ENVIRONMENTAL ASSESSMENT

For

People's Electric Solar Facility

Today's Power
Your Energy Partner

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Amended: February 2023

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TODAY'S POWER, INC.

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1.0 PROJECT PURPOSE AND NEED

1.1 PROJECT DESCRIPTION, DETAILS, AND LOCATION

Today's Power, Inc. (TPI) is a wholly-owned subsidiary of Arkansas Electric Cooperatives, Inc. a Little Rock-based utility service cooperative owned by 17 Arkansas electric distribution cooperatives. TPI partners with electric utilities across the Midwest in order to serve their members clean, renewable energy. TPI, in partnership with People's Electric Cooperative (PEC), proposes to install a new, 39.76-acre solar facility, known as the People's Electric Solar Facility (Project) near the city of Ada, Oklahoma in Pontotoc County at the intersection of Highway 1 and County Road 1610, as shown on the enclosed map, which can be found in Appendix A.

This proposed 6.97 MWDC solar facility will be located on the 39.76-acres rural, agricultural tracts of land that have been previously disturbed for agriculture activities and are currently owned by People's Electric Cooperative. The current site location is an open field that would avoid any known floodplains, wetlands or streams, and will require minimal grading and little tree clearing. The disturbance of land will be limited to the approximately 39.76-acre owned Area of Potential Effect (APE) during construction. One residential structure with outbuilding exists on the proposed site which will require removal.

The construction phase of the Project, which includes grading, will be planned, and designed to minimize the use of mechanized grading and fill materials procured off site. Controls, such as silt fences and stabilization, will be used during and after construction as needed to minimize indirect adverse environmental effects. The site is also located adjacent to existing powerlines included within the APE to provide ease of connection to the electric grid.

After construction, the proposed Project would be in operation seven days per week during conditions of adequate sunlight. Anticipated activities to support and maintain operation would consist of visits to inspect, monitor, and report the system operations and site conditions, as well as to repair or replace any equipment as necessary. These visits would total less than one average daily trip over the life of the Project. The Project will be fenced to prevent unauthorized access to protect both the Project and the public safety. Any necessary fencing, connections, and access drives for the Project will take place within the APE for the Project. An exhibit showing the proposed solar facility's location is provided in Appendix A.

1.2 PURPOSE AND NEED

Per RD Instruction 1970-C Exhibit B Section 2.3.1: "USDA, Rural Development is a mission area that includes three federal agencies – Rural Business-Cooperative Service, Rural Housing Service, and Rural Utilities Service. The agencies have in excess of 50 programs that provide financial assistance and a variety of technical and educational assistance to eligible rural and tribal populations, eligible communities, individuals, cooperatives, and other entities with a goal of improving the quality of life, sustainability, infrastructure, economic opportunity, development, and security in rural America. Financial assistance can include direct loans, guaranteed loans, and grants in order to accomplish program objectives."

Today's Power, Inc. (TPI) plans to seek financial assistance from the USDA Rural Development (RD), Rural Utilities Service (RUS) under its Electric Program for the People's Electric Solar Facility (Project).

The purpose of this Project is to provide a clean and renewable energy source to the existing electrical grid in the area. TPI is partnering with People's Electric Cooperative to construct this Project and improve the reliability and capacity of the power system in the area by providing clean, renewable energy.

2.0 ALTERNATIVES EVALUATED INCLUDING THE PROPOSED ACTION

2.1 PROPOSED ACTION

The Project proposes to construct a 39.76-acre, 6.97-Megawatt solar electric array located on land previously cleared and developed for agricultural use. The Project will interconnect to the PEC electric distribution system which would require no upgrades. The solar array is located near the city of Ada, Oklahoma in Pontotoc County at the intersection of Highway 1 and County Road 1610, as shown on the enclosed map, which can be found in Appendix A.

The Project has been sited on private property currently owned by PEC to avoid floodplains, wetlands, streams, and to minimize the need for clearing, and grading. The site is also located adjacent to existing powerlines to provide ease of connection to the electric grid.

The construction phase of the Project, which includes grading, will be planned and designed to minimize the use of mechanized grading and fill materials procured off site. Controls, such as silt fences and stabilization, will be used during and after construction as needed to minimize indirect adverse environmental effects.

2.2 OTHER ALTERNATIVES EVALUATED

TPI considered the potential sites in the area of need in terms of those which they own or could lease, those which would avoid floodplains, wetlands, streams, and those which would require a minimal need for clearing and grading. The site was chosen as it minimizes all potential negative social and environmental impacts and is already owned by PEC.

2.3 NO ACTION ALTERNATIVE

The purpose of this Project is to provide a clean and renewable energy source to the existing electrical grid in the area, the 'no action alternative' would not provide the additional power to the area, nor provide the environmental benefits of clean, renewable energy. A conversion of 39.76 acres of potential farmland will occur as part of the Project; however, the proposed Project impacts are expected to have no effect upon the environment.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 LAND USE

3.1.1 LAND OWNERSHIP AND USE

Current land use for the Project consists of undeveloped rural and agricultural areas on privately owned land. No known development plans are known to exist for the area and PEC currently owns the property upon which the array is to be constructed.

3.1.2 IMPORTANT FARMLAND

AFFECTED ENVIRONMENT

The site is located on land previously disturbed for agriculture activities. The proposed Project will be located on rural, agricultural tracts of land located near the city of Ada, Oklahoma in Pontotoc County at the intersection of Highway 1 and County Road 1610. According to the attached map using data from the Natural Resources Conservation Service (NRCS), the site is not located within farmland of local, statewide, or unique importance.

ENVIRONMENTAL CONSEQUENCES

Proposed Project location and description as well as applicable AD-1006 forms were forwarded to the U.S. Department of Agriculture – Natural Resources Conservation Service (NRCS) on August 8th, 2022 regarding impact on important farmland for the Project. The completed form resulted in a score of 148 and was not precluded from conversion of important farmland for non-agricultural uses. As the score for the proposed site was less than 160, according to the completed AD-1006 form no alternative actions needed to be considered to reduce potential adverse impacts to the environment per NRCS. Copies of NRCS correspondence, Farmland Classification results from the NRCS Web Soil Survey tool, and completed AD-1006 forms can be found in Appendix B.

3.1.3 FORMALLY CLASSIFIED LANDS

AFFECTED ENVIRONMENT

The National Map provided by the USGS as well as the EPA provided NEPAssist tool were referenced for any known Formally Classified Lands. The maps may be found in Appendix C. There are no known: National Parks and Monuments; National Forests and Grasslands; National Historic

Landmarks; National Battlefield and Military Parks; National Historic Sites and Historical Parks; National Natural Landmarks; National Wildlife Refuges; National seashores, lake shores, and trails; Wilderness areas; Wild, scenic, and recreational rivers; State parks; State fish and wildlife management areas; Bureau of Land Management (BLM) administered lands; or Areas of State and Local Interest located in the Project APE.

ENVIRONMENTAL CONSEQUENCES

The site and APE are located on land that is owned by PEC. According to the National Map and NEPAssist tool, there are no known Formally Classified Lands as defined above located in the Project APE. Therefore, no impact to any Formally Classified Lands is anticipated as a result of the Project.

3.2 FLOODPLAINS

AFFECTED ENVIRONMENT

The site is located on land outside of existing floodplains. The avoidance of floodplains was one of the initial criteria for site selection.

A project area map adapted from the Federal Emergency Management Agency's (FEMA) website (msc.fema.gov) is attached in Appendix D.

Per FEMA NFIP FIRM 40123C0300D, effective date July 17, 2012, the proposed project is not within a FEMA delineated floodplain.

ENVIRONMENTAL CONSEQUENCES

Based upon all available data for this Project, no floodplain is located in the area, and no environmental impact is anticipated to any floodplain as a result of this Project.

3.3 WETLANDS

AFFECTED ENVIRONMENT

The site is located on land outside of existing wetlands. The avoidance of wetlands was one of the initial criteria for site selection. The proposed Project is not in a known wetland per the USFWS National Wetlands Inventory. USFWS and NWI wetlands for the surrounding area are indicated on the attached maps, which can be found in Appendix D.

ENVIRONMENTAL CONSEQUENCES

As there are no wetlands in the APE for the Project, and the construction of the project will involve controls and best management practices to control any discharge from the site, there is no anticipated impact to any wetlands as a result of this Project.

3.4 WATER RESOURCES

AFFECTED ENVIRONMENT

According to the attached map, located in Appendix E, using data from the EPA's Sole Source Aquifer online data-viewer, portions of the proposed Project are located within the limits of the Arbuckle-Simpson Sole Source Aquifer's Streamflow Source Area. The proposed Project is not within a known well-head or watershed protection area. The nearest receiving stream to the proposed Project is a tributary to Black Creek located approximately 2500 feet to the north of the Project APE.

ENVIRONMENTAL CONSEQUENCES

All necessary permits will be in place prior to construction. Controls, such as silt fences, stabilization, and other Best Management Practices (BMPs) will be used as a requirement of the Land Disturbance Permit and Stormwater Pollution Prevention Plan during and after construction as needed to minimize any potential indirect adverse environmental effects to water quality. During construction activities, routine inspections will also take place to ensure that these controls are implemented correctly.

As the solar panels will discharge directly to a pervious surface and the Project will not result in any new effluent discharge, stormwater quality is not anticipated to be affected by the Project. Furthermore, the proposed Project is not within the limits of a known well-head or watershed protection area.

The project is within the limits of the Arbuckle-Simpson Sole Source Aquifer's Streamflow Source Area. However, the Project as planned will not alter the existing topography and no excavation is planned which would be deep enough to potentially impact the Aquifer. As mentioned above, the Project will also not result in any new effluent discharge, BMPs will be used during construction, and stormwater quality is not anticipated to be affected by the Project.

No effects or impacts to water resources are anticipated as a result of the proposed Project.

3.5 COASTAL RESOURCES

AFFECTED ENVIRONMENT

There are no coastal areas or protected aquatic habitats in the region.

ENVIRONMENTAL CONSEQUENCES

As there are no coastal areas or protected aquatic habitats in the region, no impact to those areas is anticipated by the Project.

3.6 BIOLOGICAL RESOURCES

3.6.1 FISH, WILDLIFE, AND VEGETATION

AFFECTED ENVIRONMENT

The site is located on land previously disturbed for agriculture activities. The proposed Project will be located on rural, agricultural tracts of land in Oklahoma southwest of the city of Ada in Pontotoc County, at the intersection of Highway 1 and County Road 1610. The construction phase of the Project, which includes grading, will be planned and designed to minimize the potential need of mechanized grading and fill materials procured off site. At present, the proposed Project site contains minimal wildlife or vegetative life.

ENVIRONMENTAL CONSEQUENCES

There are no surface waters within the Project limits providing no suitable habitat for fish, and BMPs and controls will be used to prevent any offsite impacts to the environment. The cleared former farmland that will be converted to a solar facility also currently provides little suitable habitat in general for native vegetation or wildlife on the Project site. No effects upon fish, wildlife or vegetation are anticipated as a result of this Project.

3.6.2 THREATENED AND ENDANGERED SPECIES

AFFECTED ENVIRONMENT

TPI accessed the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) website on October 24th, 2022. According to the website, there are nine endangered species that may be present in the APE of the proposed Project, the Tricolored Bat, the Piping Plover, the Red Knot, the Whooping Crane, the Alligator Snapping Turtle, the Arkansas River Shiner, the Peppered Chub, the Monarch Butterfly, and the American Burying Beetle. The Oklahoma Department of Wildlife Conservation website was also accessed for any species of Statewide importance that might be present within the Project APE. According to the State website there are an additional three Species of concern to the State of Oklahoma which may not display on the federal USFWS website, the Blackside Darter, the Longnose Darter, and the Oklahoma Cave Crayfish. The official IPaC species list and Oklahoma Threatened and Endangered Species List are provided in Appendix G.

ENVIRONMENTAL CONSEQUENCES

The Monarch Butterfly's preferred habitat consists of open fields and meadows with milkweed and flowering plants. The Whooping Crane is a bird typically found in wetlands and marshes. The Piping Plover is a bird typically be found in wetland, marine or sandy habitats. The Red Knot is a bird which prefers dry tundra as well as intertidal marine habitats. The Alligator Snapping Turtle is a reptile whose preferred habitat includes rivers, lakes, backwater swamps, as well as brackish water systems. The Tricolored Bat is a mammal that typically inhabits open landscapes with large trees. The Arkansas River Shiner and the Peppered Chub are fish typically found in wide, shallow, sand-bottomed rivers. The proposed project is being planned in a rural, agricultural area with no flowering plants, tall grasses, wetlands, tundra, rivers, lakes, marine, sandy habitats, large trees, nor streams present in the APE.

In accordance with the American Burying Beetle 4(D) Rule, the proposed project is planned to take place upon land that is currently planted in monoculture, and does not contain native vegetation and that has been maintained through frequent mowing, grazing, or herbicide application at a height of 8 inches or less. As such, we conclude that the projects take place in an area of no suitable habitat for the American Burying Beetle.

The Blackside Darter is found only in the Mountain Fork, Poteau, Kiamichi, and Little River watersheds in Oklahoma and their associated tributaries. The Longnose Darter is found only in eastern Adair and Sequoyah counties and portions of western Arkansas. The Oklahoma Cave Crayfish is found only in the shallow groundwater aquifer underneath portions of the Spavinaw and Saline Creek watersheds in southern Delaware County. The proposed Project is proposed to take place in Pontotoc County, within the watershed of the Blue River and not within any of the above counties or watersheds

Based on this, Toth & Associates determined that financial assistance for this project will have no effect upon any listed or proposed species nor result in the adverse modification of any designated or proposed suitable habitat. No environmental impact is anticipated to any threatened or endangered species as a result of this Project.

3.6.3 MIGRATORY BIRD TREATY ACT

AFFECTED ENVIRONMENT

TPI accessed the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) website on October 24th, 2022. According to the website, there is one bird of concern with a potential range that overlaps the Project location, the Chimney Swift. This Bird prefers areas of low light and vertical surfaces such as caves, trees, or wells. The official IPaC species list is provided in Appendix G.

ENVIRONMENTAL CONSEQUENCES

The proposed Project will consist of the construction of ground-mounted solar arrays, which will pose no risk to migratory birds in flight and will take place upon formerly agricultural land, which provides little suitable wildlife habitat for the listed migrating bird species and no reason to cause an impact upon its existing flight patterns. Solar panels at the site will be photovoltaic, which shall absorb sunlight, and which are the only solar panel type approved for use by the Audubon Society due to their relatively low impact upon birds (https://www.audubon.org/news/solar-power-and-birds). No impact or take of any listed species is anticipated by the Project.

3.6.4 BALD AND GOLDEN EAGLE PROTECTION ACT

AFFECTED ENVIRONMENT

TPI accessed the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) website on October 24th, 2022. According to the website, the Bald Eagle is not a bird of concern in the Project area. The official IPaC species list is provided in Appendix G.

ENVIRONMENTAL CONSEQUENCES

The proposed Project will consist of the construction of ground-mounted solar arrays, which will pose no risk to migratory birds in flight and will take place upon land which provides little suitable wildlife habitat for the Bald Eagle, and would not cause an impact upon their existing flight patterns. Solar panels at the site will be photovoltaic, which shall absorb sunlight, and which are the only solar panel type approved for use by the Audubon Society due to their relatively low impact upon birds (https://www.audubon.org/news/solar-power-and-birds). Furthermore, the Bald Eagle is not a bird of concern in the Project Area. No disturbance, impact or take of the Bald Eagle is anticipated by the Project.

3.6.5 INVASIVE SPECIES

AFFECTED ENVIRONMENT

Many invasive species have potential to be found throughout Oklahoma (https://www.okinvasives.org/). As such, some invasive species may be present in the APE. However, in general, the proposed Project site has no known invasive species present, only native growth from former farmland.

ENVIRONMENTAL CONSEQUENCES

Due to the minimized need for earthwork and thus fill material necessary from offsite, as well as the absence of surface water near the Project location, and the maintenance of any such vegetation at the site during operation, the Project will not promote the introduction or growth of invasive species and is anticipated to have no effect upon native species in the APE.

3.7 CULTURAL RESOURCES AND HISTORIC PROPERTIES

AFFECTED ENVIRONMENT

The site is located on land previously disturbed for agriculture activities. The proposed Project will be located on rural, agricultural tracts of land in Oklahoma southwest of the city of Ada in Pontotoc County, at the intersection of Highway 1 and County Road 1610. According to the Oklahoma Landmarks Inventory (OLI), no historic or cultural resources were located within the Project area.

ENVIRONMENTAL CONSEQUENCES

The Oklahoma State Historic Preservation Office (SHPO) was contacted for their review and comment on the proposed Project on August 10th, 2022. At the Oklahoma SHPO's request, the Oklahoma Archeological Survey (OAS) office was also contacted on September 6th for their review and comment. In accordance with the online Tribal Directory Assessment Tool (TDAT), the following Indian tribes were provided a finding of "no historic properties affected" on August 10th, 2022 regarding the proposed Project: Apache Tribe of Oklahoma, Cheyenne and Arapaho Tribes, Chickasaw Nation, Muscogee (Creek) Nation, Osage Nation, Quapaw Tribe, and the Wichita and Affiliated Tribes.

In order to determine the potential impact of the proposed projects on the cultural resources, TPI commissioned cultural resource survey of the APE for the Peoples Electric Solar Facility. Regarding the Project, the survey stated that "the construction/installation of the People's Electric Solar Facility Undertaking will not result in a direct effect on the historic resources of Oklahoma". The cultural resource survey was provided to all listed tribes as well as SHPO and OAS.

The Oklahoma SHPO provided their concurrence on August 30h, 2022 finding that "there are no known historic properties affected within the referenced project's area of potential effect". The OAS provided their concurrence on September 30th, finding that they "concur with the findings and recommendations as they pertain to prehistoric archaeological resources and defer opinion on overall project effects to the Historic Archaeologist with the State Historic Preservation Office." The Quapaw Nation also provided their concurrence on September 16th, 2022 requesting that if " artifacts or human remains are discovered during project construction, we ask that work cease immediately and that you contact the Quapaw Tribe Historic Preservation Office." The Osage Nation stated that the project was already reviewed by their office and that their concurrence was sent to the USDA-RUS. The Chickasaw Nation responded on August 23rd, 2022 that they "request all project correspondence come directly from USDA." Project information was given to RUS to conduct any further necessary correspondence and communication for the Chickasaw Nation on August 25th, 2022.

All tribal and SHPO correspondence can be found in the attached section 106 documentation, along with a communication log of attempts to reach the tribes. As of today's date, no further response was received by the Muscogee (Creek) Nation, Apache Tribe of Oklahoma, Cheyenne and Arapaho Tribes, and the Wichita and Affiliated Tribes.

Given the above discussion, we conclude the proposed undertaking will have no effect on historic properties or cultural resources.

3.8 AESTHETICS

AFFECTED ENVIRONMENT

The site is located on fallow land previously disturbed for agriculture activities and currently owned by PEC. The proposed solar array will be located on rural, agricultural tracts of land outside of any aesthetically sensitive location such as a scenic area or park.

ENVIRONMENTAL CONSEQUENCES

In order to determine the potential visual impact of the proposed projects on the cultural resources of the area, TPI commissioned an Indirect Effect Assessment of the APE for the People's Electric Solar Facility. Regarding the Project, the survey stated that "the People's Electric Solar Facility Undertaking will not result in a visual effect on any previously identified historical properties in Oklahoma" The cultural resource survey was provided to all listed tribes as well as SHPO and OAS.

The Project will place photovoltaic panels over the approximately 40 acres shown on the APE, outside of any scenic or otherwise aesthetically sensitive area. Due to the limited height of these structures, the existing substation of a taller height that is located adjacent to the Project, and the existing fallow land that they will be placed upon, no significant adverse impact upon the aesthetics of the area are anticipated by the Project.

3.9 AIR QUALITY

AFFECTED ENVIRONMENT

On February 15, 2023 TPI accessed the EPA Greenbook, which lists the Nonattainment Areas for Criteria Pollutants. The Greenbook did not list Pontotoc County, Oklahoma as a non-attainment or maintenance area. The attached report, located in Appendix H, using the EPA provided NEPAssist tool also shows that the proposed Project is not within EPA-designated non-attainment or maintenance areas for air quality criteria pollutants.

ENVIRONMENTAL CONSEQUENCES

As shown in the above referenced report, the Project is outside of any EPA-designated non-attainment or maintenance areas for air quality criteria pollutants.

Short term increases to dust due to construction for the Project will be negligible due to the usage of BMPs, such as silt fences and stabilization, which will be used during and after construction as needed to minimize any indirect adverse environmental effects.

Short term increases to emissions from construction vehicles may also be expected during the construction phase of the project, but this incidental increase is not anticipated to have any noticeable effect due to the short duration of construction. Additionally, long term air quality in the area should benefit given the lower emissions anticipated due to the implementation of a significant renewable energy source for the existing power grid.

3.10 SOCIO-ECONOMIC & ENVIRONMENTAL JUSTICE

Applicants are required to determine if their proposal has or may have a disproportionately high and adverse human health or environmental effects on minority and low-income populations under E.O. 12898 *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* and USDA Departmental Regulation DR 5600-2, *Environmental Justice*.

AFFECTED ENVIRONMENT

The U. S. Census Bureau data for Pontotoc County, OK was reviewed and is provided in Appendix I. It shows a population of 66.8% white, with a 14.4% poverty rate, and a reported growth trend during that time of 0.3%.

Per the attached report, also located in Appendix I, using the EPA provided EJScreen tool, the proposed project generates a report with values of N/A due to its small size and sparse population.

The proposed Project is within an undeveloped, agricultural area already owned by PEC. The development of the Project is not anticipated to impact the lives of the population. There are no known environmental issues within the APE that would be expected to pose an environmental justice risk. The surrounding area, local services, and public facilities will not be affected by the Project beyond being provided the availability of a renewable, solar source of electric energy.

ENVIRONMENTAL CONSEQUENCES

The proposed Project is being designed to meet the future power needs for growth and stability of all residents in the area by providing them clean, renewable energy.

Based upon the small size and rural location of the project, it is believed that no new jobs would be created, and that unemployment rates for the area would not be impacted by the project. The proposed project is located in a rural area and is not located in a minority or low-income area. As a result, the proposed project would not have any disproportionate effects to minority or low-income populations located in the area. The proposed Project is not anticipated to have any change on the population or economy of the area. It is further anticipated that the proposed project would not have any impact on, or be influenced by, the civil rights, ethnic origin, sex, or social status of the people located near the project area. The Project is not considered an environmental risk or controversial and will not displace any current residents, nor will it adversely impact local public facilities or public services.

The proposed project is within a rural area and within land and easements already possessed. The proposed project is being designed to meet the future power needs for growth and stability of all residents in the area.

Financial assistance for this Project is not anticipated to have any major Environmental Justice or civil rights impact.

3.11 MISCELLANEOUS ISSUES

3.11.1 NOISE

AFFECTED ENVIRONMENT

The site is located on land previously disturbed for agriculture activities and currently owned by PEC. The proposed solar array will be located southwest of the city of Ada, Oklahoma in Pontotoc County at the intersection of Highway 1 and County Road 1610. Current noise levels for the site are typical of a rural, agricultural area located beside a roadway. Based upon aerial images of the site, the nearest residences are located approximately 0.1 miles away.

ENVIRONMENTAL CONSEQUENCES

Any noise produced by construction of the facility will be localized and temporary for the extent of the construction activity. Manual equipment installation will be utilized whenever possible to reduce the need for mechanized equipment that would increase noise during the construction phase and no specialized equipment that would generate loud noise is proposed to be used at the site. The level of noise that is anticipated to be produced by the proposed solar facility will not be greater than current ambient noise levels in the area. The proposed Project is anticipated to have no effect upon the noise pollution in the area.

3.11.2 TRANSPORTATION

3.11.2.1 FEDERAL AVIATION ADMINISTRATION

AFFECTED ENVIRONMENT

The attached map, located in Appendix J, using FAA provided data, shows that the proposed Project is approximately 8 linear miles distant from the nearest airport.

ENVIRONMENTAL CONSEQUENCES

As the Project is over 5 miles from an airport and site developments are not expected to be 200 feet above the ground surface, no official notice must be filed with the Federal Aviation Administration and no impact to air traffic is expected as a result of this Project.

3.11.2.2 TRAFFIC

AFFECTED ENVIRONMENT

The site is located in Oklahoma southwest of the city of Ada, Oklahoma in Pontotoc County at the intersection of Highway 1 and County Road 1610, along an asphalt highway.

ENVIRONMENTAL CONSEQUENCES

The construction activities for the Project do not propose to impact traffic patterns, nor have any impact upon the existing roadway. In total, project construction is anticipated to last for 2 months and no obstruction to traffic is anticipated during construction. Periodic inspection of the site and maintenance activities for the site will be required once built, but will be negligible in terms of long-term impact to current traffic patterns and amounting to less than one average daily trip. No impact upon traffic is anticipated as a result of this Project.

3.12 HUMAN HEALTH AND SAFETY

3.12.1 ELECTROMAGNETIC FIELDS AND INTERFERENCE

AFFECTED ENVIRONMENT

The proposed Project will be located on rural, agricultural tracts of land in Oklahoma, southwest of the city of Ada in Pontotoc County, intersection of Highway 1 and County Road 1610 on land currently owned by PEC. The proposed Project location site is located approximately 6 miles outside of the city of Ada, beside an existing electrical substation and approximately 0.1 miles away from the nearest occupied residence.

As the Project will involve the construction of a solar panel array that will generate electricity, Electromagnetic Fields (EMFs) may be generated. Studies (Tell, 2015) based upon similar facilities suggest that any EMFs generated will be below permissible exposure thresholds. Publicly available studies used for reference are included in Appendix L.

ENVIRONMENTAL CONSEQUENCES

Current scientific literature suggests that electromagnetic fields that are generated from similar solar facilities operate below acceptable exposure levels, with the highest EMFs present at three feet of distance from the inverter units used. The solar facility is proposed to be located over 1000 feet away from any occupied residence and will be fenced off to prevent unauthorized access. As a result, no impact to human health and safety are anticipated as a result of exposure to EMFs due to this Project.

3.12.2 ENVIRONMENTAL RISK MANAGEMENT

AFFECTED ENVIRONMENT

The attached report, located in Appendix K, using the EPA provided NEPAssist tool shows that the proposed Project is not within EPA-designated areas for existing hazardous waste facilities, toxic release inventories, or TSCA sites.

The proposed Project will be located on agricultural tracts of land in Oklahoma on land without any existing facilities that is currently owned by PEC. The site is not anticipated to have any hazardous material, lead, or petroleum products within the APE.

ENVIRONMENTAL CONSEQUENCES

As shown in the above referenced report, the Project is outside of any existing RCRA facilities, toxic release inventories, or TSCA sites, and will not produce any hazardous material or waste or consist of a new RCRA hazardous materials handling facility. No effect to environmental risk management is anticipated.

3.13 CORRIDOR ANALYSIS

AFFECTED ENVIRONMENT

Connection to the existing electrical grid will be completed by PEC to the utility lines located adjacent to the Project and within the 40- acre area of the project. There is no current corridor or impact beyond that already listed for building and connecting to the existing electrical grid at this project location.

ENVIRONMENTAL CONSEQUENCES

The interconnection point will take place toward the existing lines along Highway 1 and within the project's area of potential effect, therefore the future interconnection is anticipated to have no impact outside of those listed for the existing Project.

4.0 CUMULATIVE EFFECTS

4.1 SUMMARY OF ENVIRONMENTAL EFFECTS

Environmental Resource	Determination of Effect
Land Use	**No known development plans for the area, People's Electric Cooperative currently owns the property. No Effect Anticipated.**
Farmland	**Conversion of approximately 40 acres of farmland, USDA consultation concluded. No Effect Anticipated.**

Formally Classified Land	**No known Formally Classified Lands within project area.**
Floodplains	**No Floodplains within project area. No Effect Anticipated.**
Wetlands	**No Wetlands within project area. No Effect Anticipated.**
Water Resources	**No well-heads, or watershed protection areas within project area. Project is within Arbuckle-Simpson Sole Source Aquifer Streamflow Source Area. Project will not alter existing topography, excavate to any appreciable depth, nor add any effluent discharge to the drainage area. BMPs will be utilized for construction. No Effect Anticipated.**
Coastal Resources	**No coastal areas or aquatic habitats in region. No Effect Anticipated.**
Biological Resources – Fish, Wildlife and Vegetation	**Little to no suitable habitat for native vegetation currently within project area. USFWS concurrence granted. No Effect Anticipated.**
Biological Resources – Threatened and Endangered Species	**No suitable habitat for listed threatened and endangered species currently within project area. No Effect Anticipated.**
Biological Resources – Migratory Bird Treaty Act	**Little suitable habitat for birds of concern within project area. No Effect Anticipated.**
Biological Resources – Bald and Golden Eagle Protection Act	**Little suitable habitat for Bald or Golden Eagle within project area. Neither are a bird of concern in the project area. No Effect Anticipated.**

Biological Resources – Invasive Species	**Minimized fill required from offsite and no surface water at project site. Project will not promote the introduction or growth of invasive Species. No Effect Anticipated.**
Cultural Resources and Historic Properties	**Survey concluded. SHPO, OAS, Quapaw Nation concurrence provided. RUS has been contacted to handle all correspondence with Chickasaw Nation per their request. Consultation concluded for all other tribes. No Effect Anticipated.**
Aesthetics	**Project is outside of any aesthetically sensitive area. Project will be of limited heigh. No Effect Anticipated.**
Air Quality	**Project is outside of any EPA-designated non-attainment or maintenance areas for air quality criteria pollutants. Short term increases to dust will be mitigated by BMPs and short term increases to emissions will be negligible during construction. No Adverse Effect Anticipated. Long-term Benefit Anticipated due to clean, renewable energy source.**
Socio-Economic & Environmental Justice	**Project is not an environmental risk nor controversial and will not displace any current residents, nor will it adversely impact local public facilities or public services. No Effect Anticipated.**
Noise	**Short-term noise during construction will be controlled by using manual installation methods where possible. Post-construction noise levels will be equivalent to current ambient noise levels in area. No Effect Anticipated.**
Transportation	**Project is over 5 miles from nearest airport. No significant short-term obstruction to traffic planned for construction. No significant long-term increase to traffic during Project life. No Effect Anticipated.**
Human Health and Safety	**Highest EMFs would be present at approximately three feet of distance from the inverter units used. Project location is over 1000 feet occupied residences and will be fenced off to prevent unauthorized access. No Effect Anticipated.**

4.2 CUMULATIVE EFFECTS

Environmental Resource	Past	Proposed Action	Future Action	Cumulative Effect
Land Use	Agricultural, Rural Area	Convert 40-Acres To A Solar Facility	No Effect Anticipated	**No Significant Effect Anticipated**
Farmland	Agricultural, Rural Area	Convert 40-Acres To A Solar Facility	No Effect Anticipated	**No Significant Effect Anticipated**
Formally Classified Land	None Existing Near Project Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Floodplains	None Existing Near Project Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Wetlands	None Existing Near Project Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Water Resources	No Known Wells, Or Protection Areas Near Project Area. Receiving Stream ± 2500 Feet Distant. Project does not involve actions which would impact Sole Source Aquifer.	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Coastal Resources	None Existing Near Project Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Biological Resources – Fish, Wildlife And Vegetation	Little Suitable Habitat Within Project Area. No Indirect Effects To Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**

Biological Resources – Threatened And Endangered Species	No Suitable Habitat Within Project Area. No Indirect Effects To Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Biological Resources – Migratory Bird Treaty Act	No Suitable Habitat Within Project Area. No Indirect Effects To Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Biological Resources – Bald And Golden Eagle Protection Act	No Suitable Habitat Within Project Area. No Indirect Effects To Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Biological Resources – Invasive Species	None Known Within Project Area Or Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Cultural Resources And Historic Properties	None Known Within Project Area Or Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Aesthetics	Agricultural, Rural Area	Will Convert 40-Acres Of Potential Farmland To Solar Facility	No Effect Anticipated	**No Significant Effect Anticipated**
Air Quality	Outside Of EPA-Designated Non-Attainment Or Maintenance Areas For Air Quality Criteria Pollutants	Long-Term Benefit Anticipated	No Effect Anticipated	**Long-Term Benefit Anticipated**
Socio-Economic & Environmental Justice	No Public Facilities Or Services, Nor Residential Or Commercial Properties In Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Noise	Rural, Ambient Noise Level	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**

Transportation	Light, Rural Traffic. No Airport In Surrounding Area	No Effect Anticipated	No Effect Anticipated	**No Significant Effect Anticipated**
Human Health And Safety	Vacant Farmland	EMF Potential At Project Area. Project Will Prevent Unauthorized Access. No Effect	No Effect Anticipated	**No Significant Effect Anticipated**

In general, no significant effects are anticipated either individually or cumulatively as a result of the Project both within the approximately 40-acre area of potential effect for the project and for the immediately surrounding area within the next 20 years. Per conversations on December 12-13 with the County Assessor's Office and County Commissioner's Office of Pontotoc County as well as the City of Ada's Code Enforcement Officer, land use permits are not required for the area; however, there are no masterplans, nor any projects in development, in the areas surrounding the Project. As a result of the lack of currently planned developments in the surrounding areas, the Project is not anticipated to have a significant cumulative effect upon the environmental resources of the area.

Land Use, Aesthetics, and Farmland will change from a rural, agricultural potential farming area to a solar facility as the result of the proposed construction. The solar facility will generate potential EMFs, but the amount that will be generated by such a facility is within safety standards, and the area will also be restricted from unauthorized access. Air Quality is expected to increase in quality over the lifespan of the Project, as the Project will provide cleaner energy than the current alternatives. No other effects are anticipated to provide a significant cumulative effect upon the area.

5.0 SUMMARY OF MITIGATION

The initial criteria for site selection, the use of BMPs such as silt fences and stabilization are anticipated to effectively minimize the potential effects of the Project upon the environment. Conditional approval measures were requested by interested Agencies, such as the appropriate actions to be taken in case of incidentally encountering human remains or artifacts in the Project area. All mitigation issues are discussed above as well as in the appropriate appendices, and additional mitigation measures beyond those listed do not appear warranted at this time.

6.0 COORDINATION, CONSULTATION AND CORRESPONDENCE

The following agencies or agency websites were consulted as part of the preparation of this EA, all supporting documentation and agency correspondence is provided in the Appendices:

Apache Tribe of Oklahoma

Cheyenne and Arapaho Tribes

Chickasaw Nation

Muscogee (Creek) Nation

EPA

FAA

FEMA Floodplain Map

NEPAssist

Oklahoma Archaeological Survey

Oklahoma Department of Wildlife Conservation

Oklahoma Historical Society: State Historic Preservation Office

Oklahoma Landmarks Inventory

Osage Nation

Quapaw Tribe of Indians

US Census Data

USDA – NRCS

US Fish and Wildlife Services

Wichita and Affiliated Tribes

7.0 REFERENCES

All supporting documentation and agency correspondence is provided in the Appendices.

EPA EJScreen, last accessed October 24, 2022 https://ejscreen.epa.gov/mapper/

EPA NEPAssist tool, last accessed October 24, 2022. https://nepassisttool.epa.gov/nepassist/nepamap.aspx

EPA Greenbook, last accessed February 16,2023. https://www.epa.gov/green-book/green-book-data-download

FEMA Flood Plain Map, last accessed October 19, 2022. https://msc.fema.gov/portal/home

K & K Environmental, LLC. "Oklahoma Phase I Direct Effects Investigation People's Electric Solar Facility Pontotoc County, Oklahoma" 25 July, 2022.

NRCS Web Soil Survey Tool, last accessed February 16, 2023. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Tell RA, Hooper HC, Sias GG, Mezei G, Hung P, Kavet R. Electromagnetic Fields Associated with Commercial Solar Photovoltaic Electric Power Generating Facilities. *J Occup Environ Hyg.* 2015;12(11):795-803. doi:10.1080/15459624.2015.1047021

Oklahoma Department of Wildlife Conservation: Threatened & Endangered Species List, last accessed December 8, 2022. https://www.wildlifedepartment.com/wildlife/threatened-and-endangered?page=0

Tribal Directory Assessment Tool (TDAT), last accessed October 24, 2022 https://egis.hud.gov/tdat/

US Census Data, last accessed October 24, 2022. https://www.census.gov/quickfacts/pontotoccountyoklahoma

US Fish and Wildlife Services– Information for Planning and Consultation, last accessed October 24, 2022. https://www.fws.gov/southeast/conservation-tools/information-for-planning-and-consultation/

US Fish and Wildlife Services – National Wetlands Inventory, last accessed October 19, 2022 https://www.fws.gov/wetlands/data/mapper.html

USGS National Map, last accessed October 19, 2022 https://apps.nationalmap.gov/viewer/

8.0 LIST OF PREPARERS

This EA was prepared by:

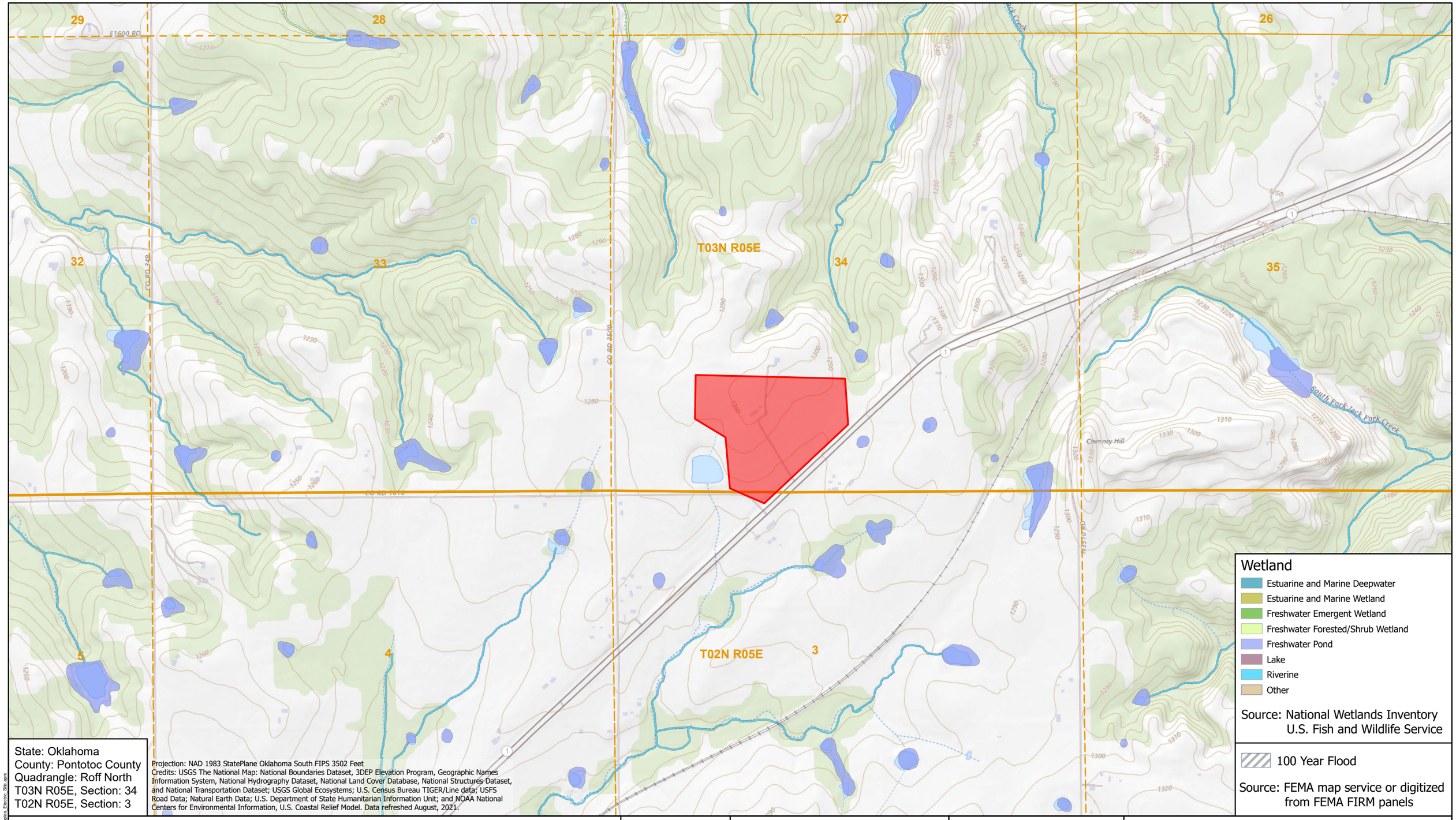
Matthew Miller, PE

Vice President, Toth & Associates

Joseph Tuey, EI

Engineer, Toth & Associates

Appendix A



State: Oklahoma
County: Pontotoc County
Quadrangle: Roff North
T03N R05E, Section: 34
T02N R05E, Section: 3

Projection: NAD 1983 StatePlane Oklahoma South FIPS 3502 Feet
Credits: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

Wetland

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Other

Source: National Wetlands Inventory
U.S. Fish and Wildlife Service

100 Year Flood

Source: FEMA map service or digitized from FEMA FIRM panels

- People's Electric Site
- Section
- Township

TOTH & ASSOCIATES
1550 E REPUBLIC RD
SPRINGFIELD, MO 65804
Ph. 417-888-0645 Fax: 417-888-0657
www.tothassociates.com

Today's Power
Your Energy Partner

MAP BY: mbrown	DATE: 5/31/2022
APPD. BY: ALB	DATE: 05/31/2022

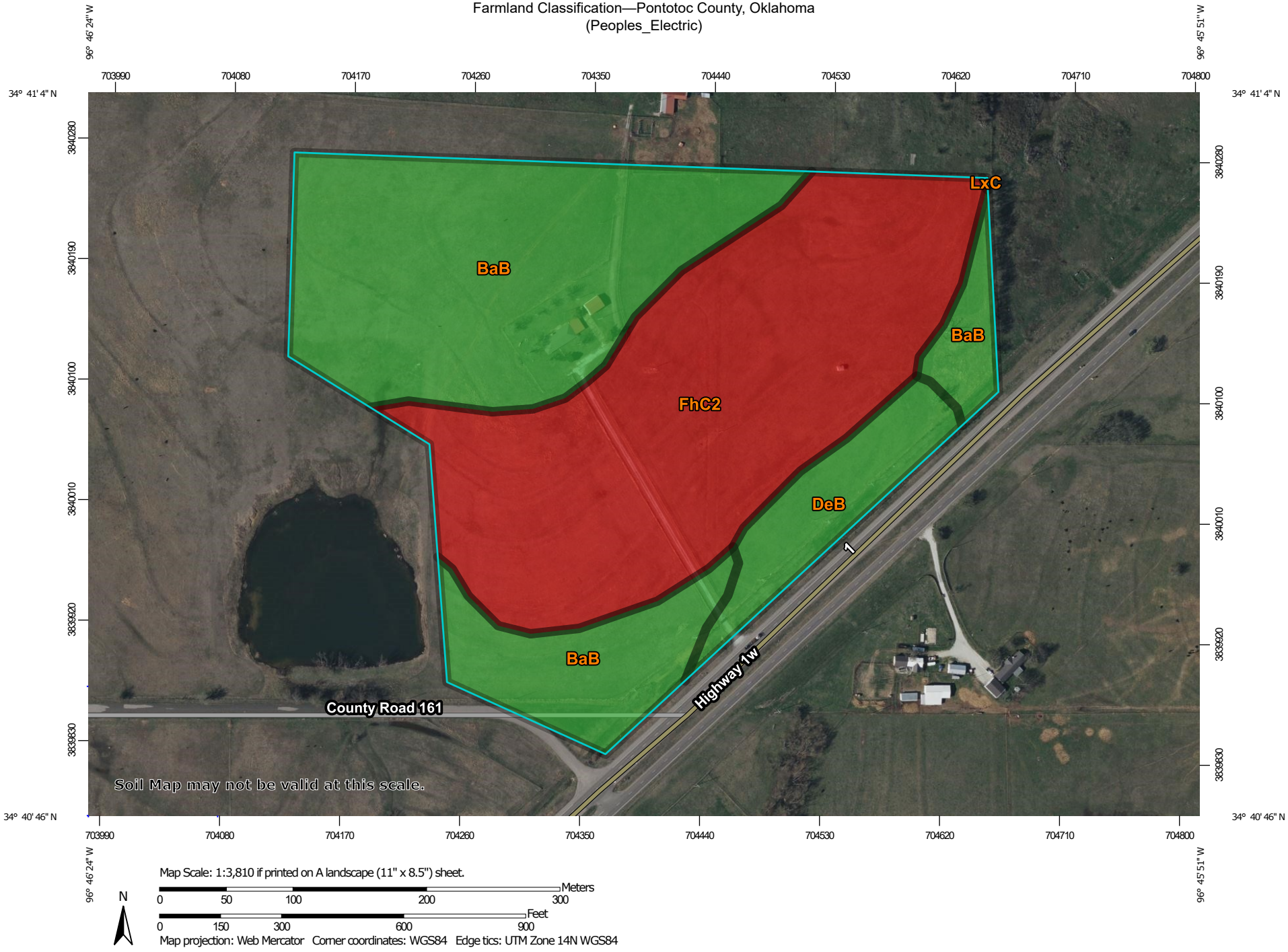
People's Electric Solar Facility

Map Title: Topo Environmental	Map Number: MB-179 : 1
Client: TODAY'S POWER NORTH LITTLE ROCK, ARKANSAS PULASKI	0 1,000 Feet

O:\Today's Power\GIS\ArcGIS Pro\RUS Maps\Peoples_Electric_Site.aprx

Appendix B

Farmland Classification—Pontotoc County, Oklahoma
(Peoples_Electric)



Map Scale: 1:3,810 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

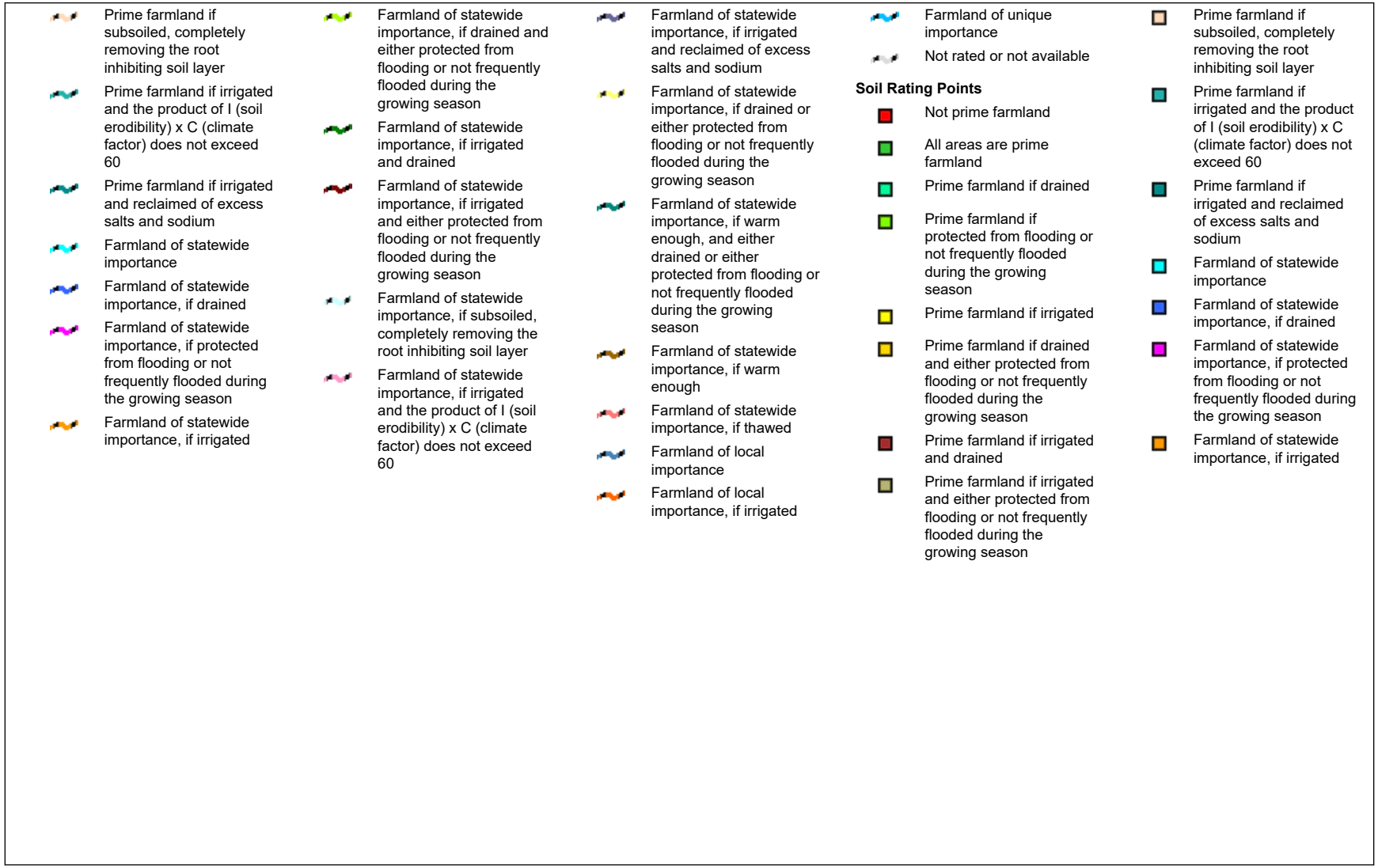
Soils

Soil Rating Polygons

- Not prime farmland
- All areas are prime farmland
- Prime farmland if drained
- Prime farmland if protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated
- Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated and drained
- Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if subsoiled, completely removing the root inhibiting soil layer
- Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Prime farmland if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance
- Farmland of statewide importance, if drained
- Farmland of statewide importance, if protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated
- Farmland of statewide importance, if drained and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated and drained
- Farmland of statewide importance, if irrigated and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if subsoiled, completely removing the root inhibiting soil layer
- Farmland of statewide importance, if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Farmland of statewide importance, if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance, if drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough, and either drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough
- Farmland of statewide importance, if thawed
- Farmland of local importance
- Farmland of local importance, if irrigated
- Farmland of unique importance
- Not rated or not available

Soil Rating Lines

- Not prime farmland
- All areas are prime farmland
- Prime farmland if drained
- Prime farmland if protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated
- Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated and drained
- Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season


Prime farmland if subsoiled, completely removing the root inhibiting soil layer
Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
Prime farmland if irrigated and reclaimed of excess salts and sodium
Farmland of statewide importance
Farmland of statewide importance, if drained
Farmland of statewide importance, if protected from flooding or not frequently flooded during the growing season
Farmland of statewide importance, if irrigated
Farmland of statewide importance, if drained and either protected from flooding or not frequently flooded during the growing season
Farmland of statewide importance, if irrigated and drained
Farmland of statewide importance, if irrigated and either protected from flooding or not frequently flooded during the growing season
Farmland of statewide importance, if subsoiled, completely removing the root inhibiting soil layer
Farmland of statewide importance, if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
Farmland of statewide importance, if irrigated and reclaimed of excess salts and sodium
Farmland of statewide importance, if drained or either protected from flooding or not frequently flooded during the growing season
Farmland of statewide importance, if warm enough, and either drained or either protected from flooding or not frequently flooded during the growing season
Farmland of statewide importance, if warm enough
Farmland of statewide importance, if thawed
Farmland of local importance
Farmland of local importance, if irrigated
Farmland of unique importance
Not rated or not available
Soil Rating Points
Not prime farmland
All areas are prime farmland
Prime farmland if drained
Prime farmland if protected from flooding or not frequently flooded during the growing season
Prime farmland if irrigated
Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
Prime farmland if irrigated and drained
Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
Prime farmland if subsoiled, completely removing the root inhibiting soil layer
Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
Prime farmland if irrigated and reclaimed of excess salts and sodium
Farmland of statewide importance
Farmland of statewide importance, if drained
Farmland of statewide importance, if protected from flooding or not frequently flooded during the growing season
Farmland of statewide importance, if irrigated

- Farmland of statewide importance, if drained and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated and drained
- Farmland of statewide importance, if irrigated and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if subsoiled, completely removing the root inhibiting soil layer
- Farmland of statewide importance, if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Farmland of statewide importance, if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance, if drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough, and either drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough
- Farmland of statewide importance, if thawed
- Farmland of local importance
- Farmland of local importance, if irrigated
- Farmland of unique importance
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Pontotoc County, Oklahoma
Survey Area Data: Version 18, Sep 6, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 26, 2021—Mar 29, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Farmland Classification

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BaB	Bates fine sandy loam, 1 to 3 percent slopes	All areas are prime farmland	18.2	45.7%
DeB	Dennis loam, 1 to 3 percent slopes	All areas are prime farmland	3.0	7.5%
FhC2	Fitzhugh fine sandy loam, 3 to 5 percent slopes, eroded	Not prime farmland	18.6	46.7%
LxC	Lula-Shidler complex, 3 to 5 percent slopes	Not prime farmland	0.0	0.0%
Totals for Area of Interest			**39.8**	**100.0%**

Description

Farmland classification identifies map units as prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland. It identifies the location and extent of the soils that are best suited to food, feed, fiber, forage, and oilseed crops. NRCS policy and procedures on prime and unique farmlands are published in the "Federal Register," Vol. 43, No. 21, January 31, 1978.

Rating Options

Aggregation Method: No Aggregation Necessary

Tie-break Rule: Lower

From: Bushong, Jacob - FPAC-NRCS, Stillwater, OK <Jacob.Bushong@usda.gov>
Sent: Thursday, September 15, 2022 11:17 AM
To: Kathrine Strickland
Cc: Alspach, Steven - NRCS, Stillwater, OK; Matt Miller; Joe Tuey
Subject: RE: [External Email]Today's Power Inc. - Peoples Electric Solar Facility
Attachments: Peoples Electric Solar Facility_OK123.pdf

EXTERNAL EMAIL

Kathrine,

Attached is the completed AD-1006 form for your project. Please let me know if you have any questions or concerns with the form.

Thanks,

Jacob T. Bushong
GIS Specialist
USDA-NRCS
(405) 742-1250

From: Alspach, Steven - NRCS, Stillwater, OK <steven.alspach@usda.gov>
Sent: Thursday, September 15, 2022 9:32 AM
To: Bushong, Jacob - FPAC-NRCS, Stillwater, OK <Jacob.Bushong@usda.gov>
Subject: FW: [External Email]Today's Power Inc. - Peoples Electric Solar Facility

---

From: Kathrine Strickland <kstrickland@tothassociates.com>
Sent: Monday, August 8, 2022 12:44 PM
To: Alspach, Steven - NRCS, Stillwater, OK <steven.alspach@usda.gov>
Cc: Matt Miller <mmiller@tothassociates.com>; Joe Tuey <jtuey@tothassociates.com>
Subject: [External Email]Today's Power Inc. - Peoples Electric Solar Facility

Mr. Alspach,
Please find the attached information requesting farmland impact ratings for the Today's Power Inc. – Peoples Electric Solar Facility. The pdf, kmz, and shp files for the projects have been attached for your reference. Please let me know if you have any questions.

Thank you,

Kathrine Strickland
Intern

1550 East Republic Road
Springfield, MO 65804
Office: 417.888.0645
Fax: 417.888.0657
tothassociates.com

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*		Date Of Land Evaluation Request 8/8/22	
Name of Project People's Electric Solar Facility		Federal Agency Involved USDA-Rural Utilities Services	
Proposed Land Use Power Generation		County and State Pontotoc County, Oklahoma	
PART II *(To be completed by NRCS)*		Date Request Received By NRCS 8/8/2022	Person Completing Form: Jacob T. Bushong
Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	YES ☑ NO ☐	Acres Irrigated 440	Average Farm Size 223
Major Crop(s) Corn, Cotton, Small Grains	Farmable Land In Govt. Jurisdiction Acres: 320,211 % 69	Amount of Farmland As Defined in FPPA Acres: 170,965 % 37	
Name of Land Evaluation System Used NCCPI	Name of State or Local Site Assessment System NONE	Date Land Evaluation Returned by NRCS 9/15/22	

PART III *(To be completed by Federal Agency)*	Alternative Site Rating			
	Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	39.76			
B. Total Acres To Be Converted Indirectly	0.00			
C. Total Acres In Site	39.76			
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland	21.15			
B. Total Acres Statewide Important or Local Important Farmland	0			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted	0.0124			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value	32			
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)	70			

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)	15			
2. Perimeter In Non-urban Use	(10)	8			
3. Percent Of Site Being Farmed	(20)	0			
4. Protection Provided By State and Local Government	(20)	20			
5. Distance From Urban Built-up Area	(15)	10			
6. Distance To Urban Support Services	(15)	10			
7. Size Of Present Farm Unit Compared To Average	(10)	0			
8. Creation Of Non-farmable Farmland	(10)	10			
9. Availability Of Farm Support Services	(5)	5			
10. On-Farm Investments	(20)	0			
11. Effects Of Conversion On Farm Support Services	(10)	0			
12. Compatibility With Existing Agricultural Use	(10)	0			
TOTAL SITE ASSESSMENT POINTS	160	78	0	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	70	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	78	0	0	0
TOTAL POINTS ***(Total of above 2 lines)***	260	148	0	0	0

Site Selected: A	Date Of Selection 10/19/2022	Was A Local Site Assessment Used? YES ☐ NO ☑

Reason For Selection:

Name of Federal agency representative completing this form:	Date:

(See Instructions on reverse side) **Form AD-1006 (03-02)**

STEPS IN THE PROCESSING THE FARMLAND AND CONVERSION IMPACT RATING FORM

Step 1 - Federal agencies (or Federally funded projects) involved in proposed projects that may convert farmland, as defined in the Farmland Protection Policy Act (FPPA) to nonagricultural uses, will initially complete Parts I and III of the form. For Corridor type projects, the Federal agency shall use form NRCS-CPA-106 in place of form AD-1006. The Land Evaluation and Site Assessment (LESA) process may also be accessed by visiting the FPPA website, http://fppa.nrcs.usda.gov/lesa/.

Step 2 - Originator (Federal Agency) will send one original copy of the form together with appropriate scaled maps indicating location(s)of project site(s), to the Natural Resources Conservation Service (NRCS) local Field Office or USDA Service Center and retain a copy for their files. (NRCS has offices in most counties in the U.S. The USDA Office Information Locator may be found at http://offices.usda.gov/scripts/ndISAPI.dll/oip_public/USA_map**,** or the offices can usually be found in the Phone Book under U.S. Government, Department of Agriculture. A list of field offices is available from the NRCS State Conservationist and State Office in each State.)

Step 3 - NRCS will, within 10 working days after receipt of the completed form, make a determination as to whether the site(s) of the proposed project contains prime, unique, statewide or local important farmland. (When a site visit or land evaluation system design is needed, NRCS will respond within 30 working days.

Step 4 - For sites where farmland covered by the FPPA will be converted by the proposed project, NRCS will complete Parts II, IV and V of the form.

Step 5 - NRCS will return the original copy of the form to the Federal agency involved in the project, and retain a file copy for NRCS records.

Step 6 - The Federal agency involved in the proposed project will complete Parts VI and VII of the form and return the form with the final selected site to the servicing NRCS office.

Step 7 - The Federal agency providing financial or technical assistance to the proposed project will make a determination as to whether the proposed conversion is consistent with the FPPA.

INSTRUCTIONS FOR COMPLETING THE FARMLAND CONVERSION IMPACT RATING FORM

(For Federal Agency)

Part I: When completing the "County and State" questions, list all the local governments that are responsible for local land use controls where site(s) are to be evaluated.

Part III: When completing item B (Total Acres To Be Converted Indirectly), include the following:

1. Acres not being directly converted but that would no longer be capable of being farmed after the conversion, because the conversion would restrict access to them or other major change in the ability to use the land for agriculture.
2. Acres planned to receive services from an infrastructure project as indicated in the project justification (e.g. highways, utilities planned build out capacity) that will cause a direct conversion.

Part VI: Do not complete Part VI using the standard format if a State or Local site assessment is used. With local and NRCS assistance, use the local Land Evaluation and Site Assessment (LESA).

1. Assign the maximum points for each site assessment criterion as shown in § 658.5(b) of CFR. In cases of corridor-type project such as transportation, power line and flood control, criteria #5 and #6 will not apply and will, be weighted zero, however, criterion #8 will be weighed a maximum of 25 points and criterion #11 a maximum of 25 points.

2. Federal agencies may assign relative weights among the 12 site assessment criteria other than those shown on the FPPA rule after submitting individual agency FPPA policy for review and comment to NRCS. In all cases where other weights are assigned, relative adjustments must be made to maintain the maximum total points at 160. For project sites where the total points equal or exceed 160, consider alternative actions, as appropriate, that could reduce adverse impacts (e.g. Alternative Sites, Modifications or Mitigation).

Part VII: In computing the "Total Site Assessment Points" where a State or local site assessment is used and the total maximum number of points is other than 160, convert the site assessment points to a base of 160.
Example: if the Site Assessment maximum is 200 points, and the alternative Site "A" is rated 180 points:

$$\frac{\text{Total points assigned Site A}}{\text{Maximum points possible}} = \frac{180}{200} \text{ X } 160 = 144 \text{ points for Site A}$$

For assistance in completing this form or FPPA process, contact the local NRCS Field Office or USDA Service Center.

NRCS employees, consult the FPPA Manual and/or policy for additional instructions to complete the AD-1006 form.

Appendix C

People's Electric Solar Facility: National Map

10/19/2022, 1:51:32 PM

- Peoples_Electric
- Bureau of Land Management
- National Cemetery
- National Grassland
- National Wilderness
- National Forest
- National Monument
- National Park
- Native American Area Large-Scale

1:36,112

0 0.25 0.5 1 mi

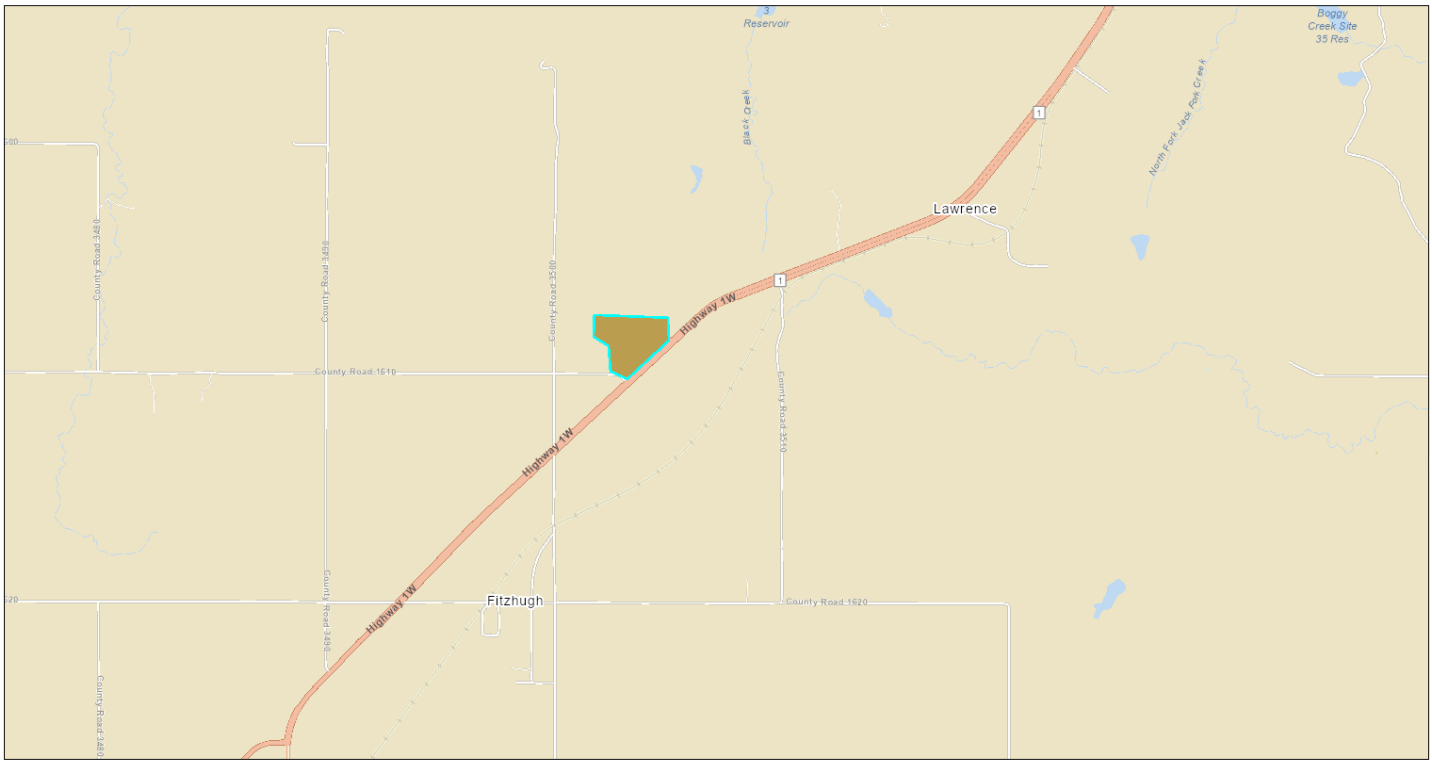
0 0.4 0.8 1.6 km

USGS The National Map: National Boundaries Dataset. Data Refreshed October, 2023., USGS The National Map: National Boundaries Dataset,

USGS

NEPAssist Report

People's Electric Solar Facility:
Federal Lands



October 24, 2022

People's Electric

peoples_electric

1:30,575

0 0.3 0.6 1.2 mi

0 0.5 1 2 km

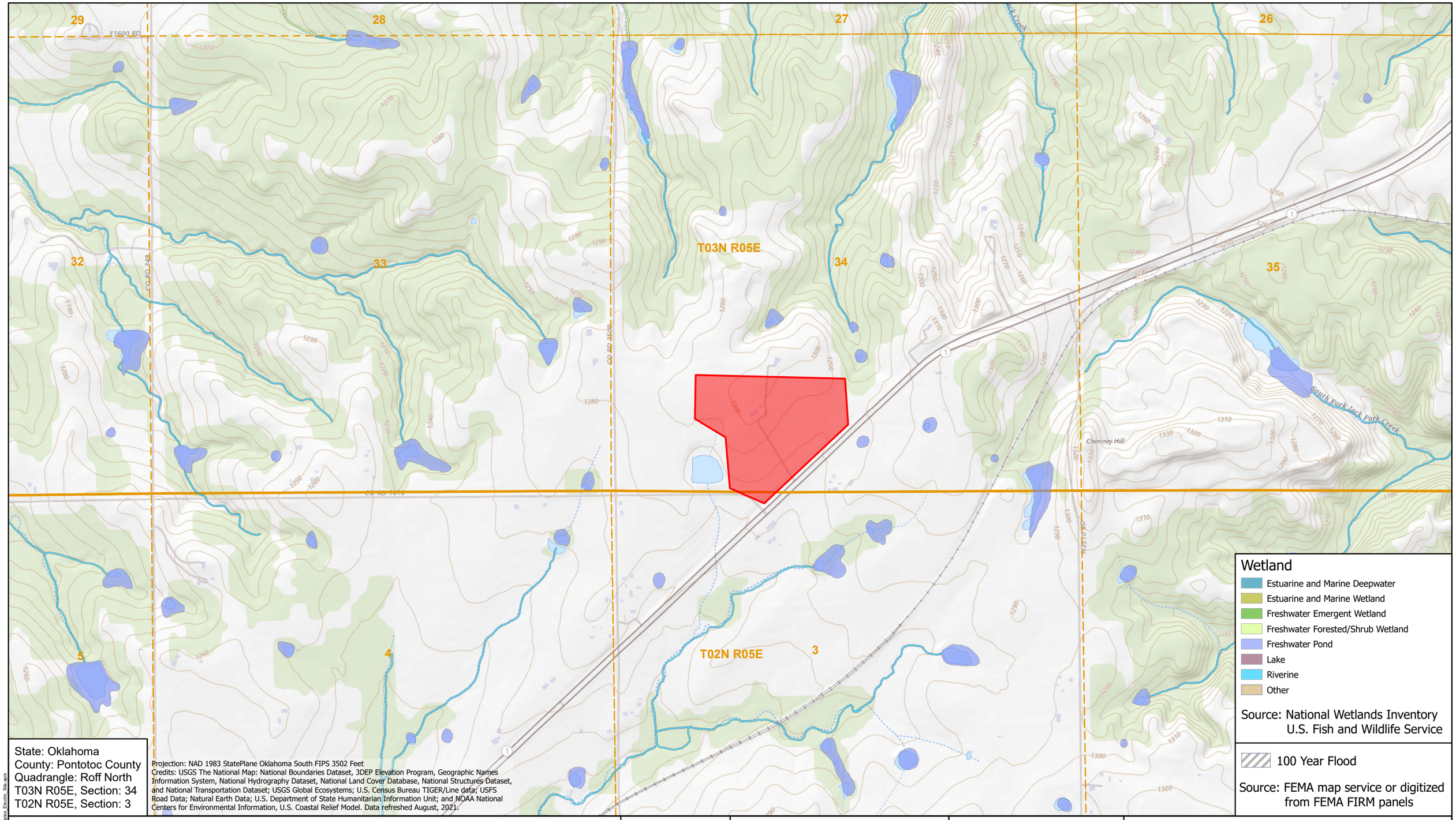
Texas Parks & Wildlife, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

Input Coordinates: 34.683937,-96.766100,34.682497,-96.766010,34.680052,-96.769226,34.680539,-96.770529,34.682142,-96.770673,34.682733,-96.771831,34.684115,-96.771778,34.683937,-96.766100	
Project Area	0.06 sq mi
Within an Ozone 8-hr (1997 standard) Non-Attainment/Maintenance Area?	no
Within an Ozone 8-hr (2008 standard) Non-Attainment/Maintenance Area?	no
Within a Lead (2008 standard) Non-Attainment/Maintenance Area?	no
Within a SO2 1-hr (2010 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 24hr (2006 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 Annual (1997 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 Annual (2012 standard) Non-Attainment/Maintenance Area?	no
Within a PM10 (1987 standard) Non-Attainment/Maintenance Area?	no
Within a Federal Land?	no
Within an impaired stream?	no
Within an impaired waterbody?	no
Within a waterbody?	no
Within a stream?	no
Within an NWI wetland?	Available Online
Within a Brownfields site?	no
Within a Superfund site?	no
Within a Toxic Release Inventory (TRI) site?	no
Within a water discharger (NPDES)?	no
Within a hazardous waste (RCRA) facility?	no

Within an air emission facility?	no
Within a school?	no
Within an airport?	no
Within a hospital?	no
Within a designated sole source aquifer?	yes
Within a historic property on the National Register of Historic Places?	no
Within a Toxic Substances Control Act (TSCA) site?	no
Within a Land Cession Boundary?	yes
Within a tribal area (lower 48 states)?	yes
Within the service area of a mitigation or conservation bank?	yes
Within the service area of an In-Lieu-Fee Program?	yes

Created on: 10/24/2022 4:15:14 PM

Appendix D



State: Oklahoma
County: Pontotoc County
Quadrangle: Roff North
T03N R05E, Section: 34
T02N R05E, Section: 3

Projection: NAD 1983 StatePlane Oklahoma South FIPS 3502 Feet
Credits: USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

Wetland

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Riverine
- Other

Source: National Wetlands Inventory
U.S. Fish and Wildlife Service

100 Year Flood

Source: FEMA map service or digitized from FEMA FIRM panels

- People's Electric Site
- Section
- Township

TOTH & ASSOCIATES
1550 E REPUBLIC RD
SPRINGFIELD, MO 65804
Ph. 417-888-0645 Fax: 417-888-0657
www.tothassociates.com

Today's Power
Your Energy Partner

MAP BY: mbrown	DATE: 5/31/2022
APPD. BY: ALB	DATE: 05/31/2022

People's Electric Solar Facility

Map Title: Topo Environmental	Map Number: MB-179 : 1
Client: TODAY'S POWER NORTH LITTLE ROCK, ARKANSAS PULASKI	0 1,000 Feet

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National Flood Hazard Layer FIRMette

FEMA

96°46'27"W 34°41'11"N

96°45'50"W 34°40'41"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

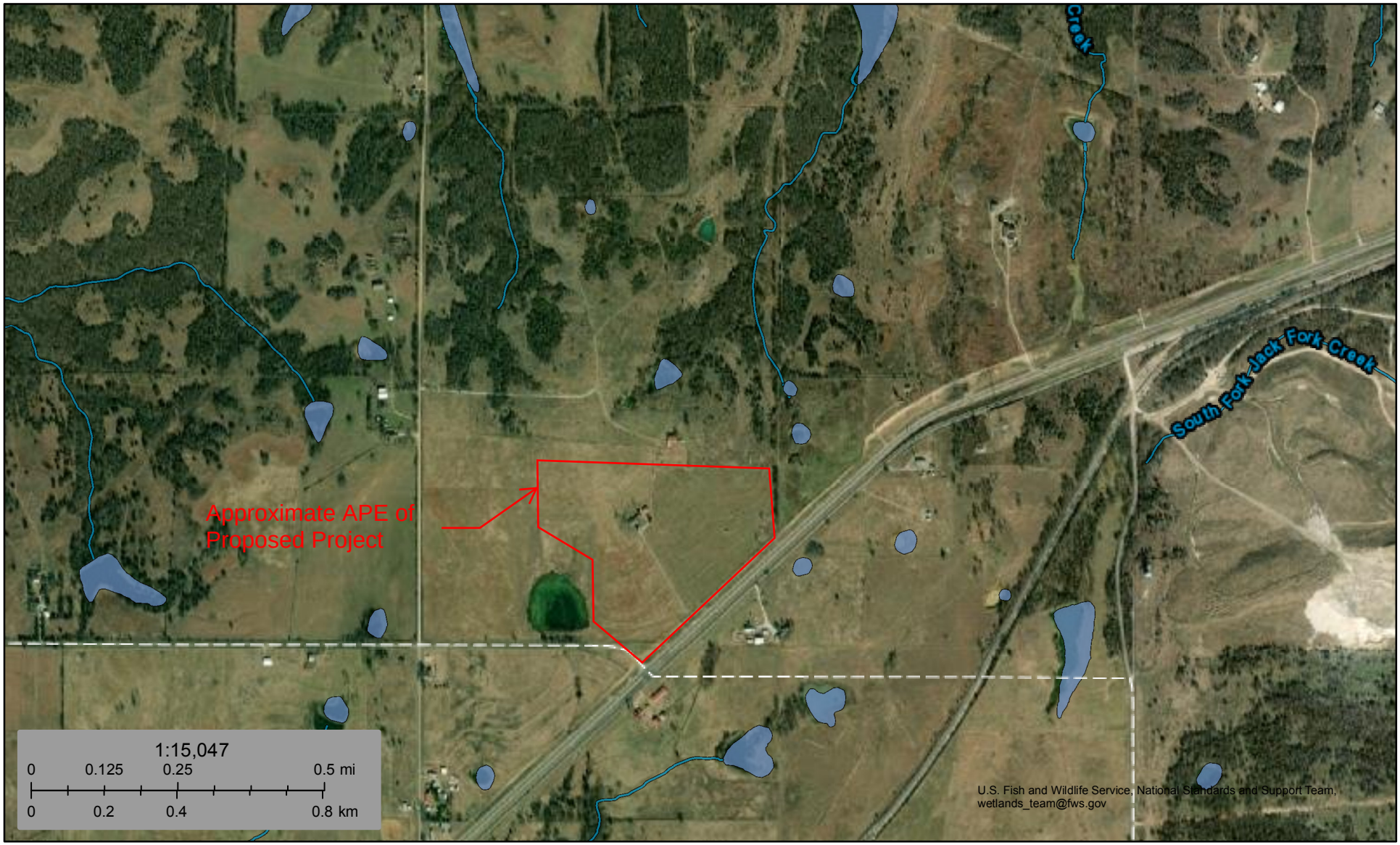
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/19/2022 at 2:55 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

U.S. Fish and Wildlife Service
National Wetlands Inventory

People's Electric Solar Facility: NWI Wetlar



October 19, 2022

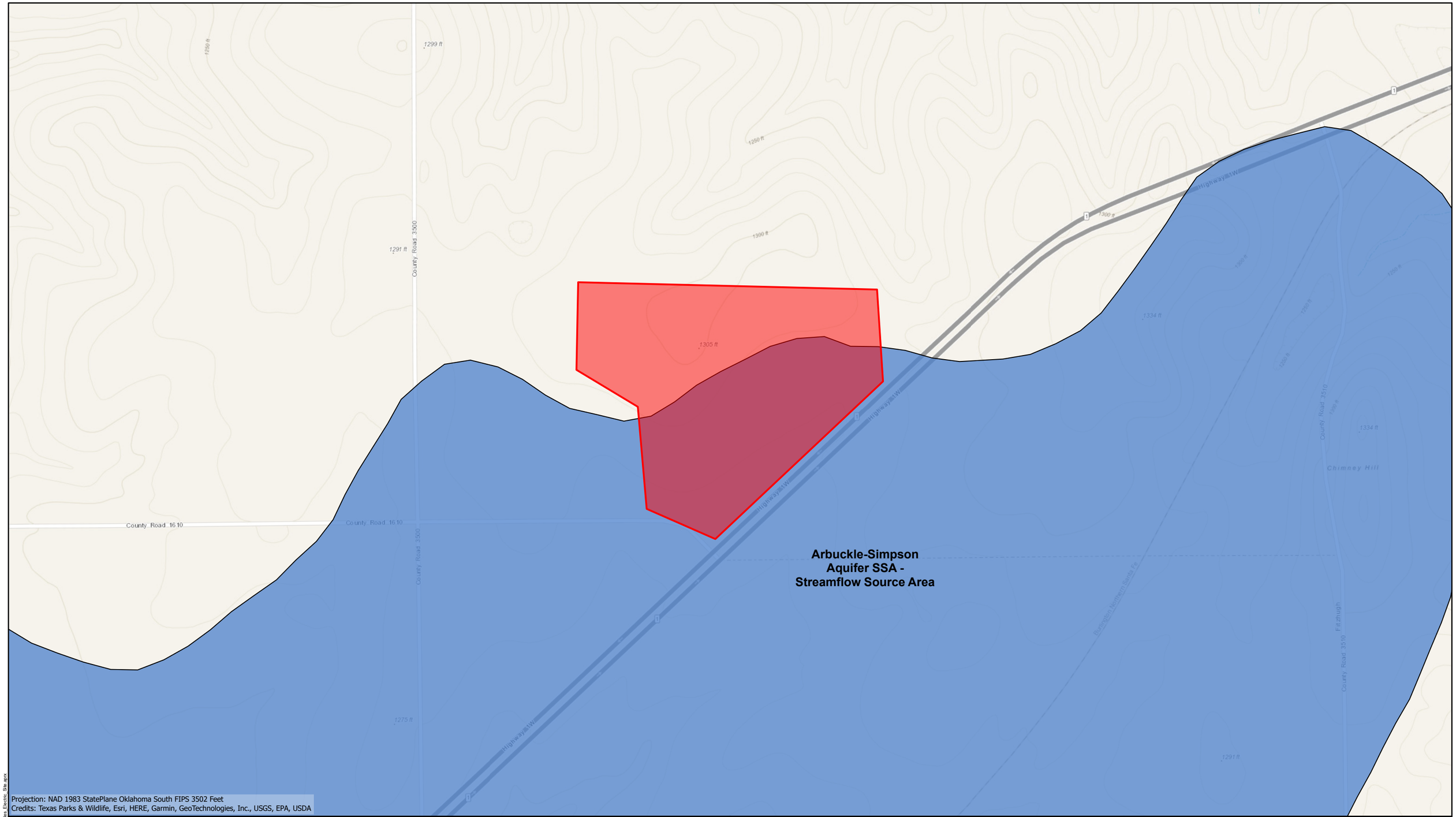
Wetlands

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

Appendix E



People's Electric Site

EPA Sole Source Aquifers (2019)

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www.tothassociates.com

Today's Power
Your Energy Partner

MAP BY: mbrown	DATE: 5/31/2022
APPD. BY: ALB	DATE: 05/31/2022

People's Electric Solar Facility

Map Title: Sole Source Aquifer Proximity	Map Number: MB-179 : 2
Client: TODAY'S POWER NORTH LITTLE ROCK, ARKANSAS PULASKI	0 500 Feet

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Appendix F

- Coastal Resources and Aquatic Habitats

There are no coastal resources or protected aquatic habitats in the region

Appendix G

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, OK 74129-1428
Phone: (918) 581-7458 Fax: (918) 581-7467

In Reply Refer To:
Project Code: 2022-0048939
Project Name: People's Electric Solar Facility

October 24, 2022

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological

evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see https://www.fws.gov/birds/policies-and-regulations.php.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/birds/policies-and-regulations/executive-orders/e0-13186.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds
- Wetlands

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, OK 74129-1428
(918) 581-7458

Project Summary

Project Code: 2022-0048939
Project Name: People's Electric Solar Facility
Project Type: New Constr - Above Ground
Project Description: The proposed project involves construction of a new electric generating facility and would require the physical disturbance of approximately 40 acres at a single site.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@34.6820831,-96.76861108924436,14z

Counties: Pontotoc County, Oklahoma

Endangered Species Act Species

There is a total of 9 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Tricolored Bat *Perimyotis subflavus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/10515	Proposed Endangered

Birds

NAME	STATUS
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened
Whooping Crane *Grus americana* Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/758	Endangered

Reptiles

NAME	STATUS
Alligator Snapping Turtle *Macrochelys temminckii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/4658	Proposed Threatened

Fishes

NAME	STATUS
Arkansas River Shiner *Notropis girardi* Population: Arkansas River Basin (AR, KS, NM, OK, TX) There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/4364	Threatened
Peppered Chub *Macrhybopsis tetranema* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/532	Endangered

Insects

NAME	STATUS
American Burying Beetle *Nicrophorus americanus* Population: Wherever found, except where listed as an experimental population No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/66	Threatened
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

---

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Chimney Swift *Chaetura pelagica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Mar 15 to Aug 25

Probability Of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season (▪)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

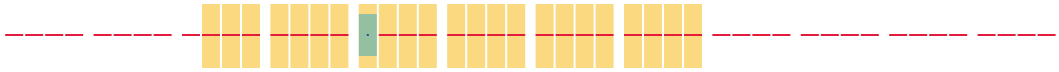
No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

▪ probability of presence ▪ breeding season | survey effort – no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

Chimney Swift
BCC Rangewide
(CON)



Additional information can be found using the following links:

- Birds of Conservation Concern https://www.fws.gov/program/migratory-birds/species
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf

Migratory Birds FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?
Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects
For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?
If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report
The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

THERE ARE NO WETLANDS WITHIN YOUR PROJECT AREA.

IPaC User Contact Information

Agency: Department of Agriculture
Name: Joseph Tuey
Address: 830 E. Primrose, Ste. 200
City: Springfield
State: MO
Zip: 65807
Email jtuey@tothassociates.com
Phone: 4178880645

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, OK 74129-1428
Phone: (918) 581-7458 Fax: (918) 581-7467

In Reply Refer To: October 24, 2022
Project code: 2022-0048939
Project Name: People's Electric Solar Facility

Subject: Consistency letter for 'People's Electric Solar Facility' project for a No Effect determination for the American burying beetle

Dear Joseph Tuey:

The U.S. Fish and Wildlife Service (Service) received on **October 24, 2022** your effect determination(s) for the 'People's Electric Solar Facility' (the Action) using the American burying beetle (*Nicrophorus americanus*) determination key within the Information for Planning and Consultation (IPaC) system.

The Service developed this system in accordance with the Endangered Species Act of 1973 (ESA) (87 Stat.884, as amended; 16 U.S.C. 1531 et seq.)
Based on your consideration of the Action and the assistance in the Service's American burying beetle determination key, you have determined that your proposed action will have No Effect on the American burying beetle.

Your agency has met consultation requirements for these species by informing the Service of your "no effect" determination. No further consultation for this project is required for the American burying beetle. This consistency letter confirms you may rely on effect determinations you reached by considering the American burying beetle DKey to satisfy agency consultation requirements under Section 7(a) (2) of the Endangered Species Act of 1973 (87 Stat. 884, as amended 16 U.S.C. 1531 et seq.; ESA).

Coordination with your local Ecological Services Office is complete for the American burying beetle. If your project may affect additional listed species, please contact your local Ecological Services Field Office for assistance with those species. Thank you for considering Federally-listed species during your project planning.

This letter covers only the American burying beetle. It **does not** apply to the following ESA-protected species that also may occur in the Action area:

- Alligator Snapping Turtle *Macrochelys temminckii* Proposed Threatened
- Arkansas River Shiner *Notropis girardi* Threatened

- Monarch Butterfly *Danaus plexippus* Candidate
- Peppered Chub *Macrhybopsis tetranema* Endangered
- Piping Plover *Charadrius melodus* Threatened
- Red Knot *Calidris canutus rufa* Threatened
- Tricolored Bat *Perimyotis subflavus* Proposed Endangered
- Whooping Crane *Grus americana* Endangered

If your project may affect additional listed species, you must evaluate additional DKeys for other species, or submit a request for consultation for the additional species to your local Ecological Services Field Office.

The Service recommends that your agency contact the Service or re-evaluate the project in IPaC if: 1) the scope or location of the proposed project is changed significantly, 2) new information reveals that the action may affect listed species or designated critical habitat; 3) the action is modified in a manner that causes effects to listed species or designated critical habitat; or 4) a new species is listed or critical habitat designated. If any of the above conditions occurs, additional consultation should take place before project changes are final or resources committed.

Action Description
You provided to IPaC the following name and description for the subject Action.

1. Name

People's Electric Solar Facility

2. Description

The following description was provided for the project 'People's Electric Solar Facility':

> The proposed project involves construction of a new electric generating facility and would require the physical disturbance of approximately 40 acres at a single site.

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@34.6820831,-96.76861108924436,14z

Qualification Interview

1. Is the action authorized, funded, or being carried out by a Federal agency?

   Yes

2. Have you determined that the proposed action will have “no effect” on the American burying beetle? (If you are unsure select "No")

   No

3. Will your activity **purposefully take** American burying beetles?

   No

4. Is your project wholly inside the 4d rule Analysis Area? For areas of your project occurring inside the Analysis Area (New England, Northern Plains, Southern Plains), your project may qualify for exemptions. For areas of your project occurring outside the Analysis Area, all incidental take is exempted according to the ABB 4d Rule.

   Automatically answered
   Yes

5. Is American burying beetle suitable habitat present within the action area?

   No

Project Questionnaire

Please select the activity that best matches your proposed action.

13. Other activities with soil disturbance - briefly describe below

If you chose 13 above, please describe below. If you did not choose 13 above, please type "0".

Installation of new Solar Facility

IPaC User Contact Information

Agency: Department of Agriculture
Name: Joseph Tuey
Address: 830 E. Primrose, Ste. 200
City: Springfield
State: MO
Zip: 65807
Email jtuey@tothassociates.com
Phone: 4178880645

/ Wildlife

THREATENED & ENDANGERED SPECIES

Below is a list of species in Oklahoma that are classified as Federally Endangered, Federally Threatened, State Endangered, or State Threatened.

ODWC Photo
Federally Threatened

American Burying Beetle

ODWC Photo
Federally Threatened

Arkansas River Shiner

ODWC Photo
State Threatened

Blackside Darter

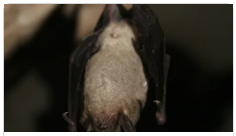


Photo by: Ann Froschauer/USFWS
Federally Endangered

Gray Bat

Photo by: Ann Froschauer/USFWS
Federally Endangered

Indiana Bat

Photo by: Richard Standage/USFS
Federally Threatened

Leopard Darter

Photo by: Michael Gatlin
State Endangered

Longnose Darter

Photo by: USFWS
Federally Threatened

Neosho Madtom

Photo by: Chris Barnhart/MSU
Federally Endangered

Neosho Mucket

Photo by: USFWS
Federally Threatened

Northern Long-eared Bat

THREATENED & ENDANGERED SPECIES

Below is a list of species in Oklahoma that are classified as Federally Endangered, Federally Threatened, State Endangered, or State Threatened.

Photo by: Dante Fenolio
State Endangered

Oklahoma Cave Crayfish

Photo by: Susan Rogers/USFWS
Federally Endangered

Ouachita Rock Pocketbook

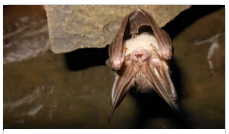


Photo by: USFWS
Federally Endangered

Ozark Big-eared Bat

Photo by: USFWS
Federally Threatened

Ozark Cavefish

Photo by: Matt Poole/USFWS
Federally Endangered

Piping Plover

Photo by: Matthew Patterson/USFWS
Federally Threatened

Rabbitsfoot

Photo by: John Maxwell/USFWS
Federally Endangered

Red-cockaded Woodpecker

Photo by: Gregory Breese/USFWS
Federally Threatened

Rufa Red Knot

Photo by: Andy Roberts/USFWS
Federally Endangered

Scaleshell

Photo by: John Noll/USDA
Federally Endangered

Whooping Crane

THREATENED & ENDANGERED SPECIES

Below is a list of species in Oklahoma that are classified as Federally Endangered, Federally Threatened, State Endangered, or State Threatened.

Photo by: Bernard Sietman/MDNR

Federally Endangered

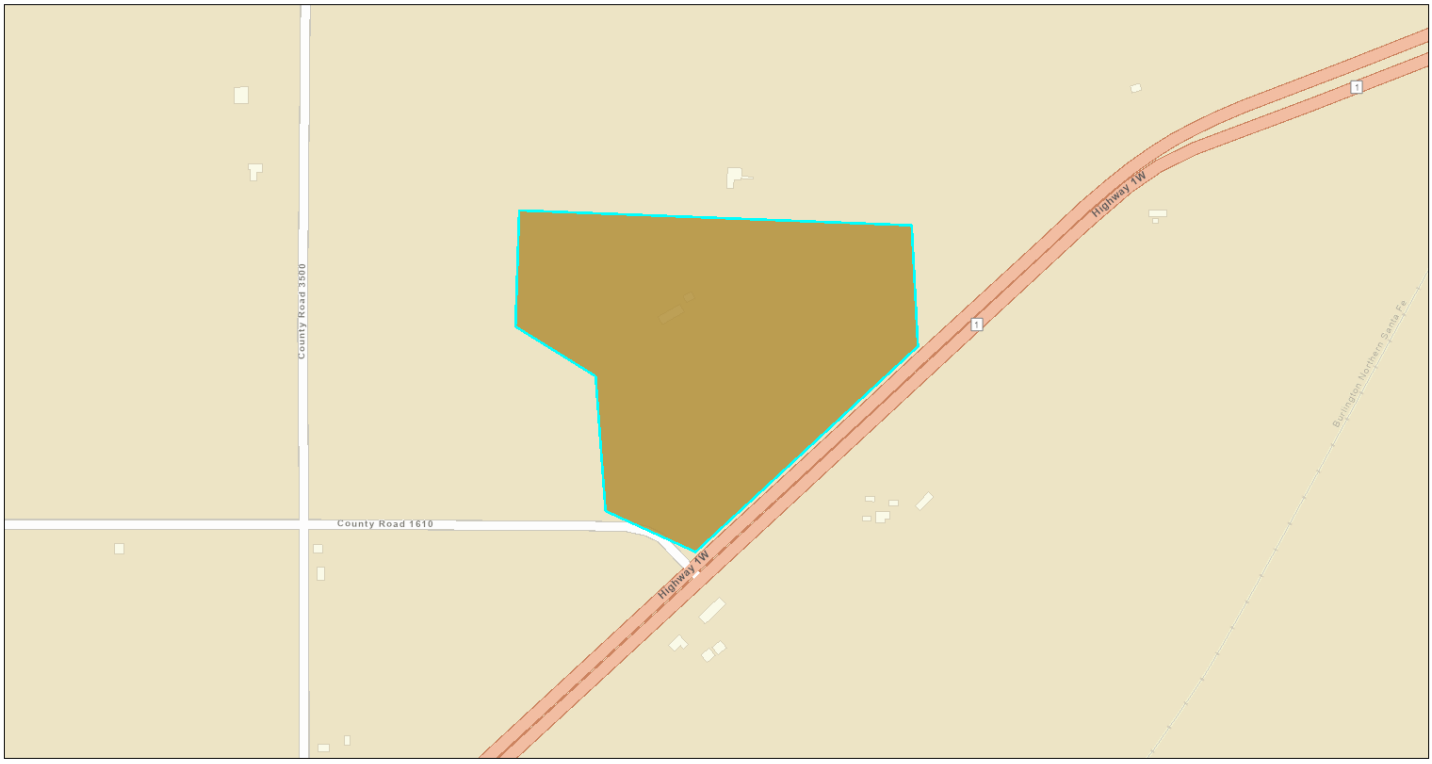
Winged Mapleleaf

« First ‹ Previous 1 2 3

Appendix H

NEPAssist Report

People's Electric Solar Facility:
Air Quality



February 9, 2023
Project 1
peoples_electric

1:5,733
0 0.05 0.1 0.2 mi
0 0.07 0.15 0.3 km

Input Coordinates: 34.683937,-96.766100,34.682497,-96.766010,34.680052,-96.769226,34.680539,-96.770529,34.682142,-96.770673,34.682733,-96.771831,34.684115,-96.771778,34.683937,-96.766100

Project Area	0.06 sq mi
Within an Ozone 8-hr (1997 standard) Non-Attainment/Maintenance Area?	no
Within an Ozone 8-hr (2008 standard) Non-Attainment/Maintenance Area?	no
Within a Lead (2008 standard) Non-Attainment/Maintenance Area?	no
Within a SO2 1-hr (2010 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 24hr (2006 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 Annual (1997 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 Annual (2012 standard) Non-Attainment/Maintenance Area?	no
Within a PM10 (1987 standard) Non-Attainment/Maintenance Area?	no
Within a Federal Land?	no
Within an impaired stream?	no
Within an impaired waterbody?	no
Within a waterbody?	no
Within a stream?	no
Within an NWI wetland?	Available Online
Within a Brownfields site?	no
Within a Superfund site?	no
Within a Toxic Release Inventory (TRI) site?	no
Within a water discharger (NPDES)?	no
Within a hazardous waste (RCRA) facility?	no
Within an air emission facility?	no

Within a school?	no
Within an airport?	no
Within a hospital?	no
Within a designated sole source aquifer?	yes
Within a historic property on the National Register of Historic Places?	no
Within a Toxic Substances Control Act (TSCA) site?	no
Within a Land Cession Boundary?	yes
Within a tribal area (lower 48 states)?	yes
Within the service area of a mitigation or conservation bank?	yes
Within the service area of an In-Lieu-Fee Program?	yes
Within a Public Property Boundary of the Formerly Used Defense Sites?	no
Within a Munitions Response Site?	no
Within an Essential Fish Habitat (EFH)?	no
Within a Habitat Area of Particular Concern (HAPC)?	no
Within an EFH Area Protected from Fishing (EFHA)?	no
Within a Bureau of Land Management Area of Critical Environmental Concern?	no
Within an ESA-designated Critical Habitat Area per U.S. Fish & Wildlife Service?	no
Within an ESA-designated Critical Habitat river, stream or water feature per U.S. Fish & Wildlife Service?	no

Created on: 2/9/2023 5:42:09 PM

Green Book Non-Attainment Areas:
People's Electric Solar Facility: Air Quality

common_c	states	common_n	o8_15npop	o8_15ncty	o8_15ncl	o8_15nnm	spl15_08	o8_08npop	o8_08ncty	o8_08ncl	o8_08nnm	splo8_08	pm2512npop	pm2512ncty	pm2512ncl	pm2512nnm	splpm2512	pm2506npop	pm2506ncty	pm2506ncl	pm2506nnm	splpm2506	pm2597npop	pm2597ncty	pm2597ncl	pm2597nnm	splpm2597	pm10_npop	pm10_ncty	pm10_ncl	pm10_nnm	splpm10	co_npop	co_ncty	co_ncl	co_nnm	splco	so210_npop	so210_ncty	so210_ncl	so210_nnm	splso210	so2_npop	so2_ncty	so2_ncl	so2_nnm	splso2	lead_npop	lead_ncty	lead_ncl	lead_nnm	spllead	lead8_npop	lead8_ncty	lead8_ncl	lead8_nnm	splled8	exportdt
2471	AK	Fairbanks	0	0			FALSE	0	0			FALSE	0	0			FALSE	87	1	Ser	Fairbanks,	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
2191	AZ	Douglas/Pa	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	17	1	Mod	Cochise Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3287	AZ	Hayden/Mi	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	11	2	Mod	Hayden, AZ	FALSE	0	0			FALSE	5	2	NonAtt	Hayden, AZ	FALSE	5	1	NonAtt	Hayden (Pi	FALSE	0	0			FALSE	5	2	NonAtt	Hayden, AZ	FALSE	1/31/2023
3287	AZ	Hayden/Mi	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	15	2	Mod	Miami, AZ	FALSE	0	0			FALSE	15	1	NonAtt	Miami, AZ	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
04023	AZ	Nogales	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	30	1	Mod	Santa Cruz	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6201	AZ	Phoenix-M	3945	3	Mod	Phoenix-M	FALSE	3850	2	Mod	Phoenix-M	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	3853	2	Ser	Maricopa a	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6771	AZ	Rillito (Pim	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1	1	Mod	Pima Coun	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
04020	AZ	West Pinal	0	0			FALSE	0	0			FALSE	0	0			FALSE	52	1	Mod	West Centr	FALSE	0	0			FALSE	283	1	Ser	Pinal Coun	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
9360	AZ	Yuma	87	1	Mar	Yuma, AZ	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	101	1	Mod	Yuma, AZ	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
0317	CA	Amador an	46	1	Mar	Calaveras (	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
0317	CA	Amador an	38	1	Mar	Amador Co	FALSE	46	1	Mar	Calaveras (	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1621	CA	Chico	220	1	Mar	Butte Coun	FALSE	220	1	Mar	Chico (Butt	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3471	CA	Imperial Co	175	1	Mar	Imperial Co	FALSE	175	1	Mod	Imperial Co	FALSE	154	1	Mod	Imperial Co	FALSE	154	1	Mod	Imperial Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4482	CA	Los Angele	15703	4	Ext	Los Angele	FALSE	15719	4	Ext	Los Angele	FALSE	15716	4	Ser	Los Angele	FALSE	15716	4	Ser	Los Angele	FALSE	15716	4	Mod	Los Angele	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	9437	1	NonAtt	Los Angele	FALSE	1/31/2023
4482	CA	Los Angele	1	1	Ser	Morongo B	FALSE	1	1	Sev5	Morongo B	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4482	CA	Los Angele	1	2	Mod	Pechanga I	FALSE	3	2	Mod	Pechanga I	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4831	CA	Mariposa a	55	1	Mar	Tuolumne (	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4831	CA	Mariposa a	18	1	Mod	Mariposa C	FALSE	18	1	Mod	Mariposa C	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
06051	CA	Mono Cour	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	Mod	Mono Basi	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5389	CA	Nevada Co	82	1	Ser	Nevada Co	FALSE	82	1	Ser	Nevada Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5991	CA	Owens Val	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	7	1	Ser	Inyo Count	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
06063	CA	Plumas Co	0	0			FALSE	0	0			FALSE	6	1	Ser	Plumas Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6921	CA	Sacrament	2240	6	Ser	Sacrament	FALSE	2241	6	Sev5	Sacrament	FALSE	0	0			FALSE	2206	5	Mod	Sacrament	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7320	CA	San Diego	3077	1	Sev5	San Diego	FALSE	3095	1	Sev5	San Diego	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7361	CA	San Franci	6969	9	Mar	San Franci	FALSE	6973	9	Mar	San Franci	FALSE	0	0			FALSE	6971	9	Mod	San Franci	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7381	CA	San Joaqui	95	1	Ser	Kern Count	FALSE	95	1	Sev5	Kern Count	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7381	CA	San Joaqui	3842	8	Ext	San Joaqui	FALSE	3842	8	Ext	San Joaqui	FALSE	3842	8	Ser	San Joaqui	FALSE	3842	8	Ser	San Joaqui	FALSE	3842	8	Ser	San Joaqu	FALSE	126	1	Ser	East Kern (	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7390	CA	San Luis O	1	1	Mar	San Luis O	FALSE	2	1	Mar	San Luis O	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7581	CA	Searles Va	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	4	1	Mod	Trona, CA	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7811	CA	Southeast I	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	258	1	Ser	Riverside C	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7811	CA	Southeast I	425	1	Sev5	Riverside C	FALSE	426	1	Sev5	Riverside C	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	237	1	Mod	San Bernar	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7811	CA	Southeast I	867	2	Sev5	Los Angele	FALSE	868	2	Sev5	Los Angele	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
06103	CA	Tuscan Bu	0	1	Mar	Tuscan Bu	FALSE	0	1	Mar	Tuscan Bu	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
06111	CA	Ventura Co	821	1	Ser	Ventura Co	FALSE	823	1	Ser	Ventura Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
9340	CA	Yuba City	0	1	Mar	Sutter Butt	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
2081	CO	Denver-Bo	3331	9	Mod	Denver Me	FALSE	3330	9	Sev5	Denver-Bo	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3045	CT	Greater Co	1629	5	Mod	Greater Co	FALSE	1629	5	Ser	Greater Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
8842	DC-MD-VA	Washingto	5136	15	Mod	Washingto	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
0520	GA	Atlanta	3669	7	Mar	Atlanta, GA	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3390	GU	Piti-Cabras	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	6	1	NonAtt	Piti-Cabras	FALSE	1	1	NonAtt	Piti, GU	FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
66011	GU	Tanguisson	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1	1	NonAtt	Tanguisson	FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
19139	IA	Muscatine (	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	30	1	NonAtt	Muscatine,	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6351	ID	Pocatello	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1	2	Mod	Power-Ban	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1602	IL-IN-WI	Chicago-Jo	9075	11	Mod	Chicago, IL	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4220	IN	Fort Wayne	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	21	1	NonAtt	Huntington	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7115	KS	Salina	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	Saline Cou	FALSE	1/31/2023
1850	KY	Henderson	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	7	2	NonAtt	Henderson	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4520	KY-IN	Louisville	1061	5	Mod	Louisville, I	TRUE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4650	LA	Evangeline	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	Evangeline	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5560	LA	New Orlea	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	36	1	NonAtt	St. Bernarc	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1122	MA-NH	Boston-Wo	0	0			FALSE	17	1	Mar	Dukes Cou	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
0720	MD	Baltimore	2663	6	Mod	Baltimore, I	FALSE	2663	6	Mod	Baltimore, I	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	990	2	NonAtt	Anne Arun	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
26005	MI	Allegan Co	47	1	Mod	Allegan Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
0870	MI	Benton Ha	157	1	Mod	Berrien Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
2162	MI	Detroit-Ann	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	52	1	NonAtt	St. Clair, M	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
2162	MI	Detroit-Ann	4705	7	Mar	Detroit, MI	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	254	1	NonAtt	Detroit, MI	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5320	MI	Muskegon	147	1	Mod	Muskegon	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5121	MN	Minneapoli	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	9	1	NonAtt	Eagan, MN	FALSE	1/31/2023
3505	MO	Iron, Dent,	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	3	NonAtt	Iron, Dent,	FALSE	1/31/2023
1851	MO	New Madri	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	New Madri	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7040	MO-IL	St. Louis	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	Alton Town	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7040	MO-IL	St. Louis	2488	8	Mod	St. Louis, M	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	3	1	NonAtt	Jefferson C	FALSE	5	1	NonAtt	Jefferson C	FALSE	1/31/2023
0880	MT	Billings/Lau	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	7	1	NonAtt	Laurel Area	FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
30087	MT	Lame Deer	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1	1	Mod	Rosebud C	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4311	MT	Libby	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	9	1	Mod	Libby, MT	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6355	MT	Polson (La	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	4	1	Mod	Lake Coun	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6905	MT	Ronan (La	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	3	1	Mod	Lake Coun	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4121	NV	Las Vegas	1892	1	Mod	Las Vegas,	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3610	NY	Jamestown	0	0			FALSE	135	1	Mar	Jamestown	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1852	NY	St. Lawren	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	12	1	NonAtt	St. Lawren	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5601	NY-NJ-CT	New York-N	20217	24	Mod	New York-N	FALSE	20217	24	Sev5	New York-N	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1586	1	Mod	New York (	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1681	OH	Cleveland-	2780	7	Mod	Cleveland,	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1642	OH-KY-IN	Cincinnati-	1929	7	Mod	Cincinnati,	TRUE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3816	OR	Klamath Fa	0	0			FALSE	0	0			FALSE	0	0			FALSE	47	1	Mod	Klamath Fa	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1674	PA	Clearfield a	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	93	2	NonAtt	Indiana, PA	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
4000	PA	Lancaster	0	0			FALSE	519	1	Mar	Lancaster,	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6281	PA	Pittsburgh-	0	0			FALSE	2356	7	Mar	Pittsburgh-	FALSE	1223	1	Mod	Allegheny (	FALSE	21	1	Mod	Liberty-Cla	FALSE	21	1	Mod	Liberty-Cla	FALSE	0	0			FALSE	0	0			FALSE	15	1	NonAtt	Beaver, PA	FALSE	0	0			FALSE	0	0			FALSE	18	1	NonAtt	Lower Bea	FALSE	1/31/2023
6281	PA	Pittsburgh-	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	127	1	NonAtt	Allegheny,	FALSE	5	1	NonAtt	Armstrong	FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6680	PA	Reading	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	29	1	NonAtt	North Reac	FALSE	1/31/2023
6680	PA	Reading	0	0			FALSE	411	1	Mar	Reading, P	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	19	1	NonAtt	Lyons, PA	FALSE	1/31/2023
42123	PA	Warren Co	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	18	1	NonAtt	Warren, PA	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
0241	PA-NJ	Allentown-B	0	0			FALSE	712	3	Mar	Allentown-B	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	109	1	NonAtt	Warren Co	FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6161	PA-NJ-DE-	Philadelphi	0	0			FALSE	197	1	Mar	Seaford, D	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6161	PA-NJ-DE-	Philadelphi	7437	16	Mod	Philadelphi	FALSE	7437	16	Mar	Philadelphi	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
470	PR	Arecibo	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	32	1	NonAtt	Arecibo, PR	FALSE	1/31/2023
4660	PR	Guayama-S	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	23	1	NonAtt	Guayama-S	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1200	PR	San Juan	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	275	5	NonAtt	San Juan,	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3661	TN	Johnson Ci	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	15	1	NonAtt	Sullivan Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1921	TX	Dallas-Fort	6202	9	Mod	Dallas-Fort	FALSE	6280	10	Sev5	Dallas-Fort	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
2475	TX	Fairfield	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	4	2	NonAtt	Freestone	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
3361	TX	Houston-Ga	5773	6	Mod	Houston-Ga	FALSE	5892	8	Sev5	Houston-G	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1853	TX	Howard Co	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	Howard Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1854	TX	Hutchinson	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	15	1	NonAtt	Hutchinson	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5265	TX	Mount Plea	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	Titus Coun	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1855	TX	Navarro Co	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	2	1	NonAtt	Navarro Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1832	TX	San Antoni	1715	1	Mod	San Antoni	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
8295	TX	Tatum	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	2	2	NonAtt	Rusk and P	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
2321	TX-NM	El Paso-La	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	3	1	Mod	Dona Ana (	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
2321	TX-NM	El Paso-La	813	2	Mar	El Paso-La	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	649	1	Mod	El Paso Co	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6521	UT	Provo	516	1	Mar	Southern W	FALSE	0	0			FALSE	0	0			FALSE	518	1	Ser	Provo, UT	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7161	UT	Salt Lake C	1616	4	Mod	Northern W	FALSE	0	0			FALSE	0	0			FALSE	1665	5	Ser	Salt Lake C	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1030	1	NonAtt	Salt Lake C	FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
49045	UT	Tooele Cou	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	58	1	NonAtt	Tooele Cou	FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1762	UT	Uinta Basin	47	2	Mar	Uinta Basin	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1856	VA	Giles Coun	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	Giles Coun	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
1857	WA	Whatcom C	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	1	NonAtt	Whatcom C	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
5081	WI	Milwaukee-	1648	5	Mod	Milwaukee,	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
7620	WI	Sheboygan	68	1	Mod	Sheboygan	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
6020	WV-OH	Parkersbur	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	4	2	NonAtt	Muskingum	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023
8600	WY	Upper Gree	0	0			FALSE	11	3	Mar	Upper Gree	FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	0	0			FALSE	1/31/2023

Appendix I

EJScreen Report (Version 2.1)

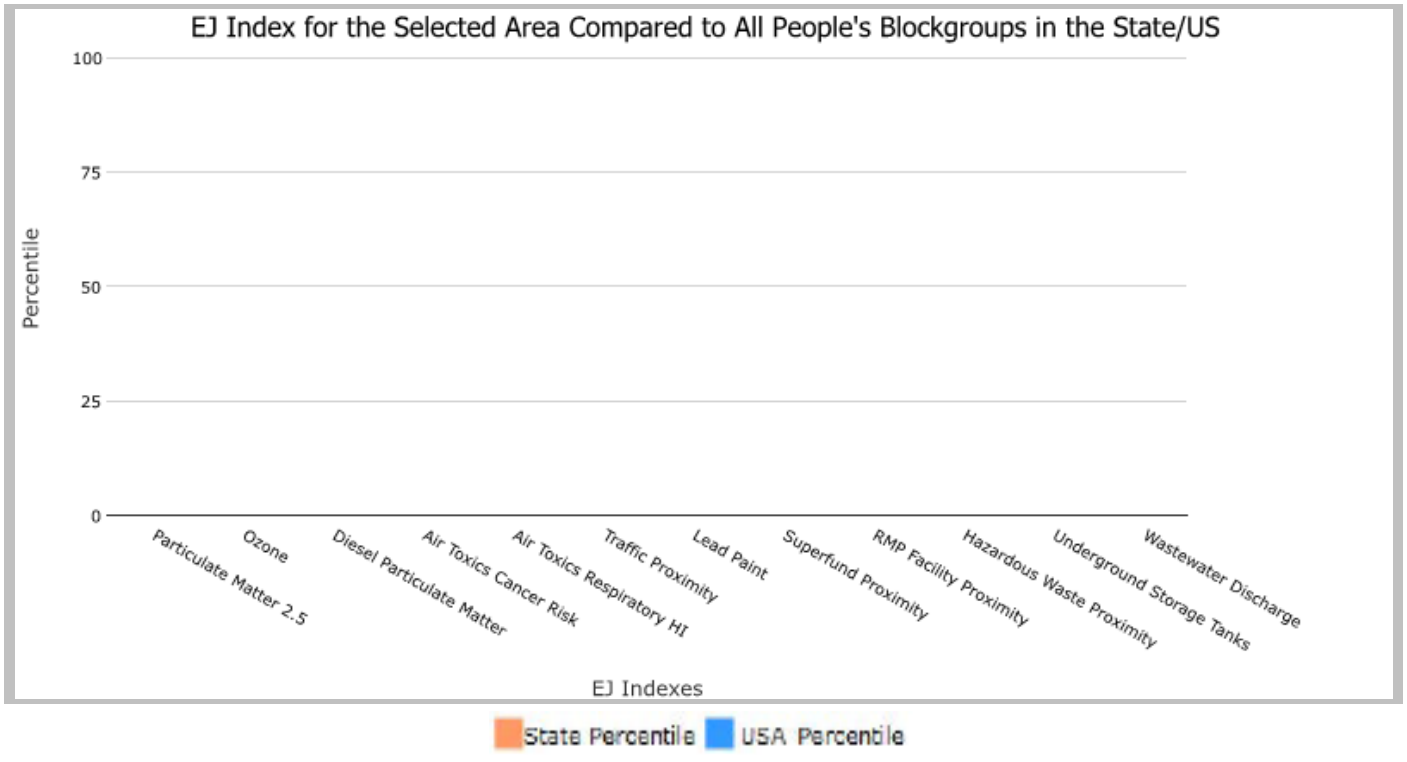
the User Specified Area, OKLAHOMA, EPA Region 6

Approximate Population: 0

Input Area (sq. miles): 0.06

People

Selected Variables	State Percentile	USA Percentile
Environmental Justice Indexes		
EJ Index for Particulate Matter 2.5	N/A	N/A
EJ Index for Ozone	N/A	N/A
EJ Index for Diesel Particulate Matter*	N/A	N/A
EJ Index for Air Toxics Cancer Risk*	N/A	N/A
EJ Index for Air Toxics Respiratory HI*	N/A	N/A
EJ Index for Traffic Proximity	N/A	N/A
EJ Index for Lead Paint	N/A	N/A
EJ Index for Superfund Proximity	N/A	N/A
EJ Index for RMP Facility Proximity	N/A	N/A
EJ Index for Hazardous Waste Proximity	N/A	N/A
EJ Index for Underground Storage Tanks	N/A	N/A
EJ Index for Wastewater Discharge	N/A	N/A



This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

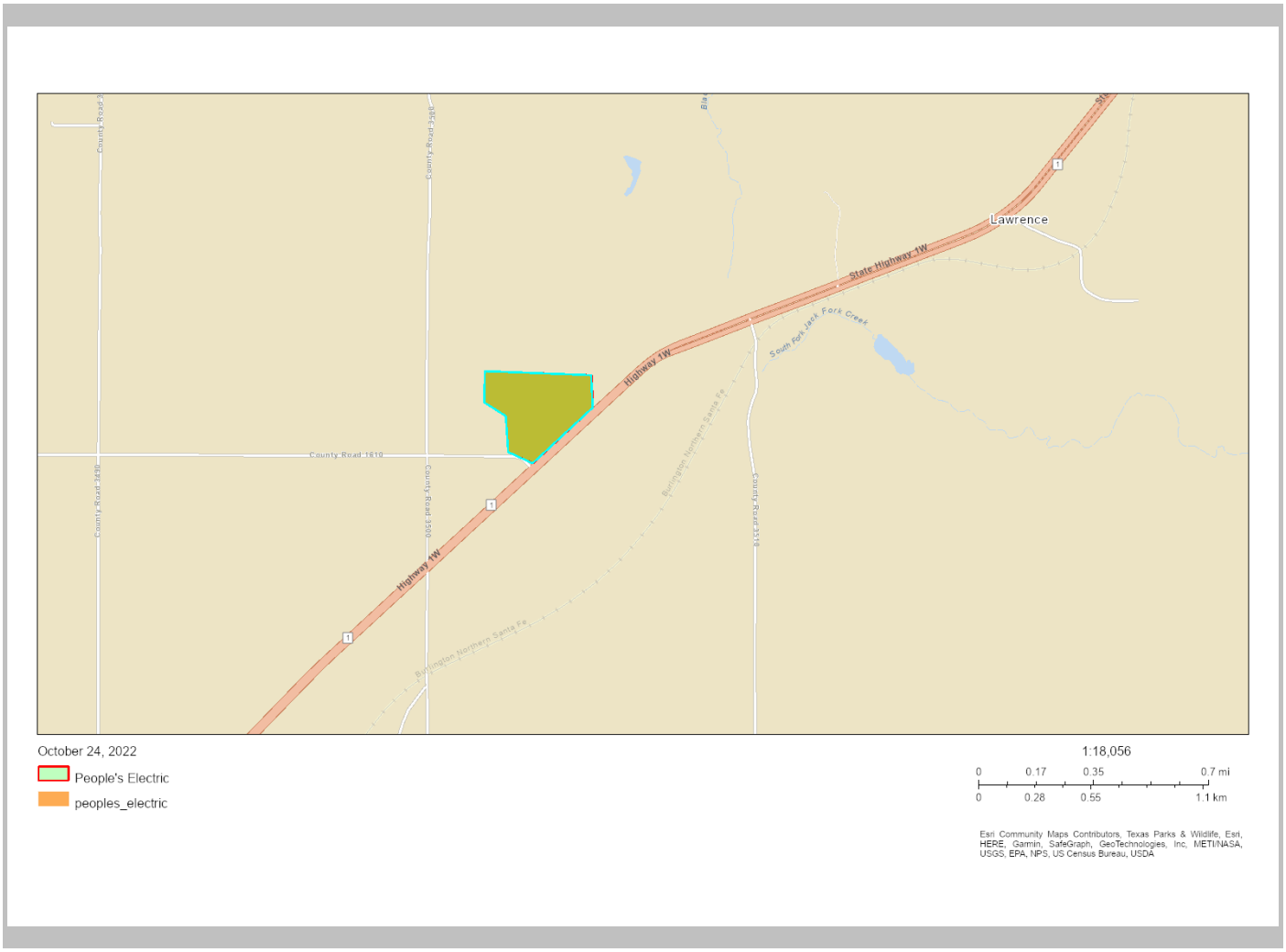
EJScreen Report (Version 2.1)

the User Specified Area, OKLAHOMA, EPA Region 6

Approximate Population: 0

Input Area (sq. miles): 0.06

People's Electric Solar Facility: Socio-economic and Environmental Justice



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	0

EJScreen Report (Version 2.1)

the User Specified Area, OKLAHOMA, EPA Region 6

Approximate Population: 0

Input Area (sq. miles): 0.06

People's Electric Solar Facility: Socio-economic and Environmental Justice

Selected Variables	Value	State Avg.	%ile in State	USA Avg.	%ile in USA
Pollution and Sources					
Particulate Matter 2.5 (µg/m^3)	N/A	9.64	N/A	8.67	N/A
Ozone (ppb)	N/A	46	N/A	42.5	N/A
Diesel Particulate Matter* (µg/m^3)	N/A	0.201	N/A	0.294	N/A
Air Toxics Cancer Risk* (lifetime risk per million)	N/A	29	N/A	28	N/A
Air Toxics Respiratory HI*	N/A	0.39	N/A	0.36	N/A
Traffic Proximity (daily traffic count/distance to road)	N/A	250	N/A	760	N/A
Lead Paint (% Pre-1960 Housing)	N/A	0.23	N/A	0.27	N/A
Superfund Proximity (site count/km distance)	N/A	0.047	N/A	0.13	N/A
RMP Facility Proximity (facility count/km distance)	N/A	0.59	N/A	0.77	N/A
Hazardous Waste Proximity (facility count/km distance)	N/A	0.87	N/A	2.2	N/A
Underground Storage Tanks (count/km^2)	N/A	1.7	N/A	3.9	N/A
Wastewater Discharge (toxicity-weighted concentration/m distance)	N/A	0.088	N/A	12	N/A
Socioeconomic Indicators					
Demographic Index	N/A	36%	N/A	35%	N/A
People of Color	N/A	35%	N/A	40%	N/A
Low Income	N/A	36%	N/A	30%	N/A
Unemployment Rate	N/A	5%	N/A	5%	N/A
Limited English Speaking Households	N/A	2%	N/A	5%	N/A
Less Than High School Education	N/A	11%	N/A	12%	N/A
Under Age 5	N/A	7%	N/A	6%	N/A
Over Age 64	N/A	16%	N/A	16%	N/A

*Diesel particular matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

For additional information, see: www.epa.gov/environmentaljustice

United States Census Bureau

QuickFacts

Pontotoc County, Oklahoma

QuickFacts provides statistics for all states and counties, and for cities and towns with a ***population of 5,000 or more***.

Table

PEOPLE	
Population	
Population Estimates, July 1 2021, (V2021)	**38,163**
Population estimates base, April 1, 2020, (V2021)	38,065
Population, percent change - April 1, 2020 (estimates base) to July 1, 2021, (V2021)	0.3%
Population, Census, April 1, 2020	38,065
Population, Census, April 1, 2010	37,492
Age and Sex	
Persons under 5 years, percent	6.6%
Persons under 18 years, percent	24.4%
Persons 65 years and over, percent	16.5%
Female persons, percent	51.4%
Race and Hispanic Origin	
White alone, percent	66.8%
Black or African American alone, percent (a)	2.4%
American Indian and Alaska Native alone, percent (a)	21.2%
Asian alone, percent (a)	1.0%
Native Hawaiian and Other Pacific Islander alone, percent (a)	0.1%
Two or More Races, percent	8.6%
Hispanic or Latino, percent (b)	6.2%
White alone, not Hispanic or Latino, percent	62.9%
Population Characteristics	
Veterans, 2016-2020	2,059
Foreign born persons, percent, 2016-2020	1.9%
Housing	
Housing units, July 1, 2021, (V2021)	17,508
Owner-occupied housing unit rate, 2016-2020	65.2%
Median value of owner-occupied housing units, 2016-2020	$134,700
Median selected monthly owner costs -with a mortgage, 2016-2020	$1,140
Median selected monthly owner costs -without a mortgage, 2016-2020	$372
Median gross rent, 2016-2020	$730
Building permits, 2021	19
Families & Living Arrangements	
Households, 2016-2020	14,234
Persons per household, 2016-2020	2.59
Living in same house 1 year ago, percent of persons age 1 year+, 2016-2020	86.4%
Language other than English spoken at home, percent of persons age 5 years+, 2016-2020	4.5%
Computer and Internet Use	
Households with a computer, percent, 2016-2020	89.6%
Households with a broadband Internet subscription, percent, 2016-2020	71.7%
Education	
High school graduate or higher, percent of persons age 25 years+, 2016-2020	89.3%
Bachelor's degree or higher, percent of persons age 25 years+, 2016-2020	28.8%
Health	
With a disability, under age 65 years, percent, 2016-2020	11.3%
Persons without health insurance, under age 65 years, percent	21.0%

All Topics

Population Estimates, July 1 2021, (V2021)

Economy	
In civilian labor force, total, percent of population age 16 ye	
In civilian labor force, female, percent of population age 16	
Total accommodation and food services sales, 2017 ($1,000) (c)	68,356
Total health care and social assistance receipts/revenue, 2017 ($1,000) (c)	476,956
Total transportation and warehousing receipts/revenue, 2017 ($1,000) (c)	96,160
Total retail sales, 2017 ($1,000) (c)	465,191
Total retail sales per capita, 2017 (c)	$12,131
Transportation	
Mean travel time to work (minutes), workers age 16 years+, 2016-2020	17.8
Income & Poverty	
Median household income (in 2020 dollars), 2016-2020	$51,682
Per capita income in past 12 months (in 2020 dollars), 2016-2020	$27,038
Persons in poverty, percent	⚠ 14.4%

BUSINESSES

Businesses	
Total employer establishments, 2020	951
Total employment, 2020	13,497
Total annual payroll, 2020 ($1,000)	540,840
Total employment, percent change, 2019-2020	-4.1%
Total nonemployer establishments, 2019	2,789
All employer firms, Reference year 2017	889
Men-owned employer firms, Reference year 2017	431
Women-owned employer firms, Reference year 2017	S
Minority-owned employer firms, Reference year 2017	118
Nonminority-owned employer firms, Reference year 2017	584
Veteran-owned employer firms, Reference year 2017	41
Nonveteran-owned employer firms, Reference year 2017	642

GEOGRAPHY

Geography	
Population per square mile, 2020	52.8
Population per square mile, 2010	52.0
Land area in square miles, 2020	720.41
Land area in square miles, 2010	720.44
FIPS Code	40123

About datasets used in this table

Value Notes

⚠ Estimates are not comparable to other geographic levels due to methodology differences that may exist between different data sources.

Some estimates presented here come from sample data, and thus have sampling errors that may render some apparent differences between geographies statistically indistinguishable. Click the Quick Info ⓘ icon to th row in TABLE view to learn about sampling error.

The vintage year (e.g., V2021) refers to the final year of the series (2020 thru 2021). Different vintage years of estimates are not comparable.

Users should exercise caution when comparing 2016-2020 ACS 5-year estimates to other ACS estimates. For more information, please visit the 2020 5-year ACS Comparison Guidance page.

Fact Notes

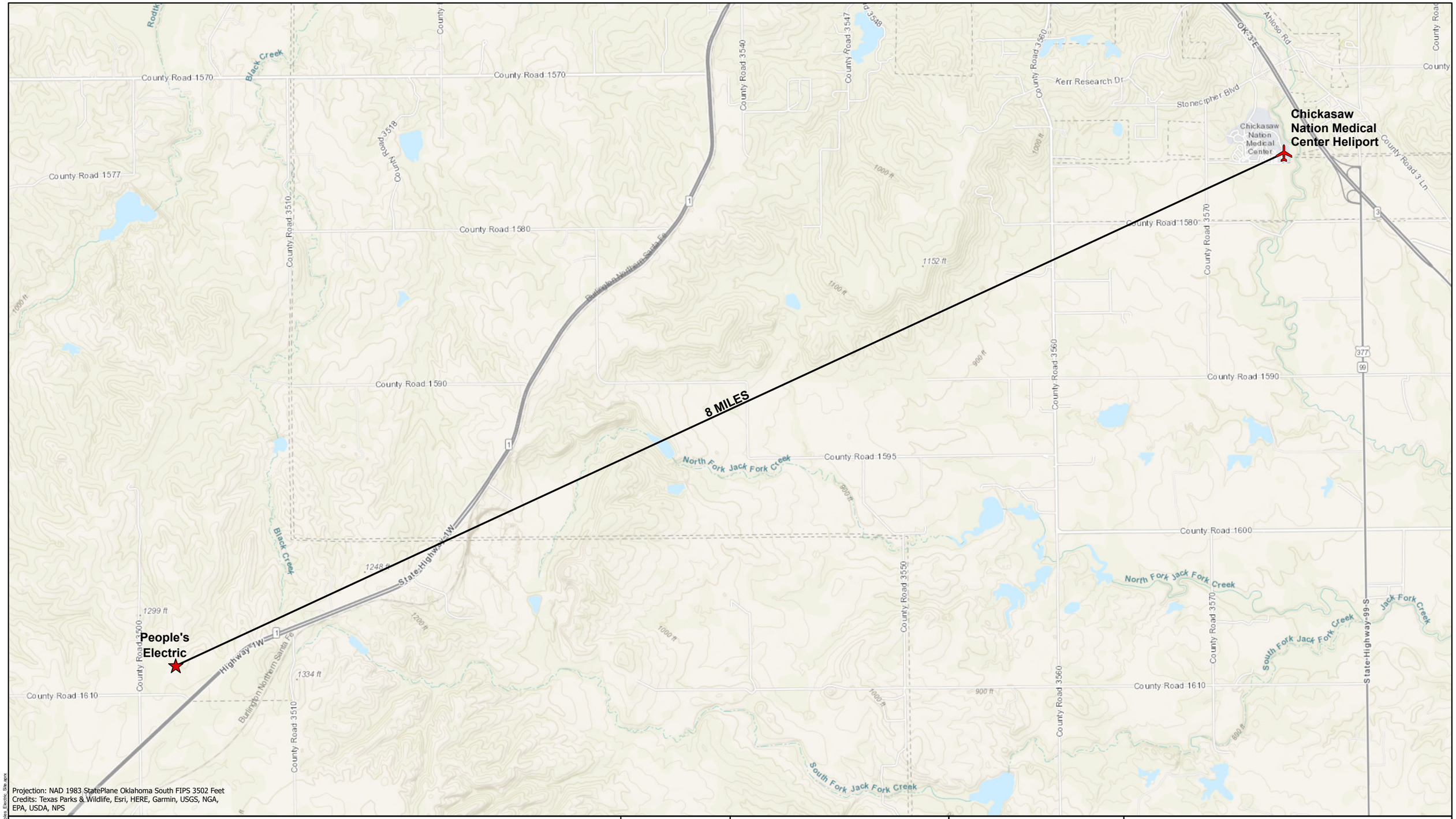
(a) Includes persons reporting only one race
(c) Economic Census - Puerto Rico data are not comparable to U.S. Economic Census data
(b) Hispanics may be of any race, so also are included in applicable race categories

Value Flags

- Either no or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest or upper in open ended distribution.
F Fewer than 25 firms
D Suppressed to avoid disclosure of confidential information
N Data for this geographic area cannot be displayed because the number of sample cases is too small.
FN Footnote on this item in place of data
X Not applicable
S Suppressed; does not meet publication standards
NA Value greater than zero but less than half unit of measure shown
Z Value greater than zero but less than half unit of measure shown

QuickFacts data are derived from: Population Estimates, American Community Survey, Census of Population and Housing, Current Population Survey, Small Area Health Insurance Estimates, Small Area Income and P Estimates, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits.

Appendix J



People's Electric Site

Airport

Distance

TOTH & ASSOCIATES
1550 E REPUBLIC RD
SPRINGFIELD, MO 65804
Ph. 417-888-0645 Fax: 417-888-0657
www.tothassociates.com

Today's Power
Your Energy Partner

MAP BY: mbrown	DATE: 4/29/2022
APPD. BY: ALB	DATE: 05/31/2022

People's Electric Solar Facility

Map Title: Airport Proximity	Map Number: MB-179 : 3
Client: TODAY'S POWER NORTH LITTLE ROCK, ARKANSAS PULASKI	0 3,000 Feet

O:\Today's Power\GIS\ArcGIS Pro\RUS Maps\Peoples Electric_Site.aprx

Title 14

§ 77.9 Construction or alteration requiring notice.

If requested by the FAA, or if you propose any of the following types of construction or alteration, you must file notice with the FAA of:

(a) Any construction or alteration that is more than 200 ft. AGL at its site.

(b) Any construction or alteration that exceeds an imaginary surface extending outward and upward at any of the following slopes:

(1) 100 to 1 for a horizontal distance of 20,000 ft. from the nearest point of the nearest runway of each airport described in paragraph (d) of this section with its longest runway more than 3,200 ft. in actual length, excluding heliports.

(2) 50 to 1 for a horizontal distance of 10,000 ft. from the nearest point of the nearest runway of each airport described in paragraph (d) of this section with its longest runway no more than 3,200 ft. in actual length, excluding heliports.

(3) 25 to 1 for a horizontal distance of 5,000 ft. from the nearest point of the nearest landing and takeoff area of each heliport described in paragraph (d) of this section.

(c) Any highway, railroad, or other traverse way for mobile objects, of a height which, if adjusted upward 17 feet for an Interstate Highway that is part of the National System of Military and Interstate Highways where overcrossings are designed for a minimum of 17 feet vertical distance, 15 feet for any other public roadway, 10 feet or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road, 23 feet for a railroad, and for a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it, would exceed a standard of paragraph (a) or (b) of this section.

(d) Any construction or alteration on any of the following airports and heliports:

(1) A public use airport listed in the Airport/Facility Directory, Alaska Supplement, or Pacific Chart Supplement of the U.S. Government Flight Information Publications;

(2) A military airport under construction, or an airport under construction that will be available for public use;

(3) An airport operated by a Federal agency or the DOD.

(4) An airport or heliport with at least one FAA-approved instrument approach procedure.

(e) You do not need to file notice for construction or alteration of:

(1) Any object that will be shielded by existing structures of a permanent and substantial nature or by natural terrain or topographic features of equal or greater height, and will be located in the congested area of a city, town, or settlement where the shielded structure will not adversely affect safety in air navigation;

(2) Any air navigation facility, airport visual approach or landing aid, aircraft arresting device, or meteorological device meeting FAA-approved siting criteria or an appropriate military service siting criteria on military airports, the location and height of which are fixed by its functional purpose;

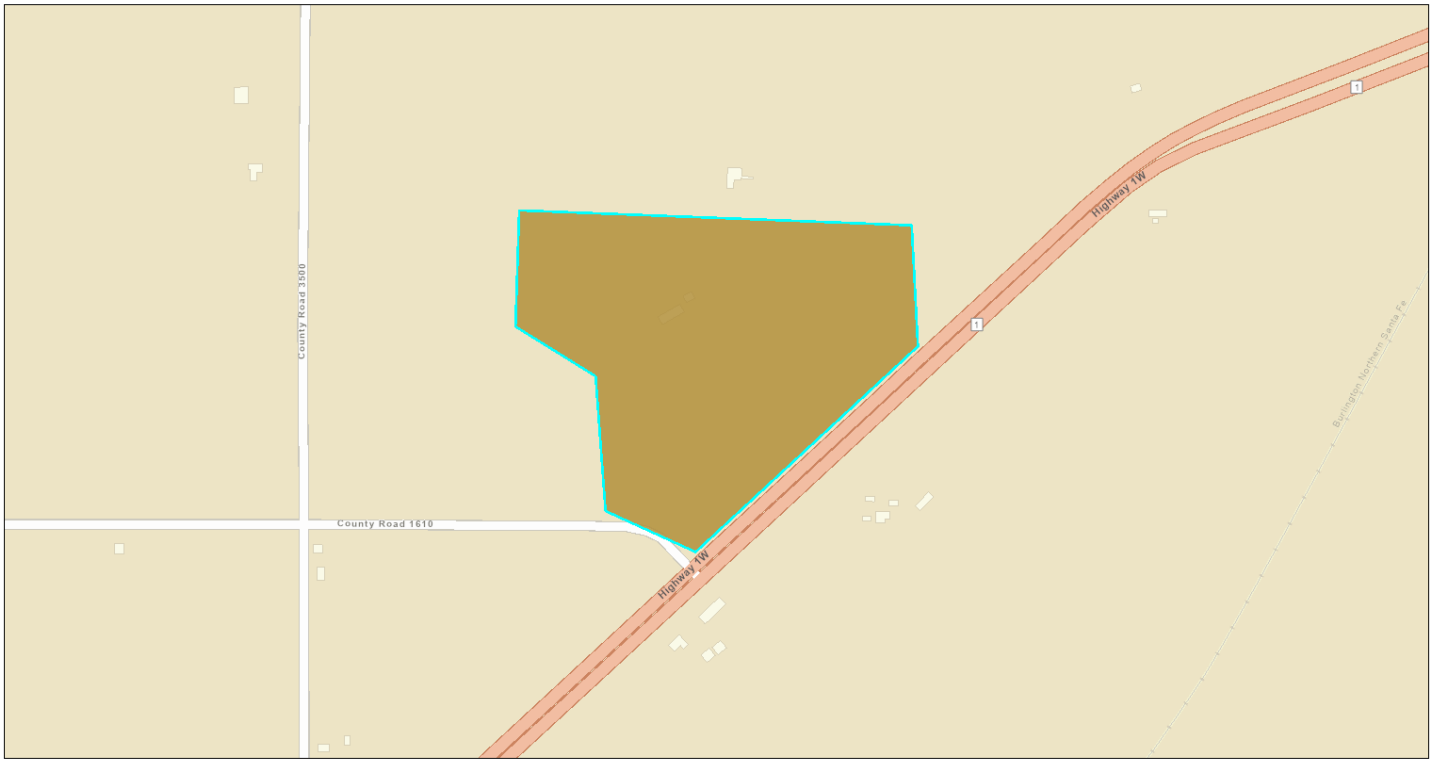
(3) Any construction or alteration for which notice is required by any other FAA regulation.

(4) Any antenna structure of 20 feet or less in height, except one that would increase the height of another antenna structure.

Appendix K

NEPAssist Report

Peoples Electric Solar Facility: Environmental Risk Management



February 9, 2023

Project 1

peoples_electric

1:5,733

0 0.05 0.1 0.2 mi

0 0.07 0.15 0.3 km

Input Coordinates: 34.683937,-96.766100,34.682497,-96.766010,34.680052,-96.769226,34.680539,-96.770529,34.682142,-96.770673,34.682733,-96.771831,34.684115,-96.771778,34.683937,-96.766100	
Project Area	0.06 sq mi
Within an Ozone 8-hr (1997 standard) Non-Attainment/Maintenance Area?	no
Within an Ozone 8-hr (2008 standard) Non-Attainment/Maintenance Area?	no
Within a Lead (2008 standard) Non-Attainment/Maintenance Area?	no
Within a SO2 1-hr (2010 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 24hr (2006 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 Annual (1997 standard) Non-Attainment/Maintenance Area?	no
Within a PM2.5 Annual (2012 standard) Non-Attainment/Maintenance Area?	no
Within a PM10 (1987 standard) Non-Attainment/Maintenance Area?	no
Within a Federal Land?	no
Within an impaired stream?	no
Within an impaired waterbody?	no
Within a waterbody?	no
Within a stream?	no
Within an NWI wetland?	Available Online
Within a Brownfields site?	no
Within a Superfund site?	no
Within a Toxic Release Inventory (TRI) site?	no
Within a water discharger (NPDES)?	no
Within a hazardous waste (RCRA) facility?	no
Within an air emission facility?	no

Within a school?	no
Within an airport?	no
Within a hospital?	no
Within a designated sole source aquifer?	yes
Within a historic property on the National Register of Historic Places?	no
Within a Toxic Substances Control Act (TSCA) site?	no
Within a Land Cession Boundary?	yes
Within a tribal area (lower 48 states)?	yes
Within the service area of a mitigation or conservation bank?	yes
Within the service area of an In-Lieu-Fee Program?	yes
Within a Public Property Boundary of the Formerly Used Defense Sites?	no
Within a Munitions Response Site?	no
Within an Essential Fish Habitat (EFH)?	no
Within a Habitat Area of Particular Concern (HAPC)?	no
Within an EFH Area Protected from Fishing (EFHA)?	no
Within a Bureau of Land Management Area of Critical Environmental Concern?	no
Within an ESA-designated Critical Habitat Area per U.S. Fish & Wildlife Service?	no
Within an ESA-designated Critical Habitat river, stream or water feature per U.S. Fish & Wildlife Service?	no

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Appendix L

Health Issues Related to the Static and Power-Frequency Electric and Magnetic Fields (EMFs) of the Soitec Solar Energy Farms

—

Memorandum on Scientific Information Related to Human Health Effects

Prepared by:
Asher R. Sheppard, Ph.D.
Asher Sheppard Consulting
Santa Rosa, California
April 30, 2014

1 Summary of Conclusions

Tierra del Sol Solar LLC, Rugged Solar LLC, LanWest Solar LLC, LanEast Solar LLC, and Soitec Solar Development LLC (applicants) have proposed four solar farm projects in southeastern San Diego County (collectively, the Proposed Project). These four projects include the Tierra del Sol, Rugged, LanEast, and LanWest solar farms. A Draft Programmatic Environmental Impact Report (DPEIR) was prepared to analyze the potential environmental impacts associated with the Proposed Project. The Tierra del Sol and Rugged solar farms were analyzed at a project-level of detail in the DPEIR because the applicants are seeking project-level approvals for those projects. The LanEast and LanWest projects were analyzed at a programmatic level of detail in the DPEIR because no project-level approvals are being sought and sufficient project-level data has not yet been developed at this time.

The analysis in this memorandum focuses on the Tierra del Sol and Rugged solar farms because project-level detail is available for those projects, however, it is equally applicable to the LanEast and LanWest solar farms assuming they are constructed using technology and layout comparable to those of the Tierra del Sol and Rugged solar farms.

This memorandum reaches three conclusions:

- There is no agreement among scientists that time-varying EMFs comparable to those of the project pose a potential health risk, and there are no defined or adopted CEQA/NEPA impacts concerning a health risk from EMF exposures;

- EMFs from the CPV trackers would not be significant outside each project's boundary;

- The static electric and magnetic fields of the Proposed Project are highly localized, very much weaker than limits found in all safety guidelines, and imperceptible at all locations accessible to the public. They pose no known concern for human health.

2 Introduction

Each of the proposed projects would introduce static and power-frequency (principally 60-Hz) electric and magnetic fields into the environment. Static fields would be produced by the CPV (Concentrator Solar Photovoltaics) modules and associated cabling for the 1 kV (1000 volt) DC underground collection system. The DC-to-AC inverters are a source of alternating electric and magnetic fields with a principal frequency of 60-Hz and also higher frequencies (harmonic frequencies). The overhead and underground transmission lines used to transfer power from the projects to the power grid also are sources of power-frequency electric and magnetic fields.

Recognizing that there is public interest and concern regarding potential health effects from exposure to electric and magnetic fields (EMFs) from power lines and other utility infrastructure, this section provides information regarding EMFs associated with electricity generation and transmission facilities with an emphasis on the potential for effects of the proposed project on public health and safety.

This memorandum supports the conclusion reached in the DPEIR (DPEIR, Sec. 3.1.4.5) that the Proposed Project would not create a health risk under CEQA because there is no agreement among scientists that EMFs comparable to those of the project pose a potential health risk, and there are no defined or adopted CEQA/NEPA impacts concerning a health risk from EMF exposures. The California Public Utilities Commission has addressed potential EMF health risks and established EMF policy (CPUC 1995; CPUC 2006a) with guidelines for project designs to implement the policy (CPUC 2006b), particularly a policy promoting designs that reduce EMFs when that can be accomplished at low-cost or no-cost. San Diego County has no policy to regulate EMF exposure. The information on EMF science and regulatory approaches presented below is given in some depth for the interest and benefit of the public and decision makers.

The recognized adverse effects of electric and magnetic fields (IEEE Std C95.6-2002 2002) occur at field strengths very much greater than can be found in areas accessible to the public near the project sites and associated transmission lines. Safety from recognized potential adverse effects is further enhanced because both electric and magnetic field strengths drop rapidly with increasing distance from EMF sources of the Proposed Project.

In general, EMFs present concerns in addition to those from possible direct influences of fields on tissues and organs of the body. These include potential health risks from induced currents, electric shock, effects on cardiac pacemakers, and nuisance factors due to corona.[1] Corona is associated with audible noise, potential interference with radio and television broadcast reception, and with electronic equipment. Mitigation measures are available in cases where environmental impacts of the just-mentioned nuisance factors could be significant.

2.1 Defining EMFs

Electric fields and magnetic fields occur both naturally and in the operation of many technological devices. Static and low frequency fields broadly relevant to EMFs of the Proposed Project occur naturally due to atmospheric phenomena and earth's geomagnetic field. Technological applications throughout modern society generate EMFs across the electromagnetic spectrum. This spectrum goes from low frequencies, such as the 60 Hz power frequency associated with the generation, transmission, and local distribution of electricity, to frequencies many millions or billions of times greater that are used for communications systems, radar, medical diagnostics, and many other purposes.

Electric and magnetic fields at all frequencies (including static fields) are vector quantities, that is, they have the properties of direction and amplitude (field strength). These fields are created, respectively, by the electric voltage and electric current. Electric power very often is created by a generator whose rotary motion yields alternating current that changes in direction and amplitude at a rate of 60 times per second in North American power systems. Power generation by solar panels uses electronic devices to produce alternating currents from the direct currents of the solar panels. The designations "60 cycle" and "60 Hz" are synonymous because the hertz, abbreviated Hz, is the unit for cycles per second. The frequency of electric power systems in Europe and many other countries is 50 Hz, the frequency at which relevant research has been done.

[1] Corona effects include audible noise, electromagnetic interference with radio or television signals, a glowing region in the air, and heat. Corona-generated audible noise is characterized as a crackling, hissing, or humming that is most noticeable during rain or fog. During fair weather, audible noise may be barely perceptible, depending on line voltage and a variety of factors. The Tierra del Sol 138-kV gen-tie and Rugged Solar 69-kV gen-tie transmission lines would create corona, but the effects would not be as strong as with higher voltage transmission lines such as the 500-kV Sunrise Powerlink.

At the much higher frequencies used for communications, electric and magnetic fields exist in a mutual relationship known as the electromagnetic field. The additional properties of electromagnetic fields make communication systems possible, but the information presented in this memo is restricted to phenomena of EMFs – independent electric and magnetic fields – from power lines operating at frequencies of 50 or 60 Hz. Possible confusion exists because electromagnetic fields also may be abbreviated as "EMFs," but electromagnetic fields can radiate a beam of energy from an antenna, in sharp distinction with the independent electric and magnetic fields of power systems that do not create a radiating energy beam.

2.2 Basic Features of Electric Power Systems and Solar Power Generation

Electric power flows across transmission systems from generating sources to serve electrical loads within the community. The energy for electricity generation may come from sources such as solar conversion panels, water power, and heat, which may be derived from nuclear reactions or the burning of gas, oil, and coal. The power flowing over a transmission line is determined by the transmission line voltage and the current. The higher the voltage level of the transmission line, the lower the amount of current needed to deliver the same amount of power. For example, a 138 kV (138,000 volt) transmission line carrying 200 amperes of current transmits approximately 47,800 kilowatts (kW), whereas a 256 kV transmission line would require only 100 amperes of current to deliver the same 47,800 kW.

The CPV trackers proposed for the Proposed Project create direct current (DC) electricity from sunlight, therefore requiring the use of inverters to create alternating current (AC) electricity suitable for use on the power system. Inverters produce currents that predominantly are at 60 Hz, but higher frequency currents also occur. Consequently, EMFs are created at 60 Hz and at harmonic frequencies. For example, inverter harmonics may be strong at 180-, 300- and 420-Hz, the third fifth and seventh harmonics of 60-Hz, but the strengths of harmonic frequency EMFs of the Proposed Project will be characteristic of the specific electronic and electrical design of the inverter/transformer units and associated equipment. Filters typically reduce most harmonic frequencies such that 60-Hz electric and magnetic fields are the dominant feature in all the parts of the system, that is, those operating at 350-400 V, 34.5 kV, 69 kV and 138 kV.

For the Tierra del Sol project, the 34.5 kV collector trunk would be on the existing right-of-way of the 500 kV AC Southwest Powerlink that is an existing source of 60-Hz EMFs and its 138 kV gen-tie would be routed underground and overhead. The Rugged Solar 69 kV gen-tie transmission line would be underslung on the approved Tule Wind 138 kV transmission line right of way.

2.3 Electric Fields

Whenever AC lines are energized, power-frequency electric fields are created with a field strength that depends directly on the voltage on the line creating it. Electric field strength is typically described in units of kilovolts per meter (kV/m). Electric field strength attenuates (gets weaker) rapidly with increasing distance from the source. Electric fields are strongly reduced at many environmental receptors because they are effectively shielded by trees, walls and roofs of buildings.

A static electric field is a feature of everyday experiences such as when pulling off a sweater, sliding across a fabric car seat, scuffing shoes across a carpet, combing hair, and grooming fur on a pet. These phenomena are more pronounced during dry weather or indoors when humidity is very low. A person walking on a carpet can acquire a voltage of several thousand volts but there is no direct health hazard from such momentary discharges to the body (World Health Organization 2006 sec. 3.2.1). In fair weather, the potential difference between the ionosphere and earth's surface results in a static electric field that averages approximately 130 V/m, but static electric fields of 3 kV/m or more are created under clouds (World Health Organization 2006 sec. 3.1.1) and in dust storms. DC transmission lines, which can be energized at ±400 kV or more, are used for transmission of large quantities of power over long distances. Ground level static electric fields of as much as 20 kV/m can occur beneath DC transmission lines (World Health Organization 2006 sec. 3.2.1), but, in comparison, a typical solar farm DC collector system carries current in cables that create negligible external electric fields.

Some phenomena of power-frequency electric fields are similar to those of static fields because a frequency of 60 Hz involves a relatively slow oscillation of field polarity. The switching of positive and negative current flow at 60 times per second means that polarity changes occur

within approximately one-hundredth second. In comparison, at typical radiofrequencies polarity switches within millionths or billionths of a second.

Unlike magnetic fields, which penetrate all non-conducting materials and are therefore unaffected by trees, most building materials, and other obstacles, both static and 60-Hz electric fields are distorted by any object that is within the electric field, including the human body. Even trying to measure an electric field with electronic instruments is difficult because the devices themselves would alter the levels recorded. Determining an individual's exposure to electric fields requires understanding many variables, including the strength and direction of the electric field itself, effectiveness of a person's electrical connection to the earth or other electrical ground, and body surface area within the electric field.

Potential health effects from exposure to electric fields from power lines, substation buswork, switchgear and transformers are typically not a focus of concern because these fields are attenuated by common environmental features such as trees with foliage and the building materials used for homes, offices and manufacturing sites. Levallois et al. (1995) found that even close to a powerline right-of-way, electric fields inside homes are similar to those in homes far from transmission lines.

Electric fields in the vicinity of power lines can cause "spark discharges" that are similar to the static electricity experiences mentioned above. Such electric discharges can occur when touching long metal fences, metal gutters, pipelines, or large vehicles with a potential safety hazard from a startle reaction causing, for example, a dropped tool or a fall from a ladder. A more threatening potential impact to public health from electric transmission lines is the acknowledged hazard of electric shock that results from accidental or unintentional contact by the public with energized wires. The issues of spark discharges and shock hazards are not addressed further because the electric fields associated with the Proposed Project are not strong enough to cause discernible spark discharges except at positions on powerline towers or poles that are inaccessible to the public.

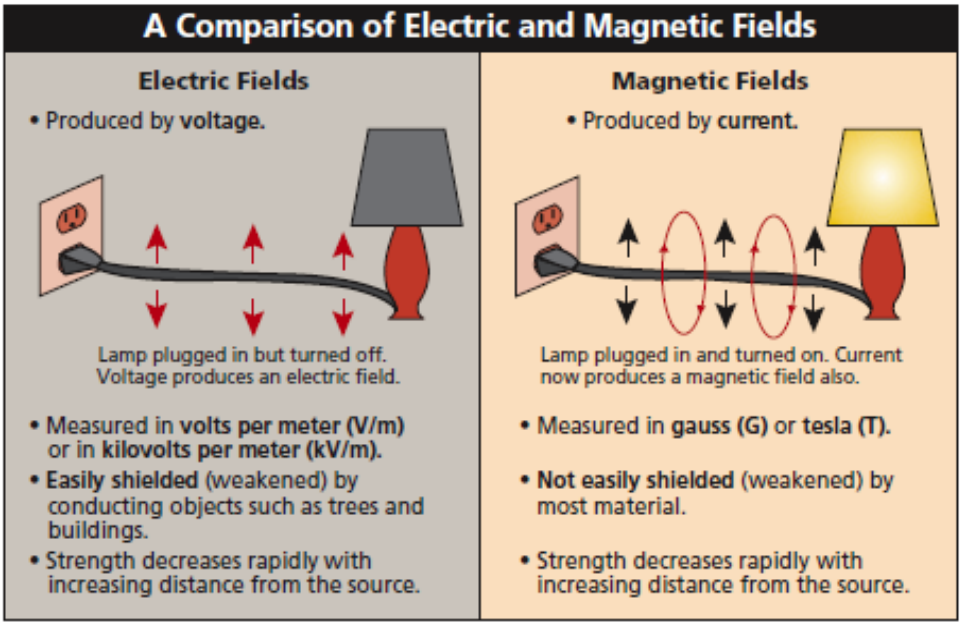
2.4 Magnetic Fields

Magnetic fields are created whenever current flows through power lines at any voltage. The strength of the field is directly dependent on the current in the line. The intensity of a magnetic field is often measured in milligauss (mG) or microtesla (μT). Like electric fields, magnetic fields attenuate rapidly with distance from the source, but unlike electric fields, magnetic fields are not shielded by most objects or materials.

2.5 Contrast between Electric and Magnetic Fields at Appliances

The nature of electric and magnetic fields can be illustrated by considering a household appliance that is plugged into an outlet but not turned on (Fig. 1). As long as it is switched off, no current flows and consequently there is no magnetic field generated in the appliance and its

Figure 1.



An appliance that is plugged in and therefore connected to a source of electricity has an electric field even when the appliance is turned off. To produce a magnetic field, the appliance must be plugged in and turned on so that the current is flowing.

Source: (NIEHS 2002 p 5)

wiring (particularly the electric "cord"). However, when off, an electric field originates from the cord the cord that is energized at the line voltage, typically 115 V (volts), and from any other parts at line voltage. Electric field strength is directly related to the magnitude of the voltage from the outlet, and when the appliance is switched on magnetic field strength is directly related

to the magnitude of the current flowing in the cord and appliance. Thus, an appliance operating at 230 V generally has higher electric field strengths than one at 115 V, and the magnetic fields surrounding the cord of an iron that draws perhaps 10 ampere (A) of current would be higher than those surrounding the cord of a typical desk lamp drawing less than 1 A.

3 EMF Sources Associated with the Proposed Project

The following EMF sources are confined to the 420-acre and 765-acre project sites of Tierra del Sol and Rugged, respectively:

- Approximately 2,657 CPV trackers at the Tierra del Sol site and 3,588 CPV trackers at the Rugged site would have localized EMFs due to the DC produced by the panel. During operation, the tracker motors and electronics would create localized EMFs typical of small-scale equipment. EMFs from the panels and related tracking equipment would not be significant outside the solar array area and therefore are not given further consideration.

- A 1 kV DC underground collection system would be a source of EMF near the cables.

- A maximum of 45 (Tierra del Sol) and 59 (Rugged) inverter stations and associated transformers would change the 1 kV DC power into 34.5 kV AC power (with an intermediary stage at 350-400 VAC).

- Tierra del Sol and Rugged each would have 34.5 kV overhead and underground collection systems to link the trackers to the on-site project substation. The 34.5 kV cables would be underground and then transition to overhead poles for the trunk lines leading to a collector substation.

- A collector substation site that includes switchgear for transfer of power on the multiple 34.5 kV lines into the 138 kV (Tierra del Sol) or 69 kV (Rugged) gen-tie transmission lines. Unlike substations typical of the electric power system, for example, the Rebuilt Boulevard Substation, the collector substation does not provide a point of interconnection for system distribution and transmission lines.

- The gen-tie transmission lines would connect each project's on-site collector substations to the Rebuilt Boulevard Substation. The Rebuilt Boulevard Substation is not considered in this memo.

The 138-kV gen-tie line of Tierra del Sol solar farm would be carried northward from the on-site substation on an underground 138-kV cable along Tierra del Sol Road for approximately 0.5 miles, turn to the east for approximately 1-mile, at which point it would transition to an overhead 138 kV structure running northward to a point just east of Jewel Valley Road. At that point the gen-tie line would then again become an underground cable running for approximately 1.5 miles in segments that carry the line in a generally northeasterly direction toward its end at the connection with the Rebuilt Boulevard Substation. EMFs along the overhead portion would be typical for the adopted design typical of this voltage class with magnitudes and spatial extent in the surrounding environment determined by the specific structures and conductor design. Figure 2 illustrates the manner in which electric and magnetic fields attenuate with distance for typical transmission lines of three voltage classes. The magnitude of the peak EMFs and their strength at distances from the 138 kV gen-tie transmission line would likely be comparable to the 115 kV line illustrated with respect to peak magnitude and the decline in strength with distance. EMFs generated by the underground cable would generally be lower in magnitude and spatial extent, except that EMF magnitudes may be relatively high within several feet of an underground cable or cables. As for the overhead sections, magnitudes and spatial extent would be determined by the specific design. EMFs of all 138-kV transmission-line magnetic fields would be greater upon completion of Phase II than for Phase I alone.

The Rugged 69-kV transmission line to be constructed as an underslung overhead line for its entire length of approximately 2.75-miles would be the source of EMFs at levels typical for the adopted design in this voltage class. The magnitudes and spatial extent of environmental EMFs generated by the overhead 69-kV line would be determined by the specific structures and conductor design for the overhead transmission circuit and the specific cable design for underground portions. During operation, nearby EMFs would depend on interaction with the existing 138-kV Tule Wind Project line. Those interactions could reduce or increase total EMFs depending on operational and design factors. Figure 2 illustrates the manner in which electric

and magnetic fields attenuate with distance for transmission lines of several voltage classes that are greater than 69 kV. The magnitude of the peak EMFs and their strength at distances from the 69 kV line would be significantly lower and follow a comparable rate of decline in strength with distance.

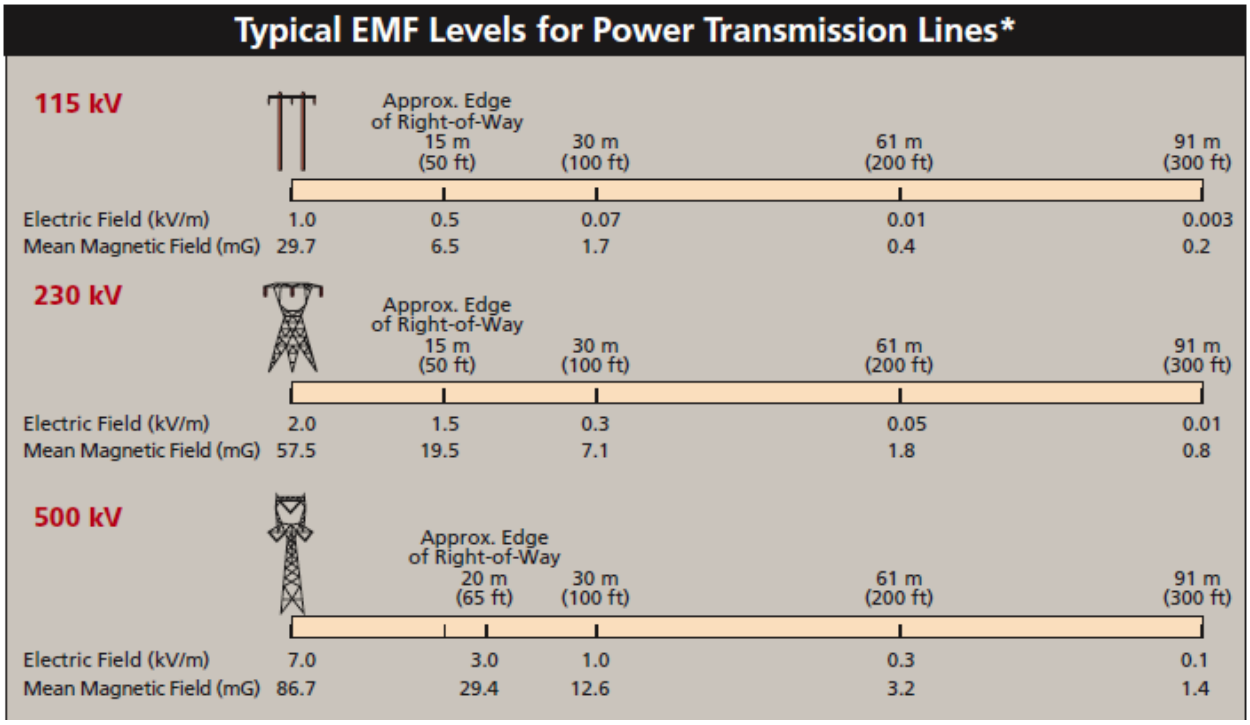
In general, common EMF exposures to the public vary over a range of field intensities and durations in reflection of sources in the home and work environments, electric power distribution system, and infrequently, from proximity to transmission lines. In contrast, for undeveloped and natural areas such as the Proposed Project area, EMFs greater than the very low natural background level are not present except in the vicinity of existing power line corridors, such as the 500 kV Southwest Powerlink (SWPL) that transects the Tierra del Sol project site and the 500 kV Sunrise Powerlink (Sunrise) transmission line that runs proximate to the Rugged project site. Rural areas that resemble undeveloped natural areas may have pole-mounted distribution circuits, and sometimes isolated residential, commercial and industrial buildings, but otherwise are characterized by low natural background EMF levels. Presently, public exposure to 60-Hz EMF in the project area at levels above those typical of residences would be limited to a strip of land parallel to the route for the underground and overhead 138-kV transmission line for Tierra del Sol, and a similar strip of land along co-existing Rugged 69-kV and Tule Wind Project transmission lines.

4 Typical Electric and Magnetic Fields of 60 Hz Transmission Lines

The Proposed Project gen-tie transmission lines will create electric and magnetic fields similar to those of other transmission lines of similar design, operating at the same voltage, and carrying similar currents. In the absence of particular designs for the 138 kV and 69 kV transmission lines of Tierra del Sol and Rugged projects, respectively, it is useful to consider the features of generic high-voltage AC transmission lines. Figure 2 illustrates that for all three voltage levels shown, and for the different support designs (dual poles or steel lattices, both with conductors suspended from a horizontal beam), both the electric and magnetic fields drop off in strength with distance from the tower.

For the 115 kV transmission line shown, the electric fields drops to approximately one-half of maximum at 50 ft from the tower and is just 7 percent of maximum at 100 ft. The magnetic fields drop to approximately one-fifth of maximum at 50 ft. and approximately 6% of maximum at 100

Figure 2



Source: (NIEHS 2002 p 37)

ft, with continuing decreases at greater distances. Numerous factors of a specific engineering design determine the actual field strengths and their patterns of decay with distance from the tower. The most significant design factors are line voltage, line current, conductor height above ground, and spatial arrangement of the conductors. In cases, there can be more than one circuit in parallel on the same right-of-way and two circuits on the same tower, as in the case of the 69 kV line of the Rugged Solar project that is placed beneath an existing 138 kV line. Nearby parallel circuits can reduce or increase the fields generated by one line in isolation depending on both design and operational factors. Most of the just-mentioned features of power transmission lines are fixed features of an installation, but load current and therefore magnetic field strength vary with the amount of power being transmitted. The power transmitted from a solar energy project varies with time-of-day, cloud cover, and seasonal changes in daylight duration.

5 Regulatory Standards and Guidelines for EMF Exposures

5.1 Scientific Background

For more than 45 years, questions have been asked regarding the potential health effects of EMFs from power lines resulting in a considerable body of research conducted to provide a foundation for a science-based response. Initial studies focused primarily on interactions with the electric fields from power lines. The subject of magnetic field interactions began to receive additional public attention in the 1980s as research increased in response to studies showing a possible association with cancer, particularly, childhood leukemia. A substantial amount of research investigating both electric and magnetic fields has been conducted worldwide over the past several decades. However, public health risks, particularly for magnetic field exposures to children, remain a subject of controversy because, according to many individual scientists and scientific panels that have reviewed the voluminous research findings, the data on that topic are inconclusive.

At sufficiently high levels, external extremely low frequency (ELF) fields can interact with - tissues through electrical effects due to currents induced in tissues and cells of the body. High-level effects of induced body currents are precluded if exposures are below the limits set by health and safety standards. (The process of induction is found widely in electrical technology. One common device relying on induction is the electric transformer where current in one coil induces current in another nearby coil. Similarly, an electromagnet powered by an alternating current works by inducing current in a nearby conducting metallic object, resulting in an attractive force that can lift the object. Contact with an electrical conductor stands in sharp contrast to induction and, of course, is the way in which electrical injuries occur.)

However, the electric currents induced by ELF fields commonly found in the environment – even those from transmission lines, substations, and transformers – are very weak when compared to certain electric currents that occur naturally in the body, such as those that control the beating of the heart and others generated by muscular activity. Only some utility employees get close enough to transmission lines and electrical machinery to experience induced electricity comparable to the electrical phenomena of natural biological functions. Of course, EMF-induced currents in the body also are vastly weaker than the currents found in electrical machines themselves, such as transformers, motors and magnets.

Research related to EMF can be grouped into four broad categories: a) mechanistic; b) cellular level studies; c) animal and human experiments; and d) epidemiological studies. Epidemiological studies, while carrying great weight in public health evaluations, have provided mixed results. Some studies show an apparent relationship between magnetic fields and health effects but other studies of comparable design do not. Laboratory studies with cells, animals, and humans, and studies investigating a possible mechanism for health effects (mechanistic studies) provide little or no evidence to support a magnetic field influence on health, especially, cancer.

Public interest and concern specifically regarding magnetic fields from power lines increased following publication in 1979 of the results of a single epidemiological study that observed an association between the wiring configuration on electric power lines outside homes in greater Denver and the incidence of childhood cancer (Wertheimer and Leeper 1979). Following publication of the Wertheimer and Leeper study, many epidemiological, laboratory, and animal studies regarding EMF have been conducted attempting to confirm the validity of the finding and determine a plausible mechanism, most of which focused on exposures to power-frequency magnetic fields.

The wide use of electricity results in background levels of EMFs in nearly all locations where people spend time – homes, workplaces, schools, cars, the supermarket, etc. A person's average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there. In most U.S.A. homes, background magnetic field levels average about 1 milligauss (mG) due to wiring within the home, electrical appliances, and power lines outside the home (Zaffanella 1993). Since the intensity of magnetic fields diminishes quickly with distance from the source, distance from a power line reduces the effect on the magnetic field level within the home. In fact, the strongest magnetic fields that are encountered indoors are from electrical appliances.

In accord with national findings, ambient magnetic fields in homes and buildings in several western states also averaged approximately 1 mG, and in rooms with appliances magnetic fields

Table 1. Typical 60-Hz Electric Field Values for Appliances at ~12 Inches

Appliance	Electric Field Strength (kV/m)
Electric blanket*	0.250
Broiler	0.130
Stereo	0.090
Refrigerator	0.060
Iron	0.060
Hand mixer	0.050
Phonograph	0.040
Toaster	0.040
Coffee pot	0.030
Vacuum cleaner	0.016
Electric range	0.004

Source: (Miller 1974 Table IV-VI).
* 1 to 10 kV/m next to blanket wires (Enertech Consultants 1985)

ranged from 9 to 20 mG (Severson et al. 1988; Silva et al. 1988). Immediately adjacent to appliances (within 12 inches), electric and magnetic field values are much higher, as illustrated in Tables 1 and 2 that indicate typical sources and levels of electric and magnetic field exposure from appliances for the general public.

5.2 Methods to Reduce EMF Levels

EMF levels from an AC transmission line can be reduced by shielding, field cancelation, or increasing the distance from the line. Shielding of electric fields can be actively accomplished by placing trees or other physical barriers along the transmission line ROW and by common building materials used in home construction. Magnetic fields can be reduced either by cancelation or by increasing distance from the source, but shielding a large volume is impractical and is used only in a few scientific research laboratories. Cancelation can be achieved between

two or more nearby circuits by taking advantage of the three-phase design used in power transmission. Placement of conductors with oppositely-directed fields of the same magnitude close to each other on a tower or pole can reduce fields significantly. Similarly, underground cables usually place the three phase conductors close together, or even wrapped into one concentric cable, thereby obtaining considerable field cancelation nearby. Field cancelation techniques have has practical limitations because of the need to avoid arcing between phases if overhead high-voltage wires are placed too close together.

Although static electric fields also can be effectively shielded by trees and building materials, field-canceling configurations on towers and poles may not be practical. Concentric DC cables and bipolar DC cables placed close to each other have excellent field cancelation properties, comparable to those of AC cables.

For both AC and DC sources of EMFs, placement of overhead power line conductors at greater heights above ground, burying underground cables more deeply, and increasing the width of the ROW can achieve significant field reductions for nearby people.

Table 2. Magnetic Field Near Household Appliances

Appliance	Magnetic Field (mG) at 1 foot
Can opener	40 to 300
Coffee maker	1
Crock pot	1
Dishwasher	6 to 30
Electric range	8 to 30
Electric oven	1 to 5
Garbage disposal	8 to 20
Microwave oven	1 to 200
Mixer	5 to 100
Refrigerator	2 to 20
Toaster	3 to 7
Clothes washer	2 to 30
Clothes dryer	1 to 3
Fans / blowers	0.4 to 40
Iron	1 to 3
Portable heater	1 to 40
Vacuum cleaner	20 to 200
Baby monitor	0 to 2
Hair dryer	1 to 70
Electric shaver	20 to 100
AC adapter	0 to 7.5
Circular saws	10 to 250
Compact fluorescent bulb	0 to 0.1
Digital clock	0 to 8
Electric drill	25 to 35
Fluorescent fixture	2 to 40
Fluorescent desk lamp	6 to 20
TV (1980s era)	9 to 20
TV – flat screen LCD	0 to 2.5

Sources: (NIEHS and US DOE 1995); (EPRI 2012b)

5.3 Scientific Panel Reviews on Power-Frequency EMF

Numerous panels of expert scientists have convened to review the data relevant to the question of whether exposure to power-frequency EMF is associated with adverse health effects. These evaluations have been conducted in order to advise governmental agencies or professional standard-setting groups. In a typical procedure, scientific panels first evaluated the available studies individually, not only to determine what specific information they can offer, but also to evaluate the validity of experimental designs, methods of data collection, nature and quality of the data, data analysis, and suitability of the authors' conclusions. Subsequently, the individual studies, with their previously identified strengths and weaknesses, were evaluated collectively in an effort to identify whether there is a consistent pattern or trend in the data that would lead to a determination of possible or probable hazards to human health resulting from exposure to these fields.

Expert panel reviews have been prepared by international agencies such as the World Health Organization (WHO, 1984, 1987, 2001 and 2007) and the international Non-Ionizing Radiation Committee of the International Radiation Protection Association (IRPA/INIRC, 1990) and governmental agencies of a number of countries, such as the U.S. EPA, the National Radiological Protection Board of the United Kingdom, the Health Council of the Netherlands, and the French and Danish Ministries of Health. As noted below these scientific panels have varied conclusions on the strength of the scientific evidence concerning health risks from exposure to power frequency EMF.

The U.S. Congress passed legislation that resulted in EMF RAPID, a program of scientific research, public information, and health risk assessment to inform government policy. Its conclusions were derived from extensive analysis of existing scientific research and from the results of studies conducted under EMF RAPID in neurophysiology, behavior, reproduction, development, cell physiology, genetics, cancer, and melatonin (the hormone regulating circadian rhythm). In May 1999 the director of the National Institute of Environmental Health Sciences (NIEHS) submitted to Congress its report titled, "Health Effects from Exposure to Power-Line

Frequency Electric and Magnetic Fields," containing the following conclusion regarding power-frequency EMF health effects:

> Using criteria developed by the International Agency for Research on Cancer (IARC), none of the Working Group considered the evidence strong enough to label ELF-EMF exposure as a known human carcinogen or probable human carcinogen. However, a majority of the members of this Working Group concluded that exposure to power-line frequency ELF-EMF is a possible carcinogen. (NIEHS 1999)

In June 2001, a scientific working group of IARC (an agency of WHO) reviewed studies related to the carcinogenicity of EMF. Using the standard IARC classification system used for chemicals in the environment and foods, magnetic fields were classified as "*possibly carcinogenic to humans*" based on epidemiological studies. "Possibly carcinogenic to humans" is a classification used to denote an agent for which there is *limited evidence of carcinogenicity in humans* and *less than sufficient evidence of carcinogenicity in experimental animals*. Other agents identified as *possibly carcinogenic to humans* include gasoline exhaust, styrene, welding fumes, and coffee (WHO, 2001).

On behalf of the California Public Utilities Commission (CPUC), the California Department of Health Services (DHS) completed a comprehensive review of existing studies related to EMF from power lines, particularly those involving several potential health risks (Neutra et al., 2002). This risk evaluation was undertaken in 2000-2002 by three DHS staff epidemiologists using Bayesian analytic techniques instead of the weight-of-the-evidence approach used by other expert panels. The conclusions found in the executive summary are:

- To one degree or another, all three DHS scientists are inclined to believe that EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig's Disease (ALS), and miscarriage. For adult leukemia, two of the scientists are "close to the dividing line between believing or not believing" and one was "prone to believe" that EMFs cause some degree of increased risk.
- All strongly believe that EMFs are not universal carcinogens because there are a number of cancer types that are not associated with EMF exposure.

· To one degree or another all three are inclined to believe that EMFs do not cause an increased risk of breast cancer, heart disease, Alzheimer's Disease, depression, or symptoms attributed by some to sensitivity to EMFs. However, all three scientists had judgments that were "close to the dividing line between believing and not believing" that EMFs cause some degree of increased risk of suicide.
· All strongly believe that EMFs do not increase the risk of birth defects, or low birth weight.

The DHS scientists were more inclined to believe that EMF exposure increased the risk of the above health problems than the majority of the members of scientific committees that have previously convened to evaluate the scientific literature. With regard to why the DHS review's conclusions differ from those of other recent reviews, the report states:

> The three DHS scientists thought there were reasons why animal and test tube experiments might have failed to pick up a mechanism or a health problem; hence, the absence of much support from such animal and test tube studies did not reduce their confidence much or lead them to strongly distrust epidemiological evidence from statistical studies in human populations. They therefore had more faith in the quality of the epidemiological studies in human populations and hence gave more credence to them.

In addition to the uncertainty regarding the level of health risk posed by EMF, individual studies and scientific panels have not been able to determine or reach consensus regarding what level of magnetic field exposure might constitute a health risk. In some early epidemiological studies, increased health risks were discussed for daily time-weighted average field levels greater than 2 mG. However, the IARC scientific working group indicated that studies with average magnetic field levels of 3 to 4 mG played a pivotal role in their classification of EMF as a possible carcinogen.

An extensive WHO review (World Health Organization 2007) concluded that evidence for a link between extremely low frequency magnetic fields and health risks is based on epidemiological studies demonstrating a consistent pattern of increased risk for childhood leukemia. However, "...virtually all of the laboratory evidence and the mechanistic evidence fail to support a

relationship between low-level ELF magnetic fields and changes in biological function or disease status. Thus, on balance, the evidence is not strong enough to be considered causal but sufficiently strong to remain a concern." For the many other diseases considered and for numerous laboratory studies, the WHO panel found "inadequate" or "no evidence" of health effects at low exposure levels.

A 2009 European Commission report identified a research gap concerning the association of ELF EMF exposures with neurodegenerative diseases and put the need for a multidisciplinary research as "very important and given high priority based on their relevance for fundamental understanding of the issue and/or their relevance for public health" (Scientific Committee on Emerging and Newly Identified Health Risks 2009). In Australia, ARPANSA provides an EMF fact sheet that concludes, "The scientific evidence does not firmly establish that exposure to 50 Hz electric and magnetic fields found around the home, the office or near powerlines is a hazard to human health" (ARPANSA), and organizations such as ICNIRP (2009; 2010), ICES (2010), and ACGIH (2006) continue to review and refine their guidelines and standards.

EMF health issues continue to be the subject of research and examination in the context of regulatory standards and guidelines. EPRI, which describes itself as "the only organization in North America funding long-term, multidisciplinary EMF research," sponsors research and scientific meetings in areas of current interest, and provides a semi-annual public newsletter on EMF research (EPRI 2014).

5.4 Regulatory Standards and Guidelines for EMF Exposures: Policy in California

Government agencies outside the U.S.A. and international- and U.S.-based standards-setting bodies have developed detailed guidance for EMF exposure across a wide range of frequencies with specific focus on power-frequency EMF. Those shown in Table 3 are notable for extended reviews of the scientific literature, risk assessment narratives, and technical details far beyond those tabulated here. These scientific reviews consistently found no conclusive evidence of human health effects below the recommended standard or guideline levels and recognized as inconclusive the epidemiologic findings concerning an association of childhood leukemia with

apparent magnetic field exposures. IEEE also developed detailed procedures for field measurements and computations (IEEE Std C95.3.1-2010 2010).

Table 3. Selected international and national standards and guidelines for exposure to 60-Hz frequency electric and magnetic fields (unperturbed rms values).

Source	E-field strength[(a)] (kV/m)	B-field strength[(a)] (mG)	Notes	Reference
General public				
Health Council of the Netherlands	4.17	833	Reference level, whole body	(Health Council of the Netherlands: ELF Electromagnetic Fields Committee 2000); (Health Council of the Netherlands 2008)
Health Protection Agency (UK)	4.17	833	Reference level, whole body	(Radiation Protection Division and Health Protection Agency 2005)
ICNIRP	4.17	833	Reference level, whole body	(ICNIRP 2010)
IEEE Std C95.6	5[(a)]	9040[(b)]	Maximum permissible exposure	(IEEE Std C95.6-2002 2002)
Occupational				
ACGIH; AIHA[(c)]	25	10,000		(American Conference of Governmental Industrial Hygienists 1991); (AIHA 2002)
ICNIRP, HPA (UK)[(d)]	8.33	4,170	Reference level, whole body	(ICNIRP 2010); (Radiation Protection Division and Health Protection Agency 2005)

Notes:
(a) Whole body; 10 kV/m within a powerline ROW.
(b) Exposure to head and torso; for arms or legs, MPE = 632,000 mG.
(c) Ceiling values (ACGIH: American Council of Government and Industrial Hygienists; AIHA: American Industrial Hygiene Association).
(d) These are reference levels (not exposure limits).

In the absence of conclusive findings of a health hazard from exposure to power-frequency EMF, there are no federal exposure limits at power-frequencies adopted as guidelines or put into law. However, various federal agencies have sponsored and collaborated on research and policy questions, including the Environmental Protection Agency (EPA), Department of Defense, National Institute of Occupational Safety and Health (NIOSH), Department of Energy (DOE), and National Institute of Environmental Health Sciences (NIEHS). The latter two agencies

collaborated under the Congressionally mandated EMF RAPID program that concluded with the 1999 report to Congress cited above (NIEHS 1999).

Likewise, no state has determined there is conclusive evidence for adverse health effects of ELF EMF exposures, but several states have developed regulatory guidance for electric utilities and particularly new transmission line projects, in the face of uncertain and inconclusive research. In some states, only electric fields are considered, in others, only magnetic fields, and in others rules were developed for both field types. A 2002 white paper treats EMF policy considerations and reviews regulatory positions in several states (Minn. W.G. 2002). Table 4 below lists rules and guidance for transmission lines in 9 states. In cases, such as North Dakota, EMF level is not specified, but a right-of-way width is specified. Some rules were determined from existing right-of-way widths to set benchmarks for the corresponding field strengths. In contrast, Florida specifies maximum electric and magnetic fields at the edge of the right-of-way and within the right-of-way.

The Calilfornia Public Utilities Commission (CPUC) established (1995) and reaffirmed (2006a) an EMF policy that does not specify EMF field strength limits but instead requires new construction to use designs and equipment that result in lower environmental EMF levels. Implementation of the CPUC field reduction policy was formulated in terms of “low-cost, no-cost” steps for EMF reduction, where “low-cost” was set at roughly 4% of total project cost. Thus, during the design phase, new facilities for electricity generation, transmission, distribution and related substations can show compliance by no-cost steps such as, for example, selection of a design that reduces EMFs by the choice of overhead line electrical phasing that takes advantage of opportunities for EMF reduction by field cancelation. Relocation of substation electrical equipment on a substation site provides another example of a no-cost option. Methods of field reduction that increase project cost, such as increasing pole or tower height, or using underground cables would be appropriate and necessary if they result in numerically significant field reductions within a cost of approximately 4% of total project cost.

Table 4. Transmission line EMF-based siting considerations of selected states.*

State	Application	Location	Electric Field (kV/m)	Magnetic Field (mG)	Notes, References
California	Project	Project	(a)	(a)	California Public Utilities Commission, General Order 131-D (http://www.cpuc.ca.gov/PUBLISHED/Graphics/589.PDF); Decision D.06-01-042
Connecticut	Project	Project		best practices for no-cost/low-cost (4%) mitigation	Siting Council assess compliance with PA 04-286, PA 04-246, PA 07-4, and best mgt. practices http://www.cga.ct.gov/2001/rpt/2001-R-0666.htm, including special focus on sensitive receptors, and possible undergrounding. K.E. McCarthy, Health effects of electric and magnetic fields, # 2009-R-0280, Office of legislative Research, 8/5/2009,see (http://www.cga.ct.gov/2009/rpt/2009-R-0280.htm) (accessed 6/11/2013); www.ct.gov/csc/cwp/view.asp?a=3&q=311180)
Florida (b)	>500 kV	In ROW	15	--	Electric and Magnetic Field Regulations: S. 62-814.450 Florida Statutes; Ch. 62-814, Florida Register & Florida Administrative Code) https://www.flrules.org/gateway/ChapterHome.asp?Chapter=62-814
	" "	Edge of ROW & substa. boundary	5.5	250	
	≤500kV & >230kV	In ROW	10	--	
	" "	Edge of ROW & substa. boundary	2	200	Exception of 250 mG for double ckt. ROWs and certain other ROWs existing before 1989
	≤230 kV	In ROW	8	--	
	" "	Edge of ROW & substa. boundary	2	150	
Minnesota	> 200 kV	In ROW	8		
Montana (b)	> 69 kV	Edge of ROW	1		(Administrative Rules of Montana 2005)
	Road crossings	In ROW	7		

State	Application	Location	Electric Field (kV/m)	Magnetic Field (mG)	Notes, References
New Jersey	all	Edge of ROW	3	--	Guideline
New York	> 125 kV, > 1 mile length	Edge of ROW	1.6	200	Interim magnetic field standard for maximum design current.
	Public roads	In ROW	7		
	Public roads	In ROW	11		
	Other terrain	In ROW	11.8		
North Dakota	Route siting	Route	--	--	Avoid siting within 500 ft. of a residence, school, or place of business (EMFs not specified); may be waived; NDCC 49-22-08 (North Dakota 2013)
Oregon[b]	≥230 kV, ≥10 miles	In ROW	9	--	Energy Facility Siting Council

* The Edison Electric Institute Generation and Transmission Siting Directory provides state-by-state information on all aspects of power system siting, including EMF considerations in transmission line siting where rules exist (EEI 2012).

[a] Submit design plan that reduces EMFs at no cost or low cost (up to approximately 4% of project cost), prioritized by land use; usually applied to magnetic fields only

[b] Regulations in Florida, Montana and Oregon were codified.

6 Health and Safety Considerations for Static Electric and Magnetic Fields

Static (zero frequency) electric and magnetic fields will occur on each of the solar farm sites in association with the underground 1-kV DC collector systems within the boundaries of each project. As noted above in section 2.3, overhead high-voltage DC transmission lines that can operate at much greater voltages such as ±500 kV can create large static electric fields near the line. These high-voltage lines also create air ions and static magnetic fields that can come into consideration in environmental reviews. However, the Proposed Project involves a very different source of static EMF because the CPV trackers and underground 1-kV cables create EMFs that are localized to the immediate area near a CPV tracker or collector cable, and are expected to be insignificant outside the site boundary.

Specific quantitative data on the EMF produced by a CPV tracker and collector cable depend on the particular equipment used. Static electric fields can be measured with commercially available instruments based on the classic electric field mill design, while static magnetic fields can be measured with a variety of commercially available gaussmeters (magnetometers). Project electric fields can be considered in context of naturally occurring atmospheric electric fields that, as mentioned above (section 2.32.3), range from a fair-weather average of 130 V/m to much greater levels during storms and near high-voltage DC transmission lines. Static magnetic fields can be compared with the naturally occurring static geomagnetic field that is approximately 470 mG at the Proposed Project locations.

People can detect electrostatic fields of several thousand volt per meter, such as occur under storm clouds because hair on the arm, head or elsewhere becomes charged. The resulting small forces deflect the hairs, which stimulate touch sensors in the skin surface causing a tingling sensation. Slight movements of body hair in a strong electrostatic field are the mechanism for perception of a static electric field for all practical exposure situations (Reilly 1998 p 357). Electrostatic effects like these are sharply distinguished from effects of the considerable currents that can flow upon direct contact with a live electric conductor, potentially causing the serious hazards of electric shock. Project electrostatic fields can be anticipated to be lower than typical ambient atmospheric levels (that are of the order of 100 V/m) at distances of several meters from an aboveground conductor at 1 kV and at much closer distances from aboveground and underground cables. Consequently, both

electrostatic effects and electric shock do not appear possible for off-site exposures from Proposed Project static electric fields.

Static magnetic fields at levels in the environment near CPV trackers, onsite DC cables, or in the general environment outside the Proposed Project solar farms, cannot be perceived by human beings. However, rapid head movement in very much stronger magnetic field can produce apparent light flashes (magnetophosphenes) in the visual field, providing a sensitive benchmark for magnetic field perception. Magnetophosphenes are due to stimulation of neuronal cells in the retina. The threshold for magnetophosphenes in an alternating magnetic field at 20-Hz (frequency of greatest sensitivity) is approximately 10 mT, or 100,000 mG. Magnetophosphenes also would occur if it were possible to move the head at a 20-Hz rate in a static magnetic of 10 mT or greater. From these considerations it is evident that the threshold static magnetic field for magnetophosphenes due to rapid head movement would be greater than 100,000 mG. For this reason, the very much weaker static magnetic fields of the proposed solar farm projects would be imperceptible.

Static magnetic fields at utility solar generation facilities have been measured and characterized with regard for electrical equipment found at solar facilities (EPRI 2012a). Measurements were made as close as 1 inch from equipment. At such close separations, static magnetic fields were measured at up to 2,000 mG at a DC fuse box and 3,000 mG at an inverter. The static fields attenuated to very much lower levels at distances greater than inches from the equipment and nowhere, including at the fuse box and inverter, did static magnetic fields exceed exposure guidelines of IEEE, ICNIRP or ACGIH (see Table 5).

In summary, the static electric and magnetic fields of the solar farm projects are highly localized, very much weaker than limits found in all safety guidelines, and imperceptible at all locations accessible to the public. They pose no known concern for human health.

Table 5. Guidelines for maximum permissible exposures to static (0-Hz) electric and magnetic fields.

Source	E-field strength (kV/m)	B-field (mT)	Notes	Reference
General public				
ICES-IEEE	5[a]	118 (1,180,000 mG)	Electric field: whole body exposure; Magnetic field: torso and head exposure	(IEEE Std C95.6-2002 2002; IEEE Std C95.3.1-2010 2010)
ICNIRP	[c]	400 (4,000,000 mG)	Magnetic field: applies to any part of body	(ICNIRP 2009)
Occupational				
ACGIH	25	60/600[b]	24-h average (TLV-TWA-8) for whole body/ extremities	(ACGIH 2011)
ICES-IEEE	20	353 (3,530,000 mG)	Magnetic field exposure to torso and head	(IEEE Std C95.6-2002 2002)
ICNIRP	[d]	2,000/8,000	head, trunk/limbs	(ICNIRP 2009)

Notes:
(a) Electric field limit is 10 kV/m within a powerline right-of-way.
(b) TLV-TWA-8 shown in table; ceiling values (not to exceeded): 2000/5000 mT for whole body/extremities; 0.5 mT for pacemakers and other implanted medical electronics (ACGIH: American Council of Governmental Industrial Hygienists).
(c) Limit at 1 Hz is 5 kV/m.
(d) Limit at 1 Hz is 20 kV/m.

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***PERSONAL*:**
Married to Ann Sheppard; three adult offspring.

***EDUCATION AND EMPLOYMENT HISTORY*:**

Consultant and Research Scientist, biological, biophysical and health effects of electric and magnetic fields and electromagnetic radiation, 1975–present.

Principal, Asher Sheppard Consulting, 1993–present.

Assistant Research Professor of Physiology, Loma Linda University, Loma Linda, California, 1979–2009.

Member, Research Staff, Department of Neurosurgery, Loma Linda University School of Medicine, 1988–1993.

Research Physicist, Jerry L. Pettis Memorial Veterans Medical Center, Loma Linda, California. Electrophysiological research on invertebrate and mammalian nervous system interactions with ELF electric and magnetic fields. Theory of the biophysical transduction of ELF signals in biological systems. Design and develop instrumentation; design and develop computer techniques for data acquisition and data analysis. Design and develop apparatus for use by my colleagues in investigations of field exposure of cells, tissues and animals. Supervise technical personnel, manage laboratory and electronics shop. April, 1978–May, 1993.

National Institute of Environmental Health Sciences (NIEHS) Fellow and UCLA Postdoctoral Scholar, Environmental Neurobiology Laboratory (W.R. Adey, director) of the Brain Research Institute at UCLA (C.D. Clemente, director). Biophysics and physiology of the neuronal membrane; brain response to self-generated fields (EEG) and to external fields. Experimental research on invertebrate neurophysiology. May 1976–March 1978.

NIEHS Fellow and NYU Postdoctoral Intern, Laboratory of Environmental Studies (M. Eisenbud, director), Institute of Environmental Medicine (N. Nelson, director), New York University Medical Center. Researched and co-authored book on biophysics and biological effects of extremely low frequency electric and magnetic fields. Training in environmental science, the toxicology of chemical and radioactive agents, and the biological effects of non-ionizing (microwave) radiation. October 1974–April 1976.

Graduate studies in physics at State University of New York, Buffalo, New York. Instructor in astronomy and physics. Doctoral thesis research in experimental atomic and molecular physics (beam resonance spectroscopy); dissertation, "Elastic scattering cross sections of metastable barium on helium and argon." MS, June 1971, PhD, February 1975.

Consolidated Edison Company of New York, Inc., Cadet Engineer 1963–1964; summer app't. June–August 1965.

Student, Union College, Schenectady, New York, BS, June 1963.

***RESEARCH GRANTS and CONTRACTS*:**

"Improved Exposure Assessment for Epidemiologic Studies of Mobile Phone Users," Subcontractor to Exponent Health Group, Inc. (Menlo Park, CA), Cooperative Research and Development Agreement (CRADA) between for US Food and Drug Administration (Rockville, MD) and Cellular Telephone and Internet Association (Washington, D.C.), 2003 – 2006.

"Attributable Fraction Estimates for EMF Exposures," NIEHS and DOE (RAPID Program), Principal Investigator, 1997–1999.

"Policy Analysis for Public Schools (K–12) and School District Day Care Centers Pertaining to Possible Health Effects from Power Frequency Electromagnetic Fields (EMFs)," California Department of Health Services and Public Health Institute of California, Electric and Magnetic Fields Program (under subcontract to EcoAnalysis, Inc.), 1995–present.

"Estimating the Potential Public Health Risks Attributable to Residential Exposures to Power Frequency Electric and Magnetic Fields Using Data from Epidemiologic Studies and Exposure Assessment Research, Southern California Edison Co., 1994–1996.

"Animal Models and Tissue Culture Studies of Possible Brain Tumor Promotion by Simulated Cellular Car Phone RF Fields," Motorola, Inc., (co-investigator), 1991–1993.

"Tissue Interactions with Non-Ionizing Electromagnetic Fields," U.S. Department of Energy (co-investigator), 1978–1993.

"Information Concerning Regulation of Electromagnetic Fields of Electric Power Facilities," State of Florida, Department of Environmental Regulation (principal investigator), 1986–1987.

Assay for Tumor Promotion by Sinusoidal 60-Hz Electric Fields Using C3H/10T1/2 Fibroblast Cultures," Southern California Edison Co. (co-investigator), 1986–1990.

"**Tests of a Model for Macromolecular Migration on Myoblast Cell Surfaces Exposed to Alternating Electric Fields," Office of Naval Research (principal investigator), 1984–1986.**

"Bioeffects of Electric Fields, Neurophysiological and Sensory Behavior: Studies of Frequency and Field Strength Dependencies," Southern California Edison Co. (co-principal investigator), 1979–1986.

"**Cellular and Organismal Response to Combined Kilohertz and other Nonionizing Electromagnetic Fields," Office of Naval Research (co-investigator), 1984–1987.**

"**Electromagnetic Radiation and Biological Systems," National Center for Radio logical Devices (formerly Bureau of Radiological Health), Department of Health and Human Services (researcher), 1979–1983.**

***REVIEW, ADVISORY, and CONSULTATIVE POSITIONS*:**

Consultant to Nevada Energy – EMF health and safety (transmission line and substation) of Bordertown Project as subcontractor to Enertech (2012 -2013).

Consultant to EPRI – Preparation of resource paper on environmental, health and safety issues of HVDC transmission (2011- 2012).

Consultant to Seattle City Light -- framework for utility managers on issues of health and safety of power frequency electric and magnetic fields, Seattle, WA, 2009-present.

Consultant to City of Yucaipa on RF fields near a 4-G cellular network base station and related health & safety issues, 2009-2010.

Consultant to Montana Department of Environmental Quality – EMF health and safety (transmission, and substations) of Montanore Project as subcontractor to ERO Resources (2006-2007).

Chairman, NIH Center for Scientific Review, Special Emphasis Panel (Electromagnetics), Feb., 2008; Invited reviewer 1993 -

Reviewer for *Bioelectromagnetics, BioScience, Brain Research, FASEB Journal, Health Physics, IEEE Transactions on Biomedical Engineering, Neuroscience, Journal of Bioelectricity, Radiation Research, Risk Analysis,* National Institutes of Health, National Science Foundation, Electric Power Research Institute.

California Department of Education— workshops on transmission line setback policy at school facilities, participant, contributor of written analysis and comments, 2005 – 2006.

ANATEL (Federal Telecommunications Agency) Brasilia, Brazil, 2000–2001.

California Public Utilities Commission through subcontracts to Dudek & Associates, Inc., 1998–present, Aspen Environmental Group (2003-present).

National Council on Radiation Protection and Measurements Scientific Committee 89-4 (Pulse-Modulated Radiofrequency Fields), 1995–2003.

Motorola, Inc., 1994–2005.

Harvard Center for Risk Analysis Peer Review Board for Cellular Telephones, 1994–1999.

General Electric Company, 1996–1997.

***Bioelectromagnetics* (journal)–Associate Editor, 1992–1994; Member, Editorial Board, 1984–2008.**

Scientific Advisor, California Department of Health Services, Oakland, 1989–2000.

IEEE International Committee on Electromagnetic Safety (ICES), Standards Coordinating Committee 28 (SCC28) Subcommittee 4 on Effects of Radiofrequency Electromagnetic Fields 1993–present; Chairman, subcommittee on Role of Mechanisms in Standards-Setting (1995–present).

IEEE International Committee on Electromagnetic Safety (ICES), Standards Coordinating Committee 28 (SCC28) Subcommittee 3 on Effects of Extremely Low Frequency Electric and Magnetic Fields, Member, 1993–present; Chairman, subcommittee on Literature Review (1996–2001).

Consultant on evaluation of scientific literature on biological effects of ELF electromagnetic fields for the Department of the Navy, Research and Development Laboratories, Culver City, CA, 1985–1999.

EMF Science Review Symposium for Epidemiological Research Findings, organized by the National Institute of Environmental Health Science for the NIEHS/DOE EMF *RAPID* Program. (a) Rapporteur, "Methodological Issues and Problems: Can These Explain the Effect or Lack of Effect Seen in Epidemiological Studies?"; (b) Member, "EMF and Adverse Reproductive Outcomes", 1998.

Santa Clara Unified School District, 1994; City of Beverly Hills, 1994, California Public Utilities Commission, 1993; National Institutes of Health (Reviewer, Radiation Studies ad hoc panel on EMFs, 1992).

Department of Energy Workshop on a National Research Strategy, 1991, Arlington, VA.

Member, Bioelectromagnetics Committee on a National Research Plan on Electric and Magnetic Field Health Effects Research, 1991–1992.

Member, Feasibility Study Committee on ELF Electric and Magnetic Field Health Effects, Health Effects Institute, Cambridge, MA, 1991.

Consultant to the Seattle City Council on policy, regulations, and scientific literature concerning non-ionizing radiation from telecommunications facilities (radiofrequency fields), Seattle, WA, 1991.

Consultant to Seattle City Light on health and safety of power frequency electric and magnetic fields, Seattle, WA, 1988.

Consultant, reviewer for United States Environmental Protection Agency on "Evaluation of the potential carcinogenicity of electromagnetic fields," (1990, 1991).

Member, IEEE Committee on Man and Radiation (COMAR), 1988–1996.

Member, Nonionizing Radiation Protection Scientific Working Group, WHO Regional Office for Europe, 1986–1990.

Member, Science Advisory Group on Biological and Human Health Effects of ELF Electric and Magnetic Fields. American Institute of Biological Sciences, Arlington, VA, 1984–1985.

Scientific Advisor, Minnesota Environmental Quality Board, 1984–1985.

Consultant to Seattle City Light on health and safety of the proposed Duwamish-Delridge transmission line, Seattle, WA, July, 1984–1986.

Scientific Advisor, World Health Organization, "Working Group on Criteria Document on Health Effects of ELF Fields," Geneva, Switzerland, 1980–1984.

Rapporteur, World Health Organization "Task Group on Health Effects of ELF Fields." Geneva, Switzerland, 1984.

Member, Advisory Group, CRC Handbook on Air Ions, 1983–1986.

Scientific Advisor, Montana Department of Natural Resources and Conservation, Helena, MT, 1982–1983.

Scientific Advisor, Minnesota Environmental Quality Board, 1981–1982.

Member, Scientific Advisory Panel on Health Effects of Electric Fields, Bonneville Power Administration, Vancouver, WA, 1980.

***HONORS and AWARDS*:**

Chairman, "Bioelectromagnetics 2005", Dublin, Ireland. Outstanding Environmental Analysis Document award (2005) by AEP San Diego Chapter as Dudek team member on CPUC/SDG&E Otay Mesa Power Purchase Agreement Transmission Project EIR. President (2001-2002) of The Bioelectromagnetics Society. EEEL Outstanding Paper Award, National Institute of Standards and Technology, 1994. NIEHS Fellow, 1974–1976. Listed in: Who's Who in American Science, Guide to Energy Specialists. Sternfeld Prize in Philosophy (1963). New York State Regents Science and Engineering Scholarship (1959–1963).

***MEMBERSHIPS*:**

American Association for Advancement of Science, American Physical Society, Bioelectromagnetics Society, European Bioelectromagnetics Association, Biophysical Society, Society for Neuroscience.

Bioelectromagnetics Society (BEMS) activities: Member, Long-range planning committee (2002-2005); President (2001-2002); Chairman, Publications Committee (1998-2001); Member, Board of Directors, (1998-2001; 1986–1989); chairman, Membership Committee (1987–1989).

***SELECTED INVITATIONS to SPEAK*:**

2006: Progress in Electromagnetics Research Symposium (PIERS), Cambridge, MA, March.

2004: Gordon Research Conference on Bioelectrochemistry, invited speaker and chairperson of session on biophysical mechanisms for RF and MRI, New London, CT, July; International workshop: "Biological Effects of Electromagnetic Fields", Kos, Greece, invited speaker and member of Advisory Committee, October;

2003: "Mobile Telephony and Health". Finnish National Research Programme 1998-2003, Helsinki, Finland, October 17.

2002: International workshop: "Biological Effects of Electromagnetic Fields", Rhodes, Greece; Workshop: "Epidemiological Considerations in Electromagnetics", (The Bioelectromagnetics Society), Washington, D.C.

2001: Asia-Pacific Radio Science Conference (International Union of Radio Scientists – URSI), Tokyo, Japan.

***LICENSURE*:**

General Radiotelephone Communications Certificate (formerly First Class Certificate), Federal Communications Commission, Washington, DC.

***PUBLICATIONS and REPORTS*:**

Kuehn S, Kelsh MA, Kuster N, Sheppard AR, Shum M, 2013. Analysis of mobile phone design features affecting radio frequency power absorbed in a human head phantom. Bioelectromagnetics 34(6):479-488.

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— (1997). Biological and Health effects of electric and magnetic fields from video display terminals. A technical Information Statement. COMAR VDT sub-committee, AR Sheppard, chairman. *IEEE Engineering in Medicine and Biology 16(3)*:87-92.

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Stell, M, AR Sheppard and WR Adey, 1993. The effect of moving air on detection of a 60-Hz electric field. Bioelectromagnetics 14(1):67-78.

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Lyle, DB, X Wang, RD Ayotte, AR Sheppard, and WR Adey, 1991. Calcium uptake by leukemic and normal T-lymphocytes exposed to low frequency magnetic fields. *Bioelectromagnetics 12(3):145-156*.

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Elder, JA, PA Czerski, MA Stuchly, KH Mild, and AR Sheppard, 1989. Radiofrequency radiation (chapter 4). In: *Nonionizing radiation protection*, second edition, MJ Suess and DA Benwell-Morison, eds. World Health Organization Regional Publications, European Series, No. 25. World Health Organization Regional Office for Europe, Copenhagen. pp 117-173.

Lyle, DB, RD Ayotte, AR Sheppard and WR Adey, 1988. Suppression of T-lymphocyte cytotoxicity following exposure to 60-Hz electric fields. *Bioelectromagnetics 9(3)*:303-313.

Sheppard, AR, 1987. Effects of a 60-Hz magnetic field on a spontaneously active neuronal system. Proceedings of the Ninth Annual Conference of the IEEE Engineering in Medicine and Biology Society, IEEE #87CH2513-0, Boston, November. pp. 79-80.

Lin-Liu, S and AR Sheppard, 1987. Tests of a model for macromolecular migration on myoblast cell surfaces exposed to alternating electric fields. Final Report on Contract N00014-84-K-0707, Office of Naval Research, Arlington.

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Sheppard, AR, 1987. ELF studies, a review of *Biological Effects and Dosimetry of Static and ELF Electromagnetic Fields*, M Grandolfo, SM Michaelson and A Rindi, eds., Plenum Press, New York, 1985, *Bioscience* 37(10) :740-1, Nov.

Adey, WR and AR Sheppard, 1987. Cell surface ionic phenomena in transmembrane signaling to intracellular enzyme systems. In: *Mechanistic Approaches to Interactions of Electromagnetic Fields with Living Systems*, M Blank and E Findl, eds., Plenum Press, N.Y., pp 365-387.

WEST Associates. Justesen DR, Peters JM, Sahl JD, Sheppard AR, Smith RF, and Wright WE, 1986. A critical review of the scientific literature on low-frequency electric and magnetic fields: assessment of possible effects on human health and recommendations for research. Southern California Edison Company, Rosemead, California, 95pp. + 6 app.

Bawin, SM, ML Abu-Assal, AR Sheppard, MD Mahoney and WR Adey, 1986. Long-term effects of sinusoidal extracellular electric fields in penicillin-treated rat hippocampal slices. *Brain Research 399*:194-199.

Bawin, SB, Sheppard, AR, Mahoney, MD, Abu-Assal, M and Adey, WR, 1986. Comparison between the effects of extracellular direct and sinusoidal currents on excitability in hippocampal slices. *Brain Research 362*: 350-354.

Sheppard, AR, 1985. Cellular studies of effects of ELF electric and magnetic fields. In: *Biological and Human Health Effects of ELF Electric and Magnetic Fields*, Report on the Navy ELF Communication System, American Institute of Biological Sciences, Arlington, VA.

Bawin, SM, AR Sheppard, MD Mahoney and WR Adey, 1984. Influences of sinusoidal electric fields on excitability in the hippocampal slice. *Brain Research 323*: 227-237.

Sheppard, AR, 1983. "Biological Effects of High Voltage AC Transmission Lines" Report to the Montana Department of Natural Resources and Conservation, Helena. NTIS publication, PB 83 207241, February.

Sheppard, AR, 1983. "Biological Effects of High Voltage Direct Current Transmission Lines," Report to the Montana Department of Natural Resources and Conservation, Helena. NTIS publication, PB 83 207258, April.

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Health and Safety Impacts of Solar Photovoltaics

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Health and Safety Impacts of Solar Photovoltaics

The increasing presence of utility-scale solar photovoltaic (PV) systems (sometimes referred to as solar farms) is a rather new development in North Carolina's landscape. Due to the new and unknown nature of this technology, it is natural for communities near such developments to be concerned about health and safety impacts. Unfortunately, the quick emergence of utility-scale solar has cultivated fertile grounds for myths and half-truths about the health impacts of this technology, which can lead to unnecessary fear and conflict.

Photovoltaic (PV) technologies and solar inverters are not known to pose any significant health dangers to their neighbors. The most important dangers posed are increased highway traffic during the relative short construction period and dangers posed to trespassers of contact with high voltage equipment. This latter risk is mitigated by signage and the security measures that industry uses to deter trespassing. As will be discussed in more detail below, risks of site contamination are much less than for most other industrial uses because PV technologies employ few toxic chemicals and those used are used in very small quantities. Due to the reduction in the pollution from fossil-fuel-fired electric generators, the overall impact of solar development on human health is overwhelmingly positive. This pollution reduction results from a partial replacement of fossil-fuel fired generation by emission-free PV-generated electricity, which reduces harmful sulfur dioxide (SO_2), nitrogen oxides (NO_x), and fine particulate matter ($PM_{2.5}$). Analysis from the National Renewable Energy Laboratory and the Lawrence Berkeley National Laboratory, both affiliates of the U.S. Department of Energy, estimates the health-related air quality benefits to the southeast region from solar PV generators to be worth 8.0 ¢ per kilowatt-hour of solar generation.[1] This is in addition to the value of the electricity and suggests that the air quality benefits of solar are worth more than the electricity itself.

Even though we have only recently seen large-scale installation of PV technologies, the technology and its potential impacts have been studied since the 1950s. A combination of this solar-specific research and general scientific research has led to the scientific community having a good understanding of the science behind potential health and safety impacts of solar energy. This paper utilizes the latest scientific literature and knowledge of solar practices in N.C. to address the health and safety risks associated with solar PV technology. These risks are extremely small, far less than those associated with common activities such as driving a car, and vastly outweighed by health benefits of the generation of clean electricity.

This paper addresses the potential health and safety impacts of solar PV development in North Carolina, organized into the following four categories:

(1) Hazardous Materials
(2) Electromagnetic Fields (EMF)
(3) Electric Shock and Arc Flash
(4) Fire Safety

1. Hazardous Materials

One of the more common concerns towards solar is that the panels (referred to as "modules" in the solar industry) consist of toxic materials that endanger public health. However, as shown in this section, solar energy systems may contain small amounts of toxic materials, but these materials do not endanger public health. To understand potential toxic hazards coming from a solar project, one must understand system installation, materials used, the panel end-of-life protocols, and system operation. This section will examine these aspects of a solar farm and the potential for toxicity impacts in the following subsections:

1.1 Project Installation/Construction

The system installation, or construction, process does not require toxic chemicals or processes. The site is mechanically cleared of large vegetation, fences are constructed, and the land is surveyed to layout exact installation locations. Trenches for underground wiring are dug and support posts are driven into the ground. The solar panels are bolted to steel and aluminum support structures and wired together. Inverter pads are installed, and an inverter and transformer are installed on each pad. Once everything is connected, the system is tested, and only then turned on.

Figure 1: Utility-scale solar facility (5 MW_{AC}) located in Catawba County. Source: Strata Solar

1.2 System Components

1.2.1 Solar Panels: Construction and Durability

Solar PV panels typically consist of glass, polymer, aluminum, copper, and semiconductor materials that can be recovered and recycled at the end of their useful life.[2] Today there are two PV technologies used in PV panels at utility-scale solar facilities, silicon, and thin film. As of 2016, all thin film used in North Carolina solar facilities are cadmium telluride (CdTe) panels from the US manufacturer First Solar, but there are other thin film PV panels available on the market, such as Solar Frontier's CIGS panels. Crystalline silicon technology consists of silicon wafers which are made into cells and assembled into panels, thin film technologies consist of thin layers of semiconductor material deposited onto glass, polymer or metal substrates. While there are differences in the components and manufacturing processes of these two types of solar technologies, many aspects of their PV panel construction are very similar. Specifics about each type of PV chemistry as it relates to toxicity are covered in subsections a, b, and c in section 1.2.2; on crystalline silicon, cadmium telluride, and CIS/CIGS respectively. The rest of this section applies equally to both silicon and thin film panels.

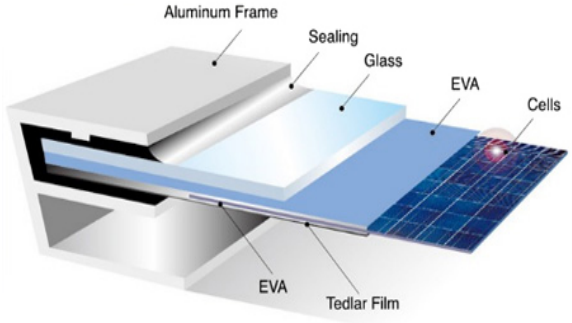

Figure 2: Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: www.riteksolar.com.tw

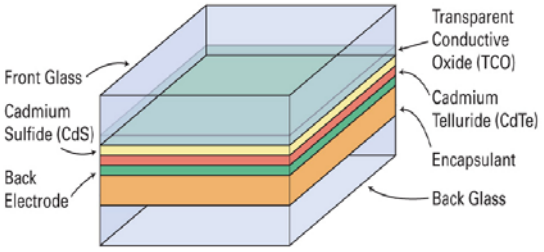

Figure 3: Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: www.homepower.com

To provide decades of corrosion-free operation, PV cells in PV panels are encapsulated from air and moisture between two layers of plastic. The encapsulation layers are protected on the top with a layer of tempered glass and on the backside with a polymer sheet. Frameless modules include a protective layer of glass on the rear of the panel, which may also be tempered. The plastic ethylene-vinyl acetate (EVA) commonly provides the cell encapsulation. For decades, this same material has been used between layers of tempered glass to give car windshields and hurricane windows their great strength. In the same way that a car windshield cracks but stays intact, the EVA layers in PV panels keep broken panels intact (see Figure 4). Thus, a damaged module does not generally create small pieces of debris; instead, it largely remains together as one piece.

Figure 4: The mangled PV panels in this picture illustrate the nature of broken solar panels; the glass cracks but the panel is still in one piece. Image Source: http://img.alibaba.com/photo/115259576/broken_solar_panel.jpg

PV panels constructed with the same basic components as modern panels have been installed across the globe for well over thirty years.[3] The long-term durability and performance demonstrated over these decades, as well as the results of accelerated lifetime testing, helped lead to an industry-standard 25-year power production warranty for PV panels. These power warranties warrant a PV panel to produce at least 80% of their original nameplate production after 25 years of use. A recent SolarCity and DNV GL study reported that today's quality PV panels should be expected to reliably and efficiently produce power for thirty-five years.[4]

Local building codes require all structures, including ground mounted solar arrays, to be engineered to withstand anticipated wind speeds, as defined by the local wind speed requirements. Many racking products are available in versions engineered for wind speeds of up to 150 miles per hour, which is significantly higher than the wind speed requirement anywhere in North Carolina. The strength of PV mounting structures were demonstrated during Hurricane Sandy in 2012 and again during Hurricane Matthew in 2016. During Hurricane Sandy, the many large-scale solar facilities in New Jersey and New York at that time suffered only minor damage.[5] In the fall of 2016, the US and Caribbean experienced destructive winds and torrential rains from Hurricane Matthew, yet one leading solar tracker manufacturer reported that their numerous systems in the impacted area received zero damage from wind or flooding.[6]

In the event of a catastrophic event capable of damaging solar equipment, such as a tornado, the system will almost certainly have property insurance that will cover the cost to cleanup and repair the project. It is in the best interest of the system owner to protect their investment against such risks. It is also in their interest to get the project repaired and producing full power as soon as possible. Therefore, the investment in adequate insurance is a wise business practice for the system owner. For the same

reasons, adequate insurance coverage is also generally a requirement of the bank or firm providing financing for the project.

1.2.2 Photovoltaic (PV) Technologies

a. Crystalline Silicon

This subsection explores the toxicity of silicon-based PV panels and concludes that they do not pose a material risk of toxicity to public health and safety. Modern crystalline silicon PV panels, which account for over 90% of solar PV panels installed today, are, more or less, a commodity product. The overwhelming majority of panels installed in North Carolina are crystalline silicon panels that are informally classified as Tier I panels. Tier I panels are from well-respected manufacturers that have a good chance of being able to honor warranty claims. Tier I panels are understood to be of high quality, with predictable performance, durability, and content. Well over 80% (by weight) of the content of a PV panel is the tempered glass front and the aluminum frame, both of which are common building materials. Most of the remaining portion are common plastics, including polyethylene terephthalate in the backsheet, EVA encapsulation of the PV cells, polyphenyl ether in the junction box, and polyethylene insulation on the wire leads. The active, working components of the system are the silicon photovoltaic cells, the small electrical leads connecting them together, and to the wires coming out of the back of the panel. The electricity generating and conducting components makeup less than 5% of the weight of most panels. The PV cell itself is nearly 100% silicon, and silicon is the second most common element in the Earth's crust. The silicon for PV cells is obtained by high-temperature processing of quartz sand (SiO_2) that removes its oxygen molecules. The refined silicon is converted to a PV cell by adding extremely small amounts of boron and phosphorus, both of which are common and of very low toxicity.

The other minor components of the PV cell are also generally benign; however, some contain lead, which is a human toxicant that is particularly harmful to young children. The minor components include an extremely thin antireflective coating (silicon nitride or titanium dioxide), a thin layer of aluminum on the rear, and thin strips of silver alloy that are screen-printed on the front and rear of cell.[7] In order for the front and rear electrodes to make effective electrical contact with the proper layer of the PV cell, other materials (called glass frit) are mixed with the silver alloy and then heated to etch the metals into the cell. This glass frit historically contains a small amount of lead (Pb) in the form of lead oxide. The 60 or 72 PV cells in a PV panel are connected by soldering thin solder-covered copper tabs from the back of one cell to the front of the next cell. Traditionally a tin-based solder containing some lead (Pb) is used, but some manufacturers have switched to lead-free solder. The glass frit and/or the solder may contain trace amounts of other metals, potentially including some with human toxicity such as cadmium. However, testing to simulate the potential for leaching from broken panels, which is discussed in more detail below, did not find a potential toxicity threat from these trace elements. Therefore, the tiny amount of lead in the grass frit and the solder is the only part of silicon PV panels with a potential to create a negative health impact. However, as described below, the very limited amount of lead involved and its strong physical and chemical attachment to other components of the PV panel means that even in worst-case scenarios the health hazard it poses is insignificant.

As with many electronic industries, the solder in silicon PV panels has historically been a lead-based solder, often 36% lead, due to the superior properties of such solder. However, recent advances in lead-free solders have spurred a trend among PV panel manufacturers to reduce or remove the lead in their panels. According to the 2015 Solar Scorecard from the Silicon Valley Toxics Coalition, a group that tracks environmental responsibility of photovoltaic panel manufacturers, fourteen companies (increased from twelve companies in 2014) manufacture PV panels certified to meet the European Restriction of

Hazardous Substances (RoHS) standard. This means that the amount of cadmium and lead in the panels they manufacture fall below the RoHS thresholds, which are set by the European Union and serve as the world's de facto standard for hazardous substances in manufactured goods.[8] The Restriction of Hazardous Substances (RoHS) standard requires that the maximum concentration found in any homogenous material in a produce is less than 0.01% cadmium and less than 0.10% lead, therefore, any solder can be no more than 0.10% lead.[9]

While some manufacturers are producing PV panels that meet the RoHS standard, there is no requirement that they do so because the RoHS Directive explicitly states that the directive does not apply to photovoltaic panels.[10] The justification for this is provided in item 17 of the current RoHS Directive: "The development of renewable forms of energy is one of the Union's key objectives, and the contribution made by renewable energy sources to environmental and climate objectives is crucial. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (4) recalls that there should be coherence between those objectives and other Union environmental legislation. Consequently, this Directive should not prevent the development of renewable energy technologies that have no negative impact on health and the environment and that are sustainable and economically viable."

The use of lead is common in our modern economy. However, only about 0.5% of the annual lead consumption in the U.S. is for electronic solder for all uses; PV solder makes up only a tiny portion of this 0.5%. Close to 90% of lead consumption in the US is in batteries, which do not encapsulate the pounds of lead contained in each typical automotive battery. This puts the lead in batteries at great risk of leaching into the environment. Estimates for the lead in a single PV panel with lead-based solder range from 1.6 to 24 grams of lead, with 13g (less than half of an ounce) per panel seen most often in the literature.[11] At 13 g/panel[12], each panel contains one-half of the lead in a typical 12-gauge shotgun shell. This amount equates to roughly 1/750th of the lead in a single car battery. In a panel, it is all durably encapsulated from air or water for the full life of the panel.[14]

As indicated by their 20 to 30-year power warranty, PV modules are designed for a long service life, generally over 25 years. For a panel to comply with its 25-year power warranty, its internal components, including lead, must be sealed from any moisture. Otherwise, they would corrode and the panel's output would fall below power warranty levels. Thus, the lead in operating PV modules is not at risk of release to the environment during their service lifetime. In extreme experiments, researchers have shown that lead can leach from crushed or pulverized panels.[15, 16] However, more real-world tests designed to represent typical trash compaction that are used to classify waste as hazardous or non-hazardous show no danger from leaching.[17, 18] For more information about PV panel end-of-life, see the Panel Disposal section.

As illustrated throughout this section, silicon-based PV panels do not pose a material threat to public health and safety. The only aspect of the panels with potential toxicity concerns is the very small amount of lead in some panels. However, any lead in a panel is well sealed from environmental exposure for the operating lifetime of the solar panel and thus not at risk of release into the environment.

b. Cadmium Telluride (CdTe) PV Panels

This subsection examines the components of a cadmium telluride (CdTe) PV panel. Research demonstrates that they pose negligible toxicity risk to public health and safety while significantly reducing the public's exposure to cadmium by reducing coal emissions. As of mid-2016, a few hundred MWs of

cadmium telluride (CdTe) panels, all manufactured by the U.S. company First Solar, have been installed in North Carolina.

Questions about the potential health and environmental impacts from the use of this PV technology are related to the concern that these panels contain cadmium, a toxic heavy metal. However, scientific studies have shown that cadmium telluride differs from cadmium due to its high chemical and thermal stability.[19] Research has shown that the tiny amount of cadmium in these panels does not pose a health or safety risk.[20] Further, there are very compelling reasons to welcome its adoption due to reductions in unhealthy pollution associated with burning coal. Every GWh of electricity generated by burning coal produces about 4 grams of cadmium air emissions.[21] Even though North Carolina produces a significant fraction of our electricity from coal, electricity from solar offsets much more natural gas than coal due to natural gas plants being able to adjust their rate of production more easily and quickly. If solar electricity offsets 90% natural gas and 10% coal, each 5-megawatt (5 MW_{AC}, which is generally 7 MW_{DC}) CdTe solar facility in North Carolina keeps about 157 grams, or about a third of a pound, of cadmium *out of* our environment.[22, 23]

Cadmium is toxic, but all the approximately 7 grams of cadmium in one CdTe panel is in the form of a chemical compound cadmium telluride,[24] which has $1/100^{th}$ the toxicity of free cadmium.[25] Cadmium telluride is a very stable compound that is non-volatile and non-soluble in water. Even in the case of a fire, research shows that less than 0.1% of the cadmium is released when a CdTe panel is exposed to fire. The fire melts the glass and encapsulates over 99.9% of the cadmium in the molten glass.[27]

It is important to understand the source of the cadmium used to manufacture CdTe PV panels. The cadmium is a byproduct of zinc and lead refining. The element is collected from emissions and waste streams during the production of these metals and combined with tellurium to create the CdTe used in PV panels. If the cadmium were not collected for use in the PV panels or other products, it would otherwise either be stockpiled for future use, cemented and buried, or disposed of.[28] Nearly all the cadmium in old or broken panels can be recycled which can eventually serve as the primary source of cadmium for new PV panels.[29]

Similar to silicon-based PV panels, CdTe panels are constructed of a tempered glass front, one instead of two clear plastic encapsulation layers, and a rear heat strengthened glass backing (together >98% by weight). The final product is built to withstand exposure to the elements without significant damage for over 25 years. While not representative of damage that may occur in the field or even at a landfill, laboratory evidence has illustrated that when panels are ground into a fine powder, very acidic water is able to leach portions of the cadmium and tellurium,[30] similar to the process used to recycle CdTe panels. Like many silicon-based panels, CdTe panels are reported (as far back ask 1998[31]) to pass the EPA's Toxic Characteristic Leaching Procedure (TCLP) test, which tests the potential for crushed panels in a landfill to leach hazardous substances into groundwater.[32] Passing this test means that they are classified as non-hazardous waste and can be deposited in landfills.[33, 34] For more information about PV panel end-of-life, see the Panel Disposal section.

There is also concern of environmental impact resulting from potential catastrophic events involving CdTe PV panels. An analysis of worst-case scenarios for environmental impact from CdTe PV panels, including earthquakes, fires, and floods, was conducted by the University of Tokyo in 2013. After reviewing the extensive international body of research on CdTe PV technology, their report concluded, "Even in the worst-case scenarios, it is unlikely that the Cd concentrations in air and sea water will exceed the environmental regulation values."[35] In a worst-case scenario of damaged panels abandoned on the ground, insignificant amounts of cadmium will leach from the panels. This is because this scenario is

much less conducive (larger module pieces, less acidity) to leaching than the conditions of the EPA's TCLP test used to simulate landfill conditions, which CdTe panels pass.[36]

First Solar, a U.S. company, and the only significant supplier of CdTe panels, has a robust panel take-back and recycling program that has been operating commercially since 2005.[37] The company states that it is "committed to providing a commercially attractive recycling solution for photovoltaic (PV) power plant and module owners to help them meet their module (end of life) EOL obligation simply, cost-effectively and responsibly." First Solar global recycling services to their customers to collect and recycle panels once they reach the end of productive life whether due to age or damage. These recycling service agreements are structured to be financially attractive to both First Solar and the solar panel owner. For First Solar, the contract provides the company with an affordable source of raw materials needed for new panels and presumably a diminished risk of undesired release of Cd. The contract also benefits the solar panel owner by allowing them to avoid tipping fees at a waste disposal site. The legal contract helps provide peace of mind by ensuring compliance by both parties when considering the continuing trend of rising disposal costs and increasing regulatory requirements.

c. CIS/CIGS and other PV technologies

Copper indium gallium selenide PV technology, often referred to as CIGS, is the second most common type of thin-film PV panel but a distant second behind CdTe. CIGS cells are composed of a thin layer of copper, indium, gallium, and selenium on a glass or plastic backing. None of these elements are very toxic, although selenium is a regulated metal under the Federal Resource Conservation and Recovery Act (RCRA).[38] The cells often also have an extremely thin layer of cadmium sulfide that contains a tiny amount of cadmium, which is toxic. The promise of high efficiency CIGS panels drove heavy investment in this technology in the past. However, researchers have struggled to transfer high efficiency success in the lab to low-cost full-scale panels in the field.[39] Recently, a CIGS manufacturer based in Japan, Solar Frontier, has achieved some market success with a rigid, glass-faced CIGS module that competes with silicon panels. Solar Frontier produces the majority of CIS panels on the market today.[40] Notably, these panels are RoHS compliant,[41] thus meeting the rigorous toxicity standard adopted by the European Union even thought this directive exempts PV panels. The authors are unaware of any completed or proposed utility-scale system in North Carolina using CIS/CIGS panels.

1.2.3 Panel End-of-Life Management

Concerns about the volume, disposal, toxicity, and recycling of PV panels are addressed in this subsection. To put the volume of PV waste into perspective, consider that by 2050, when PV systems installed in 2020 will reach the end of their lives, it is estimated that the global annual PV panel waste tonnage will be 10% of the 2014 global e-waste tonnage.[42] In the U.S., end-of-life disposal of solar products is governed by the Federal Resource Conservation and Recovery Act (RCRA), as well as state policies in some situations. RCRA separates waste into hazardous (not accepted at ordinary landfill) and solid waste (generally accepted at ordinary landfill) based on a series of rules. According to RCRA, the way to determine if a PV panel is classified as hazardous waste is the Toxic Characteristic Leaching Procedure (TCLP) test. This EPA test is designed to simulate landfill disposal and determine the risk of hazardous substances leaching out of the landfill.[43, 44, 45] Multiple sources report that most modern PV panels (both crystalline silicon and cadmium telluride) pass the TCLP test.[46, 47] Some studies found that some older (1990s) crystalline silicon panels, and perhaps some newer crystalline silicon panels (specifics are not given about vintage of panels tested), do not pass the lead (Pb) leachate limits in the TCLP test.[48, 49]

The test begins with the crushing of a panel into centimeter-sized pieces. The pieces are then mixed in an acid bath. After tumbling for eighteen hours, the fluid is tested for forty hazardous substances that all must be below specific threshold levels to pass the test. Research comparing TCLP conditions to conditions of damaged panels in the field found that simulated landfill conditions provide overly conservative estimates of leaching for field-damaged panels.[50] Additionally, research in Japan has found no detectable Cd leaching from cracked CdTe panels when exposed to simulated acid rain.[51]

Although modern panels can generally be landfilled, they can also be recycled. Even though recent waste volume has not been adequate to support significant PV-specific recycling infrastructure, the existing recycling industry in North Carolina reports that it recycles much of the current small volume of broken PV panels. In an informal survey conducted by the NC Clean Energy Technology Center survey in early 2016, seven of the eight large active North Carolina utility-scale solar developers surveyed reported that they send damaged panels back to the manufacturer and/or to a local recycler. Only one developer reported sending damaged panels to the landfill.

The developers reported at that time that they are usually paid a small amount per panel by local recycling firms. In early 2017, a PV developer reported that a local recycler was charging a small fee per panel to recycle damaged PV panels. The local recycling firm known to authors to accept PV panels described their current PV panel recycling practice as of early 2016 as removing the aluminum frame for local recycling and removing the wire leads for local copper recycling. The remainder of the panel is sent to a facility for processing the non-metallic portions of crushed vehicles, referred to as "fluff" in the recycling industry.[52] This processing within existing general recycling plants allows for significant material recovery of major components, including glass which is 80% of the module weight, but at lower yields than PV-specific recycling plants. Notably almost half of the material value in a PV panel is in the few grams of silver contained in almost every PV panel produced today. In the long-term, dedicated PV panel recycling plants can increase treatment capacities and maximize revenues resulting in better output quality and the ability to recover a greater fraction of the useful materials.[53] PV-specific panel recycling technologies have been researched and implemented to some extent for the past decade, and have been shown to be able to recover over 95% of PV material (semiconductor) and over 90% of the glass in a PV panel.[54]

A look at global PV recycling trends hints at the future possibilities of the practice in our country. Europe installed MW-scale volumes of PV years before the U.S. In 2007, a public-private partnership between the European Union and the solar industry set up a voluntary collection and recycling system called PV CYCLE. This arrangement was later made mandatory under the EU's WEEE directive, a program for waste electrical and electronic equipment.[55] Its member companies (PV panel producers) fully finance the association. This makes it possible for end-users to return the member companies' defective panels for recycling at any of the over 300 collection points around Europe without added costs. Additionally, PV CYCLE will pick up batches of 40 or more used panels at no cost to the user. This arrangement has been very successful, collecting and recycling over 13,000 tons by the end of 2015.[56]

In 2012, the WEEE Directive added the end-of-life collection and recycling of PV panels to its scope.[57] This directive is based on the principle of extended-producer-responsibility. It has a global impact because producers that want to sell into the EU market are legally responsible for end-of-life management. Starting in 2018, this directive targets that 85% of PV products "put in the market" in Europe are recovered and 80% is prepared for reuse and recycling.

The success of the PV panel collection and recycling practices in Europe provides promise for the future of recycling in the U.S. In mid-2016, the US Solar Energy Industry Association (SEIA) announced that they are starting a national solar panel recycling program with the guidance and support of many

leading PV panel producers.[58] The program will aggregate the services offered by recycling vendors and PV manufacturers, which will make it easier for consumers to select a cost-effective and environmentally responsible end-of-life management solution for their PV products. According to SEIA, they are planning the program in an effort to make the entire industry landfill-free. In addition to the national recycling network program, the program will provide a portal for system owners and consumers with information on how to responsibly recycle their PV systems.

While a cautious approach toward the potential for negative environmental and/or health impacts from retired PV panels is fully warranted, this section has shown that the positive health impacts of reduced emissions from fossil fuel combustion from PV systems more than outweighs any potential risk. Testing shows that silicon and CdTe panels are both safe to dispose of in landfills, and are also safe in worst case conditions of abandonment or damage in a disaster. Additionally, analysis by local engineers has found that the current salvage value of the equipment in a utility scale PV facility generally exceeds general contractor estimates for the cost to remove the entire PV system.[59, 60, 61]

1.2.4 Non-Panel System Components (racking, wiring, inverter, transformer)

While previous toxicity subsections discussed PV panels, this subsection describes the non-panel components of utility-scale PV systems and investigates any potential public health and safety concerns. The most significant non-panel component of a ground-mounted PV system is the mounting structure of the rows of panels, commonly referred to as "racking". The vertical post portion of the racking is galvanized steel and the remaining above-ground racking components are either galvanized steel or aluminum, which are both extremely common and benign building materials. The inverters that make the solar generated electricity ready to send to the grid have weather-proof steel enclosures that protect the working components from the elements. The only fluids that they might contain are associated with their cooling systems, which are not unlike the cooling system in a computer. Many inverters today are RoHS compliant.

The electrical transformers (to boost the inverter output voltage to the voltage of the utility connection point) do contain a liquid cooling oil. However, the fluid used for that function is either a non-toxic mineral oil or a biodegradable non-toxic vegetable oil, such as BIOTEMP from ABB. These vegetable transformer oils have the additional advantage of being much less flammable than traditional mineral oils. Significant health hazards are associated with old transformers containing cooling oil with toxic PCBs. Transfers with PCB-containing oil were common before PCBs were outlawed in the U.S. in 1979. PCBs still exist in older transformers in the field across the country.

Other than a few utility research sites, there are no batteries on- or off-site associated with utility-scale solar energy facilities in North Carolina, avoiding any potential health or safety concerns related to battery technologies. However, as battery technologies continue to improve and prices continue to decline we are likely to start seeing some batteries at solar facilities. Lithium ion batteries currently dominate the world utility-scale battery market, which are not very toxic. No non-panel system components were found to pose any health or environmental dangers.

1.4 Operations and Maintenance – Panel Washing and Vegetation Control

Throughout the eastern U.S., the climate provides frequent and heavy enough rain to keep panels adequately clean. This dependable weather pattern eliminates the need to wash the panels on a regular basis. Some system owners may choose to wash panels as often as once a year to increase production, but most in N.C. do not regularly wash any PV panels. Dirt build up over time may justify panel washing a few times over the panels' lifetime; however, nothing more than soap and water are required for this activity.

The maintenance of ground-mounted PV facilities requires that vegetation be kept low, both for aesthetics and to avoid shading of the PV panels. Several approaches are used to maintain vegetation at NC solar facilities, including planting of limited-height species, mowing, weed-eating, herbicides, and grazing livestock (sheep). The following descriptions of vegetation maintenance practices are based on interviews with several solar developers as well as with three maintenance firms that together are contracted to maintain well over 100 of the solar facilities in N.C. The majority of solar facilities in North Carolina maintain vegetation primarily by mowing. Each row of panels has a single row of supports, allowing sickle mowers to mow under the panels. The sites usually require mowing about once a month during the growing season. Some sites employ sheep to graze the site, which greatly reduces the human effort required to maintain the vegetation and produces high quality lamb meat.[62]

In addition to mowing and weed eating, solar facilities often use some herbicides. Solar facilities generally do not spray herbicides over the entire acreage; rather they apply them only in strategic locations such as at the base of the perimeter fence, around exterior vegetative buffer, on interior dirt roads, and near the panel support posts. Also unlike many row crop operations, solar facilities generally use only general use herbicides, which are available over the counter, as opposed to restricted use herbicides commonly used in commercial agriculture that require a special restricted use license. The herbicides used at solar facilities are primarily 2-4-D and glyphosate (Round-up®), which are two of the most common herbicides used in lawns, parks, and agriculture across the country. One maintenance firm that was interviewed sprays the grass with a class of herbicide known as a growth regulator in order to slow the growth of grass so that mowing is only required twice a year. Growth regulators are commonly used on highway roadsides and golf courses for the same purpose. A commercial pesticide applicator license is required for anyone other than the landowner to apply herbicides, which helps ensure that all applicators are adequately educated about proper herbicide use and application. The license must be renewed annually and requires passing of a certification exam appropriate to the area in which the applicator wishes to work. Based on the limited data available, it appears that solar facilities in N.C. generally use significantly less herbicides per acre than most commercial agriculture or lawn maintenance services.

2. Electromagnetic Fields (EMF)

PV systems do not emit any material during their operation; however, they do generate electromagnetic fields (EMF), sometimes referred to as radiation. EMF produced by electricity is non-ionizing radiation, meaning the radiation has enough energy to move atoms in a molecule around (experienced as heat), but not enough energy to remove electrons from an atom or molecule (ionize) or to damage DNA. As shown below, modern humans are all exposed to EMF throughout our daily lives without negative health impact. Someone outside of the fenced perimeter of a solar facility is not exposed to significant EMF from the solar facility. Therefore, there is no negative health impact from the EMF

produced in a solar farm. The following paragraphs provide some additional background and detail to support this conclusion.

Since the 1970s, some have expressed concern over potential health consequences of EMF from electricity, but no studies have ever shown this EMF to cause health problems.[63] These concerns are based on some epidemiological studies that found a slight increase in childhood leukemia associated with average exposure to residential power-frequency magnetic fields above 0.3 to 0.4 μT (microteslas) (equal to 3.0 to 4.0 mG (milligauss)). μT and mG are both units used to measure magnetic field strength. For comparison, the average exposure for people in the U.S. is one mG or 0.1 μT, with about 1% of the population with an average exposure in excess of 0.4 μT (or 4 mG).[64] These epidemiological studies, which found an association but not a causal relationship, led the World Health Organization's International Agency for Research on Cancer (IARC) to classify ELF magnetic fields as "possibly carcinogenic to humans". Coffee also has this classification. This classification means there is limited evidence but not enough evidence to designate as either a "probable carcinogen" or "human carcinogen". Overall, there is very little concern that ELF EMF damages public health. The only concern that does exist is for long-term exposure above 0.4 μT (4 mG) that may have some connection to increased cases of childhood leukemia. In 1997, the National Academies of Science were directed by Congress to examine this concern and concluded:

> "Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects."[65]

There are two aspects to electromagnetic fields, an electric field and a magnetic field. The electric field is generated by voltage and the magnetic field is generated by electric current, i.e., moving electrons. A task group of scientific experts convened by the World Health Organization (WHO) in 2005 concluded that there were no substantive health issues related to *electric* fields (0 to 100,000 Hz) at levels generally encountered by members of the public.[66] The relatively low voltages in a solar facility and the fact that electric fields are easily shielded (i.e., blocked) by common materials, such as plastic, metal, or soil means that there is no concern of negative health impacts from the electric fields generated by a solar facility. Thus, the remainder of this section addresses magnetic fields. Magnetic fields are not shielded by most common materials and thus can easily pass through them. Both types of fields are strongest close to the source of electric generation and weaken quickly with distance from the source.

The direct current (DC) electricity produced by PV panels produce stationary (0 Hz) electric and magnetic fields. Because of minimal concern about potential risks of stationary fields, little scientific research has examined stationary fields' impact on human health.[67] In even the largest PV facilities, the DC voltages and currents are not very high. One can illustrate the weakness of the EMF generated by a PV panel by placing a compass on an operating solar panel and observing that the needle still points north.

While the electricity throughout the majority of a solar site is DC electricity, the inverters convert this DC electricity to alternating current (AC) electricity matching the 60 Hz frequency of the grid. Therefore, the inverters and the wires delivering this power to the grid are producing non-stationary EMF, known as extremely low frequency (ELF) EMF, normally oscillating with a frequency of 60 Hz. This frequency is at the low-energy end of the electromagnetic spectrum. Therefore, it has less energy than

other commonly encountered types of non-ionizing radiation like radio waves, infrared radiation, and visible light.

The wide use of electricity results in background levels of ELF EMFs in nearly all locations where people spend time – homes, workplaces, schools, cars, the supermarket, etc. A person's average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there.[68] As stated above, the average exposure to magnetic fields in the U.S. is estimated to be around one mG or 0.1 μT, but can vary considerably depending on a person's exposure to EMF from electrical devices and wiring.[69] At times we are often exposed to much higher ELF magnetic fields, for example when standing three feet from a refrigerator the ELF magnetic field is 6 mG and when standing three feet from a microwave oven the field is about 50 mG.[70] The strength of these fields diminish quickly with distance from the source, but when surrounded by electricity in our homes and other buildings moving away from one source moves you closer to another. However, unless you are inside of the fence at a utility-scale solar facility or electrical substation it is impossible to get very close to the EMF sources. Because of this, EMF levels at the fence of electrical substations containing high voltages and currents are considered "generally negligible".[71, 72]

The strength of ELF-EMF present at the perimeter of a solar facility or near a PV system in a commercial or residential building is significantly lower than the typical American's average EMF exposure.[73, 74] Researchers in Massachusetts measured magnetic fields at PV projects and found the magnetic fields dropped to very low levels of 0.5 mG or less, and in many cases to less than background levels (0.2 mG), at distances of no more than nine feet from the residential inverters and 150 feet from the utility-scale inverters.[75] Even when measured within a few feet of the utility-scale inverter, the ELF magnetic fields were well below the International Commission on Non-Ionizing Radiation Protection's recommended magnetic field level exposure limit for the general public of 2,000 mG.[76] It is typical that utility scale designs locate large inverters central to the PV panels that feed them because this minimizes the length of wire required and shields neighbors from the sound of the inverter's cooling fans. Thus, it is rare for a large PV inverter to be within 150 feet of the project's security fence.

Anyone relying on a medical device such as pacemaker or other implanted device to maintain proper heart rhythm may have concern about the potential for a solar project to interfere with the operation of his or her device. However, there is no reason for concern because the EMF outside of the solar facility's fence is less than 1/1000 of the level at which manufacturers test for ELF EMF interference, which is 1,000 mG.[77] Manufacturers of potentially affected implanted devices often provide advice on electromagnetic interference that includes avoiding letting the implanted device get too close to certain sources of fields such as some household appliances, some walkie-talkies, and similar transmitting devices. Some manufacturers' literature does not mention high-voltage power lines, some say that exposure in public areas should not give interference, and some advise not spending extended periods of time close to power lines.[78]

3. Electric Shock and Arc Flash Hazards

There is a real danger of electric shock to anyone entering any of the electrical cabinets such as combiner boxes, disconnect switches, inverters, or transformers; or otherwise coming in contact with voltages over 50 Volts.[79] Another electrical hazard is an arc flash, which is an explosion of energy that can occur in a short circuit situation. This explosive release of energy causes a flash of heat and a shockwave, both of which can cause serious injury or death. Properly trained and equipped technicians and electricians know how to safely install, test, and repair PV systems, but there is always some risk of

injury when hazardous voltages and/or currents are present. Untrained individuals should not attempt to inspect, test, or repair any aspect of a PV system due to the potential for injury or death due to electric shock and arc flash, The National Electric Code (NEC) requires appropriate levels of warning signs on all electrical components based on the level of danger determined by the voltages and current potentials. The national electric code also requires the site to be secured from unauthorized visitors with either a six-foot chain link fence with three strands of barbed wire or an eight-foot fence, both with adequate hazard warning signs.

4. Fire Safety

The possibility of fires resulting from or intensified by PV systems may trigger concern among the general public as well as among firefighters. However, concern over solar fire hazards should be limited because only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backsheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The rest of the panel is composed of non-flammable components, notably including one or two layers of protective glass that make up over three quarters of the panel's weight.

Heat from a small flame is not adequate to ignite a PV panel, but heat from a more intense fire or energy from an electrical fault can ignite a PV panel.[80] One real-world example of this occurred during July 2015 in an arid area of California. Three acres of grass under a thin film PV facility burned without igniting the panels mounted on fixed-tilt racks just above the grass.[81] While it is possible for electrical faults in PV systems on homes or commercial buildings to start a fire, this is extremely rare.[82] Improving understanding of the PV-specific risks, safer system designs, and updated fire-related codes and standards will continue to reduce the risk of fire caused by PV systems.

PV systems on buildings can affect firefighters in two primary ways, 1) impact their methods of fighting the fire, and 2) pose safety hazard to the firefighters. One of the most important techniques that firefighters use to suppress fire is ventilation of a building's roof. This technique allows superheated toxic gases to quickly exit the building. By doing so, the firefighters gain easier and safer access to the building, Ventilation of the roof also makes the challenge of putting out the fire easier. However, the placement of rooftop PV panels may interfere with ventilating the roof by limiting access to desired venting locations.

New solar-specific building code requirements are working to minimize these concerns. Also, the latest National Electric Code has added requirements that make it easier for first responders to safely and effectively turn off a PV system. Concern for firefighting a building with PV can be reduced with proper fire fighter training, system design, and installation. Numerous organizations have studied fire fighter safety related to PV. Many organizations have published valuable guides and training programs. Some notable examples are listed below.

- The International Association of Fire Fighters (IAFF) and International Renewable Energy Council (IREC) partnered to create an online training course that is far beyond the PowerPoint click-and-view model. The self-paced online course, "Solar PV Safety for Fire Fighters," features rich video content and simulated environments so fire fighters can practice the knowledge they've learned. www.iaff.org/pvsafetytraining
- Photovoltaic Systems and the Fire Code: Office of NC Fire Marshal
- Fire Service Training, Underwriter's Laboratory

- Firefighter Safety and Response for Solar Power Systems, National Fire Protection Research Foundation
- Bridging the Gap: Fire Safety & Green Buildings, National Association of State Fire Marshalls
- Guidelines for Fire Safety Elements of Solar Photovoltaic Systems, Orange County Fire Chiefs Association
- Solar Photovoltaic Installation Guidelines, California Department of Forestry & Fire Protection, Office of the State Fire Marshall
- PV Safety & Firefighting, Matthew Paiss, Homepower Magazine
- PV Safety and Code Development: Matthew Paiss, Cooperative Research Network

Summary

The purpose of this paper is to address and alleviate concerns of public health and safety for utility-scale solar PV projects. Concerns of public health and safety were divided and discussed in the four following sections: (1) Toxicity, (2) Electromagnetic Fields, (3) Electric Shock and Arc Flash, and (4) Fire. In each of these sections, the negative health and safety impacts of utility-scale PV development were shown to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts.

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