Sunrise Powerlink Transmission Line Project
Application No. 06-08-010
MGRA Phase 2 Direct Testimony, Appendix 2B

APPENDIX 2B – SOUTHERN CALIFORNIA POWER LINE FIRES

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2B-1. Data Sources

2B-1.1. *Cal Fire Fire Perimeters*

Distribution: Open

Location: http://frap.cdf.ca.gov/projects/fire_data/fire_perimeters/

Description: Comprehensive fire perimeter data.

Fields: Name, acres, agency, cause, year, month, day

Version: April 2007

Restrictions & Limitations: This data set includes only data through the 2006 fire season. The October 2007 fires are not included.
"include[s] timber fires 10 acres and greater in size, brush fires 50 acres and greater in size, grass fires 300 acres and greater in size, wildland fires destroying three or more structures, and wildland fires causing $300,000 or more in damage."
"The current fire perimeter layer developed by BLM, CDF, NPS and USFS is the most complete digital record of fire perimeters in California. However it is still incomplete in many respects. Fires may be missing altogether or have missing or incorrect attribute data. Some fires may be missing because historical records were lost or damaged, fires were too small for the minimum cutoffs, documentation was inadequate, or fire perimeters have not yet been incorporated into the database. Agencies are at different stages of participation. CDF and the USFS have completed inventory for the majority of their historical perimeters back to 1950, while only 2002 - 2003 fires are currently present for BLM."
"Some duplicates may still exist. Additionally, over-generalization, particularly with large old fires may show unburned "islands" within the final perimeter as burned. Users of the fire perimeter database must exercise caution in application of the data."

Processing: Analyzed with ArcView.

2B-1.2. *Cal Fire Fire Threat Data*

Distribution: Open

Location: http://frap.cdf.ca.gov/projects/fire_data/

Description: "Fire Threat is a combination of two factors: 1) fire frequency, or the likelihood of a given area burning, and 2) potential fire behavior (hazard). These two factors are combined to create four threat classes ranging from moderate to extreme."

Fields: Fire Rotation Class:

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THREAT          DESCRIPTION
------          ---------
-1              LITTLE OR NO THREAT
1               MODERATE
2               HIGH
3               VERY HIGH
4               EXTREME

               FIRE THREAT MATRIX

                  Rotation
                 0  1  2  3
                 ------------
        F   -1 | -1 -1 -1 -1
        u    1 |  1  1  2  3
        e    2*|  2  2  3  3   Threat
        l    3 |  3  3  3  4
```

Restrictions & Limitations: Since it is based upon the 2001-2004 time frame of the Fuel Rank, this will also be biased by the 2003 fires, making it less suitable for long term projections.

Processing: Analyzed with ArcMap. Route analysis conducted for SPL and results put in Route_Analysis_SPL_1.1.xls.

2B-1.3. *Cal Fire October 2007 Fire Perimeter Data Set*

Distribution: Provided by Cal Fire upon request

Location: Cal Fire FRAP project:

CDF Attn: FRAP; PO Box 944246; Sacramento CA 94244-2460
Phone: (916) 327-3939 Fax: (916) 324-1180

Description: These are the preliminary data files created by Cal Fire that describe the fires associated with the October 2007 fire storm. These are identical to other FRAP fire perimeter data in format.

Fields: Name, acres, agency, cause, year, month, day

Version: Provided in January, 2008. Preliminary.

Restrictions and Limitations: This is public yet uncirculated Cal Fire data. Cal Fire ordinarily updates its public records for a given year in April of the following year, however that would not be timely for the Sunrise Powerlink proceedings. This data set is restricted in time to only those fires associated with the "October 2007 Firestorm", occurring throughout Southern California during the fourth week of October 2007. Due to its specificity, it cannot simply be added to the general Cal Fire data set for use in rate or other calculations without introducing a sampling bias. However it can be analyzed on its own. Another shortcoming is that not all cause information has been finalized and included.

Processing: Analyzed with ArcView.

2B-1.4. ***Mesowest Weather Data***

Distribution: Open

Location: http://www.met.utah.edu/mesowest/

Description: Data for RAWS and other weather stations in a database searchable by web interface. Hourly data can be obtained for any date extending back to the time that collection started for a particular station. This data is displayed in graphical (and optionally tabular) form for windows extending from 12 hours up to 30 days.

Fields: Temperature, relative humidity, wind speed (sustained & gust), wind direction, precipitation

Restrictions & Limitations: Data for SD County RAWS stations goes back to 1999, with many coming on-line between 1999 and 2001. Non-RAWS stations sometimes lack wind gust data. Data quality is considered marginal for older data. Anomalous functioning can often be identified by "wild swings" in measurements for one parameter or another, or by missing blocks of data.

Processing: RAWS data was downloaded for a window surrounding key wind events with a width of at least 12 hours.

2B-1.5. *Raws Weather Data*

Distribution: Open; limited to past 30 days

Location: Western Regional Climate Institute: http://www.raws.dri.edu/wraws/scaF.html

Description: DRI offers downloads of the most recent 30 days of weather station data from any specified weather station free of charge. It also offers historical data for a fee.

Fields: Temperature, relative humidity, wind speed (sustained & gust), wind direction, precipitation

Restrictions & Limitations: Data for SD County RAWS stations goes back to 1999, with many coming on-line between 1999 and 2001. Non-RAWS stations sometimes lack wind gust data. Data quality is considered marginal for older data. Anomalous functioning can often be identified by “wild swings” in measurements for one parameter or another, or by missing blocks of data.

Processing: Data for specified weather stations was downloaded in the aftermath of the 2007 fires in Excel spreadsheet format.

2B-1.6. *U.S. Census Tract Data*

Distribution: Proprietary. Access granted to Licensee only.

Location: Purchased from ESRI as part of the ArcGIS9.2 distribution. Also available from the US Census Bureau: http://www.census.gov/geo/www/cob/index.html
ESRI contact information:
Tele Atlas North America, Inc., ESRI
Date and time: 20070501
Publisher and place: ESRI, Redlands, California, USA
Series name: ESRI® Data & Maps
Series issue: 2007 World, Europe, United States, Canada, and Mexico

Description: U.S. Census Tracts represents the U.S. Census tracts of the United States in the 50 states and the District of Columbia.

Fields: FIPS, POP2000, POP2007, POP00_SQMI, POP07_SQMI, population fields for age, race and gender, households and size, families, housing units, and area.

Restrictions and Limitations:

Processing: Processed with ArcView.

2B-1.7. *National Digital Forecast Database Archives*

Distribution: Open

Location: Archived at the National Climate Data Center: http://has.ncdc.noaa.gov

Description: Archived forecast data for the National Digital Forecast Database(NDFD) consist of all forecast information from the National Weather Service in a grid format. These are the raw data used by weather offices to make their forecasts, and only over the last few months (from mid 2006) have these become available for Southern California. The grid forecast made at a given time projects outward for a certain period into the future, and each future projection constitutes its own grid. The data product is described in this reference2.

Fields: Data for temperature, humidity, precipitation, wind speed and direction, and several other quantities are available separately. All available fields are described here: http://www.weather.gov/ndfd/technical.htm .

Restrictions and Limitations: Datasets are large, and take some time to download.

For this reason, only wind data have been analyzed for the economic impact analysis. Data have only become available since mid-2006, meaning that only recent Santa Ana events can be analyzed. Grids are also coarse (5 km), meaning that local weather conditions may not be well-represented.

Processing: Datasets must be selected in order to be downloaded from NCDC. Once downloaded, they need to be processed with the tkdegrib program to create shapefiles that can be used by GIS systems. This is available here: http://www.weather.gov/mdl/NDFD_GRIB2Decoder/index.php

2B-1.8. *Cal Fire Press Release – Cause of October 2007 Fires*

Distribution: Public, issued by Cal Fire

Location: On request from Cal Fire. Attached below for convenience as File 2A-1.

Restrictions and Limitations: These results are preliminary.

2B-1.9. *Poisson statistics calculator*

For determining confidence levels and statistical uncertainties for small values, the Poisson.rb[1] calculator was used (available from M-bar Technologies & Consulting). This calculator estimates the probability of a random event occurring within a specified interval for a given distribution mean. It is used iteratively to determine 90% confidence levels. For a two-tailed distribution, this entails determining the 95% upper and 95% lower interval.

2B-2. Analyses

2B-2.1. *Power line fires in Southern California*

2B-2.1.1. Goal

It was observed that during the October 2007 fires that an inordinate number of power line fires purportedly started in San Diego County, which constitutes the majority of the SDG&E service area[2]. The impact of these fires upon the proposed SPL project were analyzed in the previous section. It also raises the question, addressed in this section, of whether the larger number of power line fires is historically typical of the SDG&E service area when compared to other regions of Southern California.

2B-2.1.2. Description

Using the Cal Fire fire perimeter data available on the FRAP website, we apply the same methodology as was used in our Phase I testimony[3]. However, this time we expand the sample to all fires in Southern California rather than just in San Diego County.

2B-2.1.3. Methods

We analyzed the shape files provided by Cal Fire according to the method laid out in our Phase 1 testimony.[4] This was divided up into the following counties: San Diego, Orange, Los Angeles, Riverside, San Bernardino, and Ventura. This sample of counties

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[1] Attached as Poisson.rb

[2] Cal Fire News Release (**Error! Reference source not found.**); October Fire Causes; November 16, 2007.

[3] MG-1; MGRA Phase 1 Direct Testimony, Appendix D- Power Line Fires; pp. 5-10; Sunrise Powerlink Transmission Line Project Application No. 06-08-010.

[4] Ibid.

was selected because they have meteorological and vegetation conditions that are most similar to San Diego County[5].

Attribute data was copied from the shapefiles and copied into a Microsoft Access database for additional processing. Different tables and queries were constructed for each of the six counties studied.

A cut was placed at 100 acres as being the smallest significant fire. This was necessary because there seems to be some inconsistency between fire agencies in the reporting of power line fires. Orange County, for instance, reported two fires on the order of ten acres, which is below the usual level of significance associated with this data set. Also, only fires after 1960 are examined in the data set.

Important note: this contains data only through 2006. The October 2007 fires are not included and are analyzed separately.

The file is attached below:

SCPerimeterSummar
y.xls

File 2B-1 – Analysis of wildland fire perimeter data for all of Southern California showing the comparative averages and means for power line fires alone and all fires together.

A number of values were calculated for each county. The total number of fires larger than 100 acres is shown in the column '***Fires>100***'. The total area burned by all fires is given in both square meters and acres. The average size of fire in acres is in the column headed '***Avg'***. The number of power line fires is shown in '***PL Fires***' and their fraction of total fires in '***PL %***'. The area burned in acres by these power line fires is in '***PL Acres***', and the average size of a power line fire is in the column '***PL Avg***'. The fraction of power line fire area burned to total area burned is given in the column '***PLA %***'. Finally, the ratio of the average power line fire size to that of the average wildland fire size is given in '***PL / Avg***'.

Finally, summary data was analyzed (this being shown below the table in columns F through I) that calculated the probability that San Diego County would see the number of fires it does compared to the rest of southwest California. This approach assumes that each county is as likely as any other to experience a power line fire. The five other counties – Los Angles, Ventura, Orange, Riverside and San Bernardino – are grouped together to get an average power line fire number per county, and then the probability

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[5] Moritz, Max, private communication.

that the number of observed powerline fires for San Diego (or any greater value) is a statistical fluctuation using the mean value from the other counties is calculated using a chi-squared method, shown on the tab chi2 of the worksheet.

2B-2.1.4. Analysis

The most noteworthy observation to be made in this data sample, especially as it pertains to these proceedings, is that power lines were attributed to be the cause of more fires in San Diego County than in any of the other counties studied. In the period between 1960 and 2006, San Diego County had eight power line wildland fires, six of them of the significance level necessary for this data analysis (> 100 acres), double that of Los Angeles, which is in second place with three significant fires. The summary data is analyzed in the table below:

County	Fires	Area (acres)	PL Fires	PL %	PL Area %	PL/All Ratio
Ventura	147	1,160,369	1	0.68	0.34	0.49
Los Angeles	496	1,035,183	3	0.60	0.25	0.41
San Bernardino	272	786,999	2	0.74	0.17	0.23
Orange	53	204,237	1	1.89	1.11	0.59
Riverside	635	1,082,772	1	0.16	2.26	14.33
San Diego	444	1,279,699	6	1.35	19.94	14.76

Table 2B-1 – Summary of Cal fire data for fires larger than 100 acres since 1960, including power line fires. The fraction of fires made up by power line by number, by area burned, and the ratio of average power line fire size to 'normal' fire size are calculated for the six counties of southwest California.

San Diego county has the third largest number of large fires (after Riverside and Los Angeles), but has nearly double the number of power line fires of the runner up (Los Angeles) and has almost the number of power line fires observed in the rest of Southern California put together (6 for SD versus 8 for the rest).

The observation made during Phase 1 testimony that power line fires are much larger than fires started by other sources[6] seems to be borne out only for San Diego and Riverside counties, and is not observed in the data from other counties.

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[6] MG-1; MGRA Phase 1 Direct Testimony, Appendix D- Power Line Fires; pp. 9-10; Sunrise Powerlink Transmission Line Project Application No. 06-08-010

Assuming that there is an equal probability of fires being started in any particular county (this is a questionable assumption, and more reasonable alternatives will be presented later in subsequent sections), we can calculate what this average is, and then calculate the probability that the high number of power line fires in San Diego county is a statistical fluctuation.

There were eight power line fires, total, in the five counties other than San Diego, for an average of 1.6 fires per county. The statistical probability that the observed number of fires is consistent with the hypothesis of an equal number of fires per county is 0.9%.

2B-2.1.5. Limitations

The shortcomings of the Cal Fire fire perimeter dataset were described in Appendix D of the Phase 1 testimony. It should be noted again that the 2007 data set has not been released by Cal Fire, and therefore this data set does not contain the results of the October 2007 fires. However, these would simply reinforce the observed trend, and they will be discussed elsewhere.

Since major power line fires are rare, the associated statistics tend to be small and thus subject to significant statistical uncertainty. Additionally, the statistical nature of catastrophic distributions indicates that the “typical” values, such as averages, tend to be driven by rare, extreme events. For this reason, small statistical samples will generally tend to underestimate the averages.

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Finally, it is conceded that the assumption upon which the San Diego power line fire probability is based – that there is an equal probability of power line fires for each county – is a flawed assumption. More reasonable hypothesis will be examined in subsequent sections.

2B-2.1.6. Conclusions

San Diego County has historically experienced more power line fires than any other county in Southern California, experiencing six fires larger than 100 acres. The next nearest, Los Angeles, only has three such fires. All of the counties together experienced 8 major power line fires prior to 2007. The probability that this is a statistical fluctuation is very small. Likewise, only in San Diego and Riverside counties have power line fires been observed to be much larger than fires started from other sources.

There are a number of possible factors that could potentially explain why San Diego has historically had more power line fires than other counties, and we examine these in turn throughout the remainder of this appendix.

2B-2.2. *Power Line Fires and Vegetation Exposure*

2B-2.2.1. Goal

To test the hypothesis that the observed number of power line fire in Southern California can be explained by the exposure of the grid to flammable vegetation.

2B-2.2.2. Description

As has been pointed out in previous MGRA testimony[7], the origin of a destructive power line fire requires the coincidence of strong wind that causes a power line fault or failure, creation of burning material from this fault or failure, the ignition of adjacent flammable vegetation, and the rapid spread of this fire throughout the vegetation due to the high winds so that it is too large to be contained by firefighting initial attack.

It follows that the more exposed the transmission and distribution network to flammable vegetation, the higher the expected number of power line fire starts would be. We compare relative vegetation exposure for the six counties in southwest California in order to see how this correlates with the number of observed power line fires.

2B-2.2.3. Methods

Ideally, we would measure the total length of network exposed to flammable vegetation to obtain this metric. Unfortunately, SDG&E has refused to provide infrastructure location information in a usable form, claiming that it would create a security risk[8]. Even if SDG&E were to provide this information, the other utilities in Southern California would not be under a similar obligation. Hence, we will need to use other techniques to test the hypothesis that vegetation and fire starts are related.

One thing that we can do is to use the Cal Fire "Fire Threat" metric used extensively throughout the Phase 1 testimony to indicate regions of hazardous vegetation. While this is not ideal, since the 2003 fires bias the fuel load estimate, it still provides a rough estimate of hazard region boundaries. This problem is somewhat ameliorated if we look at regions of "High" fire risk and above ("Very High" and "Extreme"), since areas burned in the 2003 fires generally dropped from "Extreme" to "Very High", but never fell out of the category "High and above". This metric, applied to southwest California, is shown in the figure below.

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[7] MG-1; MGRA Phase 1 Direct Testimony; pp. 2-3; Sunrise Powerlink Transmission Line Project Application No. 06-08-010

[8] SDG&E'S 2/6/07 RESPONSE TO MGRA Data Request No. 2

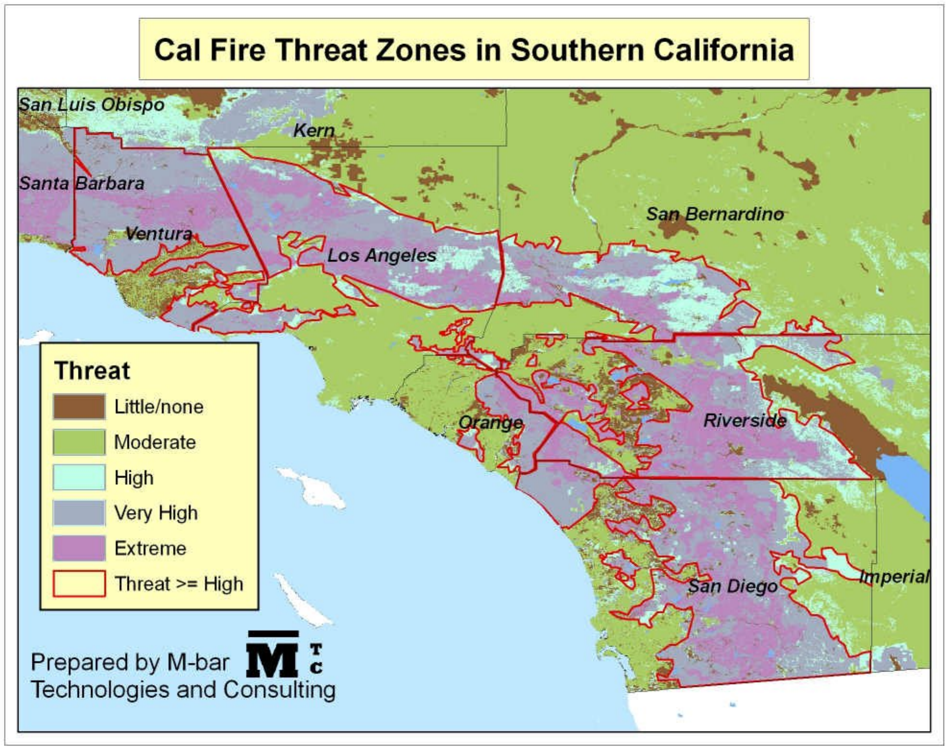

Figure 2B-1 – This figure shows the Cal Fire wildland fire threat zones for southwestern California. Areas of particular concern, having a Threat level of High, Very High, or Extreme, are outlined in red.

As indicated in the figure, a considerable fraction of the area of the southwestern California counties lies in a region of elevated fire threat. San Diego County is not unique in this regard.

In order to obtain the area under threat, contours were drawn around regions with high concentrations of "High" threat level and above. These contours were drawn manually using ArcView geoprocessing software. Contours were drawn so that they did not span county boundaries. Each area is contained in only one county.

The total area for these contours was extracted on a per-county basis. These calculations are shown in File 2B-1. The area (**'ThrtAcres'**) was used to re-weight the power line fire rates ('**PLF**/Acre') in order to see if this provides a possible explanation of the anomalously high power line fire rate (see column '**Pred:A-SD**'. These are shown in the next section.) Finally, a chi-squared fit was used to test whether the values observed in all counties were statistically consistent with the hypothesis, shown on the Chi2 tab of the attached worksheet.

2B-2.2.4. Analysis

The areas of fire threat levels of "High" and above are tabulated for each county in the table below:

Counties	PL Fires	Threat (acres)	PLF/ acre	Pred. (A-SD)	Prob.
Ventura	1	916,355	1.1E-06	1.7	
Los Angeles	3	1,179,430	2.5E-06	2.2	
San Bernardino	2	752,014	2.7E-06	1.4	
Orange	1	167,669	6.0E-06	0.3	
Riverside	1	1,286,175	7.8E-07	2.4	
San Diego	6	1,630,266	3.7E-06	3.0	19.8%

Table B-2 – The areas of significant fire threat as shown in Figure 2B-1 are tabulated on a per county basis, and a power line fire rate per acre is determined for each county. Assuming that all counties aside from San Diego provide the "correct" rate, probabilities are calculated that the observed number of power line fires is consistent with the prediction.

As can be seen, San Diego County has the largest area under significant wildland fire threat of any county in southwest California. This reduces the power line fire rate to the second largest. Orange County[9], with its one observed large power line fire, but with a relatively small area under wildland fire threat, has a higher rate even than San Diego.

Using the hypothesis that all counties other than San Diego have an identical "true" power line fire rate, an average rate of 1.9E-06 fires / acre is determined for these five counties. If a chi-squared method is used to test the vegetation hypothesis for all data, we determine the probability that all results are consistent with a statistical fluctuation, shown in the lower right box. . As can be seen, the San Diego value is not as unlikely as under the hypothesis of the previous section.

2B-2.2.5. Limitations

[9] Parts of Orange County are within the SDG&E service area.

This hypothesis has significant limitations as a predictive mechanism. It forces that the unreasonable assumption that the electrical infrastructure is uniformly distributed throughout the hazard zone. In fact, much of this hazard zone is hazardous because it is rural, remote, and undeveloped. Hence it is unlikely to have much transmission or distribution infrastructure in place in comparison to more highly urbanized areas of lower threat.

Additionally, the Cal Fire fire perimeter history is over fifty years, and it is likely that the vegetation threat zones have changed significantly over those times, growing smaller as more areas become urbanized and losing their original vegetation.

A more reasonable hypothesis would assume that the electrical distribution and transmission infrastructure density would roughly track the number of consumers of electricity. This hypothesis is tested in the next section.

2B-2.2.6. Conclusions

San Diego County has the largest area exposed to flammable vegetation of any of the southwest California counties studied. This may partially explain why it might be expected to see more power line fires. Orange County, in addition, is shown to have a high fire rate, but this is based upon one event and a relatively small area of hazardous vegetation. The logical foundation of the overall hypothesis is weak, though, and a better one would use the density of consumers as a proxy for the physical density of the distribution and transmission infrastructure.

2B-2.3. ***Power Line Fires, Vegetation, and Population***

2B-2.3.1. Goal

To expand the previous hypothesis that the proximity of flammable vegetation to power lines is a predictive factor for power line fires to include a feasible proxy for the power line density, such as the density of consumers.

2B-2.3.2. Description

This analysis builds upon the previous section, and also uses the “Hazard zones” maps created for it. It then uses a proxy for the power line density – the number of housing units – to estimate overall exposure. Rates and probabilities are calculated as in the previous section.

2B-2.3.3. Methods

We start with the Hazard zone maps that were created for the previous analysis. We then take U.S. Census tract data (see 2B-1.6) and superimpose it on these zone maps. Only census tracts that have a border within 300 meters of a "hazard" zone are included in the sample. The rest are considered "urbanized" and not subject to extraordinary wildland fire risk. The remainder can be considered representative of the "wildland urban interface" (WUI) in Southern California. See the figure below:

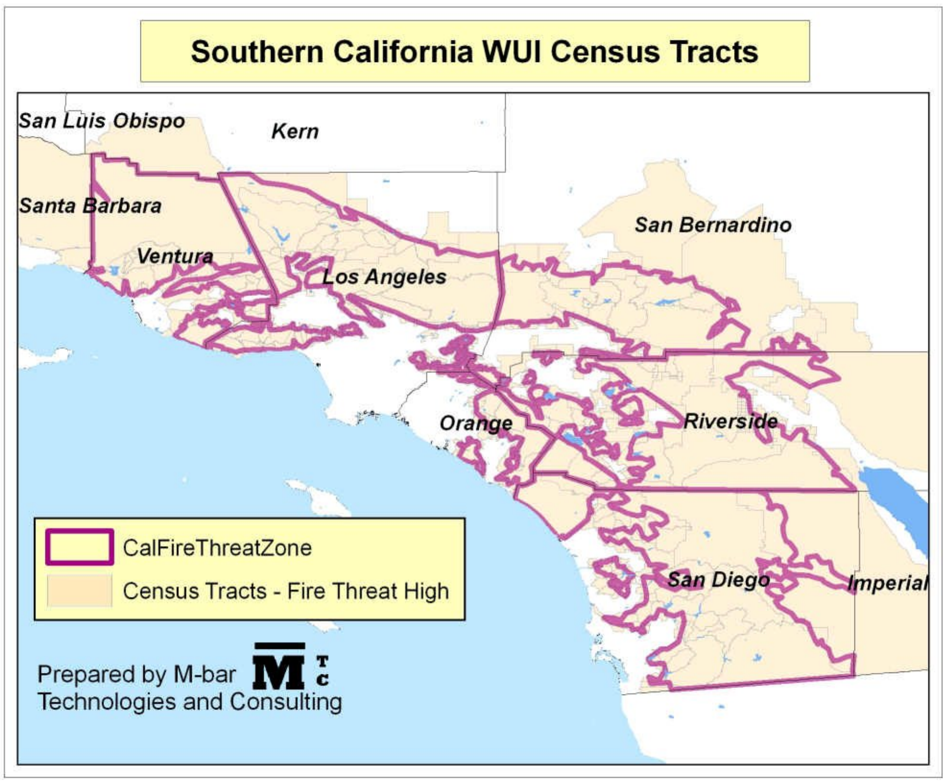

Figure 2B-2 – This figure shows census tracts in Southern California that have a border within 300 meters of the areas with Cal Fire threat levels of "High" or greater.

In File 2B-1, the number of housing units in each of these tracts was summed together on a per-county basis, giving a total number of housing units 'at risk' ('**HUsThrt**'). Power line fire rates were then calculated, creating a "fires per housing unit" metric ('**PLF/HUT**'). Once again, the five counties other than San Diego are averaged together with the hypothesis that they represent a true mean value, and the probability that San Diego experiences the number of power line fires that it did, or more, is calculated ('**Prob:A-SD**'), using the chi-squared method shown on the Chi2 tab of the worksheet.

2B-2.3.4. Analysis

The number of housing units exposed to High wildland fire threat is tabulated on a per county basis in the table below:

County	PL Fires	Housing Units Tht.	PLF/ HUT	Pred. (A-SD)	Prob.
Ventura	1	101,654	9.84E-06	1.15	
Los Angeles	3	406,282	7.38E-06	4.61	
San Bernardino	2	211,755	9.44E-06	2.40	
Orange	1	109,326	9.15E-06	1.24	
Riverside	1	234,633	4.26E-06	2.66	
San Diego	6	170,028	3.53E-05	1.93	0.16%

Table 2B-3 – Housing units that are within 300 meters of a Cal Fire threat area of "High" or greater, as defined by the contours drawn in the last section. Power line fire rates are calculated, as are predicted number of fires using the five counties other than San Diego as a 'mean' value and using

As is evident, while San Diego County might have the largest area enclosed in the "High" fire threat contours, the number of housing units enclosed is modest compared with some of the more densely populated areas of Southern California. Los Angeles, Riverside, and San Bernardino counties all have a larger number of housing units within the tracts bordering or contained in the high fire risk contours. Remarkable uniformity is now seen in the fire rates between all counties in the power line fire rates – aside from San Diego County, which has a value 3.5 times larger than the average (and Riverside County, which with its one event is a factor of two low).

The probability that the large number of San Diego fires is due to a statistical fluctuation is estimated at 0.16%.

The use of housing units as a proxy for the density of electrical distribution and transmission infrastructure is justified if one considers that each and every housing unit will require a connection to the electrical grid. Hence the overall length of the exposed line will roughly scale with the number of these interconnects, assuming equal mixtures of urban and rural dwellings in all counties surveyed.

2B-2.3.5. Limitations

The hypothesis that the length of the exposed electrical infrastructure scales linearly with the number of housing units is not expected to be exactly true. In more rural areas, for instance, there will be larger numbers of isolated housing units, each of which will require a long run from the trunk line, while in more urban and suburban settings each new housing unit will be much closer to the trunk line. If San Diego's areas under fire threat are more 'rural' than those in the other counties, this would reduce the statistical significance of the number of power line fires observed.

Another issue with the data set is that it is based on data from the 2000 census. This predates the 'housing boom', in which significant new housing was added, much of it within the wildland urban interface. While updated data is not available for housing units, the ESRI data includes estimates for 2007 population. This is used instead of housing units as a cross check, as is shown in the columns '**Pop07Thrt**', '**PLF/P07T**', '**Pred-SD**'and '**Prob**' in File 2B-1. Results were roughly consistent with those using the 2000 housing unit data.

Additionally, the Cal Fire fire perimeter history is over fifty years, and it is likely that the vegetation threat zones have changed significantly over those times, growing smaller as more areas become urbanized and losing their original vegetation.

2B-2.3.6. Conclusions

Using the number of housing units as a proxy for the size of the electrical network does not help to explain the abnormally high number of power line fires observed in San Diego County. Quite the opposite: since the number of San Diego housing units near the specified hazard threat zones is small compared to some other counties, the significance of these power line fires is amplified. These results imply that a home in the San Diego wildland urban interface is more than 3.5 times as likely to be exposed to a power line fire in San Diego County than it would be in other southwest California counties.

2B-2.4. *Power Line Fires and Santa Ana Winds*

2B-2.4.1. Goal

To determine whether Santa Ana wind patterns can provide an explanation of the excess of power line wildland fires observed in San Diego County.

2B-2.4.2. Description

Aside from flammable vegetation, another key factor associated with catastrophic wildland fires is the presence of wind conditions that allow for rapid fire growth. The

Santa Ana winds of Southern California have long been associated with catastrophic fires[10]. They are also not uniform in their distribution, so it could be argued that locations that have more severe Santa Ana winds will be more subject to wildland fires.

This is especially true of power line fires. Only power line fires have an ignition source that is actually *caused* by the presence of strong winds. Hence, if there are localized areas where the wind is more intense, these will be more likely to be the spawning area for catastrophic power line fires[11]. This begs the question of whether areas where more power line fires are observed to occur, such as San Diego County, experience more intense winds. We examine this possibility in this section of the document.

2B-2.4.3. Methods

One measure of the wind intensity as a function of location is provided by the National Weather Service in the form of short-term predicted wind intensity maps[12]. In Phase 1, the Alliance argued that these maps should be used to construct wind hazard zones[13]. This was not included as part of the EIR. Therefore, we are left with "typical" examples of the distribution of Santa Ana winds during extreme weather events. One of these is shown in the figure below, which represents the short-term wind forecast during the October 2007 Santa Ana event that led to an associated Fire Siege.

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[10] Sommers, William T.; LFM Forecast Variables Related to Santa Ana Wind Occurrences; Monthly Weather Review; September, 1978; v. 106, pp. 1307-1316.

[11] OSFM, CDF, USFS, PG&E, SC Edison, SDG&E; Power Line Fire Prevention Field Guide; Mar 27, 2001, p. 1-5.

[12] See Section 2B-1.7 for a description of the NDFD database.

[13] MG-1; MGRA Phase 1 Direct Testimony, Appendix F – Santa Ana Winds; p. 13; Sunrise Powerlink Transmission Line Project Application No. 06-08-010

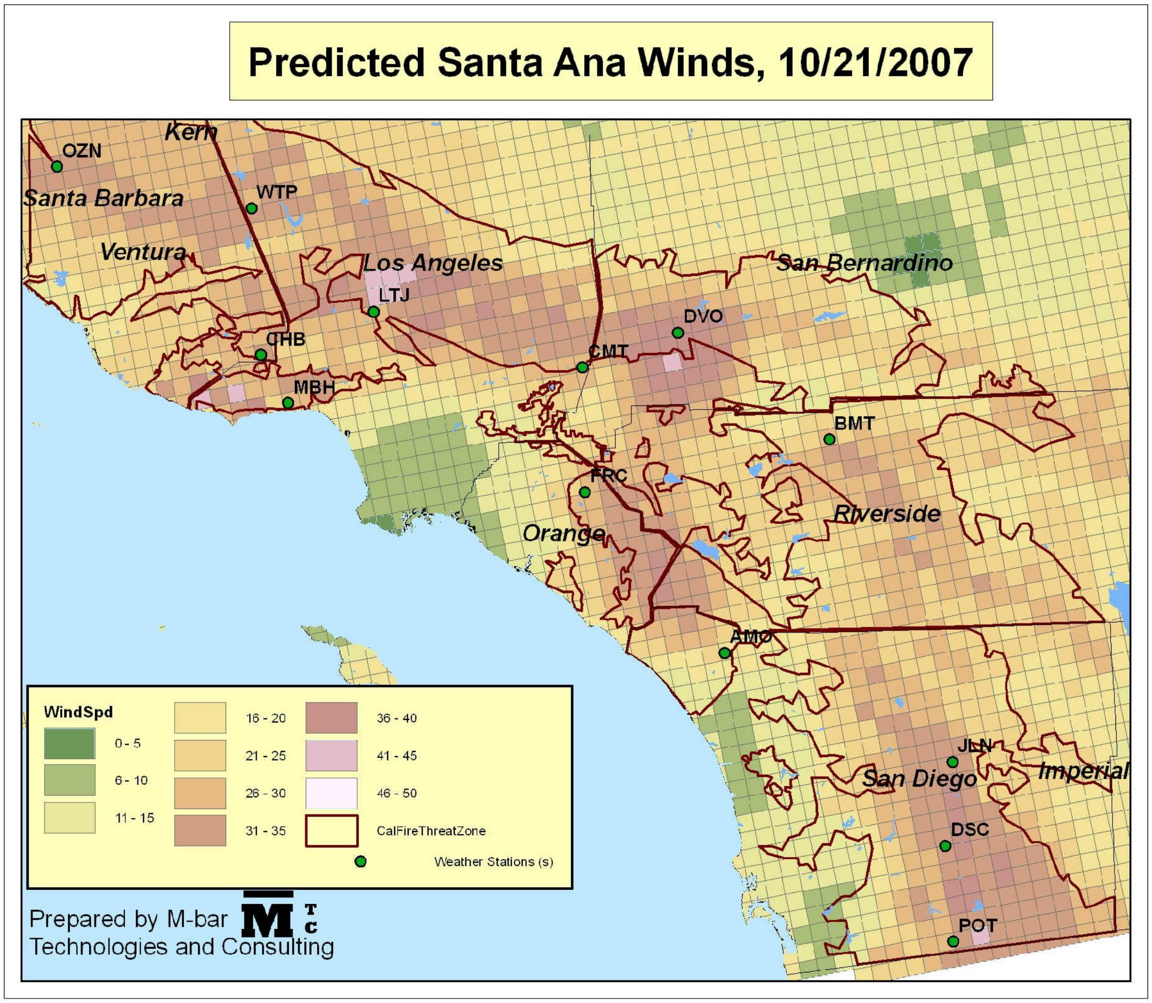

Figure 2B-3 – This map from the National Climactic Data Center's National Forecast Database shows the predicted wind gust intensities in knots at 00:00 UT on October 22, 2007 (5 p.m. October 21st, local time). Weather stations positions are indicated as green dots. The high threat vegetation zone perimeters are indicated by the maroon contours. This data was predicted two hours in advance, and shows some of the Santa Ana wind conditions typical of those throughout the October 2007 fire siege.

Most evident in the above figure is that the distribution of intense winds during a Santa Ana event are is not uniform in spatial distribution. The distribution is not even in time either, as Figure 2B-4, which shows predicted gusts at 1 p.m. PST on October 22, 2007, demonstrates.

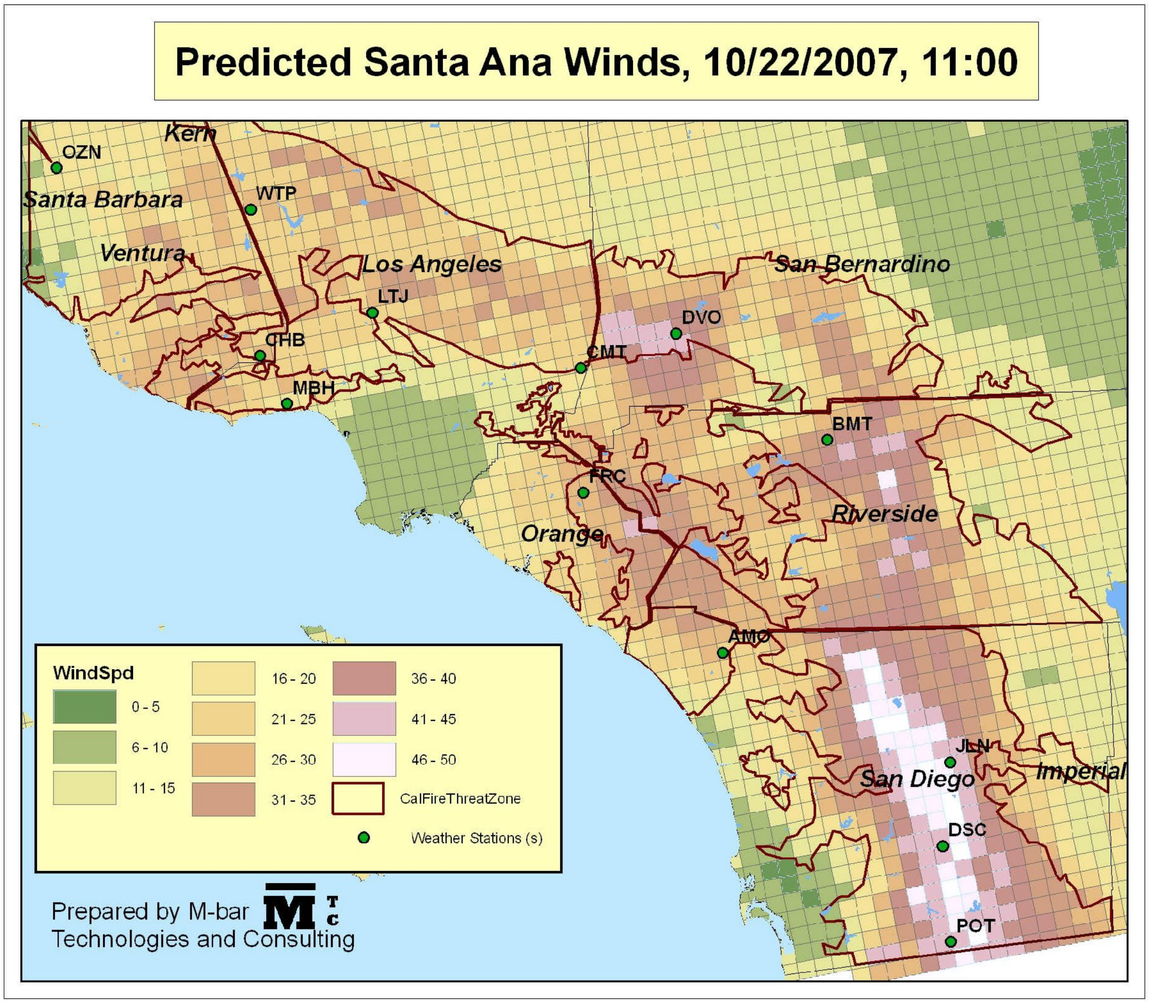

Figure 2B-4 - This figure shows the predicted wind gust conditions at 1 p.m. PST on October 22nd, the height of the wind storm in San Diego County. Intense winds seem to be restricted to certain areas, but these areas show large relative variations in intensity.

This figure would indicate that San Diego County experienced the most severe wind conditions of any other Southern California county during the October 2007 Santa Ana event and fire siege.

In order to demonstrate whether the observations from October are a trend or whether they represent a unique event, weather data from a number of weather stations (indicated by green circles in figures Figure 2B-3 and Figure 2B-4) was collected for five Santa Ana weather events that occurred in 2006 and 2007 using Mesowest weather station records (section 2B-1.4). Two metrics were collected per weather station per event: 1) The maximum gust intensity experienced at that weather station and 2) The duration in hours that the maximum wind gust was over 40 mph. This data is collected in the file below.

SCWeatherSA.xls

File 2B-2 – Collected Mesowest weather station data for six Santa Ana events: 10/26/2006, 11/29/2006, 12/24/2006, 1/6/2007, 1/12/2007 and 10/21/2007. Maximum gust speed and time that wind gusted over 40 mph were captured for the sampled weather stations.

The weather stations that were picked for this study were chosen because of their proximity to high-wind regions. The weather stations chosen are listed below:

County	Station	Name
San Diego	POT	Potrero
San Diego	JLN	Julian
San Diego	DSC	Descanso
San Diego	AMO	Ammo Dump
Orange	FRC	Fremont Canyon
Riverside	BMT	Beaumont
Riverside	CNS	Cranston
San Bernardino	DVO	Devore
Los Angeles	CMT	Claremont
Los Angeles	LTJ	Little Tujunga
Los Angeles	WTP	Whitaker Peak
Los Angeles	MBU	Malibu Hills
Ventura	CEE	Cheeseboro
Ventura	OZN	Ozena

Table 2B-4 – Weather stations selected for analysis during Santa Ana events are listed above. The locations of these stations are shown in figures Figure **2B-3** and Figure **2B-4**.

A summary of the six weather events is given below, with the three stations having the highest gusts selected for each event. The numbers displayed are maximum gust / hours that gusts exceeded 40 mph.

Event	Station#1	Values	Station #2	Values	Station #3	Values
10/26/2006	WTP	55/5	FRC	53/13	BMT	47/8
11/29/2006	FRC	73/29	MBU	70/66	WTP	55/33
12/24/2006	MBU	65/17	WTP	55/14	FRC	52/8
1/6/2007	WTP	95/33	FRC	85/72	MBU	80/85
1/12/2007	MBU	65/81	FRC	65/47	WTP	55/30
10/21/2007	FRC	85/58	POT	70/54	BMT	65/60

Table 2B-5 – This table shows the three weather stations with the most intense wind gusts during six Santa Ana events. The numerical values are (max wind gust speed in mph / hours that wind gusted above 40 mph).

It can be seen that some weather stations registered the Santa Ana event of the first week of January 2007 to be of even greater intensity than that experienced in October. The predicted spatial distribution of this event is shown in the figure below:

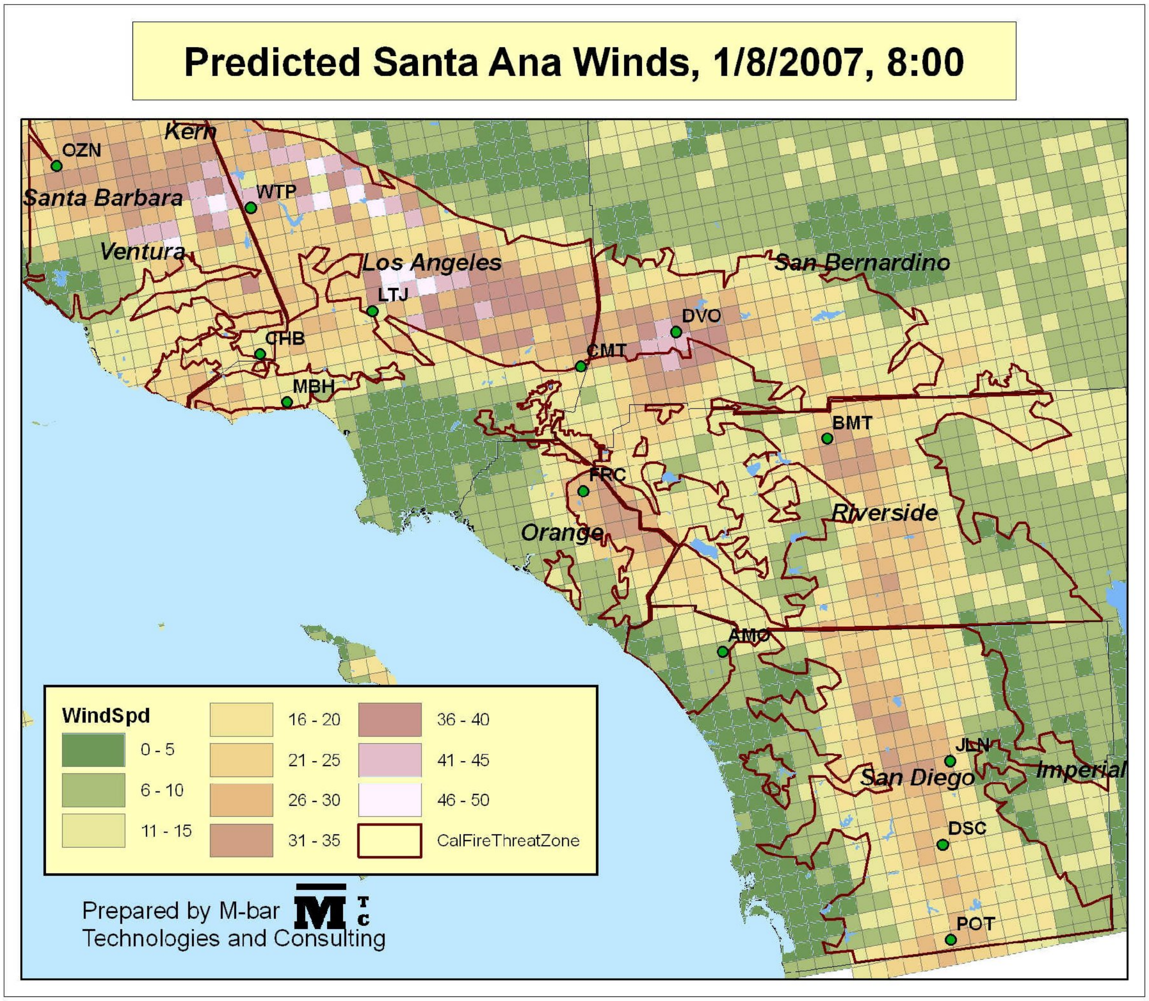

Figure 2B-5 – Santa Ana event occurring during the first week of January, 2007. It can be seen that the most intense winds are in the northernmost counties studied.

2B-2.4.4. Analysis

We can makes some observations regarding the data presented in the figures and table above:

- There are some areas that tend to have higher winds during Santa Ana events.
- Relative wind intensities vary from place to place and event to event.
- Weather station data implies that stations in San Diego County are not often those registering the highest wind intensity values. Only during the October 2007 fire siege did one of the stations (Potrero) register in the top three for wind intensity. (It should be pointed out that the Malibu Hills station went

dead during this event, possibly due to the nearby Canyon Fire – which ironically is purported to be a power line fire.)

- Inconsistencies between the weather station data and the predicted wind intensities may imply either an effect due to the physical placement of the weather stations, or it may be the NDFD forecasts are too coarse-grained to be useful for localized weather prediction.
- Figure 2B-4, shows extreme wind intensity in San Diego County that is not seen elsewhere. It should be noted that the timeframe of this figure is roughly two hours prior to the Witch Fire ignition. Judging from this alone, one might hypothesize that the preponderance of power line fire starts in San Diego County during the October 2007 fire siege were due to the fact that winds were more intense in San Diego County than elsewhere. However, this hypothesis is not supported by weather station data, which shows significant wind gusts throughout Southwest California.
- Many of the high wind intensity areas are also in areas of significant hazardous vegetation.
- The January 2007 Santa Ana event shows much more significant activity in the northern counties studied than in San Diego County, thus demonstrating that there is no county with consistently higher Santa Ana wind gust intensities.

2B-2.4.5. Limitations

A proper analysis of wind intensities would take into account many Santa Ana events to determine where the areas of significant fire threat are. Such a study was requested by the MGRA as part of the EIR[14], but this study was not performed. Additionally, the analysis needs to be conducted on a much finer grid, by trained meteorologists. Such a study is actually underway[15] but will not be ready within a time frame relevant to the SPL proceedings.

2B-2.4.6. Conclusion

While the evidence from weather station data and prediction data from the National Climate Data Center does not fully refute the hypothesis that there are more power line fires in San Diego County because the Santa Ana wind conditions are worse here, they do

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[14] MG-1; pp. 28-29.

[15] Max Moritz, personal communication.

not lend unambiguous support to such an idea either. Figure 2B-4 might be interpreted to support the claim that there were more power line fires in San Diego County during the October 2007 fire siege because the winds here were more intense than elsewhere. However, the other figures and Table 2B-5 do not add support to such a claim.

Even if weather were to turn out to be a cause of excess power line fires, the implications for SPL would be the same as if the causes were unknown: it would call into question the current engineering practices and maintenance standards for power lines in the SDG&E service area.

2B-2.5. *Power Line Fires and Fire Suppression*

2B-2.5.1. Goal

This section will address the hypothesis that power line fires are more frequent and severe in San Diego County due to inadequate fire suppression capabilities.

2B-2.5.2. Description

A recent report by the San Diego Regional Fire Safety Forum[16] was picked up in the popular press. It makes the argument that San Diego County is grossly under-funded compared to other comparable counties in San Diego. A press quote from Safety Forum founder and former city fire Chief Jeff Bowman states that: "The county spends $8 million a year on fire equipment, the report says. Los Angeles County, with a population of 10 million in a slightly smaller land area, spends $860 million a year on its county fire department, Bowman said. Orange County, with a population similar to San Diego County but less than one-quarter the land area, spends $260 million a year." [17]

This might be taken to suggest that San Diego might be prone to worse power line fires because its fire suppression capabilities do not match those of other counties.

The funding numbers presented to the press are somewhat deceptive. San Diego County is Balkanized into a large number of independently funded fire districts, and there is no centralized county fire department. To compare San Diego County regional fire spending directly against that of other counties requires that one look at the funding for all of these agencies.

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[16] San Diego Regional Fire Safety Forum; http://www.sdfiresafety.org/

[17] Welch, William M.; Report: San Diego failing at fire safety; USA Today; February 19, 2008; http://www.usatoday.com/weather/wildfires/2008-02-19-sandiego-fire_N.htm?csp=34

Also, the question arises as to what sort of effect any funding shortfall has on the number and size of power line fires. We can estimate this by looking at the effect it has on the number and size of ALL fires, not just power lines. If there is a severe lack of fire suppression capabilities in San Diego, we'd expect to see a greater number of sizeable fires, and we would expect the overall fire sizes to be larger.

2B-2.5.3. Methods

We first use County data to obtain rough funding amounts for the entire San Diego County back-country. We rely on a report issued by the San Diego Local Agency Formation Commission (LAFCO) as part of a County plan to unify the fire districts in the unincorporated areas of San Diego County into a county fire department[18,19]. This study estimates the combined funding for the unincorporated areas of San Diego County (which represent a large fraction of the area harboring flammable vegetation), and also presents county fire department funding for other comparable counties in Southern California.

To estimate what effect any funding shortfall has on fire suppression in San Diego, we once again make use of the Cal Fire fire perimeter history data for 1900 through 2006. For this analysis we restrict the fire date to dates after 1990, rather than 1960 as used in the previous analyses. Since organizations and funding tend to change with time, it was decided that it would be more appropriate to look at more recent data, which will represent the current situation more closely. Also, only fires over 100 acres were included in the study.

2B-2.5.4. Analysis

According to LAFCO Macro report[20], "There are 28 structural fire protection and emergency medical service providers within the unincorporated area." It goes on to state that these agencies received $47.1 in revenue during FY 2003-4.

The LAFCO Micro report calculated the fire and EMS funding for four counties which are similar to San Diego County in funding structure and which might be used as

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[18] San Diego Local Agency Formation Commission (LAFCO); MICRO REPORT; Reorganization of Structural Fire Protection and Emergency Medical Services in Unincorporated San Diego County; January 31, 2007. http://www.sdlafco.org/document/Fire_Micro_rpt.pdf

[19] San Diego Local Agency Formation Commission (LAFCO); MACRO REPORT; Options for Providing Structural Fire Protection and Emergency Medical Services in Unincorporated San Diego County; December 5, 2005. http://www.sdlafco.org/document/MACRO%20REPORT_wo_maps.pdf

[20] Ibid; p. 9.

models for San Diego as it restructures its fire protection services[21]. They are listed below by funding level.

County	**Funding**
San Bernardino	$134 M
Orange	$221 M
Riverside	$205 M
Sacramento	$149 M

Table 2B-6 – This table shows county funding levels derived from Table 11 of the LAFCO Micro report, and shows calculated funding levels for fire protection and EMS for four counties.

Even this table does not tell the entire story. All four of the counties listed – San Bernardino, Orange, Riverside, and Sacramento – have subsumed many of the incorporated cities into their county-wide fire departments. The $47 M estimation for San Diego County does not take into account incorporated cities in San Diego County which have their own fire department. Hence we expect the "real" fire protection funding level for San Diego County will be significantly larger than the $47 M estimation would indicate. A direct comparison of funding for ALL fire protection agencies has to our knowledge not been done. Hence we cannot see whether San Diego County fire suppression capabilities are hampered by a lack of funding – however they do not seem to be under-funded to the extent suggested by the press reports .

Apart from funding level, coordination between various fire agencies has been cited as a reason for the lack of effectiveness during major wildland fires. This was noted in a report on the 2003 fires issued jointly by the US Forest Service and the California Department of Forestry (now Cal Fire)[22], and has just been emphasized again in the wake of the October 2007 fires[23].

Another unique characteristic of San Diego from a firefighting standpoint is that it is at the southern end of California. Fire agencies in California participate in a mutual aid program in which resources are sent to the place they are needed most. As stated in the

[21] LAFCO Micro Report; pp. 41-42.

[22] United States Forest Service/California Department of Forestry (USFS/CDF). The 2003 San Diego county fire siege fire safety review; 2003; p. 6.

[23] San Diego Regional Fire Safety Forum; http://www.sdfiresafety.org/

USFS/CDF 2003 report: "The San Diego area is sometimes referred to as the 'California Cul-de-Sac'. Resources are often staged first for incidents in and around the Los Angeles basin, because Santa Ana wind events usually start in the Santa Clarita and El Cajon pass areas, and then move south. Resources can be (and often are) depleted by the time San Diego County requests them."[24]

Of course, if fire protection in San Diego County is significantly worse than elsewhere in Southern California, this should be evident in fire statistics. We turn again to the Cal Fire historical fire perimeter data, analyzed for all counties and contained in attached File 2B-1. This time only fires after 1990 are analyzed, since it is more likely then that fire agencies will have structures and capabilities more similar to those they have now within a more recent window of time. As before, only fires larger than 100 acres are included. Results are in columns AB-AG of the file, and are shown below:

County	Fires >1990	Area (acres)	Average	Median
Ventura	57	604,260	10601	820
Los Angeles	156	298,048	1911	321
San Bernardino	94	441,943	4702	555
Orange	20	62,589	3129	696
Riverside	188	384,812	2047	421
San Diego	131	692,482	5286	501

Table 2B-7 – Fire statistics between 1991 and 2006 for southwest California are shown.

It can be seen from the table above that San Diego has led in the amount of total acreage burned. It was demonstrated in section 2B-2.2, though, that San Diego has the most flammable vegetation of any county in southwest California, so this result would be expected with all else being equal. While San Diego does not have the largest average fire size – this honor belongs to Ventura County which has roughly double the average fire size of any other county (possibly due to the fact that much of it is rural, remote National Forest land) – San Diego still has a higher average fire size than any of the other four counties.

San Diego had the largest historical fire in California during this time window – the Cedar fire at nearly 270,000 acres, without which San Diego would have appeared

[24] USFS/CDF; p. 40.

similar to the other counties in terms of average fire size. Wildland fire sizes have been analyzed with models used in complexity theory such as self-organized criticality[25] and highly-optimized tolerance[26]. In such models, the statistics tend to be driven by rare, catastrophic events. Hence the statistical average, usually used as a means to smooth out statistical fluctuations, actually becomes more likely to capture an anomalous event and have a skewed result. Looking at the median instead provides a more "typical" result. It can be seen that the median fire size for San Diego County is well within the range of other counties. Hence there is no evidence that San Diego County fire suppression quality suffers as a result of San Diego's fire funding pathologies.

One event alone – the Cedar Fire – causes San Diego to have a high average fire size. To what extent problems in San Diego fire agencies were responsible for the size of this fire, or to which San Diego County was simply the unfortunate winner of the mega-fire lotto, has been discussed in many venues over the past five years. An interagency stakeholder workshop held in November 2003 to assess the fires concluded that interagency cooperation worked well during the 2003 fire siege[27], but that depletion of forces due to mutual aid had left San Diego understaffed with firefighters: "Drawdown levels were critical during the 2003 fire siege. The mutual aid system was broken."[28]

2B-2.5.5. Limitations

The funding levels for all fire protection agencies was not collected by San Diego's LAFCO study for any county except where these numbers were easy to obtain because all fire protection has been placed under a single umbrella agency. Hence, we really don't know how much is spent on fire protection in San Diego County versus anywhere else. Also, it is not clear how much would be spent on fire protection in the wildland urban interface and rural areas (where initial attack and suppression of wildland fires occurs) versus in urban areas.

2B-2.5.6. Conclusions

There is no evidence that the excess of power line fires in San Diego County has to do with the capabilities of its fire protection agencies. Examining fire history since 1960

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[25] Malamud, B. D., G. Morein, and D. L. Turcotte (1998), Forest fires: An example of self-organized critical behavior, Science, 281, 1840- 1842

[26] Moritz, Max A., et. al; Wildfires, complexity, and highly optimized tolerance; Proceedings of the National Academy of Sciences of the United States of America; December 13, 2005; vol. 102; 17913.

[27] USFS/CDF; Appendix A – Interagency Workshops; p. 2.

[28] Ibid; p. 4.

inclusive of all start types reveals that San Diego County is average in the number and size of wildland fires.

So in overall summary, there are no unambiguous reasons why we would expect to see more power line fires in San Diego County than in the other counties in the study area, both historically and during the recent fire siege. Weather may have played a role in making the October 2007 fires more damaging in San Diego than elsewhere, based upon predicted wind data from the National Climate Data Center. However, weather station data does not support this conclusion.

Implications for the Sunrise Powerlink project are that fire risk estimations must be based upon local conditions rather than generalizations based upon Southern California as a whole. It implies that the most predictive indicator of power line fire frequency in the SDG&E service area will be data from the SDG&E service area. New fire history data from SDG&E from 2007 is analyzed in Appendix D, and conclusions will be drawn from there. Another implication is the possibility that there could be one or more problems in SDG&E's engineering or maintenance practices, which if confirmed would imply that a more rigorous inspection and enforcement regime for SPL or any other proposed SDG&E transmission project might need to be implemented. These would add to the cost of the project.