AVIAN BASELINE IN THE ALTAMONT PASS WIND RESOURCE AREA

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Table of Contents

List of Tables

List of Figures

[1]For simplicity in displaying locations of fatalities, species were grouped into two sets of figures. Group 1 consists of American kestrel, brown pelican, golden eagle, loggerhead shrike, northern harrier and tricolored blackbird fatalities. Group 2 consists of burrowing owl and red-tailed hawk fatalities.

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OVERVIEW

The Altamont Pass Wind Resource Area (APWRA) is home to a number of wind energy facilities owned by several companies that provide electrical power to California. Operational since the early 1980s, at its peak the APWRA contained over 7,000 early technology wind turbines. Multiple studies have evaluated the potential bird mortality risks within the APWRA and documented high rates of avian fatalities related to wind turbines (Howell and DiDonato 1991; Orloff and Flannery 1992, 1996; Hunt 2002; Smallwood and Thelander 2004, 2005, 2008; APAMT 2008, WEST 2008; Smallwood and Karas 2009, Smallwood et al. 2009a; ICF International 2013a). Because of concerns over this elevated risk to avian species, when the conditional use permits allowing wind energy generation facilities in Alameda County came up for renewal, several lawsuits were filed to prevent permit renewal approval. Ultimately, these lawsuits were concluded when a settlement agreement was reached in 2007 that allowed conditional use permits to be extended if certain mitigation measures were adopted. One of these measures was the phased replacement of old turbines with new wind turbine technology, also referred to as repowering. The logic for this was that new technology turbines that have been developed are more efficient, producing more megawatt (MW)-hours per rated capacity, and often have higher rated capacities than the older generation models. Therefore, repowering can enable fewer turbines to supply the same amount of power, theoretically resulting in fewer avian fatalities per MW-hours produced (Smallwood and Karas 2009, ICF International 2013a). Additionally, structural modifications (e.g., tubular towers rather than lattice towers that provide perch and nesting sites) and features of new wind turbine designs are thought to pose less risk of collision to birds (see below). Three repowering projects have been completed to date within the APWRA: Diablo Winds, Buena Vista, and Vasco Winds (ICF International 2013a). This report focuses on a proposed repower of the Sand Hill Wind Facility within the APWRA.

The New Dimension Energy Company (NDEC) is proposing to use innovative turbine technology from FloDesign Wind Turbine Corp. (FloDesign) for a repower project at the Sand Hill Wind Facility (Figure 1). The FloDesign turbine, also called a shrouded wind turbine (Shrouded Turbine; Figure 2) is a 100 kW turbine which will replace existing turbines ranging in capacity from 40 kW (Enertech, n = 133) to 65 kW (Micon, n = 218; Windmatic, n = 22) to 100 kW (Polenko, n = 12). Phase 1 of the repower project involves replacing 70-80 of the existing Sand Hill Facility turbines with 40 Shrouded Turbines, thus reducing the numbers of turbines posing a collision risk to birds. Additionally, the design of the Shrouded Turbine is thought to pose a lower risk of avian fatalities compared to conventional open-bladed turbines for two reasons:

1) The unmoving shroud surrounding the turbine blades provides a physical and visual barrier that is expected to prevent birds from entering the rotor plane when they approach parallel to the rotor plane;
2) The shroud is more visible to flying birds than moving blades and reduces the likelihood of collision when birds approach perpendicular to the rotor plane (Smallwood 2013).

FloDesign is collaborating on an experimental study at the Sand Hill Facility to evaluate the effectiveness of the Shrouded Turbine to reduce avian fatalities. This study is primarily funded by a California Energy Commission (CEC) Public Interest Energy Research (PIER) Grant. The study uses a before-after-control-impact (BACI) design to evaluate the effects of the Shrouded Turbine design on avian turbine-collisions.

The results of the first complete year of the study (“before” phase) were available for, and are summarized in this report.

The primary objective of this report is to provide a baseline of avian conditions prior to repowering with Shrouded Turbines. This objective will be met by:

1) Providing descriptions for special status species detected as fatalities at the Sand Hill Facility, including occurrence and mortality data as well as population trends, if known;
2) Describing the current conditions of avian risk at the Sand Hill Facility based on previously collected data and data from the first year of the BACI study performed in 2013 by S. Smallwood (Smallwood 2013).

METHODS

A variety of sources were drawn from to provide relevant context to special status species known to occur at the Sand Hill Facility and their respective risk. Detailed discussion is limited to special status species detected as fatalities within the Sand Hill Facility using the rationale that they are of the greatest concern within the Sand Hill Facility.

As mentioned earlier, a large number of avian mortality studies have been performed within portions of or across the entire APWRA. Because the Sand Hill Facility is similar in topography, habitat, and turbine conditions to much of the rest of the APWRA (ICF International 2012), studies conducted within the APWRA are used to provide information about avian risk in general (Tables 1 and 2), and risk to special status species specifically, when available.

Avian information specific to the Sand Hill Facility is available from APWRA-wide monitoring performed by ICF International. Given the large study area, data were organized by base-layer of operating group boundaries or BLOBs (see Figure 1-2 in ICF International 2012). Turbines within the Sand Hill Facility are located in BLOBs 9, 16, 17, 18, 22; however, the Sand Hill Facility turbines within BLOB 18 were not monitored (See Figures 2-1 and 2-2 in ICF International 2012). ICF International (2012) reports by BLOB adjusted fatalities per MW per year for four focal species: American kestrel, burrowing owl, golden eagle, and red-tailed hawk. The range of mortality rates from 2005 – 2010 for the four focal species in BLOBs 9, 16, 17, and 22 are used in this report to indicate Sand Hill Facility-specific mortality rates for these species (Table 2). Avian use surveys were also performed by ICF International, with use rates reported by BLOB for the four focal species (ICF International 2013a). Additionally, raw numbers of fatalities detected at Sand Hill Facility turbines are available from ICF International’s mortality monitoring conducted from 2000 - 2012 (SRC APWRA 2013). Fatalities of special status species are presented on maps of the Sand Hill Facility (Figures 3 A-C and 4 A-C).

Additional Sand Hill Facility-specific information is provided from a biological resources technical report (ICF International 2013b). This report summarizes the results of biological resource surveys performed at the Sand Hill Facility in 2013, and includes occurrence information on burrowing owl, loggerhead shrike, and tricolored blackbird (ICF International 2013b).

Lastly, the results of the first year of the BACI avian mortality study performed by Smallwood at the Sand Hill Facility (Smallwood 2013) are presented. This study involved mortality monitoring at clusters of high-risk turbines within the Sand Hill facility that are planned to be replaced with Shrouded Turbines. Adjusted mortality rates are presented, but are not to be considered representative of the Sand Hill Facility as a whole because monitoring was specific to high-risk turbines. Additionally, locations of detections of live burrowing owls during the study were provided by Smallwood and are presented here (Figure 4A).

EXISTING DATA

Special Status Bird Species at the Sand Hill Facility

Bird species are known to be impacted by wind facilities in the APWRA (e.g., Hunt 2002, Smallwood and Karas 2009), including species with special status such as federal or state listed species, state fully protected species, state species of concern, and bird species of local concern. Special status species known to occur as fatalities in the APWRA are presented for context, but detailed discussion is limited to special status bird species known to occur as fatalities at the Sand Hill Facility, including information on local or regional abundance and population trends where data are available. These data can inform a risk assessment of the potential impacts that repowering the Sand Hill Facility will have on various bird species; however, such an assessment is beyond the scope of this report.

Federal or State Threatened and Endangered Bird Species

Federal threatened or endangered bird species (USFWS 2013) have not been detected as fatalities within APWRA (Table 1). The state threatened or endangered bird species detected as fatalities in the APWRA are the greater sandhill crane (*Grus canadensis tabida*) and Swainson's hawk (*Buteo swainsoni*). Records of fatalities for these two species are limited to one documented fatality each, during mortality monitoring conducted within the APWRA from 2000 – 2012 (SRC APWRA 2013). Neither of these species has been detected as fatalities at the Sand Hill Facility (Table 1).

State Fully Protected Bird Species

Golden Eagle (*Aquila chrysaetos*)
Golden eagles in the western U.S. are most commonly found near open spaces that provide foraging habitat such as grasslands or shrub-steppe (Kochert et al. 2002). Breeding golden eagles in central California nest primarily in large trees and cliff habitat located within open grasslands and oak savanna, or occasionally in oak woodland and open shrublands (Hunt et al. 1995, 1999). Both suitable foraging and nesting habitat for golden eagles occurs within the APWRA as documented in multiple studies (Orloff and Flannery 1992, Hunt 2002, Smallwood and Thelander 2005). Golden eagles breed within the APWRA, with approximately 18 regularly occupied territories occurring within the APWRA and outward to a distance 6.2 miles (10 kilometers; Hunt 2002). Migrant golden eagles are also known to occur within the APWRA during the non-breeding season (Kochert et al. 2002, CDFG 2004). The Sand Hill Facility includes suitable golden eagle foraging habitat, but there are no documented nests (Orloff and Flannery 1992, CDFW 2013a).

There are numerous documented occurrences of golden eagles in the APWRA from a variety of studies. Mean use rates at point count locations within the Sand Hill Facility (see Figure 2-3 in ICF International 2013a) ranged between 0.00 to 1.34 observations/minute/km^3 during use surveys in the APWRA from

2005 to 2010 (ICF International 2013a). Average golden eagle use rates were highest in the Ralph and Griffith parcels (ICF International 2013a; Figure 1).

Population Trends and Local Impacts. Results from breeding bird surveys (BBS) performed nationwide by Partners in Flight (Rich et al. 2004) and aerial transect surveys performed in the western U.S. (Nielson et al. 2012) indicate that golden eagle populations across the western U.S. are stable as of 2012 (Nielson et al. 2012, Green 2013). Strong trends do not exist for golden eagle populations in California, but survey data are limited (Sauer et al. 2012, CDFW 2013b). Studies specific to APWRA indicate no change in the territory occupancy over time but suggest that the local population is being sustained by golden eagles immigrating from other areas to replace those killed in collisions with turbines (Hunt and Hunt 2006). Adjusted annual mortality estimates for golden eagles presented in other studies of the APWRA range from 0.070 to 0.211 fatalities/MW/year (Table 2).

Within the Sand Hill Facility a total of nine golden eagles have been detected as fatalities during mortality monitoring from 2000 – 2012; none were incidental detections (SRC APWRA 2013). Eight of these were identified as likely turbine strikes, and one was likely caused by electrocution. Seven golden eagle fatalities occurred in the northernmost portion of the Ralph-Pombo parcels (Figure 3A), compared to one each in the Castello-Arnaudo and Griffith parcels (Figures 3B and 3C, respectively). Six of the nine documented fatalities occurred at Micon 65-kW turbines, and the remaining three fatalities were detected at Enertech 40-kW turbines. However, raw mortality numbers do not indicate actual levels of mortality due to inherent biases in mortality monitoring, such as detection bias, turbine sampling scheme, search interval, and scavenger densities. Adjusted mortality estimates for the Sand Hill Facility range from 0.00 to 0.50 fatalities/MW/year based on monitoring conducted from 2005 to 2010 (ICF International 2012). The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected no fatalities of golden eagles (Table 1), and thus, did not calculate an adjusted mortality estimate for high-risk turbines (Smallwood 2013; Table 2).

Collision risk factors for the golden eagle are thought to be largely related to the interaction between flight patterns and turbine locations. Specifically, golden eagles tend to favor the windward aspect of hills and ridges where they fly over slopes that face strong, prevailing winds (Smallwood and Neher 2011). While hunting, golden eagles generally follow topographical contours, creating risk of collision with turbines sited within saddles, notches, and benched slopes (Smallwood 2010). The greatest turbine attribute associated with increased collision risk is whether the turbine blades of a particular model pass within 26 feet (8 meters) of the ground (Hunt 2002, Smallwood and Thelander 2004). Other variables that appear to increase collision risk includes wide spacing of turbines, and turbines located at the edge of a turbine string or cluster (Smallwood and Thelander 2004). Furthermore, unlike with other avian species, larger-sized turbine models appear to have increased collision risk to golden eagles (Smallwood 2010). Operational status of a turbine may also be linked to collision risk as golden eagles engage in interactions with other birds more often when turbines are operational, possibly reducing their awareness of their surroundings (Smallwood et al. 2009a). Higher densities of fossorial animal species near turbines have also been related to increased golden eagle collision risk as they serve as a source of prey (Smallwood and Thelander 2004).

Brown Pelican (*Pelecanus occidentalis*)

Within northern California, the brown pelican is a migrant and part-year resident. Brown pelicans typically migrate north by early May, and return to their southern wintering and breeding grounds in early winter (Zeiner et al. 1988). The northernmost brown pelican breeding areas in California are found on the Channel Islands, south of Santa Barbara (Zeiner et al. 1988). They are typically found in warm coastal marine and estuarine waters where they forage for fish and sometimes are seen on inland freshwater lakes (Shields 2002). Brown pelicans typically nest on small estuarine or offshore islands that provide protection from disturbance and predation (Shields 2002).

The APWRA does not contain suitable foraging or nesting habitat for brown pelicans, although some individuals appear to migrate through the area based on recorded fatalities (see below). The California Natural Diversity Database (CNDDB) does not list any occurrences of brown pelicans in the APWRA (CDFW 2013a).

Population Trends and Local Impacts. After nearly 40 years on the federal and state endangered species lists, brown pelican populations have recovered, and the species was removed from both lists in 2009 (USFWS 2009). Approximately 70,680 breeding pairs are reported in California and the Pacific coast of northern Mexico (USFWS 2009 and references therein), with thousands of migrants moving up and down the Pacific coast annually.

Two brown pelican fatalities have been documented in the APWRA (Table 1). One fatality was recorded during mortality monitoring conducted APWRA-wide between 1989 and 2007 (Smallwood and Karas 2009). The second brown pelican fatality was documented at the Sand Hill Facility in 2009 during mortality monitoring, and occurred at a Micon 65-kW turbine within the Castello parcel (Figure 3B) (SRC APWRA 2013). Adjusted mortality estimates for the Sand Hill Facility are unavailable for brown pelican. The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected no fatalities of brown pelicans (Table 1), and thus, did not calculate an adjusted mortality estimate at high-risk turbines (Smallwood 2013; Table 2). No publicly available research has identified turbine collision risk factors for brown pelicans.

State Bird Species of Special Concern

Tricolored Blackbird (*Agelaius tricolor*)

Tricolored blackbirds are a colonial species that nest in dense vegetation extensive enough to support colonies of 50 pairs or more (CDFG 2008). When nesting, tricolored blackbird prefer freshwater emergent wetlands with tall, dense cattails or bulrushes for nesting, but will also breed in thickets of willow, blackberry, wild rose, or tall herbs (CDFG 2008). During the nonbreeding season, flocks are highly mobile and forage in grasslands, croplands, and wetlands (CDFG 2008).

The tricolored blackbird is largely indigenous to California, with more than 99 percent of the population residing in the State and 90 percent of the breeding population residing specifically in the Central Valley (Shuford and Gardali 2008). The CNDDB lists one occurrence of tricolored blackbirds in the Alameda County portion of the APWRA, approximately 1.5 miles (2.4 kilometers) west of the Ralph parcels (CDFW 2013a).

Suitable nesting habitat for tricolored blackbird is largely absent within the Sand Hill Facility. For this reason the potential for the species to nest at the facility is considered to be low (ICF International

2013b); nevertheless, tricolored blackbirds have occurred as fatalities at the Sand Hill Facility (see below).

Population Trends and Local Impacts. Tricolored blackbird populations have declined significantly in the past century. The National Audubon Society (2010) reports a population decrease of over 50 percent between 1950 and 1985, and a further 56 percent decline from 1994 to 2000, with declines most apparent in the Central Valley.

Mortality studies throughout the APWRA provide adjusted mortality estimates ranging from 0.000 to 0.030 deaths/MW/year (Table 2). Within the Sand Hill Facility, two tricolored blackbirds have been detected as fatalities during mortality monitoring from 2000 – 2012 (SRC APWRA 2013). These fatalities occurred at two different Micon 65-kW turbines. One fatality occurred in the Ralph parcel (Figure 3A), and one occurred in the Castello-Arnaudo parcels (Figure 3B). Adjusted mortality estimates for the Sand Hill Facility are unavailable for tricolored blackbird. The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected one tricolored blackbird fatality, resulting in an adjusted mortality estimate of 0.240 deaths/MW/year at high-risk turbines (Smallwood 2013; Table 2).

No publicly available research has identified turbine collision risk factors for tricolored blackbird.

Burrowing Owl (*Athene cunicularia*)
Burrowing owls are relatively small, semicolonial owls, and are year-round residents of open dry grasslands and desert areas throughout much of California, including the APWRA (CDFG 1999). Migrants from other parts of western North America may augment resident populations in winter (Shuford and Gardali 2008). Resident burrowing owls occupy burrows for breeding and both residents and migrants use burrows for roosting (CDFG 1999). Although capable of digging burrows, they typically use burrows excavated by ground squirrels and other small fossorial mammals, or may use artificial structures for burrows (e.g., drainage culverts, discarded pipe; CDFG 1999). Burrowing owls are active throughout the day and night, being most active during dawn and dusk (CDFG 1999, Shuford and Gardali 2008).

There are numerous documented occurrences of burrowing owls in the APWRA from a variety of studies. Mean use rates at point count locations within the Sand Hill Facility (see Figure 2-3 in ICF International 2013a) ranged between 0.00 and 3.21 observations/minute/km^3 during use surveys in the APWRA from 2005 to 2010 (ICF International 2013a). Most detections of burrowing owls occurred within the Ralph parcels (ICF International 2013a). However, ICF International (2013a) notes that "the avian use survey methodology was not designed to assess use by cryptic and crepuscular species like burrowing owl." At the Sand Hill Facility a single live burrowing owl was observed during 2012 field surveys (ICF International 2013b). Additionally, there were 10 detections of live burrowing owls during the BACI avian mortality study conducted in 2012 – 2013 by Smallwood (2013; Figure 4A).

Population Trends and Local Impacts. BBS data from 1966 to 2011 show a decrease in the burrowing owl population in California and throughout North America (Sauer et al. 2012). Population surveys in California from 1986 through 1991 found a declining trend in the number of breeding groups and breeding pairs (Bates 2006). Comprehensive surveys from 1991 through 1993 found that California's population is estimated at 9,266 breeding pairs (not including the Great Basin, desert areas, or the

Channel Islands), with 24 percent in the Central Valley and 2 percent in the Bay Area (DeSante et al. 2007). Breeding in Central California has been reduced to only three isolated populations: the Central Valley, southern San Francisco Bay between Alameda and Redwood City, and near the Livermore area (DeSante et al. 2007).

Burrowing owl fatalities have been detected in the APWRA, with estimated adjusted mortality rates ranging from 0.700 to 3.025 deaths/MW/year (Table 2). Burrowing owl fatalities detected within 3 feet (1 meter) of an active burrow were considered the result of predation and were excluded from analysis; however, in most cases fatalities caused from turbines cannot be distinguished from those caused by predation (ICF International 2013a). Predation has been identified as the likely cause of death for several detected burrowing owl fatalities at the APWRA, and a peak in August in numbers of fatalities detected roughly corresponds to the timing of fledgling dispersal, when juveniles are most subject to predation. Furthermore, a peak in fatalities in January also appears to be related to increased predation as it is strongly correlated to immigration of red-tailed hawks into the area during the winter (ICF International 2013a). These seasonal patterns in mortality rates may partially explain the lack of relationship between the average number of fatality detections each year and average monthly bird use (ICF International 2013a).

Burrowing owl fatalities have been documented within the Sand Hill Facility specifically (Table 1). A total of 94 burrowing owls have been detected as fatalities within the Sand Hill Facility during mortality monitoring from 2000 – 2012 (SRC APWRA 2013). These fatalities occurred at 76 different turbines; 52 at Enertech 45-kW turbines, 30 at Micon 65-kW turbines, three at Polenko 100-kW turbines, and nine at Windmatic 65-kW turbines. Most of these fatalities were detected within the Ralph-Johnston-Pombo parcel (n = 66 of 94; Figures 4A-C). Adjusted mortality estimates have been calculated for the Sand Hill Facility, and range from 0.00 to 10.40 fatalities/MW/year based on monitoring conducted from 2005 to 2010 (ICF International 2012). The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected 17 burrowing owl fatalities. The estimated adjusted mortality rate was 3.126 deaths/MW/year at high-risk turbines (Smallwood 2013; Table 2).

Collision risk factors for burrowing owls are largely behavioral as individuals exhibit a number of flight behaviors that may increase the likelihood of turbine strikes. They tend to hunt on the ground during the daytime, and to hunt from a perch or from a hover at night (Poulin et al. 2011). Hover-hunting generally occurs at about 32 feet (10 meters) above ground (Poulin et al. 2011), a height which verges on the rotor zone of existing turbines within the Sand Hill Facility (35 to 108 feet, or 11 to 33 meters above ground). Mating display flights which reach heights of up to 98 feet (30 meters) may also enter the rotor zone of existing turbines. Both hunting and display flights generally occur near the burrow, which may explain the correlation of higher fatalities being detected at turbines with burrows within 184 feet (55 meters; Smallwood et al. 2009b).

Northern Harrier (*Circus cyaneus*)

Northern harriers are year-round residents within California and occur in greater numbers during migration and winter than during the breeding season (Shuford and Gardali 2008). Northern harriers breed and forage in a variety of open habitats including meadows, grasslands, open rangelands, ungrazed pastures, desert sinks, freshwater and saltwater emergent wetlands, and some croplands (Shuford and Gardali 2008). Nests are constructed on the ground amid tall, dense shrubby vegetation or amid grasses, reeds, cattails, or similar vegetation commonly associated with wetland or riparian environments (Smith et al. 2011). Northern harriers typically hunt on the wing, flying low to the ground (less than 16 feet or 5 meters) and relying on both sight and sound to prey on small and medium-sized mammals, birds, reptiles, and frogs (Shuford and Gardali 2008, Smith et al. 2011).

The APWRA provides both nesting and foraging habitat for northern harriers, and individuals are commonly observed foraging over croplands, wetlands, or grasslands (Howell and DiDonato 1991, Smallwood and Thelander 2008, ICF International 2013a). Although suitable nesting habitat for northern harriers occurs within the APWRA, it is limited within the Sand Hill Facility. Nesting habitat may occur sporadically in seasonal or intermittent drainages or around existing ponds within or near the Sand Hill Facility. Foraging habitat for northern harriers is likely present within the Sand Hill Facility.

Population Trends and Local Impacts. BBS data suggest that breeding populations of northern harrier in North America have fluctuated between 1966 and 1996, with some areas experiencing population growth while populations in other areas declined (Smith et al. 2011, Sauer et al. 2012). The California wintering population was estimated at 13,200 birds in the late-1980s; the breeding population would be lower (Johnsgard 1990). Results from the Christmas Bird Count show a declining winter population in California from 1990 to 2011 (National Audubon Society 2010).

Northern harrier fatalities have been detected in the APWRA, with estimated adjusted mortality rates ranging from 0.001 to 0.015 deaths/MW/year (Table 2). Within the Sand Hill Facility, one northern harrier has been detected as a fatality during mortality monitoring from 2000 – 2012 (SRC APWRA 2013; Table 1). This fatality occurred at a Micon 65-kW turbine in the Castello-Arnaudo parcel (Figure 3B). Adjusted mortality estimates for the Sand Hill Facility are unavailable for northern harrier. The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected no northern harrier fatalities, and thus, did not calculate an adjusted mortality estimate at high-risk turbines (Smallwood 2013; Table 2).

No publicly available research has identified collision risk factors for northern harrier.

Loggerhead Shrike (*Lanius ludovicianus*)

Loggerhead shrikes are year-round residents of California that occur in the Central Valley and southern coast within shrub habitats, riparian woodlands, and grazed lands (Shuford and Gardali 2008). Local resident populations are augmented in winter by migrants from the north (Shuford and Gardali 2008). The species shows a preference for nesting and hunting perches in thorny shrubs, as it typically impales its prey on sharp twigs, thorns, or barbed wire (Shuford and Gardali 2008).

Loggerhead shrikes are known to nest in the APWRA (ICF International 2013b). Within the Sand Hill Facility, potential habitat is present and live loggerhead shrikes have been observed (ICF International 2013b).

Population Trends and Local Impacts. BBS data indicate that California populations have been declining since the surveys began in 1968 (Sauer et al. 2012). The California Audubon Society lists the loggerhead shrike as one of California's Common Birds in Decline, noting a 72 percent decline since 1967 (California Audubon Society 2010). While overall abundance remains relatively high in the Central

Valley and in the San Francisco Bay regions, significant population declines have been observed in both regions since 1966 (Sauer et al. 2012).

Loggerhead shrike fatalities have been detected in the APWRA, with estimated adjusted mortality rates ranging from 0.019 to 0.438 deaths/MW/year (Table 2). Within the Sand Hill Facility, a total of 11 loggerhead shrikes have been detected as fatalities during mortality monitoring from 2000 – 2012 (SRC APWRA 2013). These fatalities occurred at 11 different turbines; six fatalities occurred at Enertech 45-kW turbines, four at Micon 65-kW turbines, and one at a Polenko 100-kW turbine. Seven fatalities occurred in the Ralph-Johnston-Pombo parcel (Figure 3A); three occurred in the Castello-Arnaudo parcel (Figure 3B); and one occurred in the Griffith parcel (Figure 3C). Adjusted mortality estimates for the Sand Hill Facility are unavailable for loggerhead shrike. The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected no loggerhead shrike fatalities, and thus, did not calculate an adjusted mortality estimate at high-risk turbines (Smallwood 2013; Table 2).

No publicly available research has identified collision risk factors for loggerhead shrike.

Bird Species of Local Concern

There are four species identified as birds of local concern in the APWRA as a result of the 2007 settlement agreement: American kestrel, burrowing owl, golden eagle, and red-tailed hawk. These four species are disproportionately impacted by wind farms and are the focus of continuing mitigation and research efforts in the APWRA. Descriptions for burrowing owl and golden eagle are provided in the preceding sections.

American Kestrel (*Falco sparverius*)

American kestrels are common residents throughout California, inhabiting a variety of open habitats including grasslands, shrublands, early successional forests, and forest openings (Zeiner et al. 1988). Migrants from more northern latitudes overwinter in California (Zeiner et al. 1988). American kestrels typically hunt from a perched or hovering position; preferred prey items include small mammals, birds, reptiles, and amphibians as well as insects and worms (Zeiner et al. 1988). Breeding individuals nest in cavities found within trees, snags, rocky outcrops, embankments, and buildings (Zeiner et al. 1988).

There are numerous documented occurrences of American kestrel in the APWRA, and use appears to peak in late fall (Smallwood et al. 2009a). Mean use rates at point count locations within the Sand Hill Facility (see Figure 2-3 in ICF International 2013a) ranged between 0.00 to 3.87 observations/minute/km^3 during use surveys in the APWRA from 2005 to 2010 (ICF International 2013a). Average American kestrel use rates were highest in the Griffith and Castello-Arnaudo parcels (ICF International 2013a; Figure 1).

Population Trends and Local Impacts. The American kestrel population in North America appears to be relatively stable, although the population has increased in some areas and declined in others. Populations have declined in the western U.S. and California since the 1960s, with marked declines in California since 1980 (National Audubon Society 2010, Sauer et al. 2012).

American kestrel fatalities have been detected in the APWRA, with estimated adjusted mortality rates ranging from 0.490 to 0.646 deaths/MW/year (Table 2). Within the Sand Hill Facility, a total of 35

American kestrels have been detected as fatalities during mortality monitoring from 2000 – 2012 (SRC APWRA 2013). Fatalities occurred at 31 different turbines; six at Enertech 45-kW turbines, 25 at Micon 65-kW turbines, one at a Polenko 100-kW turbine, and three at Windmatic 65-kW turbines. Thirteen of the 35 fatalities occurred in the Ralph-Johnston-Pombo parcel (Figure 3A); 18 occurred in the Castello-Arnaudo parcel (Figure 3B); and 4 occurred in the Griffith parcel (Figure 3C). Adjusted mortality estimates have been calculated for the Sand Hill Facility, and range from 0.00 to 1.90 fatalities/MW/year based on monitoring conducted from 2005 to 2010 (ICF International 2012). The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected three American kestrel fatalities, resulting in an adjusted mortality estimate of 0.562 deaths/MW/year at high-risk turbines (Smallwood 2013; Table 2).

The seasonal distribution of fatalities appears to correspond with seasonal use patterns; peaks in mean fatalities detected occur in months with highest use (ICF International 2013a). For example, use by kestrels is highest in winter, and peaks in fatality detections occur in January and March (ICF International 2013a). Similarly, use is increased in July and August, corresponding with the timing of juvenile dispersal, and there is a corresponding peak in fatality detections in August (ICF International 2013a).

American kestrels exhibit a number of behaviors that contribute to a relatively high mortality rate. Kestrels observed during use surveys conducted from March 1998 to April 2000 spent a disproportionally greater amount of flight time within the rotor zone or within 164 feet (50 meters) of the rotor zone (Smallwood et al. 2009a). Additionally, Smallwood et al. (2009a) observed a substantial increase in the time American kestrels spent foraging (i.e., hovering, kiting, and diving) while within the rotor zone of operating turbines compared to non-operational turbines. Kestrels have also been observed perching on both operating and non-operational wind turbines, increasing their exposure to collision risk (Smallwood et al. 2009a). American kestrel mortality rates appear to be highest on ridgelines, ridge crests, and ridge saddles (Smallwood 2010).

Red-tailed Hawk (*Buteo jamaicensis*)

Red-tailed hawks are common as residents and migrants throughout California (Zeiner et al. 1988). They are habitat generalists and, as such, can be found in a wide range of habitats and elevations, favoring open areas interspersed with trees or other structures for perching (Zeiner et al. 1988). Red-tailed hawks prey upon a wide variety of small- to medium-sized mammals, birds, reptiles, amphibians, arthropods, and fresh carrion (Preston and Beane 2009). They are primarily perch-and-pounce raptors, although they may take prey on the wing as well as from the ground (Preston and Beane 2009).

Red-tailed hawks are year-round residents in the APWRA and are one of the most frequently-observed species, with a marked population increase in winter due to the presence of migrating and wintering individuals, (ICF International 2013a). Mean use rates at point count locations within the Sand Hill Facility (see Figure 2-3 in ICF International 2013a) ranged between 0.15 to 7.88 observations/minute/km^3 during APWRA-wide use surveys from 2005 to 2010 (ICF International 2013a). Most red-tailed hawk detections occurred within the Castello-Arnaudo parcels (ICF International 2013a; Figure 1).

Population Trends and Local Impacts. Red-tailed hawk populations have remained stable or increased throughout most of the western United States since the 1980s, increasing by 1.5 percent in California between 1983 and 2005 and by 2.1 percent between 2001 and 2011 (Sauer et al. 2012). The population of red-tailed hawks in California was estimated at 160,000 individuals (Rich et al. 2004). The Central Valley population has significantly increased since 1968 (National Audubon Society 2010, Sauer et al. 2012).

Red-tailed hawk fatalities have been detected in the APWRA, with estimated adjusted mortality rates ranging from 0.324 to 0.782 deaths/MW/year (Table 2). Within the Sand Hill Facility specifically, a total of 92 red-tailed hawks have been detected as fatalities during mortality monitoring from 2000 – 2012 (SRC APWRA 2013). These fatalities occurred at 77 different turbines; 37 at Enertech 45-kW turbines, 48 at Micon 65-kW turbines, three at Polenko 100-kW turbines, and four at Windmatic 65-kW turbines. Fifty-eight of the 92 fatalities occurred in the Ralph-Johnston-Pombo parcel (Figure 4A); 25 occurred in the Castello-Arnaudo parcel (Figure 4B); and 9 occurred in the Griffith parcel (Figure 4C). Adjusted mortality estimates have been calculated for the Sand Hill Facility, and range from 0.00 to 1.90 fatalities/MW/year based on monitoring conducted from 2005 to 2010 (ICF International 2012). The BACI avian mortality study conducted by Smallwood at Sand Hill Facility high-risk turbines in 2012 – 2013 detected one red-tailed hawk fatality, resulting in an adjusted mortality estimate of 0.190 deaths/MW/year at high-risk turbines (Smallwood 2013; Table 2).

The average number of red-tailed hawk fatalities detected each month varies seasonally (Smallwood et al. 2009a). The lowest numbers of fatalities are detected during the winter period, the season with the highest use (ICF International 2013a). Outside of the winter period, the average number of red-tailed hawk fatalities appears to increase through the fall, roughly corresponding to the time of natal dispersal and migration (ICF International 2013a).

A number of factors contribute to relatively high mortality rates of red-tailed hawk in the APWRA. Red-tailed hawks typically hunt from perches, and have frequently been observed perching on both non-operational and operational turbine towers and even on idle turbine blades (Howell and DiDonato 1991, Orloff and Flannery 1992, Smallwood and Thelander 2005, ICF International 2013a). In a study of bird behavior from 1998 – 2001, the red-tailed hawk was the species most often performing what are assumed to be more dangerous behaviors, including flight in close proximity to turbines (within 164 feet, or 50 meters) and even flights through the rotor zone of spinning turbines (Orloff and Flannery 1992, Smallwood and Thelander 2005). Furthermore, they spend disproportionally more time in close proximity to turbines, and spend a large proportion of that time foraging (Smallwood and Thelander 2005, Smallwood et al. 2009a). Red-tailed hawk mortality rates appear to be highest on notches, plateaus, and hill peaks (Smallwood 2010).

Other Common Bird Species

A number of common, non-special status species have been detected as fatalities at the Sand Hill Facility. These species are summarized in Table 1 and annual mortality estimates for these species from a number of studies in the APWRA are provided in Table 2. Mortality estimates from the BACI avian mortality study conducted at Sand Hill in 2012 – 2013 (Smallwood 2013) are also provided in Table 2 for comparison, although the data was collected only at high-risk turbines, and thus, is expected to produce relatively higher mortality estimates.

Table 1. Documented Avian Fatalities in the APWRA

Common Name[1]	Scientific Name	Status[2]	Found as Fatality at Sand Hill
American avocet	*Recurvirostra americana*	-	X
American coot	*Fulica americana*	-	-
American crow	*Corvus brachyrhynchos*	-	X
American kestrel	*Falco sparverius*	SLC	X
American pipit	*Anthus rubescens*	-	X
American robin	*Turdus migratorius*	-	-
Ash-throated flycatcher	*Myiarchus cinerascens*	-	X
Band-tailed pigeon	*Columba fasciata*	-	-
Barn owl	*Tyto alba*	-	X
Barn swallow	*Hirundo rustica*	-	X
Black-crowned night heron	*Nycticorax nycticorax*	-	-
Black-necked stilt	*Himantopus mexicanus*	-	X
Bonaparte's gull	*Chroicocephalus philadelphia*	-	-
Brewer's blackbird	*Euphagus cyanocephalus*	-	X
Brown pelican	*Pelicanus occidentalis*	CFP	X
Brown-headed cowbird	*Molothrus ater*	-	X
Burrowing owl	*Athene cunicularia*	CSC	X
California gull	*Larus californicus*	-	X
Cattle egret	*Bubulcus ibis*	-	-
Cliff swallow	*Hirundo pyrrhonota*	-	X
Cockatiel	*Leptolophus hollandicus*	-	X
Common goldeneye	*Bucephala clangula*	-	-
Common poorwill	*Phalaenoptilus nuttallii*	-	X
Common raven	*Corvus corax*	-	X
Cooper's hawk	*Accipiter cooperii*	-	-
Dark-eyed junco	*Junco hyemalis*	-	-
Double-crested cormorant	*Phalacrocorax auritus*	-	-
European starling	*Sturnus vulgaris*	-	X
Ferruginous hawk	*Buteo regalis*	-	X
Fox sparrow	*Passerella iliaca*	-	-
Golden eagle	*Aquila chrysaetos*	BGEPA, CFP	X
Golden-crowned sparrow	*Zonotrichia atricapilla*	-	X
Great blue heron	*Ardea herodius*	-	X
Great egret	*Ardea alba*	-	X
Great horned owl	*Bubo virginianus*	-	X
Hammond's flycatcher	*Empidonax hammondii*	-	-
Helmeted guineafowl	*Numida meleagris*	-	X
Herring gull	*Larus argentatus*	-	X
Horned lark	*Eremophila alpestris actia*	-	X
House finch	*Carpodacus mexicanus*	-	X
House sparrow	*Passer domesticus*	-	X
House wren	*Troglodytes aedon*	-	-
Killdeer	*Charadrius vociverus*	-	X

Table 1. Documented Avian Fatalities in the APWRA (cont.)

Common Name[1]	Scientific Name	Status[2]	Found as Fatality at Sand Hill
Lesser goldfinch	*Spinus psaltria*	-	X
Lesser yellowlegs	*Tringa flavipes*	-	-
Lincoln sparrow	*Melospiza lincolnii*	-	-
Loggerhead shrike	*Lanius ludovicianus*	CSC	X
Long-billed curlew	*Numenius americanus*	-	-
Long-eared owl	*Asio otus wilsonianus*	CSC	-
Mallard	*Anas platyrhynchos*	-	X
Mew gull	*Larus canus*	-	-
Mountain bluebird	*Sialia currucoides*	-	X
Mourning dove	*Zenaida macroura*	-	X
Northern flicker	*Colaptes auratus*	-	X
Northern harrier	*Circus cyaeneus*	CSC	X
Northern mockingbird	*Mimus polyglottos*	-	X
Northern shrike	*Lanius excubitor*	-	-
Orange-crowned warbler	*Vermivora celata*	-	-
Pacific-slope flycatcher	*Empidonax difficilis*	-	X
Peregrine falcon	*Falco peregrinus*	CFP	-
Pied-billed grebe	*Podilymbus podiceps*	-	-
Prairie falcon	*Falco mexicanus*	-	-
Red-shouldered hawk	*Buteo lineatus*	-	-
Red-tailed hawk	*Buteo jamaicensis*	SLC	X
Red-winged blackbird	*Agelaius phoeniceus*	-	X
Ring-billed gull	*Larus delawarensis*	-	-
Ring-necked duck	*Aythya collaris*	-	-
Rock pigeon	*Columba livia*	-	X
Rock wren	*Salpinctes obsoletus*	-	-
Rough-legged hawk	*Buteo lagopus*	-	-
Sandhill crane[3]	*Grus canadensis*	CT/CSC[3]	-
Savannah sparrow	*Passerculus sandwichensis*	-	X
Say's phoebe	*Sayornis saya*	-	X
Scrub jay	*Aphelocoma californica*	-	-
Spotted sandpiper	*Actitis macularius*	-	X
Spotted towhee	*Pipilo maculatus*	-	-
Swainson's hawk	*Buteo swainsoni*	CT	-
Swainson's thrush	*Catharus ustulatus*	-	-
Thayer's gull	*Larus thayeri*	-	-
Townsend's warbler	*Dendroica townsendi*	-	-
Tree swallow	*Tachycineta bicolor*	-	X
Tricolored blackbird	*Agelaius tricolor*	CSC	X
Turkey vulture	*Cathartes aura*	-	X
Vaux's swift	*Chaetura vauxi*	CSC	-
Violet-green swallow	*Tachycineta thalassina*	-	X

Table 1. Documented Avian Fatalities in the APWRA (cont.)

Common Name[1]	Scientific Name	Status[2]	Found as Fatality at Sand Hill
Warbling vireo	*Vireo gilvus*	-	-
Western bluebird	*Sialia mexicana*	-	-
Western gull	*Larus occidentalis*	-	-
Western kingbird	*Tyrannus verticalis*	-	-
Western meadowlark	*Sturnella neglecta*	-	X
Western tanager	*Piranga ludoviciana*	-	-
White-tailed kite	*Elanus leucurus*	CFP	-
White-throated swift	*Aeronautes saxatalis*	-	X
Wild turkey	*Melleagris gallopavo*	-	-
Wilson's warbler	*Cardellina pusilla*	-	X
Yellow warbler	*Dendroica petechia*	CSC	-
Yellow-rumped warbler	*Dendroica coronata*	-	X

[1]Species documented as fatalities in APWRA have been reported in one or more of the following studies: Howell and DiDonato 1991, Orloff and Flannery 1992, Orloff and Flannery 1996, Howell 1997, Hunt 2002, Smallwood and Thelander 2004, Smallwood and Thelander 2005, Smallwood and Thelander 2008, APAMT 2008, West 2008, Smallwood and Karas 2009, ICF International 2012

[2]Species Status:
- BGEPA = Bald and Golden Eagle Protection Act
- CE = California Endangered
- CT = California Threatened
- CFP = California Fully Protected
- CSC = California Species of Concern
- SLC = Species of Local Concern

[3]The greater sandhill crane is listed as California Threatened and California Fully Protected. The wintering population of lesser sandhill crane is listed as a California Species of Concern.

Table 2. Adjusted Avian Mortality Rates at the APWRA

Study Area	Entire APWRA					Sand Hill Facility	
Data Source	Smallwood and Thelander (2008)	APAMT (2008)	Smallwood and Karas (2009)	Smallwood and Karas (2009)	ICF International (2013a)	ICF International (2012)	Smallwood (2013)[1] High-risk Turbines
Years Data Collected	1998–2003	1998–2003	1998–2000	2005–2007	2005–2011	2005-2010	2012–2013
Species or Group	Adjusted Rate of Fatalities (Deaths/MW/Year)						
American kestrel	0.599	0.646	0.496	0.532	0.490	0.00-1.90	0.562
Barn owl	0.052		0.077	0.268	0.250		0.274
Burrowing owl	0.759	0.827	1.442	3.025	0.700	0.00-10.40	3.126
Ferruginous hawk	0.028				0.010		0.179
Golden eagle	0.115	0.211	0.070	0.091	0.090	0.00-0.50	
Great horned owl	0.016		0.043	0.048	0.070		0.108
Northern harrier	0.001		0.006	0.015	0.010		
Peregrine falcon					0.000		
Prairie falcon	0.002		0.003	0.006	0.020		
Red-shouldered hawk					0.000		
Red-tailed hawk	0.324	0.537	0.437	0.782	0.500	0.00-1.90	0.190
Swainson's hawk					0.000		
Turkey vulture	0.004		0.009	0.003	0.020		
White-tailed kite					0.010		
ALL RAPTORS	**1.943**	**2.459**	**2.583**	**4.786**	**1.780**		**4.441**
American avocet	0.007		0.059	0.000	0.000		
American coot					0.010		
American crow	0.017		0.068	0.049	0.010		
American pipit					0.010		
Ash-throated flycatcher							0.311
Barn swallow					0.010		
Black-crowned night heron	0.001						
Black-necked stilt			0.000	0.130	0.000		
Bonaparte's gull					0.000		
Brewer's blackbird	0.153		0.246	0.226	0.050		

Table 2. Adjusted Avian Mortality Rates at the APWRA (cont.)

Study Area	Entire APWRA					Sand Hill Facility	
Data Source	Smallwood and Thelander (2008)	APAMT (2008)	Smallwood and Karas (2009)	Smallwood and Karas (2009)	ICF International (2013a)	ICF International (2012)	Smallwood (2013)[1] High-risk Turbines
Years Data Collected	1998–2003	1998–2003	1998–2000	2005–2007	2005–2011	2005-2010	2012–2013
Species or Group	Adjusted Rate of Fatalities (Deaths/MW/Year)						
Brown pelican					0.000		
Brown-headed cowbird	0.065		0.058	0.000	0.000		
California gull	0.010		0.028	0.035	0.030		0.126
Cattle egret	0.003						
Cliff swallow	0.013		0.063	0.046	0.020		
Cockatiel	0.001		0.000	0.068			
Common goldeneye					0.000		
Common poorwill					0.000		0.257
Common raven	0.027		0.088	0.145	0.110		0.300
Dark-eyed junco					0.000		
Double-crested cormorant	0.002		0.017	0.000			
European starling	0.469		1.704	3.235	1.950		8.559
Golden-crowned sparrow					0.010		
Great blue heron			0.000	0.004	0.000		
Great egret			0.000	0.156	0.000		
Hammond's flycatcher					0.010		
Herring gull							0.118
Horned lark	0.041		0.455	0.456	0.200		0.553
House finch	0.045		0.693	0.000	0.010		0.866
House sparrow	0.021				0.000		
House wren					0.010		
Killdeer			0.000	0.012	0.020		0.322
Lesser goldfinch					0.010		0.445
Lesser yellowlegs	0.001						
Lincoln's sparrow					0.000		

Table 2. Adjusted Avian Mortality Rates at the APWRA (cont.)

Study Area	Entire APWRA					Sand Hill Facility	
Data Source	Smallwood and Thelander (2008)	APAMT (2008)	Smallwood and Karas (2009)	Smallwood and Karas (2009)	ICF International (2013a)	ICF International (2012)	Smallwood (2013)[1] High-risk Turbines
Years Data Collected	1998–2003	1998–2003	1998–2000	2005–2007	2005–2011	2005-2010	2012–2013
Species or Group	Adjusted Rate of Fatalities (Deaths/MW/Year)						
Loggerhead shrike	0.019		0.066	0.438	0.120		
Mallard	0.052		0.187	0.137	0.060		
Mountain bluebird	0.052		0.000	0.081	0.020		
Mourning dove	0.208		2.538	1.054	0.230		2.868
Northern flicker	0.066		0.247	0.087	0.040		
Northern mockingbird	0.004		0.082	0.000	0.020		
Orange-crowned warbler					0.000		
Pacific-slope flycatcher	0.003		0.058	0.000			
Pied-billed grebe					0.000		
Red-winged blackbird	0.035		0.505	0.330	0.090		0.391
Ring-billed gull	0.010		0.029	0.000	0.000		
Ring-necked duck	0.005						
Rock dove	0.325		1.339	3.520	2.300		16.609
Rock wren					0.010		
Sandhill crane					0.000		
Savannah sparrow	0.015		0.073	0.000	0.010		
Say’s phoebe					0.010		
Spotted sandpiper							0.266
Spotted towhee					0.000		
Swainson’s thrush					0.010		
Townsend’s warbler					0.000		
Tree swallow			0.000	0.013			
Tricolored blackbird	0.002		0.030	0.000	0.010		0.240
Violet-green swallow	0.001				0.000		
Warbling vireo					0.000		

Table 2. Adjusted Avian Mortality Rates at the APWRA (cont.)

Study Area	Entire APWRA					Sand Hill Facility	
Data Source	Smallwood and Thelander (2008)	APAMT (2008)	Smallwood and Karas (2009)	Smallwood and Karas (2009)	ICF International (2013a)	ICF International (2012)	Smallwood (2013)[1] Sand Hill High-risk Turbines
Years Data Collected	1998–2003	1998–2003	1998–2000	2005–2007	2005–2011	2005-2010	2012–2013
Species or Group		Adjusted Rate of Fatalities (Deaths/MW/Year)					
Western meadowlark	0.716		1.964	3.817	1.710		2.342
Western kingbird	0.001		0.021	0.000			
Western scrub-jay					0.000		
Western tanager					0.020		
White-throated swift			0.000	0.027	0.010		0.297
Wild turkey	0.002		0.013	0.000	0.000		
Wilson's warbler					0.010		
Yellow warbler	0.002						
ALL BIRDS	**4.672**		**14.220**	**21.627**	**9.360**		**47.634**

1. Rates provided from Smallwood 2013 are those from searches at high-risk turbines at the Sand Hill Facility corrected with the integrated carcass detection trial performed at the Sand Hill Facility.

BACI Avian Mortality Study at High-risk Turbines at the Sand Hill Facility

Mortality rates specific to high-risk turbines at the Sand Hill Facility are available from the preliminary results of the first year of the BACI study being conducted by Smallwood (2013). The Smallwood study was performed in order to investigate the impacts of repowering with Shrouded Turbines at the Sand Hill Facility. Search turbines were chosen by selecting 60 clusters of high-risk turbines within the 385 turbine Sand Hill Facility; turbines were defined as high-risk that had relatively high numbers of fatalities detected during previously performed mortality monitoring (i.e., monitoring performed by ICF International). Mortality monitoring began April 1, 2012 and this report makes use of data through March 31, 2013. Each 164-foot (50-meter) radius search plot was covered by transects spaced 20 feet (6 meters) apart and had a mean search interval of 4.8 days. Raw numbers of fatalities were adjusted for detection bias (e.g., carcass persistence, searcher efficiency) using integrated carcass detection trials that included scaling detection based on the body mass of carcasses. Additionally, raw numbers of fatalities were adjusted based on the proportion of fatalities that occurred within 164 feet (50 meters) of the turbine to account for the spatial carcass distribution sampled.

A total of 406 unique fatalities were detected during the first year of the study, with 253 of the fatalities attributed to turbine collision. Fatalities attributed to turbine collision were comprised of 97 fatalities of endemic species of which 25 were raptors, and 156 fatalities of non-native species (rock pigeon and European starling, n = 120 and n = 36, respectively).

Adjusted annual mortality rates for the high-risk turbines searched were estimated for individual species and groups (see Smallwood 2013 for detailed methods; Table 2). Species-specific mortality rates ranged from 0.108 fatalities/MW/year to 16.609 fatalities/MW/year at high-risk turbines (Table 2). The burrowing owl and mourning dove had the highest estimated annual mortality rates (3.126 fatalities/MW/year, and 2.868 fatalities/MW/year, respectively) among native species. It is important to note that these rates are not to be considered representative of the Sand Hill Facility as a whole, but reflect the annual rate of fatalities at high-risk turbines.

Smallwood also compared the results of his mortality monitoring against monitoring conducted concurrently by ICF International at the same high-risk turbines of the Sand Hill Facility. No Sand Hill Facility-specific detection bias corrections were available for the ICF International data; therefore, Smallwood used national averages for carcass persistence and searcher efficiency correction factors from trials conducted in annual grassland environments similar to the conditions in the APWRA. These correction factors were applied to both the Smallwood monitoring data and ICF International’s data to allow comparison and to lessen the chance of deriving anomalous adjustment values from one monitoring study (Smallwood 2013). Different search intervals were used in the analysis for the two data sources because monitoring performed by ICF International used a longer search interval (39 – 42 days) than the Smallwood monitoring. The ICF International dataset had fewer species detected, particularly small-bodied species, and the mortality estimates were lower than those produced by Smallwood’s data using the national adjustments (Smallwood 2013; Table 3). Additionally, the mortality estimates from Smallwood’s data were generally higher when adjusted using national averages from separate trials for searcher detection and carcass persistence than when they were adjusted with the integrated carcass detection trial conducted at the Sand Hill Facility (Smallwood 2013; Table 3).

Table 3. Mortality Rates Estimated From Smallwood Monitoring and From ICF International Monitoring at High-risk Turbines at the Sand Hill Facility

Species	Adjusted with Integrated Bias Trial Results from Sand Hill Facility (Deaths/MW/Year)	Adjusted with National Bias Averages (Deaths/MW/Year)	
	Smallwood Mean	Smallwood Mean	ICF Mean
American kestrel	0.562	0.869	
Barn owl	0.274	0.399	0.396
Burrowing owl	3.126	5.104	2.790
Ferruginous hawk	0.179	0.325	
Great horned owl	0.108	0.200	
Red-tailed hawk	0.190	0.325	
ALL RAPTORS	**4.441**	**7.221**	**3.186**
Ash-throated flycatcher	0.311	0.290	
California gull	0.126	0.200	
Common poorwill	0.257	0.290	
Common raven	0.300	0.519	
European starling	8.559	11.586	9.775
Herring gull	0.118	0.200	
Horned lark	0.553	0.579	
House finch	0.866	0.752	1.044
Killdeer	0.322	0.471	
Lesser goldfinch	0.445	0.290	
Mourning dove	2.868	4.536	
Red-winged blackbird	0.391	0.471	
Rock pigeon	16.609	21.631	11.243
Spotted sandpiper	0.266	0.290	
Tricolored blackbird	0.240	0.290	
Western meadowlark	2.342	3.439	1.082
White-throated swift	0.297	0.290	
Yellow-rumped warbler	1.043	0.579	
ALL BIRDS	**47.634**	**61.962**	**27.754**

Mortality rates at high-risk turbines of the Sand Hill Facility do not appear to be declining over time based on a comparison of rates from the Smallwood study to adjusted rates calculated from long-term mortality monitoring data (ICF International 2012, Smallwood 2013). Additionally, for some species such as the burrowing owl and western meadowlark, mortality rates demonstrate a cyclical nature. This may be related to species-specific inter-annual cycles of abundance, assuming that species abundance is related to collision risk.

LITERATURE CITED

APAMT (Altamont Pass Avian Monitoring Team). 2008. Altamont Pass Wind Resource Area Bird Fatality Study. July. (ICF J&S 61119.06.) Portland, OR. Prepared for Altamont County Community Development Agency.

Bates, C. 2006. Burrowing Owl (*Athene cunicularia*). *In* The Draft Desert Bird Conservation Plan: a strategy for reversing the decline of desert-associated birds in California. California Partners in Flight. http://www.prbo.org/calpif/htmldocs/desert.html

California Audubon Society. 2010. Audubon California- Common Birds in Decline. Available at: http://ca.audubon.org/birds/birds-in-decline.php. Last accessed June 24, 2013.

CDFG (California Department of Fish and Game). 1999. Life History Account for Burrowing Owl. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentVersionID=17581 Last accessed June 24, 2013.

CDFG. 2004. Golden Eagle Range Map. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=1682 Date accessed: May 28, 2013.

CDFG. 2008. Life History Account for Tricolored Blackbird. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentVersionID=18067 Date accessed: June 19, 2013.

CDFW (California Department of Fish and Wildlife). 2013a. California Natural Diversity Database. http://www.dfg.ca.gov/biogeodata/cnddb/ Data retrieved on May 29, 2013.

CDFW. 2013b. Golden Eagles in California. http://www.dfg.ca.gov/wildlife/nongame/raptors/goldeneagle/ Date accessed: May 28, 2013.

DeSante, D.F., E.D. Ruhlen, and R. Scalf. 2007. The distribution and relative abundance of burrowing owls in California during 1991-1993: evidence for a declining population and thoughts on its conservation. Pp. 1-41 in Barclay, J.H., K.W. Hunting, J.L. Lincer,, J. Linthicum, and T.A. Roberts (eds.). Proceedings of the California Burrowing Owl Symposium, November 2003. Bird Populations Monographs No.1.

Green, M. 2013. FWS Directions in Golden Eagle Conservation and Management. Division of Migratory Birds, USFWS. Presentation at the Wind and Wildlife in the Pacific Northwest workshop at the Oregon and Washington Chapters of The Wildlife Society 2013 Annual Meeting.

Howell, J.A., and J.E. DiDonato. 1991. Assessment of avian use and mortality related to wind turbine operations, Altamont Pass, Alameda and Contra Costa counties, California: September 1988 through August 1989 – Final Report. Report prepared for U.S. Windpower, Inc.

Hunt, G. 2002. Golden Eagles In A Perilous Landscape: Predicting The Effects Of Mitigation For Wind Turbine Blade-Strike Mortality. Sacramento, CA, PIER – Environmental Area, California Energy Commission.

Hunt, G. and T. Hunt. 2006. The Trend of Golden Eagle Territory Occupancy in the Vicinity of the Altamont Pass Wind Resource Area: 2005 Survey. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2006-056.

Hunt, W.G., R.E. Jackman, T.L. Brown, J.G. Gilardi, D.E. Driscoll, and L. Culp. 1995. A pilot Golden Eagle Population Study in the Altamont Pass Wind Resource Area, California. Predatory Bird Res. Group, Univ. of California, Santa Cruz.

Hunt, W.G., R.E. Jackman, T.L. Hunt, D.E. Driscoll, and L. Culp. 1999. A Population Study of Golden Eagles in the Altamont Pass Wind Resource Area; Population Trend Analysis 1994-1997. Predatory Bird Res. Group, Univ. of California, Santa Cruz.

ICF International. 2012. Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005–2010. M87. (ICF 00904.08.) Sacramento, CA. Prepared for Alameda County Community Development Agency, Hayward, CA. November.

ICF International. 2013a. Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005–2011. February. Draft. M96. (ICF 00904.08.) Sacramento, CA. Prepared for Alameda County Co mmunity Development Agency, Hayward, CA.

ICF International. 2013b. Biological Resources Technical Report for the Sand Hill Wind Project. Prepared for FloDesign Wind Turbine Corporation. February 2013.

Johnsgard, P.A. 1990. Hawks, eagles and falcons of North America: biology and natural history. Smithsonian Institute Press, Washington, D.C.

Kochert, M.N., K. Steenhof, C.L. Mcintyre and E.H. Craig. 2002. Golden Eagle (*Aquila chrysaetos*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/684

National Audubon Society (2010). The Christmas Bird Count Historical Results [Online]. Available http://www.christmasbirdcount.org. Last accessed June 24, 2013.

Nielson, R.M., L. McManus, T. Rintz, and L.L. McDonald. 2012. A survey of golden eagles (*Aquila chrysaetos*) in the western U.S.: 2012 Annual Report. A report for the U.S. Fish & Wildlife Service. WEST, Inc., Laramie, Wyoming.

Orloff, S. and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use and mortality in Altamont Pass and Solano County Wind Resource Areas. Report to the Planning Departments of Alameda, Contra Costa, and Solano counties and the California Energy Commission. Tiburon, CA, Biosystems Analysis & California Energy Commission.

Orloff, S. and A. Flannery. 1996. A continued examination of avian mortality in the Altamont Pass Wind Resource Area. Report to the California Energy Commission. Santa Cruz, CA, Biosystems Analysis, Inc.

Poulin, Ray, L. Danielle Todd, E. A. Haug, B. A. Millsap and M. S. Martell. 2011. Burrowing Owl (*Athene cunicularia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/061doi:10.2173/bna.61

Preston, C. R. and R. D. Beane. 2009. Red-tailed Hawk (*Buteo jamaicensis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/052doi:10.2173/bna.52

Rich, T.D., C.J. Beardmore, H. Berlanga, P.J. Blancher, M.S.W. Bradstreet, G.S. Butcher, D.W. Demarest, E.H. Dunn, W.C. Hunter, E.E. Iñigo-Elias, J.A. Kennedy, A.M. Martell, A.O. Panjabi, D.N. Pashley, K.V. Rosenberg, C.M. Rustay, J.S. Wendt, T.C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY.

Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr., and W.A. Link. 2012. The North American Breeding Bird Survey, Results and Analysis 1966 - 2011. Version 12.13.2011 USGS Patuxent Wildlife Research Center, Laurel, MD.

SRC APWRA (Science Review Committee: Altamont Pass Wind Resource Area). 2013. Fatality data retrieved from https://ecosystems.icfwebservices.com/#/WindData on May 24, 2013. http://www.altamontsrc.org/alt_amp_data.php

Shields, M. 2002. Brown Pelican (*Pelecanus occidentalis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/609.

Shuford, W.D. and T. Gardali, editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Smallwood, K.S. 2010. Baseline Avian and Bat Fatality Rates at the Tres Vaqueros Wind Project, Contra Costa County, California. Report to the East Bay Regional Park District. March 21, 2010.

Smallwood, K.S. 2013. First-Year Estimates of Bird and Bat Fatality Rates at Old Wind Turbines, Forebay Areas of Altamont Pass Wind Resource Area. April 2013.

Smallwood, K.S. and C.G. Thelander. 2004. Developing methods to reduce bird mortality in the Altamont Pass Wind Resource Area. Sacramento, CA, BioResource Consultants & California Energy Commission**:** 363.

Smallwood, K.S., and C.G. Thelander. 2005. Bird mortality at the Altamont Pass Wind Resource Area: March 1988-September 2001. Report by BioResource Consultants to the National Renewable Energy Laboratory.

Smallwood, K. S. and C. Thelander. 2008. Bird Mortality in the Altamont Pass Wind Resource Area, California. The Journal of Wildlife Management 72(1): 215-223.

Smallwood, K.S. and B. Karas. 2009. Avian and Bat Fatality Rates at Old-Generation and Repowered Wind Turbines in California. Journal of Wildlife Management 73(7): 1062-1071.

Smallwood, K.S., and L. Neher, 2011. Siting Repowered Wind Turbines to Minimize Raptor Collisions at the Tres Vaqueros Wind Project, Contra Costa County, California. Report to the East Bay Regional Park District. February 18, 2011.

Smallwood, K. S., L. Rugge, and M. L. Morrison. 2009a. Influence of Behavior on Bird Mortality in Wind Energy Developments: The Altamont Pass Wind Resource Area, California. Journal of Wildlife Management 73:1082-1098.

Smallwood, K.S., L. Neher, and D.A. Bell. 2009b. Map-Based Repowering and Reorganization of a Wind Resource Area to Minimize Burrowing Owl and Other Bird Fatalities. Energies 2:915-943.

Smith, K.G., S.R. Wittenberg, R.B. Macwhirter and K.L. Bildstein. 2011. Northern Harrier (*Circus cyaneus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/210 doi:10.2173/bna.210

USFWS (U.S. Fish and Wildlife Service). 2009. Endangered and Threatened Wildlife and Plants; Removal of the Brown Pelican (*Pelecanus occidentalis*) From the Federal List of Endangered and Threatened Wildlife. Federal Register 74 (220): 59444-59472.

USFWS. 2013. Federally listed species in the state of California. http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=CA&s8fid=112761032792&s8fid=112762573902 Last accessed on June 4, 2013.

WEST (Western Ecosystem Technology). 2008. Diablo Winds monitoring progress report: March 2005-Februray 2007.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1988. California's Wildlife. Vol. II: Birds. California Department of Fish and Game, Sacramento.

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FIGURES

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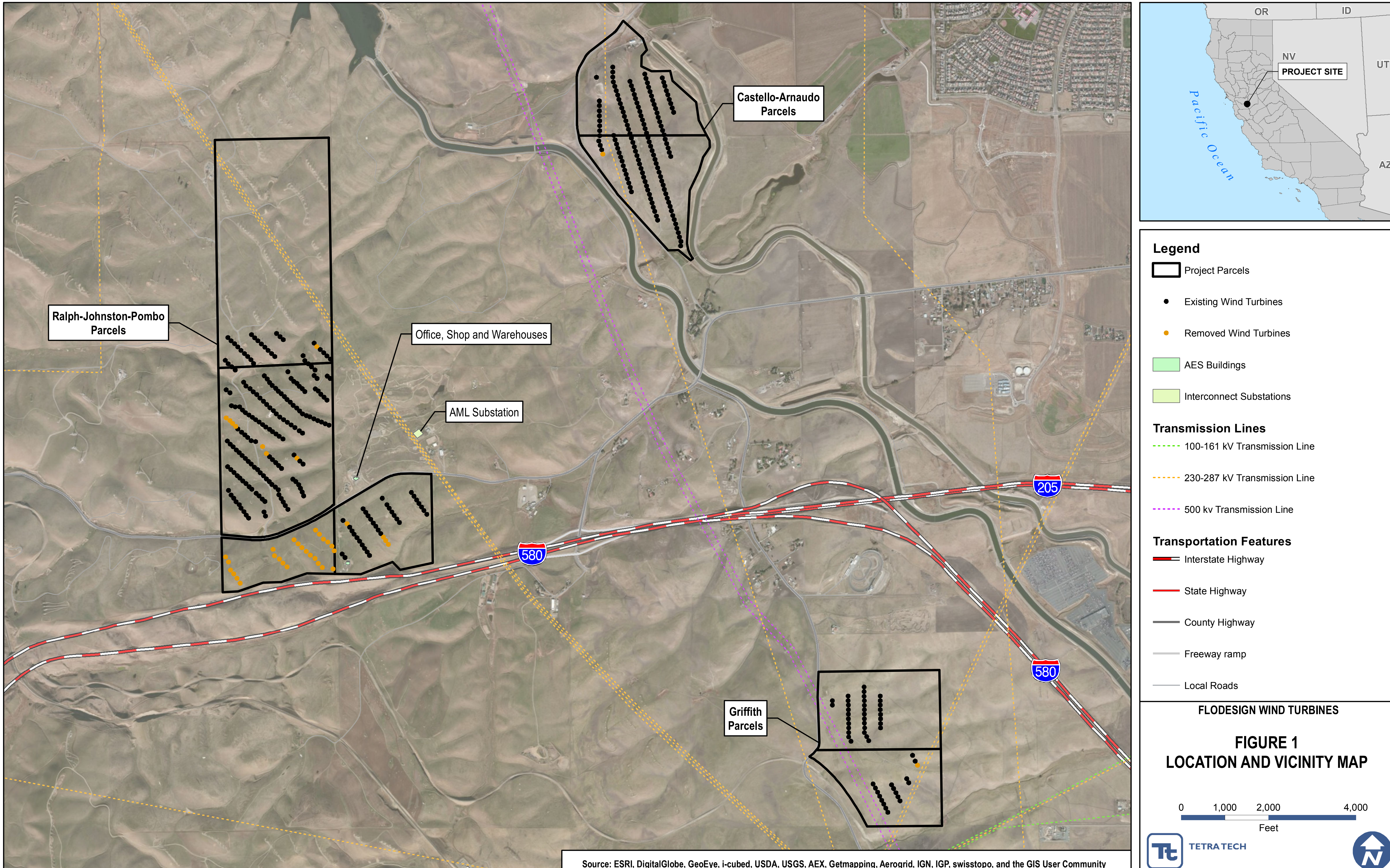

FLODESIGN WIND TURBINES

FIGURE 1
LOCATION AND VICINITY MAP

Figure 2. FloDesign Shrouded Turbine Prototype

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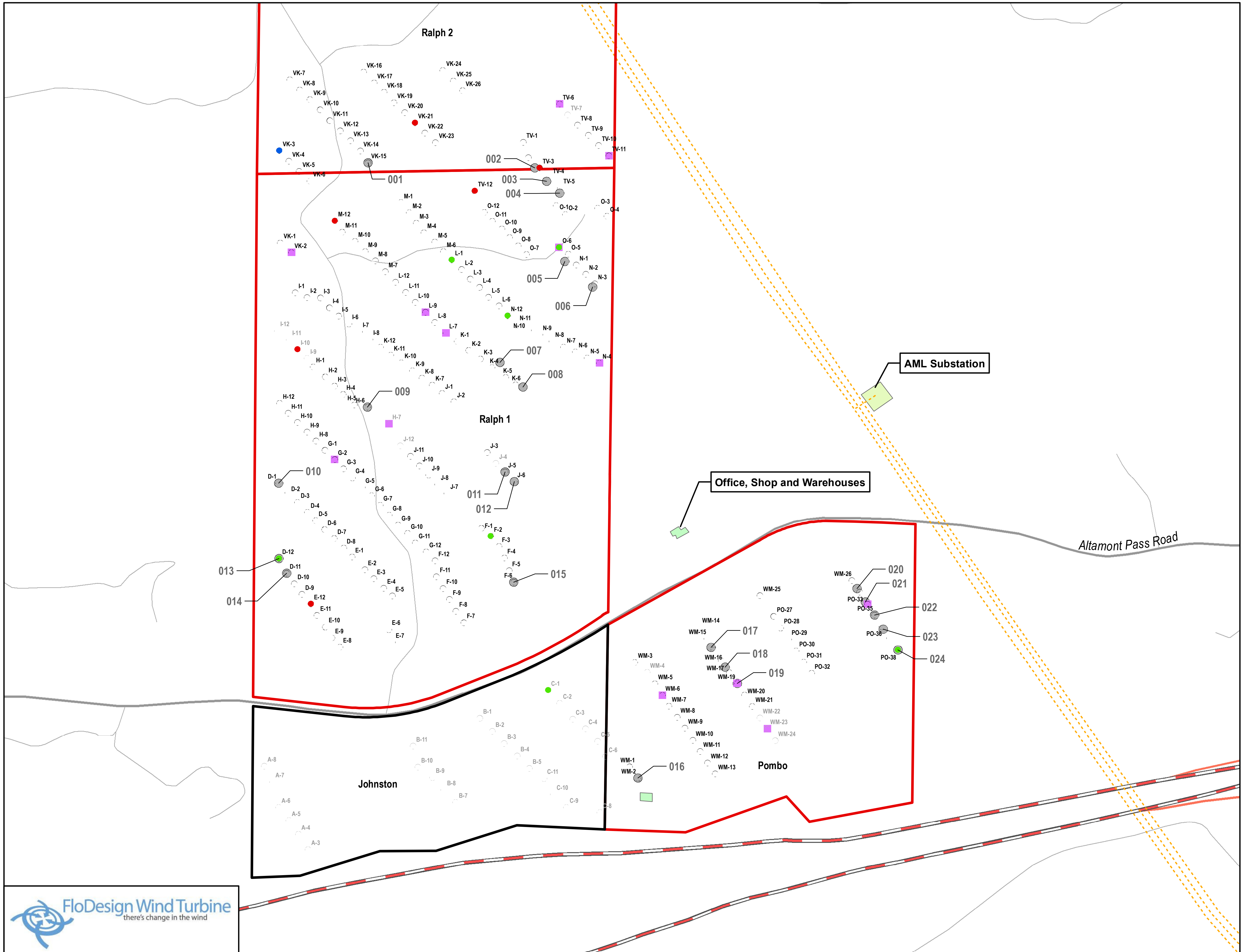

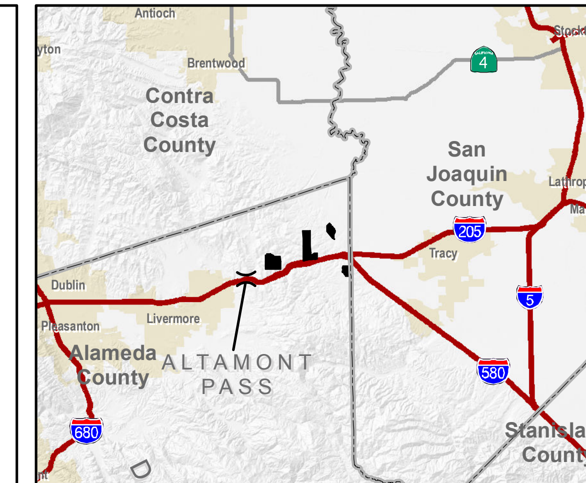

Legend

- Phase 1 Parcels
- Other Parcels
- Existing Turbine
- Removed Turbine
- Proposed Turbines

Transmission Lines

- 100-161 kV Transmission Line
- 230-287 kV Transmission Line
- 500 kv Transmission Line

Avian Fatalities

- American Kestrel
- Golden Eagle
- Loggerhead Shrike
- Tricolored Blackbird

0 105 210 420
Meters

0 350 700 1,400
Feet

Fatality data derived from mortality monitoring performed by ICF International from 2000-2012. Data retrieved on May 24, 2013 from the Science Review Committee: Altamont Pass Wind Resource Area website.

FLODESIGN WIND TURBINES

FIGURE 3A
AVIAN FATALITIES
GROUP 1

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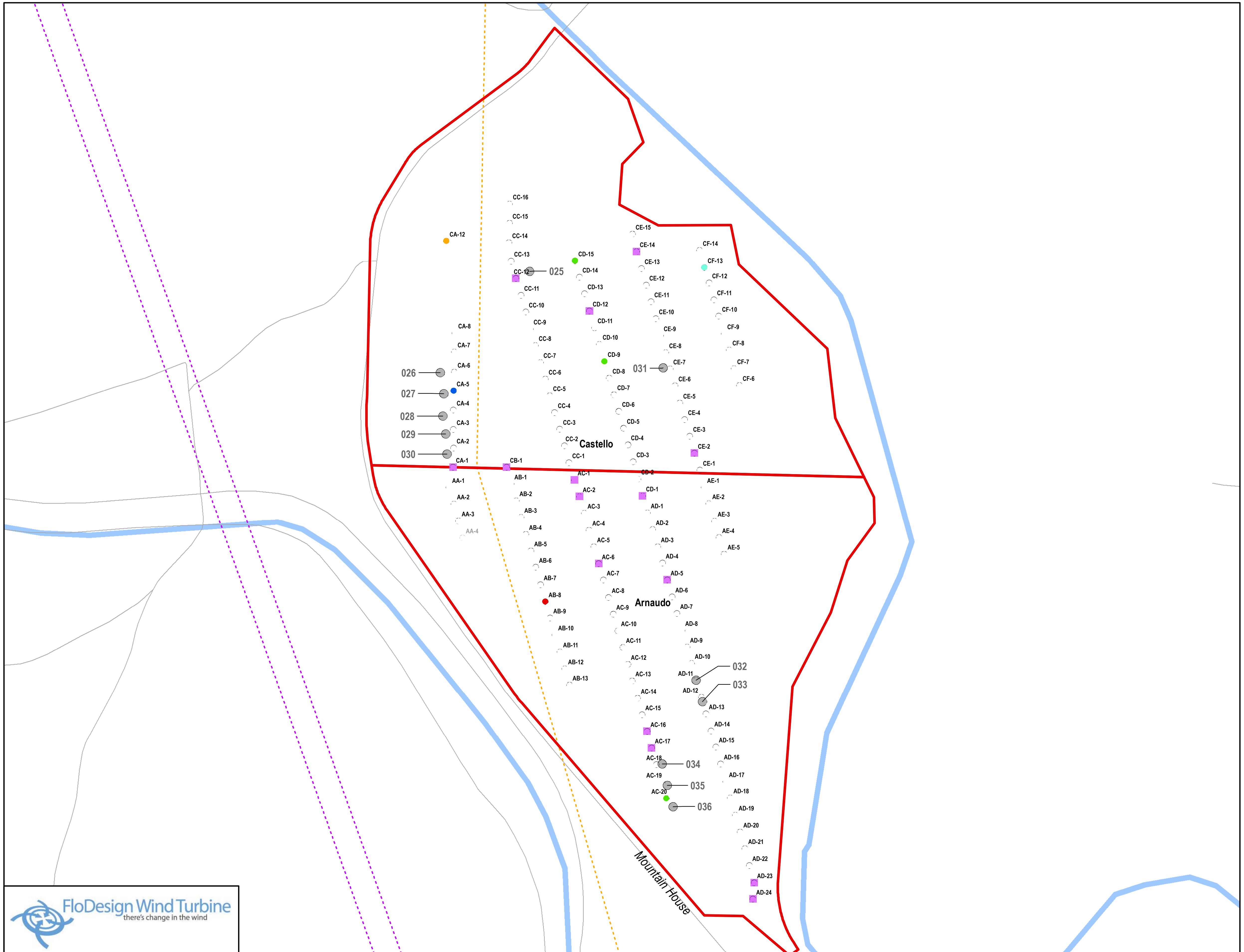

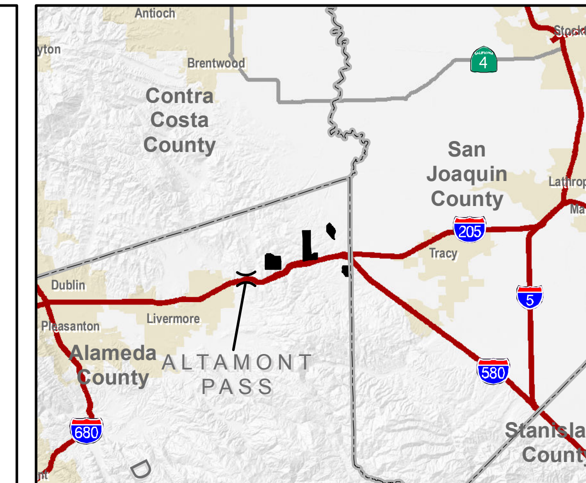

FloDesign Wind Turbine
there's change in the wind

Legend

- Phase 1 Parcels
- Other Parcels
- Existing Turbine
- Removed Turbine
- Proposed Turbines

Transmission Lines

- 100-161 kV Transmission Line
- 230-287 kV Transmission Line
- 500 kv Transmission Line

Avian Fatalities

- American Kestrel
- Brown Pelican
- Golden Eagle
- Loggerhead Shrike
- Northern Harrier
- Tricolored Blackbird

0 85 170 340
Meters

0 285 570 1,140
Feet

Fatality data derived from mortality monitoring performed by ICF International from 2000-2012. Data retrieved on May 24, 2013 from the Science Review Committee: Altamont Pass Wind Resource Area website.

FLODESIGN WIND TURBINES

FIGURE 3B
AVIAN FATALITIES
GROUP 1

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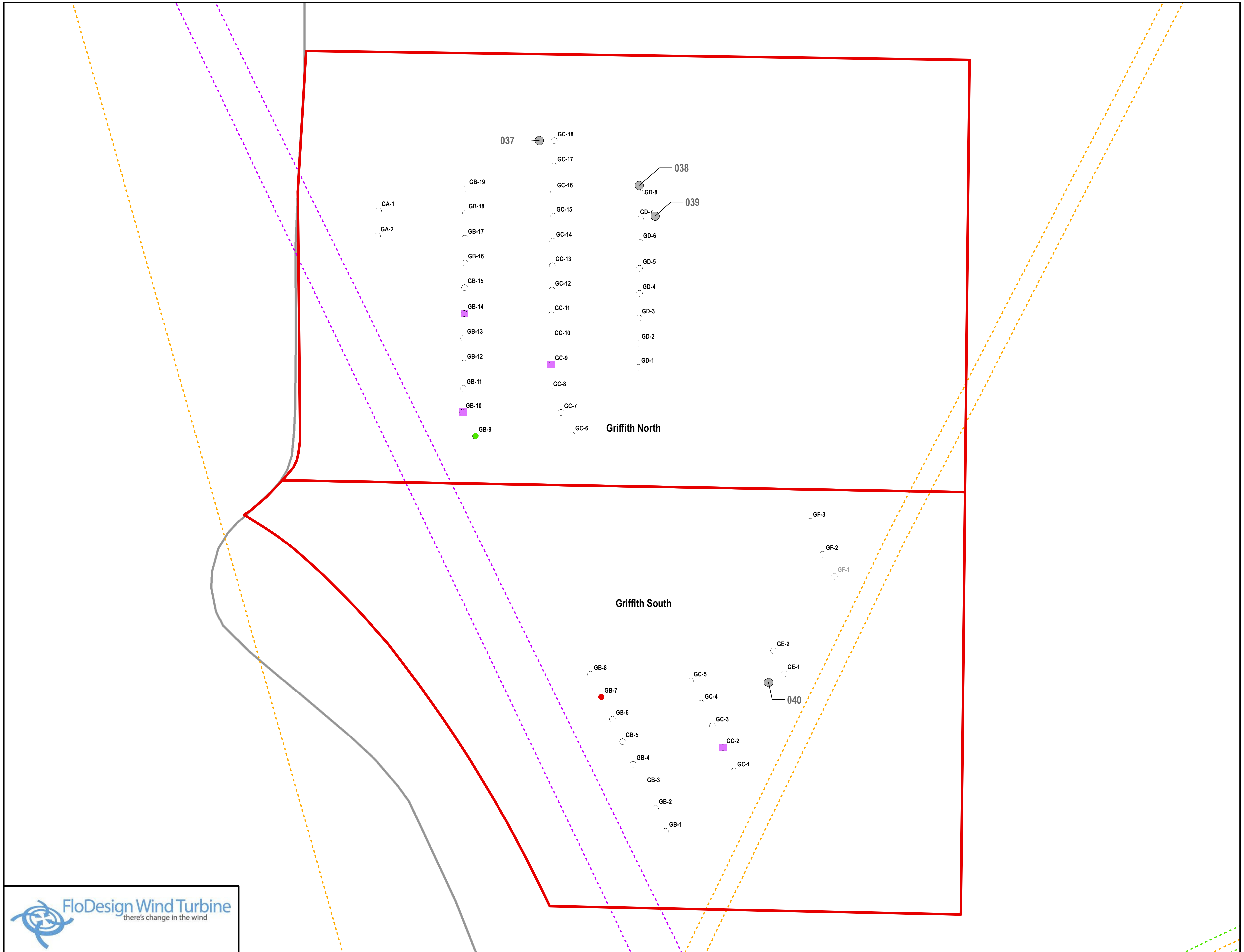

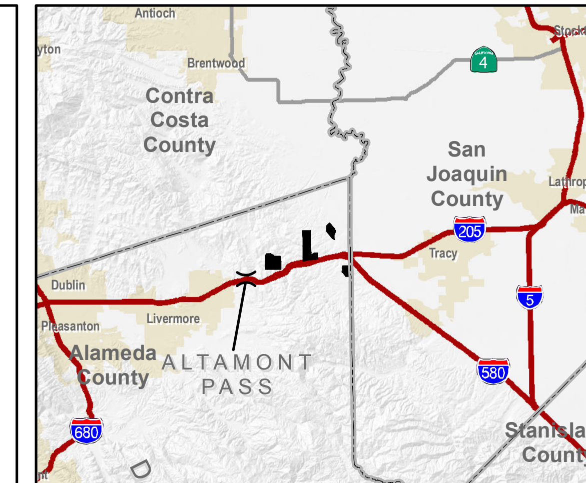

Legend

- Phase 1 Parcels
- Other Parcels
- Existing Turbine
- Removed Turbine
- Proposed Turbines

Transmission Lines

- 100-161 kV Transmission Line
- 230-287 kV Transmission Line
- 500 kv Transmission Line

Avian Fatalities

- American Kestrel
- Golden Eagle
- Loggerhead Shrike

0 60 120 240
Meters

0 200 400 800
Feet

Fatality data derived from mortality monitoring performed by ICF International from 2000-2012. Data retrieved on May 24, 2013 from the Science Review Committee: Altamont Pass Wind Resource Area website.

FLODESIGN WIND TURBINES

FIGURE 3C
AVIAN FATALITIES
GROUP 1

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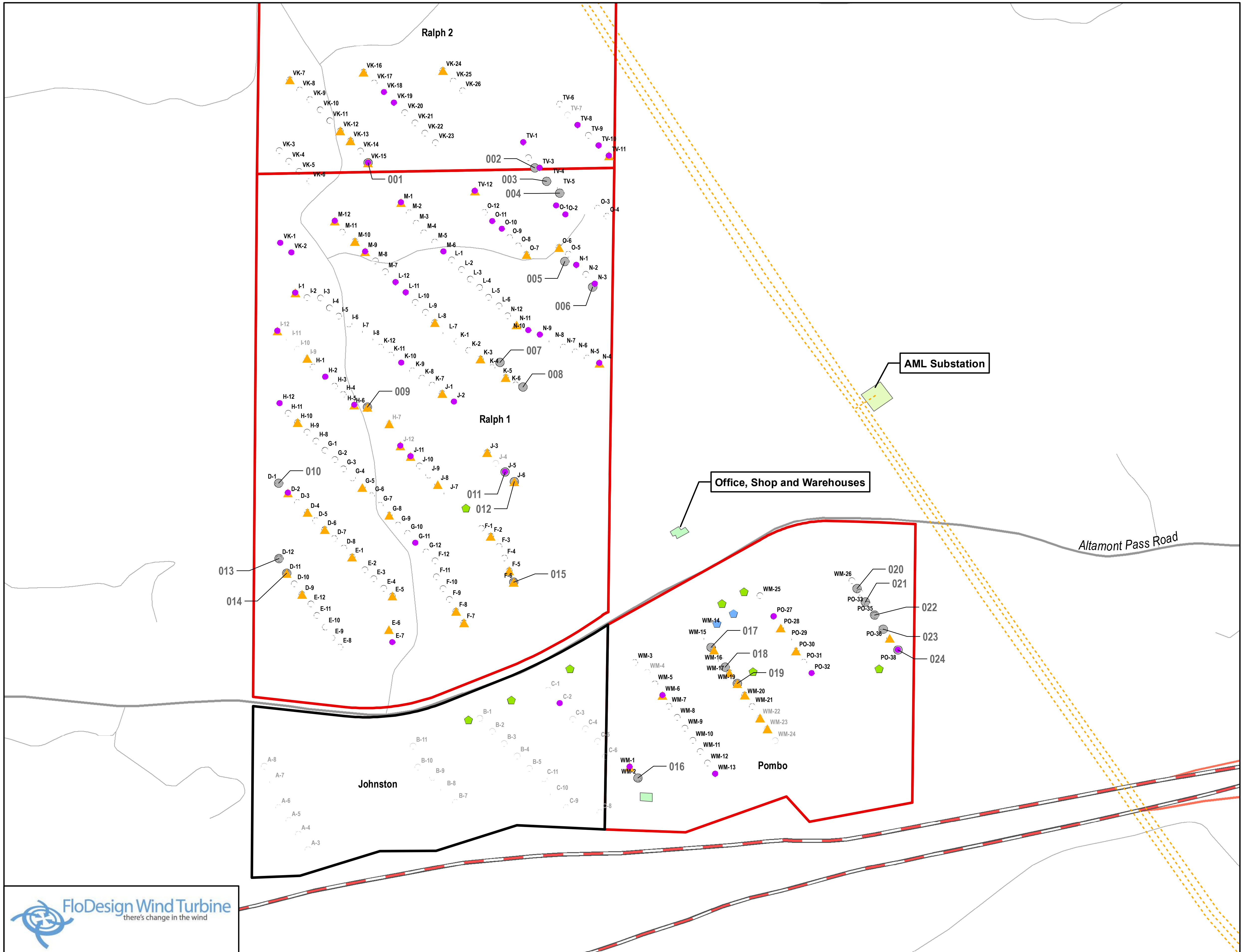
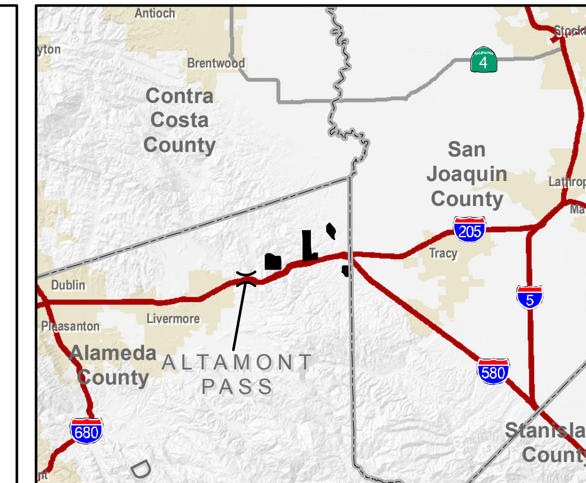


FloDesign Wind Turbine
there's change in the wind



Legend

- Phase 1 Parcels
- Other Parcels
- Existing Turbine
- Removed Turbine
- Proposed Turbines

Transmission Lines

- 100-161 kV Transmission Line
- 230-287 kV Transmission Line
- 500 kv Transmission Line

Avian Fatalities

- Burowing Owl
- Red-Tailed Hawk

Live Burrowing Owl Observations in 2013

- Male Guard
- Pair Observed

0 105 210 420
Meters

0 350 700 1,400
Feet

Fatality data derived from mortality monitoring performed by ICF International from 2000-2012. Data retrieved on May 24, 2013 from the Science Review Committee: Altamont Pass Wind Resource Area website.

FLODESIGN WIND TURBINES

FIGURE 4A
AVIAN FATALITIES
GROUP 2

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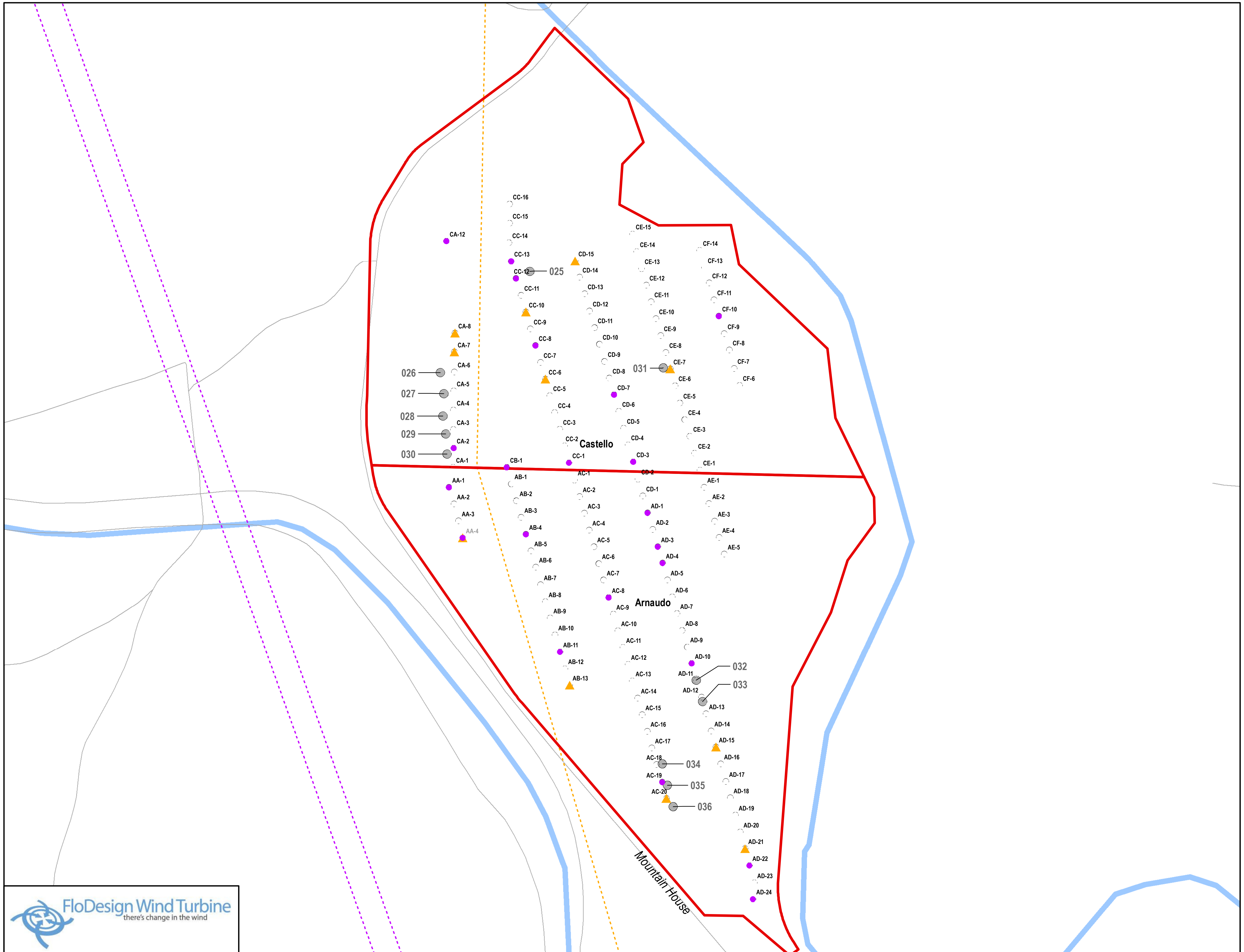
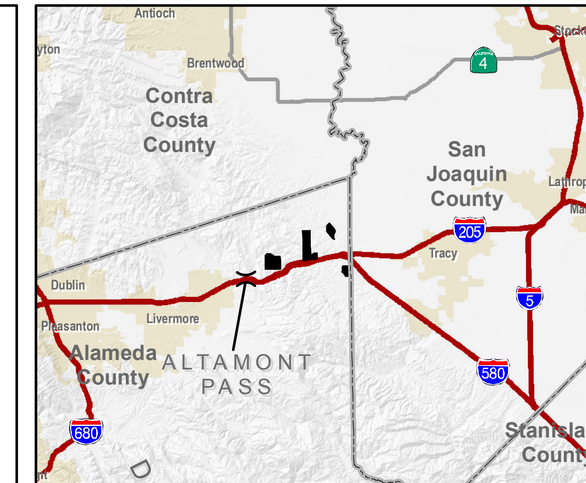


FloDesign Wind Turbine
there's change in the wind



Legend

Phase 1 Parcels

Other Parcels

Existing Turbine

Removed Turbine

Proposed Turbines

Transmission Lines

100-161 kV Transmission Line

230-287 kV Transmission Line

500 kv Transmission Line

Avian Fatalities

Burrowing Owl

Red-Tailed Hawk

0 85 170 340
Meters

0 285 570 1,140
Feet

Fatality data derived from mortality monitoring performed by ICF International from 2000-2012. Data retrieved on May 24, 2013 from the Science Review Committee: Altamont Pass Wind Resource Area website.

FLODESIGN WIND TURBINES

FIGURE 4B
AVIAN FATALITIES
GROUP 2

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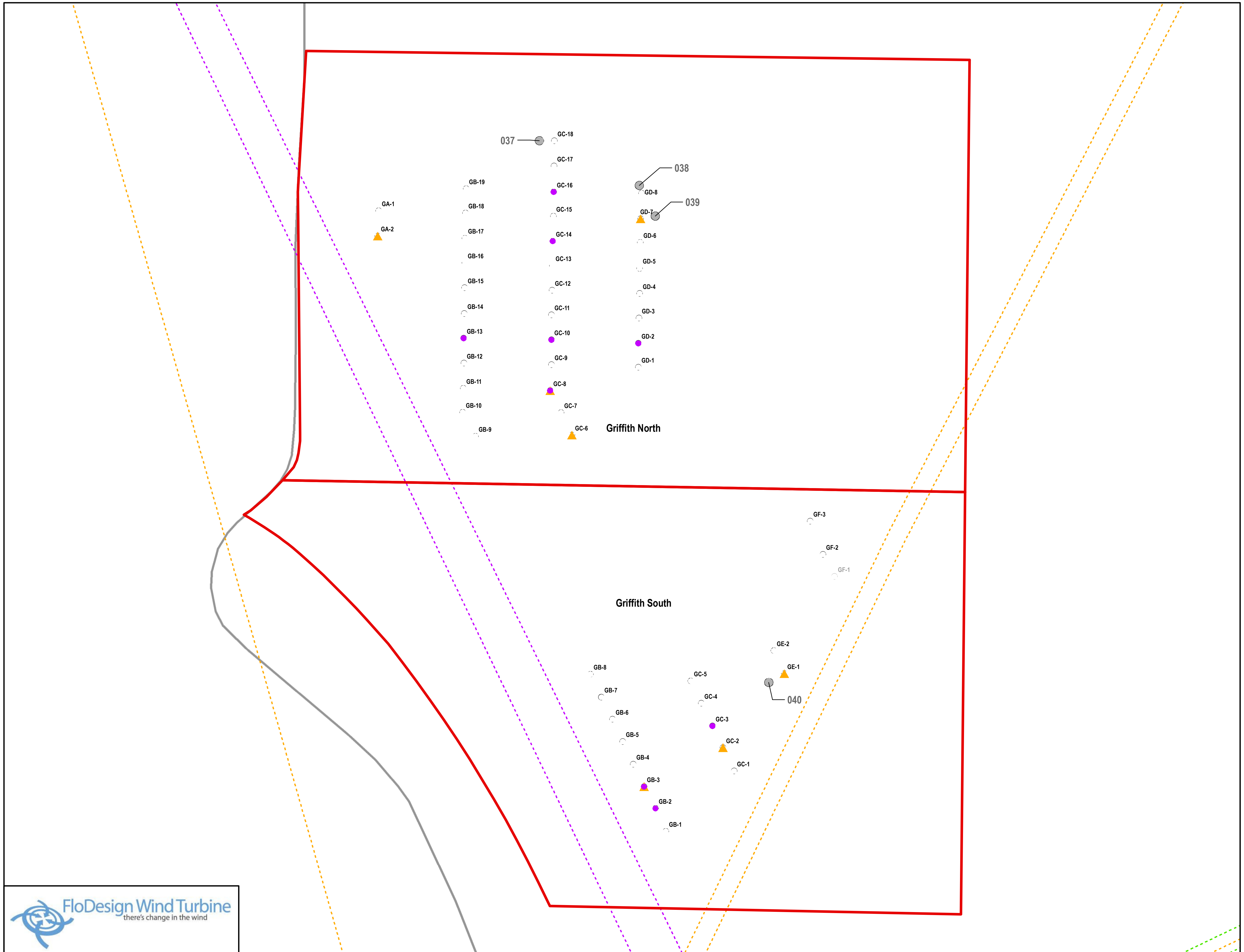
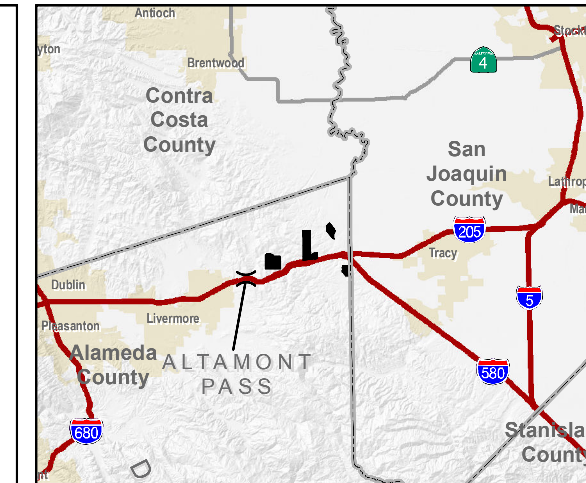


FloDesign Wind Turbine
there's change in the wind



Legend

- Phase 1 Parcels
- Other Parcels
- Existing Turbine
- Removed Turbine
- Proposed Turbines

Transmission Lines

- 100-161 kV Transmission Line
- 230-287 kV Transmission Line
- 500 kv Transmission Line

Avian Fatalities

- Burowing Owl
- Red-Tailed Hawk

0 60 120 240
Meters
0 200 400 800
Feet

Fatality data derived from mortality monitoring performed by ICF International from 2000-2012. Data retrieved on May 24, 2013 from the Science Review Committee: Altamont Pass Wind Resource Area website.

FLODESIGN WIND TURBINES

FIGURE 4C
AVIAN FATALITIES
GROUP 2

TETRA TECH