APPENDIX E – SPL ROUTE VEGETATION AND FIRE

E1. Data Sources

E1.1. CDF Fire Data, FRAP Project

E1.1.1. Fire Perimeter Data

Distribution: Free

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

Description: Comprehensive fire perimeter data.

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

Restrictions & Limitations: "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 ArcMap**.** Route analysis conducted for SPL and results put in Route_Analysis_SPL_1.1.xls[1].

E1.1.2. Fuel Rank

Distribution: Open

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

[1] Attached as RouteAnalysis_1.1.xls

Description: "The fuel ranking procedure makes an initial assessment of rank based on an assigned fuel model (see surface fuels) and slope, then raises ranks based on the amount of ladder and/or crown fuel present to arrive at a fuel rank." "The fuel ranking methodology assigns ranks based on expected fire behavior for unique combinations of topography and vegetative fuels under a given severe weather condition (wind speed, humidity, and temperature)."

Fields: Fuel Rank : (-1 = Non-Fuel, 1 = Moderate, 2 = High, 3 = Very High)

Restrictions & Limitations: Data is from 2001 to 2004. Biased by 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.

E1.1.3. Fuel Rotation

Distribution: Open

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

Description: "The fire rotation interval is the expected number of years it would take, based on past fire rates, to burn an area equivalent to that of a given stratum. Fire rotation interval for a given stratum is calculated by dividing the mean annual number of acres burned into the total area of the stratum."

Fields: Fire Rotation Class:

FROTCLASS	DESCRIPTION	NUMBER OF YEARS
0	UNDETERMINED	UNDETERMINED
1	MODERATE	> 300 Years
2	HIGH	100 – 300 Years
3	VERY HIGH	< 100 Years

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

E1.1.4. Fire Threat

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:

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

FIRE THREAT MATRIX

Fuel	Rotation 0	1	2	3	
-1	-1	-1	-1	-1	
1	1	1	2	3	
2*	2	2	3	3	Threat
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.

E1.2. LANDFIRE Project Data

LANDFIRE is a multipartner project sponsored by the US Forest Service, the USGS and other agencies. It released high-resolution data for California in January 2007.

Location: http://www.landfire.gov/dataproduct_natmap.php

E1.2.1. Scott & Burgan fuel models.

Distribution: Open

Description: Based on the Scott and Burgan fuel models[2], which expand upon the older Anderson fuel models. Also provides a richer description of shrubland / chaparral. Included because effects of 2003 fires are reduced.

Fields: Fuel Type (NB – Non-burnable, GR – grass type, GS – Grass-shrub, SH – Shrub, TU – Timber Understory, TL – Timber Litter).

Restrictions & Limitations: Unlike the CDF Fuel Rank metric, this model does not take slope into account. Used as a hazard metric, it will tend to overpredict in level areas and underpredict in areas of greater slope.

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

E1.2.2. Slope

Distribution: Open

Description: Derived from the USGS National Elevation Dataset (NED). This has impacts on fire behavior, as well as fire spread probability (due to the difficulties in access for initial attack).

Fields: Fractional slope.

Restrictions & Limitations:

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

E1.2.3. Mean Fire Return Interval

Distribution: Open

Description: "quantifies the average period between fires under the presumed historical fire regime. This frequency is derived from vegetation and disturbance dynamics simulations using LANDSUM (Keane and others 2002, Hann and others 2004)."

Fields: Return interval.

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[2] 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.

Restrictions & Limitations: Based solely on vegetation and simulation, rather than actual historical data.

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

E1.3. SANDAG (San Diego Association of Governments) GIS

E1.3.1. Community Planning Areas / Subregional Areas

Distribution: Open

Location: http://www.sandag.cog.ca.us/resources/maps_and_gis/gis_downloads/admin.asp

Files: citycpa.zip, ccpa.zip

Description: GIS shapefiles that specify the boundaries of community planning areas (in the unincorporated areas) and subregional districts (within San Diego city).

Fields: County and city planning district boundaries

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

E1.4. SDG&E SPL and SWPL GIS data

Distribution: Open

Data Requests: MGRA-38

File Name: MGRA Data Request #3.gis

Location: http://www.sdge.com/sunrisepowerlink/info/MGRADR3ResponseMar-2-07.doc

Description: GIS shapefiles for SWPL and SPL (including alternatives) in ESRI shapefile format.

Fields: Line type, Segment (Alternative).

Processing: Analyzed with ArcMap. Route analysis conducted for SPL and results put in Route_Analysis_SPL_1.1.xls. For use in route analysis, each line was selected and then divided into 1 km segments, and then written out to a new shapefile. These 1 km segments then formed the basis of the route analysis, where hazards are evaluated on a

segment-by-segment basis. This allows a more quantitative comparison of line hazards for different routes.

An example of how this was done is shown in Figure E-1.

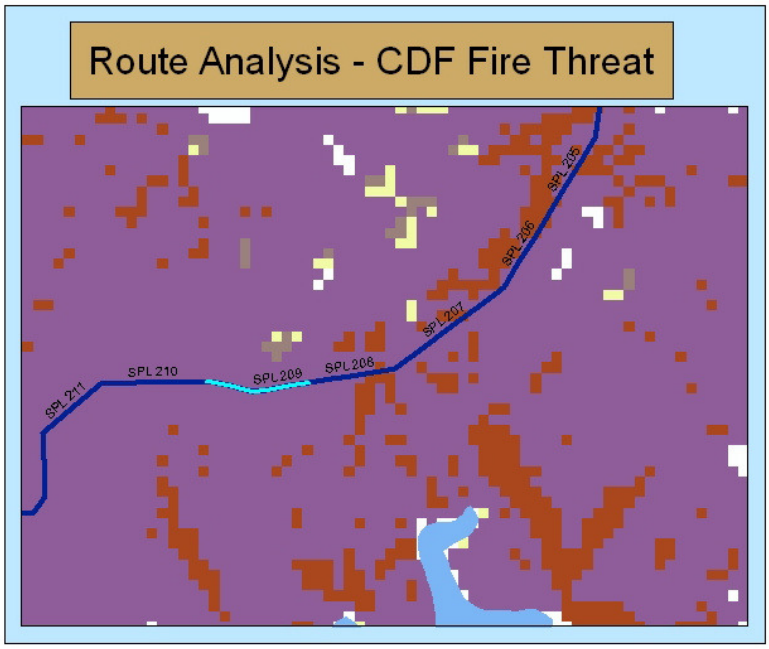

Figure E-1 – This figure shows how the Route analysis was performed for different GIS datasets. As can be seen, the SPL route has been divided into 1 km segments, labeled SPL###. If an exact measurement of the position of the segment was required, it was highlighted, as demonstrated on segment SPL209. Different colors represent different fire threat elements, so it is clear which line segments are exposed to which risk.

Limitations: Segmentation did not always work properly, due to either data or program flaws. Hence, the segmented route data should not be viewed as an absolute guide to distance along the route, but rather a general scale that allows some statistics to be extracted from the line data. To aid in position calibration, intersection data for both roads and administrative boundaries have been cross-referenced in the route analysis.

It is important to emphasize that SWPL is not included as an alternative route, but rather as a reference to which SPL can be compared in terms of a potential fire hazard.

E2. Analyses

E2.1. CDF Fuel Rank analysis for SPL

E2.1.1. Goal

The goal is to determine the length of the segments of the SPL route whose fuels and slope present wildland fire danger, and to quantify this hazard, comparing it by example to the SWPL route. This is based upon the premise that the wildfire ignition threat posed by the proposed SPL line will be proportional to its exposure to flammable vegetation.

E2.1.2. Description

As part of the Route Analysis, CDF Fuel Rank adjacent to the SPL route was analyzed per kilometer segment. This allows the summation of route lengths exposed to the different classes of wildland fuel exposure.

E2.1.3. Methods

The segmented SPL and SWPL route GIS paths were superimposed on the CDF Fuel Rank GIS map. For each 1 km segment along each route, the most hazardous condition exposed for a non-trivial span (>3 pixels) was recorded. This was done for both the proposed SPL route and SWPL in order to put risks in context. This superposition is displayed in Figure E-2.

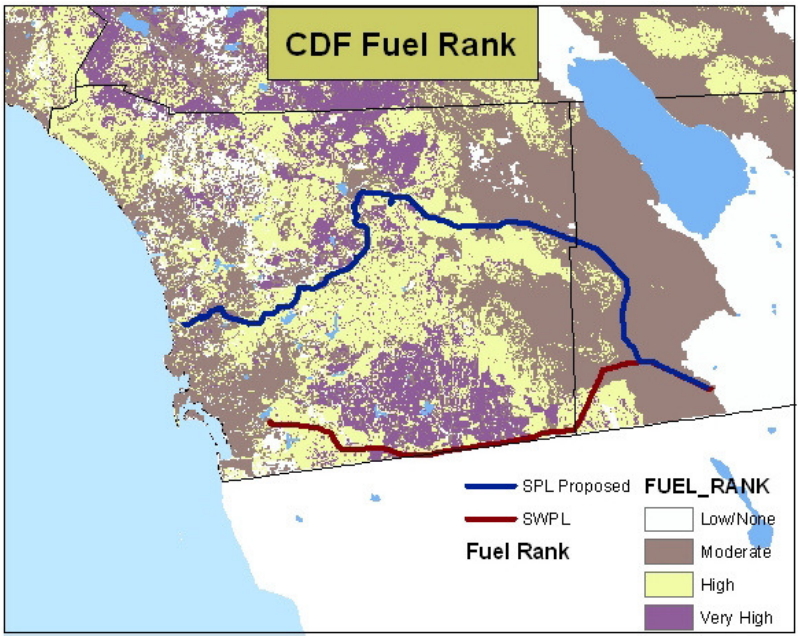

Figure E-2 – CDF Fuel Rank for San Diego County, with the paths of SWPL and the proposed SPL route displayed.

This data was histogrammed and these can be found in the tabs SPL_Hazards and SWPL_Hazards of the Route_Analysis_SPL_1.1.xls file.

E2.1.4. Analysis

The histograms for the SPL and SWPL route exposures to the various CDF fuel classes are shown below:

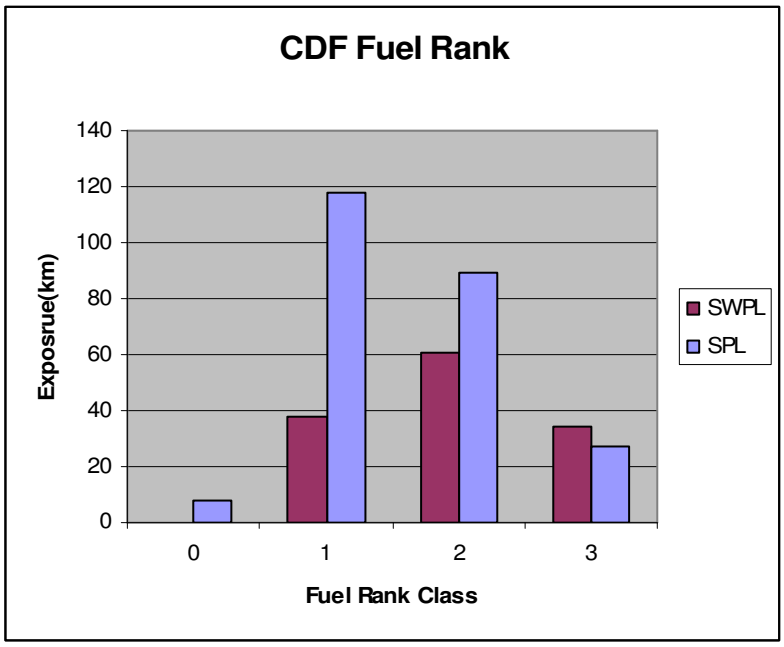

Figure E-3- CDF fuel rank for each kilometer of the proposed SPL route and SWPL, displayed as a histogram. Values are 1=Moderate, 2=High, 3=Very High.

Fuel Rank data is summarized in Table E-1 so that it can be compared for the SPL proposed and SWPL routes.

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

Table E-1 – The SPL proposed route and its fuel exposure is compared against that of the existing SWPL line. As can be seen, the distance for which a moderate fire danger exists is almost double for the SPL proposed route that it is for the SWPL transmission line. This ratio drops to roughly equal for fuel rank of "very high"; however there is a short-term suppression of "very high" fuel loads in the aftermath of the 2002 and 2003 fires. This is discussed in section E2.1.5.

E2.1.5. Limitations

The primary problem with the Fuel Rank is that it has taken the fuel reduction caused by the 2002-2003 great fires (Pines, Cedar, Paradise, Mine/Otay) into account. This is fine for short-term projections of fire risk, but it will lead to underprediction of fire risk in the time scales of interest for the SPL route (40-50 years). This bias is

displayed clearly in Figure E-4. Areas of "high" fuel rank will probably convert to "Very High" in the absence of further fires.

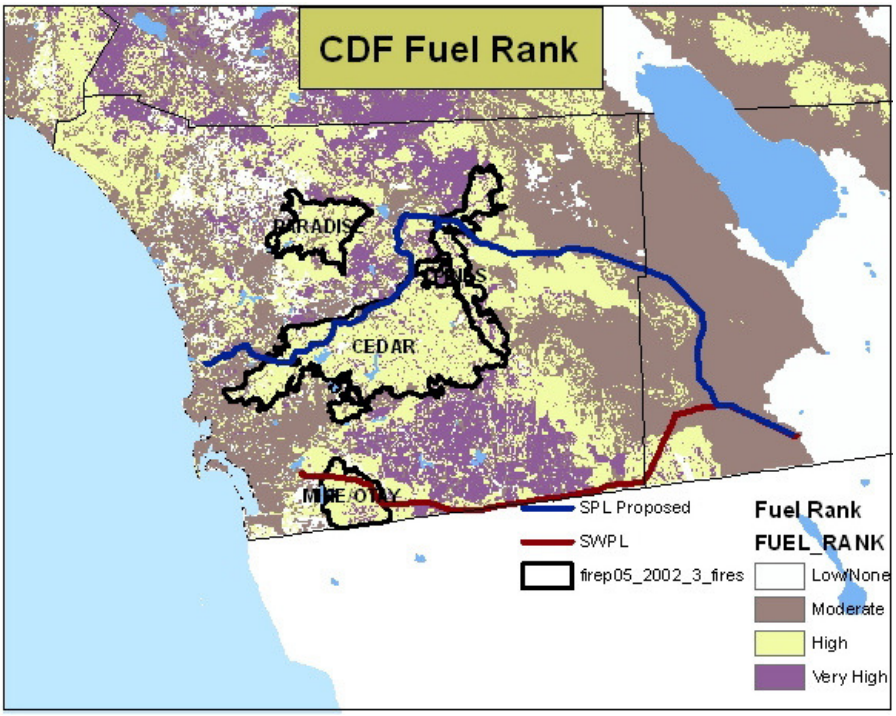

Figure E-4 – This figure shows the Fuel Rank with the perimeters of the Cedar, Pines, Paradise and Otay fires superimposed. It is clear that the fires led to a recalculation of risk, as shown by the removal of "Very High" fuel rank regions from within the fire perimeters. However, this is a short term reduction and should not be viewed as optimal for predicting exposure to vegetation along the SPL route.

E2.1.6. Conclusions

According to CDF's Fuel Rank metric, the SPL proposed route traverses flammable vegetation for the majority (234 / 243 km.) of its length. Total exposure to flammable vegetation is almost double that of the SWPL route. The routes are currently more equal in their traversal of areas of "Very High" fuel load, however this is partly due to the fact that much of the SPL proposed route traverses area burned in the Cedar and Pines fires, which caused significant fuel reduction. In a few years, these regions should regenerate their fuel load, and this would be the vegetation that any proposed line through this area would be exposed to. Hence we expect the fuel rank along the line to become more hazardous than shown by the current fuel rank before the proposed power line would come into service.

E2.2. CDF Fire Threat

E2.2.1. Goal

The goal is to determine the length of the SPL route that whose fuels and slope present wildland fire danger, and to quantify this hazard, comparing it by example to the SWPL route. This is based upon the premise that the wildfire ignition threat posed by the proposed SPL line will be proportional to its exposure to flammable vegetation.

E2.2.2. Description

As part of the Route Analysis, CDF Fuel Rank adjacent to the SPL route was analyzed per kilometer segment. This allows the summation of route lengths exposed to the different classes of wildland fuel exposure. Fire Threat is a more descriptive metric than Fuel Rank, since in addition to fuel types it characterizes the average time between fires for given regions.

E2.2.3. Methods

The segmented SPL and SWPL route GIS paths were superimposed on the CDF Fire Threat GIS map. For each 1 km segment along each route, the most hazardous condition exposed for a non-trivial span (>3 pixels) was recorded. This was done for both the proposed SPL route and SWPL in order to put risks in context. This superposition is displayed in Figure E-5.

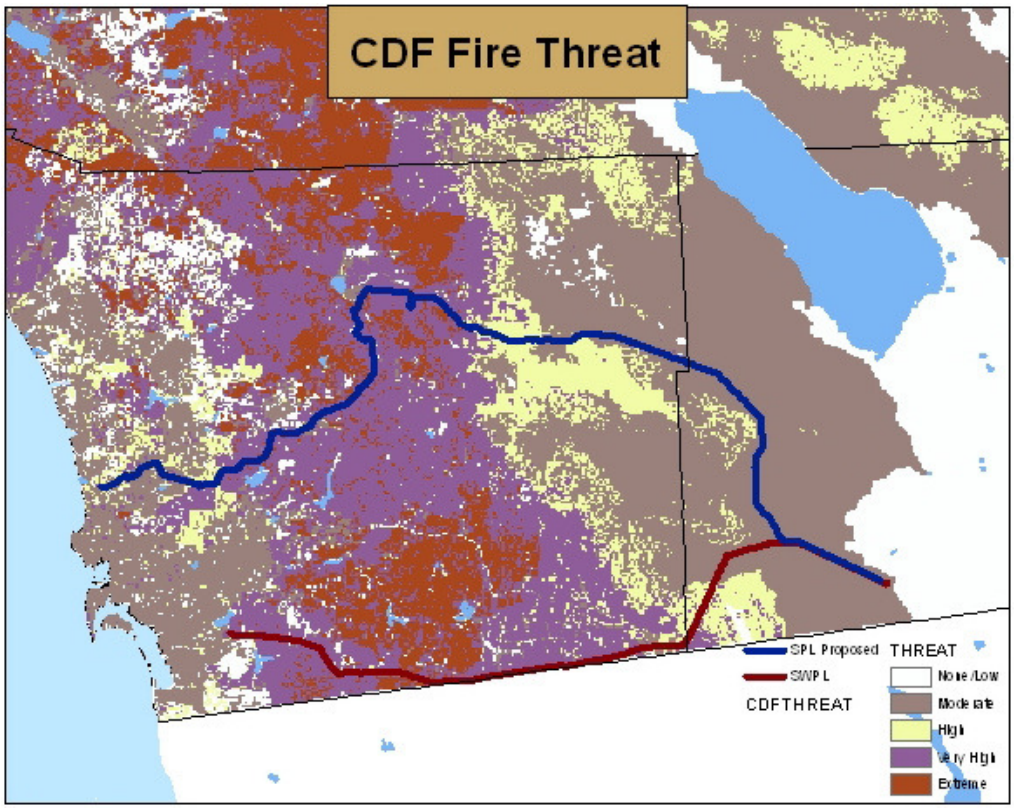

Figure E-5 – CDF Fire Threat metric plotted for San Diego, showing the proposed SPL route and the existing SWPL route.

E2.2.4. Analysis

The histograms for the SPL and SWPL route exposures to the various CDF Fire Threat classes are shown below:

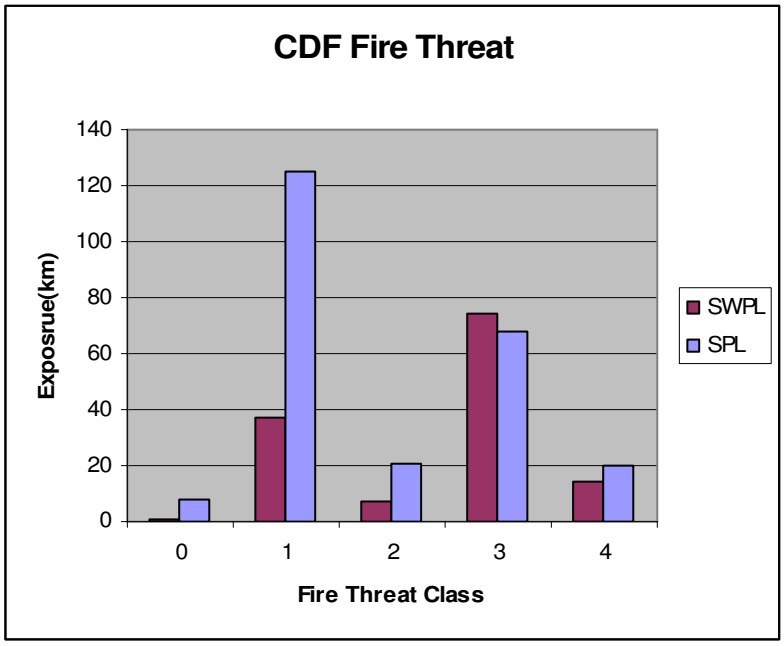

Figure E-6 - CDF fire threat for each kilometer of the proposed SPL route and SWPL , displayed as a histogram. Values are 1=Moderate, 2=High, 3=Very High, 4=Extreme

These values are summarized in Table E-2.

	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

Table E-2 - The SPL proposed route and its fire threat exposure is compared against that of the existing SWPL line. As can be seen, the distance for which a moderate fire danger exists is almost double for the SPL proposed route that it is for the SWPL transmission line. This ratio drops to roughly equal for fuel rank of "high". However, this metric is based upon the Fuel rank, which displays a short-term suppression of "very high" fuel loads in the aftermath of the 2002 and 2003 fires. This is discussed in section E2.1.5.

E2.2.5. Limitations

Because the Fire Threat metric is based upon the Fuel Rank (see E1.1.4), it shares the same limitations – in particular that it will underpredict hazard in the areas burned by

the Cedar, Pines, and Otay fires due to the temporary removal of fuel load. See E2.1.5 for a full description.

E2.2.6. Conclusions

According to CDF's Fire Threat metric, the SPL proposed route traverses flammable vegetation for virtually the entirety of its length. Total exposure to flammable vegetation is almost double that of the SWPL route. The routes are currently more equal in their traversal of areas of "high" fire threat; however this is partly an artifact of the fact that much of the SPL proposed route traverses area burned in the Cedar and Pines fires, which caused some fuel reduction. In a few years, these regions should regenerate their fuel load, and this would be the vegetation that any proposed line through this area would be exposed to. Hence we expect the fire threat along the line to become more severe than shown by the current fire threat rankings before the proposed power line would come into service.

E2.3. Hazardous vegetation analysis from Scott-Burgan model

E2.3.1. Goal

The goal is to determine the length of the SPL route that is covered by vegetation that presents wildland fire danger, and to quantify this hazard, comparing it by example to the SWPL route. This is based upon the premise that the wildfire ignition threat posed by the proposed SPL line will be proportional to its exposure to flammable vegetation.

E2.3.2. Description

As part of the Route Analysis, vegetation adjacent to the SPL route was analyzed per kilometer segment using the Scott-Burgan vegetation classes as measured by the recently published LANDFIRE data. This metric was chosen because it has a more fine-grained and accurate description of vegetation types, and furthermore does not seem to show the same vegetation suppression due to recent fires that the CDF data does. Hence it will provide a metric that may be more descriptive of the future conditions along the SPL proposed route.

E2.3.3. Methods

The general types of Scott-Burgan vegetation classes are described in E1.2.1. In general the numbering of vegetation types refers to the density of fuel and whether it is generally found under dry or humid conditions. The general types refer to non-burnable (NB), grasses (GR), grass and shrub (GS), shrub (SH), timber litter (TL) and timber understory (TU).

Vegetation classes for San Diego County are shown below:

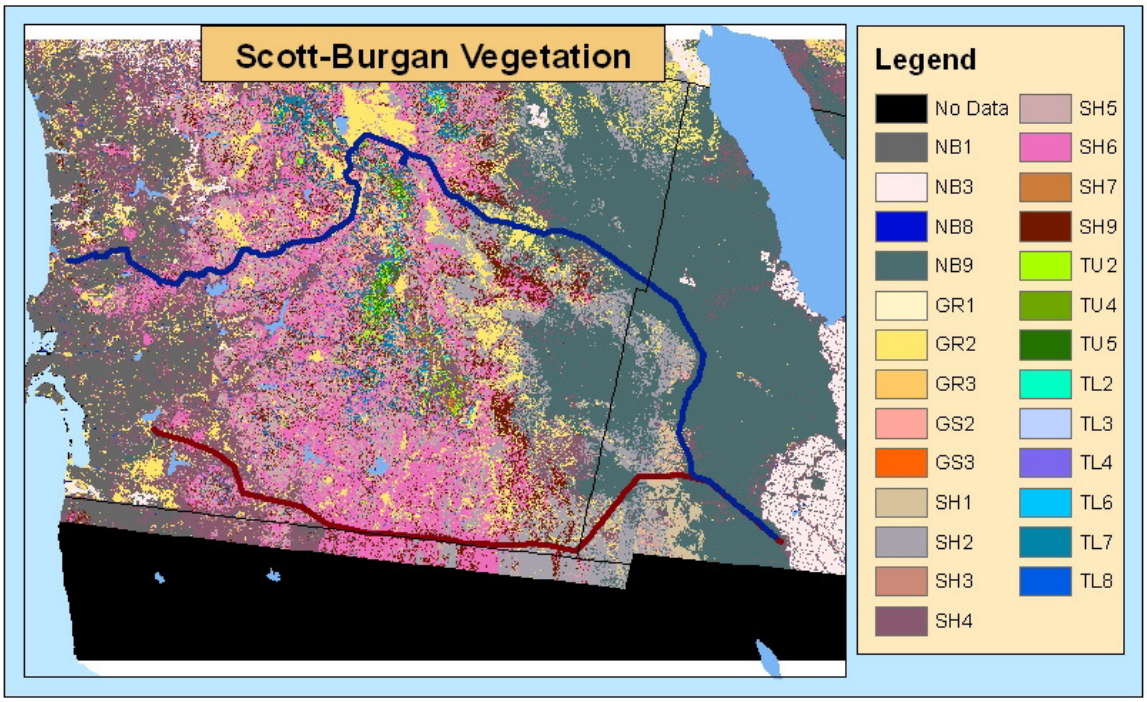

Figure E-7 – Scott-Burgan vegetation classes for San Diego County, showing the proposed SPL route and the SWPL route.

Among the values that they determine for each vegetation type is the flame length as plotted for four values of fuel moisture (high, medium, low, very low) versus wind speed from 0 to 20 mph. Values for low fuel moisture, and a wind speed of 10 mph are summarized in Table E-3.

SB Veg Class	Flame Length (ft –low, 10mph)	SB Veg Class	Flame Length (ft - low, 10mph)	SB Veg Class	Flame Length (ft - low, 10mph)
GR1	1	NB1	0	TL1	0.5
GR2	6	NB2	0	TL2	0.7
GR3	9	NB3	0	TL3	1
GR4	12	NB8	0	TL4	2
GR5	14	NB9	0	TL5	3
GR6	20	SH1	1	TL6	4
GR7	28	SH2	2.5	TL7	2.5
GR8	32	SH3	2.5	TL8	5.5
GR9	50	SH4	10	TL9	7
GS1	4	SH5	12	TU1	2
GS2	7	SH6	15	TU2	5
GS3	10	SH7	18	TU3	11
GS4	22	SH8	19	TU4	9
		SH9	25	TU5	10

Table E-3 – Scott-Burgan fuel types and the flame lengths they exhibit for low fuel moisture in a 10 mph wind.

Usually, multiple vegetation types exist along the route, and the most hazardous (longest flame length) type of vegetation was chosen.

To allow a general comparison between these fuel types and the CDF Fuel Rank, this analysis divides the SB vegetation types into four fuel classes based upon flame length:

Class	Flame Length
0	0
1	<5’
2	5-15’
3	≥15’

Table E-4 – Classes for the purpose of this analysis that divide the Scott-Burgan vegetation types into a small number of categories based upon flame length for low moisture fuels in a 10 mph wind.

E2.3.4. Analysis

The histograms for the SPL and SWPL route exposures to the Scott-Burgan vegetation classes, as grouped into the categories in Table E-4 are shown below:

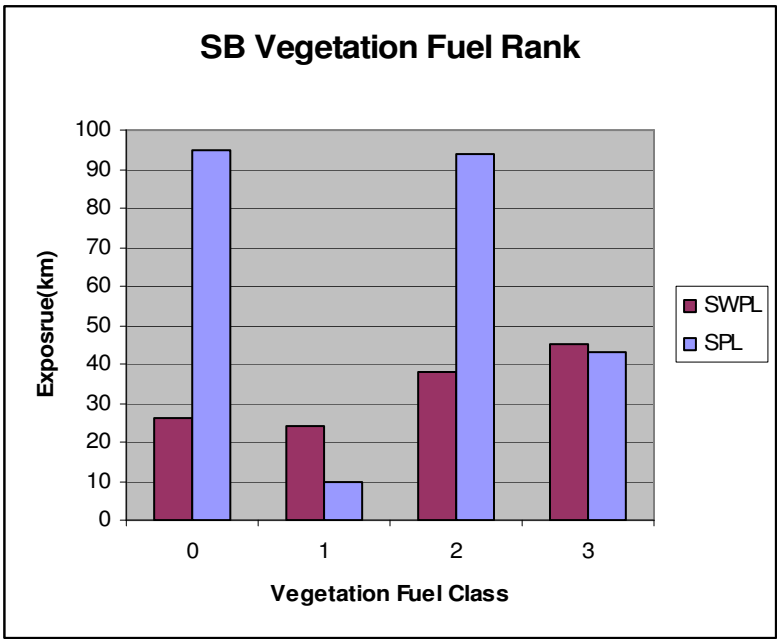

Figure E-8 – Scott-Burgen vegetation classes to which the proposed SPL route and SWPL are exposed, divided into four categories based upon flame length low fuel moisture and 10 mph wind: 0: not burnable; 1: <5’, 2: 5-15’, 3: >15’.

These values are summarized in Table E-5.

	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

Table E-5 - The SPL proposed route and its vegetation exposure is compared against that of the existing SWPL line. As can be seen, the distance for which a moderate fire danger exists is 50% higher for the SPL proposed route that it is for the SWPL transmission line.

E2.3.5. Limitations

The four classes into which the fuel types were divided on the basis of flame length are arbitrary in their boundaries, and don't have a direct relation to either Fuel Rank or Fire Threat classes. The intent was to group the vegetation classes into a small number of ranked groups to allow a comparison of route exposure that is less influenced by the short-term impact of the 2002-2003 fires.

This metric takes only vegetation into account. CDF Fuel Rank also takes slope into account, while the CDF Fire Threat also takes average rotation time into account.

E2.3.6. Conclusions

The proposed SPL route has a considerably longer exposure (50-60%) to moderately to highly flammable vegetation than the existing SWPL route, as determined by a route hazard analysis. In its proposal for this route, SDG&E uses the fire-prone condition of the SWPL corridor as motivation for selecting another route. In fact, this analysis shows is that the SPL corridor will 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, while they are roughly equivalent in the 20-40 km span of extremely hazardous area that they span. It is reasonable to assume that the risk of wildland fire from power lines will be proportional to the distance which they traverse flammable vegetation. 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.