



**CONSULTING ENGINEERING REPORT  
CONCERNING THE EFFECTS UPON  
MICROWAVE, FAA, NTIA, & CELLULAR FACILITIES  
DUE TO THE CONSTRUCTION OF A  
WIND TURBINE FARM  
IN  
YOUR COUNTY**

**Your Company**

**2011**

**By: Ralph E. Evans III  
Evans Associates, LLC  
216 Green Bay Road, Suite 205  
Thiensville, WI 53092  
262-242-6000  
[iii@evansassoc.com](mailto:iii@evansassoc.com)  
[evansassociates.com](http://evansassociates.com)**



**CONSULTING ENGINEERING REPORT  
CONCERNING THE EFFECTS UPON  
RADIO FREQUENCIES AND MICROWAVE FACILITIES  
DUE TO THE CONSTRUCTION OF A  
WIND TURBINE FARM**

**In  
Your State  
Your Company**

**I. INTRODUCTION**

This Consulting Engineering Report describes the results of a study and analysis to determine the locations of federally licensed (FCC) microwave and NTIA (U.S. Government) notified facilities that could be adversely impacted as a result of the construction of Your Company's turbine farm in/near Your State. This document describes impact zones and necessary mitigation procedures, along with recommendations concerning wind turbine siting. All illustrations, calculations and conclusions contained in this document are subject to on-site verification<sup>1</sup>.

Frequently, wind turbines located on land parcels near RF facilities can cause more than one mode of RF impact, and may require an iterative procedure to minimize adverse effects. This procedure is necessary in order to ensure that disruption of RF facilities either does not occur or, in the alternative, that mitigation procedures will be effective. For instance, once microwave impact zones (blackout areas) are identified, it may be necessary to re-survey the precise positions of nearby receive and transmit facilities to a higher degree of accuracy than is contained in the FCC's database or that can be discerned from photographs. In the case of some facilities, mitigation may not be possible, but alternatives are frequently available in terms of turbine relocation or elimination.

The purpose of this study is to facilitate the siting of turbines to avoid unacceptable impact to FCC licensed RF facilities and, to the maximum extent possible, identify available alternatives to individual licensees in intractable cases.

The wind turbines to be used have a hub height of 100 meters above ground and a blade diameter of 90 meters. Thus, the total height will be 145 meters above ground level to the tip of one blade at the 12:00 position. The turbine project comprises of turbines that will be sited on the property containing the blackout area.

Using industry standard procedures and FCC databases, a search was conducted to determine the presence of existing microwave paths crossing the subject property, as well as NTIA facilities within or adjacent to the identified area. A GIS database and map were then prepared showing the results of this research. When established, the turbine layout plan should be prepared as an

---

<sup>1</sup> The databases used in creating the attached tables and maps are generally accurate, but anomalies have been known to occur. Where feasible, coordinates have been verified using mapping sources and satellite imagery. Nevertheless, an on-site verification survey is suggested as part of the due diligence process.



overlay, showing microwave clearance, and the study should be re-run. The instant report does not include an analysis of nearby land mobile (2-way) radio facilities, satellite earth stations, or broadcast stations. The resulting maps are shown in Figures 1 through 4 attached.

The following analysis consists of three sections:

1. Microwave path analysis (Section II)
2. FAA, NTIA and Cellular analysis (Section III)
3. Conclusions (Section IV)

The database search revealed eight unique microwave paths that impact the turbine site. The locations of the microwave paths are shown in the overview illustration of Figure 1. A close-up view of the northern blackout area is shown in Figure 1.1. In this consultant's opinion, the instant study, coupled with on-site verification, represents due diligence with respect to these services and facilities.

The attached maps were generated based upon the notified operating parameters of the FCC-licensed stations as contained in the FCC databases. Industry-standard analyses methods were used.

The following analysis examines in detail the pertinent FCC licensed services in the area for significant adverse impact. This analysis assumes that all licensed services have been designed and constructed according to FCC requirements and good engineering practice. If this is not the case, the impacted facility must share responsibility with the wind turbine company for the costs of any mitigation measures<sup>2</sup>.

Each of the RF analyses is described separately in the sections that follow.

## **II. ANALYSIS OF MICROWAVE LINKS**

An extensive analysis was undertaken to determine the likely effect of the new wind turbine farm upon the existing microwave paths, consisting of a Fresnel x/y axis study and a z-axis (height) evaluation. The microwave path is overlaid on the USGS topographic base maps attached, and is also available as overlays for the Google Earth™ program files.

**Important Note:** Microwave path studies are based upon third party and FCC databases that normally exhibit a high degree of accuracy and reliability. Although Evans performs due diligence to ensure that all existing RF facilities are represented, we cannot be responsible for database errors that may lead to incomplete results. Occasionally if and when these situations occur, Evans would perform an engineering analysis at no additional cost to determine how the additional facilities can be accommodated or, if wind turbine structures are already built, determine a method to re-direct the offending beam path. Before the turbine layout is finalized, a

---

<sup>2</sup> For instance, some microwave paths may have insufficient ground clearances as they are presently configured.



land surveyor should visit the transmit and receive sites of the microwave paths that might be affected, in order to confirm their locations through actual survey, and to determine if antennas for the path are actually at the sites and if so, if they appear to be in operation. This modified information should then be forwarded to this consultant to confirm clearance. In the instant case, coordinates were rechecked using USGS maps and satellite photos where available. According to these sources, the coordinates have been specified within industry standards, and location information appears to be substantially accurate.

For this study, *Worse Case Fresnel Zones* (WCFZ) were calculated for each microwave path. The mid-point of a microwave path is the location where the widest (or worst case) Fresnel zone occurs. Possible geographic coordinate errors must be added to the Fresnel zone clearance numbers<sup>3</sup>. The radius *R* of the Worst Case Fresnel Zone, in meters, is calculated for each path using the following formula:

$$Rn \cong 17.3 \sqrt{\frac{n}{F_{GHz}} \left( \frac{d_1 d_2}{d_1 + d_2} \right)}$$

*Rn* = First Fresnel Zone Radius, meters

*n* = The Number 1

*F<sub>GHz</sub>* = Frequency of Microwave Link in GHz

*d<sub>1</sub>* = Distance to Wind Turbine from Microwave Transmitter in km

*d<sub>2</sub>* = Distance to Wind Turbine from Microwave Receiver in km

*d<sub>1</sub> + d<sub>2</sub>* = Total Microwave Path Length in km

*Note: For Worst Case Fresnel Zone calculation, d<sub>1</sub> = d<sub>2</sub>*

The WCFZ is defined by the cylindrical area (catenary) with its axis as the direct line between the microwave link endpoints and whose radius is *R* as calculated above. This is the zone where the siting of obstructions should be avoided.

As shown in Table 1 below, Evans Associates has identified 8 microwave links that intersect, or come close to, the project area:

---

<sup>3</sup> Many microwave and earth station facilities were built before accurate methods were available to establish exact geographic coordinates (such as GPS). It is not unusual for database errors of up to 4 or 5 seconds to occur, which can effect the positioning of critical turbines located near Fresnel paths.



**Table 1 – Microwave Links Crossing Turbine Area**

Path Number	Call Sign	Frequency	Bearing	Fresnel Zone Radius	Company Name
1	WG----	6197.24	346.961	32.11651	Utilities Company
2	WH----	6755	348.6725	31.31318	County
3	WN-----	6595	168.5607	31.69075	County
4	WP-----	934.9875	348.7011	84.1618	Electric, Inc.
5	WP-----	943.9875	168.5897	83.75964	Electric, Inc.
6	WP-----	6875	348.7485	31.02859	County Board of Supervisors
7	WP-----	6975	348.7011	30.81384	County Board of Supervisors
8	WP-----	5945.2	166.8371	32.79021	Utilities Company

**Table 2 – Microwave Transmitter and Receiver Information**

Path Number	Transmitter Location	Transmitter Latitude	Transmitter Longitude	Transmitter Elevation	Receiver Location	Receiver Latitude	Receiver Longitude	Receiver Elevation	Distance
1	Peak	35.11333	113.8841	2369.5	SLP	35.86333	114.0975	1347.1	85.43242
2	Peak	35.08111	113.9044	2559.7	SLP	35.8633	114.0969	1309.4	88.52125
3	SLP	35.8633	114.0969	1309.4	Peak	35.08111	113.9044	2559.7	88.52125
4	Peak	35.08111	113.9049	2514.6	SLP	35.8633	114.0969	1402	88.51231
5	SLP	35.8633	114.0969	1402	Peak	35.08111	113.9049	2514.6	88.51231
6	Peak	35.0815	113.9053	2528.6	SLP	35.86339	114.0964	1321.3	88.46362
7	Peak	35.08111	113.9049	2516.5	SLP	35.8633	114.0969	1402	88.51231
8	SLP	35.86333	114.0975	1347.1	Peak	35.11333	113.8841	2369.5	85.43242

If turbine locations are added or re-sited, clearances must be maintained with due consideration given to coordinate accuracy.

Mitigation of microwave path encroachment can involve one or more of the following possibilities:

1. Configuring the turbines to avoid the blackout zone (recommended).
2. Shifting the microwave path to by moving one endpoint to another location.
3. Increasing the height of the microwave tower above the turbines.
4. Increasing microwave transmitter power, receiver sensitivity, or type of antenna.

In this particular case, configuring the turbines to avoid the microwave path WCFZ is the most practical alternative. The distance from the microwave path centerline must be at least the *R* for the path in question, plus the radius of the blade. Final siting of the turbines should be done in coordination with a land surveyor.



Figure 1, attached, shows the pertinent microwave paths with respect to the property boundaries.

**III. ANALYSIS OF FIXED RADIO FACILITIES**

**3.1 Cell Towers**

The FCC does not license all cell towers individually, but allows the carriers to install them as needed within their service areas. The following cell towers were found in our database search:

**Table 3 – Cell Towers near the Wind Project Area**

<b>ID</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Ht. (m)</b>	<b>Location</b>	<b>Company</b>
1	35° 35' 42.6"	114° 15' 11.0"	59.4	City	Systems
2	35° 43' 49.3"	114° 32' 22.5"	21.6	City	Systems
3	35° 51' 48.0"	114° 05' 47.9"	21.9	City	Systems
4	35° 51' 48.9"	114° 05' 48.9"	24.4	City	Cellular LP
5	35° 57' 59.8"	114° 06' 21.8"	21.3	City	Cellular LP
6	36° 01' 16.2"	114° 04' 05.1"	10.7	City	Systems



These sites are outside of the turbine area (see Figure 1). A space of ¼ mile from these facilities should be maintained. Clearance to weather radar and DoD radar is shown in Figures 2, 3 and 4.

### 3.2 Land Mobile

**Table 4 – Land Mobile Facility Locations and Information**

Call Sign	Frequency	Latitude	Longitude	Height to Tip	Name
WQ-----	170.25	35° 41' 53.7"	114° 10' 22.8"	6	County Public Works Flood Control District
WQ-----	170.25	35° 38' 52"	114° 10' 3"	6	County Public Works Flood Control District
WQ-----	171.1	35° 48' 40.6"	114° 0' 54"	3	County Public Works Flood Control District

Evaluation of FCC Land Mobile fixed services was not requested by the client for this study. However, it has come to the attention that three LMR sites impinge upon the property boundary area. These sites are assigned to the County Public Works Flood Control District, representing a SCADA system. This application can be high liability if interference is caused; Evans is therefore tabulating them (see Figure 1).

### 3.3 NTIA

The National Technological Information Agency has been contacted with respect to possible interference to government-operated radio facilities caused by the proposed wind farm. A response is expected within approximately two months, whereupon this study will be updated and the results communicated to the client.

### 3.4 Airports

The following airport facilities are within 25 nautical miles of the turbine site:

**Table 4 – Public Airports Information**

Public Airports 25 Nautical Miles of Dolan Springs Wind Project Center of Area: 35° 44' 59.9" Latitude, 114° 06' 51.9" Longitude						
ID	Name	City, State	Latitude	Longitude	Distance (NM)	Azimuth
U--	City	City, State	36° 01' 13.60"	114° 20' 05.70"	19.39	326.88°
1--	Landmark	City, State	35° 59' 25.36"	113° 48' 59.13"	20.52	45.25°
L--	Public Figure	City, State	36° 05' 35.60"	114° 02' 48.20"	20.87	9.35°

Interference to ILS or other navigational or communication systems is not expected.



### **3.5 Radar and Military**

Figures 2, 3 and 4 show impact due to long-range radar and military considerations. These exhibits are self-explanatory. Turbine sites, when known, should be submitted to DoD as soon as practical.

## **VI. CONCLUSIONS**

The following conclusions have been reached as a result of the analysis undertaken with respect to the Dolan Springs wind project:

1. Eight microwave paths create blackout areas in which turbine siting should be avoided.
2. It is strongly recommended that the microwave paths crossing the turbine area be field-verified by land survey when the turbines are staked. This study should then be updated.
3. LMR radio using SCADA applications impact the property boundary and should be investigated for impact.
4. Based upon reasonable assumptions, there are no serious instances of impact potential to studied facilities.

Respectfully Submitted,

A handwritten signature in blue ink, appearing to read "Ralph E. Evans III".

Ralph E. Evans III  
Principal Communications Consultant

5/24/2011

### **ATTACHED FIGURES:**

- Figure 1 ---- Microwave Overview
- Figure 1.1 -- Microwave Path Detail: Blackout Area
- Figure 2 ---- Military Operations Screening
- Figure 2.1 -- Military Operations Screening Report
- Figure 3 ---- DoD Radar Screening: Blackout Area
- Figure 4 ---- Wx Radar: Blackout Area



Figure 1.1 – Microwave Path Detail: Blackout Area

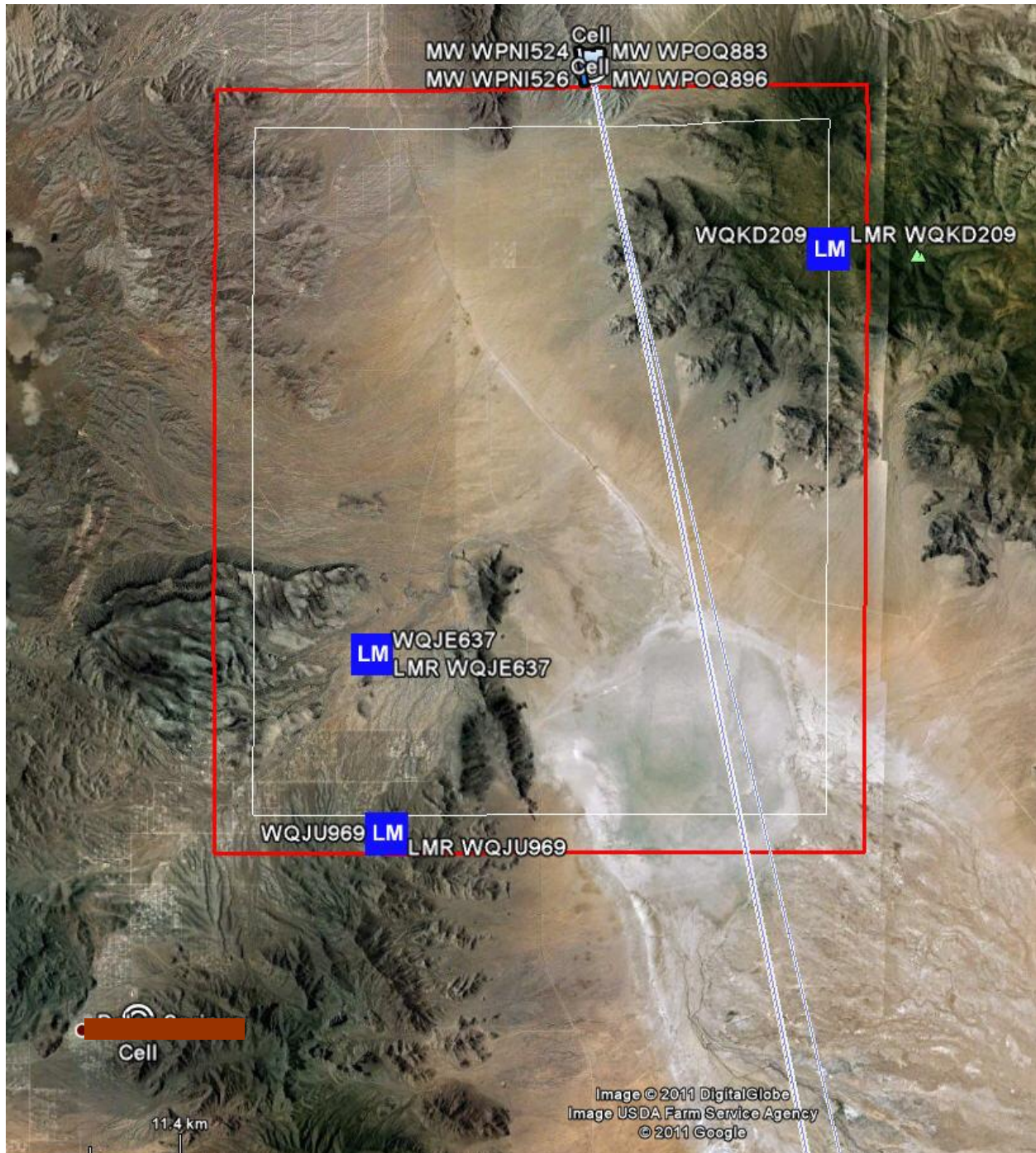
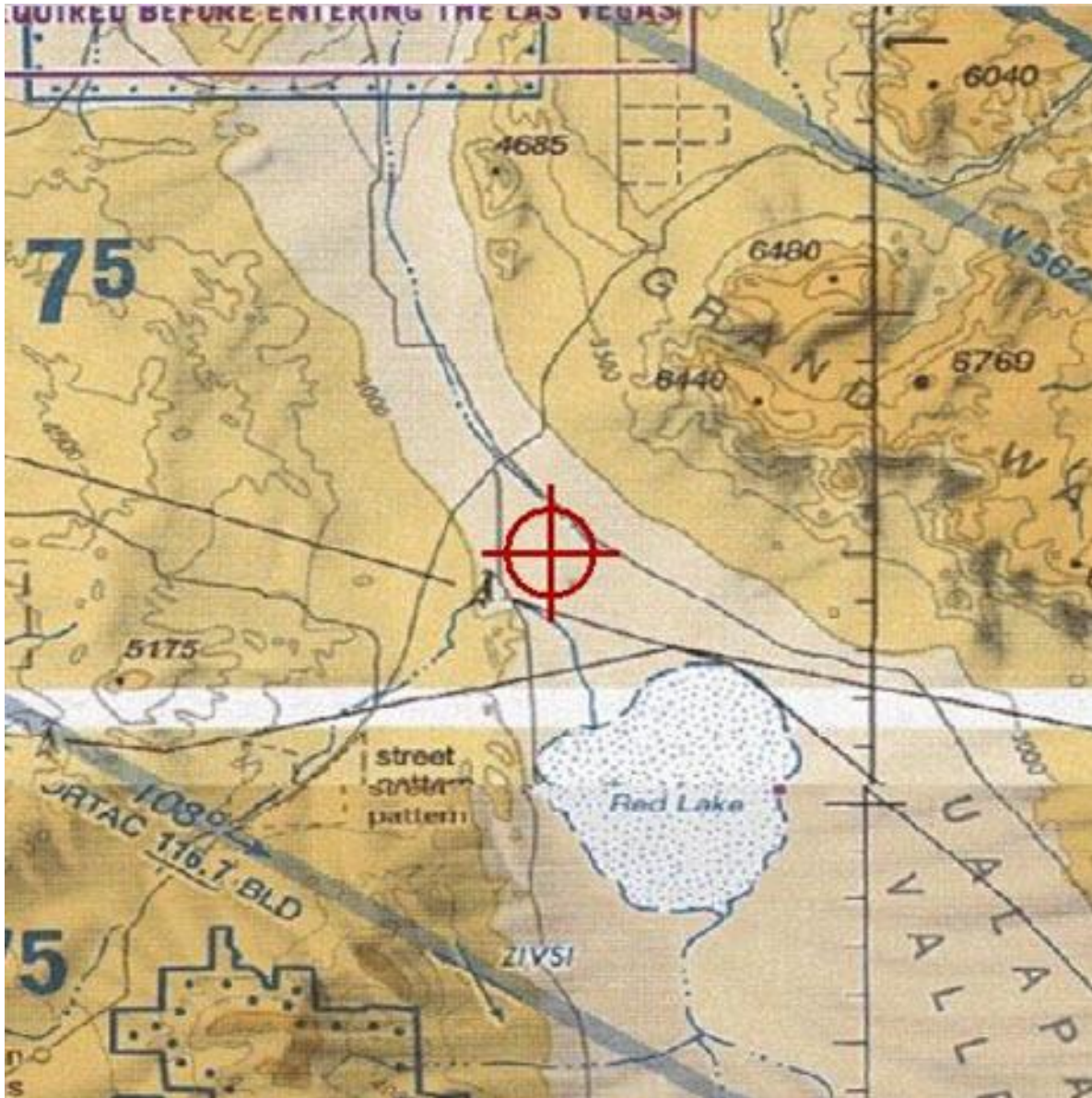


Figure 2 – Military Operations Screening



**Figure 2.1 – Military Operations Screening Report**

**Disclaimer:**

- The DoD Preliminary Screening Tool enables developers to obtain a preliminary review of potential impacts to Long-Range and Weather Radar(s), Military Training Route(s) and Special Airspace(s) prior to official OE/AAA filing. This tool will produce a map relating the structure to any of the DoD/DHS and NOAA resources listed above. The use of this tool is **100 % optional** and will provide a first level of feedback and single points of contact within the DoD/DHS and NOAA to discuss impacts/mitigation efforts on the military training mission and NEXRAD Weather Radars. **The use of this tool does not in any way replace the official FAA processes/procedures.**

**Instructions:**

- Select a screening type for your initial evaluation. Currently the system supports pre-screening on:
  - Air Defense and Homeland Security radars(Long Range Radar)
  - Weather Surveillance Radar-1988 Doppler radars(NEXRAD)
  - Military Operations
- Enter either a single point or a polygon and click submit to generate a long range radar analysis map.
- Military Operations is only available for a single point.
- At least three points are required for a polygon, with an optional fourth point.
- The largest polygon allowed has a maximum perimeter of 100 miles.

---

Screening Type:  Geometry Type:

Point	Latitude				Longitude			
	Deg	Min	Sec	Dir	Deg	Min	Sec	Dir
1	<input type="text" value="35"/>	<input type="text" value="44"/>	<input type="text" value="59.9"/>	<input type="text" value="N"/>	<input type="text" value="114"/>	<input type="text" value="8"/>	<input type="text" value="51.9"/>	<input type="text" value="W"/>

Horizontal Datum:

The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact Gary Munsterman at the USAF Regional Environmental Coordinator at (415)977-8884 for confirmation and documentation.

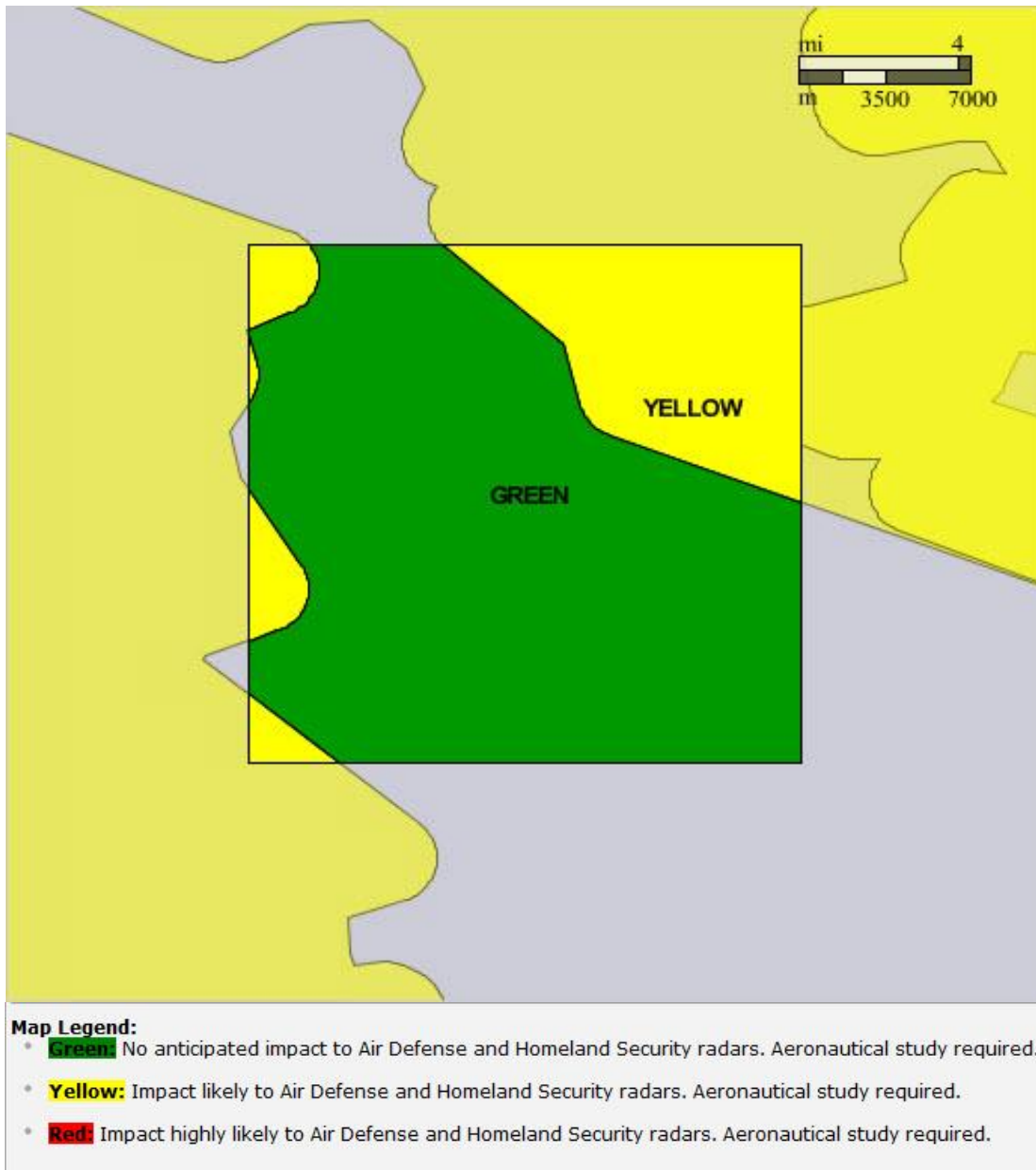
The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact the US Navy Representative, FAA Western Service Area at the USN Regional Environmental Coordinator at (425) 227-2740 for confirmation and documentation.

The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact LTC Owen B. Castlemain at the USA Regional Environmental Coordinator at (817)222-5920/5921 for confirmation and documentation.

The preliminary review of your proposal does not return any likely impacts to military airspace. Please contact the US Marine Corps Representative, FAA Western Service Area at the USMC Regional Environmental Coordinator at (425) 227-1384 for confirmation and documentation.

**This is a preliminary review of your proposal and does not preclude official FAA processes.**  
Your search data is not retained and the privacy of all your searches is assured.

Figure 3 – DoD Radar Screening: Blackout Area



**Figure 4 – Wx Radar: Blackout Area**

