

GUIDELINES FOR SOLAR DEVELOPMENT IN ARIZONA

Arizona Game and Fish Department

March 12, 2010



The Arizona Game and Fish Department Mission:

To conserve, enhance, and restore Arizona's diverse wildlife resources and habitats through aggressive protection and management programs, and to provide wildlife resources and safe watercraft and off-highway vehicle recreation for the enjoyment, appreciation, and use by present and future generations.

ABSTRACT The Guidelines for Solar Development in Arizona (*Guidelines*) provide information to help reduce impacts to wildlife from solar energy development in Arizona. They include recommendations on: 1) preliminary screening of proposed solar energy projects, 2) developing avoidance and minimization measures, 3) establishing appropriate mitigation, and 4) research opportunities.

ACKNOWLEDGEMENTS These *Guidelines* were compiled by Arizona Game and Fish Department (AGFD) employees. Some of the information contained is taken from AGFD's wind guidelines: *Guidelines for Reducing Impacts to Wildlife from Wind Energy Development in Arizona*.

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TABLE OF CONTENTS

Executive Summary	4
Introduction	5
The Future for Arizona’s Wildlife	7
<i>Habitat Connectivity & Why It Is Important</i>	7
<i>What developers should consider for accommodating wildlife and promoting connectivity</i>	7
<i>What is AGFD doing to address habitat fragmentation?</i>	8
Wildlife Protection Regulations	10
<i>Federal Regulations</i>	10
<i>Arizona Game and Fish Department Regulations</i>	12
<i>Other State Regulations</i>	12
AGFD Policies on Habitat Compensation	13
AGFD Project Review	14
Preliminary Site Screening	15
<i>Data Resources for Biological Information</i>	15
Recommendations for Avoiding or Minimizing Impacts	16
<i>Meteorological Towers</i>	16
<i>Facility Design</i>	17
<i>Hydrologic Resources</i>	18
<i>Evaporation Ponds</i>	20
<i>Habitat Disturbance and Fragmentation</i>	20
<i>Vegetation Removal and Reclamation</i>	21
<i>Noxious Weed Management</i>	22
<i>Public Recreation and Access</i>	23
<i>Seasonal Timing Limitations</i>	23
<i>Transmission Lines</i>	23
<i>Fencing</i>	24
<i>Hazardous Materials</i>	25
Mitigation	27
APPENDIX A: Wildlife and Wildlife Habitat Compensation Policy	29
APPENDIX B: Research Concepts	32

Executive Summary

These *Guidelines* are recommendations and protocols to be used by solar energy developers and local permitting agencies in Arizona, and as a resource for other parties involved in the permitting process. Local governments are encouraged to integrate the recommended study proposals described herein with biological resource information and research unique to their region. The Arizona Game and Fish Department (AGFD), acting on behalf of the Arizona Game and Fish Commission, encourages the use of the *Guidelines* for the development, mitigation, and research of solar energy projects in Arizona.

This document provides a science-based approach for assessing the potential impacts a solar energy project may have on wildlife species and includes suggested measures to avoid, minimize, and mitigate identified impacts.

The document is organized around five basic project development steps:

1. Wildlife Protection Regulations
2. AGFD Regulations and Review
3. Gather preliminary information and conduct site screening
4. Identify potential impacts to wildlife
5. Mitigation

Information in the *Guidelines* was specifically designed to employ adaptive management to address local and regional concerns and site-specific conditions. Decisions on the intensity of survey effort need to be made in consultation with AGFD. The *Guidelines* do not duplicate or supersede any/or other legal requirements. This document does not mandate or limit the types of studies, mitigation, or alternatives an agency may decide to require.

Introduction

The Arizona Game and Fish Department (AGFD) recognizes and supports the development of renewable energy facilities in Arizona. AGFD understands the need for generating electricity that reduces the nation's dependence on foreign oil, carbon emissions, and the release of other pollutants associated with fossil fuel generation. AGFD is also aware of the need for utility-scale solar facilities to meet the energy consumption needs of the United States, bringing significant benefits to Arizona's economy, the country, and the environment.

However, AGFD recognizes there will be negative impacts from the development of these technologies on wildlife, the habitats on which they depend, and other multiple uses such as hunting and wildlife viewing. These impacts include wildlife mortality, habitat loss, habitat fragmentation, hydrologic impacts, and the cumulative effects from other human activities. In addition, AGFD expects that there will be unanticipated impacts from utility-scale solar operations, given that these facilities are relatively new in the United States.

Solar energy currently carries a reputation for being "green energy" and Americans expect solar energy companies to live up to this reputation. These guidelines were developed to assist companies in meeting these standards. The objective of these guidelines is to assist energy developers in identifying potential impacts to wildlife and wildlife habitats from their proposed development and potential alternatives to avoid, minimize, and/or mitigate for these negative impacts. **The first step is to contact AGFD early, during the conceptual design of your project, to initiate a collaborative process and minimize negative impacts to wildlife and their habitat. Contact AGFD's Project Evaluation Program at:**

Arizona Game and Fish Department
Project Evaluation Program
5000 W. Carefree Hwy.
Phoenix, AZ 85086
623-236-7600
pep@azgfd.gov

Habitat Loss

Wildlife habitat loss will result from the construction of large-scale utility solar facilities. The largest continuous piece of land loss will occur within the perimeter of the facility's security fence. Additional habitat loss will take place through the construction of new or expansion of existing substations, new transmission lines, and associated access roads. Project proposals for solar energy are primarily located within creosote-bursage and mixed desert scrub, grasslands, and fallow or active agriculture fields. Proposed projects can range in size from 100 to over 5,000 acres. Each project can result in significant habitat loss for wildlife.

Habitat Fragmentation

The development of utility-scale solar projects and associated construction of new substations, transmission lines, and access roads has the potential to negatively impact wildlife movement.

Solar development will impacts not only species that live within the project areas, but also species that must move through project areas.

AGFD is engaged in an ongoing process to identify wildlife corridors between crucial habitats in the state to ensure wildlife movement and genetic diversity. In addition to addressing the need for wildlife to move across obvious barriers such as roads, railroads, and canals, current efforts are also looking to maintain movement corridors across development areas, including urban, rural, and renewable energy installations. Therefore, the siting of a solar facility would require a biological investigation to determine impacts to wildlife movement.

Hydrology

Utility-scale solar facilities generally have large impervious surface areas which block or reroute surface flows, and, may use significant amounts of groundwater if using wet-cooled systems for turbines. The resulting changes in drainage patterns, storm water runoff, and depth to groundwater could result in significant negative impacts to wildlife and their habitats.

Cumulative Effects

Currently, applications for construction of solar facilities are being submitted for private, state, and federal lands totaling approximately 800,000 acres in Arizona. This scale of development will amplify the impacts to wildlife and wildlife habitats discussed above. For example, AGFD calculated the predicted population growth (MAG 2050) and current proposed solar development could result in the loss of 31% of the existing creosote-bursage and desert scrub habitats in the state. This significant loss of acreage could substantially reduce the viability of creosote flats and mixed scrub habitats and the species dependent on them. The loss of these habitats from solar development combined with losses from infrastructure development associated with population growth has the potential to result in the listing of several desert species under the Endangered Species Act.

The Future for Arizona's Wildlife

The Arizona Game and Fish Department's vision for the future of wildlife and their habitats in Arizona includes interconnected networks of large natural areas (crucial habitats) supporting viable populations of wildlife, while providing ample opportunity for people to enjoy and benefit from the presence of wildlife. Public lands, managed under the principle of multiple use, form the cornerstone of these large natural areas, and are augmented by key state and private lands which are managed in such a way to maintain their wildlife management function in perpetuity.

In AGFD's vision for Arizona, crucial wildlife habitats are distributed throughout the state, and are large enough to support viable populations of all native and desired species of wildlife found in Arizona, from the ambersnail to the black bear. An extensive network of wildlife movement corridors connect crucial habitats across public, state and private lands, preventing genetic isolation and allowing for habitat shifts caused by climate change. Biodiversity and ecological functions are maintained and restored in crucial habitats and corridors. In crucial habitats where natural processes have been altered, active wildlife management is maintained to ensure persistence of wildlife populations. High quality habitat allows for continued hunting, fishing, and viewing of Arizona's game and non-game wildlife species. Threatened and Endangered wildlife are recovered, and populations of wildlife in Arizona are maintained, enhanced, and restored.

Habitat Connectivity & Why It Is Important

Arizona's natural environment is extremely diverse, ranging from tundra on the San Francisco Peaks, to desert scrub in the Sonoran Desert. Within this range of environments is an equally diverse assortment of habitats and wildlife that have adapted to reproduce and survive. While wildlife have always had to deal with discontinuous landscapes to move between habitats in different seasons, the rate of habitat loss and fragmentation has become a threat to which most species are not equipped to adapt, hence the need for wildlife habitat connectivity.

Habitat loss and habitat fragmentation are commonly accepted as the leading causes of species extinctions. Therefore, it is essential to have connectivity for: wildlife access to resources within their home ranges; wildlife recolonization after a local extinction; species' maintenance of gene flow (the ability to evolve); species' movement in response to changing climates; maintenance of ecological processes and flows (response to disturbances, predator/prey interactions, seed dispersals, etc.); and allowance for seasonal wildlife migrations.

What developers should consider for accommodating wildlife and promoting connectivity

While some habitat loss is inevitable, habitat fragmentation can be prevented or at least reduced by appropriate site selection and the incorporation of AGFD's wildlife-friendly guidelines (www.azgfd.gov/wc/WildlifePlanning.shtml) and these *Guidelines* in the design and construction of solar projects. Connectivity can be maintained through dedicated corridors of undisturbed lands or other forms of open spaces (parks/preserves/monuments) that support wildlife and allow wildlife to move between crucial unfragmented areas. Disturbed areas

(agriculture, flood control areas, low density residential areas) can also support wildlife and may act as movement corridors, especially if the disturbance is managed for minimizing impacts to wildlife. Both crucial habitats and the corridors connecting them can contribute to meeting the economic, recreational, social, and aesthetic needs of people. Smart planning is the key to retaining connectivity between large crucial habitat areas and increasing the value of disturbed areas to both wildlife and people. Striking a balance between the needs of people and the needs of wildlife is an essential element of responsible development.

What is AGFD doing to address habitat fragmentation?

AGFD is working with partners and stakeholders to identify wildlife corridors around the state. In 2004 several state and federal agencies and conservation organizations formed the Arizona Wildlife Linkage Workgroup (AWLW) and produced the “Arizona’s Wildlife Linkages Assessment” (2006) (http://www.azdot.gov/Highways/OES/AZ_Wildlife_Linkages/index.asp, Figure 1 below).

The Arizona Wildlife Linkages Assessment is a collaboratively-developed statewide report on wildlife habitat and linkages critical to sustaining wildlife habitat connectivity with comprehensive recommendations for land use planners and managers. The AWLW has received considerable recognition as leading a groundbreaking initiative responsible for bringing the needs of wildlife to the forefront of planning processes in Arizona. The group recognized, however, that this statewide effort was only the first step and that finer-scale analyses and reports would be needed to ensure biological, social, and economic successes at the project level. In 2007 and 2008, 16 high-priority wildlife linkages from the original report were further refined (using a least-cost corridor modeling technique where appropriate) and detailed reports were produced by Dr. Paul Beier and the corridor design team at Northern Arizona University (www.corridordesign.org). These reports detail the ownership, landscape, and on-the-ground condition of each linkage and provided crucial information that planners need—such as what kind of crossing structure to consider and the importance of riparian features in the area.

Today, the AWLW is working on the next stage in this process – a comprehensive identification of wildlife corridors and the crucial habitats they connect at the county scale. By utilizing a county-by-county approach in which stakeholders and partners are brought together to identify crucial habitats and corridors, a more comprehensive wildlife linkage assessment for Arizona will be produced. County-level reports will be developed, prioritized linkages will be modeled in GIS, and additional fine-scale linkage reports will be produced and made available upon completion.

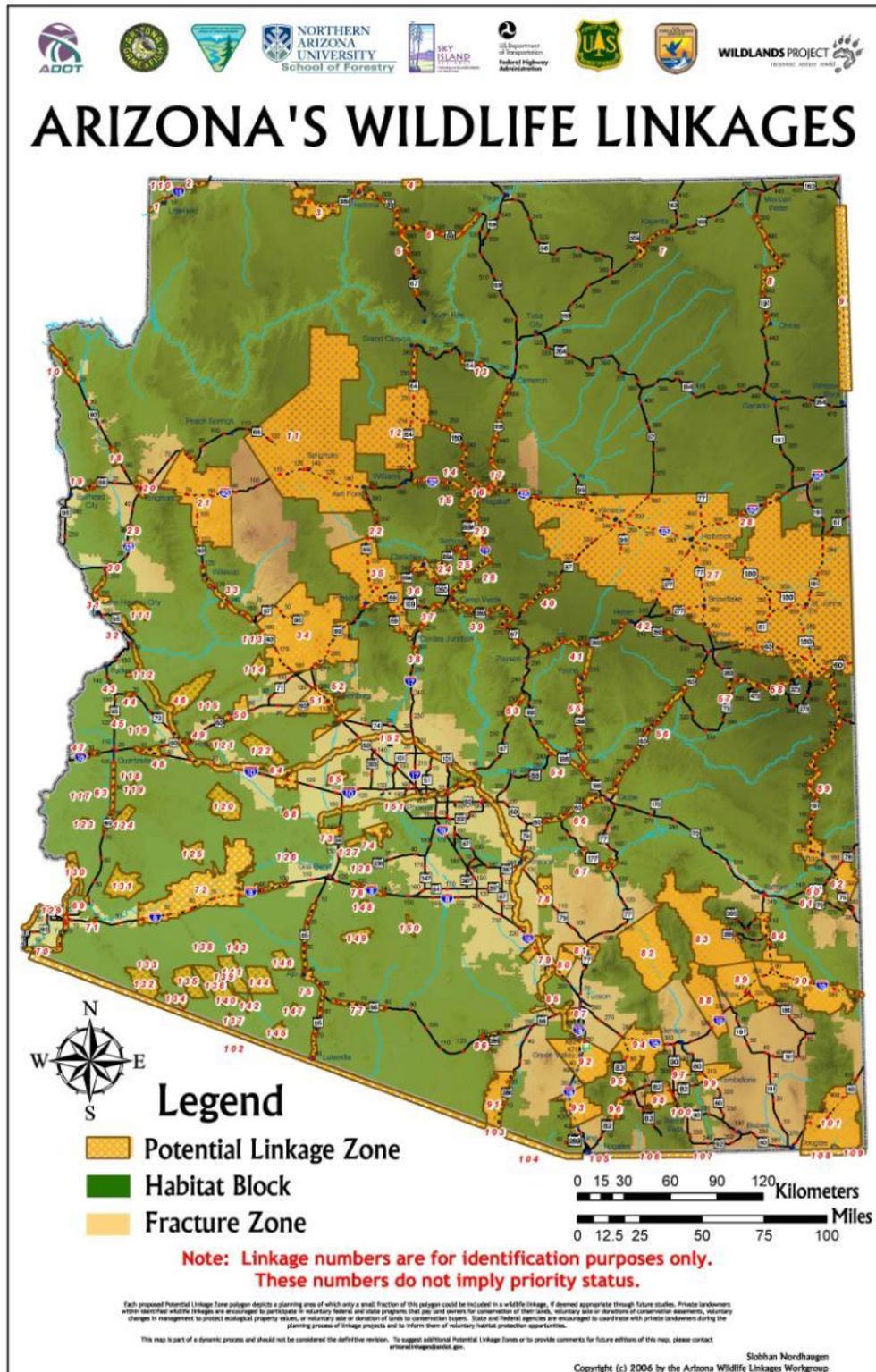


Figure 1. Arizona's Wildlife Linkages map. Each linkage identified by a number on the map is further described in the report.

Wildlife Protection Regulations

Various federal, state, and local laws regulate the permitting requirements for solar energy development in Arizona. AGFD strongly encourages adherence to these *Guidelines* to ensure impacts to wildlife populations are minimized from solar energy development and operations. Although it is not possible to absolve individuals and entities from liability for unlawfully taking wildlife under state law, AGFD will take compliance with these guidelines into consideration when considering any law enforcement action.

The permitting agency and project proponent should coordinate frequently with AGFD and USFWS throughout the process, and particularly during development of permit conditions. Permitting agencies should structure permit conditions to clearly define the obligations of the developer.

Federal Regulations

The following federal regulations may apply to protecting wildlife from the impacts of solar energy development or require federal agencies to coordinate or consult with Arizona Game and Fish Department.

- **The National Environmental Policy Act (NEPA)** and the regulations promulgated there under (42 U.S.C. § 4321, *et seq.*, 40 CFR § 1500.1, *et seq.*) require the federal government to assess the environmental impacts of any “federal action,” which includes actions undertaken (1) on federal land, (2) by a federal agency, (3) with federal funds, or (4) where the federal government will be issuing a permit. Examples when federal agencies must prepare a NEPA document for a solar development include: locating the facility on BLM land; locating transmission lines across Bureau of Land Management (BLM) land; using Western Area Power Administration (WAPA) transmission lines or obtaining a Clean Water Act 404 permit. NEPA requires federal agencies to cooperate with state and local agencies in analyzing environmental impacts of proposed federal actions. More details on NEPA can be found at <http://www.nepa.gov/nepa/regs/nepa/nepaeqia.htm>.
- **The Endangered Species Act**, 16 U.S.C. §1531, *et seq.*, executed by for U.S. Fish and Wildlife Service (USFWS) provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend. The ESA, among many other things: 1) authorizes the determination and listing of species as endangered or threatened; 2) prohibits unauthorized taking, possession, sale, and transport of endangered species (including land-use activities that “harm” or “harass”); and 3) authorizes the assessment of civil and criminal penalties for violating the Act or regulations. Taking provisions apply to private lands. ESA authorizes permits for the take of protected species if the permitted activity is for scientific purposes, is to establish experimental populations, or is incidental to an otherwise legal activity. Section 7 of the ESA requires federal agencies to insure that any action authorized, funded or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat. Section 10 allows for the development of Habitat Conservation Plans and the issuance of an incidental take permit on private lands. USFWS consults

with the state wildlife agency on Section 7 and 10 consultations. More information on the ESA can be found at <http://www.fws.gov/angered/policy/index.html>.

- **Migratory Bird Treaty Act**, 16 U.S.C. § 703, *et seq.*, prohibits taking, killing, possessing, transporting, and importing of migratory birds, including their eggs, parts, and nests, except when specifically authorized by USFWS. Slightly more than 400 species of birds that are protected by the MBTA are either resident or at least occur annually in Arizona during certain seasons of the year (winter, summer, or during migration). The MBTA authorizes permits for some activities, including but not limited to scientific collecting, depredation, propagation, and falconry. No permit provisions are available for incidental take for any project-related incidental take, including take associated with solar energy development. MBTA prohibition on take may require seasonal limitations on construction activities. For more information on the MBTA, go to <http://www.fws.gov/permits/mbpermits/regulations/mbta.html>.
- **Bald and Golden Eagle Protection Act**, 16 U.S.C. §668, *et seq.*, protects the bald eagle and the golden eagle by prohibiting, except under certain specified conditions, the take, possession, and commercial use of such birds. More information on the BGEPA can be found at <http://www.fws.gov/laws/lawsdigest/baldegl.html>.
- **Sikes Act**, 16 U.S.C. §670g, *et seq.*, requires BLM to coordinate with state wildlife agencies in the development of comprehensive plans for the conservation of wildlife. These plans may restrict uses of BLM lands, or require a plan amendment to allow an otherwise restricted use. BLM will coordinate plan development and plan amendments with the state wildlife agency.
- **Fish and Wildlife Coordination Act**, 16 U.S.C. §662, *et seq.* (FWCA) 1946 amendments, require consultation with the Fish and Wildlife Service and the state fish and wildlife agencies where the "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified" by any agency under a Federal permit or license. Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources."
- **Federal Land Policy Management Act**, 43 U.S.C. §1701 (FLPMA) is the organic act for BLM. Section 102 declares that it is the policy of the United States that (9) "the public lands be managed in a manner . . . that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use;". Section 202 (9) requires that BLM provide meaningful public involvement with state and local agencies on land use decisions.
- **Federal Water Pollution Control Act Amendments of 1972** (Clean Water Act) 33 U.S.C. §1251 *et seq.* Section 402 permits are administered by the Arizona Department of Environmental Quality (ADEQ) under authority of the Environmental Protection Agency. Solar projects may require an Arizona Pollution Discharge Elimination System (AZPDES) and/or a Stormwater Runoff permit from ADEQ. More information can be found at the ADEQ website at <http://www.azdeq.gov/environ/water/permits/azpdes.html>.
- **Federal Water Pollution Control Act Amendments of 1972** (Clean Water Act) 33 U.S.C. §1251 *et seq.* Section 404 requires a permit to dredge or put fill into a water of the U.S. 404 individual permits require a NEPA impact analysis and a FWCA consultation. 404 permits in Arizona are administered by the Los Angeles District of the Army Corps of Engineers. More information can be found at <http://www.spl.usace.army.mil/regulatory/>.

Arizona Game and Fish Department Regulations

Arizona State Statutes and AGFD Commission Policies have been established to conserve, protect, restore, and enhance fish and wildlife populations and their habitats. Project proponents should be familiar with these statutes and policies to ensure their projects are consistent with the intent of these laws and policies. Several Arizona state statutes and AGFD Commission policies, some of which are discussed below, are relevant to solar energy projects. Violation of these laws or other policies can result in criminal prosecution and/or civil liability.

- Pursuant to A.R.S. § 17-102, wildlife is the property of the state, and can be taken only as authorized by the Arizona Game and Fish Commission.
- “Wildlife” is defined in A.R.S. § 17-101(A)(22) as “all wild mammals, wild birds, and the nest or eggs thereof, reptiles, amphibians, mollusks, crustaceans, and fish, including their eggs or spawn.”
- “Take” is defined in A.R.S. § 17-101(A)(18) as “pursuing, shooting, hunting, fishing, trapping, killing, capturing, snaring or netting wildlife or the placing or using of any net or other device or trap in a manner that may result in the capturing or killing of wildlife.”
- It is unlawful to “take, possess, transport, buy, sell or offer or expose for sale wildlife except as expressly permitted” under A.R.S. § 17-309(A)(2).
- A.R.S. § 17-235 authorizes the Arizona Game and Fish Commission to regulate the taking of migratory birds in accordance with the MBTA, described above.
- Under A.R.S. § 17-236(A), “it is unlawful to take or injure any bird or harass any bird upon its nest, or remove the nests or eggs of any bird, except as may occur in normal horticultural and agricultural practices and except as authorized by commission order.”
- No state or federal lands can be closed to hunting or fishing without the consent of the Arizona Game and Fish Commission, and no person may lock a gate blocking access to state lands pursuant to A.R.S. § 17-304 and Arizona Administrative Code R12-4-110. Permittees should contact the AGFD Ombudsman at AGFD Headquarters for information regarding filing a petition with the Arizona Game and Fish Commission where a project requires the closure of state or federal lands to hunting or fishing.

Other State Regulations

- **Native Plant Law**, A.R.S. § 3-901-907 is administered by Arizona Department of Agriculture (ADOA). The law lists plants protected under the law. Information on protected plants and permitting procedures can be found at the ADOA website <http://www.azda.gov/esd/nativeplants.htm>.
- State Water Laws are administered by the Arizona Department of Water Resources (ADWR). A.R.S. §45-152 establishes the need and procedure for obtaining a permit to appropriate surface water. A.R.S. Title 45 Chapter 2 establishes groundwater code. The type of well drilling permit required to use groundwater depends on location. More information state water permitting requirements for solar projects can be found at <http://www.azwater.gov/AzDWR/WaterManagement/solar/default.htm>.

AGFD Policies on Habitat Compensation

Although AGFD enforces Arizona’s state wildlife laws, AGFD is not a permitting authority for solar energy development. Rather, AGFD makes recommendations to avoid, minimize and/or mitigate impacts to wildlife, and elects to support or oppose solar energy projects in consultation with the permitting agency. In making a decision to support or oppose a project, AGFD uses its *Wildlife and Wildlife Habitat Compensation Policy* (Commission Policy A2.16, Department Policy I2.3, authorized under A.R.S. 17-211) and its biological expertise to analyze impacts to wildlife from the proposed project activities.

The *Wildlife and Wildlife Habitat Compensation Policy* ([Appendix A](#)) guides AGFD in evaluating habitat loss from development projects such as solar energy. This policy requires AGFD to work with developers and permitting agencies to develop adequate mitigation plans for habitat losses resulting from land and water projects. General criteria used to identify mitigation goals fall into four categories:

- **Resource Category I:** Habitats in this category are of the highest value to Arizona Wildlife species and are irreplaceable on a statewide or regional basis.
Goal: No loss of existing in-kind habitat value.
Guideline: All potential losses of existing habitat values will be prevented. Insignificant changes may be acceptable provided they will have no significant cumulative impacts.
- **Resource Category II:** Habitats in this category are of high value for Arizona wildlife and are relatively scarce or becoming scarce on a statewide or regional basis.
Goal: No net loss of existing habitat value, while minimizing loss of in-kind value.
Guideline: Losses be avoided or minimized. If significant losses are likely to occur, AGFD will recommend alternatives to immediately rectify, reduce, or eliminate these losses over time.
- **Resource Category III:** Habitats in this category are of high to medium value for Arizona wildlife and are relatively abundant.
Goal: No net loss of habitat value.
Guideline: AGFD will recommend ways to minimize or avoid habitat losses. Anticipated losses will be compensated by replacement of habitat values in-kind, or by substitution of high value habitat types, or by increased management of replacement habitats, so no net loss occurs.
- **Resource Category IV:** Habitats in this category are of medium to low value for Arizona wildlife, due to proximity to urban development or low productivity associated with these sites.
Goal: Minimize loss of habitat value.
Guideline: AGFD will recommend ways to avoid or minimize habitat losses.

AGFD Project Review

Project proponents should consult with AGFD early in the project conceptual process to identify any potential impacts to special status species and other wildlife in the project area. AGFD consultations typically follow these steps:

1. The permitting agency or project proponent obtains a Special Status Species List from the [Arizona On-line Environmental Review Tool](#) or by request through the AGFD Project Evaluation Program (PEP). The list provides information on species that have been documented in the project area.
2. The permitting agency or project proponent initiates an AGFD project review through PEP. PEP provides policy, technical and environmental law compliance guidance and oversight, and coordinates an internal review of land use projects affecting fish and wildlife resources in Arizona. Providing baseline map information showing the facility layout would aid in the review. AGFD recommends mapping the location of sensitive resources to establish the layout of roads, fences, and other infrastructure to minimize habitat fragmentation and disturbance. Pre-construction studies should be sufficiently detailed in order to create maps of special status species habitats (e.g. wetlands or riparian habitat, large, contiguous tracts of undisturbed wildlife habitat, raptor nest sites) as well as other local species movement corridors (e.g., bats, birds, deer, elk, pronghorn, prairie dogs, badgers, gray/kit fox den sites) that are used daily, seasonally, or year-round, and winter bird concentrations.
3. AGFD encourages permitting agencies and project proponents to continue coordination throughout the preliminary site screening, pre-construction assessment, impact analysis and mitigation, and operations monitoring and reporting phases. Continued coordination with AGFD will ensure impacts to wildlife are avoided and/or minimized to the extent possible.

Federal and state wildlife laws can influence project siting and operations. Project proponents and permitting agencies should familiarize themselves with these laws during the permitting process to ensure impacts to wildlife are minimized and/or mitigated for in order to avoid violating state and federal law.

Preliminary Site Screening

Solar energy developers typically assess the biological sensitivity of a proposed project site early in the development process. Project proponents are encouraged to contact the AGFD Habitat Branch to aid in identifying species potentially at risk and determining the kinds of studies needed to assess the site. This allows the project proponent the opportunity to seek a different site if significant, unavoidable impacts seem likely. In addition, the project proponent needs to arrange for a qualified wildlife biologist who is knowledgeable about the wildlife in the region to conduct a reconnaissance survey. The purpose is to obtain information on the vegetative communities and significant topographic features which will help determine the wildlife community using the project site. Surveys should be of sufficient duration and intensity to adequately address all habitat types in and immediately adjacent to the project area and provide a basis for predictions about species occurrence at the area throughout the year.

Data Resources for Biological Information

AGFD Natural Heritage Program, Heritage Data Management System (HDMS) is an efficient and cost-effective source of biological information. HDMS is part of a global network of more than 80 Natural Heritage Programs and Conservation Data Centers. It identifies elements of concern in Arizona and consolidates information about their status and distribution throughout the state. Species lists are available by common name, scientific name, taxon, and county, and can be found at: http://www.azgfd.gov/w_c/edits/hdms_species_lists.shtml. Species abstracts are also available on the web at: http://www.azgfd.gov/w_c/edits/hdms_abstracts.shtml.

Another useful source of information is the Arizona Online Environmental Review Tool (<http://www.azgfd.gov/hgis/>) which The Online Tool uses HDMS data to create species lists for the project area. However, obtaining a species list does not constitute a review of the project by AGFD. In addition, HDMS data does not include potential distribution of special status species. Be aware that occurrences are only recorded in HDMS if the site has been previously surveyed during the appropriate season, detection was made, and the observation was reported and entered into the database. As such, do not use the absence from the HDMS of an occurrence in a specific area to infer absence of special status species. It is also important to evaluate known occurrences of sensitive species and habitats near the site and in comparable adjacent areas. Some permitting agencies have their own lists or stipulations you may need to consider as well.

In addition, AGFD has completed a [*State Wildlife Action Plan*](#) (formerly called the Comprehensive Wildlife Conservation Strategy) which should be used by solar developers to identify species and threats within their habitats. The *State Wildlife Action Plan* includes a list of Species of Greatest Conservation Need in Arizona by habitat type, outlines threats to species and habitats, and recommends actions which could be taken to address those effects.

Avoiding or Minimizing Impacts

Solar development has the potential to directly and indirectly affect all wildlife species within or moving through the project area. Examples of these effects are: small and large scale habitat fragmentation; displacement; collisions with structures; introductions of invasive species; behavior modifications; direct loss of habitat; degradation of aquatic habitat; and changes in water quality. Avoidance criteria are best applied during pre-construction site selection (macrositing) and during the final adjustment of the project footprint (micrositing). Good macrositing decisions are essential for choosing an acceptable site or portion of a site. Once a site is selected, micrositing efforts, such as appropriate placement of roads, power lines, and other infrastructure can avoid or reduce potential impacts to wildlife and other biological resources.

AGFD encourages project proponents to avoid impacts whenever possible. When not possible, minimization and/or mitigation are necessary conservation measures to counter the effects the project may have on wildlife and their habitats. Each solar project is unique, and no one recommendation will apply to all pre-construction site selection and layout planning. However, consideration of the following elements in site selection and development of infrastructure for the facility can be helpful to avoid and minimize impacts. AGFD staff is willing and available to help determine the best project design that avoids or minimizes negative impacts to wildlife and habitat.

Meteorological Towers

Some solar projects install meteorological towers to assess wind shear and solar intensity at proposed sites. Met towers (whether temporary or permanent) and their associated infrastructure have the potential to cause avian and bat mortalities resulting from mid-flight strikes with the tower guy wires. Studies have shown guy-wired towers can cause four times more bird mortality than towers without guy wires (Young et al., 2003. http://www.west-inc.com/reports/fcr_final_mortality.pdf). While bats can also strike guy wires, the occurrence is much less frequent. In addition, the visibility of met towers is important for the safety of aircraft pilots at low flight elevations. To reduce the potential for bat and bird collisions, and to provide guidance for keeping pilots and personnel safe, AGFD has developed the following recommendations:

- AGFD requests all *permanent* met towers be unguyed, free standing structures. If possible, AGFD also requests temporary met towers be unguyed, free standing structures.
- When guy wires are present, AGFD recommends attaching Bird Flight Diverters (BFDs) at spaced intervals along the length of multiple wires. **At a minimum, BFDs and Aircraft Warning Markers should be alternated at 10 meter intervals along the length of each outer wire**, ensuring that Aircraft Warning Markers are near the apex of the tower (Note: There are several manufacturers of BFDs: TYCO, Preformed Line Products, Dulmison, etc.). Research shows the attachment of BFDs can reduce bird collisions by as much as 86-89% (Pope et al., 2006) (http://www.chelanpud.org/documents/Burch_Final_Report_V1.pdf).

- AGFD recommends all guyed towers are only on site for the minimum amount of time needed to collect data. If towers are on site for more than 1 year, AGFD recommends carcass searches be implemented, especially during the bird migration period.
- When siting met towers, avoid habitat features that congregate wildlife such as water resources, habitat edges, etc.

AGFD Personnel Safety

- Low-level aerial flights by AGFD personnel can occur outside routine wildlife survey routes. GPS locations of all towers need to be provided to AGFD prior to construction to allow survey aircraft to avoid the towers. In addition, AGFD requests project proponents notify the AGFD when met towers are removed.
- When guy wires are present, AGFD recommends attaching Aircraft Warning Markers and Bird Flight Diverters alternated at 10 meter intervals along the length of each outer wire, ensuring that Aircraft Warning Markers are near the apex of the tower.
- For all monopole towers ≥ 50 feet tall, paint the top 30 feet of the tower in alternate orange and white paint. This does not apply to lattice towers or lit towers, both of which are more visible than monopoles.

Facility Design

The main issues affecting solar development are water and land use. Water conservation measures should be a priority when planning for any type of development in Arizona. AGFD supports and encourages the use of solar technologies which minimize the amount of water used for operation, such as photovoltaic applications. However, AGFD understands the need for concentrated solar power (CSP) which requires cooling methods for operation.

Cooling methods have the largest impact on water use for a solar facility and should be chosen carefully. AGFD recommends using dry-cooling technology, which consumes 30 times less water than traditional wet-cooling ([Land Letter](#), Aug. 6). If the dry-cooling method is not feasible, hybrid parallel wet/dry cooling methods should be chosen because it consumes about half the water of wet-cooling technology. AGFD generally does not support the use of wet-cooling technology because it consumes large amounts of water, an extremely limited natural resource in Arizona.

For more information on how to reduce water consumption with CSP technologies, please refer to the U.S. Department of Energy report entitled, “Concentrating Solar Power Commercial Application Study: Reducing Water Consumption of Concentrating Solar Power Electricity Generation,” <http://www.nrel.gov/csp/publications.html>.

Land use should also be a consideration in the planning process of any utility-scale solar facility. Installations should be sited on degraded and/or disturbed areas when possible. When possible, construction should occur on retired agriculture, brownfields (abandoned or underused industrial and commercial facilities available for re-use), abandoned mines, or other areas that do not provide quality wildlife habitat. Choose technologies that allow for versatility in siting with respect to landscape slope. This will increase the potential for available disturbed land. Fencing, grading and alteration of the natural landscape will impact the habitat quality and wildlife

movement as described in the previous section titled, 'Wildlife Connectivity & Why It Is Important.'

Hydrologic Resources

Much of Arizona's wildlife and habitat are highly dependent on the hydrologic resources of the region and the minimal precipitation received each year. Any changes to hydrologic resources, groundwater, surface water, or surface water flow may lead to broad scale mortality of vegetation and potentially change wildlife species distributions and abundance in the given area. Solar development can impact hydrologic resources through development of the project footprint (e.g., land disturbance, erosion, changes in runoff patterns, and hydrological alterations), project emissions (e.g., sediment runoff and water releases), and water use (e.g., water extraction, diversion, or change in use). Early consultation will aid in minimizing impacts to hydrologic resources through proper planning and design.

Groundwater

Groundwater can be impacted through various activities associated with the construction and operation of a solar facility. Those impacts include soil erosion, weathering of newly exposed soils leading to leaching and oxidation which release chemicals into the water, discharges of waste or sanitary water, presence of dissolved salts from untreated groundwater used to control dust, and herbicide or pesticide applications. A study on the geology of the area should be done in relation to the hydrogeology (as required by ADWR). Solar facilities are required to go through an ADWR permitting process for the use of groundwater and surface water. The following ADWR website provides links and tools to assist in the review and permitting process <http://www.azwater.gov/AzDWR/WaterManagement/solar/default.htm>. The Arizona Corporation Commission (ACC) and the Arizona Department of Environmental Quality (ADEQ) may have additional water management requirements and we strongly encouraged coordination with these entities as well.

- Identify and avoid unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, slope angles, and geologic structure).
- Develop a contingency plan to prevent potential groundwater and surface water contamination.
- Develop a storm water management plan to ensure compliance with state and federal regulations and prevent off-site migration of contaminated storm water or increased soil erosion.
- Spread excess excavated soil to match surrounding topography or dispose of in an approved manner that minimizes erosion and leaching of hazardous materials.
- Closely monitor construction near aquifer recharge areas to reduce potential contamination of the aquifer.
- Incorporate low impact development into facility layout and design to incorporate best management practices for addressing water flows and water quality with onsite processes minimizing the hydromodification impacts (e.g., retention basins for treatment of water from runoff and infiltration and recharge of the groundwater basin).
- Develop and implement a monitoring program.

Water quality can also be degraded as a result of vehicular traffic and machinery operations during maintenance (e.g., erosion and sedimentation) and wastewater disposal. AGFD recommends the following to reduce these impacts:

- Apply erosion controls relative to possible soil erosion from vehicular traffic and during construction activities (e.g., jute netting, silt fences, and check dams). Regularly monitor rights-of-way (ROWs), access roads, and other project areas for indications of erosion.
- Clean and maintain catch basins, drainage ditches, and culverts regularly.
- Refuel in a designated fueling area that includes a temporary berm to limit the spread of any spill.
- Use drip pans during refueling to contain accidental releases and under fuel pump and valve mechanisms of any bulk fueling vehicles parked at the project site.
- Limit herbicide/pesticide use to non-persistent, immobile herbicides/pesticides.
- Keep all equipment and vehicles within the limits of the previously disturbed areas.

In addition, groundwater withdrawal could affect springs and riparian areas through lowering of the ground water table, and alter subsurface groundwater flow, potentially resulting in unwanted dewatering or recharging of any of these water resources. Therefore, AGFD recommends:

- Identify sustainable yields of groundwater and nearby surface water bodies.
- Limit the withdrawal of water at the facility so it does not exceed the sustainable yield.
- Develop and implement a monitoring program.

Surface Water

Surface water can be impacted through removal of xeroriparian washes and recontouring of the site. Solar facilities are required to go through an ADWR permitting process pertaining to the use of groundwater and surface water. The following ADWR website provides links and tools to assist in the review and permitting process <http://www.azwater.gov/AzDWR/WaterManagement/solar/default.htm>. Likewise, recontouring of the site may affect jurisdictional waters of the U.S. and Army Corp of Engineers (ACOE) should be consulted. AGFD recommends maintaining sheet flow, ephemeral flows, and reduce soil erosion to the maximum extent possible.

- Avoid streams, wetlands, and drainages where possible. Where access roads would cross a dry wash, the road gradient should be 0% to avoid diverting surface waters from the channel.
- Locate access roads to minimize stream crossings and to minimize impacts where crossings cannot be avoided.
- In areas of steep slopes, erodible soils, and stream crossings implement the following:
 - i. Cross streams at right angles to the main channel if practical. Adjust the road grade to avoid the concentration of road drainage to stream crossings. Direct drainage flows away from the stream crossing site or into an adequate filter.
 - ii. Avoid unimproved stream crossings. When a culvert or bridge is not feasible, locate drive-throughs on a stable, rocky portion of the stream channel.
 - iii. Locate temporary construction bypass roads in locations where the stream course will have minimal disturbance. Time construction activities to protect fisheries and water quality.

- iv. When the slope increases, additional diversion ditches should be constructed to further reduce the damages caused by soil erosion; ditches, adequate culverts, cross drains, etc., should be installed concurrent with construction.
 - v. Stabilize the side banks of a road during construction to aid in the control of erosion and road deterioration; this may require mesh or other stabilizing material in addition to planting and/or seeding and other structural measures.
- Construct drainage ditches only where necessary. Use appropriate structures at culvert outlets to prevent erosion. Also, ensure the culvert does not impede wildlife movement.
 - Do not alter or restrict existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes. Cross water bodies at right angles to the channel and/or at points of minimum impact.
 - Develop a Stormwater Pollution Plan – the EPA site contains templates for the plan, <http://cfpub.epa.gov/npdes/stormwater/swppp.cfm>.

Evaporation Ponds

Arizona's wildlife is highly dependent on any available surface water. Wildlife, especially waterfowl, are attracted to any form of open water, even evaporations ponds, which could lead to inadvertent poisoning due to concentrated salt and other minerals or accidental drowning. Therefore, AGFD has the following recommendations regarding brine ponds toxic to wildlife:

- Locate ponds in an area undesirable to wildlife, such as high use/highly disturbed areas.
- Ponds should be fenced on the perimeter and the top screened to prevent unsuitable and possibly fatal use by wildlife.
- If screening is not feasible, create steep pond sides to minimize shallow areas that would be used by wading birds.
- Monitor ponds for wildlife mortality and have a contingency plan for wildlife mortality incidents. (i.e., if a waterfowl die-off is observed contact AGFD and US Fish and Wildlife Service (USFWS) as soon as possible and have a contingency plan to handle the situation)
- Monitoring the toxicity of the ponds over time is recommended along with a mitigation plan ready for implementation when toxicity levels rise
 - i. The plan should include short term and long term measures to deter wildlife from the area.

Habitat Disturbance and Fragmentation

Solar development will potentially disturb and fragment wildlife habitat during and after construction of a facility. Pre-construction studies must provide sufficient detail in order for the habitat of special status species within the project vicinity to be mapped (e.g., wetland/ riparian habitat, contiguous tracts of undisturbed wildlife habitat, raptor nest sites) and for seasonal species movement corridors to be determined (e.g., winter bird concentrations, pronghorn seasonal migration). These maps, as well as others, should be used to show the location of sensitive resources and used to establish the layout of roads, fences, and other infrastructure in order to minimize habitat fragmentation and disturbance. Listed below are some "Best Management Practices" for avoiding, minimizing, and mitigating impacts to wildlife:

- Avoid using or degrading high value or large, intact habitat areas; use disturbed areas or agriculture lands with low habitat value when possible.

- Avoid high quality wildlife habitat (e.g., wetlands or riparian habitat, undisturbed wildlife habitat) when disturbed areas are not an option. Areas that are temporarily disturbed during construction (e.g., roads, staging areas) should be returned to the original grade and revegetated with site appropriate native species following construction.
- Locate staging areas and construction sites in previously disturbed areas and revegetate with site appropriate native species when construction is completed.
- Use existing roads for construction and access when possible.
- Minimize habitat fragmentation when new roads or two-tracks must be constructed by:
 - i. creating the road through cross-country travel versus blading (check local land management agency for cross-country travel regulations).
 - ii. construct the minimum footprint (i.e., road width) and number of roads needed to maintain the facility.
- Close, obliterate, and revegetate any roads constructed for the project which are not necessary for facility maintenance after construction including those areas not needed within the road right-of-way (ROW). Seed mixes used for revegetation should mimic the species composition and density of the surrounding habitat.
- Locate, design, construct, reconstruct, use, maintain, and/or reclaim roads so as to:
 - i. control or prevent erosion, siltation, and air pollution by vegetating or otherwise stabilizing all exposed surfaces.
 - ii. control or prevent damage to fish, wildlife, or their habitat and related environmental values.
 - iii. prevent or control damage to public or private property.
- Coordinate with AGFD when there is any new road access or restriction (year-round or seasonal), especially where disturbance to wildlife and their habitat may occur as a result of public use of the road or when hunting season is occurring.

Vegetation Removal and Reclamation

Construction of solar facilities will create soil disturbance, opening the door to negative events such as soil erosion and/or non-native or invasive vegetation growth. The AGFD recommends each facility:

- Document pre-disturbance vegetation characteristics and soil conditions.
- Develop a Revegetation Plan that uses only native species, approximating the pre-disturbance plant community composition. The plan should include:
 - i. Background information on the area
 - ii. Goals for the revegetation
 - iii. Approach
 - iv. Implementation
 - v. Monitoring and reporting
 - vi. Mitigation measures, if necessary
- Salvage and transplant all succulents such as cacti, yucca, ocotillo, and agave to an on-site nursery for reclamation of disturbed areas. The salvaged plants should be used to revegetate temporary use areas, ROWs, and other disturbed areas post construction.
 - Revegetating with salvaged plants will enhance the natural reclamation process as well as provide structure for wildlife within the disturbed area.

- During project area clearing, scrape the first 6-12 inches of soil off of the top. Store this soil in piles no taller than four feet high (to prevent the death of soil biota).
- Reestablish soil stabilization, erosion control, restoration and vegetative cover. Contour the soil to match the original topography as much as possible.
- Re-spread the scraped top-soil over the re-contoured area to be reclaimed. Apply the seed following re-spreading (preferably the same day as a hardened soil crust will form from wind and/or rain).
 - Use certified seed sources, free of non-native herbs and grasses (e.g. intermediate wheatgrass, pubescent wheatgrass, crested wheatgrass, and smooth brome).
- Hydro-mulching is the preferred method of seed application.
 - Seeding success rate is **greatly** improved using this method because the hydromulch contains a tackifier that sticks the seed and mulch to the ground reducing seed predation by rodents, birds, and ants and reduces removal by the wind.
- Contact the applicable land management agency regarding guidelines for revegetation efforts.
- When possible push brush and surface rocks into multiple piles, scattered across the project area. The natural materials will provide habitat for many wildlife species and degrade over time returning the nutrients to the soil.
- Fence livestock out of newly reclaimed areas until proper vegetation cover is achieved. If fencing is utilized, please incorporate the recommendations provided in the AGFD wildlife friendly fencing guidelines.

Noxious Weed Management

Solar facilities should be prepared to prevent and manage noxious or invasive plants during the life of the project. AGFD recommends following these steps:

- Develop an Adaptive Weed Management Plan that includes:
 - i. Monitoring the project site to detect the presence of noxious weeds.
 - ii. Removing or treating weeds to prevent spread.
 - iii. Reducing possibilities of contamination or introduction of non-native and noxious plants.
 - iv. A post construction weed removal plan for the life of the project.
 - v. Also include the recommendations below.
- Assume immediate responsibility for the control of all noxious weeds resulting from surface disturbances.
- Thoroughly wash all surfaces and undercarriages of vehicles and equipment before moving to the project site to remove any noxious or non-native plant seeds. This will reduce the possibility of transporting noxious or non-native plants from one site to another.
- To prevent the introduction of invasive species seeds, all earth moving and hauling equipment should be washed at the contractor's storage facility prior to entering the construction site.
- All disturbed soils that will not be landscaped or otherwise permanently stabilized by construction should be seeded using species native to the project vicinity.

- To prevent invasive species seeds from leaving the site, the contractor should inspect all construction equipment and remove all attached plant/vegetation and soil/mud debris prior to leaving the construction site. If possible, the vehicles should be thoroughly washed prior to leaving the construction site.

Public Recreation and Access

- Public recreation and access to public lands for the purpose of recreation is important to maintain when considering development of utility-scale solar. Unless constructed within previously developed areas, solar plants will occupy what is currently open space and therefore must be located in areas that minimize conflict with known uses such as hunting, birding, hiking, camping, and off-highway vehicle (OHV) recreation areas. Prior to finalizing development plans, AGFD should be consulted to ensure these conflicts are prevented or minimized.
- As solar projects are constructed around the state, there is a possibility they may impede or restrict access to public lands by placing a project on top of known travel routes. To guard against the creation of “wildcat” or illegal roads and maintain access to public lands, coordination is recommended with the appropriate landowners to create alternate travel routes. These alternate routes must be created in close proximity to the project to provide this critical access and should be similar in size to the original routes. Signs should be placed indicating travel routes while project construction takes place and remain in place after project completion.

Seasonal Timing Limitations

Construction of solar projects could temporarily or permanently displace breeding, migrating, and/or wintering wildlife species. Due to the difference in elevation across Arizona, wildlife species breed and/or winter at different times across the state. Therefore, project proponents should work with AGFD for site-specific breeding and wintering seasonal timing limitations for species such as migratory birds, deer, pronghorn, elk, and numerous nongame and special status species.

Transmission Lines

To prevent avian collisions and electrocutions, bury all connecting power lines associated with the solar development, unless burial of the lines would result in greater impacts to biological or archeological resources.

- Follow existing disturbed areas during installation to minimize habitat alterations. In low areas where the power line crosses drainages, the soil should be compacted to reduce the potential for erosion.
- Trenching and backfilling crews should be close together to minimize the amount of open trenches at any given time.
- Ideally, trenching should occur during the cooler months (October – March) when wildlife is less active. However, there may be exceptions (e.g. critical wintering areas) that need to be assessed on a site-specific basis.
- Avoid leaving trenches open overnight as they can be effective traps for wildlife. Where trenches cannot be back-filled immediately, escape ramps should be constructed at least

every 45 meters. Escape ramps can be short lateral trenches or wooden planks sloping to the surface. The slope should be less than 45 degrees (1:1).

- Trenches that have been left open overnight should be inspected daily, prior to work beginning, and any animals removed. Prior to backfilling, the trenches should be inspected and any animals removed. Development of a monitoring schedule for each segment of the underground power line installation to ensure minimizing potential impacts to wildlife.

All above-ground lines, transformers, or conductors should fully comply with the [Avian Power Line Interaction Committee \(APLIC\) 2006 standards](#) to prevent avian fatality, including use of various bird deterrents and avian protection devices.

Fencing

Fencing design is best done on an individual site basis, but most solar energy projects will have similar purposes, needs, and constraints. For these *Guidelines*, AGFD assumes the typical site will be a large parcel (1/4 section or larger) of relatively flat arid lands and the purpose of the fencing is to exclude livestock, people, and large wildlife (e.g., javelina, pronghorn, elk, deer) that can damage the solar components). If your application differs from this, we recommend you consult AGFD's Wildlife Fencing Guidelines, <http://www.azgfd.gov/hgis/pdfs/FencingGuidelines.pdf>. BLM also has fencing standards that may apply when the project occurs on federal lands.

In the arid flatlands of Arizona, wildlife species targeted for exclusion from a solar project will generally be deer, javelina, and in rare cases elk. The first step in excluding wildlife within the project site is to reduce attractants such as water, food, and habitat. Since the typical solar project will reduce or eliminate vegetation in the collector field, herbivorous wildlife such as deer should not be attracted to the area. Without vegetation, rodent populations should be low and will not attract coyotes and snakes. Nonetheless, fencing needs to be sufficient to discourage the occasional explorer from entering the site. Therefore, AGFD recommends using either a six foot chain link fence with two strands of barbed wire extending outwards from the top of the fence, or a woven wire/high tensile electric/barbed wire combination exclusion fence (as described in the AGFD Wildlife Fencing Guidelines).

Any area where a fence crosses a drainage or wash represents a potential point of failure during or following a large precipitation event. Unless the site has been contoured to divert all flows outside the exclusion area the crossings are subject to damage during flood events. Free swinging flood gates (also known as water bars) should be installed where the fence crosses the drainage (*illustrations*). Even though the flood gates allow high volumes of water to pass through, they can potentially collect substantial amounts of debris which can lead to a dam effect and cause damage to the fence. Alternatively a small stretch of "sacrificial" woven wire fence could be constructed in the channel up-stream from the main fence. This fence will collect flood debris and usually prevents damage to the main fence. The sacrificial fence will need to be periodically dug out or even replaced after major flood events. Fences should be inspected immediately after storm events to check for damage.

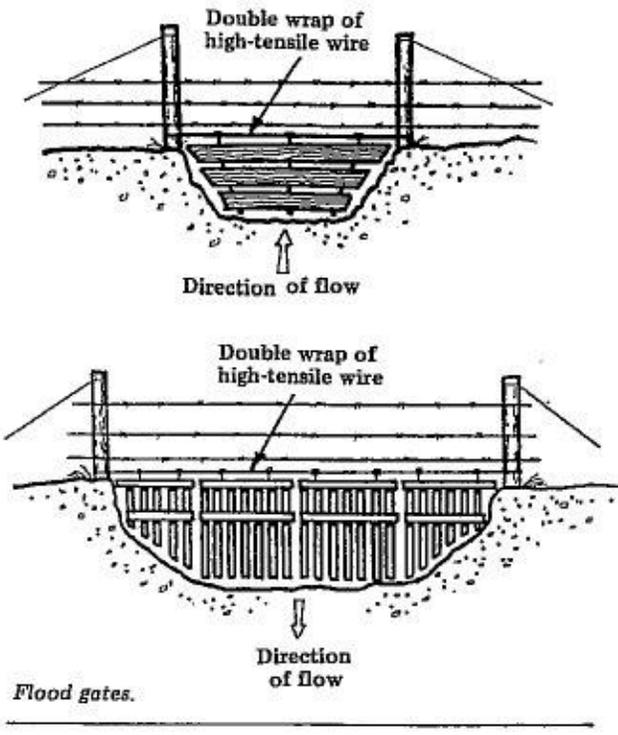


Figure 1 Free swing flood gates

Hazardous Materials

Solar energy plants have the potential to generate or spill hazardous materials during construction, operation, and/or decommissioning, which could affect wildlife, habitat, and surrounding water sources. Potential hazardous materials associated with solar energy plants include: heat transfer fluids (i.e., oils), molten salts, hydraulic fluids, coolants, lubricants, waste water, and photovoltaic panels. Most hazardous materials can be contained through good facility design, emergency planning, prudent operating practices, and proper disposal. Even general construction trash (e.g., plastic wrap, small metal scraps, and grease cartridges) can kill or injure wildlife. AGFD recommends developing a spill prevention and/or contingency plan for spills.

Solar energy plants that employ indirect energy conversion (i.e. concentrated solar power) use liquids such as oils or molten salts that may be hazardous and present spill risks. In addition, various fluids are used that are common to most industrial facilities, such as hydraulic fluids, coolants, and lubricants. These fluids may in some cases be hazardous, and present a spill-related risk. Proper planning and good maintenance practices can be used to minimize impacts from hazardous materials. If synthetic oil is involved in a spill/leak, soil should be removed to an on-site bioremediation facility and indigenous bacteria should be used to decompose the oil to acceptable levels. If inorganic salts are involved in a spill, the molten material should be immediately cooled to a solid, contained within concrete dikes and curbing, and removed or recycled back into the system.

Solar energy plants that employ direct energy conversion (i.e., photovoltaic (PV)) use solar panels that contain many of the same hazardous materials as electronic equipment waste (e.g., arsenic, cadmium, silicon). Although the panels are sealed under normal operating conditions, there is the potential for environmental contamination if they are damaged or improperly discarded (e.g., the leaching of toxic heavy metals out of the landfills into groundwater and streams). To prevent end-of-life hazards, solar plants should responsibly recycle/dispose PV panels by adhering to one or more of the following suggestions:

- create a protocol for responsible disposal of decommission PV solar panels prior to facility construction,
- determine if the PV panel manufacturers provides an Extended Producer Responsibility (EPR) service which requires the producer of the panel to take back their product thus ensuring the panels are recycled safely and responsibly, or
- recycle PV panels at existing responsible electronic waste recycling facilities or at facilities that recycle batteries containing lead and cadmium.

Mitigation

AGFD recognizes the purpose and need for renewable energy and that solar developments will impact wildlife and their habitat. Project proponents and permitting agencies should ensure that appropriate measures are incorporated into the planning and construction of the project to avoid or minimize impacts to the greatest extent possible. If these measures are insufficient to avoid negative impacts to wildlife, habitat connectivity, or depletion of water resources, mitigation can be used to offset such impacts, including cumulative impacts. The following potential mitigation options are known to protect and enhance wildlife populations at biologically appropriate locations when properly designed and implemented:

- Funding wildlife research (see [Appendix B](#))
 - Studies of displacement
 - Population impacts
 - Wildlife movement and behavior
- Offsite conservation of important/crucial/valuable habitat
 - Nesting and breeding areas
 - Foraging habitat
 - Roosting or wintering areas
 - Migratory rest areas
 - Habitat corridors and linkages
- Offsite habitat restoration
 - Restored habitat function
 - Increased carrying capacity
 - revegetation
- Offsite habitat enhancement
 - Predator control program(s)
 - Noxious/exotic/invasive species removal

Although impacts may occur, the ability to mitigate for them can influence whether a project is supported or not by AGFD. Practical and feasible mitigation is recommended when it will serve to minimize a project's effect on wildlife populations and their habitat. Mitigation is site- and species-specific, and must be formulated for each individual project. Mitigation should have a biological basis for ensuring protection or enhancement of the species affected by the project.

Funding wildlife research is one potential mitigation option with long-term benefits. The more knowledge about wildlife response to solar development in Arizona, the more effective recommendations can be made to avoid/minimize/mitigate impacts. When considering research as a mitigation option, consult with AGFD to help design and conduct investigations.

Mitigation can also involve the purchase of land through fee title, purchase of conservation easements, or other land conveyances for the permanent protection of the biological resources on these lands. The purchased land or easements should have biological value equal to or higher than the land lost for the target species, or community of species, affected by the solar energy

project. Please refer to AGFD's Conservation Easements Fact Sheet for more information at <http://www.azgfd.gov/hgis/pdfs/LandsConservationEasement.pdf>.

APPENDIX A: Wildlife and Wildlife Habitat Compensation Policy

12.3 Wildlife and Wildlife Habitat Compensation

Effective: 06/04/1994
Process Owner: WMHB Branch Chief

Department Policy: It shall be the policy of the Department to develop adequate compensation plans for actual or potential habitat losses resulting from land and water projects in accordance with State and Federal laws. Habitat compensation plans will seek compensation at a 100% level, where feasible, and will be developed using habitat resource category designations. See Commission Policy A2.16.

Authority: The Director of the Arizona Game and Fish Department is authorized under A.R.S. Title 17-211, Subsection D, to perform the necessary administrative tasks required to manage the wildlife resources of the State of Arizona. Pursuant to those duties and in accordance with federal environmental laws and resource management acts, such as the National Environmental Policy Act, Fish and Wildlife Coordination Act, and Endangered Species Act, the Director is further charged with cooperating in the determination of potential impacts to Arizona's wildlife resources resulting from federally funded land and water projects. In addition, a Commission M.O.U. assigns similar responsibilities for evaluating proposed projects on lands administered by the State Land Department. An integral part of this process is the development of adequate compensation measures aimed at eliminating or reducing project-associated impacts.

Procedure: Criteria used to identify general compensation goals are as follows:

A. Resource Category I.

1. **Designation Criteria.** Habitat in this category are of the highest value to Arizona wildlife species, and are unique and/or irreplaceable on a statewide or ecoregion basis.
2. **Compensation Goal.** No loss of existing in-kind habitat value.
3. **Guideline.** The Department will recommend that all potential losses of existing habitat values be prevented. Insignificant changes that would not result in adverse impacts to habitat values may be acceptable provided they will have no significant cumulative impact.
4. **Habitat Types.** Habitat types associated with Resource Category I shall include, but not limited to the following examples:
 - a. Perennial Stream Habitats
 - b. Wetlands and Riparian habitats of at least one acre in size, which are associated with perennial waters. Biotic communities included in this classification follow descriptions provided in Brown (1982) and Henderson and Minckley (1984).
 - c. Key utilization areas for species listed or proposed for listing under the Endangered Species Act of 1973 as Threatened or Endangered and Endangered State Threatened Native Wildlife species.

B. Resource Category II.

1. **Designation Criteria.** Habitats in this category are of high value for Arizona wildlife species and are relatively scarce or becoming scarce on a statewide or ecoregion basis.
2. **Compensation Goal.** No net loss of existing habitat value, while minimizing loss of in-kind value.
3. **Guideline.** The Department will recommend that all potential losses of Resource Category II habitat values be avoided or minimized. If significant losses are likely to occur, the Department will recommend alternatives to immediately rectify, reduce, or eliminate these losses over time.
4. **Habitat Types.** Habitat types associated with Resource Category II shall include, but not limited to, the following examples:
 - a. Key utilization areas for antelope and bighorn sheep.
 - b. Key utilization areas for Threatened and Candidate State Threatened Native Wildlife species, candidate species for federal listing as Threatened or Endangered (Categories I and 2).
 - c. Actual or potential reintroduction sites for species that are listed as Extirpated or Endangered on the State Threatened Native Wildlife list.
 - d. Blue ribbon fishing areas (i.e., Lee's Ferry and Becker Lake).
 - e. Isolated mountain ranges provided Subalpine-coniferous forest habitats (i.e., Pinaleno Mountains).
 - f. State and federally operated game preserves, refuges or wildlife areas.
 - g. Montane meadows.

C. Resource Category III.

1. **Designation Criteria.** Habitats in this category are of high to medium value for Arizona wildlife species, and are relatively abundant on a statewide basis.
2. **Mitigation Goal.** No net loss of habitat value.
3. **Guidelines.** The Department will recommend ways to minimize or avoid habitat losses. Anticipated losses will be compensated by replacement of habitat values in-kind, or by substitution of high value habitat types, or by increased management of replacement habitats, so that no net loss occurs.
4. **Habitat Types Involved.** Habitats in this category are of a natural, undisturbed condition or they involve bodies of water of economic importance and shall include, but not be limited to, the following examples:
 - a. Chihuahua, Great Basin, Mohave, and Sonoran Desert habitat types.
 - b. Desert-grasslands and Chaparral zones.
 - c. Oak and coniferous woodlands and coniferous forests.
 - d. Reservoir habitats.

D. Resource Category IV.

1. **Designation Criteria.** Habitats in this category are of medium to low value for Arizona wildlife species, due to proximity to urban development or low productivity associated with these lands.
2. **Mitigation Goal.** Minimize loss of habitat value.

3. **Guideline.** The Department will recommend ways to avoid or minimize habitat losses. Should losses be unavoidable, the Department may make a recommendation for compensation, based on the significance of the loss.
4. **Habitat Types Involved.** Habitat types associated with Resource Category IV shall include, but not be limited to, the following examples:
 - a. Agricultural Lands.
 - b. Undeveloped urban areas (i.e., land proximal to waste water treatment facilities, municipal mountain preserves, and undeveloped lands in proximity to municipal and industrial areas).
 - c. Habitats exhibiting low wildlife productivity as a result of man's influence.

APPENDIX B: Research Concepts

Information regarding impacts of utility-scale solar development on wildlife and habitats is lacking. In order to inform planning, development, and mitigation, AGFD has identified the following top solar-wildlife research needs in Arizona:

- Determine the “effective footprint” of utility-scale solar development so mitigation strategies can be implemented at the spatial extent of the impact.
 - Determine the potential effects of a proposed solar project on the demographics of select wildlife species.
- Evaluate the alteration of vegetation and micro-climate adjacent to solar facilities.
- Identify the impact that utility-scale solar development has on wildlife corridors.
 - Evaluate the movement and behavior patterns of select wildlife species (e.g. ungulates, grassland passerines, raptors) pre- and post-construction.
- Examine the impacts to migratory birds and bats.
- Develop mitigation strategies to reduce the impacts of water impoundments associated with solar facilities.

What is the “effective footprint” of utility-scale solar development?

AGFD’s Research Branch has developed a monitoring plan to elucidate whether the impact of utility-scale solar projects stops at the project boundaries or if it extends beyond the project’s physical footprint. This monitoring approach would inform planning, development, and mitigation on future projects by determining the true impacts from habitat loss, degradation, and fragmentation on wildlife habitat and connectivity. Our goal is to implement research on a landscape-scale by partnering with the solar industry, thereby allowing us to make accurate predictions regarding the impact that these projects will have on Arizona ecosystems. This data will greatly inform the appropriate planning and mitigation necessary to reduce impacts to wildlife and their habitat.

How do we mitigate the impact of utility-scale solar development on wildlife corridors?

The impacts of utility-scale solar development on the temporal and spatial movement patterns of wildlife are poorly understood. It is imperative these impacts are identified early in the development of the State’s solar resources so that the location, configuration, and extent of future facilities are compatible with AGFD’s vision for an interconnected network of conservation areas that maintain viable wildlife populations. A considerable amount of work has been done to identify, at the broad-scale, important habitat linkages that allow for the exchange of individuals among populations – a key ingredient in the long-term persistence of wildlife populations. AGFD, in a partnership with the solar industry, could identify the constraints that solar development exhibits on wildlife movement in an effort to develop proactive management recommendations that will lead to the coexistence of wildlife movement corridors and a renewable energy infrastructure.

How are vegetation and micro-climate affected by the development of utility-scale solar facilities?

Many of the proposed solar facilities will be located in what is currently considered intact wildlife habitat. These areas provide the resources required for survival and reproduction, namely access to food, water, shelter, and mates. It is unclear what the impact will be to adjacent habitat outside of the physical footprint of solar facilities although there is concern that alteration of vegetation and micro-climate resulting from solar reflectance and groundwater pumping will adversely affect wildlife habitat. These impacts need to be evaluated in order to develop habitat management strategies that retain the necessary characteristics of those habitats for wildlife persistence.

Are there impacts to migratory birds and bats resulting from the development of utility-scale solar facilities in desert ecosystems?

Some initial monitoring of large utility-scale solar facilities has shown bird mortality due to collisions with structures and burns from concentrated sunlight and mirrors. The incidence of bird collisions with solar facility structures may be amplified by the presence of open water impoundments. These water impoundments also have the potential to attract bats and increase an additional mortality risk due to collision or poisoning due to water quality issues (similar water quality issues are of concern for all wildlife). It has been shown that the heat from concentrated sunlight has led to the mortality of birds, especially aerial foragers (swifts and swallows). The mortality is thought to occur during morning startup, testing, and maintenance when the mirrors are refocused on “standby” points of sky around the tower.

Can water impoundments (i.e., salinity pools) be managed to benefit wildlife species?

Water is a limiting resource for many species that inhabit desert ecosystems. Although groundwater pumping has the potential to adversely impact habitat, the addition of water sources in the form of impoundments that are constructed as part of the solar facility could serve to benefit wildlife. AGFD has conducted a significant amount of research regarding the importance of water sources for desert wildlife and these results could be applied to water sources developed by solar facilities. As mentioned above, the attractive nature of water impoundments in Arizona can increase the likelihood of wildlife interacting with the infrastructure of the solar facility. In addition, poor water quality issues of open water impoundments can lead to increased wildlife mortality.