EPiC Series in Built Environment

Volume 7, 2026, Pages 525–534

Proceedings of Associated Schools of Construction 62nd Annual International Conference

Assessing Fire Risks in San Luis Obispo: The Impact of Building Construction and Landscaping on Wildfire Vulnerability

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As wildfires grow in frequency and intensity across California, understanding and mitigating residential fire risk has become a public safety priority. Communities in the wildland-urban interface (WUI), such as San Luis Obispo, face heightened exposure due to proximity to natural vegetation and the prevalence of older housing stock. While state and local agencies have introduced regulations and educational campaigns, there remains a need for accessible, scalable tools that help identify vulnerabilities at the individual home level. This project assessed wildfire vulnerability across 135 homes in San Luis Obispo using a visual grading rubric developed from peer-reviewed literature and expert input from a direct interview with Fire Chief Damon Pellegrini. The rubric evaluated ten observable factors, including roof and siding materials, window type, vent and eave protection, defensible space, vegetation contact, and overall property maintenance. Each home received a total score, where higher scores indicate lower wildfire vulnerability, and was categorized as Low, Moderate, High, or Extreme Risk. Results showed clear differences across neighborhoods. Neighborhood 5 had the highest (safest) average score and the fewest High/Extreme-risk homes, while Neighborhood 1 had the lowest average score and the highest concentration of High/Extreme-risk homes. Citywide, over one-third of homes fell into the High or Extreme categories. Common vulnerabilities included wood siding, single-pane windows, and vegetation in direct contact with the structure. These neighborhood-level patterns suggest that observed mitigation features and maintenance vary across San Luis Obispo and may relate to broader neighborhood context, although socioeconomic variables were not directly measured. Overall, the rubric proved effective as a simple, repeatable tool for identifying common structure-level vulnerabilities that can help guide homeowner action and support wildfire preparedness efforts.

Keywords: wildfire vulnerability, home ignition risk, fire mitigation, San Luis Obispo, wildfire preparedness, residential fire risk

Introduction

Wildfires are a growing threat across California, fueled by climate change, expanding development, and increasing fuel loads in surrounding natural areas. Communities like San Luis Obispo, where neighborhoods are adjacent to open space and vegetation-dense landscapes, face heightened exposure

to wildfire events. While large-scale fire behavior is influenced by weather and topography, structure-level vulnerability often determines which homes survive and which are destroyed. Factors such as construction materials, landscaping choices, and building maintenance play a critical role in determining a structure's resilience during a wildfire [1].

Despite widespread awareness of wildfire risks in California, there remains a gap in quick, repeatable tools for assessing individual home vulnerability across mixed-age neighborhoods using features that can be observed from the street. Existing guidance (such as defensible space recommendations and home hardening checklists) is valuable, but it is often used at the household level and does not always translate into a consistent way to compare vulnerability across many homes or neighborhoods. This project addresses that gap by developing and applying a visual, field-based grading rubric to evaluate the wildfire risk of 135 homes in San Luis Obispo. Informed by academic research and expert guidance, the rubric allows for consistent evaluation of fire-related vulnerabilities across a diverse range of homes. The goal is to highlight trends, identify common risk factors, and provide actionable insights that can inform both homeowners and policymakers in reducing structure loss during future wildfire events.

Literature Review and Interview

As wildfires increasingly threaten communities across California and the western United States, their impact on homes has become a key focus of research and mitigation efforts. In the wildland-urban interface (WUI), a home's vulnerability is shaped by factors like vegetation, topography, site layout, and construction materials. As more development pushes into fire-prone areas like San Luis Obispo County, the need for fire-resilient design is urgent. A growing body of research shows how these variables affect a home's chance of survival and offers strategies to reduce risk at both the parcel and community levels.

One of the most detailed studies was conducted by Syphard, Brennan, and Keeley [1], who analyzed over 2,000 homes affected by the 2003 and 2007 San Diego County wildfires. They looked at both broad landscape conditions and detailed building features. At the local scale, window construction was one of the strongest predictors of survival. Homes with vinyl frames and dual-pane glass performed far better than those with single-pane or wood-framed windows. Stucco siding was more fire-resistant than wood or composite materials, and tile roofing helped, although only when properly sealed to keep out embers. Although public messaging often emphasizes roofing and siding, the study found that window performance had an even bigger impact. This point was reinforced during an interview with Chief Damon Pellegrini of the San Ramon Valley Fire Department [8], who noted that radiant heat can blow out windows, melt siding, and ignite anything nearby without a flame ever touching it.

Vegetation near the structure also plays a critical role. Syphard et al. [1] found that trees or shrubs touching or overhanging roofs or walls significantly increased the chances of home burning. Even limited clearance improved survivability. Gibbons et al. [2] similarly showed that dense vegetation within the first 30 feet of a structure strongly correlated with destruction. These findings support defensible space policies, such as California's 100-foot clearance requirement. Pellegrini, in the same interview [8], explained that when his crews assess homes during an active fire, if a property is severely overgrown, they will tape the mailbox and move the fire line past it. Other studies support these conclusions. Alexandre et al. [3] found that the layout of homes and vegetation mattered more than terrain alone. Butsic et al. [4] showed that clustering development and leaving open space around it can act as a firebreak, especially in high-risk areas.

Beyond the research, policy and building standards are shifting toward prevention. Calkin et al. [5] argue that wildfire disasters are preventable through proactive risk management in the WUI. They recommend moving away from reactive suppression toward smarter community design, strict building codes, and proper landscaping. California's Chapter 7A code and FEMA's Home Builder's Guide to Construction in Wildfire Zones [7] both support this shift with guidelines on ember-resistant vents, fire-rated assemblies, and non-combustible materials.

Pellegrini's insights, shared in a direct interview [8], support many of these findings from the field. He described embers as our biggest nightmare, noting they can travel a mile or more ahead of the main fire and land on vulnerable spots like dry roofs, gutters, or decks. His observations mirror Cohen and Stratton's analysis of the Grass Valley Fire [6], which found radiant heat and embers were the leading causes of ignition. That study also showed that well-maintained defensible space dramatically improved survival rates. These lessons are now central to modern fire safety standards, which combine planning, construction, and ongoing maintenance into a unified approach.

Together, the research and field experience tell a clear story. No single fix is enough. Wildfire resilience depends on layers of protection, including fire-resistant materials, smart landscaping, better site layout, and clear policies. As wildfires become more intense and frequent, applying these strategies at both the home and community level is critical.

Methodology

The wildfire risk grading rubric used in this project was developed based on a combination of peer-reviewed research and expert input. Core guidance came from the paper "The importance of building construction materials relative to other factors affecting structure survival during wildfire" by Syphard, Brennan, and Keeley, along with a direct interview with Fire Chief Damon Pellegrini, who has experience in structure defense and wildfire behavior. Together, these sources shaped a rubric focused on factors that most strongly affect home ignition potential and structure survivability, especially vulnerabilities tied to embers, near-home fuels, and building materials.

The rubric evaluated ten categories: roof material, siding material, defensible space (in feet), tree branches in contact with the structure, vent and eave protection, gutter condition, vegetation maintenance, window type, window frame material, and age of the home. All categories were scored using predefined point scales, and total scores were calculated by summing category points (see Table 1: Full Rubric Scoring Criteria). No post-hoc adjustments were applied. Categories described as "more influential" were represented through the predefined point ranges in Table 1 rather than through any changes made after scoring.

Table 1. Full rubric scoring criteria (points); higher total score = lower wildfire vulnerability. *Primary basis indicates whether scoring logic was informed mainly by Syphard et al. (2017), the Fire Chief interview, or both.*

Category	Observable condition (street-visible)	Points	Primary basis
Roof material	Class A roof (e.g., tile, composite/asphalt architectural, metal)	+5	Syphard et al.
	Non–Class A / unknown (cannot verify)	0	Syphard et al.
	Wood shake / clearly combustible roof	−5	Syphard et al.
Siding material	Non-combustible (stucco, brick/stone, fiber cement)	+3	Syphard et al.
	Mixed/unclear from street	0	Syphard et al.

	Combustible siding (wood, vinyl)	−5	Syphard et al.
Defensible space (nearest continuous vegetation to structure)	≥ 30 ft clearance	+5	Both
	15–29 ft clearance	+2	Both
	< 15 ft clearance / continuous fuels near structure	−5	Both
	Unknown	0	Both
Branches/vegetation contact	No branches touching or overhanging roof/walls	+2	Syphard et al.
	Overhanging within ~5 ft of roof/walls	−2	Syphard et al.
	Branches/shrubs directly touching structure	−5	Syphard et al.
	Unknown	0	Syphard et al.
Vents & eaves protection	Vents appear screened/ember-resistant and eaves boxed/covered	+3	Both
	Partial/unclear protection	0	Both
	Vents/eaves visibly open or unprotected	−3	Both
	Unknown	0	Both
Gutter condition	Gutters clear / no visible debris	+2	Fire Chief interview
	Some debris present	−1	Fire Chief interview
	Clogged/heavy debris accumulation	−3	Fire Chief interview
	No gutters / unknown	0	Fire Chief interview
Vegetation maintenance (Immediate/near-home zone)	Trimmed/maintained; low fuel accumulation	+2	Fire Chief interview
	Mixed/average condition	0	Fire Chief interview
	Overgrown vegetation / heavy fuel accumulation	−3	Fire Chief interview
	Unknown	0	Fire Chief interview
Window type	Double-pane windows	+5	Syphard et al.
	Mixed/unclear	0	Syphard et al.
	Single-pane windows	−5	Syphard et al.
	Unknown	0	Syphard et al.
Window frame material	Metal/vinyl frame	+2	Syphard et al.
	Mixed/unclear	0	Syphard et al.
	Wood frame	−2	Syphard et al.
	Unknown	0	Syphard et al.
Age of home	Built 2000+ (likely newer materials / WUI-awareness era)	+2	Both (proxy)
	Built 1980–1999	0	Both (proxy)
	Built pre-1980	−4	Both (proxy)
	Unknown	0	Both (proxy)

Each home's wildfire risk score was calculated by assigning point values across the rubric categories. For example, homes with Class A roofing materials like tile or composite received positive points, while wood shake roofs received negative points. Siding materials like stucco or fiber cement earned positive points, whereas wood or vinyl scored negative points. Double-pane windows were awarded positive points and single-pane windows were penalized. Landscape factors included defensible space, tree contact with the structure, and evidence of vegetation or gutter maintenance. Homes were also scored by age, with those built before 1980 receiving negative points due to older materials and a lower likelihood of fire-resistant design. Higher total scores indicate lower wildfire vulnerability. All scores were summed, and the total was used to place homes into one of four wildfire risk categories: Low Risk (>15), Moderate Risk (6–15), High Risk (0–5), and Extreme Risk (<0).

To conduct the home surveys, a randomized sampling approach was used. Random points were generated within the San Luis Obispo city boundary and then matched to the nearest eligible single-family residence visible from the public right-of-way to create a geographically distributed sample. Apartments, non-residential parcels, gated streets, and locations that could not be surveyed safely or clearly from the street were excluded; when a random point fell on an ineligible location, it was reassigned to the nearest eligible home. Each home was surveyed in person from the public right-of-way. Photos and field notes were taken to support consistent scoring and documentation. All visual scoring was completed by a single rater using the predefined criteria and photo documentation to maintain consistency across neighborhoods.

Because surveys were conducted visually, not all features were observable for every home. When a feature could not be confidently verified from the street, it was recorded as "unknown" and scored as 0 points (neutral) rather than assumed to be safe or unsafe. This rule helped reduce bias from guesswork and kept scoring consistent across neighborhoods.

To organize the data and evaluate patterns across the city, the survey area was divided into six neighborhoods based on major roadways and neighborhood traits. Roadways were used to define boundaries, as they can act as natural firebreaks and influence development patterns. Neighborhood 1 included Old Town and downtown San Luis Obispo, characterized by older homes and higher density. Neighborhood 2 covered the outer downtown area, including Grand Boulevard. Neighborhood 3 consisted of the campus-adjacent zone, primarily made up of student rentals. Neighborhood 4 included the city's outer residential edges. Neighborhood 5 represented the North Foothill area, which included higher-value homes, newer construction, and more fire-conscious design. Neighborhood 6 encompassed the South Foothill zone, which featured a mix of older and newer homes. This structure allowed for consistent sampling across varying housing types, locations, and fire risk profiles.

To increase transparency, Table 1 identifies which rubric categories and scoring logic were primarily informed by Syphard et al. versus the Fire Chief interview, since both sources contributed to the final assessment tool.

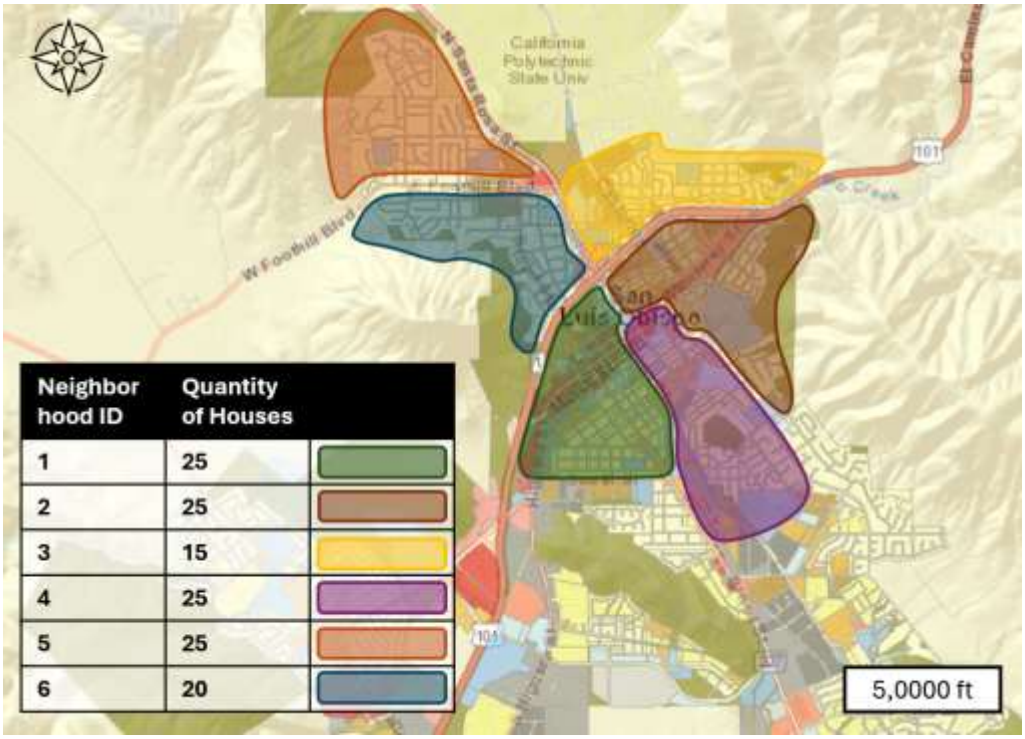

Figure 1. Neighborhood boundaries used for analysis in San Luis Obispo, with sample size per neighborhood (homes surveyed)

Results

A total of 135 homes across six neighborhoods in San Luis Obispo were surveyed using the wildfire risk grading rubric. Each home was visually assessed based on observable factors including construction materials, vegetation proximity, window type, vent coverage, and general property maintenance. Scores were calculated and categorized into four risk levels: Low (>15), Moderate (6–15), High (0–5), and Extreme (<0), where higher total scores indicate lower wildfire vulnerability.

Average scores and risk levels varied by neighborhood (Table 2). Neighborhood 5 had the highest average score at 15.52, falling into the Low-Risk category. Neighborhood 1 had the lowest average at 1.96, placing it in the High-Risk category. The remaining neighborhoods (2, 3, 4, and 6) had average scores ranging from 5.73 to 10.15, all within the Moderate Risk range.

Table 2. Neighborhood sample size and average total rubric score (points; higher score = lower wildfire vulnerability) with overall neighborhood risk rating.

Neighborhood	Homes Surveyed	Average Score	Risk Rating
1	25	1.96	High
2	25	9.08	Moderate
3	25	8	Moderate
4	15	5.73	Moderate
5	25	15.52	Low
6	20	10.15	Moderate

Citywide (n = 135), 46 homes (34.1%) were classified as Low Risk, 39 homes (28.9%) as Moderate Risk, 22 homes (16.3%) as High Risk, and 28 homes (20.7%) as Extreme Risk.

Common wildfire vulnerabilities were tracked across all homes. Wood siding was the most prevalent, appearing in 39.3% of properties. Branches in contact with homes were noted in 29.6%, and single-pane windows were observed in 28.9%. Wood window frames were found in 25.2%, and overgrown vegetation was present in 21.5% of homes. Less frequent but notable risks included uncovered vents and eaves (7.4%) and clogged gutters (5.2%). A significant number of homes had vegetation within 15 feet of the structure, placing them in the higher-risk range for defensible space.

A breakdown of risk rating distribution by neighborhood showed notable differences in preparedness. Neighborhood 1 had the highest concentration of High and Extreme Risk homes, with 64% of properties falling into those categories. Neighborhood 4 followed with 53.3%. In contrast, Neighborhood 5 had the lowest share, with only 12% rated as High or Extreme. The remaining neighborhoods ranged between 25% and 40% in these higher-risk categories.

Discussion/Conclusion

During the visual surveys, clear patterns began to emerge across neighborhoods. In most cases, the overall condition and fire risk of a neighborhood could be gauged at a glance based on street layout, home age, and visible maintenance. Neighborhood 1, San Luis Obispo's oldest neighborhood, reflected this clearly. Many homes there featured single-pane windows, wood siding, and trees in direct contact with the structure, which aligned with low rubric scores. This neighborhood also appeared to include a large number of student rentals, and many parcels showed limited vegetation maintenance and reduced defensible space. While this study did not measure ownership or demographic data directly, these patterns suggest that maintenance and mitigation capacity may vary across neighborhoods and should be explored further using parcel and demographic records.

Neighborhoods closer to downtown or near the university also tended to score lower, largely due to denser housing, aging materials, and the rental status of many homes. Construction trends were also noticeable by decade, with homes built between 1980 and 1999 favoring stucco siding, while newer developments used fiber cement designed to mimic wood with improved fire resistance.

The results suggest that San Luis Obispo is not adequately prepared for wildfire at the structure level. The areas with the highest housing density, typically closer to the center of town, also had the highest concentration of High and Extreme Risk homes. In contrast, more affluent neighborhoods on the outskirts of the city tended to score better. These areas were generally newer, more spread out, and featured better materials and maintained landscaping. This pattern is consistent with a relationship between home value and wildfire resilience.

Many homes could see immediate improvements through better landscape management. Overgrown shrubs and trees in contact with the structure were common issues that could be resolved with basic maintenance. One of the most important retrofits would be replacing single-pane windows, which not only reduce wildfire risk but also improve energy efficiency. A key takeaway from the grading process was how easily small individual vulnerabilities, such as exposed vents, wood fencing, or vegetation, can add up and push a home into a high-risk category. Homes that appear aesthetically pleasing from the street, especially those with dense greenery, often carry hidden fire hazards that are easily overlooked.

To illustrate how the rubric functions in practice, two homes from the survey provide clear contrasts in wildfire risk. an example home in Neighborhood 5 (Figure 2), located in a newer development, scored in the Low Risk category. The home featured composite Class A roofing, stucco siding, double-pane windows with metal frames, and a well-maintained landscape. It had at least 15 feet of defensible space, no vegetation contact, and all vents were properly covered. These characteristics contributed to a strong overall score, demonstrating how newer construction paired with consistent maintenance can significantly reduce wildfire vulnerability.

Figure 2. Example Low-Risk home (Neighborhood 5). Visible features include Class A roofing, stucco siding, double-pane windows with metal frames, maintained defensible space, and no vegetation contact with the structure.

In contrast, an example home in Neighborhood 1 was assessed as Extreme Risk, receiving a total score of –24 (Figure 3). This home had combustible wood siding, single-pane windows with wood frames, and less than 15 feet of defensible space. Tree branches were in contact with the structure, and vegetation was overgrown. While the roof was made of fire-resistant material, the cumulative effect of

multiple vulnerabilities placed the home well into the highest risk category. This comparison highlights how a few critical features—especially in combination—can have a dramatic impact on a home's wildfire resilience.

Figure 3. Example Extreme-Risk home (Neighborhood 1). Visible features include combustible wood siding, single-pane windows with wood frames, limited defensible space, and vegetation/branches in contact with the structure.

While the rubric provided a structured approach to assessing home-level wildfire risk, there were several limitations in its application. The most significant challenge was the inability to fully observe and evaluate backyards or areas not visible from the street, which may have contained critical risk factors such as wood decks, storage structures, or flammable vegetation. Although single-pane windows were generally easy to identify due to their reflection and appearance, other features such as vent screening, roof edge conditions, or fencing material behind the home were often obscured or inaccessible. The rubric itself could be improved by expanding the range of scoring categories. Additional criteria such as roof complexity (including valleys or intersecting slopes), the presence of attached wood elements like trellises or pergolas, and proximity to shared greenbelts or open space could provide a more complete picture of wildfire exposure. Including a hazard modifier for homes located on slopes or in wind-prone areas could also enhance scoring accuracy. Future iterations of the rubric may benefit from a combination of visual assessment and homeowner input to capture more detailed risk factors. It is also important to note that this rubric is a vulnerability index based on visible proxies. It does not model fire behavior, ember exposure, radiant heat, suppression response, or the likelihood of loss during a specific event.

This project highlights the importance of structure-level wildfire assessment in identifying preventable risks within residential neighborhoods. The visual grading rubric developed for this study proved effective in showing how building materials, vegetation management, and maintenance patterns vary across San Luis Obispo. The fact that over one-third of homes surveyed were rated as High or Extreme Risk shows that many properties remain vulnerable, particularly in older and higher-density areas. Many of the most common vulnerabilities are also actionable, especially single-pane windows, combustible siding, and vegetation in contact with the structure. With relatively low-cost changes such as window upgrades, vent screening, and basic defensible space maintenance, many

homes could reduce vulnerability quickly. This tool has the potential to support homeowners, fire departments, and planners in prioritizing outreach and mitigation efforts as wildfire threats continue to increase across California.

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