PLANNING & DEVELOPMEN

APPEAL FORM

09APL-00000-00031
SANTA BARBARA BOTANIC GARDEN: 99-DP
1212 MISSION CANYON RD 11/5/09
SANTA BARBARA 023-051-004

SITE ADDRESS:__1212 Mission Canyon Road

ASSESSOR PARCEL NUMBER: 023-340-013, -014, -015; 023-052-001, -002, -003, -004, -008, -011, -012; 023
006; 023-350-006; 021-030-001

PARCEL SIZE (acres/sq.ft.): Gross ______________ Net ______________

COMPREHENSIVE/COASTAL PLAN DESIGNATION: REC. ZONING: REC, AG-I-10, 1-E-1

Are there previous permits/applications? ☐no ☐yes numbers:______________
(include permit# & lot # if tract)

Are there previous environmental (CEQA) documents? ☐no ☐yes numbers:

1. **Appellant:** _Friends of Mission Canyon Phone: 805 682-0585 FAX: 805 682-2379

   Mailing Address:_Post Office Box 92233, SB, Ca, 93190 E-mail: Airlaw5@cox.net
   Street City State Zip

2. **Owner:** Santa Barbara Botanic Garden Phone:______________ FAX:______________

   Mailing Address: 1212 Mission Canyon Road, SB, Ca, 93101 E-mail:______________
   Street City State Zip

3. **Agent:** Ken Marshall Phone: ______________ FAX:______________

   Mailing Address:______________ E-mail:______________
   Street City State Zip

4. **Attorney:** Richard Monk Phone: ______________ FAX:______________

   Mailing Address: ______________ E-mail______________
   Street City State Zip

COUNTY USE ONLY

*Case Number:*______________ *Companion Case Number:*______________
*Supervisorial District:*______________ *Submittal Date:*______________
*Applicable Zoning Ordinance:*______________ *Receipt Number:*______________
*Project Planner:*______________ *Accepted for Processing*______________
*Zoning Designation:*______________ *Comp. Plan Designation*______________

COUNTY OF SANTA BARBARA APPEAL TO THE :

XX_ BOARD OF SUPERVISORS

_____ PLANNING COMMISSION: _____COUNTY _____ MONTECITO

E: Project Title Santa Barbara Botanic Garden Vital Mission Plan

ase No 99-CP-043; 72 CP-116 RV01

ate of Action 10/26/2009

hereby appeal the _____approval XXX approval w/conditions _____denial of the:

_____Board of Architectural Review – Which Board? ____________________

_____Coastal Development Permit decision

_____Land Use Permit decision

_XX_Planning Commission decision – Which Commission? County

_____Planning & Development Director decision

_____Zoning Administrator decision

Is the appellant the applicant or an aggrieved party?

________ Applicant

_XXX____Aggrieved party – if you are not the applicant, provide an explanation of how you are and "aggrieved party" as defined on page two of this appeal form:

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____

____

Reason of grounds for the appeal – Write the reason for the appeal below or submit 8 copies of your appeal letter that addresses the appeal requirements listed on page two of this appeal form:

- A clear, complete and concise statement of the reasons why the decision or determination is inconsistent with the provisions and purposes of the County's Zoning Ordinances or other applicable law; and
- Grounds shall be specifically stated if it is claimed that there was error or abuse of discretion, or lack of a fair and impartial hearing, or that the decision is not supported by the evidence presented for consideration, or that there is significant new evidence relevant to the decision which could not have been presented at the time the decision was made.

See Attached

Specific conditions imposed which I wish to appeal are (if applicable):

a. All

Please include any other information you feel is relevant to this application.

CERTIFICATION OF ACCURACY AND COMPLETENESS Signatures must be completed for each line. If one or more of the parties are the same, please re-sign the applicable line.

Applicant's signature authorizes County staff to enter the property described above for the purposes of inspection.

I hereby declare under penalty of perjury that the information contained in this application and all attached materials are correct, true and complete. I acknowledge and agree that the County of Santa Barbara is relying on the accuracy of this information and my representations in order to process this application and that any permits issued by the County may be rescinded if it is determined that the information and materials submitted are not true and correct. I further acknowledge that I may be liable for any costs associated with rescission of such permits.

Marc Chytilo [signature] 11/5/09

Print name and sign – Firm Date

Marc Chytilo [signature] 11/5/09

Print name and sign - Preparer of this form Date

Print name and sign - Applicant Date

Print name and sign - Agent Date

Print name and sign - Landowner Date

LAW OFFICE OF MARC CHYTILO

ENVIRONMENTAL LAW

November 5, 2009

Clerk of the Board of Supervisors Mike Brown
Santa Barbara County Board of Supervisors
105 E. Anapamu Street
Fourth Floor
Santa Barbara, California 93101

RE: Appeal of All Aspects of Botanic Garden CUP and Development Plan Approval by Planning Commission, 06APL-00000-00019

Honorable Members of the Board of Supervisors:

This office represents the Friends of Mission Canyon ("FOMC"). FOMC is a community based public benefit corporation that seeks to protect and enhance the sensitive resources of Mission Canyon. While our focus is in Mission Canyon, the planning issues raised by this Project concern and affect the entire County. And while the Botanic Garden is a treasured resource for all County residents, including those in Mission Canyon, the brunt of the impacts of the approval of largest single project in the history of Mission Canyon will be borne principally by Mission Canyon residents and the environment of Mission Canyon.

Please accept this appeal to the Board of Supervisors of the action of the Santa Barbara County Planning Commission on October 26, 2009 approving the Santa Barbara Botanic Garden Conditional Use Permit 72-CP-116 RV01 and Development ~~Plan 99-~~DP-043 ("Project"), including appeal of the certification of the environmental impact report ("EIR"), the adoption of findings, conditions, and all other elements and aspects of the Planning Commission's action on the Project.

FOMC is an "Aggrieved Party" as its organizational purposes include protection of the physical and social environment of Mission Canyon, its members include residents of Mission Canyon on whose behalf this appeal is filed, and as it has participated through counsel at all stages of the County's review of the Project, including submitting written comments and appearing before the Planning Commission at each public hearing.

The grounds for this appeal are detailed below and will be further developed in subsequent submittals. The principal underlying concern is that Mission Canyon is ill-suited for the proposed major physical expansion and intensified institutional activities due to the extremely high fire risk in the Canyon and the associated public safety hazards to the Garden's visitors and staff, as well as to Canyon residents, and from the extremely constrained evacuation capacity. Substantive land use issues include the Project's inconsistency with the Land Use and Development Code, zoning designation, General Plan and with the resource constraints of Mission Canyon. Approval was in error and constituted an abuse of discretion; was not

MARC CHYTILO
P.O. Box 92233 • Santa Barbara, California 93190
Phone: (805) 682-0585 • Fax: (805) 682-2379
Email: airlaw5@cox.net

supported by substantial evidence in the record; was the product of an unfair and partial hearing; and did not reflect new information of fundamental significance to public safety (red flag notification protocols) that was presented for the first time at the final adoption hearing and related information that has been disclosed since that time.

We respectfully request that the Board of Supervisors uphold this appeal, reject certification of the EIR and deny the Project for all of the reasons stated herein with directions to the Applicant to revise their Project to locate a portion of their physical development and activities offsite to offset the expanded uses and impacts associated with the Project. Many elements of the Project are simply not compatible with the sensitive and hazardous environment in which they are proposed, and themselves pose significant and unnecessary risks to Canyon residents and the applicant's staff and visitors. The Applicant has refused to consider and incorporate the interests and concerns of the ~~surrounding~~ communities, and instead undertaken expensive public relations efforts to excoriate concerned neighbors. While there is a need for certain specific remodeling and upgrading to the applicant's physical plant, the proposed development will unnecessarily dominate the site and the setting. While there is a benefit to imposing specific and enforceable limits on the applicant's activities in fire-vulnerable Mission Canyon, the conditions fail to ensure that activities will not cause considerable impacts to the surrounding community and allow substantial incremental expansion in uses and activities that endanger the safety of residents and visitors.

Background and Summary of Appeal

The Project includes a substantial increase ~~in the size~~ of the Botanic Garden's physical plant as well as a significant expansion in the activities and uses permitted on the site. The Project is located in a box canyon in an extremely high fire hazard zone with only a single means of emergency evacuation. The Development Plan involves adding 15 new buildings and over 29,000 square feet of new development to the existing 39,000 square feet of development. The Applicant invites large numbers of individuals to its grounds for general visitation as well as conducting educational classes and numerous public and private events. The conditional use permit ("CUP") sanctions a 50% increase in visitation over 20 years and commensurate increases in other activities on roads that fail to meet basic width and sight requirements. Development is proposed atop a Chumash village site and in the historical and landmarked portions of the Garden. The Jesusita fire burned much of the site and surrounding areas, materially changing both the baseline environmental setting and the Project itself, which now includes rebuilding the burned Gane House. The proposed level of development overwhelms the site and exceeds the evacuation capacity of Mission Canyon's roads, and the changes since the review process began are sufficient to trigger the need for recirculation of the EIR.

The Planning Commission's Review Was Cursory and Incomplete

The Planning Commission's review of the Project did not adequately analyze many important project issues. The Planning Commission never discussed or deliberated on the size, location or appropriateness of virtually any of the proposed buildings or most of the other aspects of the physical expansion elements of the project. The Planning Commission never evaluated the specific issue of emergency evacuation of Mission Canyon and the effect the Project would have on evacuation, and whether the proposed mitigation measures were at least adequate to leave existing residents exposed to the same level of risk of death from wildfire as they experienced without the Project. They never considered if the Jesusita Fire, which burned 60+% of the Botanic Garden and much of Mission Canyon, changed either the Project or the environmental assessment. They ignored the presence of a Chumash village site where new housing and an expanded new roadway and utility lines were proposed. They even defied the recommendations of the Historic Landmark Advisory Commission and allowed the Meadow Terrace Events Plaza to remain as is and re-wrote the conclusions of the EIR to both allow the historic caretaker's cottage to be moved outside the historic area and to enable even more synthetic concrete and other pavers on the site.

The Planning Commission never discussed whether such a large expansion in use and buildings was appropriate for lands designated extremely high fire hazard and located in a box canyon with a single access road. It became clear that the Planning Commission was never presented with a complete, objective analysis of the risk that the Project will cause either for Mission Canyon residents or the Garden's staff and visitors. The first draft EIR attempted to assess the ability of Mission Canyon to evacuate during an emergency, but withdrew that effort and instead relied on a generalized assessment. Mission Canyon residents asked the County to consider a report by Professor Tom Cova who studied Mission Canyon and concluded the narrow and windy roads in the Canyon, and lack of secondary access severely limited the evacuation capacity of Mission Canyon. The Planning Commission never addressed Professor Cova's study or evacuation capacity in general.

The Project's environmental impact analysis expressly relied on the County Fire Chief's commitment to declare Red Flag conditions, which would close the Garden. At the last minute, the Fire Department's representative announced that the County Fire Department would not accept responsibility for declaring Red Flag conditions, and suggested the Botanic Garden should simply look at the National Weather Service's website to know whether to close down. The Planning Commission accepted this change without meaningful discussion. This decision, relying on a regional fire condition forecast spanning Gaviota to Carpinteria, constitutes a substantial change in the way Red Flag conditions are called and communicated to the community. Subsequent news reports indicate that this change may only be preliminary, or there may be no change at all, contrary to the information provide to and relied on by the Planning Commission. Santa Barbara Independent, Reworking the Red Flag, 10/30/09, attached as Exhibit 1. Since the EIR relied on local control of Red Flag determinations to ensure that the conditions in Mission Canyon would be considered as part of the decision whether it was safe for the Garden to open, the EIR's adequacy and the sufficiency of Project conditions are called into question. As approved, the Botanic Garden itself monitors the National Weather Service website and is required to shut down whenever it notices that Red Flag conditions are present. Since the County does not enforce permit violations on nights and weekends, and the Fire Department abdicated any enforcement role whatsoever, all fire restrictions, including Red Flag closures, are essentially unenforceable at night and on weekends.

The Project worsens an already bad public safety situation for Mission Canyon residents. The EIR included a few measures to improve fire response conditions, but most are weak or otherwise required by code. The Mission Canyon community has been recognized statewide for its voluntary efforts to reduce wildfire risk and improve public safety, but residents recognize the risks associated with their location. The Botanic Garden Project increases those risks due to increased visitation, more traffic, construction-related road closures, large events, large vehicles, flammable vegetation, service of alcohol, night-time activities and other impacts. The mitigation measures fail to compensate for the increased risks and the cumulative effect is increased hazards to the residents of Mission Canyon from the Project. The Planning Commission declined to eliminate the Guild Studio Parking area which involves cars backing onto Mission Canyon Road immediately across from the unsafe intersection with Las Canoas Road. This element of the Project adds a new source of congestion at a critical intersection to an already deficient emergency evacuation route.

There are significant land use issues. Even though the Botanic Garden's proposal is the biggest single development in the history of Mission Canyon, the Planning Commission did not consider whether the development complied with the policies and standards of the proposed Mission Canyon Specific Plan that is currently being updated by the County.

The consequence of the Planning Commission's inadequate review of the issues was approval of a project ill-suited to its site and which substantially increases public safety risk in Mission Canyon. The Board's review of these issues and rejection of the proposed Project is necessary to motivate the applicant to scale back their proposal, take a portion of the development and activities off-site, and protect the sensitive historical, cultural and ecological resources at this site and protect public safety.

DETAILS OF APPEAL

1. Fire Issues

Fire hazard and the risks that fire hazards pose to public safety is the most significant issue posed by this project.

a. Antiquated Risk and Impact Analysis

The EIR's analysis relied on an applicant-drafted Fire Protection Plan ("FPP") that was not revised to reflect the lessons of either the Tea or Jesusita fires. As noted infra, the FEIR selectively made text changes to reflect the November 2008 Tea fire and May 2009 Jesisuta fires, but did so haphazardly and did not substantively update the environmental setting, Project Description, or fire impact analysis sections. The EIR's function as a "full disclosure document" is eviscerated. For example, while live fuel loads are temporarily reduced in upper Mission Canyon, there is now a substantial amount of extremely dry remaining dead fuel above the site, and the unburned areas adjacent to and below the site are exposed to more winds and have increased specific vulnerability.

Since the DEIR was first circulated, California's Climate Change Center has released a report entitled Potential Effects of Climate Change on Residential Wildfire Risk in California, CEC 500-2009-048-F which evaluated the effect of climate change on wildfire and concluded that "residential wildfire risk increases over time for all climate change scenarios" and, with caveats due to model uncertainties, predicted that "tripling or even quadrupling of residential wildfire risk is quite plausible by mid-century, with even greater increases by the end of the century." Pages 23-23, attached as Exhibit 10. This probable substantial increase in wildfire risk militates towards reducing the intensity of development in the extremely high fire hazard areas, not expanding it. This information was not considered in the EIR or staff's analysis.

b. Lack of Secondary Access

Santa Barbara County policy and Fire Code requirements mandates a secondary access remote from the primary access. FEIR 4.5-17. This is a basic and fundamental public safety requirement. Wildfires can start and move very quickly, and many people have died in their cars when they are overrun by the flame front while trying to evacuate. In the East Bay Hills fire, October 19-22, 1991, 25 people died, many in their cars, trapped on steep and narrow streets by congestion, collisions, downed power wires, and smoke. See United States Fire Administration, Technical Report Series, The East Bay Hills Fire, Oakland-Berkeley, California, Federal Emergency Management Agency, National Fire Data Center, p. 36, attached as Exhibit 2. (The entire FEMA report is included as Exhibit # 20 to FOMC's DEIR comments, midway in Volume 4 of the FEIR.) The same type of conditions exist in Mission Canyon, and it is only fortune that the Jesusita fire did not start under high wind conditions and did not turn into a firestorm for 24 hours, allowing evacuations to occur and mutual aid to arrive. Had Jesusita started in high wind conditions like the Tea fire, the loss of life and property would have likely been dramatically different.

Emergency evacuation is this Project's Achilles heel, as it is the biggest constraint to the most effective means of protecting lives from wildfire. Professor Tom Cova specifically studied Mission Canyon's evacuation capacity, and concluded that high wildfire areas like Mission Canyon had an evacuation capacity much like a large building, and that the lack of multiple accessways severely constrained the ability to safely evacuate Mission Canyon residents in extreme wildfire conditions. Public Safety in the Urban-Wildland Interface: Should Fire-Prone Communities Have a Maximum Occupancy?, Thomas Cova, Natural Hazards Review, August 2005, attached as Exhibit 3.

The lack of secondary access is a prime example of the several site constraints that render the proposed location unsuitable for such a large expansion in development and intensified activities. Secondary access is a basic public safety requirement for intensive institutional development in high fire hazard areas, and provided a basis for the County to deny the Windermere project on West Camino Cielo years ago. The County Fire Department expressly rejected the use of an overt shelter-in-place strategy for the Botanic Garden project, and thus evacuation is doubly important.

c. Double-Counting Fire Mitigation Measures

The EIR and staff's analysis concluded that the use of several suggested mitigation measures that purportedly (and mistakenly) reduce the Project's fire hazard risk to insignificance may ALSO be relied upon to overcome the fundamental policy conflict and code non-compliance due to the absence of a secondary access. FEIR p. 4.5-17 to 18; FPP at Table 7, p. 53 ("Same Practical Effect"). The measures include basic code compliance and standard fuel management practices, widening an internal, redundant road through a Chumash village site, a RAWS station (now irrelevant) to inform the Red Flag notification process and other Red Flag condition restrictions, fire hydrants that were previously installed, a water main connection project to improve the supply of water for the already-installed hydrants, and basic practices such as emergency drills. These measures are also relied on as the principal mitigation measures to reduce other fire impacts. FEIR p. 4.5-31 to 33. They fail to add any increment of safety above what is otherwise relied upon (improperly) to provide the "same practical effect" as the absence of a secondary access. This is fundamentally unfair and exposes Mission Canyon residents to undue increased risk.

2. CEQA Defects

a. Failure to Identify Related Projects

To be legally adequate the EIR must include a "list of past, present, and probable future projects producing related or cumulative impacts, including, if necessary, those projects outside the control of the agency". CEQA Guidelines § 15130 (b)(1)(A). The County has a duty to use reasonable efforts to discover, disclose, and discuss related projects. *See San Franciscans for Reasonable Growth v. City & County of San Francisco* (1984) 151 Cal. App. 3d 61, 74 (public agency abused its discretion by omitting other closely related projects that could have been easily ascertained). The list of related projects in the VMP EIR is legally defective because it fails to include the numerous reconstruction projects in ~~Mission~~ Canyon ~~and nearby~~ areas as well as at the Botanic Garden itself that are proposed and anticipated in the wake of the Jesusita and Tea Fires. *See* FEIR pp. 3-1 – 3-3. Specifically, in May 2009 the Jesusita Fire damaged or destroyed a large number of structures in the immediate vicinity of the Project site including at least eight structures onsite and a total of 189 structures. FEIR p. 2-5; Exhibit 4 (County Jesusita Fire Property Summary (5/26/09)). Additionally, the Tea Fire destroyed 210 residences in the Riviera and Montecito areas in November 2008. Exhibit 5 (City Tea Fire Damage Assessment – List Homes Destroyed).

The Final EIR updates the Project Description to briefly describe the burned structures onsite (p. 2-5) however does not describe the off-site damage. The related projects list in the final document was not updated to include either the onsite reconstruction projects or ~~the off-site~~ reconstruction associated with the hundreds of burned structures in the Project's vicinity (pp. 3-1 – 3-3). The County had an opportunity when revising the final EIR, to include the redevelopment projects associated with the Jesusita Fire in the related projects list, and incorporate their impacts into the cumulative impact discussion. Moreover the County had multiple opportunities to include Tea Fire reconstruction projects in the EIR including in the drafts released in December 2007 and April 2009. Given these opportunities to update the EIR, the County's failure to include these projects in the FEIR demonstrates that best efforts were not made at full disclosure in the EIR as required by CEQA. *See* CEQA Guidelines § 15003 (i); *San Franciscans for Reasonable Growth v. City & County of San Francisco* (1984) 151 Cal. App. 3d 61, 74.

b. Legally Inadequate Cumulative Impact Analysis

An EIR must discuss significant "cumulative impacts", defined as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts." CEQA Guidelines §§ 15130(a), 15355(a). "Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time." CEQA Guidelines § 15355(b). The list of related projects, discussed above, forms the basis of the cumulative impact analysis. *See* CEQA Guidelines § 15130(b). "When faced with a challenge that the cumulative impacts analysis is unduly narrow, the court must determine whether it was reasonable and practical to include the omitted projects and whether their exclusion prevented the severity and significance of the cumulative impacts from being accurately reflected." *Bakersfield Citizens for Local Control v. City of Bakersfield* (2004) 124 Cal. App. 4th 1184, 1215.

The cumulative impact analysis in the FEIR is legally inadequate under this standard because it fails to evaluate the additional contribution of the nearly 400 structures (see Exhibits 4 & 5) that have been or will be reconstructed or repaired following Santa Barbara's two recent devastating fires. Discussed in the prior section the County had several opportunities to include the post-fire projects in the Final EIR, making the inclusion of these projects both reasonable and practical. These additional projects will add considerable traffic on roads used to access the Project site, and increase the severity of cumulative impacts including air quality, erosion and water quality, traffic and circulation, and solid waste disposal, among others. As such the exclusion of the post-fire projects from the cumulative impacts analysis prevented the severity and significance of cumulative impacts from being accurately reflected. Under these circumstances, the cumulative impact analysis in the FEIR is legally inadequate. *Bakersfield Citizens,* 124 Cal. App. 4th at 1215.

c. Legally Inadequate Baseline

An EIR is required to include a description of the physical environmental conditions in the vicinity of the project, which constitute the baseline physical conditions for the impact analysis. CEQA Guidelines § 15125. While as a general matter CEQA "normally" requires that baseline reflect the physical environmental conditions existing at the time of the Notice of Preparation (NOP), id., CEQA requires recirculation of a draft EIR where changes in the environmental setting create new significant environmental impacts or substantially increase the severity of an environmental impact. CEQA Guidelines § 15088.5. Since the NOP the physical environmental conditions in the Project's vicinity have changed dramatically. Specifically, the Jesusita fire burned large portion of Mission Canyon, affecting visibility, soil stability, water quality, air quality, and biological resources, among other things. Dozens of additional construction projects are and will be underway throughout the area as houses are rebuilt, landscaping restored, debris is cleaned up, vegetation is cleared, and other fire-related improvements are made. These substantial changes significantly increase the severity of numerous impacts identified in the DEIR and potentially cause other new significant impacts. Two wildfires sweeping through the Project area in 6 months, destroying scores of homes and burning the majority of the Project site and its largest building is a substantial, direct and "not normal" enough change in conditions that § 15125 demands resetting of the environmental baseline. The failure to revise and recirculate the EIR following the Jesusita Fire was error, and the FEIR's impact analysis based upon the baseline environmental conditions existing at the time of NOP is rendered fundamentally inadequate.

d. Failure to Identify Potential Ethnic Impacts

The County's CEQA Thresholds Manual includes a section on Ethnic Impacts, which the FEIR does not reference. Specifically, a project may have significant effects on a community, ethnic, or social group caused by disruption or adverse effects to a property with cultural significance to a community or ethnic or social group or conflict with established recreational and religious uses of the area. County Environmental Thresholds and Guidelines Manual, p. 53. The Project site carries extraordinary significance for the local Chumash. The FEIR is defective for failing to identify, evaluate, and mitigate potential ethnic impacts.

e. Failure to Identify Inconsistencies as with Adopted Plans and Policies

Conflicts with plans and policies adopted for the purposes of avoiding or mitigating an environmental effect are potentially significant impacts under CEQA. *See* CEQA Guidelines App. G § IX (b); *Pocket Protectors v. City of Sacramento* (2004) 124 Cal.App.4th 903, 930. The FEIR is legally inadequate for failing to identify and analyze any such impacts. The specific plans and policies that the Project is inconsistent with include but are not limited to: 1) provisions of the zoning ordinance applicable to recreationally zoned lands; 2) Fire Department standards and the General Plan requirement that adequate services are available for the proposed development and; 3) cultural resource protection policies in the General Plan.

i. Conflicts with the Zoning Ordinance

The Project site is zoned Recreation, a special purpose zone. Section 35.26.020 (D) of the County Zoning Ordinance articulates the purpose of the Recreation Zone as follows:

The REC zone is applied to provide public or private open space areas appropriate for various forms of outdoor recreation. The intent is to encourage outdoor recreational uses that will protect and enhance areas with the potential to accommodate both active and passive recreation because of their beauty and natural features. Proposed recreational uses should compliment and be appropriate to the area because of the natural features.

The proposed Project is inconsistent with the purposes of the Recreation Zone because it proposes a significant increase in building area on the site, intensifying indoor and non-recreational uses. The construction associated with the Project as well as increased building area and hardscaping will actually diminish the outdoor recreational experience currently available at the Botanic garden by compromising the beauty and natural features of the Garden as well as introducing construction dust and noise.

The County Zoning Ordinance also lists specific uses that are prohibited in the Recreation zone. § 35.20.030(B)(1)(f); *see* Tables 2-3 and 4-15. "Carnivals, circuses, and similar activities" are prohibited ("— Use Not Allowed"). Table 4-15. "Carnivals, circuses, and similar activities" are further defined as including "art and craft fairs (including the sale of antiquities and art objects)". LUDC § 35.42.260 (F). The VMP Project proposes uses including "Art/Craft Exhibits" that the Garden has engaged in and proposes to continue. *See* FEIR Table 2-6, p. 2-25. Exhibits 6-8 provide examples of past Garden events that constitute an "art and craft fair" under the LUDC. Specifically, the Garden's 80th Anniversary Celebration, "Art in the Garden" is described as "a day of strolling through the Garden and an opportunity to view and acquire artwork by artists from the Santa Barbara Art Association, Goleta Art Association, and Southern California Artists Painting for the Environment." Exhibit 6. The Garden describes its "Annual Holiday Marketplace" of 2008 as "featuring new local vendors and their exciting displays of nature-related, handcrafted items." Exhibit 7. The same event in 2006 is described as "featuring the ever-popular Garden Guild crafters and local artisans" and offering a "wide range of gifts and decorative items". Exhibit 8. The events featuring these arts and crafts for sale, displayed for example on tables in the Garden as depicted in Exhibit 6, clearly fit within the LUDC and commonly understood definitions of an art and craft fair.[1] Similarly, the Project Description contemplates 2 day "community festivals" involving up to 750 people on a case by case basis. Community festivals are similarly prohibited temporary uses in REC zone districts. The applicant has even proposed turning its grounds into a Winter Wonderland complete with Giant Snowmen, 8 foot Candy Canes and thousands of twinkling lights. Exhibit 9. Careful delineation of appropriate uses on this Rec zoned parcel are required.

Both in proposing uses that are inconsistent with the purposes of the Recreation zone, and proposing uses that are specifically prohibited in the Recreation zone, the VMP is inconsistent with the County's Zoning Ordinance. The FEIR is defective for failing to identify, evaluate, and avoid or mitigate this potentially significant impact. *See* CEQA Guidelines App. G § IX (b); *Pocket Protectors,* 124 Cal.App.4th at 930.

ii. Conflicts with General Plan Land Use Development Policy 4 and Fire Department Standards

General Plan Land Use Development Policy 4 provides that prior to issuance of a use permit the County must find that "adequate public or private services and resources (i.e. water, sewer, roads, etc.) are available to serve the proposed development." This finding for cannot be made for the VMP, because adequate services are not available to serve the proposed development. Specifically, portions of proposed roads on-site do not meet the County Fire Department's minimum width requirement. FEIR p. 4.5-17. Further, Mission Canyon Road which provides the only vehicular access to the Garden does not meet the Fire Department's minimum road width

[1] See e.g. def. *fair* "a periodic gathering of buyers and sellers in an appointed place; an exposition in which different exhibitors participate, sometimes with the purpose of buying or selling"(http://dictionary.reference.com/browse/fair) def. *craft fair*: "a fair at which objects made by craftsmen are offered for sale" (http://dictionary.reference.com/browse/craft+fair)

standards. August 5, 2009 PC Staff Report, p. 45. Moreover, there is no secondary access to the site as required by the Fire Department. FEIR p. 4.5-17. Additionally, there is insufficient water available to provide for fire flows that meet the County Fire Department's standards for commercial facilities without creating deficiencies elsewhere in the system. *See* August 5, 2009 PC Staff Report, p. 45; FEIR pp. 4.9-10 – 4.9-11. Whether the proposed mitigation to extend a new water line through Mission Canyon will provide adequate water and pressure to meet commercial fire flow requirements is entirely speculative. *See* August 3, 2009 letter from fire and public safety expert Michael Decapua of Public Safety Consultants Northwest, LLC, pp. 7-8.

Because there are inadequate services available to serve the VMP, and because the VMP does not satisfy County Fire Department Fire Department minimum standards for road width, secondary access~~,~~ and ~~commercial~~ fire flows, the Project is inconsistent with General Plan LU Policy 4 and with County Fire Department standards. The FEIR is defective for failing to identify and analyze these potentially significant land use impacts. *See* CEQA Guidelines App. G § IX (b); *Pocket Protectors,* 124 Cal.App.4th at 930.

iii. Conflicts with General Plan Cultural Resource Policies

General Plan Land Use Element Historical and Archaeological Sites Policy 1 requires that "[a]ll available measures, including purchase, tax relief, purchase of development rights, etc., shall be explored to avoid development on significant historic, prehistoric, archaeological, and other classes of cultural sites." The VMP is inconsistent with this policy because no such exploration of all available measures to avoid development ~~on 1)~~ the historically significant County Landmark #24 or 2) culturally, archaeologically, and spiritually significant sites.

Additionally, General Plan Land Use Element Historical and Archaeological Sites Policy 2 requires that project design avoid impacts to cultural or archaeological sites if possible. Elements of the Project design including the proposed road on the Hansen site do not avoid significant archaeological and cultural resources, though it is possible to eliminate the road to avoid the significant sites. Moreover, the Project design includes new structures in and near Landmark #24 that impact the significance of the landmark (a cultural site), but Project redesign that would avoid these impacts was not considered.

For these reasons the Project is inconsistent with General Plan Cultural Resource policies, and the FEIR is defective for failing to recognize this inconsistency as a potentially significant impact. *See* CEQA Guidelines App. G § IX (b); *Pocket Protectors,* 124 Cal.App.4th at 930.

iv. Conflicts with the 1984 and Initiated Revised Mission Canyon Specific Plan Policies

Mission Canyon is finally updating the 1984 Mission Canyon Specific Plan ("MCSP") that sets policy goals and development standards for all development in Mission Canyon. Your Board initiated revision of specific changes to the MCSP and those changes are currently undergoing environmental review. At the same time, the applicant here has proposed the largest single project every proposed for Mission Canyon. Common sense and equity demands that the Board at least be informed by a careful, searching analysis of the proposed Project's consistency with the MCSP. As proposed, the Project conflicts with a number of the MCSP goals and policies, and will unquestionably constrain the achievement of those goals. While these inconsistencies may not provide an independent rationale for rejecting the Project on that basis alone, the Board should be apprised of the consequences of its actions. FOMC will submit additional detail on these inadequacies.

f. Applicant Manipulation of Feasibility

The agency may not simply accept at face value the project proponent's assertions regarding feasibility of alternative sites and project configurations. *Save Round Valley Alliance v. County of Inyo* (2007) 157 Cal. App. 4th 1437, 1458; *Laurel Heights Improvement Assn. v. UC Regents* (1988) 47 Cal. 3d 376, 404 (courts will not "countenance a result that would require blind trust by the public"). The applicant's feeling about an alternative cannot substitute for the required facts and independent reasoning. *Preservation Action Council v. City of San Jose* (2006) 141 Cal.App.4th 1336, 1356; *see also Uphold our Rural Heritage* (2007) Cal. App. LEXIS 165, 29 (the fact that applicant does not wish to proceed with an alternative not make that alternative legally infeasible). Here, the FEIR concludes that off-site alternatives are infeasible despite the fact that they meet most of the basic Project Objectives as required by CEQA (*see* CEQA Guidelines § 15126.6). This finding of infeasibility derives from the Project applicant's strong opposition to relocating even a portion of the Garden's facilities and/or activities off-site. Because the County based its conclusion that an off-site alternative is infeasible upon the Project applicant's desires as opposed to facts and independent reasoning, the alternatives analysis violates CEQA.

g. Inadequate Responses to Comment

The FEIR's response to public comments received on the draft must reflect a good faith reasoned analysis. "Conclusory statements unsupported by factual information will not suffice." (CEQA Guidelines § 15088 (c). The responses also must address in detail the major environmental issues raised when the City's position is at variance with recommendations and objections raised in the comments. *Id.* The responses to comment included in the FEIR do not satisfy these requirements articulated in the CEQA Guidelines. In particular, the responses failed to adequately address the numerous comments and recommendations from experts and laypeople alike urging that the Fire Protection Plan is inadequate and additional mitigation is required. FOMC will submit additional detail on these inadequacies.

3. <u>Findings</u>

Administrative findings must be adequately detailed to enable a reviewing court to trace and examine the agency's mode of analysis. *Topanga Association for a Scenic Community v. County of Los Angeles* (1974) 11 Cal. 3d 506, 516-517. Findings should function to minimize the likelihood of the County jumping randomly from evidence to conclusions. *Id.* Both CEQA and administrative findings must be supported by substantial evidence in the record. *See* Public Resources Code 21081.5; California Code of Civil Procedure 1094.5 (c). Unfortunately both the CEQA and the Project findings issued for this project do not meet this basic standard of adequacy. Additionally there are specific requirements for CEQA findings and for the particular administrative findings required here that also are not met.

a. CEQA Findings

The CEQA findings adopted by the Planning Commission that significant environmental impacts are mitigated to insignificance are not based on substantial evidence. Particular impact areas in which proposed mitigation is insufficient to reduce significant impacts to insignificance are 1) fire protection, 2) cultural and historic resources, and 3) land use/policy inconsistency. The CEQA findings that identified Project alternatives are infeasible are inadequately detailed, conclusory and also lack substantial evidence.

b. Administrative Findings

The required finding for CUP and Development Plan approval that the Project is consistent with all applicable provisions of the Development Code, General Plan, and Community Plan cannot be made. Discussed in section 1 (e), *supra,* the Project is inconsistent with several such provisions. The adopted findings on this issue lack the required level of detail and are not supported by substantial evidence.

Discussed in section 1 (e) (ii), *supra,* the required finding pursuant to LU Development Policy 4, as well as specific findings required for CUP and Development Plan approval that streets are adequate to carry the type and quantity of traffic generated by the proposed use, is not supported by substantial evidence.

Required findings that all adverse impacts are mitigated to the maximum extent feasible is inadequately detailed and unsupported by substantial evidence. The FEIR does not even adequately mitigate significant project impacts let alone merely adverse impacts. Specifically, significant and adverse impacts to fire protection could be further reduced by limiting Garden visitation and activities. Significant and adverse impacts to cultural and historic resources could be further reduced by prohibiting pavers, eliminating the proposed Meadow Terrace, eliminating the proposed road on the Hansen site, among other things.

4. Condition Inadequacy

The Planning Commission's action endorsed a set of Project conditions that fail to adequately implement mitigation measures, do not rectify policy inconsistencies, are incompetent to provide meaningful protection for the safety and well-being of the public and the Garden's staff and visitors.

In particular, conditions allowing a 50% increase in general, class and event visitation over time is inherently inconsistent with the Canyon's resource constraints. Last minute modifications change the fire protection and Red Flag notification protocols in a manner inconsistent with the EIR and FPP. Oak tree replacement ratios are improperly reduced. FOMC will submit additional detail on these and other inadequacies in the conditions of approval.

5. Historical Resources

The Planning Commission defied the recommendations of the Historic Landmark Advisory Commission and re-wrote portions of the EIR to alter its fundamental conclusions regarding the severity of impacts and need for mitigation of impacts to historical resources. The project will cause numerous irreversible changes to character-defining features of the historic and Landmarked portions of the Project site.

Condition Cult 3-1 improperly defers the preparation of a Cultural Landscape Master Plan for both County Historic Landmark #24, Santa Barbara Botanic Garden Mission Dam and Aqueduct, (also a California State Water Landmark) and certain development east of Mission Canyon Road. The Master Plan involves resource identification, impact assessment, impact mitigation and establishment of standards for both construction and operations that properly should be evaluated as part of the EIR process, not after approval. Further, relying on conformity with the Secretary of Interior's Standards is vague and illusory, as those standards themselves are generalized and vague and do not qualify as specific performance standards that are necessary when mitigation measures rely on future processes.

Additionally, the paving of trails impacts a character defining feature of the landmark and can affect the integrity of the historic design concept and use and eligibility for nomination to the National Register of Historic Places. Various new buildings are planned for location within the landmark. The Terrace Project redefines the Meadow and constitutes an inappropriate structure that conflicts with the historic landscape design concept protected in Resolution 2003-059. As approved, the process allows improper deferral of analysis until after impacts have occurred.

6. Cultural Resources

The Project includes installing a 20' wide roadway and two residences atop and/or immediately adjacent to a Chumash village site. The entire site was the locus of intensive occupation and Native American utilization, as was much of Mission Canyon, but the village site is itself is directly affected by the Project. The County is required to avoid such direct impacts whenever feasible, and there is no evidence that these resources cannot be feasibly avoided.

7. The Appeal Must Be Granted

For all of the above-stated reasons, Friends of Mission Canyon requests that the Board of Supervisors approve this appeal and deny the project.

We incorporate by reference FOMC's prior submittals regarding this project as if attached hereto, including Comments to the Draft, Recirculated and Final EIRs and exhibits attached thereto and our letters submitted to the Planning Commission. We also reserve the ability to submit additional materials in this matter prior to your Board's consideration of this appeal.

Thank you for your careful consideration of the important issues contained herein.

Sincerely,

LAW OFFICE OF MARC CHYTILO

Marc Chytilo
For Friends of Mission Canyon

EXHIBITS

Exhibit 1: Santa Barbara Independent, Reworking the Red Flag, 10/30/09
Exhibit 2: United States Fire Administration, Technical Report Series, The East Bay Hills Fire, Oakland-Berkeley, California, Federal Emergency Management Agency, National Fire Data Center, p. 36
Exhibit 3: Public Safety in the Urban-Wildland Interface: Should Fire-Prone Communities Have a Maximum Occupancy?, Thomas Cova, Natural Hazards Review, August 2005
Exhibit 4: Jesusita Fire Property Summary (5/26/09)
Exhibit 5: Tea Fire Information; Fire Statistics
Exhibit 6: Ironwood, Garden's 80th Anniversary Celebration, "Art in the Garden"

Exhibit 7:	Ironwood, "Annual Holiday Marketplace" of 2008
Exhibit 8:	Ironwood, "Annual Holiday Marketplace" of 2006
Exhibit 9:	Winter Wonderland, Santa Barbara Botanic Garden, December 2008
Exhibit 10:	California Climate Change Center, Potential Effects of Climate Change on Residential Wildfire Risk in California, CEC 500-2009-048-F, 8/2009

Santa Barbara Independent WHO. WHAT. NOW.

Photo by Paul Wellman (file)

Reworking the Red Flag

Fire Agencies Working with National Weather Service to Change Fire Danger Alert System

By Matt Kettmann

Friday, October 30, 2009

The news leaked out rather nonchalantly but to much surprise during Monday's hearing about plans to expand the Santa Barbara Botanic Garden: The Santa Barbara County Fire Department will be changing the way it issues red flag alerts, those warnings that go out to the greater community when the mix of strong winds, low humidity, high temperatures, and other factors collide to result in dangerous wildfire conditions. Once issued, these alerts lead to restrictions on certain activities, help the region's various firefighting agencies strategize proper staffing levels, and let the community know to be mindful of the dangers.

The announcement on Monday that there would be more red flag influence coming from the National Weather Service was delivered by County Fire's Glenn Fidler, and was a shock for everyone in attendance, from planning commissioners Michael Cooney ("brand new and surprising," he said) and Marell Brooks ("disconcerting," said she) to planning staffer Alex Tuttle ("I guess their methods are more refined?" he said of the NWS) and watchdog attorney Marc Chytilo ("that is just an enormous change").

According to Chytilo, Fidler said that there would be "substantial changes" in the way red flag alerts are issued for a specific area. For Chytilo, who is fighting against the Botanic Garden's expansion in large part because he and his Mission Canyon neighbors fear safety will be compromised during construction and because of increases in visitors, this was important because the garden currently must close on red flag days, and Fidler seemed to be suggesting that those closures would now be governed by a new protocol. "He announced that the chief is no longer going to do that," said Chytilo, "and if anybody wants to know if there's a red flag, look to the National Weather Service."

EXHIBIT 1

Paul Wellman (file)

SB County Fire PIO Capt. David Sadecki at a Jesusita Fire press conference.

When contacted, Fidler directed the matter to County Fire Public Information Officer David Sadecki. After an unsuccessful round of phone tag, Sadecki suggested looking at the County Fire Web site, *sbcfire.com*, which lists red flag alert info here. That document, which was last updated in April 2008, did not appear to have undergone any recent tweaks, so Sadecki was asked what changes had recently taken place. "No change," he replied. "We receive a report each morning from the NWS. We use their report as a tool to decide red flag or not. NWS uses temperature, relative humidity, and wind to decide the red flag. The chief can call a red flag if only one condition exists and feels it's warranted."

When informed that Fidler's comments had caused surprise and confusion earlier in the week, Sadecki explained, "[County Fire] is working with the National Weather Service, local fire chiefs, state officials, and Firescope [a SoCal firefighting partnership] to update the current policy regarding red flag alerts. When the new policy is worked out, it will be released to the public." So why did Fidler announce it on Monday? "I think Glenn was only giving a heads up that a change is in the works," emailed Sadecki.

As to what that change will be, no one seems to know, and Sadecki was not more descriptive. Although the City of Santa Barbara's red flag point-person Ann Marx was on vacation, the numerous city people spoken to on the way to Marx's voicemail were also wondering what the status was. Down in Oxnard at the National Weather Service, a similar doubt prevailed. "That's a good question," said NWS fire weather programmer Dave Gomberg. "I've heard the same thing, that they are considering a switch to make it a more consistent message. But I don't know what the official word is from Santa Barbara."

According to Gomberg, different agencies use different standards to call red flag alerts, and many tie it directly to the National Weather Service's opinion, which is pretty much set at sustained winds of 25 mph and relative humidity of 15 percent for six hours for Sundowner conditions or, for non-Sundowners, relative humidity at 20 percent or less for 10 hours or more. Others use temperature and various localized conditions and some, such as Ventura and Los Angeles counties, "rely heavily on trend forecasting" and essentially have their own systems, said Gomberg.

Though he can't forecast what Santa Barbara County plans to do — and no one else seems to be talking either — Gomberg was able to share his news about this weekend's weather: warm and dry, with a slight offshore influence. "It's actually going to be a really nice weekend," said Gomberg.

The East Bay Hills Fire
Oakland-Berkeley, California
(October 19-22, 1991)

Investigated by: J. Gordon Routley

This is Report 060 of the Major Fires Investigation Project conducted by TriData Corporation under contract EMW-90-C-3338 to the United States Fire Administration, Federal Emergency Management Agency.

Federal Emergency Management Agency

United States Fire Administration

National Fire Data Center

EXHIBIT 2

LIVES SAVED AND LOST

Most of the fatalities occurred between 1130 and 1200 hours as the fire spread across the north face of Temescal Canyon, involving all of the structures on Buckingham, Westmoorland, Marlborough, Norfolk, Sherwick, Bristol, Charing Cross, and Tunnel Roads. The spread of the fire by 1200 is shown on the following page. Police officers and firefighters tried to evacuate the area as wind-blown brands and embers ignited more and more spot fires ahead of the rapidly moving fire front. Police cars cruised the streets with sirens wailing, and officers used their PA speakers to warn residents to evacuate.

Residents who had been standing in front of their homes moments before, watching a fire that was two blocks away, were suddenly piling belongings, children, and pets into their cars. The steep narrow streets, now obscured by swirling smoke, were suddenly clogged with cars as falling power lines and flaming brands ignited spot fires, adding to the confusion. Some of the narrow roads were blocked by collisions as panicstricken residents searched for safe escape routes.

The body of Oakland Police Officer John Grubensky was found, along with five civilian fatalities, at a narrow point on Charing Cross Road. It appeared that the cars were jammed at this point by a collision in the narrowest part of the road, and the occupants were unable to escape the advancing flames.

The fatalities included individuals who were unable to evacuate, because of age or disabilities, and several who were overrun by the flames as they tried to escape. Firefighters reported hearing shouts for help from one home and not being able to reach it before it became heavily involved in flames. As their positions were overwhelmed, firelighting crews were split up, and for hours some members did not know the fate of the other members of their companies.

As they pulled out, they tried to evacuate everyone in the path of the fire, and some ended up taking refuge where they could find it. The Lieutenant from Engine 19 reported that he was taking refuge with a group at the base of Gwin Tank, using a hoseline to protect themselves as the fire surrounded their position.

A Lieutenant and a Firefighter had to abandon their Patrol vehicle and took refuge in the swimming pool of a hillside home, along with the homeowner, and spent more than an hour under the pool cover, sticking their heads out just often enough to splash water on the cover to prevent its ignition. The house burned, leaving only the pool, and when the fire

Public Safety in the Urban–Wildland Interface: Should Fire-Prone Communities Have a Maximum Occupancy?

Thomas J. Cova[1]

Abstract: Residential development in fire-prone wildlands is a growing problem for land-use and emergency planners. In many areas housing is increasing without commensurate improvement in the primary road network. This compromises public safety, as minimum evacuation times are climbing in tandem with vegetation and structural fuels. Current evacuation codes for fire-prone communities require a minimum number of exits regardless of the number of households. This is not as sophisticated as building egress codes which link the maximum occupancy in an enclosed space with the required number, capacity, and arrangement of exits. This paper applies concepts from building codes to fire-prone areas to highlight limitations in existing community egress systems. Preliminary recommendations for improved community evacuation codes are also presented.

DOI: 10.1061/(ASCE)1527-6988(2005)6:3(99)

CE Database subject headings: Fire hazards; Evacuation; Access roads; Traffic capacity; Transportation safety; Codes; Public safety; Transportation engineering.

Introduction

Residential development in fire-prone wildlands is a growing problem for land-use and emergency planners. Easy access to recreation, panoramic scenery, and lower property costs are enticing people to build homes in areas that would otherwise be considered wildlands. This development steadily increased in the United States from the mid 1940s, although local growth rates varied according to economic, demographic, and amenity factors (Davis 1990). At the same time, decades of fire suppression has resulted in a record abundance of fuel in and around many developments (Pyne 1997). This led the Forest Service to recently identify thousands of communities near federal lands as "at risk" to large conflagrations (U.S. Forest Service 2001).

The area where residential structures and fire-prone wildlands intermix is called the urban–wildland interface or wildland–urban interface (Cortner et al. 1990; Ewert 1993; Fried et al. 1999). In much of this area, homes are being added as the primary road network remains nearly unchanged. This is not surprising, as interface communities are often nestled in a topographic context that prohibits the construction of more than a few exiting roads. It is generally too expensive to build a road into a canyon, or onto a hillside, from every direction. Also, residents prefer less access because it reduces nonresident traffic. A common road-network addition is a culdesac that branches off an existing road to add more homes.

[1]Associate Professor, Dept. of Geography, Center for Natural and Technological Hazards, Univ. of Utah, 260 S. Central Campus Dr., Rm. 270, Salt Lake City, UT 84112-9155. E-mail: cova@geog.utah.edu

Note. Discussion open until January 1, 2006. Separate discussions must be submitted for individual papers. To extend the closing date by one month, a written request must be filed with the ASCE Managing Editor. The manuscript for this paper was submitted for review and possible publication on October 7, 2004; approved on February 15, 2005. This paper is part of the *Natural Hazards Review*, Vol. 6, No. 3, August 1, 2005. ©ASCE, ISSN 1527-6988/2005/3-99–108/$25.00.

Incremental planning in fire-prone areas has a number of adverse impacts (e.g., wildfire effects, open space decline), but the focus in this paper is evacuation egress. "Egress" is defined as a means of exiting, and it can be viewed as accessibility out of an area in an evacuation. When a wildfire threatens a community, residents generally evacuate in a condensed time either voluntarily or by order. In past urban wildfires with short warning time, limited egress has proven to be a problem ("Charing cross bottleneck was a big killer" 1991; Office of Emergency Services 1992). Sheltering-in-place is a competitive protective action when there is not enough time to escape or a homeowner wishes to remain behind to protect property, but it is much less tested than evacuation in wildfires. However given increasing housing densities in fire-prone areas without commensurate improvements in the primary road network, the case for sheltering-in-place is gaining ground. This leads to an important question: "How many households is too many?" Or alternatively, "What is the maximum occupancy of a fire-prone community?"

Maximum occupancies are well defined and enforced in building safety, and it is common to see the maximum number of people allowed in an assembly hall posted clearly on the wall. This concept has not been applied to community development in fire-prone areas, although the broader terms of "access" and "egress" appear in contemporary codes (National Fire Protection Association 2002; International Fire Codes Institute 2003). Egress standards are currently defined in terms of minimum exit-road widths, or a minimum number of exits, without regard to how many people might rely on the exits. This is less sophisticated than building egress codes which link the maximum expected occupancy of an enclosed space with the required number, capacity, and arrangement of exits (Coté and Harrington 2003). Building egress codes have been hard earned over nearly a century of research, refinement, and loss of life (Richardson 2003).

The purpose of this paper is to apply egress concepts drawn from building fire safety to community egress in fire-prone areas. Although these concepts and codes were originally developed for

EXHIBIT 3

(Date: October 20, 1995)

Fig. 1. Looking west at narrow roads surrounding 1991 Oakland–Berkeley fire origin

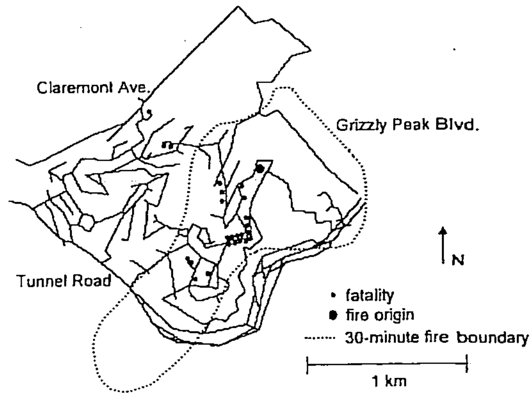


Fig. 2. Fatalities, fire origin, and approximate 30 min fire boundary in 1991 Oakland–Berkeley fire

small-scale, indoor spaces, they have potential utility in fire-prone communities. The first section reviews background on the growing urban–wildland egress problem. The next section reviews basic means-of-egress concepts defined in building codes. A method is presented to compare community egress systems based on concepts and standards from building safety that includes preliminary recommendations for new community egress codes. The paper concludes with a discussion of improvements that can be made to community egress systems.

Growing Urban–Wildland Egress Problem

Representative Communities

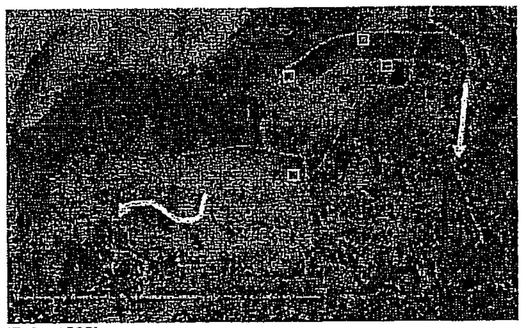
There are literally thousands of fire-prone communities in the West with a static road network and steadily increasing housing stock. This section ~~briefly examines~~ 2 representative examples. To date, the dominant focus of planners and residents in these communities has been structure protection with much less attention focused on egress issues. This may be due to the fact that property loss in wildfires is much more common than loss of life. Poor egress in interface communities is generally the result of narrow roads, irregular intersections, and few exits. In most of these areas the likelihood of an extreme fire is increasing in tandem with the vulnerability created by steadily climbing minimum evacuation times. Without fire to rejuvenate the ecological system, vegetation advances toward its fire recurrence interval as home construction adds additional fuel, residents, and vulnerability (Rodrigue 1993; Radke 1995; Cohen 2000; Cutter 2003).

Buckingham, Oakland, Calif.

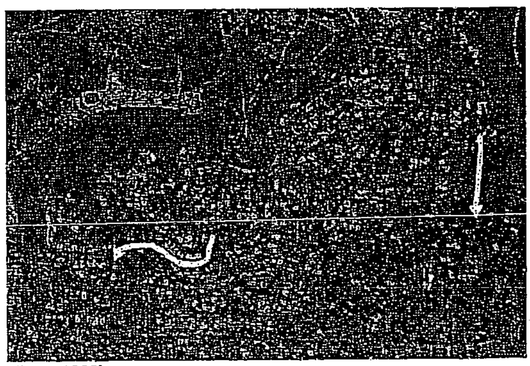
Fig. 1 shows the neighborhood at the origin of the 1991 Oakland–Berkeley Fire 4 years after the fire. Without vegetation to obscure the view, it is clear that the road network is a maze of narrow streets. The photo was taken during the initial rebuilding process when hazard abatement procedures were being considered. At the time of the fire there were 337 homes in this neighborhood with four exits. The fire blocked the two primary exits in its first 1/2 h (Tunnel Road east and west), leaving the remaining residents two narrow, uphill exits. Most of these residents chose to leave on Charing Cross Road, a 13 ft wide afterthought that was not designed to handle this volume. Many of the fatalities (Fig. 2) were residents caught in or near their cars at the end of a traffic queue when the fire passed.

Mission Canyon, Santa Barbara, Calif.

Mission Canyon is a community just northwest of downtown Santa Barbara, Calif. that is adjacent to a chaparral ecosystem. The basic road network geometry was established in the 1930s and has changed little since (Fig. 3). In 1938 there were four households in the upper canyon using two exits (shown in white), but by 1990 there were more than 400 households relying on the same two exits. All households north the two exits (above) must use one of these two exits to leave, but households south of these exits (below) have more exiting options. The area was originally grasslands, but today it contains a significant amount of flammable, non-native vegetation (e.g., Eucalyptus) intermixed with wood structures. Prior evacuation studies have concluded that



(Date: 1938)



(Date: 1990)

Fig. 3. Mission Canyon in 1938 (4 homes, 2 exits in white) and 1990 (400+homes, same 2 exits in white)

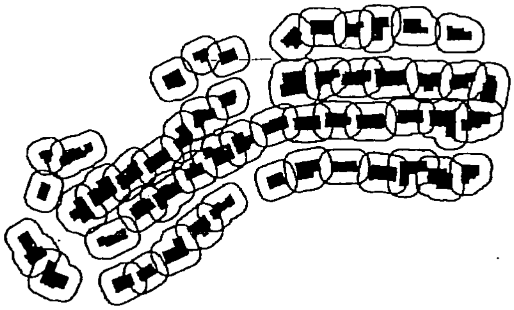


Fig. 4. Overlapping home ignition zones in fire-prone neighborhood (30 ft defensible-space buffer)

clearing upper Mission Canyon in the event of a wildfire would be relatively difficult (Cova and Church 1997; Law 1997; Church and Sexton 2002).

Protective Actions in Wildfires

Protective actions in a wildfire differ from a building fire in that sheltering-in-place in a structure, water body or safe zone (e.g., parking lot or golf course) is possible. This distinction is important because it means that evacuating a community may not be the best protective action in some cases (Krusel and Petris 1992). However, these cases can be difficult to assess during an event. Given more than enough time to evacuate, this is generally the best option for protecting life. If there is little to no time to evacuate, sheltering-in-place is likely the best option because evacuees risk being overcome by the fire in transit with much less protection than offered by a shelter. In the middle lies a gray area where evacuating may be the best option. As strongly as many experts feel about this issue (Wilson and Ferguson 1984; Decker 1995; Packman 1995; Oaks 2000), the uncertainty associated with a scenario can be too great to definitively state the best protective action. It depends on the quality of a shelter, road network geometry, fire intensity, wind speed and direction, visibility, travel demand, water availability and many other factors that are difficult to assess and synthesize under pressure.

A key hurdle in advising people to shelter-in-place in their homes is that not all structures are defensible. A defensible structure offers its occupants sufficient protection to withstand a passing wildfire. This is embodied in the concept of a "home ignition zone," or the area immediately surrounding a structure where ignition is feasible (Cohen 2000). Structures are not defensible if their ignition zones contain substantial fuel, adjacent ignition zones overlap, or both. If ignition zones overlap, then creating a defensible space would require homeowners to clear their neighbors' vegetation (Fig. 4). In other words, the wood structures in this figure are not defensible and an ignition chain reaction is possible. In cases where structures are sufficiently spaced, vegetation and other fuel within the home ignition zone can also render a structure indefensible. This is common because residents in these areas generally embrace trees and the amenities they provide. In dense, residential areas with wood structures, overlapping ignition zones and few viable shelters or safe zones, providing residents with sufficient egress is a critical issue.

Building Egress Codes

Early History

The concept of a maximum occupancy originated in an area of study called "means of egress." A means-of-egress is defined as, "... a continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three distinct parts: the exit access, exit, and exit discharge (Coté and Harrington 2003, p. 99)." Means-of-egress studies and associated codes incorporate all aspects of evacuating a building from stairway capacities and known crowd behavior under varying density to the proper illumination of exit signs. In setting standards for an enclosed space, an analyst can either examine the number, capacity, and arrangement of exits and calculate a maximum occupancy or, alternatively, examine the expected maximum occupancy and construct the required minimum egress. In either case, state-of-the-art egress standards and methods link occupancy to the number, capacity, and arrangement of exits.

Building egress standards can be traced to an occupancy–density study conducted by Rudolph Miller around 1910 in Manhattan (Nelson 2003). Miller's objective was to tabulate the density of workers per floor in 500 workshops and factories. This resulted in a wide range of densities from 19 to 500 ft^2 per person with the average for all floors at 107 ft^2 per person. In 1913 the National Fire Protection Association established the "Committee on Safety to Life" to study egress and formulate standards with a particular focus on advancing the principle of apportioning means-of-egress to the number of occupants in a building. One of the first egress standards was set by the New York Department of Labor in 1914 which limited the occupancy on each floor to 14 persons for every 22 in. of stair width. In 1935 the National Bureau of Standards published, "Design and construction of building exits," an important work in the history of building egress codes. One finding was that egress codes varied widely in regards to how many exits are needed, where they should be, and their required characteristics. Five different methods were discovered for determining required exits widths, and the report concluded with a new method that required stairwells have sufficient capacity to handle an evacuation of the most populated floor, the current method used in North American codes (Nelson 2003).

Modern Building Egress Codes

Contemporary methods for calculating a maximum occupancy for a building, floor, or meeting room are simple, but the number of possible building space uses and exit types is extensive (Coté and Harrington 2003). For example, the 2003 Life Safety Code© includes detailed exit-capacity adjustments (in persons) for stairways based on the presence, size and positioning of handrails, as well as ramp-capacity adjustments that incorporate ascending or descending slope (National Fire Protection Association 2003). In general, occupant load and building geometry determine the required number, location, and capacity of exits. An important aspect of a means-of-egress is that, "it is only as good as its most constricting component." Furthermore, a good design principle for an egress system is balance among exits because one or more might be lost in a fire.

A central concept in determining building egress is that of an occupant load factor. Occupant load factors are upper limits on density that vary with the use of the space. In other words, the nature of the use of a space determines its allowable density. For example, a "residential apartment building use" is allowed a gross

Table 1. Occupant Load Factors from Life Safety Code®[a]

Use	m^2 per person	ft^2 per person
Assembly use		
Concentrated, without fixed seating	0.65 net	7 net
Less concentrated, without fixed seating	1.4 net	15 net
Educational use		
Classrooms	1.9 net	20 net
Shops, laboratories, vocational rooms	4.6 net	50 net
Day Care use	3.3 net	35 net
Residential use		
Hotels and dorms	18.6 gross	200 gross
Apartment buildings	18.6 gross	200 gross
Industrial use		
General and high hazard	9.3 gross	100 gross

[a]Reprinted with permission from NFPA 101-2003, *Life Safety Code*®, Copyright © 2003. National Fire Protection Association, Quincy, Mass. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the standard in its entirety. Life Safety Code® and 101® are registered trademarks of the National Fire Protection Association, Qunicy, Mass.

density of 200 ft^2 per person while a "concentrated assembly (without fixed seating) use" allows a much higher net density of 7 ft^2 per person (Table 1). "Net" density refers to rooms, and "gross" density refers to floors or an entire building. Defining the maximum density for an indoor space based on its use is valuable because it bypasses the need to conduct an empirical occupancy study for every building. Occupant load factors derived from the table are then used in conjunction with the area of a meeting room or floor to design the means-of-egress system and also to trigger provisions like the need for a sprinkler system.

The required number, capacity, and arrangement of exits are determined using the occupancy load, the use of the space, and simple geometric rules. The required number of exits for each story is determined with a step function based on the use of the space and the occupancy load. Stories with less than 500 occupants require a minimum of two exits, those with between 500 and 1,000 require at least three exits, and more than 1,000 occupants requires at least four. A capacity-factor table specifies the minimum width for stairways and horizontal exits based on the use of the space. Most indoor activities require stairwells to have 0.3 in. of width for each person on the floor with the greatest number of occupants, but areas with hazardous contents require 0.7 in. per person, a much greater capacity (Table 2).

The linear relationship between the maximum number of occupants and exit widths was originally proposed by Pauls (1974) and widely adopted in North America. For example, a stairwell 44 in. wide has a capacity of (44 in./0.3 in. per person)=147 persons for most floor uses (Table 2). If the occupancy of the floor is expected to exceed 147, then the stairwell capacity is insufficient and the maximum occupancy must be lowered or the stairwell egress capacity must be increased. The arrangement of the exits is determined using a simple geometric rule called the "one-half diagonal rule" that states that two exits shall not be located closer than one half the length of the maximum diagonal dimension of the area served (Fig. 5). This requires exits to be sufficiently remote so as to prevent a fire from blocking more than one. For example, if the maximum diagonal distance across a room with two exits is 60 ft., then the exits must be at least 30 ft. apart. Finally, an arbitrary distance cutoff is used to ensure that no building occupant is too far from an exit.

Table 2. Capacity Factors from Life Safety Code®[a]

Area	Stairwells (width per person) (mm)	Stairwells (width per person) (in.)	Level components and ramps (width per person) (mm)	Level components and ramps (width per person) (in.)
Board and care	10	0.4	5	0.2
Board and care, sprinklered	7.6	0.3	5	0.2
Health care, nonsprinklered	15	0.6	13	0.5
High hazard contents	18	0.7	10	0.4
All others	7.6	0.3	5	0.2

[a]Reprinted with permission from NFPA 101-2003, *Life Safety Code*®, Copyright © 2003. National Fire Protection Association, Quincy, Mass. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the standard in its entirety.

Community Egress Codes

Despite the tremendous fire hazard in many interface communities, few studies have been done on residential densities in fire-prone areas (Theobald 2001; Schmidt et al. 2002; Cova et al. 2004). There is certainly nothing as complete as Nelson's (2003) longitudinal study of Washington D.C. federal building occupancy densities from 1927 to 1969. Second, there are no road-capacity studies for fire-prone communities on par with Pauls' (1974) extensive research on doorway and stairwell capacities. Roads in interface communities can be very narrow, intersect at odd angles, and vary in width. The capacity of this type of road network in dense smoke is difficult to quantify but would likely be very low. Third, existing egress codes for fire-prone communities are very general and do not provide the elegant methods for comparing and testing egress systems found in the building safety codes. The following codes serve as representative examples of contemporary community egress codes (National Fire Protection Association 2002):

1. 5.1.2 Roads shall be designed and constructed to allow evacuation simultaneously with emergency response vehicles.
2. 5.1.3 Roads shall be not less than 6.1 m (20 ft) of unobstructed width with a 4.1 m (13.5 ft) vertical clearance.

While the intent of the codes is clear, they do not link the occupant load with the required minimum number, capacity, and arrangement of exits. Current codes also tend to overlook the furthest distance a household is from its closest exit as well as vulnerability owed to dense fuel along the exits. In general, standards for interface community access focus more on maintaining fire-fighter ingress than resident egress (International Fire Code Institute 2003). Given that it is easy to find growing interface communities with miles of tangled narrow roads, many residents, and few exits, improved egress codes are a growing need.

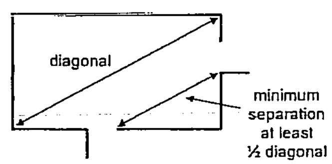


Fig. 5. One-half diagonal rule in building egress codes ensures that exits are sufficiently remote from one another

Differences in Community and Building Means-of-Egress Systems

Although there are many similarities between building and community egress systems, there are also significant differences. First, notification systems vary across communities (Sorensen 2000), whereas warning is generally issued with a siren, flashing lights, and a public address system in a building. For this reason, warning is nearly instantaneous and uniform in modern buildings, where it can take minutes to hours to warn all residents in a community, depending on the area, population density, and notification modes (e.g., reverse 911 or door to door). This has egress implications because the most constraining component in a community's egress system may simply be information, a vital yet scarce resource in most emergencies (Alexander 2002). However, slow notification can have benefits (if it is not too slow), as it can dampen household departure rates which reduces the likelihood of a traffic jam from a sudden burst of travel demand in a wildfire. Sudden bursts of travel demand are rare in evacuations but can lead to extreme stress when egress is constricted (Quarantelli et al. 1980; Chertkoff and Kushigian 1999), as in the case of the 1991 Oakland Fire.

Emergency manager behavior, population mobility, and human response are also important elements of an egress system. Emergency manager behavior is important because an incident commander generally decides who should evacuate and when they should leave (Lindell and Perry 1992). Mobility in a community context refers to the proportion of available drivers and vehicles in a population, whereas building evacuees are generally on foot or in a wheelchair. A glaring example of this constricting factor exists in many developing countries where mobility can be so low as to render regional evacuation infeasible (e.g., cyclones in Bangladesh). However, mobility can also cause problems if a highly mobile population leaves in a condensed amount of time and overloads an egress system.

Human response is also important, and evacuee behavior can be very different in wildfires than buildings. In building fires, occupants generally proceed directly out of the building or facility given sufficient egress, knowledge of the floor plan, and clear directions. In wildfires, there are family members, pets, horses, and livestock to evacuate, property to protect, and sheltering-in-place is always an option. These factors can dampen sudden spikes in egress demand but are more often a drawback in clearing an area quickly. In a building evacuation, the "walk, don't run" rule is used to dampen demand spikes and to reduce the likelihood of panic. Unfortunately, there are very few studies on wildfire evacuation behavior, but analogies can be drawn to evacuation behavior in other hazards that have been studied in greater depth (Perry 1985; Mileti and Sorensen 1990; Zelinsky and Kosinski 1991; Vogt and Sorensen 1992; Drabek 1996; Dow and Cutter 2002).

Perhaps the most obvious difference between building and community egress systems is the engineered components. Buildings have stairways, elevators, escalators, ramps, doors, handrails, and hallways, where communities have driveways, roads, intersections, stop signs, and traffic signals. Although these differences are significant, general concepts drawn from building codes may have value in a community context. One approach is to modify and extend building egress codes to achieve codes of comparable quality for communities.

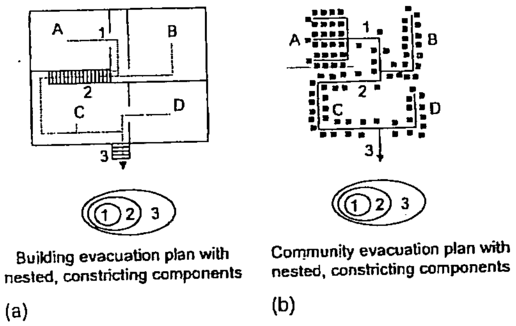


Fig. 6. Comparing nested, constricting components in building egress system with similar ones in community

What is a Community "Exit"?

An initial geographic problem in designing codes for communities might be deemed "the community exit problem." In a building context, exits have a component referred to as the discharge that leads people to a public way outside the building. In other words, safety is defined as "outside" the room or building. Inside and outside are ambiguous concepts in a community context and difficult to specify. If a predefined emergency planning zone (EPZ) is centered on a known hazard like a nuclear power plant or chemical stockpile site (Sorensen et al. 1992), then safety can be defined as outside the EPZ. In wildfires the zone to evacuate is defined on-the-fly at the time of the event and may expand in any direction as the fire progresses. For this reason, setting egress codes in advance that relate occupancy load to exit capacities requires searching the set of all potential evacuation zones.

An insight drawn from building studies can aid in addressing this problem. As noted, "A means of egress is only as good as its most constricting component." In a road-network context, this is referred to as a "bottleneck." A bottleneck can be used to define the inside and outside of a community, as traversing one is similar to clearing an exit discharge in a building (Cova and Church 1997). In other words, once a vehicle has successfully traversed a bottleneck, it is no longer a constraint on travel. This means that the community exit problem can be viewed as a search for potential roadway bottlenecks. In a sense, this is the approach adopted by interface codes that require at least two exits, as this precipitates a search for communities with only one exit, a potential bottleneck.

One problem with requiring that communities have more than one exit is that a bottleneck can still exist. In short, more than one exit does not ensure that an egress system is sufficient. It depends on the number of occupants, the arrangement and capacity of the exits, and the concentration of travel demand in space and time. Adding to this problem, bottlenecks can be nested in communities as they can in buildings. Fig. 6 compares nested constricting components in a building egress system with similar constricting components in a community context. Neighborhood A is nested within bottlenecks 1, 2, and 3. A building's outer wall is the point at which nested constraining components terminate, but in a community context, components nest from a street segment to a neighborhood, city, region, and so on. This can be addressed by terminating the search for egress bottlenecks when the area constrained is larger than that likely to be evacuated in a wildfire.

Table 3. Proposed Load Factors for Interface Communities

Use	Road length per household (m)	Road length per vehicle (m)
Residential[a]		
Low wildfire hazard	12.5	6.3
Moderate wildfire hazard	16.7	8.3
High+ wildfire hazard	20.0	10.0
Residential and tourism[b]		
Low wildfire hazard	12.5	4.2
Moderate wildfire hazard	16.7	5.6
High+ wildfire hazard	20.0	6.7

[a]2 vehicles per household.

[b]3 vehicles per household.

Table 5. Proposed Capacity Factors for Interface Communities

Use	Minimum total exit capacity (vph per household)	Minimum evacuation time (h)
Residential[a]		
Low wildfire hazard	1	2
Medium wildfire hazard	2	1
High+wildfire hazard	4	0.5
Residential and tourism[b]		
Low wildfire hazard	1.5	2
Medium wildfire hazard	3	1
High+wildfire hazard	6	0.5

[a]2 vehicles per household.

[b]3 vehicles per household.

Improving Community Egress Codes

Methods

The focus in a community context is therefore on identifying constricting components in a means-of-egress system. Furthermore, to achieve a comprehensive code and associated methods, the most constricting component should be defined in terms of the expected maximum occupancy as well as the number, capacity, and arrangement of exits. This is accomplished in a building context with look-up tables and simple geometric rules like the one-half-diagonal rule. In this section, preliminary analogues for interface communities are proposed. Agreed-upon community egress tables and codes will take significant cooperation among planners, and this represents a more formidable hurdle in terms of code development and compliance than the technical concepts discussed here (Burby et al. 1998).

Tables 3–5 represent community look-up tables for residential loading factors and the minimum number and capacity of exits. Table 3 depicts preliminary recommendations for community-based load factors expressed in road length per household, where communities with a greater fire hazard are required to have a lower density. In other words, as fire hazard increases the maximum allowable household density along roads should decline (Fig. 7). This is analogous to building codes which require a lower occupant density for buildings that contain hazardous materials (Table 1). To avoid delimiting a community's boundary, which is very subjective, "density" was defined as the average length of road (e.g., street centerline) per household in kilometers. This can be viewed as the average number of driveways per unit length of road. This calculation requires two easily acquired inputs that can be objectively measured: the number of households and total road length in the community.

Table 4 represents the minimum number of exits required for a community, which is a step function of the number of households. Allowing communities with only one exit to have up to 50 households avoids classifying all culdesacs as noncompliant with a two-exit minimum code. Table 5 represents the required minimum (total) exit capacity expressed in vehicles per hour (vph) per household. This is analogous to the linear relationship between persons and stairwell width in North American building egress codes (Table 2). The basis for the minimum required vph per household is a desired minimum evacuation time. For example, if a community has a high fire hazard (or greater), then the minimum evacuation time should be at most 30 min (0.5 h). Assuming two registered drivers per household, this requires that the exits have a minimum capacity of 4 vph per household. So a community with 100 households would need a total exit capacity of at least 400 vph to allow the estimated 200 vehicles to leave in 1/2 h (200 vehicles/0.5 h=400 vph). This coarse approach to estimating minimum evacuation time can be better tested for a given community with a traffic simulation model (Cova and Johnson 2002).

In most fire-prone communities, the "use" of the space is residential, but in larger communities there may be businesses, schools, churches, community centers, and tourist attractions (e.g., lakes, botanical gardens, hiking trails). Facilities and attractions above and beyond residences are important because community occupancy may vary significantly when tourists and tran-

Table 4. Proposed Minimum-Exits Table for Interface Communities

Number of households	Minimum number of exiting roads	Maximum households per exit
1–50	1	50
51–300	2	150
301–600	3	200
601+	4	

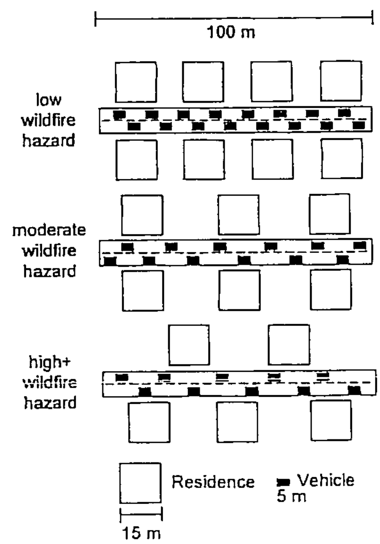


Fig. 7. Visual depiction of loading factor table for "residential use" assuming average of 2 registered drivers per home

sients are drawn (Drabek 1996). Furthermore, transient knowledge of the environment (e.g., evacuation routes) can be very poor. A community with a high degree of transients is analogous to an "assembly use" in building egress codes because occupants are generally unfamiliar with their environment. Table 5 requires a minimum capacity of 6 vph per household for high fire-hazard communities with tourism. So a community with 100 households and tourists would need a total exit capacity of at least 600 vph to allow the estimated 300 vehicles to leave in 1/2 h (300 vehicles/0.5 h = 600 vph). The assumed mean number of vehicles per household can be adjusted, but standards should be set using the maximum probable occupancy in an area rather than the residents (and thus vehicles) recorded by the census.

Using Tables 3–5 in conjunction with a diagonal rule, a maximum-distance threshold and an exit-vulnerability rule, it is relatively straightforward to develop preliminary codes and compare community egress systems. For example:

1. Occupant load factor (density). The density of homes along the roads in any fire-prone community or portion thereof should not exceed that specified in Table 3.
2. Number of exits. The number of means-of-egress from any fire-prone community or portion thereof shall meet the minimum specified in Table 4.
3. Exit capacity. The total egress capacity from a fire-prone community or portion thereof shall meet the factors specified in Table 5.
4. Exit arrangement. The closest distance between any two points along any of the n exits from a fire-prone community must be at least $1/n$ the maximum diagonal distance across the community. The maximum diagonal of a community is defined as the greatest Euclidean distance between any two households that rely on the same exit set, and the minimum distance between exits is defined as the shortest Euclidean distance between any two points along two exiting roads.
5. Maximum exit distance. No household in a fire-prone community shall be further than 3 km by road from its closest exit. The maximum exit distance for a community is defined as the household with the greatest shortest-path distance on the road network to an exit discharge in the most constraining bottleneck set (i.e., the end of one of the exiting roads from the community).
6. Exit vulnerability (distance to fuel). Exits in a fire-prone community shall have a 30 ft buffer on each side that is clear of fuel.

An important aspect of this approach is that each recommended code is an independent test. This means that a community can meet or fail any subset of the codes. For example, a community might meet the density and minimum-number-of-exits codes but fall short of the exit-capacity code. The advantage of independent tests is that distinct limitations in a community's egress system can be highlighted separately. Fig. 8 depicts the proposed characteristics measured for Mission Canyon.

Table 5 provides the important link between expected maximum occupancy and required minimum exit capacity. An interesting aspect of this table is that it can be applied in reverse to calculate a community's maximum occupancy. For example, if a high-fire-hazard residential community (i.e., minimum evacuation time no greater than 30 min) has a total exit capacity of 1,000 vph in the most constraining bottleneck set, then from Table 5 the maximum occupancy would be (1,000 vph/4 vph *per household*) = 250 households.

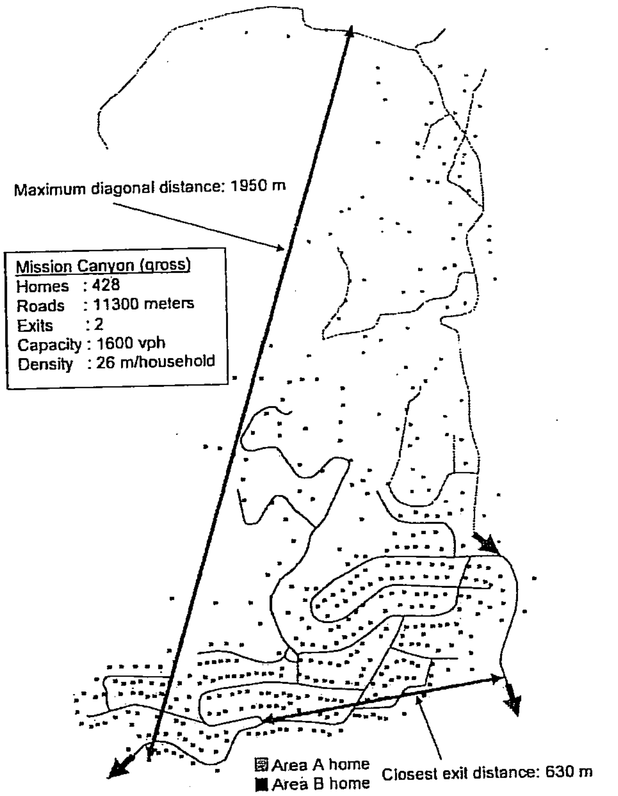


Fig. 8. Example (gross) egress calculations for Mission Canyon

Comparing Interface Communities

This section applies the proposed method to sample interface communities with high wildfire hazard, relatively low egress, and residential land use. A community with residential land use simplifies the estimation of occupant load by eliminating commercial, educational, and tourism activities. The inside (and outside) of each community is defined by the most constraining road-network bottleneck set. For example, if a community's most constraining bottleneck set is two exits, the calculations are for the households that would need to traverse one of these exits in an evacuation.

Perhaps the most involved calculation is for road capacity. This was crudely estimated using Eq. 8-3 in the *1997 highway capacity manual* (Transportation Research Board 1997):

$$SF_i = 2{,}800(v/c)_i f_d f_w f_g f_{HV} \quad (1)$$

This equation states that a road's service flow rate (SF_i) in vehicles per hour (vph) is the product of the volume-to-capacity ratio for level-of-service i $(v/c)_i$ and a set of adjustment factors for directional traffic distribution f_d, lane and shoulder width f_w, grade f_g, and the presence of heavy vehicles f_{HV}. A narrow, mountainous road operating at level-of-service E (0.78) (maximum capacity) is assumed (for this analysis) with 100% of the traffic in one direction (0.71) on a 9 ft wide lane and 2 ft shoulder (0.70) heading downhill (1) with the possible 3% presence of large recreational vehicles (0.75) for an estimate of capacity per exit in clear visibility conditions with moderate demand rates of 814 vph (rounded to 800). In communities with uphill exits, wider roads or no recreational vehicles, this can be adjusted. Concentrated demand could greatly degrade this flow rate to level of service F where capacity can no longer be reliably estimated. Also, it should be noted that this number is very optimistic be-

Table 6. Data for Comparing Interface Community Egress Systems

Community	Homes	Exits	Road length (m)	Density (m per home)	Exit capacity (vph)	Max. diam. (m)	Exit separ. (m)	Max. dist. (m)	Exit fuel buffer
Buckingham[a]	337	4	5,293	16	3,200	1,040	85	430	No
Emigration Oaks	250	2	11,820	47	1,600	3,212	1,589	2,550	No
Summit Park	446	2	18,960	43	1,600	2,230	395	4,700	No
Mission Canyon	428	2	11,300	26	1,600	1,950	630	2,300	No
Area A (net)	60	1	4,576	76	800	1,520	NA[b]	1,750	No
Area B (net)	368	3	6,724	18	2,400	1,250	630	1,900	No

[a]1991 data.

[b]Not applicable.

cause it does not consider driveways along a road or other merge points that may create flow turbulence.

Table 6 shows the raw data for the communities in the comparison which all have "high+" wildfire hazard during the fire season. Community fire hazard was grossly assigned based on the predominant vegetation and residential construction type. A community of wood structures intermixed with a combination of highly flammable vegetation (e.g., Gambel Oak or Eucalyptus) was assigned a "high+" wildfire hazard. Table 7 is derived from Table 6 and the recommended codes presented in the prior section by determining which aspects of each community are "compliant" (C) or "noncompliant" (N).

An interesting result of this comparison is that the neighborhood at the origin of the 1991 Oakland–Berkeley fire is compliant for three of the six egress tests. The number and total capacity of the exits, as well as the furthest distance from any home to its nearest exit were reasonable. The problem appears to have been the relatively high residential density, the close proximity of exits 1 and 3 (Fig. 9), and the tremendous amount of fuel along the exits. The neighborhood had been built to urban density with only 16 m of road per household (i.e., street centerline length), the most densely developed neighborhood in the comparison (Table 6). This means that in 1991 the neighborhood had a driveway, on average, every 16 m. This is very dense development for an area with extremely high fire hazard. The arrangement of the exits was also not ideal, as exits 1 and 3 were closer than 1/4 the maximum diagonal distance between the furthest two households relying on the exits. In 1991, exits 1 and 2 were blocked by the fire in its first 1/2 h, and most of the remaining residents chose exit 3 (Charing Cross Road). However, from the point of view of a wildfire, exits 1 and 3 are too close to one another to be considered genuinely separate means-of-egress, so a fire that blocks exit 1 is almost certain to block exit 3 which is just uphill, and this is what happened in 1991. Finally, there was a substantial amount of fuel along the exits, and this is what led exits 1 and 2 to be blocked by the fire so early in the event. However, all told, if this neighborhood had less than four exits the number of fatalities would likely have been much higher.

In regards to the other neighborhoods in comparison, it is easy to identify canyon and hillside neighborhoods in the West with relatively poor egress systems to varying degrees. Emigration Oaks is a neighborhood just East of Salt Lake City, Utah that has a reasonably good egress system, but it is an elongated community and the two exits are less than 1/2 its maximum diagonal distance (Cova and Johnson 2002). This resulted in the community being noncompliant in regards to exit arrangement. The community also has a substantial amount of highly flammable Gambel Oak lining the exit-road shoulders. Summit Park is a community on the Wasatch Mountain ridgeline between Salt Lake City and Park City. This neighborhood did very poorly, as it currently has 446 homes relying on two proximal exits that are lined with conifers. Mission Canyon in Santa Barbara, Calif. also scored poorly for the same reasons. To provide one example of "net" egress calculations for a community, Mission Canyon is divided into areas A (upper canyon) and B (lower canyon). Area A is not compliant in regards to the number of exits because it has 60 homes and only one exit, where Area B is too dense and does not

Table 7. Comparing Interface Communities Against Egress Standards[a]

Community	Density	Number of exits	Exit capacity	Exit arrange	Maximum exit distance	Exit fuel buffer
Buckingham, Oakland, Calif.[b]	N	C	C	N	C	N
Emigration Oaks, Utah	C	C	C	N	C	N
Summit Park, Utah	C	C	N	N	N	N
Mission Canyon, Calif.	C	N	N	N	N	N
Area A (net)	C	N	N	N	N	N
Area B (net)	N	C	N	C	N	N

[a]C=compliant. N=noncompliant.

[b]1991 data.

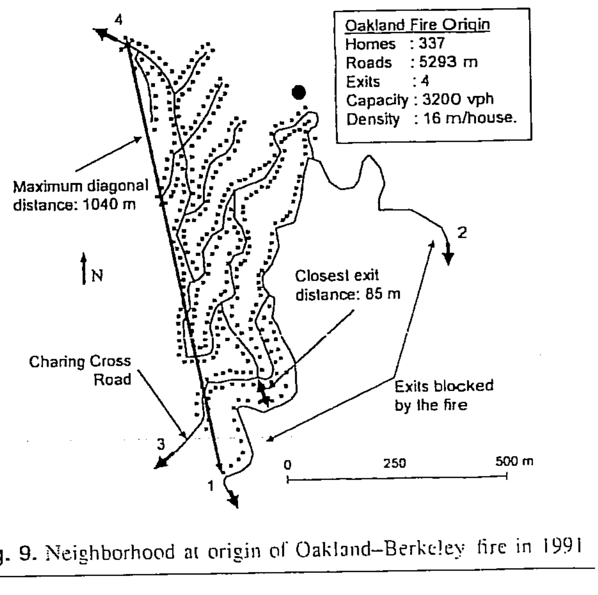


Fig. 9. Neighborhood at origin of Oakland–Berkeley fire in 1991

have sufficient exit capacity to serve its households. The main point with Tables 6 and 7 is simply that it is easy to identify neighborhoods with equal or greater fire hazard than the 1991 Oakland–Berkeley fire case and a more constrained egress system.

Urban and Emergency Planning Implications

The primary implication of developing a method comparable to building egress codes is that it is easy to identify fire-prone communities with relatively poor egress. The focus for urban and emergency planners should then turn to implementing new codes and improving egress systems. The proposed codes in the prior section can serve as a starting point and would need to be adjusted (or expanded) to work for a given locality. Also, despite the obvious limitations of the egress systems in the prior section, there are many actions that communities can take to improve their overall system (Plevel 1997). If a community has relatively poor egress, there are both demand-side and supply-side improvements (or adjustments) that can be implemented with varying cost (Burton et al. 1993). The focus in demand-side adjustments is reducing the concentration of vehicles in an evacuation in space and time to alleviate the need for egress capacity (e.g., supply). Example demand-side options include limiting the construction of new homes or businesses, limiting renters, constructing wildfire shelters, and identifying internal safe zones. Another demand-side adjustment is to require that structures be defensible so that residents can shelter-in-place. If a community can demonstrate that enough structures are defensible or there is sufficient public wildfire shelter or safe areas provided within the community, then the loading and capacity calculations could be adjusted to recognize that all not all residents will need to evacuate in a wildfire. This means that the following statement might be appended to each of the prior preliminary recommended codes:

"... unless a sufficient number and capacity of defensible structures, public shelters, or safe areas exist in the community for residents to shelter-in-place during a wildfire."

Supply-side adjustments to improve a community's egress system are also an option. This includes detailed evacuation route planning (i.e., Who will go where?) as well as reversing lanes and restricting turns at intersections to improve exit capacities (Wolshon 2001; Cova and Johnson 2003). Communities should also maintain their egress system. On-street parking restrictions can prevent low-capacity roads from becoming even lower, and clearing vegetation and other fuel along evacuation routes can minimize the loss of important exits during a wildfire. In cases where the egress system is severely substandard, widening roads or building new roads may be needed if more households are to be added.

Conclusion

Residential development in fire-prone areas is continuing without commensurate improvements to community-based transportation egress systems. This is only a small part of a much larger policy problem in fire-prone areas (Busenberg 2004), but it is an important one in protecting life. The codes presented in this paper would need to be integrated into a community's comprehensive hazard mitigation plan (Burby et al. 2000; Prater and Lindell 2000). However, the methods presented in this paper should help an analyst or planner in comparing community egress systems and possibly formulating codes. This may lead to improved community egress codes comparable to the higher-quality ones already in place for buildings. Limiting residential construction in low-egress, fire-prone areas with a "maximum occupancy" is not currently practiced but may be needed in some communities. If very few homes in a low-egress community are defensible and there is no safe zone or other public shelter, then limiting occupancy is one approach to maintaining public safety.

Economic pressure is strongly toward developing fire-prone communities to a density beyond which the egress system can safely handle in an urgent wildfire evacuation. The beneficiaries of new home development include new residents, developers, construction companies, and property tax collectors among many others. The parties that stand to lose include the residents who may perish in a wildfire, insurance companies, and the emergency managers challenged with the increasingly difficult task of protecting life and property in these rapidly growing areas. Thus, for political and economic reasons the methods presented in this paper may only find application in evacuation planning and comparing community egress systems. In the longer term, it is up to engineers and planners to ensure public safety in the urban–wildland interface by providing sufficient egress (or shelter) and educating residents on protective actions.

Acknowledgments

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COUNTY OF SANTA BARBARA

Planning and Development

www.sbcountyplanning.org

Jesusita Fire Property Summary - Web Version

Printed on May 28, 2009 at 1:39 pm

Supervisor District 1

ADDRESS	APN	Project Number	Case Manager	Phone Number	Destroyed		Damaged	
					Residences	Accessory	Residences	Accessory
1173 EDGEMOUND DR	023-112-003	09JES-00000-00116	Philip Oates	(805) 568-3113	0	0	1	0
1199 EDGEMOUND DR	023-051-032	09JES-00000-00033	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2600 FOOTHILL RD	023-180-007	09JES-00000-00129	Lisa Martin	(805) 568-2032	0	1	0	0
3035 GIBRALTAR RD	153-280-021	09JES-00000-00128	Noel Langle	(805) 568-2067	0	1	0	0
3040 GIBRALTAR RD	153-280-020	09JES-00000-00044	Kimberley McCarthy	(805) 568-2005	1	1	0	0
2600 HOLLY RD	023-330-058	09JES-00000-00090	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2730 HOLLY RD	023-340-003	09JES-00000-00059	Kimberley McCarthy	(805) 568-2005	1	1	0	0
2745 HOLLY RD	023-340-002	09JES-00000-00089	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2809 HOLLY RD	023-320-019	09JES-00000-00058	Kimberley McCarthy	(805) 568-2005	1	1	0	0
2815 HOLLY RD	023-320-010	09JES-00000-00057	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2820 HOLLY RD	023-320-017	09JES-00000-00056	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2840 HOLLY RD	023-320-016	09JES-00000-00055	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2850 HOLLY RD	023-320-024	09JES-00000-00054	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2921 HOLLY RD	023-320-012	09JES-00000-00053	Kimberley McCarthy	(805) 568-2005	1	1	0	0
2931 HOLLY RD	023-310-010	09JES-00000-00052	Kimberley McCarthy	(805) 568-2005	1	1	0	0
2934 HOLLY RD	023-330-034	09JES-00000-00063	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2938 HOLLY RD	023-330-035	09JES-00000-00064	Kimberley McCarthy	(805) 568-2005	1	0	0	0
1324 LAS CANOAS LN	023-070-035	09JES-00000-00123	Kimberley McCarthy	(805) 568-2005	0	1	0	0
1400 LAS CANOAS LN	023-070-050	09JES-00000-00124	Kimberley McCarthy	(805) 568-2005	1	0	0	0
1976 LAS CANOAS RD A	021-010-034	09JES-00000-00065	Kimberley McCarthy	(805) 568-2005	1	0	0	1
1980 LAS CANOAS RD	021-010-043	09JES-00000-00117	Lisa Martin	(805) 568-2032	0	2	0	0

EXHIBIT

Supervisor District 1

continued ...

ADDRESS	APN	Project Number	Case Manager	Phone Number	Destroyed Residences	Destroyed Accessory	Damaged Residences	Damaged Accessory
1990 LAS CANOAS RD	021-010-064	09JES-00000-00118	Kimberley McCarthy	(805) 568-2005	1	2	0	0
2000 LAS CANOAS RD	021-010-044	09JES-00000-00119	Lisa Martin	(805) 568-2032	1	3	0	0
2018 LAS CANOAS RD	021-010-050	09JES-00000-00051	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2040 LAS CANOAS RD	021-010-046	09JES-00000-00050	Kimberley McCarthy	(805) 568-2005	0	1	0	0
2050 LAS CANOAS RD	021-010-045	09JES-00000-00049	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2115 LAS CANOAS RD	023-070-042	09JES-00000-00108	Philip Oates	(805) 568-3113	0	0	0	1
2150 LAS CANOAS RD	023-070-011	09JES-00000-00122	Kimberley McCarthy	(805) 568-2005	1	0	0	0
2223 LAS CANOAS RD	023-070-014	09JES-00000-00077	Kimberley McCarthy	(805) 568-2005	0	1	0	0
2233 LAS CANOAS RD	023-070-048	09JES-00000-00076	Kimberley McCarthy	(805) 568-2005	1	1	0	0
2262 LAS CANOAS RD	023-052-017	09JES-00000-00045	Kimberley McCarthy	(805) 568-2005	0	1	0	0
2320 LAS CANOAS RD	023-070-005	09JES-00000-00075	Kimberley McCarthy	(805) 568-2005	0	1	0	0
1200 MISSION CANYON RD	023-052-003	09JES-00000-00018	Alex Tuttle	(805) 884-6844	1	2	0	0
1212 MISSION CANYON RD	023-052-001	09JES-00000-00019	Alex Tuttle	(805) 884-6844	0	1	0	0
1220 MISSION CANYON RD	023-350-013	09JES-00000-00127	Philip Oates	(805) 568-3113	0	0	1	0
1228 MISSION CANYON RD	021-010-057	09JES-00000-00115	Philip Oates	(805) 568-3113	0	0	1	0
1232 MISSION CANYON RD	021-010-056	09JES-00000-00020	Lisa Martin	(805) 568-2032	0	3	0	0
1234 MISSION CANYON RD	023-350-026	09JES-00000-00092	Lisa Martin	(805) 568-2032	0	1	0	0
1300 MISSION CANYON RD	023-350-024	09JES-00000-00125	Lisa Martin	(805) 568-2032	0	1	1	0
1402 MISSION CANYON RD	023-350-002	09JES-00000-00021	Lisa Martin	(805) 568-2032	1	3	0	0
1405 MISSION CANYON RD	023-330-014	09JES-00000-00022	Lisa Martin	(805) 568-2032	1	1	0	0
1417 MISSION CANYON RD	023-330-042	09JES-00000-00071	Lisa Martin	(805) 568-2032	0	1	1	0
1480 MISSION CANYON RD	023-330-067	09JES-00000-00074	Lisa Martin	(805) 568-2032	0	1	0	0
1528 MISSION CANYON RD	023-330-064	09JES-00000-00073	Lisa Martin	(805) 568-2032	1	1	0	0
1530 MISSION CANYON RD	153-270-020	09JES-00000-00072	Lisa Martin	(805) 568-2032	1	4	0	0
2618 MONTROSE PL	023-112-011	09JES-00000-00110	Philip Oates	(805) 568-3113	0	0	1	0
2620 MONTROSE PL	023-112-012	09JES-00000-00002	Lisa Martin	(805) 568-2032	0	1	1	0

Supervisor District 1
continued ...

ADDRESS	APN	Project Number	Case Manager	Phone Number	Destroyed Residences	Destroyed Accessory	Damaged Residences	Damaged Accessory
2624 MONTROSE PL	023-112-014	09JES-00000-00111	Philip Oates	(805) 568-3113	0	0	1	0
2625 MONTROSE PL	023-113-004	09JES-00000-00003	Lisa Martin	(805) 568-2032	1	0	0	0
2626 MONTROSE PL	023-112-015	09JES-00000-00004	Lisa Martin	(805) 568-2032	1	0	0	0
2627 MONTROSE PL	023-113-003	09JES-00000-00112	Philip Oates	(805) 568-3113	0	0	1	0
2630 MONTROSE PL	023-112-029	09JES-00000-00113	Philip Oates	(805) 568-3113	0	0	1	0
2652 MONTROSE PL	023-101-005	09JES-00000-00006	Lisa Martin	(805) 568-2032	1	0	0	0
2655 MONTROSE PL	023-102-003	09JES-00000-00005	Lisa Martin	(805) 568-2032	0	1	0	0
2656 MONTROSE PL	023-101-006	09JES-00000-00007	Lisa Martin	(805) 568-2032	1	0	0	0
2660 MONTROSE PL	023-101-020	09JES-00000-00008	Lisa Martin	(805) 568-2032	0	1	0	0
2677 MONTROSE PL	023-113-018	09JES-00000-00036	Lisa Martin	(805) 568-2032	1	1	0	0
1550 N ONTARE RD	153-260-023	09JES-00000-00121	Veronica Lanz	(805) 568-2013	0	2	1	0
1560 N ONTARE RD	153-260-024	09JES-00000-00120	Veronica Lanz	(805) 568-2013	0	1	0	0
1450 ORANGE GROVE AVE	023-032-010	09JES-00000-00062	Lisa Martin	(805) 568-2032	1	0	0	0
1452 ORANGE GROVE AVE	023-032-011	09JES-00000-00106	Philip Oates	(805) 568-3113	0	0	1	0
1000 PALOMINO RD	023-300-015	09JES-00000-00029	Lisa Martin	(805) 568-2032	0	1	0	0
1091 PALOMINO RD	023-300-004	09JES-00000-00035	Kimberley McCarthy	(805) 568-2005	1	0	0	0
1105 PALOMINO RD	023-290-029	09JES-00000-00034	Brian Banks	(805) 568-3559	1	0	0	0
1108 PALOMINO RD	023-300-020	09JES-00000-00086	Lisa Martin	(805) 568-2032	1	0	0	0
1110 PALOMINO RD	023-300-019	09JES-00000-00085	Lisa Martin	(805) 568-2032	1	0	0	0
1115 PALOMINO RD	023-300-023	09JES-00000-00028	Lisa Martin	(805) 568-2032	1	0	0	0
1125 PALOMINO RD	023-290-005	09JES-00000-00032	Lisa Martin	(805) 568-2032	1	0	0	0
1138 PALOMINO RD	023-290-033	09JES-00000-00084	Lisa Martin	(805) 568-2032	1	1	0	0
1139 PALOMINO RD	023-290-027	09JES-00000-00027	Brian Banks	(805) 568-3559	1	0	0	0
1144 PALOMINO RD	023-290-016	09JES-00000-00026	Brian Banks	(805) 568-3559	0	1	0	0
1159 PALOMINO RD	023-290-009	09JES-00000-00025	Brian Banks	(805) 568-3559	1	0	0	0
1166 PALOMINO RD	023-290-012	09JES-00000-00031	Brian Banks	(805) 568-3559	1	0	0	0

ADDRESS	APN	Project Number	Case Manager	Phone Number	Destroyed Residences	Destroyed Accessory	Damaged Residences	Damaged Accessory
1168 PALOMINO RD	023-290-017	09JES-00000-00030	Brian Banks	(805) 568-3559	1	0	0	0
1410 PASEO DEL OCASO	023-350-003	09JES-00000-00023	Brian Banks	(805) 568-3559	1	1	0	0
1413 PASEO DEL OCASO	023-350-022	09JES-00000-00107	Philip Oates	(805) 568-3113	0	0	1	0
1414 PASEO DEL OCASO A	023-330-066	09JES-00000-00069	Brian Banks	(805) 568-3559	1	1	0	0
1414 PASEO DEL OCASO A	023-330-066	09JES-00000-00070	Brian Banks	(805) 568-3559	1	2	0	0
1415 PASEO DEL OCASO	023-350-010	09JES-00000-00068	Brian Banks	(805) 568-3559	1	1	0	0
1535 SAN ROQUE RD	023-310-002	09JES-00000-00047	Brian Banks	(805) 568-3559	1	1	0	0
1581 SAN ROQUE RD	023-320-029	09JES-00000-00046	Brian Banks	(805) 568-3559	1	1	0	0
1697 SAN ROQUE RD	023-310-011	09JES-00000-00048	Brian Banks	(805) 568-3559	1	1	0	0
2825 SPYGLASS RIDGE RD	153-270-025	09JES-00000-00109	Philip Oates	(805) 568-3113	0	0	0	1
2875 SPYGLASS RIDGE RD	153-270-023	09JES-00000-00114	Philip Oates	(805) 568-3113	0	0	1	1
2885 SPYGLASS RIDGE RD	153-270-022	09JES-00000-00131	Philip Oates	(805) 568-3113	0	0	1	0
2895 SPYGLASS RIDGE RD	023-310-012	09JES-00000-00091	Brian Banks	(805) 568-3559	0	1	0	0
1140 TUNNEL RD	023-060-022	09JES-00000-00037	Alex Tuttle	(805) 884-6844	1	1	0	0
1165 TUNNEL RD N - N	023-051-021	09JES-00000-00038	Brian Banks	(805) 568-3559	1	0	0	0
1165 TUNNEL RD N - N	023-051-041	09JES-00000-00039	Brian Banks	(805) 568-3559	0	1	0	0
1165 TUNNEL RD N - N	023-051-014	09JES-00000-00040	Brian Banks	(805) 568-3559	0	1	1	0
1165 TUNNEL RD N - N	023-051-013	09JES-00000-00041	Brian Banks	(805) 568-3559	1	0	0	0
1165 TUNNEL RD N - N	023-051-012	09JES-00000-00042	Brian Banks	(805) 568-3559	0	1	0	0
1165 TUNNEL RD N - N	023-051-027	09JES-00000-00043	Brian Banks	(805) 568-3559	1	0	0	0
1165 TUNNEL RD N - N	023-051-020	09JES-00000-00095	Brian Banks	(805) 568-3559	1	0	0	0
1165 TUNNEL RD N - N	023-051-034	09JES-00000-00130	Brian Banks	(805) 568-3559	0	1	0	0
1215 TUNNEL RD	023-051-002	09JES-00000-00087	Brian Banks	(805) 568-3559	1	0	0	0
1239 TUNNEL RD	023-340-011	09JES-00000-00081	Veronica Lanz	(805) 568-2013	0	1	0	0
1242 TUNNEL RD	023-340-023	09JES-00000-00082	Veronica Lanz	(805) 568-2013	1	0	0	0
1255 TUNNEL RD	023-340-020	09JES-00000-00088	Veronica Lanz	(805) 568-2013	1	1	0	0

Supervisor District 1

continued ...

ADDRESS	APN	Project Number	Case Manager	Phone Number	Destroyed		Damaged	
					Residences	Accessory	Residences	Accessory
1265 TUNNEL RD	023-340-024	09JES-00000-00078	Veronica Lanz	(805) 568-2013	1	0	0	0
1285 TUNNEL RD	023-340-021	09JES-00000-00079	Veronica Lanz	(805) 568-2013	1	1	0	0
1295 TUNNEL RD	023-340-018	09JES-00000-00080	Veronica Lanz	(805) 568-2013	1	1	0	0
1297 TUNNEL RD	023-340-008	09JES-00000-00083	Veronica Lanz	(805) 568-2013	1	1	0	0
1330 TUNNEL RD	023-330-030	09JES-00000-00060	Veronica Lanz	(805) 568-2013	0	1	0	0
1350 TUNNEL RD	023-330-028	09JES-00000-00105	Philip Oates	(805) 568-3113	0	0	1	0
1454 TUNNEL RD	023-021-016	09JES-00000-00001	Veronica Lanz	(805) 568-2013	1	1	0	0
1455 TUNNEL RD	023-031-017	09JES-00000-00061	Veronica Lanz	(805) 568-2013	1	0	0	0
1481 TUNNEL RD	023-310-014	09JES-00000-00013	Veronica Lanz	(805) 568-2013	1	0	0	0
1489 TUNNEL RD	023-330-005	09JES-00000-00014	Veronica Lanz	(805) 568-2013	1	0	0	0
1491 TUNNEL RD	023-330-004	09JES-00000-00015	Veronica Lanz	(805) 568-2013	1	1	0	0
1495 TUNNEL RD	153-270-008	09JES-00000-00094	Veronica Lanz	(805) 568-2013	1	3	0	0
1497 TUNNEL RD	023-330-001	09JES-00000-00093	Veronica Lanz	(805) 568-2013	1	1	0	0
2786 WILLIAMS WAY	023-101-017	09JES-00000-00024	Veronica Lanz	(805) 568-2013	1	0	0	0
2794 WILLIAMS WAY	023-101-026	09JES-00000-00132	Philip Oates	(805) 568-3113	0	0	1	0
		Supervisor District 1 Totals:	**Number of Parcels:**	**113**	**71**	**75**	**18**	**4**

Supervisor District 2

ADDRESS	APN	Project Number	Case Manager	Phone Number	Destroyed Residences	Destroyed Accessory	Damaged Residences	Damaged Accessory
1300 BARGER CANYON RD	153-370-014	09JES-00000-00011	Kimberley McCarthy	(805) 568-2005	0	1	0	0
3770 FOOTHILL RD	055-020-032	09JES-00000-00012	Kimberley McCarthy	(805) 568-2005	0	1	0	0
3830 FOOTHILL RD	153-340-022	09JES-00000-00016	Kimberley McCarthy	(805) 568-2005	0	2	0	0
1450 LA VISTA RD	153-370-009	09JES-00000-00009	Kimberley McCarthy	(805) 568-2005	1	2	0	0
1556 LA VISTA RD	153-370-002	09JES-00000-00010	Kimberley McCarthy	(805) 568-2005	1	0	0	0
1574 SAN MARCOS PASS RD	153-340-049	09JES-00000-00017	Brian Banks	(805) 568-3559	0	1	0	0
1604 SAN MARCOS PASS RD	153-340-033	09JES-00000-00066	Brian Banks	(805) 568-3559	0	1	0	0
4581 VIA MARIA	153-232-003	09JES-00000-00067	Veronica Lanz	(805) 568-2013	1	0	0	0
		Supervisor District 2 Totals:	**Number of Parcels:**	8	3	8	0	0
		Grand Totals:	**Number of Parcels:**	121	74	83	18	4

- Tea Fire Incident
- Fire Danger - Moderate | Forecast: Mon Night: Tue:

TEA FIRE INFORMATION

FIRE STATISTICS

1,940 acres burned
100% contained on May 20, 2009
210 residences destroyed: 130 City of Santa Barbara, 80 County of Santa Barbara; 9 residences damaged
22 injuries from smoke inhalation
3 burn injuries
30 firefighter injuries
Estimated firefighting costs $5,700,000

TEA FIRE RECOVERY ASSISTANCE

Click here for information on the application process for Tea Fire Recovery Assistance not addressed by FEMA, SBA or insurance.

BURN AREA FLOOD POTENTIAL

Click here for a map of burn area flooding potential (provided by Santa Barbara County Flood Control.)

ASSISTANCE ORGANIZATIONS

American Red Cross - Pam Voge - Tea Fire Case Manager - 805-687-1331
Contact for assitance with any needs not being addressed by FEMA, SBA or your insurance.

Contractors State License Board
http://www.cslb.ca.gov/Consumers/consumers-overview.asp
Provides guidance in obtaining licensed contractors and provides information to help protect against fraudulent contractor practices, etc.

Department of Insurance - 800-927-HELP (800-927-4357)
http://www.insurance.ca.gov
Provides information regarding insurance issues, such as policy retrieval, claims filing, expediting claim settlements, etc.

Department of Social Services -
http://www.dss.cahwnet.gov/dis/CALIFORNIA_1474.htm
Administers the State Supplemental Grant Program (SSGP), which provides grant funds for unmet recovery needs to individuals and families.

DISASTER ASSISTANCE.GOV - http://www.disasterassistance.gov/daip_en.portal
DisasterAssitance.gov consolidates disaster information in one place. Currently, 17 U.S. Government agencies, which sponsor more than 40 forms of disaster assistance, contribute to the website. You can apply

EXHIBIT 5

for many forms of assistance with a single, online application.

FEMA - 1-800-621-3362
Determines eligibility for various federal programs after citizen teleregisters and receives a Control Number. Services include:

- Low interest loans.
- Cash grants for housing assistance, medical, dental, funeral and other disaster needs.
- Home Repair Assistance for essential living areas.
- Sponsors crisis counseling, disaster legal services and financial recovery planning.
- Determines eligibility for Small Business Administration (SBA) Personal Property Loans, low-interest, long-term loans to repair or replace a primary residence.

Santa Barbara County Assessor/Recorder/Clerk - (805) 568-2550
http://sbcassessor.com/assessor.aspx
http://sbcassessor.com/clerkrecorder.aspx
Provides information on Property Tax Relief - Click here for the Property Tax Relief form.
Replacement Birth/death/marriage certificates / Copies of deeds

Santa Barbara County- Department of Planning Development - 805-568-3030

Santa Barbara County - Tea Fire Ombudsman Tony Nisich - 560-1098
105 E. Anapamu, Basement Suite 3
Santa Barbara, CA 93101

SBA (Small Business Administration) - 800-659-2955
www.sba.gov/services/disasterassistance
Provides low-interest loans for personal and real property damages/losses as well as business losses.

Social Security Administration - 800-772-1213
http://www.socialsecurity.gov
Provides information about replacing lost Social Security and Medicare cards.
Frequently Asked Questions

DAMAGE ASSESSMENT LISTS INFORMATION

Click Here for a lists of Montecito Fire District and/or County of Santa Barbara with significant structural damage or total destruction. Please be aware that these are preliminary reports and are continuing to be updated.

Click Here for Montecito Fire District rebuilding guidelines within the Tea Fire Burn area.

Click Here for frequently asked questions regarding rebuilding for Tea Fire Survivors

Montecito property owners with questions regarding the status of their property are encouraged to call the Montecito Fire District at (805) 969-2537.

FEMA Links

FEMA Denial Letter: Not The Last Word

Host Of Federal-State Aid Programs Available

Wildfire Survivors Beware of Recovery Scams

Mobile Disaster Recovery Center Supporting Santa Barbara LAC

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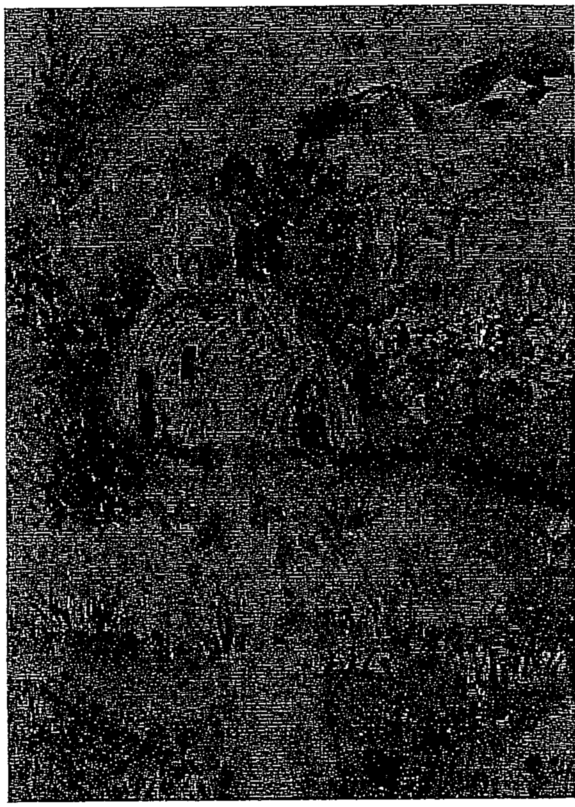
ta Barbara ARD

1212 Mission Canyon Road, Santa Barbara, CA 93105

80th Anniversary Celebration — Art In The Garden

80th Anniversary Celebration
Art In The Garden
11:00 a.m.⊠4:00 p.m. Saturday, June 24
10:00 a.m.⊠4:00 p.m. Sunday, June 25
Enjoy a day of strolling through the Garden and an opportunity to view and acquire artwork by artists from the Santa Barbara Art Association, Goleta Art Association, and Southern California Artists Painting for the Environment. A percentage of the purchase price will benefit the Santa Barbara Botanic Garden's education and research programs.



from last year's showing "toad Hall" artist: Mary Freericks, watercolor 14x20. Copyright 2005

80th Anniversary Celebration
Art In The Garden
11:00 a.m.⊠4:00 p.m. Saturday, June 24
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email: info@sbbg.org phone: 805-682-4726 fax: 805-563-0352

EXHIBIT 6

the Santa Barbara Botanic GARDEN

garden news
The Santa Barbara Botanic Garden is the proud recipient of a prestigious National Endowment for the ... Read more

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1212 Mission Canyon Road, Santa Barbara, CA 93105

Annual Holiday Marketplace

November 2223

Courtyard, 10:00 a.m.-4:00 p.m.

Free admission to sale

November 2223

Courtyard, 10:00 a.m.-4:00 p.m.

Free admission to sale

When nature calls, let it be to the Botanic Garden! Celebrate our 15th Annual Holiday Marketplace, featuring new local vendors with their exciting displays of nature-related, handcrafted items. Get a headstart on your gifts for this holiday season and be sure to shop early for the best selection!

email: info@sbbg.org phone: 805-682-4726 fax: 805-563-0352

EXHIBIT 7

garden news

On October 10, 2009, the Santa Barbara Botanic Garden will host an ART from the ashes exhibit and sa...
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the Santa Barbara Botanic GARDEN

1212 Mission Canyon Road, Santa Barbara, CA 93105

When Nature Calls - Holiday Marketplace

It's time for the annual Holiday Marketplace featuring the ever-popular Garden Guild crafters and local artisans.

When Nature Calls
Holiday Marketplace
Saturday & Sunday, November 18-19
10:00 a.m.–4:00 p.m.

Calling all shoppers! It's time for the annual Holiday Marketplace featuring the ever-popular Garden Guild crafters and local artisans. Select from a wide range of gifts and decorative items that reflect the beauty and charm of the Botanic Garden. The Garden Gift Shop and the Garden Growers Nursery will feature special gifts as well, making it the perfect place to kick off your holiday season. See you there!

email: info@sbbg.org phone: 805-682-4726 fax: 805-563-0352

EXHIBIT 8

Marc Chytilo

From: Santa Barbara Botanic Garden [megan@santabarbarabotanicgarden.ccsend.com] on behalf of Santa Barbara Botanic Garden [lorsua@sbbg.org]
Sent: Friday, December 26, 2008 11:42 AM
To: airlaw5@cox.net
Subject: Winter Wonderland

the Santa Barbara Botanic GARDEN

WISH LIST

Imagine a Winter Wonderland... Strolling through walking trails illuminated by thousands of twinkling lights, amidst a setting of holiday displays... all nestled throughout 65 acres of beautiful California landscape.

It's our Holiday wish here at the Santa Barbara Botanic Garden- With your help and generosity we can make this dream come true in 2009!

Donate Your Gift Today

- Outdoor Light Displays: Nativity Scenes, Trees, Wreaths, Garland, Giant Snowmen, Santa Claus, Elves, and Reindeer Sets, Animated Santa's Workshop, Holiday Signs, Sleighs, Carolers, Lamp-posts, Large Toy Soldiers, Victorian Skaters, Hanging Christmas Bells, 7 and 8 Foot Candy Canes, Animated train.

Light Bulbs
Strings

EXHIBIT 9

- Snowflakes
- Controllers
- Electrical supplies
- Pre-Lit Wreaths
- Garland
- Rope Light Clips
- Mounting Hardware
- Cash Donations
- A portable DVD player

Donations can be brought to the Garden from 9am to 5pm M-F
For Cash Donations Please Mail to: Santa Barbara Botanic Garden at 1212 Mission Canyon Rd. Santa Barbara, CA 93105
Attn: Holiday Donations
For more information on how you can help donate please call our Membership Coordinator

Leana Orsua at: (805) 682-4726 ext. 110

POTENTIAL EFFECTS OF CLIMATE CHANGE ON RESIDENTIAL WILDFIRE RISK IN CALIFORNIA

A Paper From:
California Climate Change Center

Prepared By:
Benjamin Bryant, Pardee RAND Graduate School
Anthony Westerling, University of California at Merced

FINAL PAPER

DISCLAIMER

Arnold Schwarzenegger, *Governor*

August 2009
CEC-500-2009-048-F

EXHIBIT 10

Acknowledgments

The authors would like to thank Todd Hawbaker, Susan Stewart, and Alexandra Syphard for valuable conversations on the nature of wildfire risk and modeling approaches, as well as Henry Willis for discussions on relative risk. Three anonymous reviewers were helpful in improving our original draft.

Preface

The California Energy Commission's Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program conducts public interest research, development, and demonstration (RD&D) projects to benefit California's electricity and natural gas ratepayers. The PIER Program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts focus on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

In 2003, the California Energy Commission's PIER Program established the **California Climate Change Center** to document climate change research relevant to the states. This center is a virtual organization with core research activities at Scripps Institution of Oceanography and the University of California, Berkeley, complemented by efforts at other research institutions. Priority research areas defined in PIER's five-year Climate Change Research Plan are: monitoring, analysis, and modeling of climate; analysis of options to reduce greenhouse gas emissions; assessment of physical impacts and of adaptation strategies; and analysis of the economic consequences of both climate change impacts and the efforts designed to reduce emissions.

The California Climate Change Center Report Series details ongoing center-sponsored research. As interim project results, the information contained in these reports may change; authors should be contacted for the most recent project results. By providing ready access to this timely research, the center seeks to inform the public and expand dissemination of climate change information, thereby leveraging collaborative efforts and increasing the benefits of this research to California's citizens, environment, and economy.

For more information on the PIER Program, please visit the Energy Commission's website www.energy.ca.gov/pier/ or contract the Energy Commission at (916) 654-5164.

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Abstract

We model the interaction of climate-dependent wildfire risk and one spatially explicit population growth scenario in California to generate measures of changes in wildfire risk to residential property under different scenarios for future climate. While absolute estimates are affected by multiple uncertainties, the following conclusions appear robust to those uncertainties explored: Wildfire risk increases throughout the century in both high emission (A2) and low emission (B1) climate scenarios. There is little noticeable difference between A2 and B1 *Special Report on Emission Scenarios* scenarios for the periods 2005–2035 and 2035–2065, but the higher emission A2 scenario does lead to noticeably higher fire risk in the 2070–2100 period when compared to a B1 climate. Average annual monetary impacts due to home loss may easily prove to be in the billions of dollars by mid-century.

Keywords: Fire, wildfire, risk, climate, scenario, WUI, wildland-urban interface, spatial

1.0 Introduction

Wildfires in California routinely threaten people and property, destroy homes, force evacuations, and result in the death or injury of some citizens and firefighters. As described in the companion report (Westerling et al. 2009) and previous work, climate change can affect the size and frequency of wildfires in California, and do so differentially across the state (Westerling and Bryant 2008, Westerling, Hidalgo et al. 2006, and Lenihan, Drapek et al. 2003). And while fire poses many hazards, its most direct impact on humans is fundamentally connected to how people are distributed over the state. Thus, to better create a reasonable picture of how the California population will be affected by changing wildfire patterns, it is important to consider both climate-induced changes in wildfire and the interactions of these changes with growth.

The primary aim of this report is to describe how climate change and human development patterns over California may interact to lead to differing levels of fire-caused risk to human residences. In this report, we examine how two climate change scenarios (high emission A2 and low emission B1) interact with one plausible growth scenario to yield estimates for residential wildfire risk under a variety of uncertainties. In order to mitigate the impact of uncertainties, our primary results are in the form of statistics on aggregate statewide relative risk (referenced to the year 2000), though we also present relative risk distributions mapped over the state of California, in addition to highly caveated estimates for possible monetary damages related to housing loss.

In the remainder of the introduction, we discuss the impacts associated with wildfire in present-day California, including the many types of impacts that are not addressed in this report. We then provide a brief overview of our general approach to modeling and the outcome measures we use to present the climate impacts.

1.1. Types of Wildfire Impacts

Wildfire impacts humans and the environment in many ways. The most apparent costs arising from wildfires are those of fighting the fires, and the cost of the homes and other structures burned by wildfires that encroach into populated areas. These events can be extreme and receive much attention - in one week in October 2003 over 3000 homes were destroyed, 26 lives were lost and 3000 square kilometers were burned (Keeley, Fotheringham et al. 2004, Westerling et al. 2004). In October 2007, over 350,000 households were evacuated in response to wildfires in southern California (Reza, Leovy et al. 2007). But there are many other less obvious impacts, both to humans and also to ecosystems, some of which are listed in Table 1. (See the California Forestry Board's California Fire Plan for an extremely thorough attempt at comprehensively assessing wildfire impacts of all sorts). In this paper we focus only on quantifying changes in direct damages to homes, and therefore when evaluating our results it is important to remember that these impacts represent just a fraction of the total impacts from wildfire. While monetization of many of the impacts listed in Table 1 is difficult, the California Department of Forestry estimated that, for example, watershed impacts of wildfire, in the form of soil erosion and potential required sediment removal from water bodies, may easily average out to magnitudes on the order $100 per acre burned, possibly even up to thousands of dollars per acres burned in some cases (California Forestry Board 1996). This translates to at least tens of millions of dollars of annual impacts from that source alone. In addition, many of the environmental impacts have human consequences. The health and viewshed impacts of reduced air quality are readily apparent, but there are other more subtle effects, such as watershed impacts reducing desired fish populations and reducing power generation ability from hydroelectric dams.

Table 1. Example types of wildfire impacts

Direct Human Impacts	Indirect Impacts
Structures burned/property value lost	Watersheds - soil loss, deposits
Suppression expenditures	Timber loss
Evacuation costs/lost productivity	Habitat disruption
Lives lost and adverse health effects of smoke	Species loss
Diminished recreational opportunities and viewsheds	Non-native species invasion
Disruption to infrastructure availability	

When considering damages, it is important to acknowledge that wildfire is in principle a natural phenomenon that serves a role in maintaining healthy ecosystems, but human presence and action combine to make fire both a risk to humans, and also potentially a risk to ecosystems. This is due to humans causing unnatural *patterns* of wildfire with intensities or frequencies outside the range of natural variability. For example, fuel suppression may lead to higher intensities, and human presence may lead to higher numbers of ignitions and higher frequencies (Syphard, Radeloff et al. 2007). These changes can impact ecosystems in undesirable ways that may or may not be proportional to the residential impacts we address here.

1.2. Primary Approach: Aggregate Relative Risk

There is a great deal of uncertainty involved in essentially every aspect of wildfire risk scenarios. The model-generated data required to produce our results is at the end of a long chain of cascading uncertainty, thus any individual estimates for a particular year or particular locality cannot be trusted as a "prediction," even contingent on the climate and population scenario.

However, by careful analysis, we can still usefully *compare* different outcomes, while avoiding taking stock in the precise values for any point in time. This involves circumventing the two issues of bias and variance. Bias refers to systematic error in the underlying models that will tend to routinely lead to misestimation in a certain direction. While there is no flawless solution to this problem, it can be addressed to some degree by considering relative risk changes, rather than looking at the absolute estimates. If both estimates are off by a common factor, this will be cancelled out in the relative comparison.

Second, we can help account for random variation at the small scale by only considering significant aggregations over space and also over time. In any given time period and locality, there will be effectively random forces changing the risk by various amounts. But when considered over large enough aggregations, these variations work to cancel each other out, so that the percentage error will be lower when considering impacts over all of California than when considering impacts in a tiny area like the surroundings of a specific town.

While these techniques do not solve all the problems associated with modeling long-term impacts, they help significantly. Thus our primary outputs of interest will be aggregate measures of relative risk. For each combination of climate change scenarios and model uncertainties, we assess the risk summed over all of California relative to the risk in a baseline year, where the risks being compared represent the product of probability of exposure to a fire and the value (number of households) exposed to that fire—though due to fire dynamics, exposed value is less than total value. For the sake of illustration, we do also present some spatially distributed data, along with plausible estimates of monetary impacts under highly caveated assumptions.

2.0 Risk Estimation Methods

The fundamental terms that affect our measures of risk due to wildfire are the expected frequency and size of wildfires, and the population and number of households in areas potentially affected by wildfires. How they are related to generate true risk is not necessarily straightforward, and is a function of many other variables as well. In this section, we first discuss the model-generated data we have available as potential inputs to our own risk modeling, then discuss a conceptual model of wildfire risk. Lastly, we describe how we implement a modeling approach that attempts to capture the important relationships with the data we have available, while minimizing the impact of our missing data and the fundamental difficulty of modeling fire-human interactions.

2.1. Base Input Data at the 1/8 Degree Scale

Because forces governing human-fire interactions act over many scales (Falk, Miller et al. 2007), the appropriateness of any given risk modeling technique is also governed by the spatial scale for which we are considering impacts. In this case, we are constrained by the spatial resolution of available hydroclimatic data. These are available for gridcells of 1/8-degree latitude and longitude (a little less than 14 kilometers between north and south boundaries, less between east and west boundaries). As described in the Westerling et al. companion report (Westerling et al. 2009), climate change models using A2 and B1 emissions scenarios are downscaled to this spatial level and used to force hydrologic simulations. The resulting hydroclimatic data are used to drive statistical models of both the probability of wildfires exceeding arbitrary thresholds (using nonlinear multinomial logistic regression methods), which are then combined with extreme value distributions describing the size of burned areas above those thresholds (using Generalized Pareto Distributions of extremes). Wildfire occurrence and extent is originally estimated monthly for 1950 to 2100, though we rely on annualized time-averaged values for thirty-year windows in generating our risk estimates. The ultimate output of the fire modeling we utilizing is the expected total burned area in wildfires exceeding the 200 ha minimum threshold.

To consider the evolving geographic distribution of population and number of households, we rely on a base case distribution provided by the U.S. Environmental Protection Agency. The Integrated Climate and Land Use Scenarios (ICLUS) were developed to create thematically consistent land use scenarios at high resolution across the United States (US EPA 2008). They link country level population growth assumptions with the SERGOM spatial distribution model to generate housing density projections at the 100 meter (m) level (Theobald 2005). At the time of analysis, spatial housing density data was available only for a midrange case, but not for the A2 and B1 socioeconomic growth conditions. These projections were provided on the 100 m level (hereafter "pixel", in contrast with 1/8 degree "gridcell"). The precise spatial distribution of pixels within 1/8 degree gridcells plays no role in our analysis, though as discussed later we do retain information about the distribution of pixel values within a gridcell, rather than simply aggregating their associated values to the gridcell level. Other methods for assessing fire risk do utilize fine spatial detail to construct buffer zones defining fire risk, under the (justified) assumption that houses may catch fire due to falling embers that land significant distances from the true fire perimeter (FRAP 2003). Due to lack of reliable spatial data decades in the future, our approach is essentially independent of this method, relying instead on density distributions within the gridcell, which may imply an underestimation of risk.

2.2. Conceptual Model of Fire, Exposure and Risk

Climate change has the potential to affect wildfire patterns through multiple channels. One is its effect on vegetation patterns—as climate changes, vegetation patterns may change as well, with plants suited to a specific climate and locale migrating or dying off, and being replaced by plants more suited to the new climate. The combination of vegetation type and moisture patterns (also affected by climate) can change fuel build-up and moisture levels, which in turn lead to different distributions of fire probabilities and fire size.

The distribution of people over the landscape also changes with time. The interaction between humans, landscape and wildfire risk runs through multiple channels as well, some of which work to counteract each other. In one sense, development in a given region decreases the vegetation footprint available for the ignition of wildfires, but human presence may more than compensate by an increase in human-caused ignitions, where there were only natural ignitions before. However, the increased presence of humans may also have the effect of decreasing fire size in the region, through early identification of fires and increased suppression efforts. In general, the statistical relationship between population density and the human-related "risk of fire" is some form of inverted U (or even one having multiple maxima), being zero at zero human presence, and zero at some saturated density, where everything is urban and wildfires cannot exist. However, the range of shapes possible in between these extremes is not known and likely highly contingent on many other variables associated with the locality.

Our model of fire risk accounts for human impacts on wildfire probabilities, and also allows for humans to act in ways that mitigate their exposure to fire proportionally with the value at risk, thereby capturing some of the interactions described above. These relationships are shown conceptually in Figure 1. The first several steps were carried out by other researchers as part of the California Climate Impacts Assessment. The *Special Report on Emissions Scenarios* (SRES) scenarios affect population growth and also emissions. Population growth combined with assumptions about its spatial allocation yields a spatially explicit population trajectory through time. As modeled by Westerling et al. (2009) this population distribution, together with climate change, affects the probability and size of wildfires, both directly and through their joint impact on vegetation change. The focus of the present paper is on the last two steps: Integrating spatial population with exposure assumptions to estimate value exposed to loss from wildfire, and then integrating that exposed value with expected values for area burned by wildfire to generate estimates of risk.

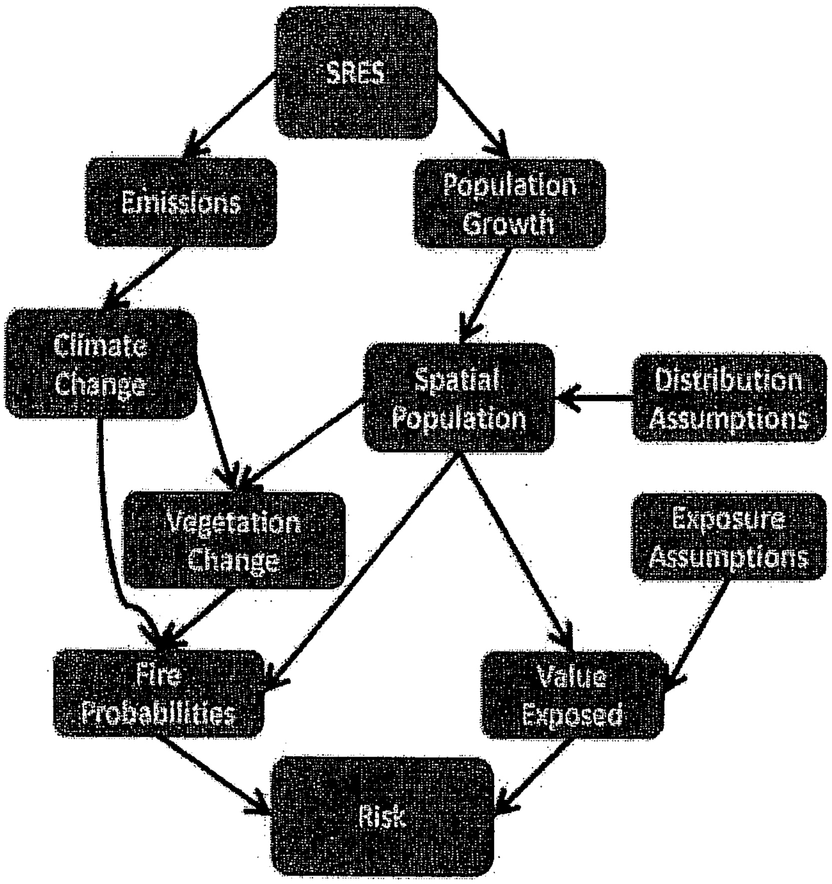

Figure 1. Conceptual model of climate-impacted fire risk

As can be seen from Figure 1, the first way in which human presence is allowed to impact fire probabilities is by incorporating a population term directly into the statistical model of fire probabilities affected by human population growth. This term is allowed to be nonlinear, and has the potential to account for both the increase and decrease in fire risk as population goes from very low to very high density (Syphard, Radeloff et al. 2007).

Human presence also affects fire probabilities through its impact on the available vegetated area over which fire is allowed to start and burn. The fraction of each gridcell covered by vegetation also enters the fire probability model directly, and we adjust this fraction depending on the amount and density of human presence in the gridcell. The precise method by which this allotment is made is discussed in Appendix 1 of the companion Westerling report (Westerling et al. 2009), but essentially we use the spatial urbanization projections to identify how much of each gridcell lies above a certain threshold household density. We then allot that fraction of area proportionally to the different classes of non-developed, non-water areas remaining in the gridcell. The thresholds used to define urban are treated as uncertainties in the model, and affect the variation of our final estimates as described in Section 3.1. Future work will also explore different vegetation allocation methods as well.

In addition to allowing for human presence to affect the baseline wildfire probabilities, we also allow that the amount of value exposed to risk may scale negatively as a function of household density. Here, the concept is that because there exists some density at which an area is urban and no longer subject to the threat of wildfires, there must be some (statistical, rather than deterministic) function which relates the value (e.g., number of homes or households) *existing* in a given area to the value *exposed* to the risk—since it is not necessarily the case that all households in a given area are genuinely at risk for burning due to a wildfire.

These ideas combine into an underlying conceptual model of fire risk for a given gridcell:

$$RISK_{gc} = p(C_{gc}, P_{gc}, V(H_{pix \subset gc})) \times E(A)_{gc} \times \sum_{pix \subset gc} X(H_{pix} s(H_{pix}))$$

Where p is the probability of a large fire above an arbitrarily specified size, C is climate, P is population, and V describes the vegetation fraction at the gridcell level as a function of the household distribution at the pixel level. $E(A)$ denotes the expected burned area conditional on a large fire occurring, expressed as a fraction of the total non-water area of the gridcell. X is the household value exposed at the pixel level, which relates value enclosed to a function $s(H)$, which scales total value in a pixel to the fraction of that value genuinely exposed to risk. The multiplication by area fraction to generate an estimate of risk involves the assumption that exposed value is likely to be lost to wildfire in direct proportion to the size of the wildfire relative to the size of the gridcell. This assumption does not necessarily hold in many cases, but is made irrelevant in discussions of relative risk. It does play a role in our absolute monetary estimates described later.

Components of the fire-estimation methodology are rigorously detailed in Preisler and Westerling (2007) and Holmes, Hugget and Westerling (2008). Here we focus on the estimation of the value-exposed component. The formalized value-exposed model presented here is not based on preexisting work, but is designed specifically for this study in order to quantify the qualitative relationships documented in the literature discussed above. We consider the value exposed to wildfire risk within a gridcell to be a function of the value existing within the gridcell, and also a function of how exposure to fire decreases with increasing household density. In doing this, we do not take into account the explicit spatial location of household distributions at the 100 m level, but we do utilize information about the distribution *of values* associated with the 100 m pixels in each gridcell. That is, we perform our exposure scaling at the 100 m level, and then aggregate the exposure-adjusted values to the 1/8 degree level, rather than first aggregating value enclosed to the 1/8 degree level and then applying the scaling function. The rationale behind this ordering is that protective action against wildfire is more accurately described as taking place at the 100 m level, rather than the ~10 kilometer level. It is likely that the true scale of relevance lies somewhere in between, and future work may explore different spatial scales of aggregation, but such exploration was not undertaken for this project.

The form of the exposure scaling function itself is unknown to us, however we assume it to fall within an envelope of possibilities, and explore the impact of these assumptions. The effect of its precise form should be somewhat diminished in our consideration of relative risk, though it does play a larger role in our analysis on absolute values. To capture a suitable variation in functional form we choose a function satisfying $x^k + y^k = 1$, and allow k to vary. Here x is the ratio of the household density in a 100 m pixel to the "threshold density" above which an area is considered too urban to be subject to wildfires, and y is the fraction by which the existing value is scaled. As can be seen in Figure 2, high values of k imply that not much scaling happens until close to the threshold, while low values of k (below one) imply more drastic scaling even with low densities. Additionally, to the extent that the fire probability model sufficiently accounts for human presence, it may or may not be necessary to normalize these scaling adjustments so that total probability is preserved in the gridcell. In order to address this possibility, we introduce as another uncertainty a normalization factor in which the scaled values are multiplied by the reciprocal of the area under the scaling curve. Additional discussion of this rescaling function is provided in the appendix.

The full functional form for our value exposed to fire in a gridcell is then:

$$\sum_{pix \subset gc} \left(H_{pix} [A(s)]^{-I} s(H_{pix}, d, k) \right)$$

Where $A(s)$ is the area under the exposure scaling function $s(H_{pix}, d, k)$, defined as:

$$s(H_{pix}, d, k) = \begin{cases} \left[1 - \left(\frac{H_{pix}}{d} \right)^k \right]^{1/k} & \text{if } \frac{H_{pix}}{d} \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

The value d represents the threshold density, and I is an indicator function for whether normalization should take place. As a reminder, only H_{pix} is provided as a formal scenario level – k and d are all considered uncertain parameters describing features of human-fire interaction.

It is this expression which is multiplied by the expected burned fraction for a given gridcell and month in order to arrive at a gridcell-level risk estimate.

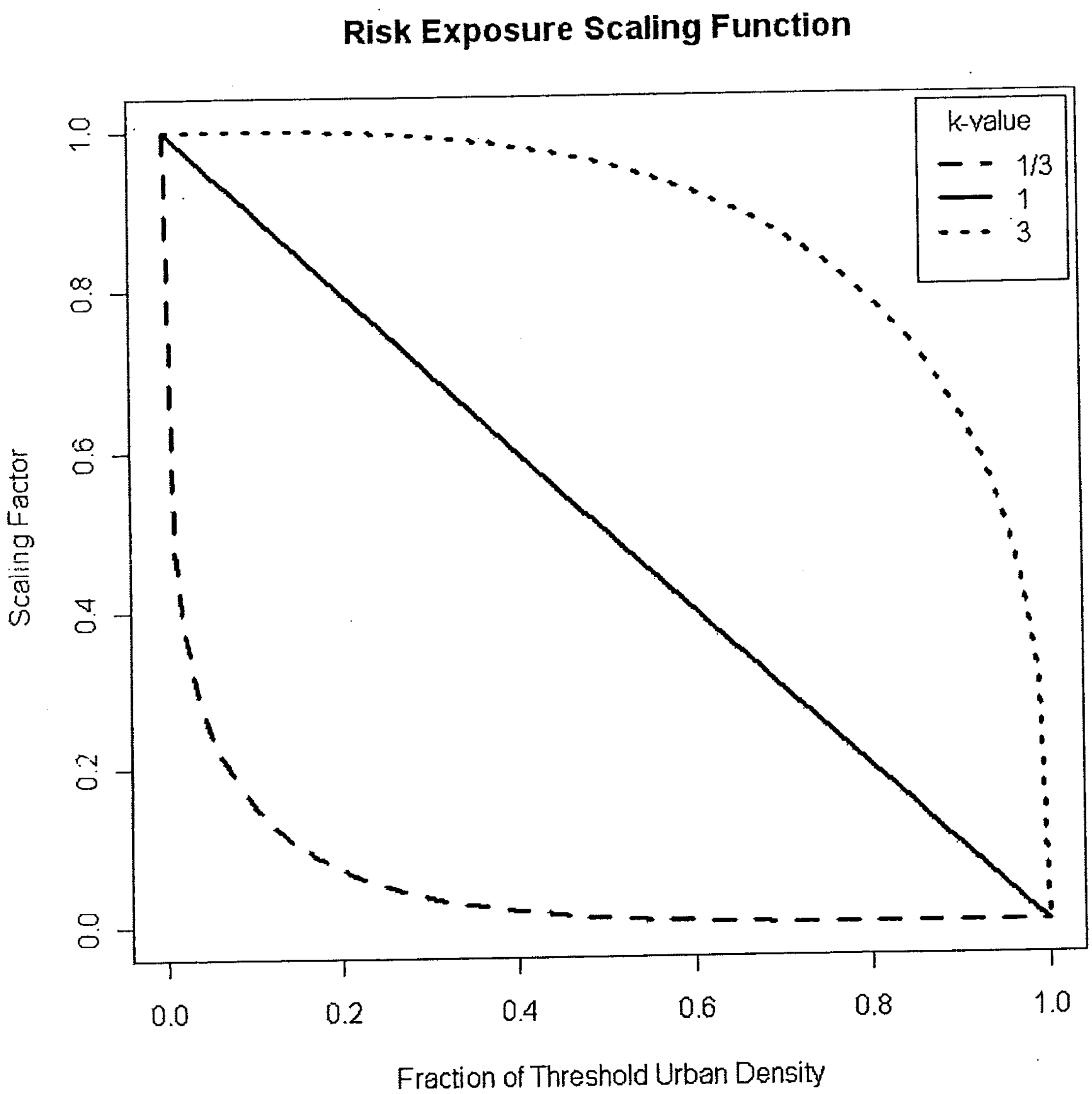

Figure 2. Exposure scaling function for different parameter values

2.3. Aggregate Relative Risk to Address Model Bias and Variance

Both the model for wildfire burned area and the growth model for allocation of residences are likely subject to bias and variance, the statistical terms referring to the size of systematic and random error, respectively. While these problems of bias and variance suggest that we should not place a great deal of confidence in the particular estimated values, we can arrive at still-useful estimates of another form, ones in which we can place more confidence. First, by aggregating the gridcell-level risk to larger geographical regions, we cancel out much of the random variation. Second, if we assume that the bias in the model is approximately proportional to the true model, then this bias will largely cancel when comparing aggregate risk estimates relative to a baseline risk. In order to capitalize on this increase in accuracy, we take as our primary outputs of interest the aggregate relative risk ratios over all of California. Specifically:

$$RR_{CA} = \frac{\sum_{gc \subset CA} p_{gc}(S,T) \times E(A)_{gc} \times X_{gc}(S,T)}{\sum_{gc \subset CA} p_{gc}(S_0,T_0) \times E(A_0)_{gc} \times X_{gc}(S_0,T_0)}$$

That is, we compare the risk in a given scenario S and time period T to the risk in a baseline (historical) scenario, with both calculated under a common set of assumptions.

2.4. Supplementary Illustrative Impacts

We consider two additional forms of impacts that provide more detail of the impacts, with the tradeoff that they are more strongly affected by uncertainties. The first is an illustrative display of statewide risk distributions at the 1/8 degree level. This output format requires no additional calculations—we merely retain the distributions over the state calculated for each gridcell, although the variance-stabilizing effect of aggregating to the state level is then lost.

The second presentation involves estimating monetary impacts associated with statewide fire risks. This requires supplementing our risk model above with additional assumptions in order to arrive at measures of expected value lost. Such a technique was described in Westerling and Bryant (2008), and requires assumptions about housing value and the expected fraction of housing value lost given a housing unit is lost to a wildfire.

For the estimation of housing value, we use year 2000 housing values scaled by the average 10-year increase in statewide inflation-adjusted average housing cost from 1940 to 2000. This is approximately 38 percent (US Census, 2009).

The expected fraction of housing value lost given a house is burned is referred to as the "improved fraction"—this is not equal to 1 because a property retains at least some land value even if the home is lost. Our estimates will be directly proportional to this ratio, so exploration of sensitivity to this value is trivial. Therefore, for this study we simply use .5, the median value utilized by Westerling and Bryant (2008).

Formally, the expected damages function is:

$$E(damage)_{gc} = V \times I \times RISK_{gc}$$

Where V is the housing value, and I is the improved ratio (.5). It is recognized that all of the above factors will in reality be highly property dependent. However, modeling this greater detail decades into the future would be shrouded in such uncertainty that we chose merely to consider illustrative values in this analysis.

2.5. Nominal Calibration Exercises

When model parameters are unknown, it is common to estimate them by finding parameter combinations that generate model behavior consistent with observed data or historical experience. Because there are often multiple combinations of parameters that lead to matching of historical output, successful calibration does not necessarily guarantee the model will predict well when tested outside the period of calibration. However, in our case we can use very basic calibration techniques not to completely restrict our parameters sample, but to provide a reference within which our broader range of uncertainties is explored.

The data we calibrate to is the California Department of Forestry's data on annual structures lost, from 1989 to 2006 (CDF, 2009). Our calibration technique is to fit a linear time trend and estimate 95% confidence intervals around a prediction for the year 2000, and identify which parameter combinations we sampled lead to housing losses within those bounds. Applying this technique, we find a 95% confidence interval on Year 2000 structures lost of 150 to 1501. Under the assumption that all structures lost are homes (discussed below), we find the following risk parameter combinations are consistent with this range:

Threshold urban density (d) =147 and k = 1 and no normalization

Threshold urban density (d) =147 and k = .333 and no normalization

Threshold urban density (d) = 1000 and k = .333 and no normalization

We found that no parameter combination that included normalization and no parameter combination that included a exposure scaling coefficient ('kval') of 3 led to values within even the 99 percent confidence intervals around the year 2000, so we excluded those from our analysis. Our results are then presented in following forms: Our maximal bounds arise from considering as our input space the outer product of parameter values that were plausible individually, while our calibrated cases include only those parameter combinations that actually led to consistent year 2000 values, which we provide for reference. It turns out that our calibration parameter combinations include the lowest bound, so in this case there is no difference between lower calibrated bound and minimum outputs of our uncertainty combinations. The upper bound case not considered as part of the calibrated set is k=1 simultaneously paired with a density threshold of 1000. The relative sensitivity of all the fire-probability uncertainties was much smaller, so all combination of those are included.

Clearly this a very simple first-order calibration exercise with several limitations. First, we make two assumptions regarding the data: One is that all structures lost are housing units, (which biases our results upwards), and one is that all housing units lost fall within CDF jurisdiction (which biases our results downward). These opposite biases should partially cancel each other, but we do not know with which side of zero the net effect lies. Another key issue is that we applied the calibration after our combinations of uncertain parameters were chosen, so that our sampling was not a search process to probe the boundaries of plausible parameters. In reality, many parameter combinations would likely lead to year 2000 values consistent with the damage estimates of our model, but different parameter combinations may cause the model to behave differently farther out in the future, even though they match in historical periods. Future work will explore these implications in more detail.

3.0 Results

3.1. Overall Impacts

Our overall results are captured in the box and whisker plot of Figure 3. The ranges displayed in this plot are contingent on year and emissions scenario, but otherwise all other variables are treated as uncertain, and their variation contributes to the range of estimates for each climate scenario. The variation is due to our pre-specified non-random experimental design over the uncertainties, rather than arising from some probability distribution. Therefore, statistical inferences related to the differences between the resulting distributions should be avoided.

We see that aggregate statewide risk increases with each time period under both emissions scenarios. Additionally, we can see that the effect of different emissions scenarios is nearly indistinguishable through mid century, but that by the 30-year period[1] centered around 2085, the SRES A2 emissions scenario displays noticeably higher risk of property losses due to wildfire as compared to the B1 scenario.

[1] Most scenario analysis for this series of reports reference the 30 year periods 2005–2034, 2035–2064, and 2070–2099. Our spatial housing distributions were available in 10-year increments only, and as these form the core of the estimates for value at risk, they are averaged over the 31 year periods extending one year beyond each of the "standard" periods. The probabilities and expected burn areas are from time averages over the original 30 year periods.

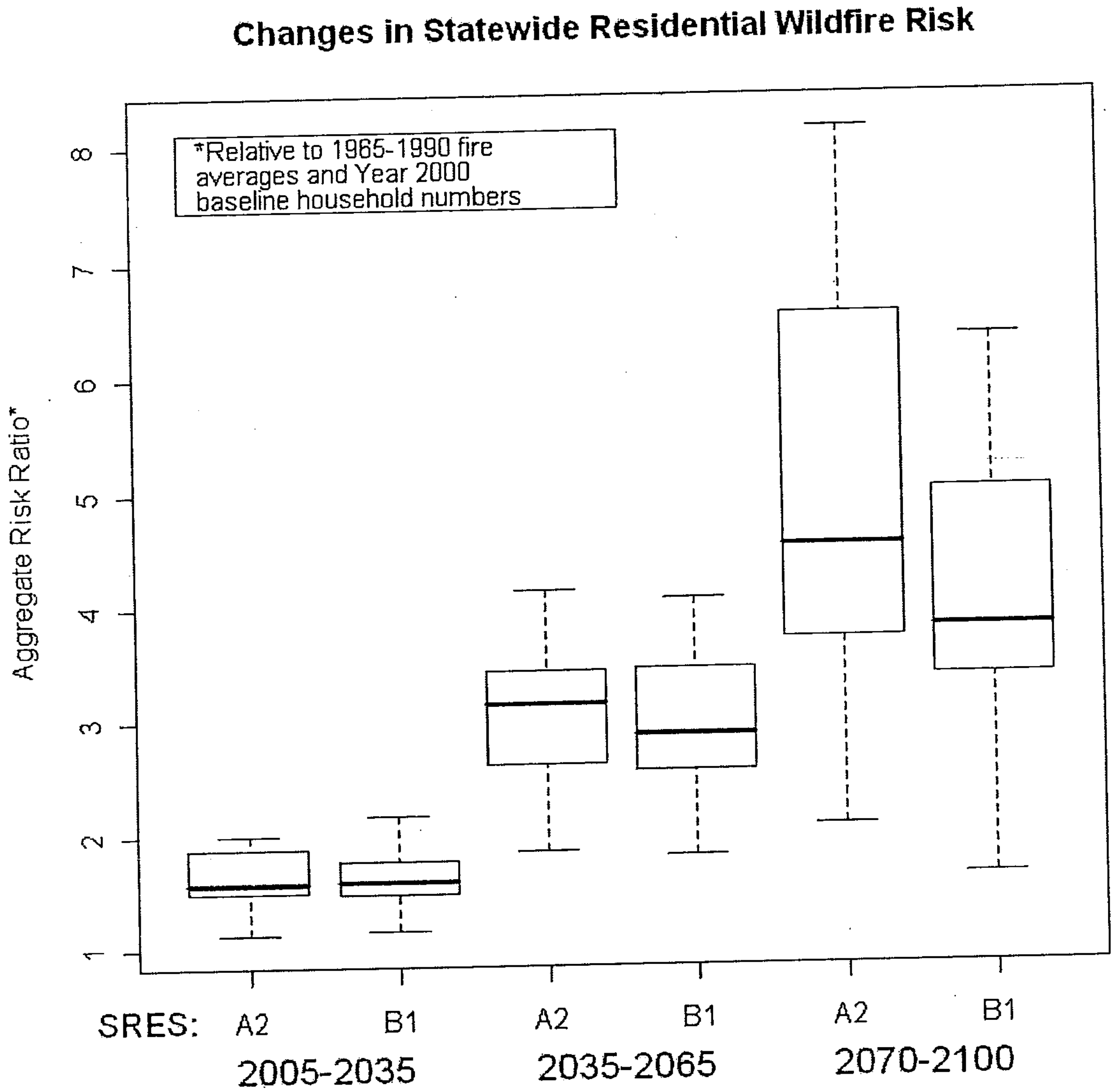

Figure 3. Changes in wildfire risk to households, by time period and emissions scenario

The minimum and maximum values associated with Figure 3 are summarized in Table 2, along with the lower and upper estimates found when applying only the Y2K-consistent parameters. While we discourage taking great stock in the precise values presented, the current model and assumptions used suggest California could experience anywhere between a 61 to 715 percent increase in aggregate fire risk by the end of the century, with a tripling or even quadrupling of fire risk appearing quite plausible by mid-century, under either climate scenario. It can be seen that the ranges on the box-and-whisker plot do extend quite far, especially in 2085. However, the fact that none of the 80 plausible combinations of uncertain parameters yielded a relative risk ratio lower than 1.611 by 2085 suggests we can be reasonably confident the risk will increase substantially, under this particular growth scenario and assuming no drastic improvements in fire protection ability. The growth scenario we utilize does assume a near doubling of population from 2000 to 2100, thus much of the risk increase can be explained by the new population—but the remainder is due to a combination of climate-induced change, and potential changes in growth patterns that create larger exposed value per capita.

Table 2. Relative risk ratios by period. The 'Min' and 'Max' columns represent the bounds of cases we explored. The 'Min' and 'Upper' columns represent the bounds from parameter combinations consistent with Year 2000 damage estimates.

Summary Statistics for Aggregate Relative Risk

	2005-2035			2035-2065			2070-2100		
	Min	Upper	Max	Min	Upper	Max	Min	Upper	Max
SRES A2	1.12	1.93	2.00	1.83	4.14	4.14	2.06	6.82	8.15
SRES B1	1.14	1.99	2.17	1.79	4.07	4.07	1.61	5.42	6.33

3.2. Illustrative Spatial Impacts

Figure 4 displays the spatial distribution of residential wildfire risk throughout the state for the period centered around 2085, using two different climate models and two different climate scenarios. The color scale codes the expected damages in terms of expected annual structures lost, by gridcell. The patterns are similar across the state regardless of model and climate scenario, though it can be seen that for a given model, the A2 scenario shows greater orange and red areas of high risk as compared to the B1 scenario.

These maps demonstrate graphically the important relationship between population and risk, with high risk areas clustering around population centers and the development in the Sierra Nevada foothills. This is a reflection of multiple factors, including population's influence on wildfire itself and the fact that population correlates with structures (homes) exposed to wildfire, as well as the effects of climate on wildfire. While they are assumed to do so here, neither the relationship between population and fire nor the relationship between population and exposed structures must stay fixed through time, which implies a potentially large role for policies to mitigate residential wildfire risk, both through reducing ignitions, and also through better protection of homes. In addition, because we employed a single base-case growth scenario that lies between the population and development that would be consistent with the SRES A2 and B1 storylines, the differences between modeled risks for the A2 and B1 scenarios (Figure 4) are less than they should otherwise be if we assume consistency between California's development narrative and that of the world. That is, the effects on our relative risk measure of the greater burned areas in the A2 scenarios would be compounded by greater population growth and more sprawl, and vice versa for the B1 scenarios. The analysis reported here will be extended in the near future to incorporate new ICLUS growth scenarios compatible with the A2 and B1 storylines.

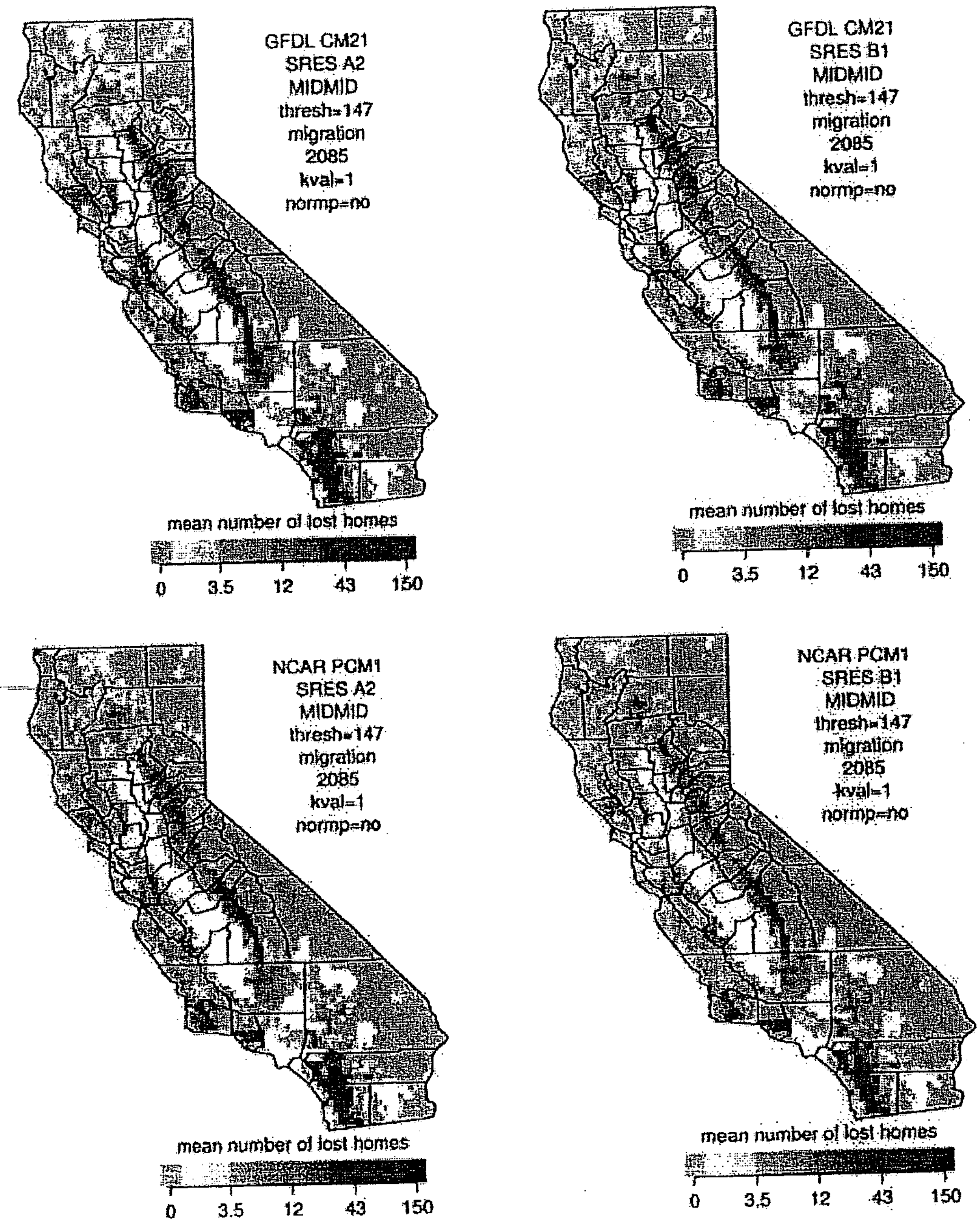

Figure 4. Annual Residential Wildfire Risk in 2085 for A2 and B1 expressed as the mean number of lost homes, for two different climate models.

3.3. Illustrative Monetary Impacts

Table 3 displays example monetary impacts derived using the methodology described in Section 2.4, using the base year 2000 value of $211,500. Each value in the table represents a plausible monetary impact (in billions of 2000 $US) due to lost home value in the center year of each period (i.e., 2020, 2050, and 2085). We emphasize that the particular values are highly speculative. Even though the ranges in any given year are already fairly wide, there are still many factors we do not consider that could strongly affect the results. These include deviation from the population trajectory that we utilize, as well as different housing value trajectories, the impact of local variation in housing prices, and the deployment of technologies for better protecting homes in the face of wildfire, and changes in fire severity. Nevertheless, we can see from this chart that *average* annual damages on the order of billions of dollars are quite plausible beginning mid-century. In general, the higher emissions A2 scenario seems to allow for potentially worse outcomes, though the difference is slight in any given time period. It should also be noted that the maximum values shown are associated with parameter combinations that were outside the year 2000 range, and would require a somewhat implausible worsening of effective fire protection techniques, though sprawling growth patterns and changing fire regimes could have this effect.

Table 3. Plausible estimates for aggregate average annual monetary damages summed across the State of California. The 'Min' and 'Max' columns represent the bounds of cases we explored. The 'Min' and 'Upper' columns represent the bounds from parameter combinations consistent with Year 2000 damage estimates.

Summary Statistics for Aggregate Example Damages

	2005-2035			2035-2065			2070-2100		
	Min	Upper	Max	Min	Upper	Max	Min	Upper	Max
SRES A2	0.050	0.48	2.4	0.20	2.3	13	0.68	14	80
SRES B1	0.047	0.45	2.6	0.21	2.5	13	0.53	11	62

Figures are in billions of undiscounted Year 2000 dollars and represent possible monetary impacts in a representative year during each period.

3.4. Discussion of Uncertainties and Sources of Error

Our model of fire risk is subject to a multitude of uncertainties. These include those uncertainties that affect the modeled wildfire burned areas used as inputs, and additional uncertainties about how households distributed on the landscape are interacted with wildfire burned area to generate a meaningful measure of risk. As can be seen by referring to Table 2, these uncertainties have the potential to impact the results by a significant factor, with relative risks spanning all the way from 1.6 to 8.15 for the period centered around 2085.

The primary uncertainties explicitly modeled on the exposure side and which contribute to the variance in our results include the form of the exposure scaling function, and the threshold household density for considering a pixel too urban to be subject to wildfire. In this modeling exercise, we do not perform a thorough sensitivity analysis to estimate marginal effects of changing these uncertain parameters. Rather, our focus is on ensuring we have captured a reasonably wide range of plausible conditions, and illustrated the impact they may have when propagated through to our outcome measure of interest. Further work to explore the effect of these uncertainties in more detail may be warranted if more reliance is to be placed on the precise numeric outcomes.

While we believe we have adequately addressed the explicitly modeled uncertainties with respect to the qualitative conclusions of this report, the results generated are also subject to potential sources of error not explicitly considered in the modeling. In particular, the model of risk may be insufficient to capture important interactions and hidden costs. For example, perhaps the decrease in exposure with increasing density comes at sizable increase in expenditures and risk to firefighters (Headwaters Economics 2008). In general, the magnitude of systematic errors is diminished by our relative risk measure, but this is not the case if the effects are significantly nonlinear, or if certain interaction effects qualitatively change over time (for example, through radically different fire management policies).

Another important source of uncertainty we do not consider is the technological and management responses to mitigate the damages. Primarily, these responses include the use of defensible space around homes, combined with home construction technology that is designed to withstand the presence of wildfire. Many new home construction techniques were introduced during the twentieth century, and we may assume further innovations throughout the twenty-first century, although the impact of fire-mitigating technological innovations will be reduced in proportion to their actual adoption, which may or may not be significant. Modeling the presence of these technologies in conceptually accurate detail is at present infeasible, though future study within our current framework could explore the potential impacts via changes to our exposure scaling function over time. Additionally, the ability of technology and forest management to mitigate exposed value may also vary geographically based on fire and vegetation type. While vegetation plays an explicit role in our fire model, its potential effect on fire severity and thus value lost is not incorporated into our estimates of exposed value. Both new technologies and the impact of these fire regime changes could be represented by reducing the area under the exposure scaling function in different time periods and regions.

4.0 Conclusions

Our modeling exercise demonstrated the following key results:

- Residential wildfire risk increases over time for all climate scenarios.
- The difference between an A2 climate scenario and a B1 climate scenario is minimal through mid-century, but some differences emerge in the period 2070–2100, with the A2 scenario leading to approximately 20–30 percent higher risk of property losses from fire.

In addition, our particular modeling approach and assumptions led to the following secondary findings, which should be interpreted with greater caution due to their greater sensitivity to the specifics of the modeling process:

- A tripling and even quadrupling of residential wildfire risk is quite plausible by mid-century, with even greater increases by the end of the century.
- The general spatial distribution of fire risk is mostly independent of climate scenarios, though most areas see higher risks under an A2 scenario. In addition, the very strong correlation between risk and population implies a large role for mitigation of risk through policies affecting ignitions of wildfires and the vulnerability of homes.
- The average annual cost associated with homes lost to wildfire could easily be in the billions of dollars by mid-century (in undiscounted year 2000 dollars), and under our assumptions, will almost always be at least in the tens of millions of dollars.

All of our findings, especially those dealing with absolute numeric estimates (rather than comparisons between scenarios), should be taken as illustrations of plausible futures under various sets of consistent assumptions. They are not predictions, and they are contingent on one particular growth scenario and assumptions of constant fire-protection technology. However, we did take many steps to account for some of the uncertainties involved, and these explorations demonstrated robustness in the key findings, which should provide some confidence that they accurately capture the nature of climate change's impact on the residential wildfire risk in California. Lastly, it should be remembered that residential wildfire impacts represent only a fraction of the impacts that climate-induced changes in wildfire patterns may have on California over the remainder of this century.

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Appendix

Specification of Uncertainties

Appendix: Specification of Uncertainties

Our model is subject to the uncertainties of both the fire probability model as well as the exposure estimation model. Some of these were described above, but we enumerate them completely here, with some additional discussion. Here we take the climate scenario itself (A2 or B1) as well as the spatially explicit growth scenario as given, and discuss uncertainties in form and parameter values contingent on the climate and growth scenario. Except where noted, every combination of these parameters was sampled (a full factorial design), leading to an initial sampling of 72 combinations for most periods, though we eventually ruled out some parameter combinations as entirely unrealistic.

Non-growth related uncertainties:

Climate-based vegetation migration: A binary variable indicating whether or not vegetation fractions are allowed to adapt over time to changing fire and climate conditions.

Climate model: Given emissions scenarios produce different changes in climate depending on the climate model that relates emissions to their climate impacts. This analysis uses the output of three different models: GFDL CM2.1, NCAR PCM3, and CNRM-CM3.

Uncertainties affecting both fire probabilities and exposure estimates:

Threshold urban density: What value of housing density, in units of household per square kilometer, is considered the threshold for a pixel being too dense to be subject to wildfires? In this analysis we use 147 and 1000, which are based on the upper and lower bounds for suburban density as defined in the ICLUS scenarios.

Growth-vegetation interaction: An ordered indicator for the method by which new residential growth affects vegetation fraction existing in a given gridcell. There are three options, which either minimize or maximize vegetation fraction remaining in a gridcell given new growth, and an option for allotting new growth proportionally to the area fraction already occupied by vegetation. Model results proved largely insensitive to this variable, so results presented here use only the proportional option.

All of the above are discussed in more detail in the companion Westerling et al. report (Westerling et al. 2009). Discussion of the climate and adaptation models can be found in text, while the threshold values and growth-vegetation interactions are thoroughly discussed in Appendix 1 of that report.

Uncertainties affecting exposure estimates only:

Concavity of exposure scaling function: The exposure scaling function scales the number of households in a pixel down to the number considered at risk for wildfire damages, as a function of density. This is described thoroughly in Section 2.2—we consider three parameter values (1/3, 1, and 3), each leading to different concavities in the exposure scaling function. As discussed in section 2.5, we find that the value of 3 is entirely unrealistic, so we do not consider that parameter combination in presenting our results.

Normalization of the exposure scaling function: The exposure scaling function can be interpreted as capturing two different effects: One is the simple effect that wildfire is not likely to spread beyond a certain "depth" into a group of houses (e.g., beyond 3 "rows")—due to a combination of suppression efforts and physical interactions between fire, structures and open space like roads—though inter-structure spread is a documented phenomenon (Institute for Business & Home Safety 2008). The scaling also captures the effect that the probability of a fire reaching a particular pixel is diminished in some proportion to the number of households in that pixel, via suppression efforts and pre-fire management efforts such as the creation of defensible space. However, this latter effect is also captured to some degree by inclusion of the population variable in the fire probability model. This means that if the relative magnitude of the first effect is small compared to the latter effect, the exposure scaling function will over-estimate the reduction in risk. If the second effect was perfectly accounted for in the fire probability model, it would be appropriate to additionally rescale the exposure function so that total probability was preserved. This is done by dividing by the area under the scaling curve (which will be less than one). It is unlikely that the true behavior is modeled at either extreme, so we consider both, and take rescaling as a binary uncertainty in the model. In reality, this does not need to be a binary variable, and future work should consider values between zero and one. Our calibration exercises also found that normalizing the scaling function led to unrealistically high values for the year 2000, so we did not utilize that parameter setting in futher analysis.

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