holmesfire

24 May 2013 106975.10

Geoff Bradley
Planning Manager
City of Petaluma
Community Development Department
11 English Street
Petaluma, CA 94952

RIVERFRONT MIXED-USE DEVELOPMENT, 500 HOPPER STREET, PETALUMA, CA: ADJUSTED EVA REVIEW

Dear Mr. Bradley,

As requested, Holmes Fire is providing the City of Petaluma with a third-party peer review of the proposed Emergency Vehicle Access (EVA) modifications relating to the Riverfront mixed-use project.

INTRODUCTION

The site is bounded by State Highway 101 to the South, The Petaluma River to the West, existing rail tracks to the East that are to be reinstated for the S.M.A.R.T commuter rail project, and existing sites to the North. Therefore the proposed development presents a unique challenge for ingress and egress from the subject site. The primary ingress and egress will be from Caulfield Lane, this intersection has been shown to provide the capacity needed for use by the development. The proposed secondary ingress is from the Lakeville/D Street intersection via Hopper Street.

The California Fire Code (CFC 2010) as amended by the City of Petaluma requires a minimum of two (2) EVA points to the site. An alternative design to the EVA has been developed to incorporate the limitations and constraints of the project in order to meet the intent of current regulations.

A number of design considerations have been raised by The City of Petaluma in relation to emergency vehicle access to the site and emergency evacuation of residents, in a large scale emergency scenario. Holmes Fire has previously completed a third-party peer review of the of the initial proposed EVA solution as documented in the Fire Engineering Report dated October 11, 2011 (106975_500 Hopper_FER_draft_BHJ_vC).

San Francisco
Telephone
+1 415 796 7100
Facsimile
+1 415 693 1760
Email
info@holmesfire.com
Holmes Fire LP
130 Sutter Street
Suite 400
San Francisco
CA 94104
USA
www.holmesfire.com

Subsequently the site EVA provisions have been modified per documentation received via email on March 20, 2013, including drawings TM-12 and TM-13 dated November 11, 2012 attached with this letter. These modifications are the result of the operation of the S.M.A.R.T rail redevelopment. The proposed EVA modifications occur at the D Street/Lakeville intersection and relocation of the onsite EVA from within the City Corporation yard to within the Pomeroy Property.

The proposed modifications have been evaluated by Holmes Fire with regards to their impact on the initial third-party peer review. The evaluation is limited to the EVA modifications as addressed in this letter.

MODIFICATIONS

HOPPER STREET EVA

The previously completed third party review assessed the Hopper Street EVA at the D Street intersection as shown in **Figure 1**. The modified EVA condition is shown in **Figure 2**. The D Street intersection modifications are summarized below:

- Hopper Street will provide two-way access instead of one-way access.
- The Lakeville Street access will no longer be available. Site access from this location will be from a new entrance road from East D Street.
- The new entrance road will include public and emergency vehicle access. Fire apparatus access road gates will no longer be used.

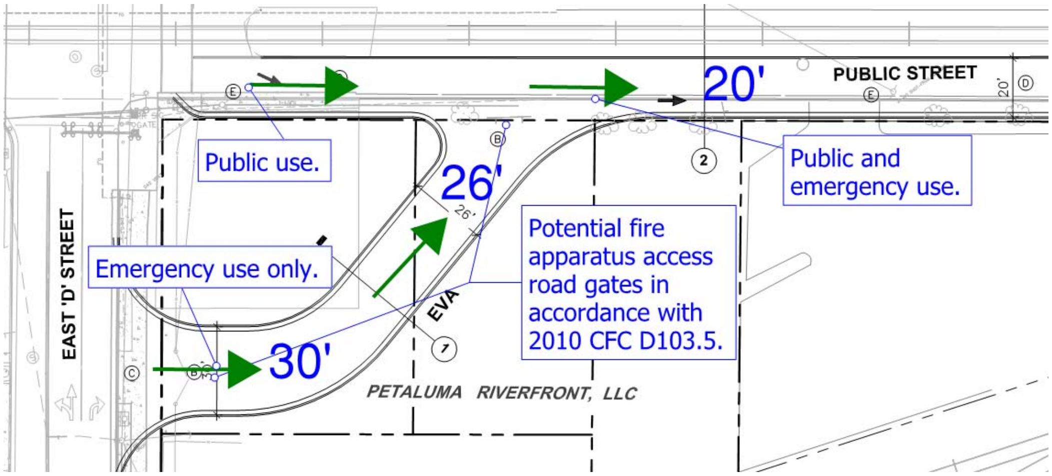


Figure 1: Hopper Street EVA access as assessed in previous third-party peer review.

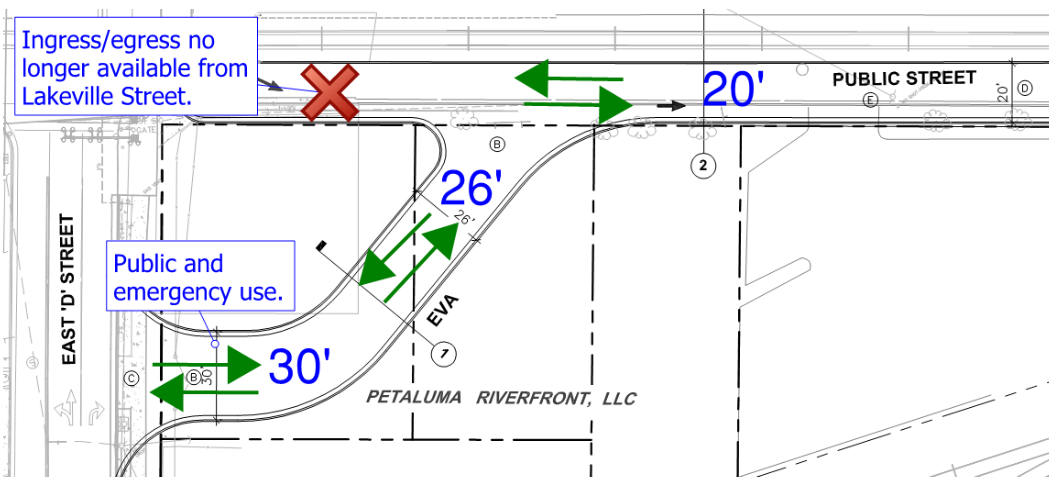


Figure 2: Current proposed Hopper Street EVA.

SITE EVA MODIFICATIONS

Our previous review assessed the Hopper Street EVA through the City of Petaluma Yard. The modified EVA route does not penetrate the City of Petaluma Yard, but will remain on the Pomeroy Corporation property. The modified EVA allows for 3 EVA access points from the EVA path. The EVA route modifications are shown in **Figure 3**.

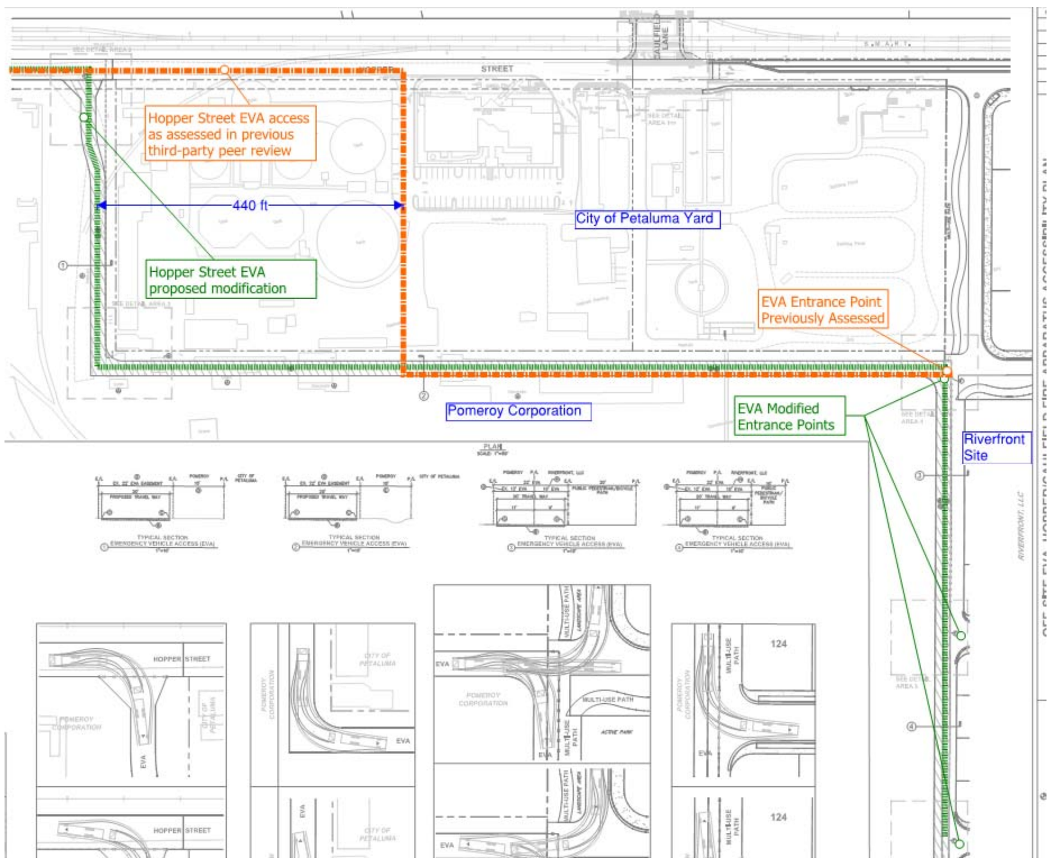


Figure 3: Proposed Modified Hopper Street EVA access route.

EVALUATION

The implications of the modifications to the D Street intersection are outlined below:

- Our previous review assessed the emergency vehicle use through the new entrance off of East D Street. The intended path or width of the EVA has not changed. The change impacts the EVA interaction with the public use.
- The removal of fire apparatus access road gates is expected to improve response times and eliminate the risk of the gates malfunctioning during an emergency.

- The previous scheme proposed a 20-ft wide one-way path along Hopper Street with a 10-ft wide zone striped and designated for EVA only use. The new scheme proposes a minimum unobstructed width of 20-ft, which is sufficient for two-way fire apparatus access in accordance with 2010 CFC Section 503.2.1. The designation of Hopper Street as a two-way road is code compliant for ingress and egress.

- It is considered the revised layout will maintain sufficient emergency vehicle access and passing width of non-emergency vehicles. The revised scheme will also better facilitate two way vehicle flow, for ingress of emergency vehicles and exiting of private vehicles, in the event of a large emergency scenario requiring site evacuation.

The implications of the modifications to the onsite EVA route are outlined below:

- The proposed modifications to the EVA route includes turning off of Hopper Street 440-ft west of the turn under the previous scheme. It is considered the revised EVA route, at the least, maintains the level of safety assessed for the previous scheme.

- The separation of the Hopper Street EVA and the intersection of the Hopper St and Caulfield Lane EVA is now increased by 440-ft, therefore providing a greater separation of the EVA's and further reducing the likelihood of both EVA's being compromised by a single event.

- The primary ingress/egress EVA access remains from Caulfield Lane. The proposed modifications provide one EVA route from Hopper Street and 3 access points along the western edge of the Riverfront site. The Hopper Street EVA access points maintain the level of safety as previously assessed.

Our review of the proposed EVA modifications are considered to at least maintain the level of safety assessed for the previous EVA scheme, documented within the Fire Engineering Report dated October 11, 2011 (106975_500 Hopper_FER_draft_BHJ_vC). It is considered that the proposed EVA provisions for the project meet the intent of, and are equivalent to, the relevant provisions of the model building code.

Please do not hesitate to contact me should you have any queries.

Sincerely,

HOLMES FIRE LP

Bevan Jones, PE
National Manager | Principal Fire Engineer
FP1672

CC: Cary Fergus; City of Petaluma

APPENDIX C-8

holmesfire

EMERGENCY VEHICLE ACCESS ASSESSMENT

RIVERFRONT MIXED-USE DEVELOPMENT

500 HOPPER STREET
PETALUMA, CALIFORNIA

for

The City of Petaluma

11 October 2011

Version C

CONTENTS

1. INTRODUCTION

Holmes Fire has been engaged to undertake a third party peer review of the Emergency Vehicle Access (EVA) for the proposed Riverfront mixed-use development to be located at 500 Hopper Street, Petaluma, CA.

The City of Petaluma have indentified that the subject site has the potential to present a challenge to their ability to respond to an onsite emergency event. The intent of this report is to document the review of the proposed EVA design and site emergency access/egress to facilitate emergency response, in the event of reasonably foreseeable emergency scenarios.

Regulations for the EVA are provided by the 2010 California Fire Code (CFC) as modified by the 2011 Petaluma Municipal Code (PMC). Pursuant to Section 104.9 of the CFC, the code allows for alternative methods where the equivalent level of safety of the code is provided and approved by the Fire Code Official. The CFC provisions have been used as a benchmark to evaluate the performance of the EVA under reasonably foreseeable emergency scenarios, considered herein.

1.1 Project Background

The proposed development is to comprise the following:

Table 1.1: Project Summary

Use	Area
Office	60,000 SF (3-Story)
Townhouse	37 Units
Hotel	120 Rooms (3-Story)
Mixed Use	
- Commercial	30,000 SF (3-Story)
- Apts.	100 Units
Single Family Dwellings	135 Lots
Parks	
– Central Green	0.38 Acre
– Active Park	2.14 Acre
– River Park	3.67 Acre
– Riverfront Activity Area	0.59 Acre

All site buildings are assumed to comply with the prescriptive provisions of the Building Code, which includes the provision of automatic sprinkler systems.

The site is bounded by State Highway 101 to the east, The Petaluma River to the south, existing rail tracks to the north, and existing sites to the west. Therefore the proposed development presents a unique challenge for ingress and egress from the subject site. The primary ingress and egress will be from Caulfield Lane; this intersection has been shown to provide the capacity needed for use by the development. The proposed secondary ingress is from the Lakeville/D Street intersection via Hopper Street (refer to Figure 2.1 for further detail).

1.2 Basis for the Analysis

The applicable prescriptive provisions of the California Fire Code (2010), as amended by 2011 Petaluma Municipal Code (PMC), are as follows:

Section 503.1.2 - Additional access: The *fire code official* is authorized to require more than one fire apparatus access road based on the potential for impairment of a single road by vehicle congestion, condition of terrain, climatic conditions or other factors that could limit access.

Section 503.4 - Obstruction of fire apparatus access roads: Fire apparatus access roads shall not be obstructed in any manner, including the parking of vehicles.

Section D104.3 – Remoteness: Where two access roads are required, they shall be placed a distance apart equal to not less than one half of the length of the maximum overall diagonal dimension of the property or area to be served, measured in a straight line between accesses.

Section D106.1 - Projects having more than fifty (50) dwelling units: Multiple-family residential projects having more than fifty (50) dwelling units shall be provided with two (2) separate and approved fire apparatus access roads.

Section D107.1 - One or Two-Family Dwelling Residential Developments: Developments of one and two-family dwellings where the number of dwelling units exceeds fifty (50) shall be provided with two (2) separate and approved fire apparatus access roads and shall meet the requirements of Section D104.3.

Per Sections 503.1.2 and 503.4 of the California Fire Code, the City of Petaluma consider that the proposed site could be subject to reasonably foreseeable emergency scenarios, where access roads to the site may be obstructed, and thereby inhibit the actions of emergency responders. This third party review has been undertaken to assess the performance of the site access provisions to facilitate emergency response actions in such reasonably foreseeable emergency scenarios.

1.3 Reference Information

The EVA assessment contained herein is based upon the following information:

- Site drawings provided by the City of Petaluma;
- Correspondence between the various project stakeholders on the EVA provisions of the site, dated from 08/30/2010 to 07/13/2011.
- Meetings with the City of Petaluma taking place on 07/14/2011 and 08/17/2011.

1.4 Limitations of the Report

The intent of the California Fire Code is to facilitate a reasonable level of safety for occupants and emergency responders in the event of a fire or other dangerous conditions. Hence, the purpose of the assessment within this report is to demonstrate an acceptable level of fire and life safety is provided for the development site. Aspects of fire safety relating to property protection and fire safety compliance for the individual buildings is assumed to meet the prescriptive provisions of Code, and therefore have not been specifically addressed herein.

Given the specific conditions that exist, in relation to ingress and egress for the subject site, this analysis has been undertaken to consider emergency scenarios beyond that which are reasonably expected of a prescriptive design. It is acknowledged that emergency scenarios could result from extreme events that are not reasonably foreseeable and possibly be worse than that factored into the assessment herein. The scenarios assessed herein have been selected based upon the conditions that currently exist and their foreseeable impact to the emergency ingress and egress of the subject site. Should the client or authorities having jurisdiction elect to consider additional emergency scenarios based upon extraordinary events, then these can be assessed, however this is beyond the intended purpose and scope of this study.

2. Proposed Emergency Vehicle Access (EVA)

2.1 Site Layout and EVA Use

Figure 2.1 depicts the site layout, relevant boundary conditions and the proposed EVA provisions. Only relevant neighbor sites where emergencies could affect both EVA's are labeled. Both EVA routes use Hopper St, and are described as follows:

- **Hopper St EVA:** Emergency vehicles arrive from D St through a new 30-ft one-way entrance road that reduces to 26-ft. The route continues onto Hopper St where a 600-ft section of road reduces to a minimum width of 20-ft. The EVA is approximately 2500-ft along Hopper St at a width of 24-ft before turning onto a neighboring site. Two emergency access gates are proposed along this 1200-ft EVA road before entering the Riverfront site. Upon entering the site, there is an emergency access gate directly south followed by another approximately 350-ft further south to create a road with restricted vehicle access for emergencies only.

- **Caulfield Ln EVA:** Emergency vehicles arrive via Caulfield Ln. and drive over a railway crossing before turning left onto Hopper St. Hopper St allows for two-way traffic for 440-ft before entering the Riverfront site.

The following site boundary conditions in relation to the EVA are depicted on Figure 2.1.

- **Water boundary:** Petaluma River and McNear Channel are located to the south of the development and proposed EVA.
- **Bordering highway:** Highway US-101 runs adjacent to the east boundary of the site. US-101 does not cross the site or EVA at any point.

- **Neighboring site:** The neighboring sites labeled in Figure 2.1 are those considered to be most influential on EVA. The site includes a homeless shelter, Municipal water pump facility, decommissions waste-water treatment facility and other minor structures associated with City infrastructure works.
- **Rail track:** Railway tracks to the north have intended passenger use by Sonoma-Marin Area Rail Transit (SMART) and freight (non-hazardous goods) use by North Coast Railroad.

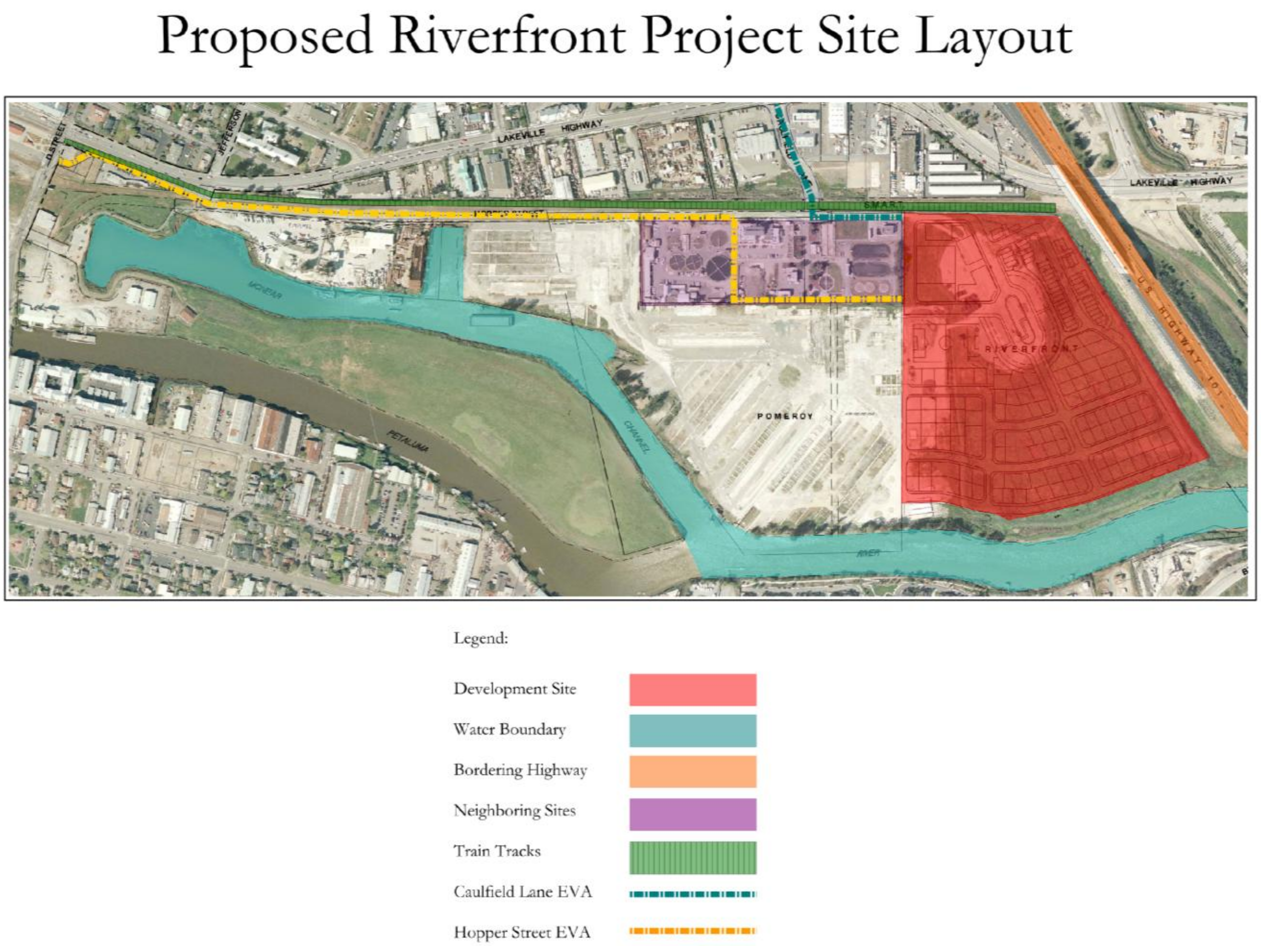


Figure 2.1: Site Layout, Boundary Conditions and Proposed EVA, Petaluma.

3. EVA Scenario Evaluation

The development location and boundary conditions present several aspects unique to the project that necessitate further analysis to determine their effects on EVA performance.

3.1 On-Site Emergency

Appendix D104.3 of the CFC (Remoteness) states: "Where two access roads are required, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the property **or the area served,** measured in a straight line between accesses" **as they enter the property.** The diagonal dimension of this development (area served) is approximately 1,650 feet; therefore half the diagonal distance is approximately 825 feet (Figure 3.1; EVA Separation). It should be noted that the distance from the effective site access point (diagonal starting point) to where the EVA enters Hopper Street (near the Mary Isaac Center) is also about 825 feet. While it appears the separation and relative location of the two access roads conceptually meets minimum fire code requirements, functional emergency response challenges have been identified that require further review and analysis. One such issue is the relative closeness of Caulfield Lane and where the EVA discharges onto Hopper Street, which is as close as 370 feet. The risk of site access being affected by neighboring site fires has been assessed in Section 3.2. The proposal to maintain separation of the site EVA access points is to include gates at the entrance of the southern EVA route (shown in yellow [dashed]) so as to provide an extended route only accessible to emergency vehicles and pedestrians.

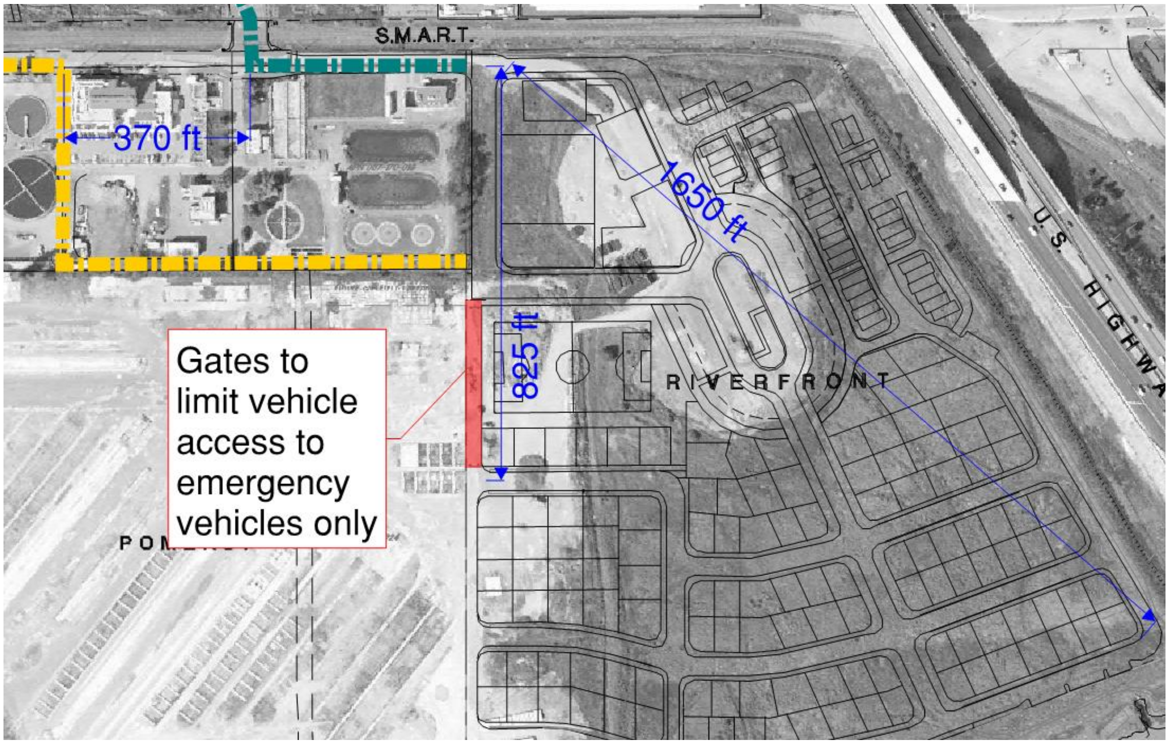


Figure 3.1: EVA Separation and Access Restricted EVA Extension.

The gates provided to restrict access to the EVA are to comply with Section D103.5 of the California Fire Code:

D103.5 Fire apparatus access road gates. Gates securing the fire apparatus access roads shall comply with all of the following criteria:

1. The minimum gate width shall be 20 feet (6096 mm);
2. Gates shall be of the swinging or sliding type;
3. Construction of gates shall be of materials that allow manual operation by one *person*;
4. Gate components shall be maintained in an operative condition at all times and replaced or repaired when defective;
5. Electric gates shall be equipped with a means of opening the gate by fire department personnel for emergency access. Emergency opening devices shall be *approved* by the *fire code official*;
6. Manual opening gates shall not be locked with a padlock or chain and padlock unless they are capable of being opened by means of forcible entry tools or when a key box containing the key(s) to the lock is installed at the gate location;
7. Locking device specifications shall be submitted for approval by the *fire code official*;
8. Electric gate operators, where provided, shall be *listed* in accordance with UL 325;
9. Gates intended for automatic operation shall be designed, constructed and installed to comply with the requirements of ASTM F 2200.

Emergency Response to Site

Figure 3.2 provides a map overlay of the 4-minute response time by the City of Petaluma Fire Department. It can be seen that the site is well within the 4-minute response time of the both Stations 1 and 3. Stations 1 and 3 are located on opposite sides of the railway tracks and the Petaluma River, therefore emergency response would still be able to access the site via either Hopper St, or Caulfield Ln, where site access may be obstructed due to an event involving either the rail line, or the river.

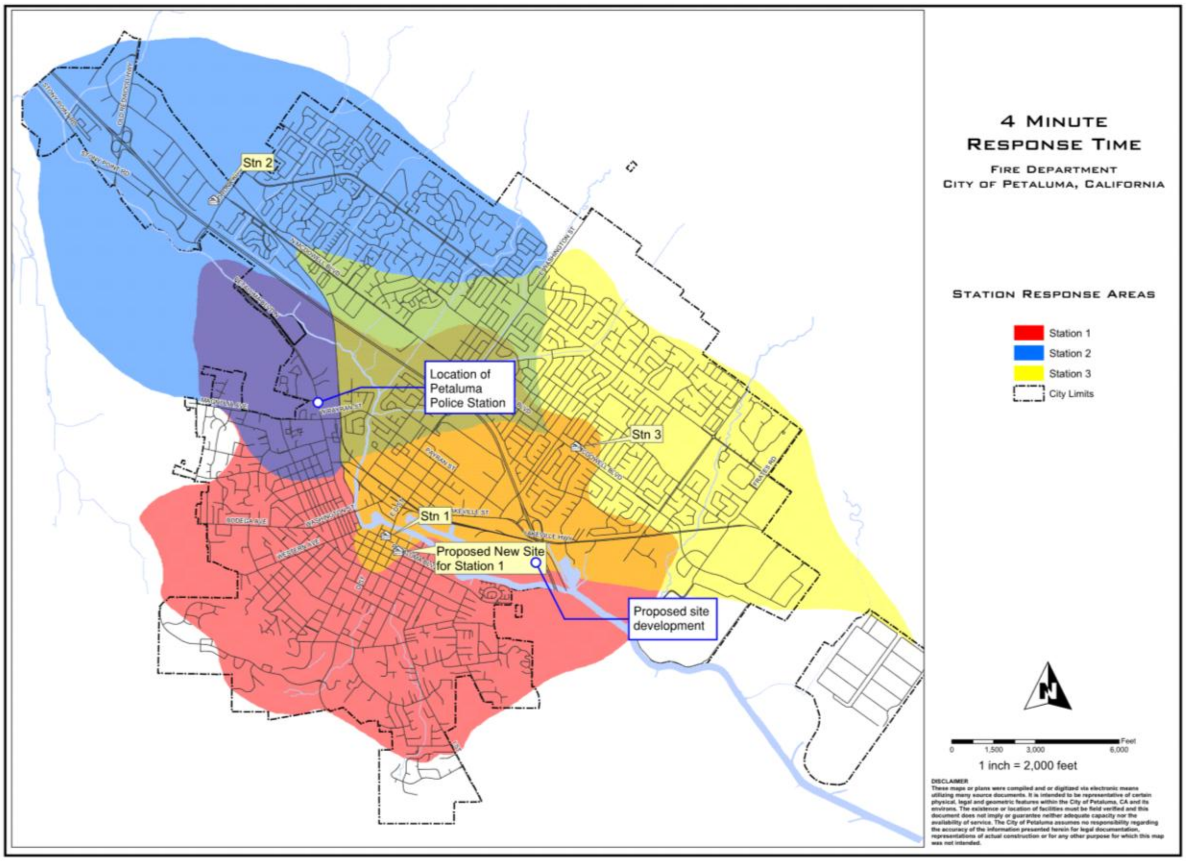


Figure 3.2: Emergency Response Locations and 4-minute Response Overlay.

Automatic Sprinkler System Reliability

The site is provided with two separate points of access, however, there is a possibility that an event involving either rail or road, could delay the response time of responding emergency services to a building fire on the site. The following statistics acknowledge that sprinklers have an exceptional record for controlling fires when they are installed and maintained properly, such that they activate successfully and perform as designed in a fire incident.

The terminology "sprinkler controlled fire" does not mean that the fire is extinguished. Rather, it means that the fire growth rate and spread is controlled by the sprinkler activation. This acknowledges the fact that objects in the room may protect the seat of a fire, such that the water discharge by the sprinkler system is unable to make direct contact with the combustible fuel surface (these are referred to as shielded fires).

According to the International Fire Engineering Guidelines[1] it can be assumed that the probability for a sprinkler system to activate is 95% for a flaming non flashover fire and 99% for a flashover fire. The probability of sprinkler control after sprinkler activation is estimated to 99%.

Data for reliability was compiled by Johansson[2] from a range of sources. Probabilities for a combination of the sprinkler system to activate and thereafter control or extinguish the fire were recorded. This data is summarised in Table 3.1 below.

Table 3.1: Reliability Data for Installed Automatic Sprinkler Systems (Johansson).

Source	Time Period	Reliability (%)
Industrial Risk Insurers	1975-1992 full sprinkler protection	98
Industrial Risk Insurers	1975-1992 partial sprinkler protection	92
NFPA	1925-1969	96.2
Department of Energy (DOE)	1952-1980	98.2
Australian and New Zealand data	1886-1968	99.8
Australian and New Zealand data	1968-1977	99.3
England (fire and loss statistics)	1965-1969	91.8
England (fire and loss statistics)	1966-1972	78.2

Similar data was also presented by Edward and Budnick[3] as summarised in Table 3.2 below for general occupancies.

---

[1] International Fire Engineering Guidelines, 2005 Edition. Australian Building Codes Board, Department of Building and Housing New Zealand, International Code Council® and the National Research Council of Canada

[2] Johansson H, Osäkerheter i varibaler vid riskanalyser och brandteknisk dimensionering (Swedish) (Uncertainties for variables for risk analysis and fire safety engineering), Report 3105, Department of Fire Safety engineering, Lund University, Lund 1999.

Table 3.2: Reliability Data for Sprinkler Systems (Edward and Budnick).

Reference and Publication Year	Reliability (%)
Building Research Est., 1973	92.1
Miller, 1974	95.8
Miller, 1974	94.8
Powers, 1979	96.2
Richardson, 1985	96
Finucane et al, 1987	96.9 – 97.9
Maryatt, 1988	99.5

The buildings within the subject site are to be provided with sprinkler protection throughout in compliance with California Building and Residential Codes.

The above information clearly indicates the level of reliability and performance achieved by installed sprinkler systems. Therefore, it is not expected that delays to responding fire services would result in an escalation of operations to combat an uncontrolled fire scenario.

3.2 Neighboring Site Fire (Off-Site Analysis)

The risk of an off-site event is significantly lowered as the site is located in an area where two separate departments (or stations) can access the site from completely separate routes (as shown in Figure 3.2). As mentioned in Section 3.1, the EVA enters Hopper Street and is only 370 feet from the Caulfield Lane intersection. There are several large buildings in this area which may have the potential to impact or compromise either of the two fire access roads. When considering a fire-related scenario, a radiant heat analysis has been conducted to understand if untenable conditions (received radiant heat to a person exceeding 2.5kW/m^2)[4] could result simultaneously at both fire access roads from a single event.

The locations along the EVA with the shortest separation distances are shown in Figure 3.2 to occur at the site entrance and on Hopper St prior to entering the site. Reasonable worst-case fire scenarios are determined to be located inside the buildings presenting the highest risk to both EVA routes. The scenarios involve two buildings, with an analysis of two walls for each structure. Each scenario uses a height of 30-ft, noted as the maximum building height. The thermal calculation assumes the entire width and height of the buildings are at 1112˚F (600˚C), typical room temperatures reaching flashover

---

[3] Edward K, Budnick P.E., *Sprinkler System Reliability*, published in Fire Protection Engineering, Winter 2001.

conditions[4]. The assessment considers that one façade of the building is the fire source. The historical performance and reliability of sprinkler systems has been previously reported, and therefore a conservative assumption has been made to consider worst case conditions. Realistically the fire would be contained to the room of origin.

FireWind 3.6 software is used for radiant heat calculations[5]. The fires are represented as 2-dimensional planes at a constant temperature of 1112˚F. The radiant heat is conservatively analyzed at the closest point of the secondary EVA to determine if both EVA's could be compromised. The locations of the planes and radiant heat evaluated locations are shown in Figure 3.3.

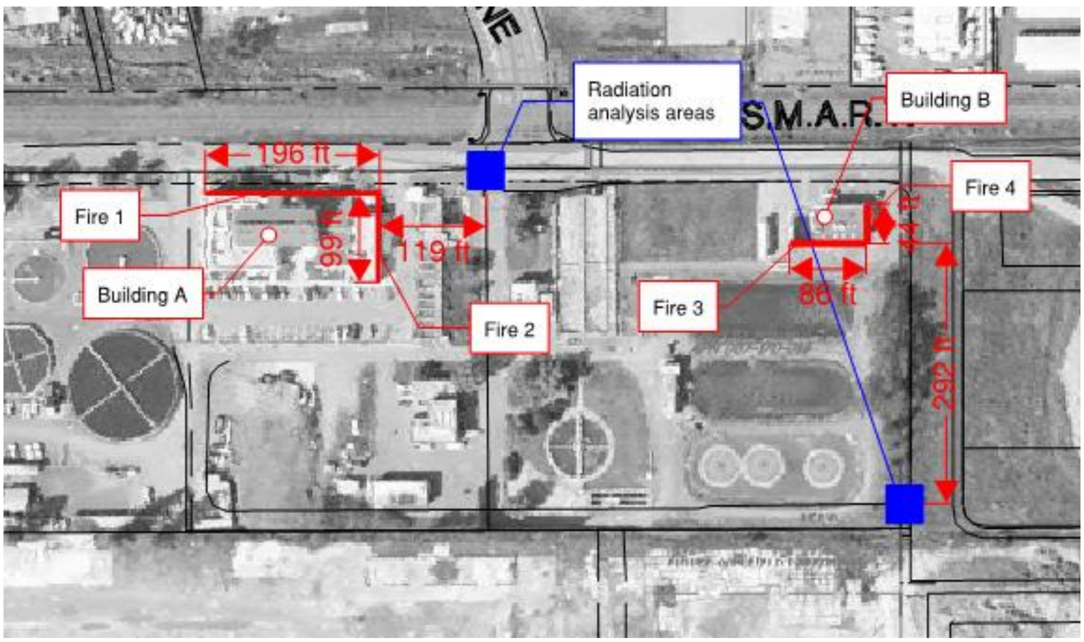


Figure 3.3: Fire Scenario and Radiant Heat Assessment Locations.

A radiant heat level of 2.5 kW/m² is considered the tenable limit for long-term exposure for people[4]. Responding fire service personnel in turn-out gear are able to withstand higher radiant heat levels, however, conservatively the lower limit is used in this analysis. The evaluated radiant heat values are shown in Table 3.3 to be significantly lower than the tenable limit. The analysis does not take into account future development. However the current radiant heat values are low despite conservative assumptions and therefore foreseeable development is not expected to result in excessive received radiant heat levels. Building A produces greater levels of radiant heat due to increased size of the radiator. For the scenario analyzed there is approximately 100-ft of tenable road conditions between the edge of the building and Caulfield Ln to provide space for emergency vehicles and operations. Therefore should a large fire scenario occur at either building location, the alternative EVA will be accessible for to facilitate site access and egress.

[4] M. Spearpoint, Fire Engineering Design Guide, Centre for Advanced Engineering, University of Canterbury, 3rd Edition, July 2008.
[5] FireWind 3.6, Fire Modelling and Computing, NSW, Australia. Version 10, December 2004

Table 3.3: Radiant Heat Analysis (detailed in Appendix A)

Building	Fire Scenario	Fire Size	Temperature	Radiation Area	Radiation at Edge of EVA
Building A	Fire 1	197 ft wide x 30 ft tall	1112˚F	Caulfield Lane entrance	**0.21 kW/m^2**
Building A	Fire 2	99 ft wide x 30 ft tall	1112˚F	Caulfield Lane entrance	**0.36 kW/m^2**
Building B	Fire 3	44 ft wide x 30 ft tall	1112˚F	Site entrance	**0.02 kW/m^2**
Building B	Fire 4	86 ft wide x 30 ft tall	1112˚F	Site entrance	**0.28 kW/m^2**

3.3 Highway Hazardous Spill

Highway US-101 is adjacent to the proposed site and approximately 1200-ft east from the Caulfield Ln EVA access point. The intent of this assessment is to consider an incident involving heavy transport of hazardous goods US-101. Transportation of hazardous material requires a Hazardous Materials Transportation License as regulated by the Department of California Highway Patrol. Data sourced from the 2005 Caltrans annual traffic study indicated that approximately 4,550 trucks pass by the development site on Highway US-101[6].

Truck accident information is taken from a report developed for the US Department of Transportation[7]. Assuming the accident rate is comparable for hazardous or non-hazardous trucks, 15% of trucks carry hazardous material. The average incident rate for trucks carrying hazardous materials is 0.51 accidents per million vehicle-miles. Of the hazardous material incidents, about 1% recorded evacuations of the local area. The risk of an evacuation resulting from a hazardous goods vehicle incident along the mile of US-101 adjacent to the development is 683 trucks at a rate of 0.0051 evacuations per million vehicle-miles. This results in an approximate annual risk of evacuation of 3.5×10^{-6}, for the subject site. While there is uncertainty of input values as they are from a national database, the risk calculation can be considered conservative as it assumes any evacuation within 1-mile of the development. Table 3.4 provides a summary of the statistical data.

---

[6] Kleinfielder. *Public Draft Environmental Impact Report North Coast Railroad Authority Russian River Division Freight Rail Project*. Santa Rosa, CA, 2009.

[7] Federal Motor Carrier Safety Administration. *Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents*. Columbus, OH: Battelle, 2001.

Table 3.4: Risk of Site Evacuation from Hazardous Vehicle Incident on HWY US-101.

Data	Value	Calculation	Comment
Number of trucks passing by the site (annually)	4,550		
Percentage of trucks that are transporting hazardous goods (%)	15	4,550 x 0.15 = 683	Hazardous goods trucks passing by the site annually
Average rate of truck incidents involving hazardous goods (per vehicle-miles)	0.51×10^{-6}	$683 \times 0.51 \times 10^{-6} = 348 \times 10^{-6}$	Probability of a hazardous goods truck incident on HWY-101 within a mile of the site
Percentage of truck incidents involving hazardous goods that require local area evacuation (%)	1.0	$348 \times 10^{-6} \times 0.01 = 3.48 \times 10^{-6}$	Annual probability of a hazardous goods truck incident on HWY-101 within a mile of the site, requiring site evacuation.

The return period is the inverse of the probability that the event will be exceeded in any one year, therefore, the return period for the site being evacuated as a result of a hazardous vehicle spill on HWY US-101 is approximately a 287,356 year event. It is noted that Maximum Credible Earthquake (MCE) design in California is based upon an event return period of 2500 years (likelihood of exceedance of 2% in 50 years)[8]. This indicates the hazardous goods scenario is an extremely unlikely event, several magnitudes less likely to occur than an MCE earthquake.

The location of the EVA routes on the opposite side of the development site from the highway improves the opportunity for evacuation from a hazardous spill on the highway. The current EVA locations could be closer to the highway and be deemed code compliant for separation.

3.4 Railway Crossing

The current EVA via Caulfield Lane intersects a railway crossing prior to entering Hopper St, as discussed in Section 2.1. The railway is used by North Coast Railroad, with future plans to share usage with SMART (commuter rail service). The primary entrance for the development is via Caulfield Ln. The bi-directional road currently comprises a total of 4 lanes wide (two lanes each direction) and aligned perpendicular to rail lines. The Caulfield Ln. railway intersection is evaluated to determine if there is a hazard for obstructions resulting in non-compliance with CFC 2010 Section 503.4 – Obstruction of fire apparatus access roads.

[8] ASCE-7 – Section 2.4.2.3: Maximum Considered Earthquake Ground Motion

SMART Usage

SMART be a 70-mile long passenger railway system connecting Cloverdale, CA to Larkspur, CA. The Downtown Petaluma Station is to be located on Lakeville St between Washington St and D St[9]. There is proposed to be 14 daily round trips, or 28 total crossings at the Caulfield Ln rail line intersection. The proposed trains are to be a maximum of 300-ft[10] in length. During normal operations the train will be travelling at a reduced speed of 15-mph through the downtown area and therefore take approximately 11-seconds to cross the Caulfield Ln intersection[11]. SMART estimates the total wait time, including signal light and gate crossing is expected to be 35 seconds.

North Coast Railroad Usage

The railway lines that run adjacent to Hopper Street and intersect Caulfield Ln will be shared between SMART and for freight use by the North Coast Railroad Authority (NCRA)[12]. The freight cars carry materials such as aggregate materials, lumber and grain. Solid waste will also be moved daily. Small amounts of oil, waste oil, grease, cleaning products, paints and diesel fuel will be stored and handled per applicable regulations. The transported freight on the subject section of rail line will not include hazardous waste, dangerous, highly flammable or explosive material.

The Caulfield Ln crossing will have a maximum of 6 freight train crossings daily[13]. The train will pass at a maximum speed of 25 mph. The expected worst case delay at the crossing is 57-seconds, inclusive of 25-seconds for gate closure. The NCRA report addresses potential emergency response delays, where an interview of operations professionals stated no significant delays for emergency response vehicles for current rail use in the local area[13]. NCRA notes that trains must be able to stop in the station without blocking road crossings. Caulfield Ln is located approximately 3600-ft further from the station than from D St. During normal operational use, obstruction to roadways is not common and therefore not expected during future use, while the risk of emergency vehicles being obstructed has been addressed by the NCRA for emergency conditions. The NCRA comments on the lowered chance of delay in Petaluma due to fire stations being located on both sides of the track[13].

The combined use at the Caulfield Ln intersection includes approximately 34 crossings on the order of 1 minute delays (expected maximum during normal operations). While not ideal, the probability and length of the delay and is relatively small and is mitigated by the proximity and number of fire stations.

---

[9] *SMART Stations Summary Information*. San Rafael: Sonoma-Marin Area Rail Transport, 2009.

[10] *SMART Technical Specification for Diesel Multiple Units (DMUs)*. San Rafael: Sonoma-Marin Area Rail Transport, 2010.

[11] *Downtown Traffic and SMART - White Paper*. no. 17. San Rafael: Sonoma-Marin Area Rail Transport, 2008.

[12] Kleinfelder. *North Coast Railroad Authority Russian River Division Contingency Plan and Emergency Procedures for Management of Hazardous Materials/Waste*. Santa Rosa, CA, 2009.

[13] Kleinfielder. *Public Draft Environmental Impact Report North Coast Railroad Authority Russian River Division Freight Rail Project*. Santa Rosa, CA, 2009.

The performance and reliability of installed automatic fire sprinkler systems is discussed in Section 3.1.2. It is expected that delays to the response time of emergency crews to the site, during an onsite fire-related emergency, would not significantly worsen conditions for responding fire personnel.

Railway Crossing Incident

The event of a railway incident could lead to an extended blockage of the Caulfield Ln EVA. The probability and impact of potential incidents is evaluated based on available railway data. The Federal Railway Administration (FRA)[14] provides a public database of train emergency statistics. Highway-rail is defined as a location where a public highway, road, street, or private roadway, including associated sidewalks and pathways, crosses one or more railroad tracks at grade. Highway-rail incidents include any event with an impact at a crossing site, regardless of severity.

Based on 2010 data, there were 2.86 highway-rail incidents every 1,000,000 train miles in the United States[14]. In 2010 there were 2,013 highway-rail within the US, of which 124 incidents occurred in California (6.2%). The delay time length would depend on the severity of the incident. These incidents do not include all disruptions of service, such as scheduling issues or rerouting of trains.

The probability for these issues can be considered low due to the low frequency of trains and management practices in place, however no quantitative risk is provided by the FRA. Train operators are aware of intersections and policies are in place to not block traffic when stopped. The majority of usage is by SMART, having a maximum length of 300-ft. The short train length and distance from the station leads to a lower likelihood of obstructing the Caulfield intersection. In the event of an emergency, NCRA will send a message to stop approaching trains, and avoid disruption to road ways.

Table 3.5 provides a summary of the statistical data.

Table 3.5: Risk of Rail Incident at Caulfield Lane Intersection (Based upon 2010 Data).

Data	Value	Calculation	Comment
Frequency of highway-rail incidents in the US (per train-miles)	2.86×10^{-6}		
Percentage of rail-crossing accidents that occurred in California (%)	6.2	$6.2/100 \times 2.86 \times 10^{-6} = 17.7 \times 10^{-8}$	Rate of accidents at highway-rail crossings in California per train miles
Number of trains passing by the site (annually)	12,410	$12{,}410 \times 17.7 \times 10^{-8} = 2.2 \times 10^{-3}$	Likelihood of a train incident at Caulfield Ln Intersection (per train miles-annually)

[14] Federal Rail Administration – Incident Database (www.safetydata.dot.fra.gov) – Appendix B

The return period is the inverse of the probability that the event will be exceeded in any one year, therefore, based upon 2010 data, the theoretical return period for the Caulfield Ln rail intersection being blocked by a highway-rail accident is approximately a 455 year event. This is comparable to a 475 year event (90-percent exceedance in 50 years) for ordinary structure earthquake design[8]. It is noted that the assessment conservatively assumes that the rail operations cross the intersection 34 times a day, for 365 days a year. It should also be noted that the Caulfield Ln intersection represents 1 in 10,067 rail crossings in California, however, there is no information as to how the statistics are regionally distributed, which is likely to further increase the return period of a train incident near the site.

In the occurrence of a blocked intersection at Caulfield Ln, emergency vehicles would still be able to enter and exit the site via Hopper St. In such an event, the one-way street would be used as ingress/egress for emergency vehicles. There is approximately 600-ft of Hopper St where the road narrows to 20-ft, in width. It is unlikely that the ingress of emergency vehicles will be hindered, as their travel will be with the direction of public traffic. Where such a scenario necessitates, Police assistance will be provided at the entrance to Hopper St from D St to manage the flow of traffic along Hopper St, and facilitate the exit of emergency vehicles from the site, via Hopper St to D St.

To further facilitate the ingress and exit of emergency vehicles via the Hopper St EVA, when the Caulfield Ln EVA is obstructed, the following is proposed:

1. A separate gated EVA, providing a second means of accessing Hopper St, from D St, to allow controlled bi-directional flow during an emergency, and to also provide separation of the EVA from the rail intersection at D St.

2. The widened section of Hopper St (one-way) will feature a 10-ft wide signed and striped EVA use only portion.

3. Signage will direct public ingress to the southern side of Hopper St, maintaining clearance of the striped EVA.

It is recommended that emergency gate operations use systems that are common to all necessary emergency services to minimize delays to responding services activities.

3.5 Petaluma River

Hazardous Spill

The development site is bordered by the Petaluma River to the south. The EVA through Hopper Street has portions of the road directly adjacent to the river. The Caulfield Lane EVA route is 1500-ft away at the closest point. The river is primarily used for recreation or transferring of non-hazardous goods.

Flood Risk

The proximity of the site to the Petaluma River leads to the potential for the EVA's to be obstructed by flooding. Appendix C provides flood hazard maps from FEMA. Areas subject to an annual 1%

risk of flooding are highlighted. The map shows Hopper St may be considered unusable during a 100-year flood along with the roadways connecting Hopper St to 'Station 1' from Figure A-1. The primary access at Caulfield Ln is located on the border of the hazard area. Therefore the annual probability of both EVA routes becoming unusable during a flood would be approximately 1.0%. In the event of a flood situation, it can be assumed that the city will plan appropriately for evacuation of high-risk areas, if necessary.

It has been confirmed with the Engineer for the City of Petaluma that Hopper St is elevated 2-feet above the 100-year floor level. Hopper St is within the 500-year floor area.

4. Summary

The assessment herein has evaluated the performance of the proposed EVA for the Riverfront development, to meet the intent of the applicable Code provisions, and to meet the requirements of responding emergency services, as documented by the referenced information. The scenarios discussed and assessed have been selected based upon the conditions that currently exist and their foreseeable impact to the emergency ingress and egress of the subject site. These scenarios are considered to be beyond that which is reasonably expected of a prescriptive design. However, the Authority Having Jurisdiction has highlighted the site as presenting unique challenges to responding emergency personnel, and therefore the following is a summary of third party review of the sites EVA provisions:

1 The site is within a 4-minute response time of both Stations 1 and 3, which are located on opposite sides of the railway tracks and Petaluma River. Therefore emergency responders would still be able to access the site via either Hopper St, or Caulfield Ln, where site access may be obstructed due to an event involving either the rail line, or the river.

2 Historical data on the level of reliability and performance achieved by installed sprinkler systems, confirms that it is not expected that delays to responding fire services would result in an escalation of operations to combat an uncontrolled fire scenario.

3 Separation of the proposed EVA's is sufficient, such that a large building fire, would not compromise the tenability of both EVA's simultaneously.

4 The likelihood of a hazardous good spill on HWY US-101 requiring a local area evacuation is a 287,356 year event.

5 Worst case delays to emergency service access associated with normal rail operations at the Caulfield Lane crossing, are not expected to exceed 1-minute.

6 The likelihood of a train incident blocking the Caulfield Lane EVA is approximately a 455 year event. The Hooper St EVA would be available to access the site, in such an event.

7 The annual probability of both EVA's being flooded is approximately 1%.

8 The EVA provisions feature six EVA only gates. These gates are proposed to be automated for emergency personnel use. It is recommended that emergency gate operations use systems that are common to all necessary emergency services to minimize delays to responding services activities.

5. CONCLUSION

Holmes Fire has undertaken a third party peer review of the Emergency Vehicle Access (EVA) for the proposed Riverfront mixed-use development to be located at 500 Hopper Street, Petaluma, CA.

The City of Petaluma have indentified that the subject site has the potential to present a challenge to their ability to respond to an onsite emergency event. Given the specific conditions that exist, in relation to ingress and egress for the subject site, it is considered that the proposed EVA for the site provide adequately for the emergency scenarios assessed by this third party evaluation.

Should you have any queries, please do not hesitate to contact the undersigned.

Sincerely,

HOLMES FIRE LP

Bevan Jones, P.E.
National Manager | Principal Fire Engineer
Certificate No. FP 1672

106975.00_500 Hopper St_FER _11Oct2011_vC

6. Appendix A: Protection of External Egress Path

The following assessment demonstrates that sufficient separation distance is provided between the neighbouring buildings and the EVA routes, such that occupants can safely use at least one public access point in the event of an emergency.

The methodology for assessing the radiant heat received at a point of interest from a radiating source is based upon that provided within Section 2 Chapter 14 of the SFPE Fire Protection Handbook[15]. The program "Radiation" in the software tool FireWind 3.6[16], was used to calculate the received radiant heat at the path of travel.

The following constant parameters have been used in the assessment:

- The emissivity of the radiating source is conservatively assumed to be 1 (100%)
- The opening area of the emitting source is conservatively assumed to be 100%
- The external building temperature for the fire is assumed to be 1112°F (600°C)
- The maximum acceptable received radiant heat level is 2.5 kW/m², as defined within the Tenability Criteria for humans (Section 3.2)
- The width of the EVA route is maintained, with the received point being the closest to the path along the road

15 Lattimer, Brian L., Heat Fluxes from Fires to Surfaces. Section 2 Chapter 14, SFPE Handbook of Fire Protection Engineering, Third Edition 2002.

16 FireWind 3.6, Fire Modelling and Computing, NSW, Australia. Version 10, December 2004

holmesfire

Program Radiation

(All dimensions are in meters)

X-sources:

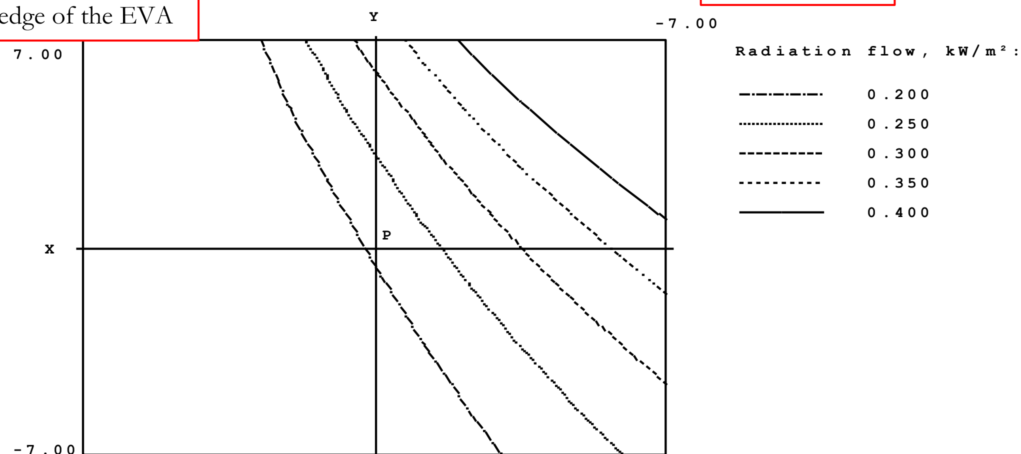
Radiation temperature 600°°

Distance	Offset		Size of source		Opening
X	Yx	Zx	Y	Z	%
7	66.1	7.2	60	9.2	100

Distances to evaluate the edge of the EVA

Size of the fire

RADIATION MAP XY



Point P (0,0) represents the edge of the EVA road leading to the maximum radiation level that can affect the road.

Nodal radiation data, kW/m²:

Y \ X	7.00	3.50	0.00	-3.50	-7.00
7.00	0.000	0.166	0.321	0.457	0.568
3.50	0.000	0.132	0.256	0.367	0.461
0.00	0.000	0.106	0.207	0.300	0.380
-3.50	0.000	0.087	0.171	0.248	0.317
-7.00	0.000	0.072	0.143	0.208	0.267

Orientation of maximum radiation flow

at point P(0,0,0): $\theta = 81.9°, \varphi = 82.0°$

Figure A-1: Fire 1 Scenario

holmesfire

Program Radiation

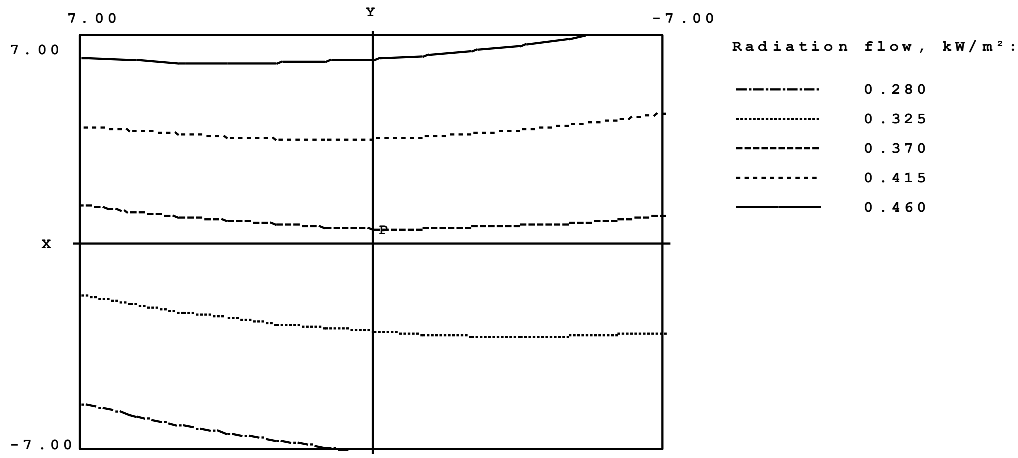
(All dimensions are in meters)

X-sources:

Radiation temperature 600°°

Distance	Offset		Size of source		Opening
X	Yx	Zx	Y	Z	%
36.3	56.5	7.2	30.2	9.2	100

RADIATION MAP XY



Nodal radiation data, kW/m²:

Y \ X	7.00	3.50	0.00	-3.50	-7.00
7.00	0.475	0.478	0.474	0.465	0.453
3.50	0.407	0.414	0.415	0.411	0.403
0.00	0.350	0.359	0.363	0.363	0.359
-3.50	0.303	0.313	0.319	0.321	0.320
-7.00	0.263	0.274	0.281	0.285	0.286

Orientation of maximum radiation flow

at point P(0,0,0): $\theta = 83.6°, \varphi = 55.5°$

Figure A-2: Fire Scenario 2

Program Radiation

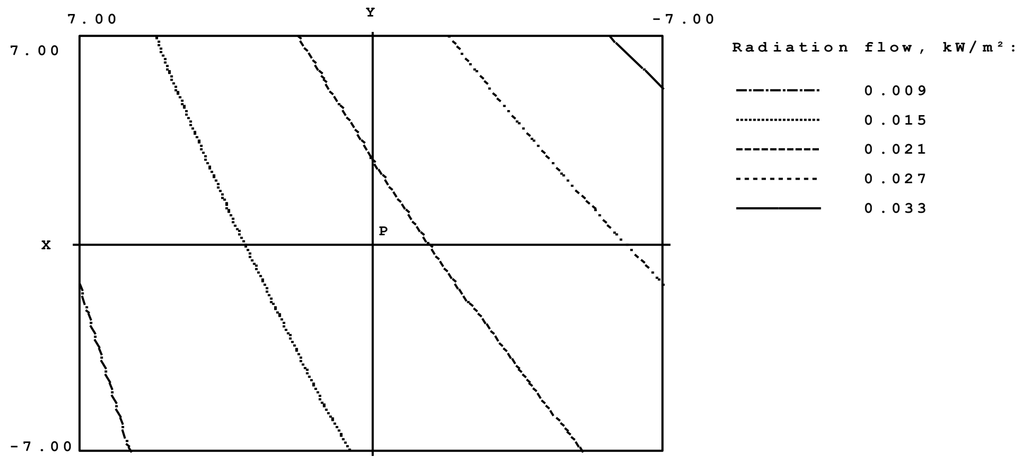
(All dimensions are in meters)

X-sources:

Radiation temperature 600°°

Distance	Offset		Size of source		Opening
X	Yx	Zx	Y	Z	%
13.4	95.7	7.2	13.4	9.2	100

RADIATION MAP XY



Nodal radiation data, kW/m²:

Y \ X	7.00	3.50	0.00	-3.50	-7.00
7.00	0.012	0.018	0.024	0.030	0.035
3.50	0.010	0.016	0.021	0.027	0.031
0.00	0.009	0.014	0.019	0.024	0.028
-3.50	0.008	0.013	0.017	0.021	0.025
-7.00	0.008	0.012	0.016	0.019	0.023

Orientation of maximum radiation flow

at point P(0,0,0): $\theta = 85.7°$, $\varphi = 82.0°$

Figure A-3: Fire Scenario 3

Program Radiation

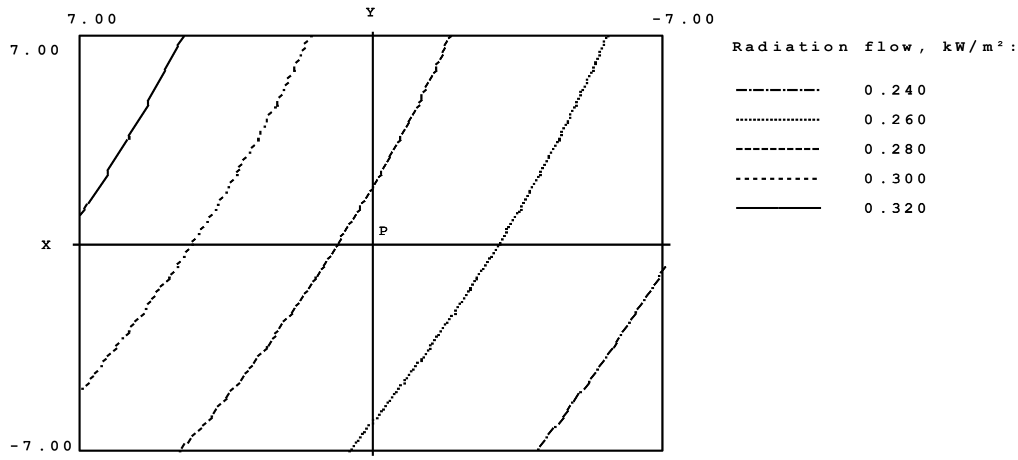
(All dimensions are in meters)

X-sources:

Radiation temperature 600°°

Distance	Offset		Size of source		Opening
X	Yx	Zx	Y	Z	%
89	26.5	7.2	26.2	9.2	100

RADIATION MAP XY



Nodal radiation data, kW/m²:

Y \ X	7.00	3.50	0.00	-3.50	-7.00
7.00	0.338	0.313	0.291	0.271	0.253
3.50	0.328	0.305	0.284	0.265	0.248
0.00	0.317	0.295	0.276	0.258	0.241
-3.50	0.305	0.285	0.267	0.250	0.235
-7.00	0.293	0.274	0.257	0.242	0.227

Orientation of maximum radiation flow

at point P(0,0,0): $\theta = 85.6°$. $\varphi = 16.2°$

Figure A-4: Fire Scenario 4

holmesfire

The results demonstrate that sufficient distance is provided between the buildings and the EVA routes such that evacuating occupants are not exposed to untenable levels of radiant heat within the required width of the EVA.

holmesfire

7. Appendix B: Federal Rail Administration Data

SELECTION: RAILROAD - ALL / January TO December, 2010

TOTAL ACCIDENTS/INCIDENTS: 11,438 Number of fatal accidents/incidents 704 6.15%
Overall frequency rate: 16.26 Total train miles: 703,475,271
Total fatalities: 737 Switching miles: 87,553,672
Total nonfatal conditions: 8,186 Employee hours: 437,272,151

Total accidents/incidents is the sum of train accidents, highway-rail incidents, and other incidents.
Total accident/incident rate is the number of events times 1,000,000 divided by total train miles.

TOTAL TRAIN ACCIDENTS: 1,873 Number of fatal train accidents 7 0.37%
Number per million train miles: 2.66 Collisions: 131 6.99%
Total fatalities: 8 Derailments: 1,324 70.69%
Total nonfatal conditions: 100 Other accidents: 418 22.32%

-----------------------------Primary causes-----------------------------
Human factors: 33.53% 628 Track defects: 666 35.56%
Equipment defects: 13.13% 246 Signal defects: 66 3.52%
Miscellaneous causes: 14.26% 267

Number of accidents on yard track: 1,009 53.87% of all train accidents.
Nbr per million yard train miles: 11.52 For other tracks: 1.40

Train accidents represent 16.38% of all reported events.

Number of train accidents involving passenger trains 134 7.15%

Number of train accidents that resulted in a release of hazardous material 21 1.12% of total
Number of persons evacuated 1,682 Number of rail cars releasing hazmat 40

A train accident is an event involving ontrack rail equipment that results in monetary damage to the equipment and track above a certain threshold. Lading, clearing costs, environmental damage is not included.

HIGHWAY-RAIL TRESPASSING INCIDENTS (not at crossings)
Incidents: 2,013
Number per million train miles: 2.86 Frequency per million train miles: 1.18
Total fatalities: 261 Total fatalities: 442
Total nonfatal conditions: 842 Total nonfatal conditions: 389
Number of fatal crossing incidents 238 11.82%

Highway-rail and trespassing incidents account for 95.39% of all fatalities.
Highway-rail incidents represent 17.60% of all reported events.

A highway-rail incident is any impact between a rail and a highway user at a crossing site, regardless of severity. Includes motor vehicles and other highway/roadway/sidewalk users at both public and private crossings.

Figure B-1: Highway-Rail Incidents for 2010 in the US.

State - CALIFORNIA County - All Counties
January To December, 2010

TOTAL ACCIDENTS/INCIDENTS: 693 Number of fatal accidents/incidents 88 12.7%
Total fatalities: 93 Total nonfatal conditions: 518

Total accidents/incidents is the sum of train accidents, highway-rail incidents, and other incidents.

TOTAL TRAIN ACCIDENTS: 83 Number of fatal train accidents 1 1.20%
Total fatalities: 1 Total nonfatal conditions: 5
Collisions: 7 8.43%
Derailments: 57 68.67%
Other accidents: 19 22.89%

---------------------------Primary causes---------------------------

Human factors:	53.01%	44	Track defects:	19	22.89%
Equipment defects:	7.23%	6	Signal defects:	2	2.41%
Miscellaneous causes:	14.46%	12			

Number of accidents on yard track: 57 68.67% of all train accidents.

Train accidents represent 11.98% of all reported events.

Number of train accidents involving passenger trains 6 7.23%

Number of train accidents that resulted in a release of hazardous material 1 1.20% of total
Number of persons evacuated 35 Number of rail cars releasing hazmat 1

A train accident is an event involving ontrack rail equipment that results in monetary damage to the equipment and track above a certain threshold. Lading, clearing costs, environmental damage is not included.

HIGHWAY-RAIL INCIDENTS
Crossings: 10,067 Incidents: 124
Total fatalities: 29
Total nonfatal conditions: 72
Number of fatal crossing incidents 29 23.39%

TRESPASSING INCIDENTS(not at crossings)
Total fatalities: 62
Total nonfatal conditions: 53

Public Crossings 6,425 With gates 3,146 Other activated crossings 968 Number with passive warnings 2,311
Private crossings 3,642 ***** THE COUNT OF CROSSINGS IS THE COUNT IN THE CURRENT INVENTORY *****

Highway-rail and trespassing incidents account for 97.85% of all fatalities.
Highway-rail incidents represent 17.89% of all reported events.

A highway-rail incident is any impact between a rail and a highway user at a crossing site, regardless of severity. Includes motor vehicles and other highway/roadway/sidewalk users at both public and private crossings.

Figure B-2: Highway-Rail Incidents for 2010 in California.

holmesfire

8. Appendix C: FEMA Flood Map

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was California State Plane Zone II (FIPSZONE 402). The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information on this FIRM was derived from multiple sources. Data was provided in digital format by the County of Sonoma Information Systems Department, derived from 1:1,200, 1:2,400, and 1:4,800 scale digital orthophotos, dated April-May 2000. Information was provided by the City of Healdsburg Department of Public Works, derived from 1:600 scale digital orthophotos, dated March 3, 2007. Additional information was derived from 1:12,000 scale U.S. Geological Survey Digital Orthophoto Quadrangles, dated 2002.

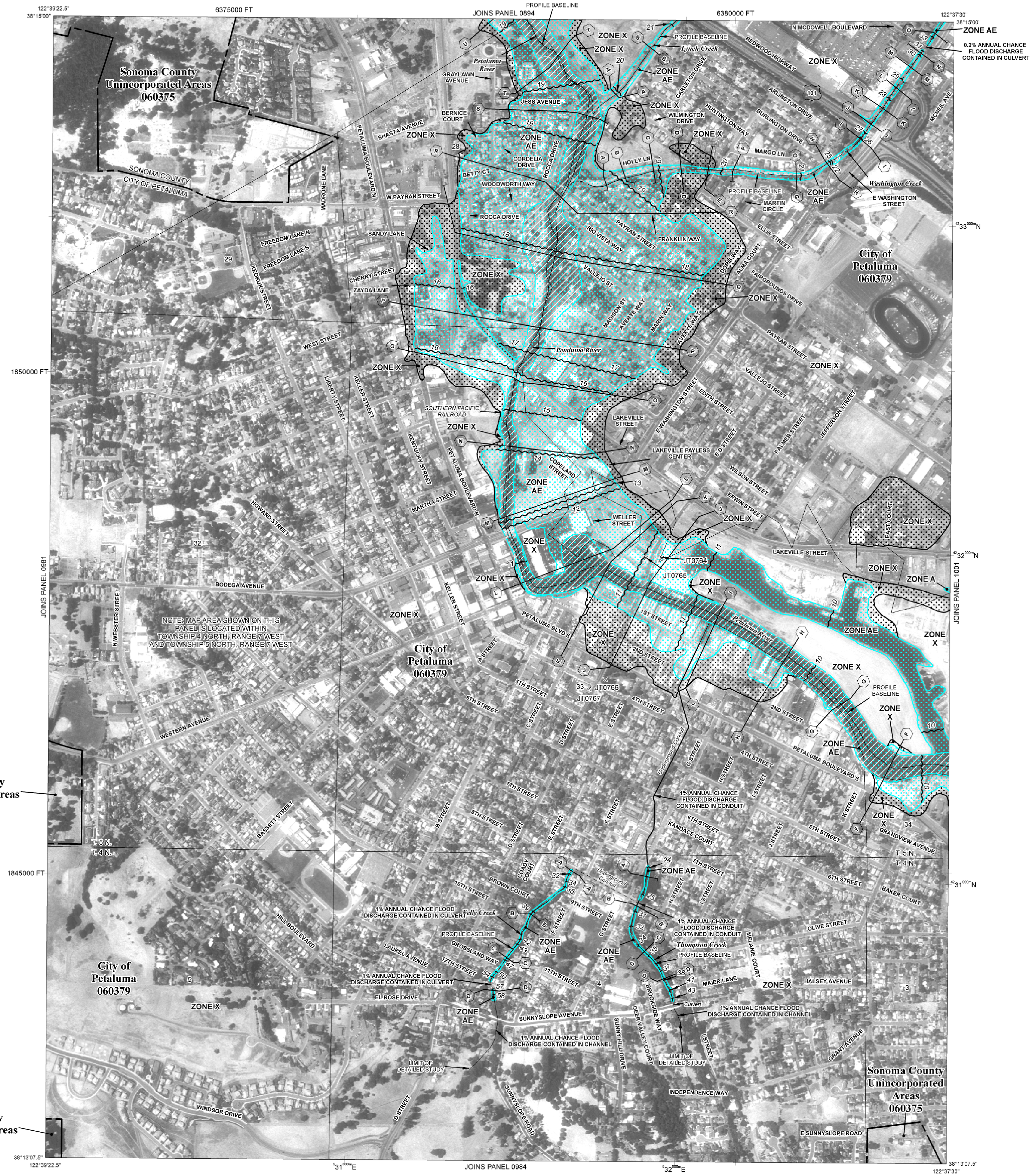
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)——(A)	Cross section line
(23)- - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone II (FIPSZONE 0402), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
December 2, 2008

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0982E

FIRM

FLOOD INSURANCE RATE MAP

SONOMA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 982 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PETALUMA, CITY OF	060379	0982	E
SONOMA COUNTY	060375	0982	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06097C0982E

EFFECTIVE DATE
DECEMBER 2, 2008

Federal Emergency Management Agency