues at a programmatic 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, but do provide decision makers, regulatory agencies, and the public with considerations of where the Net Zero proposal may likely affect environmental media areas in a general sense, along with information on the socioeconomic effects potentially resulting from the implementation of the various Net Zero management practices, projects and technologies at a typical Army installation.

This PEA will inform the decision-making process on the proposed alternatives and will provide installations with a tool for evaluating the potential environmental and socioeconomic effects that may result from implementing Army Net Zero initiatives. Within an Army installation, only locations that are compatible with the mission of that installation would be considered, and analysis will be conducted to address changes and understand environmental effects. Any potential conflicts with training, operations, or long-range plans would be resolved at the local installation level and fully coordinated at that Headquarters Department of the Army (HQDA) level during the siting and design process.

Commands and/or installations would prepare site-specific analysis, and coordinate the analysis at the HQDA level, as necessary to: (1) examine the compatibility of the proposed project with mission needs and land use inside and outside of the Army Installation; (2) address potential effects to environmental media 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 media.

Methods

This PEA assesses three "activity groups," Energy, Water, and Waste, and their likelihood to produce effects. These activity groups served as the evaluation elements for use as a planning and decision-making tool. The management practices, projects and technologies that were evaluated within each activity group were applied to environmental media areas, and potential effects were rated from "low" to "high" as follows:

- ***Low*** – No impact to minor effects anticipated
- ***Medium*** – Moderate effects anticipated (less than significant)
- ***High*** – Significant effects are anticipated (with mitigation efforts, likely to be less than significant)

3.2 Land Use

General land use patterns characterize the types of uses within a particular area and can include urban, agricultural, residential, scenic, natural, military, and recreational. Land

ownership is a categorization of land according to type of owner. The major land ownership categories include Federal, Indian reservations, state/local, and private. Land management plans include those documents prepared by agencies to establish appropriate goals for future use and development. As part of this process, sensitive land use areas are often identified by agencies as being worthy of more rigorous or protective management.

Army Regulation (AR) 200-1 – Environmental Protection and Enhancement requires Army installations to prepare, implement, and maintain an Integrated Natural Resources Management Plan (INRMP) for the management of its land and biological resources. *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. 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. *AR 350-19 – The Army Sustainable Range Program* requires Army installations to prepare Range Complex Master Plans (RCMPs). The RCMP depicts the installation's current range and training lands, general siting of future range complex project requirements, and the installation's requirements and constraints that may impact ranges or training lands. RCMPs provide the source data for the installation's INRMP and RPMP.

Aspects of land use that are relevant to the proposed Net Zero management practices, projects, and technologies include the following:

- *Current land use within and surrounding the proposed projects(s).* Any proposed location must be compatible with existing land uses within an Army Installation, resulting in no net loss of training or operational capability. However, such uses must be described as part of the existing conditions so that changes to them are identified in the NEPA document.

- *Land ownership/real estate interests in natural resources surrounding the facility.* Adjacent to each Army Installation will be various landowners and their real estate interests in natural resources. These may be private, Indian trust, municipal, county, state, or other Federal agencies.

- *Compatibility with neighboring land uses and land use plans.* Surrounding each Army Installation are various land uses, some of which may be governed by municipal, county, regional, state, or Federal plans. Land uses can include urban, agricultural, residential, scenic, natural, military, and recreational. Although an Army installation is not legally subject to the ordinances, plans, and policies of the adjacent local jurisdiction, consideration of relevant plans and policies is required under NEPA. For any proposed project affecting resources within a state coastal zone, the Coastal Zone Management Act requires an evaluation of consistency with the local coastal plan.

- *Special use areas near the proposed site.* Sensitive land use areas, such as historic properties or sensitive natural areas, are often identified by agencies as being worthy of more rigorous or protective management.

3.2.1 Existing Conditions

As of 30 September 2011, Army installations included over 14 million acres of land, over 1 billion square feet of building space, over 70,000 miles of roads (paved and unpaved),

over 3,900 miles of railroads, and over 71,000 miles of utilities (electric, gas, water, and sewer). Land use categories include cantonment areas, housing areas, training lands, retail areas, forested areas, grazing lands, and protected wetlands and threatened or endangered species habitat.

Buffer zones have been established on surrounding off-Post lands at many Army installations. These zones serve several purposes, including use as buffers for encroachment of off-Post land development, noise buffers, and as habitat for threatened and endangered (T&E) species. These T&E species buffers are generally established under the Army Compatible Use Buffer (ACUB) program. More information about the ACUB program is provided in Section 3.7.

3.2.2 Environmental Consequences

Multiple factors were considered when determining whether an alternative would have a significant effect on land use. These factors were evaluated and distinguished by the degree to which the effect would impair the Army's ability to sustain land resources to maintain effective training grounds, ranges, and supporting installations, and conflict with existing Federal, state, or local statutes or regulations.

- Energy: The Net Zero Energy hierarchy seeks to reduce total energy demands through: changes in behavior to conserve energy; sustainable master planning concepts (e.g., compact, walkable communities); improved equipment efficiencies and building envelopes; and capture and reuse of waste heat/energy (e.g., boiler stack exhaust, building exhaust). The reduced energy demand would then be met by renewable energy where technically and financially feasible. Small-scale renewable energy efforts, which could have little effect on land resources, may include installation of photovoltaic (PV) and/or solar hot water panels on existing buildings or installation of ground source heat pumps. Utility-scale solar energy development such as ground-mounted solar arrays, biomass plants, and/or multiple wind turbines could preclude other land uses within the project footprint and could alter the character of largely rural areas. These types of utility-scale renewable energy projects may require clearing trees and establishing new roads, may result in modified traffic patterns during construction and operation, and may affect the viewscape of the area, all of which may reduce surrounding property values. Development of supporting infrastructure (e.g., new transmission lines, roads) would locally affect land use. Impacts from utility-scale projects (particularly wind turbines) can include obstruction/safety hazards and concerns, and may interfere with electro-magnetic spectrum and radars (military and commercial). Constructing and implementing microgrids (a coordinated energy and electrical distribution system capable of independent and dispatchable grid interactive operation that includes multiple distributed energy generation resources, energy storage, and multiple loads) to improve energy security would disturb land use during the construction phase and would alter land use in the immediate area of the microgrid, but to a lesser degree than development of new large-scale renewable energy sources. Depending on the site and size of the project, installation of external equipment (e.g., PV panels) or construction of new facilities can adversely affect the viewshed. Stakeholder coordination/consultation and/or consolidation of infrastructure during the scoping and design of any large-scale project could effectively avoid or minimize many of these effects. Careful incorporation of renewable energy projects into the

installation's real property master plan will help minimize the effect of the proposed project.

- Water: The Net Zero Water hierarchy seeks to first reduce freshwater demands through changes in behavior to conserve water, and by improving the water efficiency of on-Post water distribution systems, installing low-flow plumbing fixtures, etc., followed by water reuse where feasible and cost-effective (e.g., installation of closed-loop or recirculation systems, rainwater capture, greywater reuse). Ensuring current and future water supplies to an installation may require construction of new infrastructure or modification of existing infrastructure. Intensive water capture and water re-use could affect surface water supply to wetlands and/or threatened and endangered species habitats. Rehabilitation of existing water distribution lines, rerouting existing wastewater distribution lines to allow greywater re-use, or similar projects will temporarily disturb soil and vegetation around the lines/projects and may temporarily alter land use (e.g., traffic detours for the duration of the construction/repair). Construction of new water capture structures may permanently alter land use and may affect the viewshed around the new structure.

- Waste: The Net Zero Waste hierarchy seeks to reduce solid waste disposal in landfills through waste avoidance (e.g., changes in purchasing practices that generate less waste) and improved re-use and recycling practices. Land-based solid waste management methods range from 'curbside' collection containers, sorting/recycling facilities, and composting of organic materials to municipal solid waste landfills and waste-to-energy (WTE) facilities. Generating less waste would reduce the need for land-based waste disposal; however, increased recycling, composting, or WTE efforts may increase the demand for land-based waste sorting/handling areas. Army installations could use existing facilities on Post or in the surrounding communities, or could establish new facilities (on or off Post) alone or in partnership with local or regional governments or private parties. Establishment of new or additional curbside recycling options should have little to no effect on land use. Construction and operation of new on-Post sorting/recycling facilities or WTE facilities will alter land use and viewshed in the area of the new facility, with the degree of change dependent on the site selected for the new facility (e.g., cantonment area versus forested area or training land) and the size of the facility.

3.4.3 Existing Conditions and Environmental Consequences, Airspace

Site-specific studies and coordination with the installation air operations, air traffic, and airspace managers, range managers, and users would occur for each potential Net Zero project site. Federal Aviation Administration coordination would also occur for potential projects that could affect federal airspace. Wind turbines and other potential projects that involve towers or above-ground transmission lines are of particular concern to flight operations, air assault training, and related activities. For that reason, the HQDA G-3/5/7 has established a review process for all such projects. This process, together with application of siting and design criteria, would assist in the identification of any potential impacts to flight operations, including Air Traffic Control Radar systems and physical hazards posed by the Net Zero project, ensuring compatibility with air/ground operations, training, testing, and operational mission requirements. As a result, there would be no significant effect on airspace.

3.3 Geological Resources

Geological resources are defined as the topography, geology, and geological hazards of a given area. Topography is typically described with respect to the elevation, slope, aspect, and surface features found within a given area. 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 (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 (sedimentary rocks). Soil lies above bedrock and consists of weathered bedrock fragments and decomposed organic matter from plants, bacteria, fungi, and other living things. The value of soil as a geologic resource lies in its potential to support plant growth, especially agriculture. Mineral resources are metallic or non-metallic earth materials that can be extracted for a useful purpose, such as iron ore that can be refined to make steel, or gravel that can be used to build roads. Paleontological resources are the fossilized remains of plants and animals. Fossils, both vertebrate and invertebrate, have major scientific value. The principal geologic hazards influencing the stability of structures are soil stability and seismic activity.

Aspects of geological resources that are relevant to the proposed Net Zero management practices, projects (solar, geothermal, and ground source heat pumps), and technologies include:

- *Topography and Soils.* The topography of a proposed project site can be determined with topographic maps published by the U.S. Geological Survey (USGS), the Bureau of Land Management (BLM), or through GIS datasets available online. Soil information is available through the Natural Resources Conservation Service. The topography and soils at a project site would be characterized prior to construction to assess their suitability for construction and potential for erosion.

- *Mineral Deposits, Paleontological Resources, and Unique Geological Features*. Site conditions would be reviewed to determine if mineral deposits, paleontological resources, or unique geological features are present or expected. For proposed project sites located on Army installations, the potential for the occurrence of mineral deposits, paleontological resources, and unique geological features should be known from previous construction projects. Additional sources of information about paleontological resources in a region may be found at a state repository of fossil finds.

- *Geologic Hazards and Seismic Activity*. Geologic hazards include landslides and faulting hazards. Potential geologic hazards and seismic activity would be identified in a geotechnical study of any proposed project. The geotechnical study should provide design and construction recommendations that address potential geological hazards and seismic activity at a site.

3.3.1 Existing Conditions

Existing geological resources on Army installations are representative of geological resources across the U.S. Soil series at Army installations range from sandy to clay, depending on the geographic setting. Geologic formations vary by location and include sandstones, shales, karst formations, and glacial features such as tills, moraines and outwash plains. Similarly, geologic hazards also vary by location, ranging from areas

with little to no hazards to areas subject to seismic activity due to their proximity to geologic fault lines.

3.3.2 Environmental Consequences

Factors considered when determining whether an alternative would have a significant effect on geological resources were evaluated and distinguished by the degree to which the effect would impair the ability of the geological resources of the Army to sustain effective training grounds and ranges, and conflict with existing Federal, state, or local statutes or regulations.

- Energy: Improved energy conservation and small-scale renewable energy efforts such as installation of PV and/or solar hot water panels on existing buildings would have little effect on geologic resources. Development of geothermal resources may affect groundwater. Development of large blocks of land for ground source heat pumps, geothermal, solar arrays, wind turbines, and related infrastructure may result in effects to geologic and soil resources in terms of soil compaction and erosion, although these effects could be effectively mitigated. Effects on biological soil crusts would be long term and possibly irreversible.

- Water: Some of the on-Post water efficiency improvements (e.g., installation of low-flow plumbing fixtures or closed-loop or recirculation systems; repair of aging water distribution systems) would have little or no effect on geologic resources. Other efforts, like installation of rainwater capture systems or more traditional storm water retention basins, could significantly reduce soil erosion by reducing storm water runoff. However, rainwater capture systems that preclude infiltration could subsequently alter the site's contribution to groundwater recharge. Ensuring current and future water supplies to an installation may require construction of new infrastructure or modification of existing infrastructure. These infrastructure changes may affect existing topography and surface/sub-surface geological resources during construction.

- Waste: Existing land-based solid waste management methods (e.g., curbside collection containers, sorting/recycling facilities, composting of organic materials, municipal solid waste landfills, and WTE facilities) would have little to no effect on geologic resources. The establishment of new facilities, on or off Post, may affect existing topography and surface/sub-surface geological resources during construction.

Potential impacts resulting from erosion during grading and construction activities would be controlled through the use of appropriate erosion control Best Management Practices (BMPs) such as sandbags, silt fences, earthen berms, fiber rolls, sediment traps, erosion control blankets, check dams in medium-sized channels, or straw bale dikes in a smaller drain channels, or other BMPs specified in the installation's storm water pollution prevention plan. In addition, soil conservation and storm water management regulations require that appropriate BMPs be used to minimize/eliminate site-specific erosion concerns. Project sites would be excluded from consideration if the proposed construction activities would result in substantial alteration to topography or substantially increase the potential for erosion. Sites located in existing disturbed areas or requiring little grading would have minimal effects to topography or soils. A site-specific analysis

should be prepared for sites with varied topography requiring considerable grading to ensure the appropriate and sufficient application of BMPs.

3.4 Air Quality

Air quality is regulated in the U.S. by the U.S Environmental Protection Agency (USEPA) per the Clean Air Act (CAA) of 1970, as amended, and is important because of the status of regional ambient air quality in relation to National Ambient Air Quality Standards (NAAQS). 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 are wind speed and direction, atmospheric stability, temperature, presence or absence of inversions, and topography.

NAAQS are established by the USEPA 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 non-attainment if they exceed the NAAQS. Army installations can be located in both attainment and non-attainment areas.

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

According to USEPA'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 management action or project remain below applicable *de minimis* thresholds, a CAA Conformity Determination is not required. In this case, Army guidance requires the preparation of a Record of Non-Applicability (RONA) for CAA Conformity. If management action or project emissions of one or more of the criteria pollutants were to exceed applicable *de minimis* thresholds, a CAA Conformity Determination would be required to determine if emissions conform to the approved State Implementation Plan (SIP).

For management actions or project sites in nonattainment or maintenance areas, a site-specific analysis would be required to determine if *de minimis* thresholds would be exceeded requiring a Conformity Determination. Failure to conform to the SIP would exclude a proposed project site from further consideration.

3.4.1 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 periodic air emissions monitoring. These permits may be federal, state, or local, and the type of permit is a function of the

equipment and the amount of criteria and HAPs pollutants emitted. Smaller Army facilities that are more administrative in nature (e.g., National Guard armories) generally do not have air emissions that are regulated under the CAA, but may fall under local air quality requirements (e.g., dust suppression during construction activities).

Air quality effects would be a concern if they:

- added equipment such as boilers, stationary engines, and 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

3.4.2 Environmental Consequences

Factors considered when determining whether an alternative would have a significant effect on air quality were evaluated and distinguished by the degree to which the effect would impair the ability of the Army to sustain effective training grounds, ranges, and supporting installations; result in air emissions that, while compliant with applicable emissions standards, could decrease air quality; and conflict with existing Federal, state, or local statutes or regulations.

- Energy: Improved energy conservation and small-scale renewable energy efforts, such as installation of PV and/or solar hot water panels on existing buildings or installation of ground source heat pumps, could improve air quality by reducing power plant emissions and decreasing the use of fossil fuels. Construction of new renewable energy sources (including biomass plants, solar technologies, wind turbines, geothermal and ground source heat pumps) could adversely affect air quality locally and temporarily by fugitive dust and vehicle emissions, although effects would be relatively minor and could be mitigated (e.g., dust control measures, emissions control devices, vehicle maintenance). The nature and magnitude of these effects would vary by phase and would be determined by the project location and size. Operation of solar, wind, geothermal, and ground source heat-related energy projects could result in improved air quality as Army installations used less fossil fuel-derived energy and increased their use of renewable energy sources with lower greenhouse gas (GHG) emissions. However, operation of biomass facilities could affect local and regional air quality, depending on the size of the facility, source of feedstock, and emissions controls utilized.

- Water: Actions such as installing low-flow plumbing fixtures may slightly improve air quality by eliminating the GHGs and other air emissions associated with the energy required to pump and process the ‘saved’ water. Construction of new closed-loop or recirculation systems or rainwater capture structures, or repair of aging water distribution systems would have little or no effect on air quality during their operation, but air quality may be temporarily affected during the construction phase. Ensuring current and future water supplies to an installation may require construction of new

water supply infrastructure, which may temporarily affect air quality during the construction phase, but have little or no effect on air quality during their operation.

- Waste: Improved material procurement and management could reduce air emissions from transportation-related activities. Land-based solid waste management (e.g., recycling centers, sort facilities, composting) and disposal (e.g., landfills, WTE) may generate methane, carbon dioxide, and non-methane organic compounds, which may require a CAA permit. The Army currently uses a variety of these existing facilities, on and off Post. Should existing recycling centers, sort facilities, composting sites, and WTE facilities be incapable of handling different volumes anticipated due to Net Zero Waste activities, new facilities may be constructed (on or off Post). Construction of these new facilities could temporarily increase dust and other air emissions.

  Operation of new/additional recycling centers, sorting facilities, composting sites, and WTE facilities, especially if the facility is designed and permitted to accept waste from the surrounding community (e.g., under an enhanced use lease), may increase transportation-related emissions, but those emissions may be at least partially offset by reduced methane production from landfill-based disposal. Composting operations could include anaerobic digestion, which could create objectionable odors as well as produce emissions (including GHGs). Air emissions from new WTE facilities would be regulated under the CAA. Incineration-based WTE facilities could emit CAA-regulated criteria pollutants and HAPs. Newer WTE technologies (e.g., plasma- or pyrolysis-based systems) may generate fewer regulated emissions. Use of best available technology, proper management, and compliance with applicable CAA permit requirements should ensure that all these risks are controlled. Additionally, reduced landfill disposal would reduce long-term production of methane from the landfill. Energy recovery at WTE facilities would offset fossil-fuel derived energy use at the installation. However, air quality effects from WTE may include release of HAPs, ash, and other emissions; may increase ambient air pollution concentrations above any NAAQS; or trigger a conformity determination.

3.5 Noise

The Noise Control Act of 1972, along with its subsequent amendments (Quiet Communities Act of 1978 [42 USC Parts 4901−4918]), delegates to the states the authority to regulate environmental noise and directs government agencies to comply with local community noise statutes and regulations. Although no Federal noise regulations exist, the USEPA has promulgated noise guidelines (EPA 1974). Similarly, most states have no quantitative noise-limit regulations. Many local governments, however, have enacted noise ordinances to manage community noise levels. The noise limits specified in such ordinances are typically applied to define noise sources and specify a maximum permissible noise level. The Army considers these in evaluating noise effects.

3.5.1 Existing Conditions

Sources and levels of noise at Army installations are representative of cities and towns across the nation, with the exception of military test and training activities (including proving grounds and detonation sites). Existing noise sources on Army installations include traffic and transportation on/off Post, cantonment activities (e.g., administrative

buildings, public works facilities, motor pools), housing areas, shopping areas (e.g., commissaries, post exchanges, shoppettes), schools, and construction activities. Army training activities generate noise that can vary from ground troop movements and associated artillery firing to fixed- and rotary-wing aircraft flights, but may be cyclic or periodic in nature.

3.5.2 Environmental Consequences

The significance of potential noise effects is determined by the comparison of affected receptors to the acceptable compatible land uses. Sensitive receptors include residential areas, hospitals, and schools. Considerations used while evaluating noise effect include whether land use compatibility problems would be created (*AR 200-1, Environmental Protection and Enhancement*); and whether peak noise and random blast noise levels are exceeded 15 percent of the time and would be likely to cause significant annoyance to individuals in incompatible land uses.

- Energy: Construction-related noise (e.g., for solar, wind, geothermal, ground source heat pumps, biomass facilities) could adversely affect nearby residents and/or wildlife. Operations-related noise effects of solar, wind, geothermal, and ground source heat-related energy projects would generally be less significant than construction-related noise effects but could still be significant. However, operation of biomass facilities could generate a constant new source of noise. Some new operations, such as geothermal plants or wind turbines, may produce different types of noise (e.g., different tones and frequencies) that may affect wildlife and other biological resources. However, use of other energy technologies, such as PV panels (vs. generators) should significantly reduce noise levels.

- Water: Similar to energy, ensuring current and future water supplies to an installation may require construction of new infrastructure or modification of existing infrastructure. The temporary duration of the construction associated with these construction activities may temporarily affect noise levels.

- Waste: Establishment of new or additional curbside recycling may increase traffic and noise in residential and commercial areas on Post if additional trucks are required. Similarly, increased activity at sorting/recycling facilities could increase noise levels. However, improved procurement practices could reduce traffic and noise from transportation of goods and services. Composting operations (e.g., anaerobic digesters) and WTE facilities projects can generate noise. During the design of any new composting or WTE facility, consideration should be given to potential noise from pumps, compressors, power sources and the overall scheme to minimize noise.

3.6 Water Resources

Water resources as defined in this assessment are sources of water available for use by humans, flora, or fauna, including surface water, groundwater, nearshore waters, wetlands, and floodplains. Surface water resources, including, but not limited to, storm water, lakes, streams, rivers, and wetlands, are important for economic, ecological, recreational, and human health reasons. Groundwater is classified as any source of water beneath the ground surface and may be used for potable water, agricultural irrigation, and industrial applications. Near-shore waters

can be directly affected by human activity, and are important for human recreation and subsistence. Wetlands are habitats that are subject to permanent or periodic inundation or prolonged soil saturation, and include marshes, swamps, and similar areas. Areas described and mapped as wetland communities may contain small streams or shallow ponds, or pond/lake edges. Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. Floodplains are relatively flat areas adjacent to rivers, streams, watercourses, bays, or other bodies of water subject to inundations during flood events.

Aspects of water resources that are relevant to the proposed Net Zero management practices, projects and technologies include:

- *Surface Water Quality.* Wastewater, cooling water, and storm water discharges from Army installations are regulated under the Clean Water Act (CWA). CWA discharge permits are issued by USEPA or authorized state agencies under the National Pollutant Discharge Elimination System (NPDES). NPDES permits may be issued to point source discharges to "waters of the US", 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. As part of the storm water permitting process, Army installations prepare Storm Water Pollution Prevention Plans (SWPPPs) that include implementation of best management practices (BMPs), performing frequent visual inspections, and benchmark monitoring to determine BMP effectiveness. 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.

- *Wetlands and Waters of the United States (WoUS)*. If a formal wetland delineation has already been determined for the Army installation or the proposed project area, this can be used to determine the occurrence of jurisdictional wetlands or WoUS within the footprint of the construction area for any proposed new facilities. If no previous delineation has been performed, available Army and other Federal agency data will be used to determine the potential for wetlands or WoUS within the proposed project footprint. These include aerial photographs, U.S. Fish and Wildlife Service National Wetlands Inventory (NWI), and soil classification maps developed by the U.S. Department of Agriculture, Natural Resources Conservation Services (which identify the presence of hydric soils). 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 wetlands or WoUS are present. If there are indications that wetlands or WoUS may be located within the proposed project footprint, then formal wetland delineation would be conducted according to the U.S. Army Corps of Engineers (USACE) *Wetlands Delineation Manual (1987)* and any regional supplements. A wetland delineation report would then be prepared and submitted to USACE, who would make a determination on whether or not a wetland is jurisdictional and therefore subject to CWA Section 404 Nationwide Permit requirements.

- *Floodplains*. The Federal Emergency Management Agency's (FEMA) flood maps (FEMA 2010b) can be used to determine if the proposed project area is located within a FEMA-designated 100-year floodplain. 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. EO 11988 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.

AR 200-1 – Environmental Protection and Enhancement summarizes Army program requirements for water resources management and CWA compliance.

3.6.1 Existing Conditions

Existing water resources on Army installations are representative of water resources across the U.S. Surface water bodies at Army installations include rivers, streams, lakes, and wetlands. A few Army installations abut near-shore marine waters. Wetlands have been formally delineated at multiple Army installations. 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 body's quality.

Some Army installations operate their own wastewater treatment plants (regulated under their site-specific NPDES 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 'pre-treatment' permits. As of May 2010, Army installations held a total of 678 CWA permits.

3.6.2 Environmental Consequences

The proposed Net Zero management actions, projects, and technologies could be located at Army installations in areas that have been previously disturbed or are undisturbed. Potential effects could include changes to surface and near-shore waters from storm water runoff during both construction and operations; potential presence of jurisdictional wetlands and WoUS within the proposed project footprint; and, depending on the proposed technology, potential increased demand for water resources (either surface water or groundwater). During construction activities, pollutants that could potentially affect water quality include sediment from ground disturbance and potential spills or leaks from construction equipment. During the operations phase, efforts to increase storm water infiltration could also potentially increase infiltration of oils or hazardous substances from spills and leaks from maintenance activities, which could potentially affect water quality.

Multiple factors were considered when determining whether an alternative would have a significant effect on water resources. These factors were evaluated by the degree to which the effect would impair the ability of the Army to sustain effective training grounds, ranges, and supporting installations; result in unacceptable increases in water demand or degradation of water quality; and conflict with existing Federal, state, or local statutes or regulations.

- Energy: Improved energy conservation and small-scale renewable energy efforts, such as installation of PV and/or solar hot water panels on existing buildings or installation of closed-loop ground source heat pumps, would have little or no effect on water resources. Open-loop ground source heat pumps could affect water resources. Depending on the type of renewable energy, construction of new larger-scale renewable energy sources (e.g., concentrating solar power, which is

sometimes referred to as solar thermal electric or thermoelectric) could affect water resources. Solar thermal energy technologies with wet-cooling systems require large volumes of water, with potentially significant environmental effects; however, such projects would be limited primarily to locations with ample water supplies (e.g., surface water, groundwater, treated greywater) where water rights and the approval of water authorities could be obtained. Solar thermal projects with dry-cooling systems require less than one-tenth of the amount of water required for wet-cooling systems. All solar energy facilities require smaller volumes of water for mirror or panel washing and potable water uses, which would result in relatively minor effects on water supplies. Ocean wave and river current technologies could affect surface waters in the vicinity of the project. Use of geothermal heating and cooling could result in minor alterations to local groundwater resources. Other potential effects, including modification of surface and groundwater flow systems, water contamination resulting from chemical leaks or spills, and water quality degradation by runoff or excessive withdrawals, can be effectively mitigated. Development of new renewable energy sources may require significant removal of vegetation at the proposed project site, which could result in altered drainage patterns, runoff, and sedimentation. Design features (e.g., minimizing size of disturbed areas, erosion control measures) could significantly reduce many of these effects.

- Water: Some of the on-Post water efficiency improvements (e.g., installation of low-flow plumbing fixtures) could have a positive effect on water resources by reducing water demand. Extensive use of pervious pavement and other groundcover could significantly increase rainwater and storm water infiltration, which would also increase the possibility of inadvertent infiltration of oil or hazardous substances from spills and/or leaks. Other efforts (e.g., installation of closed-loop or recirculation systems, greywater systems, or rainwater capture systems) could also subsequently alter the site's contribution to groundwater recharge. Similarly, repair of aging/leaking water distribution systems could reduce the site's contribution to groundwater recharge; however, this may be partially offset by reduced groundwater pumping to meet the installation's water demand (i.e., less water is required in a distribution system with a significant reduction in leakage). Ensuring current and future water supplies to an installation may require construction of new infrastructure or modification of existing infrastructure. These infrastructure changes or intensive storm water capture (where not prohibited by state regulation) and water re-use could affect existing water resources including surface water, groundwater, wetlands, and floodplains, which could affect surface water supply to threatened and endangered species and their habitats.

- Waste: Improved material procurement and management could slightly decrease an installation's water use due to reduced manufacturing and transportation-related activities. However, some practices (e.g., replacement of disposable food service items with reusable service items that require washing/sterilization) could increase water (and energy) use on the installation. Implementation of some new small-scale waste technologies, such as organic digesters to minimize food waste in Army dining/food service facilities and commissaries, could slightly increase water use. Increased use of existing recycling/repurposing facilities or sorting centers could have little or no effect on water resources, on or off Post, since rinsing the added recycling containers and transport vehicles and increased dust suppression would be offset by equal reductions in solid waste disposal activities. Should existing recycling centers and WTE facilities be incapable of handling the increased volumes and

potentially different waste streams anticipated as a result of Net Zero Waste activities, new facilities may be constructed (on or off Post). Construction of these new facilities, depending on type of the facility, could temporarily affect storm water quality during the construction phase. Operation of new facilities could increase water use, and could increase the potential for spills of waste materials or oils from maintenance activities and waste transportation vehicles.

3.7 Biological Resources

Biological resources include native and naturalized plants and animals and their habitats. Potential effects of concern include: (1) construction-related effects on legally protected habitats or species (e.g., destruction of wetlands, endangered animal/plant species habitat, or active nests of Migratory Bird Treaty Act (MBTA)-protected bird species); and (2) potential injury or mortality to animals, especially Endangered Species Act (ESA)-listed and state-listed species.

EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds) provides specific direction to Federal agencies to conserve migratory birds and to assess the effects of their actions on migratory bird populations. A subsequent 2006 Memorandum of Understanding (MOU) between the DoD and U.S. Fish and Wildlife Service (USFWS) requires DoD to review wind turbine and 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 of proposals for locating communications towers, power lines, or wind turbines on military lands.

Aspects of biological resources that are relevant to the proposed Net Zero management practices, projects, and technologies include the 147 USFWS recognized “Birds of Conservation Concern” (USFWS 2008), bird or bat species listed as threatened or endangered under a state-level ESA regulation, along with their habitats, and areas designated by local organizations to be of conservation importance, such as local parks, refuges, or Audubon-designated Important Bird Areas (IBAs).

Management of these species and their habitats, along with other land areas, are addressed in the installation’s Integrated Natural Resources Management Plan (INRMP). 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. Installations must review their INRMP annually, and modify it as needed. Additionally, the Sikes Act requires installation INRMPs to be reviewed every 5 years by the USFWS and the corresponding state agency. Public input is requested during this 5-year review.

Where construction or operation of facilities occurs near threatened or endangered species’ habitats, buffer distances have been typically established through consultation with USFWS to avoid an ‘incidental take’ by disturbance of ESA-listed species. Such distances are indicative of the potential for disturbance by other types of projects. Applicable buffers will be established for individual projects based on the location and proximity to sensitive resources. Under the Army’s ACUB program, buffer zones can also be established in the public or private lands surrounding an installation to provide additional habitat for threatened and endangered species.

3.7.1 Existing Conditions

Existing biological resources on Army installations are representative of biological resources across the U.S. As of September 2011, Army installations collectively had 213 Federally-listed endangered species, and 23 'species at risk'. Management of these species and their habitats are addressed in the installation's INRMP. Additional (off-post) habitat protection may be provided under the ACUB program. As of September 2011, 28 Army installations had ACUB partnerships which collectively protected over 158,000 acres of habitat.

3.7.2 Environmental Consequences

Multiple factors were considered when determining whether an alternative would have a significant effect on biological resources. These factors were evaluated by the degree to which the effect would impair the ability of the Army to sustain effective training grounds, ranges, and supporting installations; result in loss of habitat or adverse effects to threatened or endangered species or species at risk; and conflict with existing Federal, state, or local statutes or regulations. For proposed projects, installations will conduct site-specific analysis to assess the occurrence of resources of concern and their vulnerability. Input from state and local agencies or nongovernmental organizations (e.g., National Audubon Society) would be sought as part of the site-specific analysis.

- Energy: Most energy conservation and energy efficiency measures (e.g., increased energy awareness programs; replacement of conventional lighting with energy-efficient lighting; installation of more energy-efficient HVAC systems; improved building envelope features such as added insulation or more energy-efficient windows) should have little to no effect on biological resources. While development of new renewable energy sources could affect biological resources, effects will be dependent on the type of project and the proposed project location. For example, installation of PV or solar hot water panels on existing roof tops, car ports, or building facades could affect biological resources during construction/installation and may generate additional heat or light reflection that could affect biological resources during the operation phase. However, these effects would be less than those anticipated during construction of entirely new facilities. Similarly, construction of renewable energy facilities on previously disturbed land would generally have fewer effects on biological resources than would construction on previously undisturbed lands. Proposed projects on previously undisturbed lands could potentially affect locally-present wildlife species by loss or disturbance of habitat (including breeding areas), habitat fragmentation (which in turn could affect movement and migration), loss of food and prey species, introduction of new species, and changes in water availability. Construction and operation of wind turbines, whether on disturbed or undisturbed land, could adversely affect migratory birds if sited in migration corridors. Similarly, construction and operation of new biomass facilities could adversely affect small and large mammals, birds, and other wildlife. Careful site selection (including conducting pre-disturbance surveys) could avoid designated habitat areas. Similarly, careful design and construction (e.g., minimizing land disturbance, controlling surface water runoff, invasive species control programs, fugitive dust control) could reduce many of these potential effects. The site-specific NEPA analysis of a proposed project could identify additional ESA-related mitigation requirements (e.g., translocation; or acquisition and protection of compensatory habitat). A potential

positive effect is the possible use of the areas under ground-mounted solar panels for cover or protection by various small mammals or birds.

- Water: Most water conservation and water efficiency measures (e.g., increased water awareness programs; replacement of conventional plumbing fixtures with water-efficient plumbing fixtures; installation of more water-efficient industrial systems) should have little to no adverse affect on biological resources and may actually have a positive affect if fresh water use is reduced. More extensive water conservation/efficiency measures, especially 'outdoor' measures such as repair/replacement of aging water distribution, could potentially affect biological resources during the construction. Ensuring current and future water supplies to an installation, much like ensuring secure energy, may require construction of new infrastructure. Additionally, while decreasing the use of freshwater, new water capture and water reuse projects could decrease surface water runoff, which could affect water availability in some surface water bodies and wetlands, in turn affecting habitat for threatened and endangered species and species at risk. As with new renewable energy projects, construction of new water facilities on previously disturbed land would generally have fewer effects to biological resources than would construction on previously undisturbed lands. Proposed projects on previously undisturbed lands could potentially affect locally-present wildlife species by loss or disturbance of habitat (including breeding areas), habitat fragmentation (potentially affecting movement and migration), loss of food and prey species, introduction of new species, and changes in water availability. Careful site selection (including conducting pre-disturbance surveys) could avoid designated habitat areas. Careful design and construction (e.g., minimizing land disturbance, controlling surface water runoff, invasive species control programs, fugitive dust control) could reduce many of these potential effects. The site-specific NEPA analysis of a proposed project could identify additional ESA-related mitigation requirements (e.g., translocation; acquisition and protection of compensatory habitat).

- Waste: Most waste avoidance measures (e.g., improved procurement practices) should have little to no affect on biological resources and may actually have a positive affect if less solid waste is generated. More extensive or intensive recycling, processing, or disposal activities, especially where new or additional outdoor facilities are constructed or where significant increased transportation-related traffic is anticipated, could potentially affect biological resources during construction and operation. Additionally, while decreasing the volume of solid waste disposal in landfills, new waste sorting/recycling or WTE facilities could provide new opportunities for disease vectors (i.e., animals or microorganisms that can carry/transmit infectious pathogens to other living organisms) and invasive species. These activities may also attract increased numbers of birds, which could interfere with flight operations and related mission operations. As with energy and water, construction of new waste facilities on previously disturbed land would generally have fewer effects to biological resources than would construction on previously undisturbed lands. Proposed new waste facilities on previously undisturbed lands could potentially affect locally-present wildlife species by loss or disturbance of habitat (including breeding areas), habitat fragmentation (potentially affecting movement and migration), loss of food and prey species, introduction of new species, and changes in water availability. Careful site selection (including conducting pre-disturbance surveys) could avoid designated habitat areas. Careful design and construction (e.g., minimizing land disturbance, controlling surface water

runoff, invasive species control programs, fugitive dust control) could reduce many of these potential impacts. The site-specific NEPA analysis of a proposed project could identify additional ESA-related mitigation requirements (e.g., translocation or acquisition and protection of compensatory habitat).

3.8 Cultural Resources

Cultural resources can be present within landscapes as districts, sites, buildings, structures, or objects (Little et al. 2000). Cultural resources also include cultural properties, locations with enduring significance to the beliefs, customs, and/or practices of living communities. Properties are considered eligible for nomination to the National Register of Historic Places (NRHP) if they are associated with cultural practices or beliefs of a living community that are: (a) rooted in the community's history, and (b) important in maintaining the continuing cultural identity of the community (Parker and King 1998). Culturally-sensitive locations called Areas of Native American Concern which may not be considered eligible for nomination to the NRHP may still be protected under the Native American Grave Protection and Recovery Act (NAGPRA). Historic properties can include both prehistoric and historic objects, sites, buildings, structures, and districts as well as traditional cultural properties. All historic properties within a project area constitute the affected environment for cultural resources.

The Army is required to take into account the effects of its undertakings on cultural resources and historic properties and to consult with the State Historic Preservation Office (SHPO) and/or Tribal Historic Preservation Officer (THPO). *AR 200-1 – Environmental Protection and Enhancement*, requires Army installations to maintain an Integrated Cultural Resources Management Plan (ICRMP) that serves as a guide for compliance with the NHPA and other applicable Federal laws and regulations, including identification and preservation of cultural resources and historic properties.

3.8.1 Existing Conditions

Existing cultural resources on Army installations are representative of cultural resources across the U.S. As of September 2011, Army installations collectively had the following cultural resources:

- Over 57,000 buildings or structures over 50 years old and subject to NHPA; approximately 10,000 of those buildings/structures were either listed on or eligible for the NRHP
- 21 National Historic Landmarks
- Approximately 77,000 archeological sites had been recorded on Army lands, with over 7,600 of those sites either listed or eligible for the National Register
- Native American collections protected under NAGPRA at 25 installations

The Army's 129 installation-specific ICRMPs are the framework for managing and protecting these cultural resources.

3.8.2 Environmental Consequences

Effects to cultural resources can be direct or indirect and may affect the integrity of the historic property or adversely affect those characteristics that cause a property to be listed, or eligible for listing, on the NRHP. Direct effects include physical modification to all types of historic properties, in addition to visual effects to the physical setting of historic districts, buildings, structures, cultural properties, and objects where physical setting is an important aspect of their integrity. Indirect effects are those that change the accessibility, use, or economic viability of the historic property. Physical effects include the partial or complete demolition or destruction of the historic property. Visual effects to historic properties occur when the setting of the property is severely affected by the proposed action to the extent that its historical importance is no longer able to be conveyed. Effects to accessibility can occur when access to historic properties is either enhanced or restricted. Enhanced access can 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 historic properties can indirectly affect the communities to which they are important for their cultural identity (e.g., limiting access by Native American communities to traditional cultural properties, limiting access to churches or other historic buildings of importance to the identity of local communities). Restrictions on access can indirectly affect the use and economic viability of historic buildings and structures that can lead to their destruction or demolition. The primary criterion for determining the significance of the potential effects from the proposed action is whether or not there are adverse effects on eligible historic properties. If a historic property will not be affected by a proposed action, it is determined to have no effect. Effects to historic properties that do not affect those aspects of integrity that cause a historic property to be listed in, or considered eligible for listing in, the NRHP are said to have no adverse effects. Adverse effects occur when a proposed action has a negative effect on those qualities (characteristics) that make a property eligible for listing on the NRHP. Adverse effects on historic properties are generally caused by changes to their integrity. They include physical destruction or damage to all or part of the property; removal from its historic location; change in the contributing features of setting that contribute to its historic significance; and introduction of visual, atmospheric, or noise elements that diminish integrity. If the proposed action causes a change in the setting of a historic property, adverse visual effects could potentially occur to historic properties where setting has been specifically identified as an important aspect of the property's integrity. The setting of a historic property would be most likely an important aspect of integrity for a property that is located within or adjacent to a National Register Historic District or a National Historic Landmark.

Factors considered when determining whether an alternative would have a significant effect on cultural resources were evaluated and distinguished by the degree to which the effect would impair the ability of the Army to sustain effective training grounds, ranges, and supporting installations; result in adverse effects on cultural resources; and conflict with existing Federal, state, or local statutes or regulations.

- Energy: Most energy conservation and energy efficiency measures (e.g., increased energy awareness programs; replacement of conventional lighting with energy-efficient lighting; installation of more energy-efficient HVAC systems; improved building envelope features such as added insulation or more energy-efficient

windows) should have little to no effect on cultural resources with the exception of buildings/sites subject to the NHPA. While development of new renewable energy sources could affect cultural resources, the degree of effect will be dependent on the type of project and the proposed project location. For example, for buildings not subject to the NHPA, installation of PV or solar hot water panels on existing roof tops, car ports, or building facades could potentially affect archeological resources during the construction/installation phase if staging of construction equipment is done outside the zone that was previously disturbed for the existing building, but these effects would generally be less than those anticipated during construction of entirely new facilities. Similarly, construction of new renewable energy facilities on previously disturbed land would generally have fewer effects to cultural/archeological resources than would construction on previously undisturbed lands. These general assumptions do not apply to modification of historic buildings/sites subject to the NHPA, or construction of new facilities within or near historic districts. In those cases, careful design in close consultation with the SHPO may minimize adverse effects, but it should be noted that some proposed energy-related modifications to historic properties may not be possible without significant adverse effect to the property.

Proposed projects on previously undisturbed lands could potentially disturb or affect surface and subsurface cultural resources, particularly if thorough cultural resources surveys have not been conducted (e.g., construction of new renewable energy sources within previously undisturbed training lands). Careful site selection (including conducting pre-disturbance surveys), design, and construction (e.g., minimizing land disturbance, controlling surface water runoff) could be done to avoid any identified cultural resources. The site-specific NEPA analysis of a proposed project could identify additional NHPA- or NAGPRA-related mitigation requirements.

- Water: Most water conservation and water efficiency measures (e.g., increased water awareness programs; replacement of conventional plumbing fixtures with water-efficient plumbing fixtures; installation of more water-efficient industrial systems) should have little to no adverse effect on cultural resources. More extensive water conservation/efficiency measures, especially 'outdoor' measures such as repair/replacement of aging water distribution, could potentially disturb cultural resources during the construction. Ensuring current and future water supplies to an installation, much like ensuring secure energy, may require construction of new infrastructure or modification of existing infrastructure. As with new renewable energy projects, construction of new water facilities on previously disturbed land would generally have fewer effects to cultural resources than would construction on previously undisturbed lands. These general assumptions do not apply to modification of historic buildings/sites, or construction of new facilities within historic districts. In those cases, careful design in close consultation with the SHPO may minimize adverse effects, but it should be noted that it some proposed water-related modifications to historic properties (e.g., addition of external rain barrels) may not be possible without adverse effects to the historic property.

  Proposed projects on previously undisturbed lands could potentially disturb or affect surface and subsurface cultural resources, particularly if thorough cultural resources surveys have not been conducted (e.g., construction of new water retention structures or drilling new groundwater supply wells within previously undisturbed training lands). Careful site selection (including conducting pre-disturbance surveys),

design, and construction (e.g., minimizing land disturbance, controlling surface water runoff) could be done to avoid any identified cultural resources. The site-specific NEPA analysis of a proposed project could identify additional NHPA- or NAGPRA-related mitigation requirements.

- Waste: Most waste avoidance measures (e.g., improved procurement practices) should have no effect on cultural resources. More extensive or intensive recycling, processing, or disposal activities, especially where new or additional outdoor facilities are constructed, could potentially affect cultural resources during construction and may permanently alter the viewscape. As with energy and water, construction of new waste facilities on previously disturbed land would generally have fewer effects to cultural resources than would construction on previously undisturbed lands. These general assumptions do not apply to modification of historic buildings/sites, or construction of new waste facilities within historic districts. In those cases, careful design in close consultation with the SHPO may minimize adverse effects, but it should be noted that some proposed waste-related modifications to historic properties (e.g., addition of external waste collection and sorting containers) may not be possible without adverse effects to the historic property.

  Proposed new waste facilities on previously undisturbed lands could potentially disturb or affect surface and subsurface cultural resources, particularly if thorough cultural resources surveys have not been conducted. Careful site selection (including conducting pre-disturbance surveys), design, and construction (e.g., minimizing land disturbance, controlling surface water runoff) could be done to avoid any identified cultural resources. The site-specific NEPA analysis of a proposed project could identify additional NHPA- or NAGPRA-related mitigation requirements.

3.9 Health and Safety

Any aspect of a project that creates a potential risk to human health and safety requires consideration under NEPA. This includes occupational hazards to workers as well as the exposure of the general public to conditions creating the risk of immediate injury or long-term health hazards. The latter may include indirect effects related to noise, utilities, airspace, and hazardous materials, respectively, which are addressed in separate sections of this chapter.

Aspects of health and safety that are relevant to the proposed Net Zero management practices, projects, and technologies include the following:

- *Existing land use.* The existing land use (with regard to level of development and human presence) at each site provides a means to estimate baseline conditions.

- *Nearest residential and public use areas.* Because sites would be located on Army installations, security measures at each site would restrict or limit public access.

3.9.1 Existing Conditions

Conditions that affect health and safety on Army installations are representative of those across the U.S. Army installations include adult populations that work in a wide range of occupations, including managerial and administrative, education, health care, services, facilities and equipment repair, and related occupations found in cities across the Nation.

The workplaces for these occupations are subject to Occupational Safety and Health Administration (OSHA) regulations and oversight, as well as Army health and safety-related regulations (e.g., AR 385-10 – The Army Safety Program). More unique to the DoD, Army installations also have adult populations that work in activities that provide direct tactical training support to the U.S. military mission.

In addition to the adult population, most Active Component Army installations include family housing areas with child populations, as well as the facilities that support that population (e.g., child development centers, schools, youth services facilities). These workspaces and facilities are subject to Federal and state regulations, in addition to Army and DoD regulations such as AR 608-12 (Child Development Services), DoD Instruction (DoDI) 6055.1 (DoD Safety and Occupational Health Program), DoDI 6055.4 (DoD Traffic Safety Program), and DoDI 6055.07 (Mishap Notification, Investigation, Reporting, and Record Keeping).

3.9.2 Environmental Consequences

Multiple factors were considered when determining whether an alternative would have a significant effect on health and safety. They were evaluated and distinguished by the degree to which the effect would: impair the ability of the Army to sustain effective training grounds, ranges, and supporting installations; result in adverse effects to the health and safety of the installation's occupants as well as the surrounding community; and conflict with existing Federal, state, or local statutes or regulations.

- Energy: When properly implemented, most energy conservation and energy efficiency measures (e.g., increased energy awareness programs; replacement of conventional lighting with energy-efficient lighting; installation of more energy-efficient HVAC systems; improved building envelope features such as added insulation or more energy-efficient windows) should have little effect on health and safety. Replacement of older lighting and HVAC systems with newer technologies may create the potential for exposure to electrical hazards; however, the longer lifespan of some of these technologies (e.g., lighting) should reduce the exposure potential over the system's lifecycle when compared to conventional systems. When replacing conventional lighting with energy-efficient alternatives, including compact fluorescent lights (CFLs), light-emitting diodes (LEDs), dimmers, timed lighting, and motion detectors, care should be taken to ensure adequate levels of illumination to avoid eye strain or insufficient lighting levels that may contribute to slip/fall hazards. Maintenance workers and occupants will need to be trained in any special handling and disposal associated with the new lighting (e.g., handling and disposal of CFLs). Similarly, training may be needed to ensure maintenance workers and building occupants can effectively operate new energy-efficient thermostats to ensure occupant comfort.

  While development of new renewable energy sources could affect health and safety, effects will be dependent on the type of project and the proposed project location. For example, installation of PV or solar hot water panels on existing roof tops, car ports, or building facades could pose greater risk to maintenance workers due to their elevated location (requiring use of ladders, chair lifts, etc.), but these risks could be minimized by updating the associated facility maintenance health and safety (H&S) plan and periodic training. Construction of any new renewable energy sources (e.g., solar arrays, geothermal, wind) will have the potential risks inherent to

any construction site. These risks could be minimized through implementation of a comprehensive construction H&S plan. Operation of new renewable energy sources, including solar and geothermal energy and biomass facilities, may pose risks to maintenance workers (e.g., exposure to high-temperature materials and fluids). These risks could be minimized through implementation of a comprehensive H&S plan for operation and maintenance of the new equipment/facility.

Modification of any existing building or structure to install energy-efficient equipment/features could potentially encounter hazardous building materials, including asbestos and other hazardous fibrous insulating material and lead-based paint (LBP). Risk associated with exposure to these materials can be minimized through Toxic Substances Control Act (TSCA)-required building surveys, workplans, H&S plans, and construction-related protective measures (e.g., personal protective equipment, air barriers, hazard labels).

One potential risk of energy-efficiency measures could be the inadvertent creation of conditions that foster bacteria, mold, and pathogens (e.g., lowering the temperature of hot water systems, resulting in conditions conducive to Legionnaires Disease). To minimize this risk, building operators and maintenance workers must be trained to understand the optimum system settings to avoid growth and transport of bacteria, mold, and pathogens.

- Water: Many water conservation and water efficiency measures (e.g., increased water awareness programs; replacement of conventional plumbing fixtures with water-efficient plumbing fixtures) should have little to no adverse effect on health and safety. More extensive water conservation/efficiency measures (particularly in older buildings), installing more water-efficient industrial systems, or repair/replacement of aging water distribution systems, could potentially disturb hazardous building materials during the construction. Water conservation measures that result in decreased water pressure may potentially result in inadequate levels of residual disinfection in the more distant portions of the drinking water distribution system. Ensuring current and future water supplies to an installation may require construction of new infrastructure or modification of existing infrastructure. While construction of new or modified water infrastructure could affect health and safety, the effects will be dependent on the type of project and the proposed project location. For example, installation of roof-top water capture systems could pose greater risk to maintenance workers due to their elevated location (requiring use of ladders, chair lifts, etc.), but these risks could be minimized by updating the associated facility maintenance health and safety (H&S) plan and periodic training. Construction of any new water infrastructure (e.g., new water retention structures or distribution systems) will have the potential risks inherent to any construction site. These risks could be minimized through implementation of a comprehensive construction H&S plan.

  Modification of any existing building or structure to install water-efficient equipment/features could potentially encounter hazardous building materials, including asbestos and other hazardous fibrous insulating material and LBP. Risk associated with exposure to these materials can be minimized through TSCA-required building surveys, workplans, H&S plans, and construction-related protective measures (e.g., personal protective equipment, air barriers, hazard labels).

Implementation of new water reuse systems may pose new risks to maintenance workers and building occupants (e.g., exposure to or accidental consumption of untreated greywater). Greywater can contain disease-causing micro-organisms such as bacteria, protozoa, viruses and parasites. It may also contain fats, oils, detergents, soaps, salt, nutrients, food and hair. These constituents can pose both health and environmental risks. Untreated recycled greywater is never safe to drink, but filtration and microbial digestion can be used to provide water for washing or flushing toilets. Some greywater may be applied directly from the sink to the garden or container field, receiving further treatment from soils and plant roots. Similarly the risk of environmental damage from the careful use of greywater is low. These risks could be minimized through implementation of a comprehensive H&S plan for operation and maintenance of the new water reuse system.

- Waste: Most waste avoidance measures (e.g., improved procurement practices) should have no effect on health and safety. More extensive or intensive recycling, processing, or disposal activities could potentially provide additional exposure to pathogens and/or disease vectors as well as increased slip/fall hazards or injuries to limbs associated with solid waste handling. Risks to workers associated with this activity could be minimized through a comprehensive task-related H&S plan and access to sinks (and showers where appropriate). Risks to the on-Post population could be managed through control of site access (e.g., within a sorting center) and signage (e.g., at a recycling center that accepts resident drop-offs).

  Construction of any new waste treatment facilities (e.g., food digesters, biomass facilities, waste-to-energy facilities) will have the potential risks inherent to any construction site. These risks could be minimized through implementation of a comprehensive construction H&S plan. Operation of new waste treatment facilities may pose new risks to facility workers (e.g., exposure to high-temperature equipment, pathogens, disease vectors). The effects will be dependent on the type of project and the proposed project location. Anaerobic digestion projects may have some risk to human health from the pathogenic content of the feedstock and digestate. There may also be some risk of fire and explosion, although no greater than with systems using natural gas. These risks could be minimized through implementation of a comprehensive H&S plan for operation and maintenance of the new equipment/facility.

  Modification of any existing building or structure to install waste-collection equipment/features could potentially encounter hazardous building materials (e.g., asbestos, other hazardous fibrous insulating material, LBP). Risk associated with exposure to these materials can be minimized through TSCA-required building surveys, workplans, H&S plans, and construction-related protective measures (e.g., personal protective equipment, air barriers, hazard labels).

3.10 Hazardous Materials

This section addresses the use or inadvertent release of hazardous materials by the Proposed Action. Hazardous materials include all chemicals listed by the USEPA under the Superfund Amendments and Reauthorization Act of 1986 (40 C.F.R. §355 *et seq*.). The generation, transportation, treatment, storage, and disposal of hazardous wastes are regulated under the Resource Conservation and Recovery Act of 1976 (42 U.S.C. 6901 *et seq*.).

The aspects of hazardous materials that are relevant to the proposed Net Zero management practices, projects, and technologies include the following:

- *Existing hazardous materials use and previously contaminated sites.* Because sites would be located on Army installations, storage, use, and disposal of hazardous materials in support of military operations is likely to occur at proposed sites. Hazardous materials use can contribute to the degradation of the project sites, and the presence of known or potential contamination sites must be considered.

Factors considered in determining whether hazardous 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 ordnance or other hazardous materials without adequate protection;
- Cause a spill or release of a hazardous substance (as defined by Title 40, CFR Part 302 [Comprehensive Environmental Response, Compensation, and Liability Act or CERCLA], or Parts 110, 112, 116 and 117 [CWA]);
- 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 Installation Restoration Program remediation activities;
- Cause the accidental release of friable (easily crumbled by hand pressure) asbestos or lead-based paint (LBP) during the demolition or renovation of a structure; or
- Generate either hazardous or acutely hazardous waste, resulting in increased regulatory requirements over the long term.

The Army follows strict standard operating procedures (SOPs) for storing and using hazardous materials; therefore, no new procedures would need to be implemented to store or use the construction-related or operation related hazardous materials.

3.10.1 Existing Conditions

Hazardous material use on Army installations is representative of hazardous material across the U.S. and across the municipal, services, commercial, and industrial sectors. Typical hazardous materials used on Army installations include: cleaning and disinfecting supplies; antifreeze and petroleum, oil, and lubricants (POLs); degreasers and other industrial compounds; and other hazardous materials common to public and private sector operations. Army installations also use hazardous materials more commonly found in activities that provide direct tactical training support to the US military mission (e.g., ammunition, explosives). 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 (Environmental Protection and Enhancement), AR 385-10 (The Army Safety Program), AR 710-2 (Supply Policy Below National Level), AR 700-141 (Hazardous Materials Information Resource System), DA PAM 700-16 (The Army

Ammunition Management Program), AR 700-143 (Packaging of Hazardous Material), and DLAD 4145.41 (Packaging of Hazardous Material).

3.10.2 Environmental Consequences

Multiple factors were considered when determining whether an alternative would have a significant effect from hazardous material use. They were evaluated and distinguished by the degree to which the effect would impair the ability of the Army to sustain land resources to maintain effective training grounds, ranges, and supporting installations; result in adverse effects to the environment or to the health and safety of the installation's occupants as well as the surrounding community; and conflict with existing Federal, state, or local statutes or regulations.

- Energy: Many energy conservation and energy efficiency measures (e.g., increased energy awareness programs; replacement of conventional lighting with energy-efficient lighting; installation of more energy-efficient HVAC systems; improved building envelope features such as added insulation or more energy-efficient windows) would not use hazardous materials that are not already in use on the installation or in the surrounding communities. While installing some energy efficiency measures may result in greater quantity or frequency of exposure to hazardous materials (e.g., replacing conventional lighting with energy-efficient CFLs, adding additional layers of insulation), the exposure could be reduced by choosing alternatives that contain fewer hazardous materials (e.g., LED lights; 'rock wool' or fiberglass insulation). Maintenance workers and cleaning personnel will need to be trained in any special handling and disposal associated with the energy efficiency measures (e.g., handling and disposal of CFLs).

  Personnel who install energy-efficient equipment/features in older Army facilities may be exposed to LBP, asbestos, and/or other hazardous fibrous insulating material. The risk associated with this potential exposure can be minimized by confirming the presence of hazardous building materials prior to the work (e.g., through the installation's LBP and asbestos inventories and confirmation sampling prior to initiation of the work) and, when present, implementing workplans, H&S plans, and construction-related protective measures (e.g., personal protective equipment, air barriers, hazard labels).

  Site selection for any proposed new renewable energy sources (e.g., solar arrays, geothermal, wind) should include screening to avoid known previously-contaminated sites. Development of renewable energy facilities could potentially expose construction and maintenance workers to hazardous materials, but the effects will be dependent on the type of project and the proposed project location. These risks can be minimized through implementation of a comprehensive construction H&S plan. Photovoltaic (PV) systems are almost entirely benign in operation, and potential environmental hazards occur at the production and disposal stages. There are well-established methods of monitoring and controlling potential hazards caused by the semiconductor materials used in PV modules (e.g., silicon, copper indium diselenide, cadmium telluride). The main environmental hazards of photovoltaics are connected to the production processes.

- Water: Many water conservation and water efficiency measures (e.g., increased water awareness programs; replacement of conventional plumbing fixtures with

water-efficient plumbing fixtures) would not use hazardous materials that aren't already in use on the installation or in the surrounding communities. More extensive water conservation/efficiency measures (particularly in older buildings), installing more water-efficient industrial systems, or repair/replacement of aging water distribution systems, could potentially disturb existing hazardous building materials (e.g., LBP, asbestos, lead solder) or contaminated soils during construction. Ensuring current and future water supplies to an installation may require construction of new infrastructure or modification of existing infrastructure, which may temporarily use, generate or inadvertently release hazardous materials. The risks associated with exposure to these materials can be minimized through implementation of TSCA-required building surveys, workplans, a comprehensive construction H&S plan, and construction-related protective measures (e.g., personal protective equipment, air barriers, hazard labels). Operation of this infrastructure may also use, generate, and/or inadvertently release hazardous materials. These risks could be minimized by updating the associated facility maintenance H&S plan and periodic training.

- Waste: Many waste avoidance measures (e.g., improved procurement practices, including green procurement) should reduce, rather than increase, the use of hazardous materials and subsequent generation of hazardous waste. These actions would also reduce the associated transportation of hazardous material or waste on public roads to and from the installation. Modification of any existing building or structure to install waste-collection equipment/features could potentially encounter hazardous building materials (e.g., asbestos, other hazardous fibrous insulating material, LBP). Under the Net Zero concept, installations may construct new waste treatment facilities (e.g., food digesters, biomass facilities, WTE facilities) or modify existing facilities to treat their residual wastes that cannot be reduced, reused, or recycled. Construction of new waste treatment facilities or modification of existing facilities may temporarily use hazardous materials, generate hazardous waste, or inadvertently release HAPs. The risks associated with exposure to these materials can be minimized through implementation of TSCA-required building surveys, workplans, a comprehensive construction H&S plan, and construction-related protective measures (e.g., personal protective equipment, air barriers, hazard labels). Operation of this infrastructure may also use hazardous materials, generate hazardous waste, and/or inadvertently release HAPs. These risks could be minimized by updating the associated facility maintenance H&S plan and periodic training.

3.11 Socioeconomics

Socioeconomics is defined as the basic attributes and resources associated with the human environment, particularly population and economic activity. Economic activity typically encompasses employment, personal income and industrial growth. Effects on these fundamental socioeconomic components can influence other issues such as housing availability, utility capabilities, and fire and police protection.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low Income Populations,* requires Federal agencies to assess the potential for disproportionate occurrence of effects of Federal projects on minority or 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.

Prior to development of any proposed project that does not fall under an existing categorical exclusion, the proponent Army installation will complete a site-specific NEPA analysis, to include potential socioeconomic effects. A demographic analysis, using 2010 U.S. Census data or, if available, American Community Survey data from 2006, 2008, or 2010, will be included in the site-specific NEPA analysis. Available Federal, state, regional, county, and local plans or documents will be reviewed for relevant data, along with income, age, and racial characteristics for the area around the installation, to determine whether environmental justice communities exist.

Socioeconomic effects should be described 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. Effect threshold definitions for socioeconomics and environmental justice used in this document are as follows:

- *Negligible*: Socioeconomics or environmental justice would not be affected, or effects would not depart measurably from the baseline conditions.

- *Minor*: Socioeconomic or environmental justice effects would be detectable, but would have a negligible effect on children, population, income, and/or employment, would not have a disproportionate adverse effect on low-income or minority populations, and would not warrant mitigation.

- *Moderate to Severe*: Socioeconomic or environmental justice effects would be readily apparent and could affect children or result in an increase or decrease in population, income, and/or employment, particularly one which would disproportionately affect a minority or low income population. Such effects would warrant mitigation.

3.11.1 Existing Conditions

As of 30 September 2011, the Army had 155 installations across the US and in Europe and the Pacific (not including forward operating bases used in contingency operations). The installations included over 290,000 barracks spaces, over 105,000 family housing units (i.e., 15,281 Army-owned units, 7,945 leased units, and 81,837 privatized units), and had a plant replacement value of $329 billion. The installations supported a population of 565,500 Active Army, 204,800 U.S. Army Reserve, and 361,600 Army National Guard military personnel; 278,600 civilian employees; and 878,400 retired military personnel. When located in more rural areas or near smaller communities, the Army installation may be the largest employer and contributor to the surrounding economy. In larger urban areas, the percent contribution from the installation may be less but still significant. In addition to the direct socioeconomic impact, 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 sites.

3.11.2 Environmental Consequences

Multiple factors are considered in determining whether a significant effect on the socioeconomic structure, including the extent or degree to which its implementation would: change the local housing market or vacancy rates, particularly when compared to the availability of affordable housing; increase student enrollment beyond the capacity of the local schools; change any social, economic, physical, environmental, or health conditions so as to disproportionately affect low-income or minority populations; or disproportionately endanger children in areas on or near the proposed project activities or installations. The actions envisioned under Net Zero would not involve significant movements of personnel to or from the installation. There may be minor increases or decreases in employment associated with construction periods or changes from one technology to another, but these changes are not expected to be significant in either direction. Any socioeconomic effect will be dependent on the installation-specific proposed actions and local and regional conditions, and will be analyzed in the installation-specific NEPA analyses.

Chapter 4 – Conclusions

The Net Zero Installation program takes a holistic approach to energy, water, and waste management at Army Installations. This PEA provides an analysis of the environmental, social, and economic issues at a programmatic level and not at the installation- or project-specific level; installation- or project-specific analysis will still be performed and documented for proposed installation-level action. The Proposed Action (Alternative 3) and subject of this PEA is Strategically Implement Net Zero after evaluation of mission needs, consumption and existing resource constraints while still achieving existing environmental mandates. The Net Zero Installation program is comprised of changes in management behavior as well as multiple possible projects and technologies to enhance resource efficiency with a broad focus on increased sustainability based on the following three concepts:

- Producing at least as much energy on the installation from renewable sources as it uses annually
- Limiting the consumption of freshwater resources and return water back to the same watershed so as not to deplete the groundwater and surface water resources of that region in quantity or quality
- Reducing, reusing, and recovering waste streams, converting them to resource value with zero solid waste disposed in landfills

The Proposed Action's potential projects represent a broad spectrum of possible energy, water and waste related projects that may be implemented. Proposed Net Zero activities will be reviewed to ensure they are compatible with installation's training missions and operations, resulting in no net loss of training or operational capability. Not all potential projects discussed in this PEA will be implemented and some of these may have already been implemented at pilot and non-pilot installations to help achieve existing Federal and Army environmental mandates. The Army does not consider Net Zero as a stand-alone program and intends to leverage existing resources and collaboration with the private sector to strive toward the Net Zero Initiative's energy, water, and waste reduction goals. The Army also recognizes current fiscal constraints and will allocate limited existing resources to support implementation of Net Zero Army-wide where fiscally responsible.

During the preparation of this PEA, two alternatives to the Proposed Action were identified. These alternatives are:

- Alternative 1: No Action. This alternative would result in the Army not pursuing Net Zero initiatives to reduce overall consumption of energy and water resources and disposal of solid waste in landfills beyond those Federal, DoD, and Army policies and procedures that are currently in place.

- Alternative 2: Implementation of the Net Zero Installation program across the Army.

Detailed analysis of the effects of the Proposed Action and Alternative 2 did not identify any significant adverse environmental effects that cannot be mitigated to a level of insignificance with site-specific best management practices or other mitigation measures. All installation-specific actions to implement Net Zero will require an appropriate level of supplemental NEPA analysis and documentation.

The following effects are anticipated from the implementation of the Proposed Action: minor effects to land use (except for any proposed large-scale renewable energy projects which would be mitigated within the installation-specific NEPA analysis), negligible to minor effects to geological resources, minor effects to air quality, negligible effects to airspace, minor effects from noise, minor effects to water resources, minor effects to biological resources, minor effects to historical and cultural resources, minor effects to health and safety, minor effects from hazardous materials, negligible to positive effects to the local socioeconomic environment, and minor cumulative effects. Many of these effects are temporary in nature (e.g., associated with construction) that can be mitigated through project workplans and health and safety plans, and through implementation of best management practices. Some of the minor effects associated with the construction phase may also be offset by positive effects during the operations phase (e.g., the production of renewable energy).

The principal conclusions of this PEA are:

- Implementing Alternative 2 (implementation of the Net Zero Installation program across the Army) and Alternative 3 (the preferred alternative) would not result in significant adverse environmental effects, provided that installation-specific NEPA analysis is prepared and best management practices to mitigate any potential environmental effects are adhered to during construction and operation of potential projects.

- Implementing Alternative 3 (the preferred alternative) would allow the Army to address key Federal environmental mandates and sustainability initiatives.

- Implementing Alternative 1 (No Action) would not allow the Army to be as effective at addressing Federal mandates, nor enhance energy or water security.

Appendix A – Summary of Key Regulatory & Army Drivers

Key regulatory drivers and environmental compliance requirements are summarized in the following table.

Federal Legislation	
American Indian Religious Freedom Act (AIRFA) (42 USC §§ 1996)	This Act protects the traditional religious rights of American Indians, Eskimos, Aleuts, and Native Hawaiians. It. requires consultations and resolutions to address identification and access to sacred sited for traditional rites and ceremonies.
Bald and Golden Eagle Protection Act (BGEPA) (16 USC §§ 668 et seq.)	The BGEPA of 1940 prohibits anyone from "taking" bald or golden eagles (including their parts, nests, or eggs) without a permit issued by the Secretary of the Interior. The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." Among other actions, "take" includes disturbance to the degree that it substantially interferes with breeding, feeding, or sheltering behavior or results in injury. With the recovery and ESA delisting of the bald eagle in 2007, it is no longer protected under the ESA, and a new process for regulating take of both bald and golden eagles under the BGEPA has been developed by USFWS. A final rule for two new permit regulations became effective in November 2009. 50 CFR Part 22.26 would allow "take" of both species of eagles (including disturbance and limited "take resulting in mortality"), and 50 CFR Part 22.27 would allow the "take" of nests of both species for eagle and human health and safety reasons, and in other limited circumstances. Under Part 22.26, the "take" of an eagle refers to the non-purposeful disturbance, wounding or killing of eagles, which is associated with but is not the purpose of an activity. "Take" can only be authorized when it is compatible with the preservation of bald and golden eagle populations.
Clean Air Act (CAA) (42 USC §§ 7401 et seq.)	The CAA of 1970 is the comprehensive Federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants. The Act was amended in 1977 and 1990 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines. Under the CAA, as amended, states are responsible for enforcing the established air quality regulations. The General Conformity Rule (40 CFR Part 51, Subpart W) requires that any proposed Federal action that has the potential to cause violations in a NAAQS nonattainment or maintenance area must undergo a conformity analysis.
Clean Water Act (CWA) (33 USC §§ 1251 et seq.) and EO 11990 (Protection of Wetlands)	The CWA of 1972 is the primary Federal law that protects the nation's waters, including wetlands (as defined in 33 CFR 328.3). Section 402 established the National Pollutant Discharge Elimination System (NPDES), under which a state regulates the discharge of point source pollution. Section 404 requires a permit from the U.S. Army Corps of Engineers (USACE) for any discharge of excavated or fill material into waters of the U.S. (WoUS), defined to include navigable waters and their tributaries and adjacent wetlands that have a significant nexus (i.e., functional relationship) to the navigable water (USACE and USEPA 2008). Section 401 requires a state Water Quality Certification for the issuance of a Section 404 permit, verifying that the discharge would meet state water quality protection requirements. EO 11990, Protection of Wetlands of 1977 requires Federal agencies "to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands."

Coastal Zone Management Act (CZMA) (16 USC §§ 1451 et seq.)	The CZMA of 1972 requires that "any federal activity within or outside of the coastal zone that affects any land or water use or natural resource of the coastal zone" shall be "consistent to the maximum extent practicable with the enforceable policies" of a state's coastal zone management plan. Federal agencies, prior to carrying out activities, must comply with the "consistency" regulations of the CZMA promulgated by the Secretary of Commerce. These regulations establish the procedures that Federal agencies must follow to coordinate with coastal states prior to carrying out activities that are reasonably likely to affect coastal uses or resources within a state's coastal zone. The CZMA applies to the coastal regions of states bordering the Atlantic and Pacific Oceans, Gulf of Mexico, and Great Lakes.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.) and Superfund Amendments and Reauthorization Act (SARA) (40 CFR §355 et seq.)	Commonly known as Superfund, CERCLA was enacted by Congress on December 11, 1980. This law provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA also established prohibitions and requirements concerning closed and abandoned hazardous waste sites, and provided for liability of persons responsible for releases of hazardous waste at these sites. It also created a tax on the chemical and petroleum industries and to establish a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites. SARA, passed on October 17, 1986, amends CERCLA which increased the Superfund trust fund by $8.5 billion and reinforced the importance of human health, community involvement, cooperation with state and local laws and authorities, and permanent solutions to hazardous-waste cleanup.
Endangered Species Act (ESA) (16 USC §§ 1531 et seq.)	The ESA of 1973, as amended, provides for the Federal protection of threatened plants, insects, fish, and wildlife. It is administered by the US Fish and Wildlife Service (USFWS). The major components of the act include: 1. Provisions for listing threatened and endangered (T&E) species 2. A requirement for consultation with the USFWS on Federal projects 3. Prohibitions against the "taking" of listed species 4. Provisions for permits to allow the incidental taking of T&E species. Under Section 7, "each Federal agency shall, in consultation with and with the assistance of the Secretary of the Interior [through the USFWS], insure that continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species." Therefore, if the proposed action involves a Federal agency, Federal permit, or Federal funding, under Section 7, the Federal agency must consult with the USFWS to determine if a T&E species "may be present" in the area. If the USFWS determines that a protected species may be present, and the Federal agency cannot determine that the proposed action will not affect any listed species or designated critical habitat, the agency must submit a Biological Assessment (BA) to the USFWS and the USFWS will, in turn, issue a Biological Opinion (BO) stating whether the action will "jeopardize" a protected species, and issue an incidental take permit, allowing a certain amount of taking incidental to implementation of the proposed action.

Energy Independence and Security Act of 2007 (EISA 07)	EISA 07 supports energy independence and security through increased efficiency and the availability of renewable energy. Includes provisions affecting vehicle fuel economy, production of biofuels, energy efficiency standards, energy savings in public/government institutions, research and development, carbon capture and sequestration, management of energy policy, international energy programs, green jobs, energy transportation and infrastructure, small business programs, and grid modernization. It requires new Federal buildings and major renovations to achieve a 55% reduction in fossil fuel energy use by 2010 (2003 baseline), and a 100% reduction by 2030.
Energy Policy Act of 2005 (EPAct 05)	EPAct 05 was the first major energy-related legislation passed by Congress since 1992. It established a number of energy management goals for Federal facilities and fleets, as well as amended portions of the National Energy Conservation Policy Act (NECPA). It sets Federal energy management requirements in several areas, including: metering and reporting, energy-efficient product procurement, energy savings performance contracts, building performance standards, renewable energy requirements, and alternative fuel use.
Federal Acquisition Regulations (FAR) Part 77 – Obstructions Affecting Navigable Airspace	FAR Part 77 of 1977 establishes the Federal criteria for use by local planning and land use jurisdictions to control the height of objects in the vicinity of airports in order to protect the airspace and approaches to runways from hazards that could affect the safe and efficient operation of airports. It requires filing a Notice of Proposed Construction or Alteration (Form 7460-1) with the Federal Aviation Administration (FAA) for all structures over 200 ft above ground level (AGL), or lower if closer than 20,000 ft to a public use airport with a runway over 3,200 ft in length. In the latter case, the filing requirement is based on a 100 to 1 slope from the closest runway. The FAA conducts an initial study within the responsible FAA Region and issues either a Determination of No Hazard (DNH) to air navigation or a Notice of Presumed Hazard (NPH).
Marine Mammal Protection Act (MMPA)	The MMPA protects marine mammals and prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.
Marine Protection, Research, and Sanctuaries Act (MPRSA)	Also referred to as the Ocean Dumping Act, the MPSRA regulates the dumping of wastes in the ocean.
Migratory Bird Treaty Act (MBTA) (16 USC §§ 703-712) and EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds)	The MBTA of 1918 implements various treaties and conventions among the U.S. and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing, or possessing migratory birds is unlawful unless permitted by regulations. The Act provides that it is unlawful to pursue, hunt, take, capture, or kill; attempt to take, capture, or kill; possess, offer to or sell, barter, purchase, deliver, or cause to be shipped, exported, imported, transported, carried, or received any migratory bird, part, nest, egg, or product, manufactured or not. The MBTA does not provide for the regulation of structures that pose a collision risk to migratory birds, and there is currently no defined permit or consultation requirement for wind turbines associated with the MBTA. However, EO 13186 provided more specific direction to Federal agencies to conserve migratory birds and to assess the effects of their actions on migratory bird populations as part of NEPA compliance. The EO led to a Memorandum of Understanding (MOU) between the DoD and USFWS (2006), which states: DoD will review wind turbine and power line guidelines published by (US)FWS and the Avian Power Line Interaction Committee, respectively, and consult with (US)FWS as needed, in considering potential effects on migratory birds of proposals for locating communications towers, power lines or wind turbines on military lands.

National Energy Conservation Policy Act (NECPA)	NECPA serves as the underlying authority for Federal energy management goals and requirements.
National Historic Preservation Act (NHPA) of 1966 (16 USC §§ 470-470x-6) and Archeological Resource Protection Act (ARPA) of 1979 (16 USC §§ 470aa-470mm)	NHPA established historic preservation as a national policy and defined historic preservation as the protection, rehabilitation, restoration, and reconstruction of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, or engineering. Section 106 requires Federal agencies to take into account the effects of their undertakings on any district, site, building, monument, deposit, structure, or object, listed in or determined eligible for listing in the National Register of Historic Places (NRHP). ARPA regulates archaeological finds on Federal and Indian lands and aims to prevent looting and destruction of archaeological resources. The Act protects the material remains of past human existence that are more than 100 years old and that are of archaeological interest. The legislation also includes procedures for issuing permits to lawfully excavate archaeological sites.
Native American Graves Protection and Repatriation Act (NAGPRA)	NAGPRA provides a process for museums and Federal agencies to return certain Native American cultural items (e.g., human remains, funerary objects, sacred objects, and objects of cultural patrimony) to lineal descendants, culturally affiliated Indian tribes, and Native Hawaiian organizations.
National Environmental Policy Act (NEPA) (42 USC 4321 et seq.) and Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and DA NEPA regulation (32 CFR Part 651)	NEPA requires Federal agencies to review the effects of its actions on the natural and human-made environment prior to taking action. The review process helps Federal officials, and also the public, understand the environmental consequences of major projects as well as actions to protect, restore, and enhance the environment. NEPA requires all Federal actions that could result in a significant impact on the environment to be subject to review by Federal, tribal, state, and local environmental authorities, as well as by affected parties and interested citizens.
Noise Pollution and Abatement Act of 1972 (42 USC § 4901 - 4918)	This act regulates noise pollution with the intent of protecting human health and minimizing annoyance of noise to the general public. It establishes mechanisms to set emission standards for virtually every source of noise, including motor vehicles, aircraft, certain types of heating, ventilation, and air-conditioning (HVAC) equipment and major appliances. It also puts local governments on notice as to their responsibilities in land use planning to address noise mitigation.
Pollution Prevention Act (PPA) (42 USC §13101 et seq.)	PPA established the national policy that focused industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials use. Pollution prevention includes practices that increase efficiency in the use of energy, water, or other natural resources, and protect our resource base through conservation.
Resource Conservation and Recovery Act (RCRA) (42 USC § 6901 et seq.) Rivers and Harbors Appropriation Act (RHA), Section 10 (33 USC 401 et seq.)	RCRA regulates hazardous waste from "cradle-to-grave," including the generation, transportation, treatment, storage, and disposal of hazardous waste. It includes provisions for waste minimization and corrective action. RCRA also establishes a framework for the management of non-hazardous solid wastes and underground storage tanks containing petroleum and other hazardous substances. Section 10 of the RHA of 1899 requires a permit from the USACE for structures or work in or affecting navigable WoUS. Structures include any pier, wharf, bulkhead, etc. Work includes dredging, filling, excavating, or otherwise modifying navigable WoUS. The USACE has a single combined permit process for Section 10 of the RHA and Section 404 of the CWA where both statutes apply.

Safe Drinking Water Act (SDWA) (42 USC § 300f)	The Act aims to ensure the quality of drinking water to protect public health. It requires public water systems to comply with health-related drinking water standards and encourages attainment of nuisance-related standards. The Act also establishes programs to protect underground sources of drinking water.
Sikes Act and Sikes Act Improvement Act (16 USC §§ 670a to 670o), Conservation Programs on Government Lands	The Sikes Act requires the preparation of Integrated Natural Resources Management Plans (INRMPs) for military installations with existing natural resources, and provides for cooperation by the Department of the Interior and DoD with state agencies in planning, development, and maintenance of fish and wildlife resources on military reservations throughout the U.S. At any installation with an approved INRMP, the siting, construction, and operation of small-scale wind energy projects would be done in a manner consistent with that INRMP.
Toxic Substance Control Act (TSCA)	TSCA establishes requirements for the production, importation, use, and disposl of chemical substances to protect human health and safety (e.g., asbestos, lead, radon and PCBs).
Executive Orders	
EO 11988, Floodplain Management	This EO requires Federal agencies to avoid (to the extent possible) the long- and short-term adverse impacts associated with the occupancy and modification of flood plains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.
EO 11990, Protection of Wetlands	This EO provides for avoidance of long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or Indirect support of new construction in wetlands wherever there is a practicable alternative.
EO 12196, Occupational Safety and Health Programs for Federal Employees	This EO subjects Federal agencies to the requirements of the OSH Act and its implementing regulations promulgated by the Occupational Safety and Health Administration (OSHA).
EO 12898, Federal Actions to Address Environmental Justice in Minority and Low Income Populations	This EO directs Federal agencies to identify and address the disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations, to the greatest extent practicable and permitted by law; to develop a strategy for implementing environmental justice; and to promote nondiscrimination in Federal programs that affect human health and the environment, as well as provide minority and low-income communities access to public information and public participation.
EO 13007, Indian Sacred Sites	This EO requires Federal land managers, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, to: (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, and (2) avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies shall maintain the confidentiality of sacred sites.
EO 13031, Federal Alternative-Fueled Vehicle Leadership	This EO reaffirms the intent for the Federal government to provide leadership in the adoption of alternative-fuel vehicles and establishes reporting requirements to ensure that agencies comply with the requirements of the Energy Policy Act.
EO 13150, Federal Workforce Transportation	This EO was issued to reduce Federal employees' contribution to traffic congestion and air pollution and to expand their commuting alternatives.
EO 13175, Consultation and Coordination With Indian Tribal Governments	This EO calls for establishing regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the U.S. government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes.

EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	Migratory bird conventions impose substantive obligations on the U.S. for the conservation of migratory birds and their habitats, and through the Migratory Bird Treaty Act (Act), the U.S. has implemented these migratory bird conventions with respect to the U.S. This EO directs executive departments and agencies to take certain actions to further implement the Act.
EO 13212, Actions to Expedite Energy-Related Projects	This EO requires executive departments and agencies to take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy.
EO 13221, Energy Efficient Standby Power Devices	This EO calls for Federal agencies to purchase products that use minimal standby power when possible.
EO 13352, Facilitation of Cooperative Conservation	This EO ensures that the Departments of Interior, Agriculture, Commerce, and Defense and the EPA implement environmental and natural resources laws in a manner that promotes cooperative conservation, with an emphasis on appropriate inclusion of local participation in Federal decision making, in accordance with their respective agency missions, policies, and regulations.
EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management	This EO sets goals in the areas of energy efficiency, acquisition, renewable energy, toxics reductions, recycling, renewable energy, sustainable buildings, electronics stewardship, fleets, and water conservation. It also requires more widespread use of Environmental Management Systems as the framework in which to manage and continually improve these sustainable practices.
EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance	This EO extends the EO 13423 goals (e.g., energy efficiency, acquisition, renewable energy, toxics reductions, recycling, renewable energy, sustainable buildings, electronics stewardship, fleets, and water conservation). It also establishes requirements for setting greenhouse gas (GHG) reduction targets, completion of GHG inventories, and annual GHG reporting, as well as a requirement for Federal agencies to prepare Agency Strategic Sustainability Performance Plans.
DoD Directives (DoDD) and Instructions (DoDI)	
DoD 4160.21-M, Defense Materiel Disposition Manual, Chapter 10: Environmentally Regulated and Hazardous Property	This manual establishes requirements for the handling, processing, and disposing of DoD excess, surplus, and Federal Excess Personal Property (FEPP) that may be hazardous to human health and the environment in accordance with applicable environmental, safety, and other pertinent laws and regulations. DLA Disposition Services is responsible for the disposal of hazardous waste for the DoD and is the preferred method of disposal for DoD.
DoDI 4715.16: Cultural Resource Management, 11 December 2006	This DoDI establishes requirements for integrated management of cultural resources on DoD-managed lands. It requires DoD to consult in good faith with internal and external stakeholders and promote partnerships to manage and maintain cultural resources by developing and fostering positive partnerships with Federal, tribal, State, and local government agencies; professional and advocacy organizations; and the general public.
DoDI 6055.1, DoD Safety and Occupational Health Program	This DoDI requires that the risk management process be institutionalized and be an inherent part of all DoD operations to address safety and occupational and environment health risks.
DoDI 6055.4, DoD Traffic Safety Program	This DoDI establishes responsibilities and procedures for administering the DoD Impaired Driving Prevention Program and the DoD Traffic Safety Program to reduce deaths, injuries, and property damage caused by vehicular mishaps.

DoDI 6055.07, Mishap Notification, Investigation, Reporting, and Record Keeping	This DoDI establishes requirements to protect DoD property from damage and DoD personnel from accidental death, injury, or occupational illness and to protect the public from risk of death, injury, illness, or property damage because of DoD activities. It also establishes the procedures for mishap notification, investigation, reporting, and record keeping; requirements to report explosives and chemical agent mishap information to the DoD Explosives Safety Board; and requirements for interactions with the National Transportation Safety Board (NTSB) and the Secretary of Transportation
DoDI 6055.05, Occupational and Environmental Health (OEH), 11 November 2008	This DoDI expands the risk management procedures to anticipate, recognize, evaluate, and control health hazards associated with occupational and environmental exposures to chemical, physical, and biological hazards in DoD workplaces to include military operations and deployments.
Army Regulations (AR)	
AR 200-1, Environmental Protection and Enhancement	This AR implements Federal, State, and local environmental laws and DoD policies for preserving, protecting, conserving, and restoring the quality of the environment. The AR also addresses environmental responsibilities of all Army organizations and agencies.
AR 210-20, Real Property Master Planning for Army Installations	This AR requires installations to prepare, implement, and maintain Real Property Master Plans (RPMPs) that address all lands within the installation footprint. 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
AR 385-10, The Army Safety Program	This AR establishes mandatory guidance, functions, policies, and procedures for the Army's Safety Program. Its goal is to reduce the risk of death or injury to Soldiers and civilians, and damage to vehicles, equipment and property due to accidents.
AR 608-12, Child Development Services	This AR contains the requirements for establishing and operating Army Child Development Services (CDS), and applies to the following CDS delivery systems: Child Development Centers (CDC), Family Child Care (FCC), and Supplemental Programs and Services (SPS).
AR 700-2, Supply Policy Below National Level	This AR allows commanders some leverage to either store or not store commodities with the proviso to gradually lessen inventory over time. As most commodities can be obtained within 72 hours if they are part of a centrally managed inventory controlled program or where responsive contracts are in place)e.g., Prime Vendor, Virtual Inventory management contracts, Integrated Sustainment Maintenance (ISM) management, just in time delivery practices).
AR 710-141, Hazardous Materials Information Resource System	This AR establishes the procedures for Army input to and use of the DoD Hazardous Materials Information Resource System. It also provides instructions for obtaining and processing material safety data sheets and hazard communication standard-compliant labeling.
DA Pamphlet (PAM) 700-16, The Army Ammunition Management Program	This publication provides a system description for management of the ammunition program by the Department of the Army (DA). The Army Ammunition Plan will reflect the time-oriented planning of the DA Staff and major Army commands for achieving the Army goals in ammunition development, production, procurement, storage, maintenance, supply, and distribution.
DLA Directive 4145.41, Packaging of Hazardous Material	This DLA directive is a Joint Service publication (the Army designation is AR 700-143 with the same title) that establishes uniform policy for packaging hazardous materials for safe, efficient, and legal storage, handling, and transportation, to include Certifications of Equivalency, DOT exemptions, and Competent Authority approvals.

Appendix B – Renewable Energy Technologies

The following renewable energy technologies could be used to provide energy security and meet Federal renewable energy goals:

Photovoltaic (PV) Systems

PV systems are based on the use of semiconductors, materials that can generate small amounts of electric current when exposed to sunlight. Semiconductors are materials that hold their bonding electrons tightly in covalent bonds (and therefore act as insulators in their pure state), but that have conducting properties when combined with small amounts of impurities called dopants. Currently, the silicon-based solar cells that have efficiencies of about 15% are likely to be used in utility-scale PV facilities built in the U.S.; however, multi-junction solar cells that contain two or more semiconductors and can increase efficiency to 30% or greater will likely be used in utility-scale PV facilities in the future. Another means of increasing efficiency is to use concentrating lenses (also known as concentrating PV technology [CPV]) and tracking systems to capture additional energy from the sun over longer periods of daylight. To produce electricity at utility scale, many individual solar cells are connected as a module; modules are combined to make individual solar panels; and solar panels are grouped into arrays producing direct current (DC) electricity.

The power-producing components of utility-scale PV facilities are the solar field, which contains the PV panels, and the power conditioning system (PCS), which contains an inverter to convert the produced DC to AC and a transformer to boost voltage for feeding into the power grid. The PCS also contains devices that can sense grid destabilization and automatically disconnect the PV facility from the grid if needed.

PV technologies can be grouped into two types of systems: flat-plate and concentrating systems. The solar cell materials in either system are typically a thin film in a weather-resistant enclosure. The two systems differ in the manner in which they capture incident sunlight and direct it to the solar cell materials. In flat-plate systems, the modules are placed in the solar field, either in a fixed position optimal for capturing sunlight, or on a tracking system that follows the sun's path to optimize power production. CPV systems use silicon solar cells or high-performance multi-junction solar cells (typically made of aluminum, gallium, indium, nitrogen, phosphorus, antimony) and use concentrating or reflecting optical devices to concentrate sunlight that strikes the solar cells. They also usually incorporate tracking devices. Because of their higher efficiency, CPV systems also generate excess heat, which may require cooling systems to dissipate the heat (e.g., passive cooling fins; active forced air cooling or water cooling). (Bureau of Land Management (BLM). Solar Energy Development Draft Programmatic Environmental Impact Statement. December 2010.)

Concentrating Solar Power (CSP)

CSP is sometimes referred to as solar thermal electric or thermoelectric power since all variations are designed to convert the sun's energy to heat and then apply that heat in various ways to produce electricity. CSP can be very water intensive, so regional water availability will be a key consideration of whether the technology is appropriate in a specific setting. CSP technologies are distinguished by three basic design architectures for reflecting and concentrating solar energy:

- Line-focus systems that concentrate solar energy along a line-shaped receiver, typically an oil-filled pipe positioned at the focus of parabolic-shaped reflectors (parabolic trough systems) or flat mirrors using Fresnel lenses as concentrators
- Point-focus systems that concentrate solar energy to a point-receiver by means of flat plate mirrors focusing reflected light on a receiver located at the top of a centrally located tower (solar power tower systems)
- Point-focus systems that use a parabolic-shaped reflector dish to focus the sun's energy on a point-receiver at which is located the gas-filled chamber of an external heat engine (solar dish engines)

To produce heat, all CSP technologies utilize direct normal insolation; that is, sunlight that directly strikes the reflecting/concentrating surface, rather than global sunlight which also includes sunlight that has been refracted or diffused by clouds, airborne dusts, or the ground. Thus, for optimal performance, the reflective surfaces of CSP technologies must track the sun (keeping the sun's incident rays perpendicular to the reflecting surface), and reflectors and/or concentrators must exhibit good optical characteristics.

Parabolic trough and solar power tower CSP systems will typically utilize a heat-transfer fluid (usually synthetic oil in the case of parabolic trough facilities and molten salt in the case of power tower facilities) to transfer the heat generated at the solar collectors to a heat exchanger where steam is produced to drive a conventional Steam Turbine-Generator (STG). The Compact Linear Fresnel system dispenses with the heat-transfer fluid, making steam directly at the solar field for delivery to the STG. The Power Block of a solar thermal facility containing the STG and other related power-generating and power management equipment is virtually identical in both form and function to the Power Block of fossil fuel and nuclear power plants that also utilize steam to produce electricity. The solar dish engine is unique among CSP technologies in that it uses the sun's heat not to produce steam but to expand a gas, generating mechanical energy in the form of angular momentum (torque) as that gas acts on the piston of a Stirling-type external heat engine, which then directly drives an electric generator or alternator. Although all CSP systems rely on their ability to collect and concentrate the sun's energy and convert it to heat, point-focus systems such as solar power towers and solar dish engines can attain greater degrees of concentration of the sun's energy and thus can be designed to operate at higher temperatures than parabolic troughs. These higher temperatures generally equate to greater overall system power and efficiency.

A thermoelectric technology alternative to steam uses Organic Rankine Cycle (ORC) turbines coupled to conventional generators. ORC turbines use heat (vs. an external steam source) to boil an organic working fluid contained in the reservoir of a closed system, allowing the resulting hot expanding vapors of the working fluid to drive the turbine-generator set. The working fluid loses sufficient thermal energy to return to its liquid state, and, after further cooling, it is returned to its reservoir, allowing the process to repeat. ORC turbines have many industrial applications, recovering otherwise wasted heat and converting it to electrical power or mechanical energy. Their advantages include: the ability to produce power from relatively minor sources of heat, minimal internal corrosion issues due to the absence of water, thermal efficiencies as high as 85%, and extended mechanical life due to relatively slower rotational speeds than conventional STGs. More importantly for CSP applications in water-deprived locations, ORC turbines require substantially less water than conventional STGs.

An option to increase reliability of power production for parabolic trough and power tower technologies is to use some form of energy storage (e.g., storage as chemical energy in a chemical or galvanic battery; compressed air / pneumatic battery). However, these energy storage options are impractical and/or inefficient for adaptation to CSP facilities. Because the form of energy initially captured and controlled in these facilities is heat, thermal energy storage opportunities are both technically feasible and efficient additions to parabolic trough and power tower CSP facilities. Because solar dish engine systems do not produce steam, they cannot be easily hybridized with thermal energy storage. Adding thermal energy storage capabilities allows a portion of the heat generated during periods of greatest solar insolation to be diverted to storage for later use rather than being used immediately to produce steam. Simple salts with high heat capacities have been found to act as excellent heat storage media.

Fuel Cells

Fuel cells are electro-chemical devices that act as fully-charged batteries while they are supplied with fuel. Fuel cells convert fuels (e.g., natural gas, propane, hydrogen, landfill gas, biogas) directly to electricity. This process is highly efficient and produces extremely low criteria pollutants. Fuel cell systems have been on the market since the early 1990's, and US manufacturers produce systems ranging from 100 to 1,400 kW for large stationary installations. These large fuel cell systems typically operate on natural gas and produce electricity and heat or cooling. By using a low-intensity carbon fuel (e.g., natural gas) and by utilizing both the electricity and waste heat, fuel cell systems can often reduce emissions vs. grid by 20-50%. In remote locations, fuel cells can operate with delivered fuel (e.g., LPG). High efficiency leads to less fuel deliveries required for electricity heat and cooling.

Another fuel cell market segment produces small 2-10 kW systems for backup power (e.g., for telecommunications). These systems use hydrogen as fuel, which is typically delivered but can also be made with on-site electrolyzers. This type of system also provides options for energy storage to balance renewables such as solar and wind power.

Besides stationary applications, fuel cells are also mobile. Fuel-cell powered vehicles are ultra-quiet as they have all electric drives, have similar driving range as conventional gasoline vehicles, and have very low thermal signatures due to ultra-high efficiency drives. Fuel efficiency for SUV-sized vehicles ranges from 45 to 68 miles per gallon of gasoline equivalent (on energy basis).

Fuel cells are also penetrating the materials-handling market by replacing lead acid batteries on fork lift trucks. They allow quick refueling instead of battery replacements and charging, which allows higher productivity, lower greenhouse gas (GHG) emissions, and ability to work in indoor and cold environments.

Ground Source (Geothermal) Heat Pumps (GSHPs)

GSHPs use the constant temperature of the earth to heat or cool buildings instead of the outside air temperature. GSHP systems are generally composed of geothermal heat pumps, fluid circulating pumps, and a buried ground loop heat exchanger usually composed of plastic pipe. In the summer, GSHPs extract heat from buildings and transfer it to the circulating fluid in the cooler ground loop system. In the winter, fluid circulating in the ground loop system absorbs heat from the earth and transfers it to the GSHPs. The GSHPs then extract the heat from the fluid which is then used to increase the temperature of the air transported to the buildings. Implementation would require the installation of multiple GSHP units within each building. The

location of the units within each building would be dependent upon the thermal and occupancy zoning requirements of each building. The number of wells would be based on the dominant load condition (i.e., heating or cooling) of each building. Each building would require the design and installation of new supply air ductwork.

Landfill Gas (LFG) Recovery

LFG is created as solid waste decomposes in a landfill. This gas consists of about 50 percent methane (the primary component of natural gas), about 50 percent carbon dioxide (CO_2), and a small amount of non–methane organic compounds. Instead of escaping into the air, LFG can be captured, converted, and used as an energy source. LFG is extracted from landfills using a series of wells and a blower/flare (or vacuum) system. This system directs the collected gas to a central point where it can be processed and treated depending upon the ultimate use for the gas. From this point, the gas can be flared, used to generate electricity, replace fossil fuels in industrial and manufacturing operations, or upgraded to pipeline-quality gas where the gas may be used directly or processed into an alternative vehicle fuel.

Waste-to-Energy (WTE)

WTE is the process by which solid waste material (typically municipal solid waste, MSW) is converted into energy through various processes. The primary WTE technologies include:

- ***Mass Burn.*** This is the most proven technology, using standard combustion techniques. Waste materials are delivered to the facility using collection trucks, each carrying 13-14 tons of MSW, or transfer trucks carrying approximately 24 tons of MSW each. The waste is tipped in a receiving area, kept at a slight negative pressure to minimize the release of odors to the surrounding areas. Large appliances or other non-combustible materials are removed and the remaining waste is fed into a chute that directs the waste into a furnace. In the furnace, the waste is either combusted on a grate or in a fluidized bed to release energy in the form of heat. The gaseous and particulate products of the combustion reaction pass through several stages of emissions controls to meet EPA air emissions standards. The heat released from the combustion of the fuel is transferred to water in the boiler. This water is converted to steam which drives a steam turbine to produce electricity or is used for various heating applications.

- ***High-Temperature Gasification.*** This is an emerging WTE technology in which fuel is heated in a limited-oxygen environment. Waste materials are delivered and stockpiled in a similar manner as mass burn systems. These facilities are typically smaller in scale and the rate of feedstock delivery much smaller. They are also more likely to include sorting of feedstock to remove recyclable materials and help provide a more homogeneous fuel. The non-recyclable material is fed into the gasification chamber using an auger feed mechanism. Once in the chamber, the fuel is heated and a portion of the fuel is combusted, using the small amount of oxygen present. This exothermic reaction releases heat necessary to produce endothermic reactions which produce a synthetic gas, or syngas, made up primarily of hydrogen and carbon monoxide. The syngas can be used in several ways:

    – Steam creation: syngas can be combusted to create heat for converting water to steam, which drives a steam turbine to generate electricity.

  - Direct motive force: syngas can be cooled and cleaned for use as fuel for an internal combustion engine or gas turbine, either of which can coupled to a generator for electricity production.
  - Liquid fuel conversion: cooled and cleaned syngas can be converted to various liquid fuels using the Fischer-Tropsch process, a series of chemical reactions occurring from introduction of a catalyst to the syngas.
  - Energy storage: syngas can be stored for later use or transferred to another location.

- ***Anaerobic Digestion***. This is an emerging WTE technology using biologic methods to process waste materials. The feedstock collection and processes for anaerobic digestion are the same as discussed for mass burn and gasification. The importance of sorting materials is higher for anaerobic digestion than other WTE technologies. As such, manual or automatic sorting of materials is typically the first step, removing inorganic materials and recycling those materials with value. The organic materials are placed into a digester, where microorganisms break down the material and release a biogas high in methane. The resulting biogas is captured and serves several purposes:
  - Steam creation: the biogas can be combusted to provide heat for steam to drive a turbine, coupled to a generator for power production.
  - Motive force: the biogas can be conditioned and serve as fuel for an internal combustion engine or gas turbine, linked to an electrical generator for power production.
  - Energy storage: the biogas can be stored for later use or transferred to another location.

Biomass Heating & Cooling

These systems are similar to the WTE systems noted above with the exception of the feedstock. Biomass systems typically use residual organic materials such as woody biomass from forestry operations or crop residues from agricultural operations. Technologies noted as emerging in the WTE section (gasification and anaerobic digestion) are more proven using biomass feedstocks. This is due to the relative homogeneity of biomass material relative to MSW. In general, similar to WTE, combustion is used for larger systems and gasification or anaerobic digestion are used for smaller applications.

Solar Thermal Heating & Cooling

These systems differ by the type of collector used to gather and store solar energy. There are three basic types of liquid collector systems: flat plate, evacuated, and concentrating. Air collectors use air as the working fluid for absorbing and transferring solar energy. Technologies include:

- ***Glazed and unglazed flat plate collectors.*** Flat plate collectors are the simplest and most common type of collector, designed to heat water or another fluid to medium temperatures (approximately 140°F). This collector generally consists of a thin flat-plate absorber sheet that intercepts and absorbs solar energy. The absorber may have a selective coating or it may be chemically coated to increase its solar absorption capacity. Copper pipes or tubes wind back and forth across the absorber and carry fluid through

the flat plate collector. Often the pipes are painted black and bonded to the material of the flat plate collector to maximize heat absorption. The collector is covered with glass, or "glazing," that allows solar energy to pass through but reduces heat loss from the absorber. As heat builds up in the collector, it heats the fluid passing through the pipes. "Unglazed" flat plate collectors without the glass covering are best suited for low temperature applications, such as heating swimming pools. While these unglazed collectors capture a larger portion of the sun's energy, they lose a large portion of the absorbed heat because they are not insulated with a covering. These types of collectors are substantially less expensive than glazed systems.

- ***Evacuated tube collectors.*** Evacuated tube collectors produce higher temperatures (approximately 300°F). This collector is made of parallel rows of tempered glass vacuum tubes and an absorber surface inside the tube. The absorber is surrounded by a vacuum that reduces heat losses. The glass tubes heat up the solar absorbers and, ultimately, the solar working fluid in order to heat domestic hot water, or provide space heating.

- ***Air collectors.*** Collectors for air heating systems perform the same important function as those for liquid heating systems, although they operate on a much different principle. They consist of a dark-colored, perforated façade installed on a building's south-facing wall. These systems operate by using a fan or the building's own ventilation system to draw ventilation air into the building through a perforated absorber plate on the façade and up through the airspace between the absorber and the south wall.

Hydroelectric Power or Hydropower

Hydropower is produced when capturing flowing water to power machinery or make electricity. Water constantly moves through a vast global cycle, evaporating from lakes and oceans, forming clouds, precipitating as rain or snow, then flowing back down to the ocean. The energy of this water cycle, which is driven by the sun, can be tapped to produce electricity or for mechanical tasks like grinding grain. There are several types of hydroelectric facilities; all are powered by the kinetic energy of flowing water as it moves downstream. Turbines and generators convert the energy into electricity, which is then fed into the electrical grid to be used in homes, businesses, and by industry

Wind Energy

Wind energy is the process by which wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as pumping water) or a generator can convert this mechanical power into electricity. Wind turbines, turn in the moving air and power an electric generator that supplies an electric current. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity. Wind turbines are often grouped together into a single wind power plant, also known as a wind farm, and generate bulk electrical power. Electricity from these turbines is fed into a utility grid and distributed to customers, just as with conventional power plants.