BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

In the matter of the Application of San Diego Gas & Electric Company (U 902-E) for a Certificate of Public Convenience and Necessity for the Sunrise Powerlink Transmission Project	Application No. 06-08-010 (Filed August 4, 2006)

PHASE 1 DIRECT TESTIMONY OF THE

MUSSEY GRADE ROAD ALLIANCE

FIRE ANALYSIS – ECONOMIC IMPACTS

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1. INTRODUCTION AND TESTIMONY SUMMARY

Q. Please state your name, address, company and qualifications.

A. My name is Dr. Joseph W. Mitchell. I live at 19412 Kimball Valley Road, Ramona, CA 92065. I am the principal of M-bar Technologies and Consulting, also in Ramona, CA. My qualifications are provided in Appendix J[1] of this testimony.

Q. On whose behalf are you submitting this testimony?

A. I am submitting this testimony on behalf of the Mussey Grade Road Alliance.

Q. What is the purpose of your testimony?

A. The overall purpose of this Phase 1 testimony is to lay the foundation for, describe, and document the risk of wildland fire ignition with respect to San Diego Gas & Electric's (SDG&E) proposed Sunrise Powerlink Transmission Project (SPL) and to estimate the effects on the project in terms of the unanticipated costs of the SPL as a result of potential liability due to the ignition and consequences of wildland fire events.

Q. What is the summary of your testimony regarding the economics of the proposed Sunrise Powerlink Project?

A. The Mussey Grade Road Alliance's primary testimony is that, according to this analysis, negative public health and safety impacts as well as large unanticipated costs to the public, public lands, and ratepayers may occur due to one or more wildland fires accidentally ignited by normal operation and

[1] Attached as MGRA_Mbar_SPL_AppJ_CV.pdf

maintenance of San Diego Gas & Electric Company's (SDG&E) proposed Sunrise Powerlink Transmission Project (SPL) during the lifetime of the project. Ignition of fires during the lifetime of the project has been determined to be not unlikely, and the probability that these will be destructive fires causing significant damage is not small, though uncertainties in these estimates are large. These potential costs, weighted by likelihood, should be added to the cost/benefit analysis for this project.

Q. What is the scope of this testimony?

A. This testimony is intended to apply to any route that is considered as a potential route for the Sunrise Powerlink. Many of the analyses herein have been applied specifically to the original "preferred" route proposed by SDG&E, referred to as "the proposed route" in this testimony and supporting documentation. The methods and techniques used to gauge wildland fire risks that have been applied to this route should likewise be applied to any alternative route being considered as part of the EIR. These methods have been described in detail in the supporting documentation, and supporting data have also been provided as an example.

2. SUNRISE POWERLINK AND WILDAND FIRES

Q. What is the most likely scenario in which the proposed project would initiate a catastrophic wildland fire?

A. The conditions that lead to catastrophic power line fires are generally as follows:

1) A section of transmission line, tower, or other hardware is unusually vulnerable due to aging, material defects, assembly defects, poor maintenance, or exposure to unusually extreme conditions.

2) This section of transmission line, tower, or other hardware is also in the proximity of flammable vegetation.
3) Weather conditions with strong gusting winds and low humidity (i.e. 'Santa Ana' conditions) are present.
4) Stress from the wind causes a component failure.
5) The component failure causes arcing and the ejection of hot or flaming materials.
6) The hot or burning materials ignite the adjacent vegetation.
7) The fire is rapidly spread due to the high wind and low moisture conditions.
8) Remoteness of the site or the rapid growth of the fire foils initial firefighting response, and the fire grows to a large size.

3. SDG&E FIRE HISTORY

Q. Should the proposed project be expected to generate wildland fires?

A. Probably. Based on historical fire data collected by SDG&E, we predict a rate of one induced fire per 20 years along the 230 kV segment of the proposed SPL route, with a 90% confidence level of statistical uncertainty ranging from 1 per 200 years to 1 every 4 years. Under the hypothesis that the fire rates for 500 kV and 230 kV lines are expected to be the same, this rate increases to every 15 years, with the uncertainties adjusted by the same ratio.

Q. How were these probabilities determined?

A. The full analysis from which these numbers are derived can be found in Appendix B[2]. Fire data was provided to the Alliance by SDG&E for the period February 2004 to December 2006. Prior to 2004, SDG&E did not collect data on fire. This data was analyzed to determine a general rate of fires occurring due to

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[2] Attached as MGRA_Mbar_SPL_AppB_SDGEFire.pdf

or involving power lines. SDG&E has provided us with the lengths of transmission lines of various voltages within their network, and these can be used to determine a fire rate per mile of transmission line. These numbers can then be extrapolated for the proposed SPL project.

Q. Is detailed location information included in the data provided by SDG&E?

A. No, and according to SDG&E's response to data request MGRA-10, no such data exists. This is despite the following entry in the Power Line Fire Prevention Field Manual, of which SDG&E was a co-author[3]: "Critical to the prevention of fires caused by electrical power is knowing when and where they occur and building this information into a GIS database which is shared by the fire agencies and electric utilities for future models and projects."

Q. How many fires were recorded in the SDG&E records?

A. Eighty seven fires were recorded by SDG&E over a 35-month period.

Q. How large were these fires?

A. The majority of the fires were small, less than .1 acre. Total area burned by all fires was 352 acres.

Q. What characterized the largest fires?

A. Fires for which wind was recorded as a contributor were much larger than other fires, as indicated in Table B-1 in Appendix B, shown below:

[3] OSFM, CDF, USFS, PG&E, SC Edison, SDG&E; Power Line Fire Prevention Field Guide; Mar 27, 2001, p. 1-2

	No wind	**Wind**
Acres burned (total)	**52.1**	**300.3**
Number of fires	**80**	**7**
Average size (acres)	**0.65125**	**42.9**
Median size (acres)	**0.1**	**2**

It can be seen that both average and median fire sizes were much larger for the seven wind-related fires.

Q. Did any of these fires put lives or property at risk?

A. Yes. The Open fire of December 2006 near Santa Ysabel and not far from the proposed SPL route required an extremely aggressive and risky attack by firefighters to control it, reportedly described as "kamikaze" by one Division Chief who led the operation[4]. This was deemed necessary because of the very windy and dry conditions, and the proximity of the fires to 25,000 acres of unburned vegetation which would have carried the fire into the town of Ramona had it escaped initial attack.

Q. How many fires were caused by or related to transmission lines?

A. Nine fires were related to transmission lines in the 35-month period studied.

Q. How many miles of transmission lines are in the SDG&E service

[4] Jones, J. Harry and Kristina Davis; Downed power line blamed for morning blaze that burned almost 300 acres in Santa Ysabel; San-Diego Union Tribune; Dec. 1, 2006.

area?

A. According to SDG&E's response to data request MGRA-18, the length and type of transmission lines in their service area is given below:

Total transmission line lengths in the SDG&E service area:

69 kV	884.2 mi.
230 kV	387.1 mi.
500 kV	158.2 mi.

Q. What is the rate of fires per mile of transmission line?

A. This gives a raw rate of 3.1 fires per year. According the table, the total length of transmission lines in the SDG&E service area is 1,430 miles, yielding a fire probability rate of .0022 fires yr^{-1} mi^{-1}.

Q. What were the causes of the transmission line fires?

A. Causes of SDG&E transmission line failures are summarized in the table below. Details are summarized in Appendix B[5].

[5] Appendix B, Table B-3. Summary of transmission line fires.

Cause	**Events**	**Rate ($yr^{-1}mi^{-1}$)**
Human (maintenance, vandalism)	2	4.8e-4
Kites & balloons	3	7.2e-4
Equipment failure	2	4.8e-4
Wind-induced failure	2	4.8e-4

Q. How many of these fires were caused by 230 kV and 500 kV transmission lines?

A. One fire, a December 2006 fire at Camp Pendleton that burned three acres, was caused by a 230 kV downed line, with the cause given as wind. If this number of events is typical of the expected rate, then one would expect .0009 fires per year per mile from 230 kV transmission lines. Statistical uncertainties on this number give us a statistical 90% confidence interval of .00009 to .0043 events per mile per year. No fires were caused by 500 kV lines.

Q. How are uncertainties in rates be estimated?

A. This is more fully described in Appendix B[6]. Expected rates are determined by assuming that the observed number of events is equal to the expected rate. To determine confidence intervals, an expected rate is calculated that would yield the observed number or less 5% of the time according to a Poisson distribution, which is used for the statistics of small numbers. The same is

[6] Appendix B, Sec. 2.2.5. Transmission Line Fires / Limitations. Attached as MGRA_Mbar_SPL_AppB_SDGEFire.pdf

done at the opposite end of the distribution to get the lower range.

Q. Assuming that this fire rate is typical of that which would be expected for the SPL, how often might fires be expected?

A. Assuming a 54 mile 230 kV segment of the line, a rate of .05 per year, or one fire per 20 years, would be expected. Statistical uncertainties would range from 1 per 4 to 1 per 200 years, with the wide range arising from the low statistics. If the 500kV line has the same fault rate as the 230 kV line, then this number would be expected to be 1 per 15 years.

Q. What factors make SPL more or less likely to experience a significant fire than this estimate?

A. A large fraction of the SPL route, and the vast majority of the 230 kV segment, traverses highly flammable vegetation, while other transmission lines may be more concentrated more in developed areas of the County. This would INCREASE the relative fire risk for SPL.

If the fire season increases in length due to climate change as suggested by Westerling[7], this would INCREASE the number of fires expected.

If the path of the SPL is more exposed to extreme winds and Santa Ana conditions than other lines in the transmission network, this would INCREASE the number of fires expected[8].

If the period examined was unusually mild in the number of wind events experienced, this would INCREASE the number of fires expected.

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[7] Westerling, A. L., et al.; Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity; Science; v. 313; pp. 940-943; 18 Aug 2006

[8] See Appendices C and F.

One might reasonably expect that the remoteness of the line from population centers will DECREASE the probability of fires induced by kites or Mylar balloons.

Changes in construction materials and line components in the future can either DECREASE fire probability (through advances in technology) or INCREASE fire probability (through use of less expensive materials with potentially higher defect rates to reduce operating costs).

Q. How would including the 500 kV line segment change these estimates?

A. Only about 20 miles of the 500 kV line segment traverse significantly hazardous vegetation. If we were to assume that the fault rate for 500 kV lines is the same as that for 230 kV lines, this would increase the expected rate to 1 every 15 years.

4. WIND AND TRANSMISSION LINE OUTAGES

Q. Is the period for which SDG&E has been collecting fire data typical regarding extreme wind events?

A. No. In response to data requests MGRA-17 and MGRA-32, SDG&E has provided an outage history for lines of 69 kV or higher. This response was analyzed in Appendix A[9], and compared against wind data. This analysis indicates that wind events causing multiple outages were observed in 2002-2003, but none have been observed since.

Q. How do we know which outages are caused by wind?

[9] Appendix A – Power line Outages and Wind

A. SDG&E characterizes each outage with a cause, if the cause is known, or specifies it as "Undetermined" if no cause has been found. "Wind" is given as a cause for line outages.

Q. How many wind-caused outages were observed?

A. Fourteen wind events were observed over 9 years, causing a total of 126 outages. Six of these events attributed to wind caused a single outage; two caused a double outage, while the remaining 6 events were responsible for the 117 remaining outages. Of these, two events were responsible for a majority of the outages.

A wind storm from 2/9/02 to 2/10/02 caused 51 outages, and one on 3/29/03 was responsible for 42 outages.

Q. Can wind cause catastrophic failure of 230 kV or 500 kV towers?

A. Yes. Over the past year, there have been two catastrophic failures of high-tension towers in California, one in the SCE[10] and one in the PGE[11] service areas. The SCE tower was a 500 kV tower. Both of these failures were reportedly caused by high winds.

Q. How is the severity of wind events determined?

A. As described in Appendix A[12], historical data was analyzed for three weather stations around the County, and this was compared to line outage data. The maximum gust speed within 12 hours of the outage time (or outage window

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[10] Queen, Rolla; Weather Topples Powerline Tower; BLM California; News Bytes; 238; July 5, 2006; available at http://www.blm.gov/ca/news/newsbytes/xtra-06/238-xtra_tower.html

[11] Manekin, Michael; PG&E Tower Topples in Redwood City; Oakland Tribune; Dec. 28, 2006; available at http://www.builderonline.com/industry-news.asp?sectionID=96&articleID=415186

[12] Appendix A – Section A2.1.4

for multiple outages) was used. Two metrics were obtained: in one, the maximum gust speed for the three stations was averaged, and in the other the maximum was recorded.

Q. What stations were used, and how were these determined?

A. Stations were selected based upon good historical quality of data and the wide geographic dispersal. Stations at Julian, Potrero, and Camp Pendleton were chosen. These are displayed as AMO, POT, and JUL in the map in Figure A-1[13].

Q. How does the weather station data characterize the SDG&E wind outages?

A. For the 14 wind events categorized by SDG&E, good weather station data was available for eight of them. Of these eight events, five were correlated with dry "Santa Ana" conditions, including the two largest events responsible for most outages. The remaining three events were wet winter storms. One dramatic result is shown in Figure A-2[14]. This demonstrates that the number of outage events shows a distinct correlation with the wind gust metrics above, with a somewhat better correlation for the average rather than the maximum. This correlation, as characterized by the average, shows a threshold wind speed at around 30 mph before outages begin to appear, with a very rapid rise up to the maximum of 49 mph measured, which produced the 51 outage event. The trend for the maximum is similar, but shifted upwards by 5 mph or so. A very approximate parameterization of this relationship by a power law would have the equation $N = (S - 29mph)^{1.5}$, where S is the wind speed in mph and N is the number of outages.

Q. Are the SDG&E characterizations of wind-induced outages accurate?

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[13] Appendix A, p. 5
[14] Appendix A, p. 7

A. With two exceptions, SDG&E has characterized all wind events leading to line outages correctly and completely. This was determined by examining clusters of outages which were not classified as wind-induced and for which the cause was not well determined. One of these correlated with a wind event as determined by weather station data. All outage data was also examined for 230 kV and 500 kV lines, which showed no excess outages during SDG&E reported wind events. Only one event was observed, and this was the one causing the Camp Pendleton fire of December 2006. Weather station data classifies this event as having borderline significance, but the fire record from SDG&E classifies it as a wind event.

Q. How do wind-induced faults and outages relate to fires?

A. According to the Power Line Fire Prevention Field Guide[15], line separation or materials coming in contact with the line and causing faults are likely to cause arcing and the ejection of hot or burning materials. While safety measures are taken to prevent this occurrence, SDG&E does not maintain that these are adequate to prevent arcing, as they state in their response to data request MGRA-9. The Power Line Field Guide also notes that fires caused by power lines tend to be particularly dangerous because the same wind that causes the fault and ignition to occur will make it more likely that a large fire will be produced.

5. WIND AND WILDLAND FIRES

Q. What is the relationship between wind and wildland fires?

A. It is widely acknowledged that winds, particularly the dry easterly 'Santa Ana' winds of Southern California cause rapid spread of fires through wildland

[15] OSFM, CDF, USFS, PG&E, SC Edison, SDG&E; Power Line Fire Prevention Field Guide; Mar 27, 2001

fuels. These usually occur in the autumn and winter, after the long dry season has desiccated vegetation. They are initiated by a high pressure system over the western US and a low pressure system off of the coast. This causes an easterly wind, and as this wind drops from the high plateaus and mountains it is compressed and heated, further lowering the humidity. It is further accelerated as it is funneled through valleys.

Moritz[16] has analyzed the relationship between extreme weather events and the size of wildland fires in the Los Padres National Forest, which is characterized by chaparral communities. He finds that "Comparing distributions of an index for severity of Santa Ana conditions (i.e., characterized by hot, dry winds) and extreme fire events in the Main Division [of the National Forest] indicated a convergence of distributions with increasing event size. The distribution of fire events larger than >4000 ha appears to be coupled with that of severe Santa Ana conditions, suggesting a strong climatic forcing for extreme fires and a threshold for the transition from small- to large-fire dynamics."

Q. What is the impact of large fires compared to that of small fires?

A. Large, catastrophic wildland fires are responsible for the vast majority of area burned, and for number of homes lost. The change wrought by wildland fire is predominated by rare large events, rather than the accumulation of change by many smaller events. For instance, the 2003 Cedar fire burned more homes than the U.S. total wildland fire losses for 1999-2002 combined[17]. This sort of relationship is preserved as one looks at shorter time scales as well.

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[16] Moritz, M. A.;ANALYZING EXTREME DISTURBANCE EVENTS: FIRE IN LOS PADRES NATIONAL FOREST; (1997) Ecol. Appl. 7, 1252–1262

[17] Mitchell, Joseph W.; Wind-enabled ember dousing; Fire Safety Journal; Volume 41, Issue 6, September 2006, Pages 444-458

Q. Are the reasons for this relationship between large and small fires understood?

A. Probably. Classes of models coming out of complexity theory suggest that power- law relationships dominated by large events will dominate statistics. In the theory of 'self-organized criticality', a model suggested for forest fires was found to actually match the measured distribution of forest fire sizes[18]. More recently another class of models based on the theory of "Highly Optimized Tolerance" was used by Moritz and others to compare against fire sizes in the Los Padres National Forest[19]. These were also compared against a deterministic fire spread model which used randomly generated fire starting points to predict a size distribution. The models assumed that the trigger occurred during a four-day Santa Ana event, and that there was an attempt at fire suppression. The researchers found an extremely close match in the fire size distributions between the model from complexity theory, the model from fire modeling, and the actual fire size data from the Los Padres National Forest. What this implies is that large catastrophic fires can be expected to dominate economic and ecological losses based upon relatively simple assumptions which include the presence of strong dry wind conditions. These are described in more detail in Appendix C[20].

Q. What is the relation between catastrophic wind-driven fires and economic loss through the destruction of homes and businesses?

A. Catastrophic, wind-driven fires are especially destructive because they are responsible for the mass transport of burning embers or firebrands. These are now

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

[19] 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

[20] Appendix C – Wind and Large Wildland Fires

widely acknowledged to be a primary cause of structure ignition. The literature backing this assertion is reviewed in Appendix C, section 2.3[21]. Briefly, small bits of burning vegetation are driven by wind into nooks and crannies in the structure, or ignite flammable materials next to the structure, even if there is separation between the structure and primary fuels. Eaves, window sills, attic vents, and under roof tiles have all been observed to be ignition points[22,23,24,25]. Once the structure ignites, it is very likely to burn down unless the fire is immediately suppressed, leading to economic loss.

Q. Is there a relationship between the largest fires observed in California and strong, dry winds?

A. Yes. All of the historically largest fires in terms of structure loss and economic damage were wind-driven catastrophic wildfires. Halsey[26] has prepared a table of the thirteen largest fires in California in terms of structure loss and area burned. Every one of them occurred under conditions of strong dry winds.

Q. How do catastrophic wind-driven fires affect public health and safety?

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[21] Appendix C – Sec. 2.3

[22] Ramsay, G.C., McArthur, N.A. & Dowling, V.P.; Preliminary results from an examination of house survival in the 16 February 1983 bushfires in Australia. Fire and Materials, 11 (1987) 49

[23] FOOTE, E.I.D.; 1994; Structure survival on the 1990 Santa Barbara "Paint" fire: A retrospective study of urban-wildland interface fire hazard mitigation factors. MS thesis, University of California at Berkeley

[24] Cohen, Jack D. 2000. Preventing disaster: home ignitability in the wildland-urban interface. Journal of Forestry 98(3): 15-21

[25] Mitchell, Joseph W. and Oren Patashnik; Firebrand Protection as the Key Design Element for Structure Survival during Catastrophic Wildland Fires; Fire and Materials 2007, San Francisco, Jan. 2007. Available at: http://www.mbartek.com/FM07_FirebrandsWildfires_1.1F.pdf

[26] Halsey, Richard W; Fire, Chaparral, and Survival in Southern California; Sunbelt Publications; San Diego; 2005, p. 49

A. The vast majority of deaths and injuries that occur from wildland fire occur in catastrophic wind-driven fires[27]. The rapid movement and expansion of the fire front in combination with the large number of homes simultaneously threatened results in short evacuation notice or none at all. Dense smoke carried ahead of the front reduces visibility and causes accidents, while restricted egress from rural neighborhoods slows traffic. Most deaths and injuries occur during evacuation[28].

6. POWER LINE FIRES

Q. How many of California's largest and most destructive fires were caused by power lines?

A. This question is analyzed in Appendix D[29]. In this, we review data available from the CDF in which they tally the 20 largest and the 20 most destructive fires in recorded California history. This tally shows that three out of the twenty largest wildland fires were caused by power lines:

#	Name	Date	County	Acres	Structures	Deaths
3	LAGUNA	Sept. 1970	SAN DIEGO	175,425	382	5
8	CAMPBELL CPX.	Aug. 1990	TEHAMA	125,892	27	0
12	CLAMPITT	Sept. 1970	LOS ANGELES	105,212	86	4

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[27] Ibid.
[28] Webster, Joan; The complete bushfire safety handbook; Random House, Sydney; 2000; p. 214
[29] Attached as MGRA_Mbar_SPL_AppD_Power lineFires.pdf; Appendix D, Sec. 2.1

Likewise, three of out of the twenty fires causing the greatest loss of structures were due to power line fires:

#	Name	Date	County	Acres	Structures	Deaths
7	BERKELEY	Sept. 1923	ALAMEDA	130	584	0
10	LAGUNA	Sept. 1970	SAN DIEGO	175,425	382	5
15	SYCAMORE	July 1977	SANTA BARB	805	234	0

Data source references can be found in Appendix D[30].

Q. What fraction of all fires in California is started by power lines?

A. Between 2000 and 2005, the CDF reports that roughly 3% of all fires were started by power lines. Data reference can be found in Appendix D[31].

Q. What is the probability that the observation of three events out of twenty (15%) is a random fluctuation of the 3% expected fire rate due to power lines?

A. This is calculated in Appendix D[32]. The probability that the observed number of largest fires would randomly end up with three being caused by power lines is 2%. This is likewise true for the three power line fires in the group of twenty largest home losses.

Q. What does the discrepancy between the expected number of power line fires in the list of largest and most destructive fires and the expected rate imply?

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[30] Appendix D, Section 1
[31] Appendix D, Section 1.2
[32] Appendix D, Section 2.1

A. One likely explanation is that there is a common element that causes power line fires and also causes fires to be larger. As shown in previous sections, this element is asserted to be wind.

Q. What is the fraction of wildland fires due to power line incidents in San Diego County?

A. This analysis is shown in Appendix D[33]. The CDF offers fire perimeter data for fires between 1910 and 2005 as GIS data available for download. Only data on fires greater than 50 acres or responsible for damage is included. Data associated with these perimeters, such as their date and cause, are also collected. These data were extracted into a spreadsheet so that statistics could be performed on them.

Total number of fires in the sample is 1,354. Of these, only seven were listed as power line fires, corresponding to 0.5%. Restricting the sample to after 1960, as the development of San Diego commenced, reduces the total number of fires to 759. All of the power line fires occurred in the post-1960 time frame, leading to a rate of 0.9%.

Q. Why would there be fewer power line fires in San Diego County?

A. A likely reason that the rate of power line fires in San Diego County would be less than that elsewhere in California is the predominance of chaparral fuel types. Most power line fires are due to tree-power line contact, which is not as serious of an issue in San Diego due to the comparative scarcity of trees.

Q. How damaging were power line fires in San Diego?

[33] Appendix D, Sec. 2.2 - Power line fires in San Diego, 1910-2005

A. Power line fires in San Diego County have been extremely damaging, burning a total of 17% of the area burned since 1960.

The power line fires are listed below:

YEAR	FIRE	ACRES
1970	LAGUNA	174158
1993	GUEJIUTO	17819
1997	LAUREL	702
1996	PALA	467
1999	STEWARD (MAIN)	33.4
2002	PINES	61690
2005	MILLER	19.7

The perimeters of these fires are shown in Figure D-3[34].

Both average and median fire sizes were calculated for both power line fires and for the full post-1960 data set. These and their ratios are shown below:

	Fires since 1960	**Power line Fires**	**Ratio**
Number of fires	759	7	.0092
Acres burned	1,460,000	255,112	.17
Average fire size	1,924	36,445	19
Median fire size	149	711	4.8

[34] Appendix D, p. 9

Examination of historical data reveals that while power line-related fires have been fairly rare in San Diego County, constituting less that one percent of all fires, they have been extremely destructive, burning 17% of all the area burned during this period. This supports the hypothesis that the increased likelihood of power line faults during wind events will make it more likely that power line fires are large, wind-driven fires. Average fire sizes for power line fires have been around 20 times larger than for all fires, while the median fire size has been roughly five times as large, with the discrepancy caused by the fact that fire statistics tend to be driven by the largest catastrophic events.

Q. What factors might lead to greater or lesser risk of wildland fires than would be indicated in the preceding analysis?

A. Historical data will be based upon fewer power lines in operation. This factor would suggest that the real risk values are HIGHER than those indicated above.

The fact that the proposed route passes through flammable vegetation for a considerable portion of its path would INCREASE risk.

The fact that SPL traverses particularly windy areas of the County would INCREASE risk.

Current population growth trends that INCREASE the number of power lines and possible impacts of climate change will be effects that will tend to INCREASE this risk and therefore the number of future power line fires.

7. FUEL LOAD HAZARD ALONG THE SUNRISE POWERLINK ROUTE

Q. What means are available to characterize the vegetation along the SPL route, and which were chosen?

A. This analysis is performed in Appendix E[35]. Three means of determining wildland fire threat from fuels were used. Two of these were based upon fuel hazard metrics available from CDF through their FRAP service. Another was a vegetation model (Scott-Burgan) available from the USGS/USFS/BLM LANDFIRE project. These reference data are described in Appendix E[36].

Two allow a quantitative analysis of the SPL route, it was divided into 1 km segments and the vegetation type and hazard along each segment was calculated. This type of route hazard analysis is extremely useful, because it allows the correlation in space of various hazard factors that affect each other for fire risk estimates (for instance, wind and vegetation). <u>Data in the EIR should be provided to the public in this format, since it does not require GIS software for manipulation.</u> For comparison, the route of the Southwest Powerlink (SWPL) is also analyzed, since part of the justification used for an alternative route for SPL by SDG&E is that the existing SWPL is excessively fire-prone. This file has been attached to Appendix E as Route_Analysis_SPL_1.1.xls[37]. An example of this type of analysis can be seen in Figure E-1[38]. One note to emphasize is that vegetation types and fuel exposures are very mixed on the scale of 1 km, so the algorithm used to select a ranking is consisted of choosing the most hazardous fuel, threat, or vegetation ranking with significant line exposure (more than about 10% of the kilometer span).

Fuel Rank was one of the datasets supplied by CDF, and it takes into account both the vegetation type and the slope to calculate the relative intensity of a fire using the following scale: -1 = Non-Fuel, 1 = Moderate, 2 = High, 3 = Very High. This scale projected onto San Diego County and showing the proposed SPL and the

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[35] Attached as MGRA_Mbar_SPL_AppE_Vegetation.pdf
[36] Appendix E, Section 1
[37] Attached as RouteAnalysis_1.1.xls. Original Excel file available upon request from MGRA.
[38] Appendix E, p. 7

SWPL routes is shown in Figure E-2[39]. One problem with the CDF Fuel Rank, aside from the coarse scale, is the fact that it is based on a 2004 survey in the immediate aftermath of the 2003 fires – Cedar, Paradise, and Otay, and the 2002 Pines fire. This creates a zone of reduced fuel load within the footprints of these fires, as shown in Figure E-4[40]. While this may be true now, it will be much less so in the near future as the vegetation regenerates, and this is the time period of interest for the proposed project. Hence, the CDF Fuel Rank, or any other analysis using it, is not the best predictor of the fuel load to be expected during the 40 year lifetime of the project.

An alternative is the CDF Fire Threat ranking, which incorporates the Fuel Rank and then also takes into account the mean fire recurrence time, which CDF has calculated based on historical fire data. This has the added advantage of taking ignition sources into account. The scale is as follows:

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

[39] Appendix E, p. 9
[40] Appendix E, p. 11

This metric as applied to San Diego County and the proposed and existing power line route is shown in Figure E-5[41].

Finally, vegetation analysis for the LANDFIRE project has just been completed for California, and all areas have been analyzed according to the Scott & Burgan[42] vegetation model. These vegetation types are classified as to expected fire behavior. They are shown for San Diego County and the proposed SPL and existing SWPL route in Figure E-7[43]. As the data is very fine grained, it is difficult to translate it into a form directly comparable to the other models. To aid in this, the fuel models were all ranked as to what their expected flame lengths would be for a 10 mph wind and vegetation with low moisture levels. These flame lengths are tabulated in Table E-3[44]. A second step was to divide these into four classes 0 = non-burnable, 1 = low (<5'), 2 = medium (5 ≤ 15') and 3 = high (≥ 15'). This allows direct comparison with the other coarse-grained CDF models.

Q. How much of the SPL route is exposed to flammable vegetation, and how does this compare to the existing SWPL route?

A. Line distances for SPL proposed and SWPL routes which pass through each CDF Fuel Rank zone are shown in Figure E-3[45]. The results of these histograms are tallied below:

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[41] Appendix E, p. 13

[42] Scott, Joe H.; Burgan, Robert E. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model; Gen. Tech. Rep. RMRS-GTR-153; Fort Collins, CO; U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station

[43] Appendix E, p. 16

[44] Appendix E, p. 17

[45] Appendix E, p. 10

CDF Fuel Rank	**SPL Proposed (km)**	**SWPL (km)**
Fuel rank ≥ 1 (moderate)	234	133
Fuel rank ≥ 2 (high)	116	95
Fuel rank =3 (very high)	27	34

The distance which the proposed SPL and existing SWPL routes traverse each Fire Threat zone are shown in histograms in Figure E-6[46], respectively. These results are summarized in the table below:

CDF Fire Threat Rank	**SPL Proposed (km)**	**SWPL (km)**
Fire Threat ≥ 1 (moderate)	234	132
Fire Threat ≥ 2 (high)	109	95
Fire Threat ≥ 3 (very high)	68	88
Fire Threat = 4 (extreme)	20	14

The distance which the proposed SPL and SWPL routes traverse the reduced Scott-Burgan vegetation regimes is shown in the histograms in Figure E-8[47]. These results are summarized in the table below:

[46] Appendix E, p. 14
[47] Appendix E, p. 18

Scott-Burgan Vegetation	SPL Proposed (km)	SWPL (km)
SB Veg. Class ≥ 1 (0-5')	147	107
SB Veg. Class ≥ 2 (5-15')	137	83
SB Veg. Class = 3 (>15')	43	45

Comparison of the proposed SPL route and the SWPL line and their respective exposure to ignition-prone vegetation once again displays that the SPL route has a considerably longer exposure (50-60%) to moderately to highly flammable vegetation than the existing SWPL route. In its proposal for this route, SDG&E uses the fire-prone condition of the SWPL corridor as motivation for selecting another route for SPL. What this analysis shows is that the preferred SPL corridor may be expected to have an equivalent or greater exposure to fire danger due to its longer path length, much of which spans flammable vegetation.

The three metrics examined – CDF Fuel Rank, CDF Fire Threat, and Scott-Burgan Vegetation, all indicate that the SPL route traverses a longer path (150-240 km, 50-100% more than SWPL) of significant fire risk than SWPL, while they are roughly equivalent in the 20-40 km span of extremely hazardous area that they span. The exposure to wildfire faced by San Diego County will be increased by the degree to which these lines present an ignition source. From this standpoint, we can conclude that the proposed SPL route presents a greater risk of starting a wildland fire than does the existing SWPL route.

Q. How do the line exposures of the proposed SPL route and SWPL compare to those of the rest of the SDG&E transmission network?

A. It is not possible to calculate this value because SDG&E has refused to supply data on the remainder of its transmission network, citing security concerns[48]. The applicant should be directed to conduct a comparison of the vegetation and fuel exposure of its proposed route with that of the rest of its transmission network so that outage and fire rates can be appropriately scaled from the existing network. This work should be conducted as part of the EIR.

8. WIND EXPOSURE OF POTENTIAL SPL ROUTES

Q. Are locations in San Diego County equally vulnerable to Santa Ana wind events?

A. No. Analysis of data from RAWS weather stations going back to 2002 reveals that some locations in San Diego County experience Santa Ana wind conditions more strongly than others[49]. Some areas experience stronger winds, while some are more likely to exhibit low humidity conditions. Results are summarized in the table below, for number of hours per year that wind speeds greater than 30 miles per hour are experienced:

RAWS Weather Station	2006	2005	2004	2003	2002
Potrero	164/164	76/31	89/46	--	--
Goose Valley	14/14	5/2	5/5	48/41	32/27

[48] SDG&E responses to data requests MGRA-3, MGRA-4, and MGRA-39.
[49] Appendix F, Section F2.1

Julian	290/65	65/0	--	--	--
Ranchita	411/12	476/6	522/26	686/31	514/61

The Goose Valley weather station is to the north-east of Ramona. The numbers to the left side of the forward slash are the total number of hours measured with gust speeds in excess of 30 mph, while the right side matches the same condition with the additional requirement that humidity be less than 20%, thus characterizing "Santa Ana" wind conditions.

Q. What fractions of time do given locations spend under "Santa Ana" conditions?

A. In order to determine these numbers, the values in the above table are divided by the number of "live" hours for each weather station. Doing so produces the following result:

	2006	**2005**	**2004**	**2003**	**2002**
Potrero	0.0194	0.00368	0.00559	--	--
Goose Valley	0.00204	0.000291	0.000589	0.00491	.00321
Julian	0.00769	0.0	--	--	--
Ranchita	.00141	0.000716	0.00305	0.00366	0.00791

Hence, over all years and stations, the fraction of time spent under "Santa Ana" conditions can vary from .05 - .8%, making these uncommon events from a statistical standpoint.

Q. Why is the weather station data incomplete?

A. Because this data had to be extracted manually, there was insufficient time to extract all relevant data. Santa Ana wind data for all weather stations relevant to proposed routes should be extracted and entered as part of the EIR.

Q. How can the values in the table above be related to proposed SPL route?

A. The Julian and Ranchita stations are particularly close to the proposed SPL route. However further interpolation between these stations can be done using computer modeling. Computer models, in the form of digital forecasts for the immediate future, are available from the National Weather Service, and have been available to the public since 2006.

This method has been evaluated in Appendix F[50], by comparing RAWS weather station data with the digital forecast and was found to be applicable. Some stations, such as Julian, Potrero, and Ammo Dump, were found to have weather data that was correlated, albeit broadly, with the predicted values from the digital forecast. Other stations, such as Goose Valley and Ranchita, did not correlate well, either because the model was inaccurate in their locales or because the specific station locations were not typical of the 5 km grid element in which the model placed them.

In order to characterize any SPL proposed route, the following should be undertaiken in the EIR:

[50] Appendix F, Sec. 2.2

1) More computer data from Santa Ana events should be collected using the method specified in Appendix F[51].

2) These data, in map format (such as Figure F-2[52]) should have their maximum values averaged to create an "average" Santa Ana threat map.

3) The wind values should be added to the Route Hazard Analysis grid, so that they can be correlated with vegetation.

Q. What are the characteristics of typical wind distributions during a Santa Ana wind event?

A. During a typical Santa Ana wind event, an example of which is shown in Figure F-2, there is a band of high winds stretching from north to south through the center of San Diego County, with the highest winds in the central mountainous regions. Within this band there are two concentrations of exceptionally high winds, one of which occurs near Julian in the north and the other near Potrero and Campo in the south. These affect both the SPL proposed route and the SWPL route.

9. EFFECT OF SANTA ANA WINDS ON SUCCESS OF FIRE SUPPRESSION

Q. What is the success rate of fire service initial attack in controlling fires before they become major fires?

A. Data from the CDF (now Calfire) ignition database was obtained[53]. Data records for 941 fires between 2003 and 2006 were analyzed. It was found that 97.8% of fires were controlled before they reached 100 acres in size, while 91.5% of fires were controlled before they reached 10 acres in size.

[51] Attached as MGRA_Mbar_SPL_AppF_SAWind.pdf
[52] Appendix F, p. 10
[53] Section F2.3

Q. How do Santa Ana wind conditions affect the probability of successful fire service initial attack?

A. By comparing the ignition data with weather station data, it has been shown that all major fires larger than 100 acres occurred when the nearest weather station measured gusts of 30 mph or more. Fourteen fires were ignited under these conditions. Of these, 5 events were larger than 100 acres and 6 events were larger than 10 acres, corresponding to approximate attack success rates of 64% and 57%, respectively.

Q. What is the expected occurrence rate, based on the estimates made on page 6, of a large fire from SPL that escapes initial attack by firefighters?

A. The rate was estimated at one per 15-20 years (4 year – 200 year 90% confidence level) for the occurrence of a fire. Assuming that a fire would start when wind gusts speeds are in excess of 30 mph, the predicted large fire rate would be one every 42 to 56 years. The uncertainty range would be relatively broader because of the uncertainty in regard to the initial attack success rate.

Q. Are there other methods that can be used to obtain estimates of fire rates?

A. Yes, there are other methods which can be used for this estimation. Five of these are listed in Appendix F, Section 2.5, and others may be devised. Assuming that all transmission lines have equal fire rates would yield a recurrence rate of 79 years (40% probability of a significant fire in 40 years). Prediction using CDF fire histories going back longer in time, but having no transmission line history, yields a recurrence rate of 217 years if ad-hoc assumptions are made about the growth of the transmission network. These same assumptions lead to a lower limit on the recurrence time due to the fact that no significant historical transmission line fires have been observed. Asserting that the fault rate ratios between 69 kV and 230 kV lines are indicative of fire start rates leads to a reduction in the predicted rate by a factor of 2.8, giving a recurrence rate of 220 years (18% probability of a significant fire in 40 years).

Q. What is the preferred method for calculation?

A. The preferred method of calculations uses the fewest unproven assumptions to calculate the predicted fire recurrence times. Basic assumptions inform all predicted fire rates, as shown in Appendix F, Table F-3[54], however some of these assumptions are more ad-hoc than others. In particular, the growth of the transmission and distribution networks over time is critical to using historical data, and this should be included in the EIR. Another ad-hoc assumption would be to assume that fire starts scale with fault rates, since the higher energy of faults on higher voltage lines could lead to a greater fire start rate. The simplest calculation remains to take the well-measured recent data as indicative of future fire rates, and this remains the preferred calculation. If the data on the historical growth of distribution and transmission lines is obtained, this should be used to recalculate likelihoods combining the historical and recent data sets. This should be done in the EIR.

Therefore, I recommend that the primary calculation be used as the basis for future prediction until such data is obtained and analysis done. The validity of all assumptions should be examined within the scope of the EIR, in order to choose the best and most predictive model.

Q. What is the significance of the various calculations, their similarities and differences?

Despite the broad range of obtained values, they are not outside of the range of

[54] Appendix F, p. 25

variation stated for the original calculation. The initial assumptions chosen to perform the primary risk calculations in Appendix B and in section 2.4 of this appendix were those that used known data, made the fewest assumptions and used the simplest models.

All these predictive analyses assume that SPL would be no more or less likely to start a fire than other line in the network. However, much of the work in the accompanying appendices indicates that it is unusually exposed to conditions that create a fire hazard.

Notably, ALL of these methods (aside from the limit in Appendix F, section 2.5.4.3) imply that there is a significant foreseeable risk of wildland fire being caused by the Sunrise Powerlink during its estimated lifetime, even when ignoring the particular but very significant hazards of the proposed route and alternatives. Hence, it follows that economic impacts of such fires need to be calculated.

10. LIABILITY DUE TO LOSSES FROM POWER LINE FIRES

Q. Might SDG&E be held liable for damages caused by fires started by power lines or other equipment?

A. Yes. Appendix G[55] lists statute and case law that may be relevant to power line fire cases. Among the statutes are:

CACI 416

"AMOUNT OF CAUTION REQUIRED IN TRANSMITTING ELECTRIC POWER

[55] Attached as MGRA_Mbar_SPL_AppG_Liability.pdf

People and companies must be very careful in constructing, insulating, inspecting, maintaining, and repairing power lines and transmission equipment at all places where it is reasonably probable that they will cause harm to persons or property."

<u>Cal Health & Safety Code § 13007</u>

"Any person who personally or through another willfully, negligently or in violation of law, set fire to, allows fire to be set to, or allows a fire kindled or attended by him to escape to, the property of another, whether privately or publicly owned, is liable to the owner of such property for any damages to the property caused by the fire."

The following cases have been found to be relevant in power line fire cases:

<u>Lozano v. PG&E Co.</u>, 70 CA.2d 415(1945)

"The duty of due care with which the company was charged consists not only in the proper installation of the dangerous instrumentality but in the maintenance thereof in a safe condition at all times and places and under the changing circumstances of the particular case. Even if at the outset of the installation of the equipment the company may have been entirely free from fault, yet, if under changing circumstances, a hazardous condition arose, nonaction or the failure to remedy such condition would constitute culpable negligence. (Cites)" (P.423)"

<u>Ireland-Yuba Gold Quartz Mining Co., v. PG&E</u>, (1941) 18 C.2d 557.

"It is not unreasonable to require Appellant to anticipate that with high winds usually blowing in the vicinity in which the fire occurred, the tree might fall across and break one of the wires. Under the circumstances here presented, Appellant was bound to anticipate the existence of a wind even of high velocity where such winds were not unusual. (Cite)". (P.565). – This indicates duty to consider wind conditions.

Beresford v. PG&E (1955) 45 C.2d 738

“. . . if, under changing circumstances, a hazardous condition arose, nonaction or the failure to remedy such condition would constitute culpable negligence. (Cite).” (P.746)”

“. . . not unreasonable to require the power company to anticipate that during a high wind a tree might fall across high voltage lines and result in a fire.”

Q. Can additional damages be levied against SDG&E above and beyond those caused by a fire?

A. Yes. Two theories supporting additional damages have been used in power line fire cases. The first is the theory of trespass, which allows the assessment of double or triple damages to the plaintiff, as well as the awarding of attorney fees. The theory of trespass in regard to fire is supported by the following case:

Elton v. Anheuser Busch etc. (1996) 50 CA.4th 1301

“It would be difficult to justify a distinction between damage caused by the thermal energy of a fire and that caused by the kinetic energy of vibrations. Certainly, a fire presents a potential for damage and destruction which is at least as great as that presented by vibrations. When negligently inflicted with resulting actual damage, either way constitute a trespass. Since it is undisputed that the fire in this instance cause actual damage to the Plaintiff’s property and since the jury expressly found that those damages were caused by the Defendant’s negligence, the invasion of the fire onto Plaintiff’s property constituted a trespass.” (P.1307) Another theory that can be used to support double or triple damage assessment is the theory of inverse condemnation, which is used in the event that private property is condemned by a public agency without due process. Because of their power of condemnation, utilities have been held to be public agencies in regard to their liability. This is supported by the following case:

<u>Barham v. So. Cal. Edison</u>, (1999) 74 CA.4th 744
“ . . . SCE may be liable in inverse condemnation as a public entity. Further, Art. 1 § 19 of the California Constitution and the cases which interpret and apply it have as their principal focus the concept of public use, as opposed to the nature of the entity appropriating the property.” (P.753)
“Rather, the issue is whether the Barham’s property was taken for a public use, i.e., the transmission of the electric power to the public. The evidence reflects the circuit of which the subject pole and transmission wires were a part, provides electric service to more than 1000 households. Based upon the above cited authority, we must conclude that the transmission of electric power through the facilities (i.e. broken electric line) that caused damage to the Barham’s property was for the benefit of the public . . . Thus the Barham’s property was ‘taken or damaged’ for a public use.” (P.754)
It has also been held in the following case that public agencies may also invoke inverse condemnation against other public agencies:
<u>Marin Mun. Water Dist. v. City of Mill Valley</u> (1988) 202 Cal App 3rd 1161.

Q. Can these damages be passed on to SDG&E ratepayers?
A. Yes, partially or fully.
In one regard, since the proposed SPL route runs through the SDG&E service area, it is likely that property damage accrued by any fire started as a result of the SPL will be incurred by SDG&E customers, regardless of whether SDG&E is held liable for the fire. Hence, damages should be incorporated into rate payer benefit calculations.

In the case that SDG&E is found liable, according to its reply to data request MGRA-28, it may pass on some costs:

"SDG&E maintains a significant self-insured retention for third party liability insurance. Disaster costs within the self-insured retention are paid for by transmission customers. Commercial insurance for third party liability arising out of disasters and/or emergencies is purchased above the self-insured retention."

Hence, ratepayers will need to refresh the self-insured retention. They also help pay the premiums for the commercial third party liability insurance. In the event of a major fire event due to either SDG&E negligence *or that of another insured utility*, insurance rates may be substantially increased, or insurance on the current terms might no longer be available. It is probable that these added costs would be passed on to consumers through higher utility prices. SDG&E should disclose these costs, and they should be explicitly included in the cost/benefit calculation for the proposed line.

11. ECONOMIC IMPACTS OF WILDLAND FIRE – PROPERTY DAMAGE

Q. What is the most economically significant damage that is likely to be caused by power line fires?

A. The most significant damage likely to be caused by power line fires is property damage. Data from the Insurance Information Institute for the sixteen most damaging wildland fires in the United States since 1970 are tabulated in Appendix H[56]. These sixteen fires were responsible for $ 7 billion in property damage.

Q. What were the largest fires in terms of losses?

[56] Attached as MGRA_Mbar_SPL_AppH_Costs.pdf; Appendix H, section H2.1

A. The largest fires in terms of losses were the Oakland or "Tunnel" fire of 1991, which was responsible for $2.5 billion in 2006 dollars, and the Cedar fire of San Diego County, which was responsible for $1.2 billion in 2006 dollars. Together these two fires were responsible for $3.7 billion dollars of loss, which is over half of the losses in the table.

Q. How do the rest of the fires in the list contribute to overall loss?

A. Every pair of adjacent fires in the list have losses that when summed exceed the sum of losses of the rest of the files lower down the list. In other words, big fires dominate no matter what scale is chosen.

Q. Is there a reason for this steep fall in loss sizes as we go down the list?

A. Probably. It is likely due to the fact that wildland fire sizes are well described by the models arising out of complexity theory, which were described in Appendix C[57]. These lead to size relationships described by "power-law" functions that often display this type of behavior. Since economic losses will to some degree be affected by fire size, we might expect this type of relationship to apply to losses as well as fire area.

Q. What would a power-law relationship in wildland fire loss sizes imply for how potential economic losses from wildland fires should be calculated?

A. It would mean that the most extreme events, though very rare, must be factored into the economic analysis of wildland fire because their costs rise more steeply than their probability falls.

Q. What is the maximum loss size that should be considered?

[57] Appendix C, section C2.2

A. There is usually a cut-off value for maximum loss for this type of behavior, which depends on system size, but it is not clear whether this has yet been reached. In the Cedar fire for instance, only a sudden change in wind direction, accompanied by extreme firefighting effort, prevented the head of the fire from following the coastal canyons into the high-value community of La Jolla, which if it had happened would have further multiplied losses.

Q. How should these low probabilities and costs be taken into account when doing an economic analysis?

A. One way to address these costs as applied to the SPL is to calculate the 'minimum' insurance premium that would effectively cover these damages. This can be determined by multiplying the probability of the catastrophic event by its cost, and then amortizing over the lifetime of the project.

Q. What is the probability of catastrophic losses near the upper end of the loss scale?

A. If we look at Figure F-4[58], this shows only a few points for fires started during periods of high winds that are not rapidly controlled. What is noteworthy, though, is that these few points seem to be distributed in a "flat" manner logarithmically. In other words, medium-sized fires show up as often as large fires, which show up as often as huge fires. Keep in mind that the 2003 firestorm dominates this graph, and this being such an extreme event might not be representative of future catastrophic fires (but then again, it might). We can therefore calculate a "pessimistic" case, which is suggested by the graph, and an "optimistic" case, which uses a value five times less for the probability than the pessimistic case.

[58] Appendix F, p. 15

The mean time between fires escaping initial attack for the proposed SPL has already been very roughly estimated to be 42 years. We have chosen the optimistic case and the pessimistic case accordingly to be 10% and 2% probability over the 40 year lifetime of the line.

12. COST/BENEFIT IMPACTS FROM PROPERTY DAMAGE

Q. What damages are used for this calculation?

A. We assume a maximum value of $1 billion dollars as the raw economic damages that would accrue as a worst-case catastrophic fire entering the developed portions of San Diego County. This may be a conservative figure, because some "reasonable" fire paths could impact even more properties than the Cedar fire. However, as fire sizes approach their maximum size, departures from power-law behavior are expected, with lower probabilities.

Additionally, SDG&E might be held liable for double or triple damages under the theories of trespass or inverse condemnation, as described in Appendix G[59]. This is also factored into the calculation.

Q. What is the probability-weighted cost due to catastrophic fire that we can expect for the SPL?

A. This is shown in the table below:

Damages	Probability	Cost/yr	Liability	Cost/yr
$1,000 M	10%	$ 2.5 M	$ 3,000 M	$ 7.5 M
$1,000 M	2%	$ 0.5 M	$3,000 M	$ 1.5 M

[59] Appendix G, section G2.1

The cost per year shown in the table is the "minimum insurance premium" that SDG&E would need to pay to cover the cost of a $1 billion catastrophic fire. This is calculated for the 2% and 10% probability cases, and also for the case of triple damage awarded. This value ranges from $0.5 to 7.5 million per year.

<u>Note that this is simply illustrative of the method that should be used to estimate cost/benefit impacts of the SPL, and a full estimate using proper actuarial techniques should be performed in the EIR</u>.

Q. How should this cost per year derived from the probability-weighted cost be applied to the cost/benefit analysis for the proposed SPL?

A. The yearly cost of the "insurance premium" should be subtracted from the societal benefits claimed for the line, and then factored into the cost/benefit analysis. This is justified from the standpoint that if the community of ratepayers would benefit from the SPL economically due to lower rates, they would also have to bear the brunt of any damages caused by fire – either directly, or through higher rates due to losses by SDG&E or higher insurance premiums being levied upon SDG&E.

Q. What are the uncertainties in the above calculation?

A. As previously stated, uncertainty in the 42 year recurrence rate is greater than a factor of ten. ***However, it also assumes that the SPL is no more or less likely to cause fire than other transmission lines. Other portions of this testimony indicate why the risk along the proposed SPL route may be higher than that expected for other transmission lines.***

Other uncertainties include the fact that as population grows in San Diego, the number of high-value properties along the wildland-urban interface will increase, thus increasing the maximum potential fire loss. Additionally, climate change could make the fire season longer and more severe. However, future advances in construction techniques, technologies, or fire fighting capabilities might reduce losses.

13. COST/BENEFIT IMPACTS OF HABITAT RESTORATION OR REPLACEMENT

Q. Are there other economic damages that might accrue from a power line fire started by the SPL?

A. Yes. There is the possibility that habitat could be permanently lost or put at risk, and that SDG&E would be required to correct this loss.

Q. How can San Diego habitat be put at risk by wildland fire?

A. The chaparral of Southern California is fire-adapted. However, if fires are too frequent, a process called "type conversion" occurs, in which invasive, highly flammable weeds replace the native chaparral. This is described in Appendix H[60]. A good review of this phenomenon which cites the major sources is given by Halsey[61]. Type conversion could have severe ecological impacts and should be dealt with in depth in the EIR. It could also have economic impacts on ratepayers if SDG&E were required to replace or restore preserved habitat.

Q. What areas along the proposed route are at risk for type conversion?

A. Areas in San Diego County which have recently burned will be at risk for type conversion until their chaparral communities stabilize, a period of about 10 to 20 years. In particular, areas near potential ignition sources such as the SPL or SWPL will be at greater risk. These areas, along with the age of their

[60] Appendix H, Section H2.2
[61] Halsey, p. 25

corresponding fires, are shown in Figure H-2. In particular, significant portions of the proposed SPL route follow the path of the Cedar fire.

The route hazard analysis (attached in Appendix C) also has been used to calculate the at-risk segments of both the proposed SPL route and the exiting SWPL route for comparison. Results are shown in the table below:

Date last fire	SPL(km)	SWPL(km)
1991-1995	0	10
1996-2000	0	16
2001-2003	57	24
2004-2005	13	5
Total	70	55

Including only line segments with flammable vegetation, 67% of the proposed SPL route that is at risk of ignition is also at risk for type conversion, as opposed to 61% for the SWPL route.

Q. How much of the land at risk is in public preserves?

A. A very significant percentage of the proposed SPL route is either through or adjacent to public lands, at least in San Diego County[62]. The total path length of the proposed SPL route adjacent to or through public lands is 100 km, or roughly 41% of its total path in San Diego County, as opposed to 35 km for SWPL. We also calculate the length of these segments west of where the region of significantly flammable vegetation begins (km 138 for SPL proposed; km 45 for SWPL). These give 62 km for SPL and 35 km for SWPL of path adjacent to

[62] Appendix H, Section H2.3

public property. This implies that 59% of the SPL path at risk for fire is adjacent to public lands.

Q. What public lands would be affected by the proposed SPL route?

A. Public lands affected by the preferred route are owned by the City of San Diego, the County of San Diego, and the BLM, and include the Mt. Gower Open Space preserve, the Los Penasquitos Canyon Prserve, the Boulder Oaks Open Space preserve, the Sycamore Canyon Preserve, Mt. Gower Open Space preserve, among many others. Alternative routes have similar impacts on these and other preserves.

Q. Are these the only lands that would be at risk in the event of a power line fire?

A. No. Public lands will be at risk of exposure to power line wildland fires even if they are far removed from the ignition source, due to the tendency of catastrophic wildland fires in San Diego County to spread rapidly westward.

Q. How might damages to public lands due to type conversion be remedied by SDG&E?

A. These damages could be remedied either by restoring the chaparral communities using established methods, or by replacing the public preserve with an equivalent preserve. SDG&E might also be held responsible for double or triple damages under the theory of inverse condemnation.

Q. What are the costs for restoration?

A. Estimates were received from a consulting firm that does restoration work[63], and the costs range from $42,000 - $60,000 per acre depending upon the method chosen.

Q. How will the fraction of public lands along the proposed SPL route at risk for type conversion change over time?

A. Due to the adjacency of the proposed SPL route to public lands, the probability that a fire started by the line will escape onto San Diego County public lands is over 59%. The fraction of land along the proposed route vulnerable to both ignition and type conversion for the next 20 years is 67%. Even as the 2003 fire scars heal, new ones will take their place, as indicated in the SWPL fire data, though we might reasonably expect the total exposed fraction to reduce due to the historically large nature of the 2003 fires. We shall use 50% as the minimum fraction for the period after 2025. <u>The EIR should study the average historical exposure to type conversion by looking at fire history throughout San DiegoCounty and determining what the probability has been historically that any given location has had a fire within the last 20 years.</u>

Q. What are the costs for restoration that could be anticipated over the lifetime of the line, and how can these be included in the cost/benefit ratio?

A. We can apply an actuarial method similar to that used for calculating potential property damage by calculating the full cost incurred and weighting it by the probability of fire. Many preserves are on the order of 1,000 acres, and this is used as a median value for the potential size of public lands that could be at risk

[63] Appendix H, Section H2.4

in the aftermath of a major fire. We assume a restoration cost of $50,000 per acre and a recurrence rate of 42 years.

For the first 15 years of line operation we get:

30% probability * 1,000 acres * $50k/acre * 59% pub lands
* 67% type conv * 3X damages = $ 21.3 M

For the period from 2025 to 2050,

45% probability * 1,000 acres * $50k/acre * 59% pub lands
* 50% type conv * 3X damages = $ 19.9 M

Total for the 40-year life of the line would then be $40.2 million, which amortized would be a cost of $1.0 M/year. This would be the cost of the minimum insurance premium to safeguard against this contingency.

While this represents a 'ceiling' for costs as far as reparations per acre, it does NOT properly characterize the extent of possible damages if a catastrophic fire were to damage multiple large preserves. <u>This should be fully analyzed in the EIR.</u>

<u>Note that this is simply illustrative of the method that should be used to estimate cost/benefit impacts of the SPL, and a full estimate using proper actuarial techniques should be performed in the EIR.</u>

Q. What would be the cost of land replacement, rather than restoration?

A. At least presently, the cost of land replacement is significantly less than that of restoration. Data back to 2001 was scanned for large parcel real estate sold in San Diego County[64]. Between late 2001 and the present (May, 2007), the

[64] Appendix H, Section H2.5

average price per acre for large (300+) parcels has been $2565.11. The purchases of preserves under San Diego County's Multiple Species Conservation Plan was also examined[65]. Three large parcels of equivalent chaparral have been purchased since 2000:

Name and Location	Acres	Purchase Date	Cost	Cost/Acre
Hollenbeck Canyon, Daley Ranch, Ph I	312.5	9/7/2000	$2,000,000.00	$6,400.00
Iron Mountain, Boulder Oaks	1,215.00	9/26/2003	$4,410,000.00	$3,629.63
Iron Mountain, Ramona Serena/ Barnett Ranch	716.5	1/25/2002	$4,440,000.00	$6,196.79

It can be seen that the price of preserve-quality parcels is higher than that of average lands and that currently the cost of replacement is around a factor of ten less than restoration.

Q. Are there circumstances that would make restoration necessary rather than replacement?

A. Yes. It may be that as population expands and large parcels of suitable habitat become rarer, the value of these parcels will increase up to the ceiling set by restoration.

It may also happen that certain preserves are irreplaceable because they contain unique habitats. <u>The EIR should determine if this is applicable to any proposed SPL routes.</u>

[65] Appendix H, Section H2.6

14. OTHER WILDLAND FIRE ISSUES TO BE REVIEWED

Q. Are there other analyses of wildland fire issues that should be conducted as part of the EIR review process?

A. Yes, a number of additional and supplemental analyses need to be conducted as part of the EIR. Aside from those already mentioned, these include, but are not limited to, the following:

1. The MGRA analysis to this point has concentrated only on the original proposed SPL route, and the SWPL route for the sake of comparison. All routes being considered need to be analyzed using a route hazard analysis method in the EIR, such as that illustrated with by the "Route_Analysis_SPL.xls[66]" file. This method allows the relative hazards along each segment of the line to be compared and analyzed. The results should also be presented in a format such as that of the Route Analysis spreadsheets, which allow users without specialized software or tools to examine correlations between factors along the route. This is critical, because certain hazards occur when various conditions occur in conjunction. Some of these are described below.
2. Santa Ana wind hazard maps, created from NWS computer models by averaging over recent events, should be generated as part of the EIR. This is described in more detail in Appendix F.
3. A fire hazard metric applicable to power line fires should be created as part of the EIR. This should take into account locational dependencies of vegetation fuel load, slope, and Santa Ana wind threat. This should be included in the Route Analysis for all routes under consideration.

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[66] Attached as Route_Analysis_SPL.xls

4. Routes of current transmission lines within the SDG&E service area should be similarly analyzed via Route Analysis hazard mapping as part of the EIR in order to gauge the applicability of historical fire information to predicting future fires. Future fire rates should be predicted based on this more comprehensive information.
5. The EIR should address what the maximum strength of an expected Santa Ana event will be within the lifetime of the project, taking into account possible climate change effects.
6. The correlation of earthquake risk and vegetation should be considered as part of the EIR.

Q. What is the relationship between earthquake and wildland fire?

A. If an earthquake causes faulting or structural failure of live lines, then arcing may occur and hot material may be ejected. If this falls onto vegetation it can cause a fire.

Q. Aren't transmission lines engineered to withstand earthquakes?

A. The best industry practice, according to sources cited in SDG&E's response to data request MGRA-35, is to consider wind and ice loading to be the limiting case for line stress, usually exceeding that for seismic stresses. Hence seismic vibrations are typically not modeled. However, El-Attar[67] has calculated seismic loading for transmission lines using both computer simulation and analytical techniques, and has concluded that in areas where wind and ice load are small, such as Southern California, that seismic loadings can exceed design limits

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67 El-Attar, Mohamed Mohsen; Nonlinear dynamics and seismic response of power transmission lines; PhD Dissertation, MCMASTER UNIVERSITY; 1997

for wind and ice load. This can occur for earthquake horizontal accelerations as small as 0.35g[68] (g is the acceleration equivalent to earth's gravity).

Q. Where along the line route might we expect such accelerations?

A. The greatest seismic hazard to the line itself will occur along the desert segment of the route. Failures and faults in this region would impact reliability and lifeline capabilities for the SDG&E service area, but would not create a substantial wildland fire risk. According to USGS seismic hazard maps[69], however, a substantial portion of the proposed SPL route, specifically its "northern loop" including the proposed central substation, are at 10% risk for exceeding .3-.4g acceleration within the lifetime of the project. This area also happens to have the most hazardous fuel regions along the route. It may be assumed that in the aftermath of a serious earthquake, emergency services will be overtaxed and unable to effectively suppress a wildland fire until external resources arrive, creating the threat of conflagration.

Q. How should the earthquake issue be addressed?

A. <u>The EIR should conduct a thorough review of El-Attar's calculations as applied to the planned SPL construction techniques and materials, including if appropriate seismic modeling of the planned structures. Included in the Route Analysis should be peak accelerations, and a metric should be calculated that takes into account vegetation and maximum acceleration in order to define a hazard zone. Finally, if the results require re-engineering the SPL in hazardous areas, the added costs of more robust construction should be added to the cost/benefit analysis.</u>

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[68] El-Attar, pp. 79-80, 114-115

[69] Rukstales, Kenneth S.(compiler); ATLAS.ATLAS_SEISMIC_HAZARD (digital vector file); US Geological Survey, National Seismic Hazard Mapping Project; Reston, VA; 2002; available from http://www.landfire.gov

15. OTHER ISSUES TO BE REVIEWED

Q. Are there any other issues relating to economics or reliability that MGRA wishes to raise?

A. Yes. One point raised by MGRA and answered by SDG&E in its response to data request MGRA-37 illustrates a fundamental issue with reliability. One of the main arguments used for SPL is that it provides redundancy for the SWPL transmission line. However, both SWPL and SPL originate at a common location: the Imperial Valley substation. This creates a "single point of failure" that could put the entire supply to San Diego County at risk.

SDG&E has at our request modeled the effect of the loss of the Imperial Valley substation under 2010 conditions, for both summer load and light winter load. They found that under summer conditions, the removal of all lines leading to the Imperial Valley substation might cause a cascading blackout.

The Imperial Valley is in an extreme seismic hazard zone, and recent work suggests that a large earthquake along the southern San Andreas is overdue and not unlikely within the lifetime of the project[70]. Furthermore, this exposes our electrical grid to a terror attack on a single point target. This lack of redundancy seems counter to the spirit of reliability.

Q. Does this conclude the MGRA testimony?

A. Yes, this concludes the MGRA testimony.

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[70] Fialko, Yuri; Interseismic strain accumulation and the earthquake potential on the southern San Andreas Fault; Nature; v. 441; pp. 968-971; 22 June, 2006

CERTIFICATE OF SERVICE

I hereby certify that I have served, by electronic mail, a copy of the foregoing Phase I Direct Testimony of the Mussey Grade Road Alliance Fire Analysis – Economic Impacts to each party in Docket No. A.06-08-010.

Executed on May 31, 2006 at Ramona, California.

/s/ Diane Conklin

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