MOKELUMNE WATERSHED AVOIDED COST ANALYSIS:

Why Sierra Fuel Treatments Make Economic Sense

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FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

Chapter 5: Postfire Infrastructure Damages and Values

5.1 Introduction

The footprints of the Five Fire scenario described in Chapter 3 overlap with homes, businesses, public infrastructure, private utility infrastructure, and timber-producing lands. In this section, we measure the value of land, structures, and timber that fall within the fire footprints, as well as estimate the value that is saved due to the smaller footprints associated with the modeled fuel treatment. Depending on the infrastructure type, we consider the value of either damages from total loss or the repair of less-damaged infrastructure. For lands within the fire footprint in the treated scenario, we calculate the value of potential damages avoided as a result of lower fire intensity. This is calculated from the differences in flame length between treated and untreated scenarios (see Chapter 3 for more on the differences in flame length and fire severity). In later chapters we discuss and value the indirect effects of these wildfire scenarios (see chapters 6 - 8).

5.2 Summary of Findings

Table 5.1 summarizes the results presented in this chapter. It is important to note that the summary only considers changes in impacts based on the difference in the sizes of the fire footprints that are the result of fuel treatments. Please see Table 5.4 for how the change in fire severity due to the modeled fuel treatments within the fire footprints is expected to affect parcel values.

Table 5.1: Summary of findings based on the change in fire footprint size due to fuel treatments

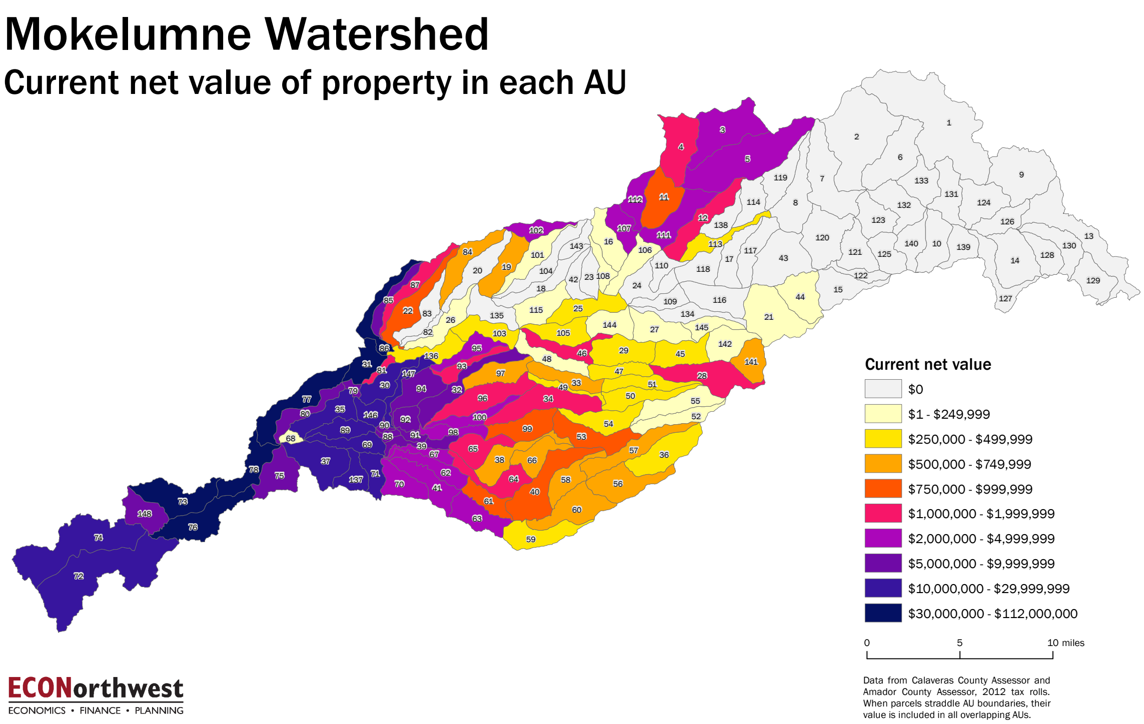
	Hectares burned	*Land value damage (millions)*	*Structural improvement value (millions)*	*Canals impacted (miles)*	*Roads impacted (miles)*	*Roads - costs of repairs (millions)*	*Trans-mission lines impacted (miles)*	*Trans-mission line - costs of repairs (millions)*
Without treatment	18,359	$39.2	$63.2	14.4	235	$16.0	1.81	$3.1
With treatment	11,078	$14.6	$17.6	9.9	147	$7.4	0.85	$1.5
Difference	7281	$24.6	$45.6	4.5	88	$8.6	0.96	$1.6

5.3 Value of Land and Structures (Non-Utility)

Communities in the Mokelumne watershed are concentrated in the lower portions of the watershed. Residences and commercial activity account for the majority of the net (land and structure) value in the lower watershed, while land is the primary component of value in the upper watershed (Figure 5.1). We used Amador County and Calaveras County assessor data on assessed property values for analyses in this section. The assessor data may underestimate property value because of a fixed maximum 2% annual increase in assessed property values in California, due to

Proposition 13 (1978) tying values to most-recent sales.[1] For some parcels, however, these estimates might be overestimates if fire does not result in total structural loss. County assessor data do not include value estimates for undeveloped public lands, which is why many areas in Figure 5.1 and Figure 5.2 are not valued within the data we used.

Figure 5.1: Net value of property in the Mokelumne watershed (land and structures)



When a parcel falls within the modeled fire perimeters, we use the value for the entire parcel because we cannot identify where in the parcels the valuable structures and assets are located. Because the fire perimeters are unbroken, these edge effects are rare and most of the affected parcels had fire across the full area. The total land area of the affected parcels equals 90% of the area of the fires. Thus we use the portion of intersected parcels that extend beyond the fire footprint as a proxy for an equivalent portion of the area not covered by assessor data. For the remaining 10% of the fire footprints not covered by assessor data, we use half the value of average per hectare values for timberlands, and include those values separately. The remaining land not covered by the parcel data is public, primarily Bureau of Land Management (BLM) and US Forest Service (USFS) land. In this section, we consider only the differences between lands that fall within an untreated scenario fire perimeter, not those within the treated scenario modeled fire

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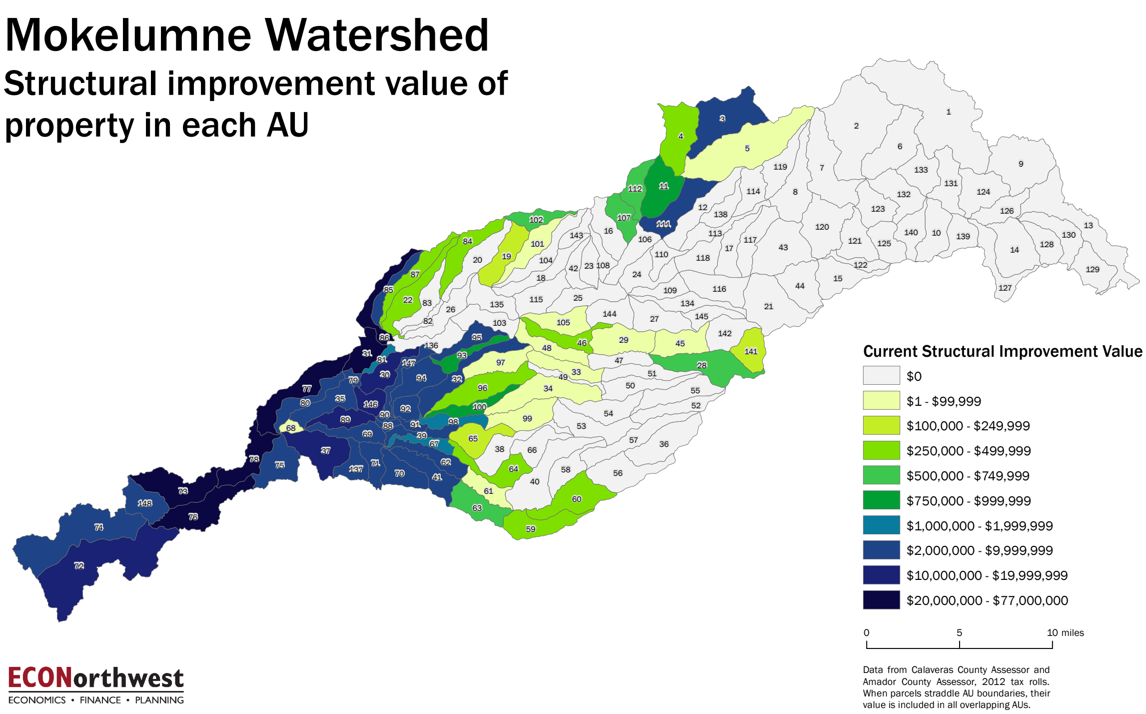
[1]Rapid increases in property value are more typically a result of market demand rather than increases in structural supply costs (materials and labor). Consequently, rapidly increasing property values that outpace assessed value do not likely correspond to rapidly increasing replacement cost as well, in terms of repair or reconstruction.

perimeter. Later in this chapter, we look at the impact that reduced fire severity from treatments may have on structural values.

Figure 5.2: Structural improvement value of property in the Mokelumne watershed



The land value of all parcels in the Mokelumne watershed in Amador and Calaveras counties, for which assessor data are available, is $241 million (Alpine County, located at the highest elevations within the Mokelumne watershed, falls outside of our modeled fire perimeters). The corresponding structural value is $409 million, for a total of $650 million. Table 5.2 shows the aggregated values available from assessor data for parcels that lie within the perimeters of the five fires. The 18,359 hectares of parcels with assessor data in the untreated baseline scenario have a total assessed value of $99 million, while the 11,078 hectares in the treated scenario have a net value of $32 million. It is unlikely that the full $68 million difference in value would be lost, because much of this land would still hold some, if diminished, value. However, there is no standardized methodology for predicting the change in value based on fire modeling, and therefore we include the full value change in this report to highlight the potential change in value that is possible.

Structures, on the other hand, are more likely to lose their full value, and the difference in structural value between the two scenarios is $46 million. While all structures might not be totally lost, repair and removal costs (which are not included in our analysis), could be substantial. The magnitude of the values at risk corresponds to the amount of human development in the area. Areas in the higher elevation reaches of the watershed have fewer structures, while areas lower in

Table 5.2: Impacts on parcels, by fire perimeters (millions $)

	Pretreatment	*Posttreatment*	*Difference*	*Percent decrease in value loss*
Hectares	18,359	11,078	7,282	40%
Land value	$39.2	$14.6	$24.7	63%
Structural improvement value	$63.2	$17.6	$45.6	72%
Net value	$99.4	$31.7	$67.7	68%

Source: ECONorthwest, with data from Amador and Calaveras county assessors.

the watershed contain significant wildland-urban interface (WUI) areas, and therefore have more value at risk. Based on our modeling, the fuel treatments reduced the footprint of the fires and therefore reduced the number of parcels exposed to the modeled fires.

The assessor data also provide a description of the land use for each parcel. We provide a breakdown of values at risk by land use type in Table 5.3. The majority of hectares within the fire perimeters are used for timber production, and are primarily owned by Sierra Pacific Industries. While the value of timberland is not primarily in built structures, the timber value itself is at risk by wildfire, which is accounted for within the value of the land. The majority of structural values are associated with residential parcels.

In addition to decreasing the extent of fire, fuel treatments can also alter the severity of the fire within the perimeter. We assume flame lengths from 0-4 feet as low severity, 4-8 feet as moderate severity, and over 8 feet as high severity. In high-severity fire areas, and their associated longer flame lengths, complete destruction is more likely than in areas with shorter flame lengths. This is because lower flame lengths allow fire fighters to more safely protect structures and land. Therefore, in low severity areas we would expect partial losses to no damage at all of property and structures. Table 5.4 and Figure 5.4 show that, with fuel treatments, the total assessed value of property and structures exposed to low-intensity fire increases, while the total value of property and structures exposed to moderate- and high-intensity fire decreases. The important trend to take from Table 5.4 is that the area of high and moderate severity generally decrease with treatment. This is because the treatments affected fire behavior and many of the lands that burned at high severity under untreated conditions burn at lower intensities under treated conditions.

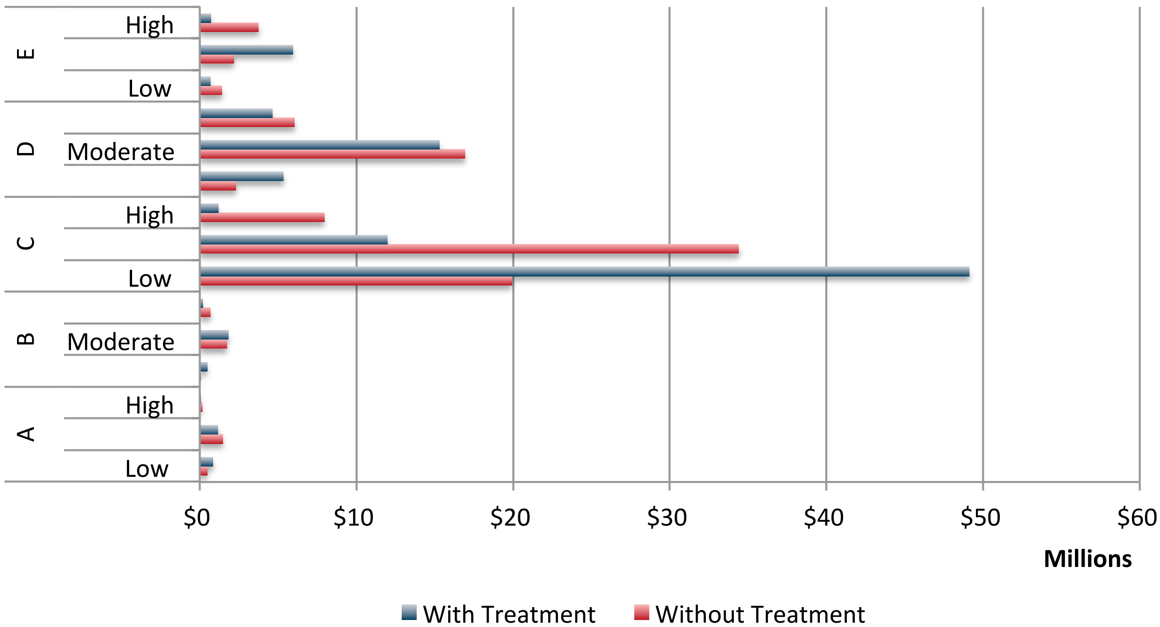
These data suggest that treated parcels and timberlands within fire perimeters are at substantially less risk to damage than if they had been untreated. Firefighters often report that treated lands provide more suitable conditions for successfully defending structures, as well as safer conditions for fire crews to access fire and more effectively suppress it.

Table 5.3: Impacts on parcels, by fire perimeters and land use

Land use	Category	Without treatment	With treatment	Decrease	Percent decrease in lost value
Agriculture	Hectares	2,043	1,405	638	31%
	Land value	$2.1	$1.4	$0.7	34%
	Structural improvement value	$2.7	$0.8	$1.9	69%
	Net value	$4.9	$2.2	$2.7	54%
Commercial	Hectares	8	3	6	67%
	Land value	$0.9	$0.0	$0.9	98%
	Structural improvement value	$2.3	$0.4	$1.9	82%
	Net value	$3.0	$0.4	$2.6	86%
Ranches/ Ranchettes	Hectares	2,220	837	1,383	62%
	Land value	$11.4	$4.3	$7.1	62%
	Structural improvement value	$15.3	$4.5	$10.8	70%
	Net value	$26.3	$8.8	$17.5	67%
Residential	Hectares	1,294	504	790	61%
	Land value	$19.9	$5.9	$14.1	71%
	Structural improvement value	$41.2	$11.3	$29.9	73%
	Net value	$59.0	$16.7	$42.3	72%
Timber production	Hectares	12,312	8,111	4,201	34%
	Land value	$3.6	$2.4	$1.2	33%
	Structural improvement value	$0.2	$0.0	$0.2	93%
	Net value	$3.8	$2.4	$1.4	37%
Other	Hectares	482	218	264	55%
	Land value	$1.3	$0.6	$0.7	54%
	Structural improvement value	$1.5	$0.5	$1.0	65%
	Net value	$2.4	$1.1	$1.3	54%

Source: ECONorthwest, with data from Amador and Calaveras county assessors.

Figure 5.3: Modeled fire impacts on parcels, by fire severity, for the five modeled scenarios



Note: Low = 0-4 ft. flames, Moderate = 4-8 ft. flames, and High = 8 ft. + flames. Source: ECONorthwest, with data from Amador and Calaveras county assessors.

Table 5.4: Modeled impacts of fire severity on parcels, based on the five fire scenario

Fire	*Fire severity category*	*Without treatment*	*With treatment*	*Change*	*% change in value of parcels affected*
A	Low	$0.5	$0.8	$0.4	77%
	Moderate	$1.5	$1.2	-$0.3	-21%
	High	$0.15	$0.08	-$0.065	-44%
B	Low	$0.1	$0.5	$0.4	633%
	Moderate	$1.7	$1.8	$0.1	6%
	High	$0.7	$0.2	-$0.5	-74%
C	Low	$19.9	$49.1	$29.2	147%
	Moderate	$34.4	$12.0	-$22.4	-65%
	High	$7.9	$1.2	-$6.7	-85%
D	Low	$2.3	$5.3	$3.0	132%
	Moderate	$16.9	$15.3	-$1.6	-10%
	High	$6.0	$4.6	-$1.4	-23%
E	Low	$1.4	$0.7	-$0.7-	-52%
	Moderate	$2.2	$5.9	$3.8	174%
	High	$3.8	$0.7	-$3.0	-81%

Note: Low = 0-4 ft. flames, Moderate = 4-8 ft. flames, and High = 8 ft. + flames. Source: ECONorthwest, with data from Amador and Calaveras county assessors.

5.4 Canals and Powerhouses

The 17-mile concrete canal from Salt Springs to Tiger Creek is the only above-ground conveyance in the Mokelumne watershed analysis area; fuel treatments reduce the miles of canal exposed to fire by 31%. Of the 14 miles within the untreated fire footprint (Table 5.5 and Figure 5.3) over 10 of these miles are within Fire A and the remaining miles are within Fires C and D. While wildfires may not directly affect the canal, they can increase the severity of floods and mudslides. A landslide through the canal can destroy an entire section of canal, but less dramatic events, such as a small slide that fills the canal with debris, can also be costly. The cost of damage to canals and water conveyance structures depend heavily on the circumstances, and information is not readily available to reasonably estimate potential costs.

Table 5.5: Miles of canals within the perimeters of the modeled five fires

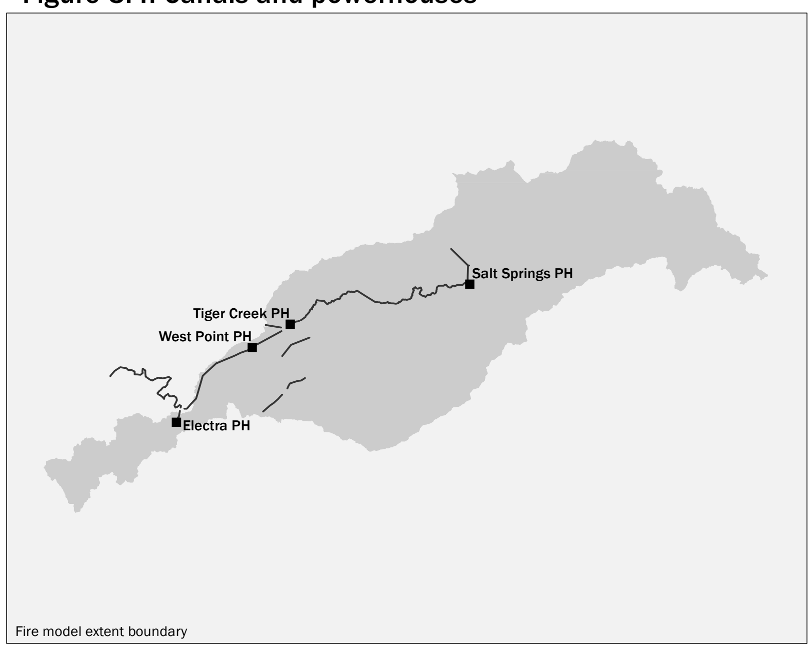
	Without treatment	*With treatment*	*Difference*	*Percent difference*
Canals (miles)	14.4	9.9	4.5	31%

Source: ECONorthwest, with data from Sierra Nevada Conservancy

Cost estimates for canal damages are difficult because effects could range from hours of staff work to clear debris all the way to major repair and loss of operations. Where landslides and debris flows are likely, dredging could be a potential cost. We discuss potential operational impacts on water and energy supplies in Chapter 6.

Even though utility representatives have reported that they are not strongly concerned that there will be major structural damage to powerhouses or canals from wildfire, if there were damage, costs could be substantial. PG&E has protocols for reducing wildfire risk around major structures and defending them from wildfire. Overall, capital costs for new hydropower projects range from $2,000 to $3,000 per kW of capacity (US Energy Information Administration 2010). Based on PG&E's 234 MW of hydropower capacity in the watershed, the capital replacement cost would therefore range from $470 to $700 million.[2] Electra Powerhouse is the only powerhouse within the fire pretreatment perimeter. No

Figure 5.4: Canals and powerhouses



[2] See detailed utility infrastructure inventory in Chapter 6.

powerhouses are within the posttreatment fire perimeters. No dams overlap with the fire perimeters, with or without fuel treatments. Similar to canals and powerhouses, we discuss operational effects of wildfire, and its aftereffects, on dams in Chapter 6, including the value of changes in their operational capacity.

5.4.1 Roads

A wide variety of road repair and replacement costs can be incurred following wildfire. Roads can be heavily affected by runoff, debris, and sediment, including the removal of logs, the repaving or re-grading of heavily damaged sections, and the repair of drainage structures. The California State Transportation Agency (CalTrans), for example, described the following $2.5 million in damages from a fire in Ventura, and the type of tasks that need to be undertaken to restore function: "The wildfire burned and damaged vegetation, roadway signs and highway fencing. This project is to place guardrail to protect the roadway from post-fire falling rocks and debris flows, protect drainage system, replace damaged roadway signs, replace damaged highway fencing, and repair wire mesh and cable anchored covered hillside" (Keck 2013). Similarly, during the 2003 San Diego Fires, CalTrans suffered approximately $15 million in damages to existing roadways[3] (CAL FIRE 2003). This figure included the costs of maintenance and damage assessment teams, field data collection, and the replacement of roads, guardrails, signage, electrical supply, and culverts. Wildfire can disrupt access to roads, reducing the ability to use infrastructure and access assets. Disruptions such as these are relevant to the discussion of periods of loss of use of utility infrastructure in Chapter 6.

Table 5.6 and Table 5.7 show the miles of road, by jurisdictional entity, that would be exposed to fire under the fire model scenarios, and the potential costs associated with restoring these roads to their prefire conditions. The costs are based on per unit values for general project estimates. These costs are based on near total replacement of costs and are consequently possibly over-estimates, although CalTrans individual project costs for postfire repairs are of similar magnitude.

Table 5.6: The effects of the five fire scenario on roads (miles of roads affected)

	All roads	*Forest service roads*	*State highway 26*	*All other roads (state, county, and private)*
Without treatment	235	153	7	75
With treatment	147	109	2	36
Difference	88	44	5	39
Percent difference	37%	29%	71%	52%

Source: ECONorthwest, with data from ESRI.

[3] The 2003 Cedar Fire in San Diego County burned 1,134 km^2. CAL FIRE. 2003.

Table 5.7: Representative total cost of repairing/replacing affected roads

	Forest service roads	*State highway 26*	*All other roads (state, county, and private)*
Without treatment	$6,894,000	$1,560,000	$14,400,000
With treatment	$4,915,000	$459,000	$6,850,000
Cost per mile	$45,000	$225,000	$192,000

Source: ECONorthwest, with data from multiple sources. See footnote.[4] Based on per unit values and compared to total costs from recent fires in California.

5.5 Power Transmission Lines:

Following the 2003 San Diego fires, San Diego Gas and Electric spent roughly $71.1 million to replace lost equipment and to restore services, which included the repair or replacement of approximately 3,200 power poles, 400 miles of wire, 400 transformers, and more than 100 other pieces of equipment (Rahn 2010). Table 5.8 shows average costs of a new transmission line. Taking the average of these costs ($1.725 million per mile) and assuming that a conservative 10% of the transmission line mileage exposed to fire in the model needs to be replaced, we obtain the results shown in Table 5.9.

Table 5.8: Average cost per mile (2012$)

	New transmission line	*Removal of transmission line*	*Reconducter/upgrade transmission*
60 kV	$1.24-$2.21 million	$0.22-$0.37 million	$1.04-$2.57 million
115 kV	$1.24-$2.21 million	$0.22-$0.37 million	$1.04-$2.57 million
230 kV	$1.45-$2.62 million	$0.40-$0.58 million	$1.25-$3.21 million

Source: California ISO. 2012. *PG&E 2012 Final Per Unit Cost Guide*. Retrieved on April 17, 2013 from www.caiso.com/Documents/ PGE_2012FinalPerUnitCostGuide.xls.

Notes: These costs do not include: (1) engineering costs), (2) capitalized licensing and permitting costs, (3) civil work, (4) general facilities, (5) substation control buildings, (6) incremental cost for transmission line crossings, (7) incremental cost of soil/geotechnical mitigation measures, (8) incremental environmental monitoring and mitigation, (9) corporate overheads, (10) income tax component of contribution.

The assumption of 10% is based on conversations with PG&E and review of expectations by other utilities, based on protocols to treat areas and defend transmission lines during wildfire. This is largely due to the fact that utilities keep transmission line corridors clear of overhanging branches, providing enhanced protection even if the line is within the fire perimeter. For this reason we used a 10% transmission line replacement rate in both our high and low cost estimates in the final results. Under severe fire conditions, however, the damages and subsequent costs could be ten

[4] Forest service road estimates based on the per mile cost of reconstructing existing roads to meet current design standards. The work involved is similar to clearing and reconstructing fire-damaged roads (Krause 2000). County highway reconstruction/upgrade cost: Foth and Van Dyke 2003. Average county road construction cost: Texas 2001.

times these amounts. This was the case in the aforementioned fires in the San Diego area in 2003, which saw a higher rate of damage. If fires in the Mokelumne burn at a higher intensity with a faster rate of spread, a loss of 50% of the transmission line within the fire perimeter is possible, with a resulting replacement cost of $8.0 million dollars.

Table 5.9: Potential transmission line impacts and costs

	Power transmission lines (miles)	*Percent of total mileage affected by fire*	*Mileage affected by fire*	*Repair/ replacement costs*
Without treatment	18	10%	1.81	$3.1 million
With treatment	8	10%	0.85	$1.5 million

Source: ECONorthwest, with data from Sierra Nevada Conservancy.

5.6 Unquantified Land Effects

In this analysis, we do not directly evaluate the natural capital value of ecological structures (e.g., nesting trees, old growth forests) that would be lost in a wildfire, as well as their associated ecological processes and potential goods and services. We also do not evaluate the impact a large wildfire within the watershed may have on jobs and the local communities. Several of our analyses do capture elements of these values, as property and structural values are in part based on the aesthetic, recreational, and even spiritual benefits associated with the Mokelumne ecosystem. Timber values capture a share of the consumptive values. We also discuss erosion and sediment effects (Chapter 6), which are also associated with ecological structures. While we do not describe the value of habitat function nor the associated plant and wildlife species, the effectiveness of the treatments in reducing the fire footprints in our modeled scenario suggests that valuable ecological structures could be protected by the treatments.

Because the results of the modeling are spatial, further analysis can overlay the results on key ecological areas to determine the extent of the treatments' effectiveness. With the onset of climate change and continued ex-urban growth, the scarcity of forest, riparian, and aquatic ecosystems in California will continue to raise the natural capital value and importance of intact ecosystems.

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Disclaimer

This report is rich in data and analyses and may help support planning processes in the watershed. The data and analyses were primarily funded with public resources and are therefore available for others to use with appropriate referencing of the sources. This analysis is not intended to be a planning document.

The report includes a section on cultural heritage to acknowledge the inherent value of these resources, while also recognizing the difficulty of placing a monetary value on them. This work honors the value of Native American cultural or sacred sites, or disassociated collected or archived artifacts. This work does not intend to cause direct or indirect disturbance to any cultural resources.

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