

# **GUIDELINES FOR SITING WIND TURBINES RECOMMENDED FOR RELOCATION TO MINIMIZE POTENTIAL COLLISION-RELATED MORTALITY OF FOUR FOCAL RAPTOR SPECIES IN THE ALTAMONT PASS WIND RESOURCE AREA**

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Alameda County SRC

## **SECTION 1. INTRODUCTION**

The Scientific Review Committee (SRC) for Alameda County's Altamont Pass Wind Resource Area (APWRA) avian mortality monitoring program has prepared the following guidelines to assist the wind power companies in the APWRA with re-siting of wind turbines recommended by the SRC for removal or relocation. Relocation or removal recommendations were made for the purpose of minimizing the potential for collision-related mortality of four focal raptor species in the APWRA.

As a result of the SRC's process of identifying hazardous turbines and exploring and evaluating the topographic, wind pattern, bird behavior, and turbine siting variables related to hazardous conditions, the SRC was also able to provide guidance on relocation of hazardous turbines to sites that pose lower hazard to the four focal species.

These guidelines are intended to provide the wind companies with basic information regarding avian collision hazards associated with turbine siting in the APWRA that can be used to evaluate the risk of potential relocation sites as well as the possible increased risk created by non-operational turbines and removal of turbines. Initially released in August 2008, the guidelines were updated following the ratings of additional wind turbines by an SRC subcommittee composed of Jim Estep and Shawn Smallwood during March 2010.

### **Background**

The Altamont Pass Wind Resource Area (APWRA) is known to cause hundreds of raptor fatalities per year due to wind turbine collisions alone (Howell and DiDonato 1991, Orloff and Flannery 1992, Smallwood and Thelander 2004, 2005, 2008, WEST, Inc. 2007). Because collision-related mortality of long-lived, protected species has continued largely unabated since the initial development of the APWRA, the recent renewal of the conditional use permits (CUPs) for the continued operation of existing, old-generation wind turbines proved controversial. To

alleviate concerns expressed by members of the public and the resource agencies about the APWRA's impacts on raptors and other birds, the Alameda County Board of Supervisors introduced new requirements along with the renewal of the CUPs.

The Alameda County Board of Supervisors issued a resolution on 22 September 2005, which required the shutdown or relocation of Tier 1 and 2 turbines<sup>1</sup> according to a schedule (Exhibit G-2), as well as the removal of all derelict and non-operating turbines<sup>2</sup> by 22 September 2006. Following a settlement agreement between the County of Alameda and the plaintiffs in a legal challenge of the CUP renewals under the California Environmental Quality Act, the Board of Supervisors amended the resolution and associated CUPs on 11 January 2007. This amendment applied to the wind companies agreeing to the settlement. It maintained the shutdown and relocation requirements, but expanded them to the removal of all Tier 3 turbines by 31 October 2008. It also maintained the requirement that all derelict and non-operating turbines be removed by 22 September 2006. The original and amended resolution included additional requirements, but the most relevant requirements for the foregoing document were the shutdowns and relocations of the most hazardous wind turbines and the removal of derelict and non-operating wind turbines.

The resolution by the Board of Supervisors also required the formation of a scientific review committee (SRC), which was to “investigate, monitor and evaluate the effectiveness of the [Avian Wildlife Protection] Program” (Exhibits G-1 and G-2). After receiving input from the Permittees, the monitoring team, and state-sponsored research, the SRC was also to “recommend adjustments [to the Program], and design and implementation of alternative strategies” (Exhibits G-1 and G-2). The original resolution (Exhibit G-2) charged the SRC with recommending management actions aimed at achieving “progressive and substantial reductions in avian mortality and injuries,” whereas the amended resolution (Exhibit G-1) charged the SRC with recommending management actions aimed at achieving a 50% reduction in wind turbine-related mortality of golden eagles, red-tailed hawks, American kestrels and burrowing owls, while also minimizing losses to wind power generation. Thus, the goals were not exactly the same for settling and non-settling companies, but the SRC's role was consistent in terms of recommending management actions to reduce bird mortality.

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<sup>1</sup> Most hazardous wind turbines, based on a classification of hazard level developed by Smallwood and Spiegel (2005a,b,c).

<sup>2</sup> The CUPs did not explicitly define the term “derelict,” but its use followed from language used in Smallwood and Thelander (2004), who intended it to mean towers lacking turbines or supporting non-functional turbines. Indeed, the CUPs address derelict and “non-operational turbines” in the same phrase. Confusion over the term emerged when the companies said that many of the towers without turbines or with non-functional turbines are simply “vacant,” which means they are awaiting repair or new turbines to be mounted on them and placed back into service. Regardless of whether a tower is *vacant* or *derelict*, it poses an increased hazard to raptors, and is essentially the same thing until either the tower is removed or it supports a functional turbine.

As part of the SRC's investigation directed toward management recommendations, the full SRC visited the APWRA on 29 November – 1 December and on 10 December 2007. An SRC subcommittee consisting of Jim Estep and Shawn Smallwood visited the APWRA to rate more wind turbines during March 2010. The SRC relied on available research reports and their combined expertise to review the configuration and environmental setting of wind turbines at sites associated with large numbers of fatalities relative to the majority of the APWRA, and they identified candidate wind turbines that could be deemed relatively more hazardous to raptors (see SRC documents P67, P68, and P69). The SRC evaluated and ranked wind turbines according to their hazard to raptors, with the intent to consider mitigation actions involving permanent shut down and removal of the most dangerous turbines. The SRC ultimately recommended removal of high-ranking wind turbines, as well as removals of additional wind turbines if the wind companies' decided to shutdown all old-generation wind turbines for only part of the winter instead of the SRC's recommended four months over the winter. The SRC specifically recommended the following:

- Remove all towers and turbines rated 8 through 10 (SRC document P69);
- If the winter shutdown is not extended to at least 3 full search rotations (anticipated to be about 3 months), then remove towers and turbines rated 7 and 7.5; and,
- The SRC evaluates turbines and towers not previously evaluated for hazard and removal.

These recommendations were revised slightly based on the March 2010 visit by the subcommittee (see below). The SRC's rankings were later assessed by comparing mortality estimates from recent fatality monitoring data, and were found to contribute disproportionately to the mortality of golden eagles, red-tailed hawks and American kestrels (Smallwood 2008, 2010).

During the field trip, the SRC noticed many derelict or vacant wind towers which sometimes create vertical or lateral gaps<sup>3</sup> that raptors may incorrectly perceive as safer to fly through (SRC document P67). Also, raptors perch disproportionately more often on derelict or vacant towers, or on towers of non-operating turbines (Smallwood and Thelander 2004, 2005; Smallwood et al. 2009), which often places these raptors in close proximity to adjacent, functional turbines. Whenever derelict or vacant towers lure raptors closer to functional wind turbines, whether for

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<sup>3</sup> Gaps refer to spacing between functional turbines that are wider than the average spacing along the row of turbines as originally sited or as has emerged due to one or more turbines being removed or becoming non-functional.

crossing perceived gaps or for perching, there is the chance of conspecific<sup>4</sup> or inter-specific interactions that could distract the raptors, leading to collisions.<sup>5</sup>

During the field trips, the SRC observed multiple opportunities for relocating wind turbines from relatively hazardous to safer locations, or to locations where overall safety to birds could be increased. The SRC concluded that the companies could likely relocate at least some of the wind turbines the SRC recommended for removal, with relocation sites subject to SRC approval. In order to provide a common understanding of the safest relocation sites and to facilitate the identification of these sites by wind energy companies, the SRC developed guidelines characterizing preferred relocation sites as well as sites to be avoided (see Section 3). In addition to the need for developing written guidelines, the SRC recognized that consultation with the companies' engineers may be needed to identify opportunities for relocation, as well as technical restrictions.

The primary goal of these guidelines and of subsequent deliberations between the companies and the SRC is to relocate turbines from more hazardous to less hazardous sites and remedy existing hazardous conditions due to vacant or derelict sites, ultimately contributing to a 50% reduction in raptor mortality in the APWRA.

## **SECTION 2. DESCRIPTION OF SITING FACTORS**

The SRC's guidelines are based largely on published and unpublished results of research in the APWRA and personal observations and experience of SRC members. Some of the most influential experience was obtained during the SRC's four-day field trip, when the SRC was able to view the cumulative distribution of fatalities recorded by the Wildlife Reporting and Response system (WRRS)<sup>6</sup> and scientific research studies (Orloff and Flannery 1992, Smallwood and Thelander 2004, and unpublished, on-going monitoring data). The SRC related the distribution of these fatalities to topography and wind patterns, as well as to the arrangement of wind turbines. Research reports that identified factors associated with fatalities included Orloff and

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<sup>4</sup> "Conspecific" refers to individual(s) of the same species.

<sup>5</sup> Smaller birds often harass raptors while they are flying, causing them to defend themselves while fleeing the harassment. Larger-bodied raptors sometimes attack smaller-bodied raptors, in predatory-prey relationships. Also, raptors often chase individuals of the same species to defend territories or foraging space. While raptors are flying they often flush perched raptors, because the perched bird is at a strategic disadvantage. Flying raptors also sometimes change their flight direction to avoid another perched raptor, and if close by, the flying raptor will keep watch of the perched raptor. All of these types of interactions are distracting to a flying bird, and can lead to collisions.

<sup>6</sup> WRRS is the self-monitoring program used by the wind companies.

Flannery (1992, 1996), Smallwood and Neher (2004), Smallwood and Thelander (2004, 2005), Smallwood et al. (2007), and Smallwood et al. (2009). The biological resources section of the repowering EIR (Alameda County 1998) also contributed to the SRC's knowledge of factors associated with raptor fatalities.

The causal factors of raptor collisions with wind turbines appear to be interaction effects of raptor flight patterns with topography, wind patterns, and the arrangement of functional and non-functional wind turbines/towers. Flight patterns associated with foraging, e.g., hovering and kiting, have been most often linked to collisions, largely because most of the eye-witness accounts of red-tailed hawk and American kestrel collisions involved these behaviors. Raptors often forage where they can utilize slope-accelerated winds<sup>7</sup> to power their flights and to hold their positions while scanning for prey items. The spatial patterns of golden eagle fatalities among wind turbines also appear consistent with contour hunting by golden eagles.<sup>8</sup> Clusters of fatalities also occur where raptors have often been viewed foraging and crossing the terrain, including relatively low-lying areas, such as through canyons, ravines, saddles in and between ridges, and at the base of shoulders of hills or ridges. Steeper slopes are also associated with more fatalities.

Raptor fatalities at wind turbines have also been associated with wind turbines at the ends of turbine rows. Behavior data suggest at least some raptor species may perceive both the individual wind turbine and the row of wind turbines as units to be avoided, prompting raptors to more often attempt to fly around the entire turbine row. More frequent flights by the end-of-row turbine may be one reason why these turbines are often associated with more fatalities. Another reason for the association would be the frequent occurrence of end-of-row turbines at locations lower on the slopes, or on steeper slopes, where raptors often fly or where they may have less control of their flights. More recently, the wind companies have left derelict towers at the ends of rows as an alternative to perch-free flight diverters recommended by Richard Curry Associates (1997) and Smallwood and Thelander (2005a,b), and these derelict towers may have increased fatalities at the last functional turbine in the row, next to the derelict tower, because the end-of-row derelict towers likely attract raptors looking for perch sites. Wind turbines next to gaps in turbine strings have also sometimes been associated with fatalities, perhaps because raptors misperceive gaps created by vacant tower pads<sup>9</sup> or derelict or vacant towers as safe

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<sup>7</sup> Slope-accelerated winds are winds that are accelerated due to being pushed up the slope or through a ravine or canyon. Typically, winds are strongest at the top of the slope facing the wind, or where the slope facing the wind breaks over to a gentler gradient.

<sup>8</sup> Contour hunting is flying relatively close to the terrain, quickly adjusting flight surfaces in complex winds to maintain a similar distance from the ground while traversing multiple slopes. The strategy is intended to surprise prey items by suddenly appearing from over a narrow ridgeline or from around the corner.

<sup>9</sup> "Vacant tower pads" are turbine addresses lacking turbines or towers.

crossing points through the turbine row. Also, raptor behavior and fatality data have indicated an avoidance of denser turbine fields<sup>10</sup> (Smallwood and Thelander 2004, 2005; Smallwood, Lee Neher, Doug Bell, Joe DiDonato, Brian Karas, Sara Snyder, and Sal Lopez, unpublished data in submitted final report to Public Interest Energy Research Program), and greater mortality at more isolated turbines and at turbines at the edges of the wind farm or local turbine fields (Smallwood and Thelander 2004, 2005).

Additional fatality associations have been documented or suspected, including at wind turbines nearby rock piles, trees, ponds, transmission towers, litter control fences outside the perimeter of the landfill, and electric distribution poles. Some of these features might attract perching raptors, thereby placing perched raptors near functional wind turbines. As suggested earlier, perched raptors can interact with other animals. They can attack prey items from the perch, they can change flight paths of conspecifics or other smaller-bodied raptor species, and they can be flushed by other raptors. These types of interactions can distract birds, leading to collisions with wind turbines.

### SECTION 3. SITING GUIDELINES

The siting guidelines apply primarily to wind turbine relocations. *Relocation* refers to turbines that have been recommended for removal due to hazardous conditions for which these guidelines can assist the wind companies in selecting a less hazardous relocation site. The guidelines may also apply to turbines that are removed or become derelict in the future, causing hazardous conditions that can be created by newly vacant or derelict sites. The guidelines may also be useful for siting new wind turbines as part of repowering.<sup>11</sup> However, these guidelines apply specifically to wind turbine ‘addresses,’ which are the locations permitted for wind turbine operations.

These guidelines, which are not intended for any other locations that were not permitted with an existing wind turbine address as of January 2006, list the features of preferred sites or settings into which wind turbines can be relocated. The guidelines also list features of sites or settings into which wind turbine relocations are discouraged. The guidelines are deliberately not ranked, because the SRC recognizes that each of the thousands of wind turbine addresses in the APWRA have unique combinations of conditions that can mitigate or enhance the hazard associated with individual factors. As the SRC continues its efforts to understand the conditions under which a turbine location presents excessive hazards to birds, then there may be additional settings or

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<sup>10</sup> A turbine field is a group of turbines, sometimes but not always of the same model, that are relatively separated from other groups of turbines. An example would be the AES-owned Micon 65-KW turbines near Mountain House.

<sup>11</sup> Repowering is the replacement of existing, old-generation wind turbines with new, modern turbines.

situations not covered in these guidelines that the SRC later determines to be too hazardous for a wind turbine relocation.

### **Preferred Relocation Sites or Settings**

- a. Hill peaks, ridge crests, and relatively even terrain to fill gaps due to presently derelict or vacant towers, or empty pads (Photos 1 and 2);
- b. Wind walls<sup>12</sup> where vacant or derelict towers create vertical or lateral gaps between functional turbines (Photo 3);
- c. Into turbine rows that already occur in high density, i.e., to increase the density of an already dense turbine field (Photo 4);
- d. Interior to the turbine row to fill small gaps created by the removal of a turbine or where vacant towers occur as potential perch sites, except in cases where a gap in the interior of a turbine row is large enough to provide a safe flight path, and where relocating a turbine into that gap would result in a smaller unsafe gap (Photos 5 and 6);
- e. Slopes that are leeward to one or two prevailing wind directions or that are set back from slopes facing prevailing wind directions (Photo 7); and,
- f. Interior to a turbine field, unless the location is within a ridge saddle or on a steep slope, or unless other factors about the site outweigh the hazard reduction that may be achieved by the site's interior location.

### **Discouraged Relocation Sites or Settings**

- a. Sites classified as Tier 1, Tier 2, or Tier 3 according to any of the Tier classifications developed by Smallwood and Spiegel (2005a,b,c), unless the proposed new turbine arrangement creates a situation where a relocation to one of these addresses would improve safety to birds;
- b. Ends of turbine rows, especially where the end of the row is at the edge of a steep slope, on a steep slope, or in a saddle, ravine, or canyon (Photo 8);

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<sup>12</sup> Wind walls are rows of wind turbines mounted on towers at two heights above the ground, so that turbines on shorter towers are immediately in front of turbines on taller towers.

- c. Where raptor fatalities have been reported previously, or potential flight paths have been identified such as through excessively long rows, unless the conditions associated with greater hazard have since changed so that the particular locations are no longer as hazardous;
- d. Saddles of ridges or saddles between ridges, and especially where saddles form the apex of ravines that face a prevailing wind direction (Photos 9 through 13) or especially where these types of slope conditions occur in combination with nearby electric distribution lines (Photo 14) or other tall structures;
- e. On benches of hill slopes or ridges, or just at the base of shoulders of hills, i.e., in locations of sudden elevation changes, where a raptor more often decides to fly while contouring around the slope (Photos 15, 16, and 20);
- f. On or immediately adjacent to steep slopes (Photo 17);
- g. At the edges of turbine fields or at the edge of the wind farm, unless the relocation somehow reduces the hazard posed by other nearby wind turbines occurring at the edge;
- h. Next to artificial rock piles or natural rock formations, so long as addresses of equal or lesser hazard are available where there are no rock piles or rock formations within 100 meters (Photo 18);
- i. Next to streams or ponds (Photo 13);
- j. Next to transmission towers, electric distribution poles, or litter control fence around the landfill (Photos 19 and 20);
- k. Where slope-accelerated winds would likely position a raptor at the height domain of the rotor plain of functional turbines (Photo 21), including where lips in the slope can locally accelerate winds used by hovering or kiting American kestrels (Photo 22);
- l. Gaps in strings that are large enough for birds to safely cross (Photo 223);
- m. Locations remote from other functional wind turbines, or more isolated locations; and,
- n. Where turbine rows suddenly change directions (Photo 24).







Photo 1. The two derelict towers to either side of this functional turbine on the ridge crest should either be removed or put back into service. If the derelict towers are removed, then the interior functional turbine should also be removed.



Photo 2. A derelict tower interior to the turbine row and at the top of the hill would be a relatively safer relocation site.



Photo 3. Turbines missing from tall towers in wind walls (e.g., red highlight at left) can create vertical and lateral gaps in turbine operations, which might be misperceived by raptors as safe perches or fly-through locations. Turbines removed from shorter towers, such as the functional one highlighted on the right, can also create vertical and lateral gaps.



Photo 4. Where possible, turbine relocations should be directed to the interior aspect of relatively denser turbine fields.



Photo 5. Turbine relocations would be relatively safer at towers interior to the turbine rows and atop a hill or ridge.



Photo 6. Turbine relocations would be relatively safer at towers interior to the turbine rows and atop a hill or ridge.





Photo 7. Turbine relocations would be relatively safer where they are set back (see yellow bar) from steep slopes facing prevailing wind directions (blue arrow).



Photo 8. Turbines should not be relocated to ends of turbine rows, especially where the towers are next to steep slopes or ravines, such as the derelict tower on the right side of the turbine row in the foreground.



Photo 9. Turbines should be relocated to hill peaks or ridge crests (e.g., green highlight), but not to saddles in the ridge (red highlight).



Photo 10. Turbines should not be relocated to ridge saddles, especially in a situation like above, where trees and rock formations occur nearby.





Photo 11. Turbines should not be relocated to ridge saddles, especially where declivity winds from a prevailing wind direction funnel into the saddle, as in the red zone at the right side of this photo.



Photo 12. Wind turbines should not be relocated to saddles formed by the meeting of two ridges.



Photo 13. Wind turbines should not be relocated to saddles or to the lower aspects of a ravine or canyon, especially not next to a pond or stream.



Photo 14. Slope-accelerated winds can be hazardous where wind turbines are sited, and especially if electric distribution lines or other tall structure provide American kestrels or other raptors additional perching opportunities near the wind turbines.



Photo 15. Wind turbines should not be relocated to shoulders of the ridge or hill, or where the slope suddenly changes, such as seen in this photo.





Photo 16. Wind turbines should not be relocated to shoulders of the ridge or hill, or where the slope suddenly changes, such as seen in this photo. This is especially true for long turbine rows like this one, where opportunities for raptors to fly through gaps are absent.



Photo 17. Derelict towers should not be put back into service where they abut steep slopes or ravines.



Photo 18. Derelict towers should not be put back into service where they occur near rock piles or trees or other structures that may be attractive for perching or hunting. In the photo above, rock piles appear just this side of the derelict tower, which should be removed. Note, however, that removing the derelict tower would result in a potentially hazardous gap in the turbine string, suggesting the importance of fully evaluating all hazardous conditions before a relocation or removal decision is made.



Photo 19. Avoid relocating wind turbines next to transmission towers or other perch sites.



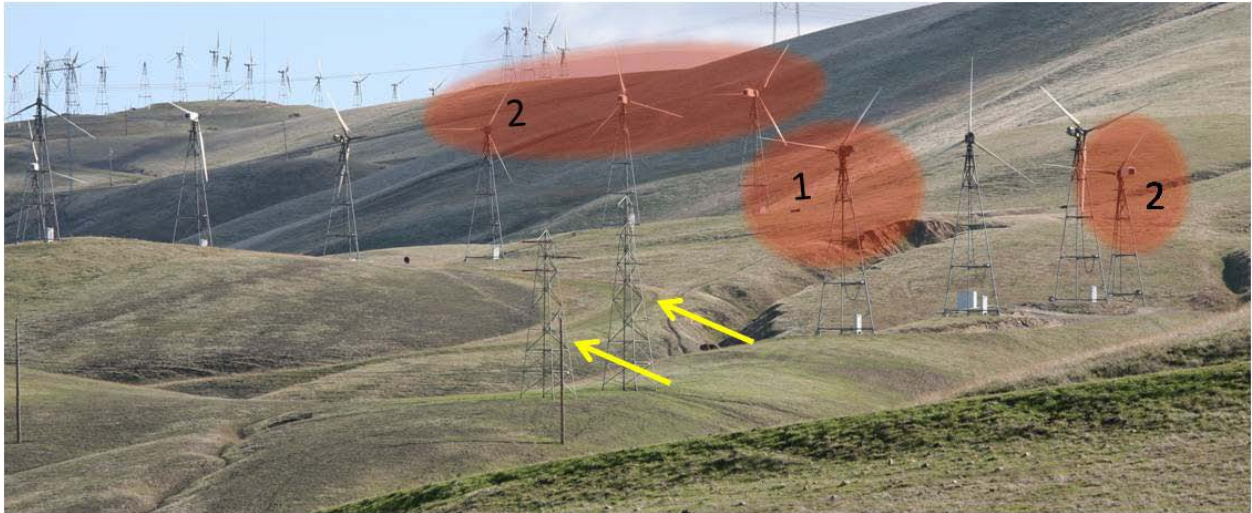


Photo 20. Avoid relocating wind turbines near transmission towers (1) or other perch sites, or to shoulders of the hill (2).



Photo 21. Wind turbines should not be relocated to locations on the slope where downslope hill morphology pushes the wind toward these locations from two different prevailing wind directions. In this photo, the red highlight identifies a portion of the air space where winds will be pushed to greater speeds by winds blowing from the northwest, west, southwest, and south.



Photo 22. Lips formed in the slope either naturally or due to grading for roads or wind turbine laydown areas might also encourage American kestrels to hover or kite in moderate and strong winds in front of wind turbines.



Photo 23. Wind turbines should not be relocated to towers within otherwise wide gaps between other turbines, such as seen above.





Photo 24. Wind turbines can be more hazardous where turbine rows zig-zag in direction (yellow arrow), especially where slope-accelerated winds (blue arrows) intersect the change in direction of the turbine row.

## **SECTION 4. IMMEDIATE NEXT STEPS**

The SRC proposes the following steps for developing a near-term relocation plan:

1. The companies decide how many and which of the wind turbines they wish to relocate rather than remove, following the SRC's recommended removals of identified wind turbines;
2. The companies decide where they would prefer to relocate the removed turbines, and then provide a map of these locations to the SRC, as well as all current locations of potential other relocation addresses (empty pads, and derelict or vacant towers);
3. The SRC reviews the proposed relocation sites and considers other identified addresses, if needed;
4. The companies' engineers inform the SRC of which of their suggested alternative relocation addresses are infeasible and why; and
5. The SRC recommends a final relocation plan following steps 1-4, and which is directed toward immediate implementation.

The final relocation plan would be intended for immediate implementation for the purpose of achieving a 50% mortality reduction of raptors during the interim period preceding repowering of the Altamont Pass Wind Resource Area. Following the final relocation plan, the SRC recommends a relocation program for the future, during which the companies take the lead on using the SRC's relocation guidelines to evaluate the hazards associated with candidate relocations.

## **SECTION 5. RELOCATION PROGRAM FOR THE FUTURE**

Given that wind turbine removal and relocations will continue throughout the time when wind turbines are operating in the Altamont Pass, and given that these removals and relocations will change the arrangement of wind turbines, there is a need to initiate a program to assess the collision hazards of wind turbines as they are removed or relocated. As wind turbines are removed or relocated, not only will the hazard status of the relocated turbines change, but so will the adjacent turbines from where the turbine was removed and to where the turbine will be relocated. The SRC recommends that the companies regularly update the SRC or a subcommittee of the SRC on planned or recent turbine removals and relocations. Alternatively,

the companies could work with the SRC to train a company employee to assess the hazard status of turbines as removals and relocations are planned. These steps are necessary to ensure sustained confidence by the SRC in effectiveness of the turbine relocation management strategy outlined in these guidelines.

The final near-term relocation plan recommended by the SRC (see step 5 in Section 4) could identify turbine addresses to where the SRC feels it would be safer to relocate turbines during the subsequent relocation program. The SRC should meet and confer annually to identify new candidate relocation sites in order to remain current with changes in the APWRA. These new candidate addresses could be put into map form for implementation by the designated company employee or the SRC subcommittee.

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