APPENDIX Q

CORRECTIVE ACTION COST ESTIMATES AND FINANCIAL ASSURANCE

WATER RELEASES

COUNTY OF SONOMA
DEPARTMENT OF TRANSPORTATION
AND PUBLIC WORKS
2300 COUNTY CENTER DRIVE, SUITE B 100
SANTA ROSA, CALIFORNIA 95403

Phillip M. Demery, Director

AREA CODE (707)
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November 6, 2009

File: 50-01-17.3

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☐ EO ☐ WMgmt ☐ Admin
☐ AEO ☐ Timber ☐ Legal
☐ Reg/NPS ☐ Cleanups ☐

Ms. Terri Cia, Engineering Geologist
California Regional Water Quality Control Board
North Coast Region
5550 Skylane Boulevard, Suite A
Santa Rosa, CA 95403

Re: **Financial Assurance – Corrective Action Costs Estimate Central Disposal Site, Petaluma, California**

Dear Ms. Cia:

The County is requesting the review and concurrence with the enclosed report "Financial Assurance Assessment for Known and Reasonably Foreseeable Releases from the Sonoma County Central Landfill, Sonoma County, California", dated September 22, 2009, by Shaw Environmental. This report was prepared pursuant to Section 22220 of Title 27, which requires operators of disposal facilities to demonstrate the availability of resources to conduct corrective action activities. As agreed to in our July 2009 meeting with RWQCB staff, this report will also be incorporated into the County's final closure plan for the Central Disposal Site.

As you may recall, the preceding document to this submittal was provided to the RWQCB on February 15, 2005, and again on June 8, 2008 pursuant to WDR R1-2004-0040 and the corresponding requirements of CCR Title 27. However, based on our meeting in July 2009, comments from RWQCB staff indicated that this document was out of date; hence, the 2005 report was never approved. The enclosed report is based on all information and data gained since the 2005 report was originally submitted, including information provided in the August 2009 report "Technical Memorandum on the Compliance with the Waste Discharge Requirements for Landfill 1 at the Sonoma County Central Landfill", by Shaw Environmental.

County staff is available, and as always, ready to work and engage with RWQCB staff to address any questions or concerns regarding this submittal. If you have any questions, please contact me at (707) 565-7940.

Very truly yours,

DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS

J. Glenn Morelli, PG

Encl.: **Financial Assurance Assessment for Reasonably Foreseeable Releases from the Sonoma County Central Landfill, September 22, 2009 by Shaw Environmental**

c: Susan Klassen, Trish Pisenti, Randy Forbes, DTPW
Sheryl Bratton, County Counsel
Leslie Graves, SWRCB w/encl., Jonalyn Bajurin, CIWMB w/encl.
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September 22, 2009
Project 129429

Mr. Glenn Morelli
Engineering and Operations, Integrated Waste Division
County of Sonoma, Department of Transportation and Public Works
500 Mecham Road
Petaluma, California 94952

RE: Financial Assurance Assessment for Known or Reasonable Foreseeable Releases from the Sonoma Central Landfill, Sonoma County, California

Dear Mr. Morelli:

Shaw has prepared this assessment to provide a revised Financial Assurance (FA) funding mechanism for Corrective Action of a Known or Reasonably Foreseeable Release at the Sonoma Central Landfill (SCLF).

SUMMARY

Financial assurance corrective action cost estimates for the known or reasonably foreseeable releases have previously been prepared for Landfill 1 (Central Canyon) and Landfill 2 (East Canyon) at the SCLF. This summary section provides a brief description of the previous corrective action cost estimates, which will be followed by a detailed description.

Landfill 1

The basis for the previous Landfill 1 financial assurance cost estimate is described in a report prepared by The MARK Group *(Proposed Water Quality Monitoring Program and Response Plan, August 8, 1994),* which ranged from $1.4 million to $4.7 million to cover corrective actions for a reasonable foreseeable release.

The Mark Group prepared the FA cost estimate in accordance with Article 5, Subchapter 15, Title 23 of the California Code of Regulations (CCR), which is now out of date as current FA estimates are now regulated under CCR Title 27.

Landfill 2

The basis for the previous Landfill 2 financial assurance cost estimate is described in a letter report prepared by GeoSyntec Consultants *(Corrective Action Financial Assurance, East Canyon Area Expansion, August 9, 1999),* which was based in part on the Landfill 1 cost estimate procedure described by The MARK Group. The cost estimate to cover corrective actions for a reasonable foreseeable release from Landfill 2 was $300,000.

Current Regulations

The current financial assurance regulations for corrective action cost estimates are now under Sections 22220 and 22221, Article 4, Subchapter 2, Chapter 6, Title 27 of the CCR. Section 22220 requires operators of disposal facilities to demonstrate that financial resources are available to conduct corrective action activities. Section 22221 requires operators to demonstrate financial responsibility to the California Integrated Waste Management Board (CIWMB) for initiating and completing corrective action for all known or reasonably foreseeable releases from the disposal facility.

Section 20430 defines "corrective action" as implement corrective action "measures that ensure that constituents of concern (COCs) achieve their respective concentration limits at all monitoring points and throughout the zone affected by the release, including any portions thereof that extend beyond the facility boundary, by removing the waste constituents or treating them in place." The regulations require a cost estimate for either "all known" or "reasonably foreseeable" releases. Because both Landfills 1 and 2 of SCLF have experienced a release, these cost estimates will address the "known releases."

The CIWMB is also responsible for approving Post Closure Maintenance cost estimates under Section 21840 of the CCR. The costs that are to be included in the post closure estimate are as follows:

- Site security
- Maintenance and integrity of the final cover including material acquisition, labor, and placement for repair of the final cover as required due to the effects of settlement, slope failure, or erosion
- Maintenance of vegetation including fertilization, irrigation and irrigation system maintenance
- Monitoring, operation and maintenance (O&M) of the environmental monitoring and control systems, including, but not limited to, the landfill gas (LFG), leachate, and groundwater systems
- Maintenance of the drainage and erosion control systems including clearing materials that block drainage conveyances; and repairing drains, levees, dikes and protective berms

Therefore, these items would not need to be accounted for in the corrective action cost estimate. Notably, among these items are the O&M costs of the leachate and groundwater control systems.

LANDFILL 1-DETAILS of the 1994 MARK GROUP COST ESTIMATE

The MARK Group's 1994 report did not have the benefit of all of the information on the "known release," so they based their estimate on a "reasonably foreseeable release." In their

report, they presented an evaluation of a hypothetical release of leachate to groundwater. When the MARK Group document was prepared, a landfill release had not been confirmed by the County.

Hypothetical Level of Impact

The cost estimate for a reasonable foreseeable release in 1994 was based on the three following hypothetical levels of groundwater impact from leakage of leachate from the base of the landfill:

- Worst case (Case 1) –Groundwater contamination covers 320,000 square feet (sf) in the alluvium and 5.6 million sf in the Franciscan Formation; if the monitoring network detected the release a considerable amount of time after the release had started (late stage detection)
- Medium case (Case 2) –Groundwater contamination covers 128,000 sf in the alluvium and 4.4 million sf in the Franciscan Formation.
- Minimum case (Case 3)—Groundwater contamination covers 50,000 sf in the alluvium and 4 million sf in the Franciscan Formation; if the monitoring network detected the release soon after the release had started (early stage detection)

Corrective Actions

The corrective actions would consist of a groundwater extraction and treatment system capable of removing, treating, and disposing of the impacted groundwater on-site. The MARK Group postulated in 1994 that a system would be designed to intercept impacted groundwater via extraction trenches and wells in the alluvium and the Franciscan Formation. Remediation of the hypnotically impacted groundwater would consist of the following treatment measures:

- Oxidation and precipitation
- Coagulation and filtration
- Ultraviolet sterilization
- Granular activated carbon adsorption

Cost Estimates

The cost estimates for each level of impact was subdivided into the following three categories:

- Extraction System Capital Costs
  - Case 1 - $534,500
  - Case 2 - $363,000
  - Case 3 - $280,500

- Treatment System Capital Costs
  - Case 1 – $770,500
  - Case 2 - $544,500
  - Case 3 - $328,000
- Yearly O & M Costs
  - Case 1 - $468,000
  - Case 2 - $171,500
  - Case 3 - $98,000

Depending on the level of impact, each case would require five extraction wells and at least 1,500 linear feet of extraction trench. Therefore, the duration and cost required for effective groundwater extraction systems would be:

- Case 1 – The remediation system is active for 12 to 15 years with corrective action costs ranging from $4 million to $4.7 million, which is based on a late stage detection of the release.

- Case 2 – The remediation system is active for 10 to 12 years with corrective action costs ranging from $2.3 million to $2.6 million.

- Case 3 – The remediation system is active for 8 to 10 years with corrective action costs ranging from $1.4 million to $1.6 million, which is based on early stage detection of the release.

The difference between these three cases is the aerial extent of impact, which was based on how soon the impact would be detected before remediation could be implemented.

Under a Case 1, late detection, worst-case scenario, the plume of impacted groundwater would extend 1,600 feet past the toe of the landfill, which is over 1,000 feet off-site. In addition, the Case 1 condition also assumed the plume would extend almost 1,000 feet to the east encompassing all of the Landfill 2 area.

Under a Case 3, early detection, best-case scenario, the plume would extend 200 feet past the toe of the landfill, which is within the site boundary. This scenario also assumed the plume would extend almost 200 feet to the east to the approximate position of well F-3.

The Mark Group estimates were based on two key factors: the minimal groundwater monitoring system in place in 1994 and extensive remediation measures considered necessary in 1994.

LANDFILL 2—DETAILS OF THE 1999 GEOSYNTEC COST ESTIMATE

GeoSyntec's 1999 letter report was based in part on the MARK Group's Landfill 1 cost estimate procedure. The 1999 assessment also did not have the benefit of all of the information on the "known release," so they also based their estimate on a "reasonably foreseeable release."

Hypothetical Level of Impact

The hypothetical impact scenario was a leachate/landfill gas release to the groundwater underdrain because of defects in the base liner. Because an impact to the underdrain would be easily detectable, GeoSyntec assigned a MARK Group Case 3 level of impact (least impact).

Corrective Actions

The corrective action would be groundwater extraction using the existing Landfill 2 underdrain system complemented by additional extraction wells. Remediation of the hypothetically impacted groundwater would require off-site disposal at Santa Rosa Waste Water Treatment Plant (publicly owned treatment works, POTW).

Cost Estimate

The cost estimate for the assumed level of impact was divided into the following three subcategories:

- Treatment off-site - $104,000
- Hauling off-site - $120,000
- Additional extraction wells - $75,000

The total cost estimate for correction action financial assurance was $300,000. The costs were based on the need to treat 8 million gallons of impacted groundwater per year. The treatment costs at the POTW were estimate to be 1.3 cents per gallon, and the cost of hauling the impacted groundwater to the POTW was estimated to be 1.5 cents per gallon.

At the time GeoSyntec prepared the document in 1999, releases from either Landfill 1 or Landfill 2 had not been confirmed by the County. In addition, during the same year, the County developed a Leachate Management Plan (LMP) capable of disposing of approximately 2 million gallons of leachate per year. GeoSyntec assumed that the underdrain beneath Landfill 2 could produce 8 million gallons of groundwater per year. The underdrain would act as a monitoring point and a remediation component. In 1999, on-site treatment of leachate consisted of evaporation from surface impoundments and off-site disposal at the POTW. In addition, an on-site mercury treatment plant was also available.

PRESENT LANDFILL CONDITIONS

Since 1994, when the MARK Group prepared an estimate for Landfill 1 estimate, significant changes have occurred at the facility. The groundwater monitoring program in 1994 consisted of only nine wells, whereas, the current monitoring program has 47 wells. In addition, a series of significant evaluation monitoring programs have been conducted. The results of these investigations have concluded that a release from Landfill 1 has occurred, and the extent of impact in groundwater is well defined. In addition, a release from Landfill 2 has also occurred.

Impacted groundwater was detected in the early stages of release from both landfills. The extent of groundwater impact determined by the current monitoring program is less extensive then the best-case hypothetical predictions for both landfills.

The two previous corrective action cost estimates were based on "reasonably foreseeable releases." However, because a "known release" has been fully defined, Shaw has prepared the following revised cost estimate to reflect these conditions.

Landfill 1

The "known release" from Landfill 1 originated via two mechanisms:

- Leakage of leachate from the base of Landfill 1, as postulated in the MARK Group report
- Vadose zone transport of LFG causing an impact to groundwater, a mechanism that was not originally postulated in the hypothetical release scenarios in the MARK Group report.

Treatment Measures The previous corrective action cost estimate was based on an extensive groundwater extraction system and series of treatment measures. However, a different set of contaminant extraction and treatment measures have been implemented. To date the County has implemented an extensive leachate control and removal system (LCRS) to remediate the release of leachate to groundwater. The LCRS consists of 91 pumping wells, sumps, and an extensive network of underdrains.

To monitor the effectiveness of the LCRS, the County developed a leachate and groundwater level-monitoring network at the site. This network consists of 23 leachate piezometers within Landfill 1 and 46 groundwater monitoring wells surrounding it. These piezometers and wells are currently monitored on a monthly basis to provide data for ongoing evaluation of the effectiveness of the leachate extraction system.

The existing LCRS discharges approximately 14 million gallons of leachate per year to the POTW. The purpose of the LCRS is to reduce the leachate build-up over the base of Landfill 1 to the maximum extent practicable. Because the POTW can accept the leachate without any on-site pre-treatment, no additional financial assurance funds are necessary for on-site treatment.

To remediate the release of LFG from Landfill 1, the County has installed an extensive gas collection and control system (GCCS). The GCCS consists of 129 vertical LFG extraction wells and 6 horizontal LFG collection trenches in Landfill 1. The LFG is destroyed in a gas-to-energy (GTE) plant that consists of 10 internal combustion engines. In addition, a flare is available as a backup means of LFG destruction. The purpose of the GCCS is to reduce the migration of LFG from the base of the unlined landfill to the maximum extent practicable.

The previously described components of the LCRS and GCCS treatment measures for Landfill 1 are analogous to the groundwater extraction and treatment systems previously

proposed in the MARK Group report. The proposed groundwater extraction wells and trenches estimated in the "reasonably foreseeable release" scenario have been replaced in-kind with leachate and LFG extraction wells. In addition, the previously proposed on-site groundwater treatment system estimated in the "reasonably foreseeable release" scenario has been replaced in-kind by off-site treatment of leachate at the POTW and the on-site destruction of LFG and VOCs in the GTE plant.

The County has not withdrawn any funds from their existing FA fund to accomplish the corrective action tasks at Landfill 1. Although the FA fund was setup to pay for the completion of these tasks, all costs has been covered under the operating budget of the County.

Site Conceptual Model In addition, the County has implemented a significant program to better understand the mechanisms of contaminant movement and control. This program has been referred to as the development of the Site Conceptual Model (SCM). Based on the development of the SCM, a rigorous numerical groundwater flow model (NGFM) was also prepared. The NGFM has been used in the following ways:

- As a predictive tool to evaluate the effectiveness of the existing LCRS at Landfill 1
- To assess modifications to the LCRS to improve and optimize system performance
- To assess various landfill closure scenarios
- To identify and prioritize significant data gaps

Revised Cost Estimate Based on the results of the NGFM additional leachate and LFG extraction wells have been added to the corrective action systems. If additional leachate and LFG extraction wells are required, their costs will be covered under the operating budget of the County.

The current operation of the LCRS and GCCS appears to be effective in mitigating the "known releases" from Landfill 1. This is apparent by the fact that the "known releases" have been stabilized in extent and concentration magnitude. Thus, the County has met the conditions for which the original FA Fund was set up.

The annual estimated cost to operate and maintain the existing corrective action systems (LCRS and GCCS) is based on the following conditions:

- The current cost for hauling and treating leachate at the POTW is 3.3 cents per gallon. The cost of treatment with a pipeline would be 2.1 cents per gallon at the POTW. All of these costs are currently covered by the site's operating budget.
- Destruction of LFG at the GTE plant incurs zero cost because of electrical generation payments. The electrical generation payments from the operation of

this corrective action component offsets 100% of the leachate treatment costs at the POTW.

Going forward, Shaw considered the following cost items to augment the current corrective action measures to remediate the "known release" from Landfill 1:

Expansions to the LCRS – The current LCRS consists of 91 pumping wells, sumps, and an extensive network of underdrains. Twenty additional leachate extraction wells were recently added to the system. This expansion to the LCRS had a capital cost of approximately $175,000 in 2007. It is possible that another more extensive augmentation of the LCRS will be necessary. Therefore, it is proposed that a capital cost sum of $350,000 should be placed in the FA Pledge of Revenue (POR) Fund. These funds could be used for additional leachate extraction wells, leachate pumps, or expansion of the existing groundwater interceptor trench (LWS-2) below the toe of landfill 1.

Expansions to the Leachate Treatment System – The current leachate treatment system consists solely of off-site treatment by the POTW. Any new increases in the volume of leachate sent to the POTW from Landfill 1 will not require any additional capital cost expenditures. Therefore, no additional leachate treatment system costs should be covered in the FA POR Fund.

Expansions to the GCCS – The current GCCS consists of 129 vertical LFG extraction wells and 6 horizontal LFG collection trenches. The wells used for the leachate extraction are dual-purpose wells, as they are also used to extract LFG for the GCCS. Any additions to the LCRS are also additions to the GCCS. Therefore, no additional GCCS capital costs should be covered in the FA POR Fund.

Expansions to the LFG Treatment System – The current LFG treatment system is the on-site GTE plant. Because the GTE is a cash-generating entity, a requirement to destroy additional LFG would be offset by additional electrical generation payments. Therefore, no additional LFG treatment system costs should be covered in the FA POR Fund.

Corrective Action Program Monitoring – The current groundwater/leachate monitoring network is very robust. It contains 82 groundwater monitoring wells and piezometers and 23 leachate piezometers. Therefore, no additional funding for evaluation monitoring is currently proposed to be placed in the FA POR Fund. However, it is possible that additional groundwater or leachate wells will be necessary for corrective action monitoring. Therefore, it is recommended that the County place $40,000 for this purpose in the FA POR Fund.

O & M of LCRS – The current leachate extraction well system at Landfill 1 is projected to discharge approximately 14 million gallons per year to the POTW at a cost of 3.3 cents per gallon (including hauling), which amounts to approximately $462,000 per year.

The County is the process of constructing a leachate pipeline from the SCLF to the POTW. The capital cost of the pipeline is covered by the site's operating budget. The pipeline will significantly reduce long-term O&M costs for disposal of leachate to 2.1 cents per gallon or $294,000 per year. However, in accordance with CCR Section 21840, the long-term O&M of

the LCRS is to be included in the Post Closure Maintenance Cost Estimate and not in the Corrective Action Cost Estimate.

In addition, all of the past and current O & M costs have been paid out of the County's operating budget. Based on this payment history and CCR Section 21840, it would not appear to be necessary that any of future O & M costs be covered in the corrective action FA fund. However, the County believes that it would be prudent at this time that a three-year O & M contingency be covered in the corrective action FA Fund for the LCRS. Therefore, the County proposes placing a sum of $882,000 in the FA POR Fund.

County understands that this item is discretionary and not required in the corrective action FA Fund, because they are already covered in the Post Closure Maintenance Fund. As a result, this funding figure amounts to a double allocation of monies beyond that required by regulation.

O & M of the GTE Plant – The destruction of LFG requires O & M of the existing GTE plant. These O & M costs have been recovered from the electrical generation payments. Therefore, no future GTE O & M costs should be covered in a FA POR Fund.

Landfill 2

The "known release" from Landfill 2 occurred via the following two mechanisms:

- Leakage of leachate through defects in the base liner, as postulated by GeoSyntec
- LGF migration around the anchor trench for the base liner, which was not originally postulated by GeoSyntec

Investigations conducted at Landfill 2 indicate that the underdrain has effectively captured these two sources of release. In addition, no new remediation measures have been required.

Revised Cost Estimate Shaw considered the following cost items to cover the corrective action measures necessary to remediate "known releases" from Landfill 2:

LCRS – Landfill 2 is fully lined and contains a LCRS underlying the entire landfill. All future expansions to Landfill 2 will be lined and contain a LCRS. The cost of LCRS expansions will be covered in the installation cost of the landfill. As the landfill expands, the appropriate leachate corrective action measures will be built into the expansion design. Therefore, no additional LCRS capital costs should be covered in the FA POR Fund.

Underdrain - Landfill 2 is fully lined and contains a groundwater underdrain beneath the entire landfill. All expansions to Landfill 2 will be lined and contain a groundwater underdrain. The cost of underdrain expansions will be covered in the installation cost of the landfill. As the landfill expands, the appropriate groundwater corrective action measures will be built into the expansion design. Therefore, no additional underdrain capital costs should be covered in the FA POR Fund.

Expansions to the Groundwater Treatment System – The current groundwater treatment system consists solely off-site treatment by the POTW. Any new increases in the volume of impacted groundwater sent to the POTW from Landfill 2 will not require any additional capital cost expenditures. Therefore, no additional groundwater treatment system costs should be covered in the FA POR Fund.

Expansions to the GCCS – The current GCCS in Landfill 2 consists of 15 horizontal LFG collection trenches. The cost of GCCS expansions will be covered in the installation cost of the landfill. As the landfill expands, the appropriate LFG corrective action measures will be built into the expansion design. Therefore, no additional GCCS capital costs should be covered in the FA POR Fund.

Expansions to the LFG Treatment System – The current LFG treatment system is the on-site GTE plant. Because the GTE is a cash-generating entity, a requirement to destroy additional LFG from Landfill 2 would be offset by additional electrical generation payments. Therefore, no additional LFG treatment system costs should be covered in the FA POR Fund.

O & M of Underdrain – The current underdrain discharges approximately 1 million gallons of impacted groundwater per year to the POTW from Landfill 2 at a cost of 3.3 cents per gallon (including hauling), which amounts to approximately $33,000 per year.

The County is the process of constructing a leachate pipeline from the landfill to the POTW. The capital cost of the pipeline is being covered by the site's operating budget. The pipeline will significantly reduce long-term O&M costs for disposal of leachate to 2.1 cents per gallon or $21,000 per year. However, in accordance with CCR Section 21840, the long-term O&M of this system is to be included in the Post Closure Maintenance Cost Estimate and not in the Corrective Action Cost Estimate.

All of the past and current O & M costs have been paid out of the County's operating budget. Based on this payment history and CCR Section 21840, it would not appear to be necessary that any of future O & M costs be placed in a corrective action FA Fund.

However, the County believes that it would be prudent at this time that a three-year O & M contingency be covered in the corrective action FA Fund. For that reason, a sum of $63,000 is proposed to be placed in the FA POR Fund. The County understands that this item is discretionary and not required in the corrective action FA Fund, because they are already covered in the Post Closure Maintenance Fund. As a result, this funding figure amounts to a double allocation of monies beyond that required by regulation.

O & M of the GTE Plant – The destruction of LFG from Landfill 2 requires O & M of the GTE plant. These O & M costs have been recovered from the electrical generation payments. Therefore, no future GTE O & M costs should be covered in the FA POR Fund.

FINANCIAL ASSURANCE MECHANISM

These cost estimates were developed to assist the County in establishing a POR Fund for completing the corrective action for the "known releases" from the SCLF.

A POR has been established in accordance with the requirements of CCR Title 27, Section 22245 (*Pledge of Revenue*). The County has passed a resolution authorizing this financial assurance mechanism with the CIWMB and the Regional Water Quality Control Board.

Amounts Required by Regulation

Based on this revised FA assessment of the "known releases" from Landfill 1 and Landfill 2 the following funds should be placed in a POR fund:

- $350,000 to cover potential future capital cost additions to the leachate extraction well system and expansion of the existing groundwater interceptor trench (LWS-2) below the toe of in Landfill 1

- $40,000 to cover potential future capital cost for additional corrective action monitoring wells

Therefore, Shaw recommends that the POR Fund for Landfill 1 and Landfill 2 be set at $390,000 to cover the future capital corrective action costs for the "known releases."

Discretionary Amounts

However, the County believes that it would be prudent at this time that a three-year O & M contingency be covered in the corrective action FA Fund for Landfill 1 and Landfill 2 at the following amounts:

- $882,000 to cover a three-year leachate extraction O & M contingency period for Landfill 1

- $63,000 to cover a three-year leachate extraction O & M contingency period for Landfill 2

The County understands that these items are discretionary and not required in the corrective action FA Fund because they are already covered in the Post Closure Maintenance Fund. As a result, these funding figures amount to a double allocation of monies beyond that required by regulation.

As a result of the combination of regulatory and discretionary amounts, it is recommended at this time that the POR Fund for Landfill 1 and Landfill 2 be set at $1,335,000 to cover the future capital and O&M corrective action costs for the "known releases."

CONCLUSIONS

The County continues to improve the existing LCRS and GCCS in accordance with CCR Title 27 and the existing Waste Discharge Order (WDR R1-2004-0040) for the site. The existing systems adequately control the "known releases," and the existing groundwater-

monitoring network has fully defined the extent of impact. In addition, the NGFM was used by the County as a predictive tool to evaluate the effectiveness of the existing LCRS, to assess modifications to improve system performance and to identify data gaps.

All past and current corrective action measures have been paid out of the operating funds for the facility. To date no FA funds have been used for any corrective action measures. The County has demonstrated that they have sufficient financial stability to continue forward with any additionally needed corrective action measures. However, the County believes that it would be prudent at this time to place $1,335,000 in a POR FA Fund for the "known releases" to the Waters of the State in accordance with CCR Title 27 Sections 22220 and 22221.

STATEMENT OF CERTIFICATION

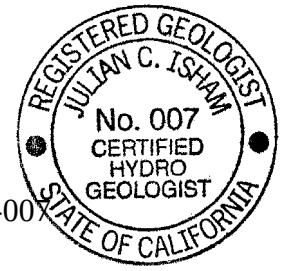
This statement is to certify that this document was prepared under the professional supervision of the undersigned California professional geologist. The findings, recommendations, specifications, or professional opinions presented in this document were prepared in accordance with generally accepted professional geologic practice.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted, is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Please call me (925) 288-2381 if you have any questions.

Sincerely,

SHAW ENVIRONMENTAL INC.,



J. C. Isham, PG-38, CEG-1321, CHG-007
Geology Manager

NON-WATER RELEASES

September 21, 2011
140897

Mr. Glenn Morelli
Sonoma County, Department of Transportation and Public Works
Integrated Waste Division
500 Mecham Road
Petaluma, CA 94952

Subject: Corrective Action Plan Cost Estimate for Non-Water Releases from the Sonoma Central Disposal Site, Sonoma County, California

Dear Mr. Morelli:

The purpose of this letter is to provide a financial assurance cost estimate for Sonoma County (County) for Sonoma Central Disposal Site (CDS) for a non-water release corrective action plan (CAP). The State of California (State) has recently instituted the requirement to prepare a cost estimate for a non-water release from landfills. The State's financial assurance requirement for corrective action is based on the highest cost estimate from either the water release corrective action or the non-water release corrective action.

The landfill property encompasses a 398.5 acre parcel, of which approximately 172 acres are currently permitted for Class III waste disposal as shown on the attached RMC Geoscience figure. Ancillary facilities at the site include a recycling and reuse facility, a wood and yard waste chipping facility, a compost operations area, a landfill gas power plant and flare, scales, gatehouses, maintenance areas, surface impoundments, and an operations and administration building.

Three southerly-trending canyons characterize the property that have been developed or that have been identified for future development and waste placement. These canyon areas are identified as the "East," "West," and "Central" Canyons. Approximately 115 acres of the 130 acre Central Canyon area is covered by Landfill 1 (LF-1). The Rock Extraction Area (REA) abuts LF-1 to the west and occupies the remaining 15 acres of the Central Canyon. Landfill 2 (LF-2) is located in the East Canyon area of the site; a relatively thin strip of undeveloped property in the East Canyon is located between LF-1 and LF-2. The West Canyon has not been developed and is not being contemplated for development as part of the current re-permitting effort. A more detailed description of the CDS is contained in the March 2011 Joint Technical Document (JTD) prepared by SCS Engineers that is currently going through the agency review process.

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916.928.3300 • FAX 916.565.4356 • SHAW ENVIRONMENTAL, INC.

REGULATORY SETTING

The financial assurance regulations for corrective action cost estimates are under Sections 22220 and 22221, Article 4, Subchapter 2, Chapter 6, Title 27 of the California Code of Regulations (CCR Title 27). Section 22220 requires operators of disposal facilities to demonstrate the availability of financial resources to conduct corrective action activities. Section 22221 requires operators to demonstrate financial responsibility to Department of Resources Recycling and Recovery (CalRecycle) for initiating and completing corrective action for all known or reasonably foreseeable releases from the disposal facility.

The requirements for corrective action cost estimates and plans are under Sections 22100 through 22103, Chapter 4, Subchapter 5, CCR Title 27. The water release CAP is under Section 22101(a) and the non-water release CAP is under Section 22101(b).

The corrective action program must have a detailed written estimate, in current dollars, of the cost of hiring a third party to perform the corrective action. The corrective action cost estimate must account for the total costs of corrective action activities as described in the CAP for the entire corrective action period. The operator must annually adjust the estimate for inflation until the corrective action program is completed.

The operator must increase the corrective action cost estimate and the amount of financial assurance provided, if changes in the CAP or disposal facility conditions increase the maximum costs of corrective action. The operator may also reduce the amount of the corrective action cost estimate and the amount of financial assurance provided, if the cost estimate exceeds the maximum remaining costs of corrective action. CalRecycle generally requires the Regional Water Quality Control Board (RWQCB) to also approve any modifications to the corrective action cost estimate.

The CalRecycle is also responsible for approving Postclosure Maintenance cost estimates under Section 21840. The costs that are to be included in the postclosure estimate are as follows:

- Site security
- Maintenance and integrity of the final cover including material acquisition, labor, and placement for repair of the final cover as required due to the effects of settlement, slope failure, or erosion
- Maintenance of vegetation including fertilization, irrigation and irrigation system maintenance
- Monitoring, operation and maintenance (O&M) of the environmental monitoring and control systems, including, but not limited to, the landfill gas (LFG), leachate, and groundwater systems
- Maintenance of the drainage and erosion control systems including clearing materials that block drainage conveyances; and repairing drains, levees, dikes and protective berms

Therefore, these items would not need to be accounted for in the corrective action cost estimate. Notably, among these items is the integrity of the final cover.

NON-WATER RELEASE CAP

The non-water release CAP estimate is a new requirement with the following stipulations:

- Section 22101(b)(1) - The operator shall calculate this cost in one of the following two ways:
  - Section 22101(b)(1)(A) - By providing a new estimate of the cost of complete replacement of the final cover, including, but not limited to, the cost of removing the existing cover and preparing for and installing the new cover, as necessary, depending on the replacement final cover system design; or
  - Section 22101(b)(1)(B) - By providing the greater of either the most recently approved or most recently submitted closure cost estimate, adjusted, as necessary, to reflect closure of the entire solid waste landfill and current unit costs
- Section 22101(b)(2) - The operator, in lieu of providing a separate corrective action cost estimate pursuant to (b)(1)(A) or (B), may provide a site-specific corrective action plan (CAP)

This report complies with Section 22101(b)(2), the site-specific CAP cost estimate and is based on the best management practices (BMPs) prepared by CalRecycle staff to assist in the preparation of the CAP. This site-specific CAP cost estimate provides an assessment of the known or reasonably foreseeable impacts due to the following six causal events:

1. Earthquake
2. Precipitation
3. Flood
4. Tsunami
5. Seiche
6. Fire

In addition to the assessment of the reasonably foreseeable causal events, the CAP also contains the following:

- An evaluation of the long-term performance of the final cover system to ensure that it meets the requirements of Title 27 without the need for corrective action
- Provisions to restore the integrity or establish the adequacy of a damaged or inadequate containment structure or environmental monitoring or control system, to bring a landfill into compliance

CalRecycle has developed guidance criteria for site-specific cost estimates for each causal event. The purpose of the guidance criteria was to develop cost estimates based on sound science, engineering, and professional standards of practice. A summary of the BMP descriptions for the six causal events are presented below.

Earthquake BMP: The earthquake causal event is based on an assessment of damages that could occur based on the following criteria:

- The maximum creditable earthquake (MCE) for the site
- Is the site in a Seismic Hazard Zone?
- Is the site within 200 feet of a Holocene fault?

Precipitation BMP: The precipitation causal event is based on an assessment of damages that could occur during the 1000-year, 24-hour storm event.

Flooding BMP: The flood causal event is based on an assessment of damages if the landfill is within a 500-year flood zone.

Tsunami BMP: The tsunami causal event is based on an assessment of damages if the landfill is located in an area that is designated to be prone to be inundated by a tsunami.

Seiche BMP: The seiche causal event is based on an assessment of damages if the landfill is located within 1/2 mile of a lake or landlocked bay and the height of the wave that could inundate the landfill.

Fire BMP: The fire causal event is based on an assessment of damages from a subsurface or a wildfire.

CORRECTIVE ACTION COST ESTIMATE

Shaw used the above criteria to assess each causal event to develop reasonably foreseeable damage scenarios and evaluate the cost to repair that damage. The types of structures and systems requiring corrective action include:

- Final cover system
- Landfill gas monitoring and collection system
- Slopes, roads, and drainage systems
- Vegetation and irrigation systems
- Environmental monitoring and control systems

The corrective action cost estimates are based on a conservative assumption that a causal event would occur after full build out of the landfill as presented in the March 2011 JTD. This scenario would cause the greatest damage to landfill structures and systems.

The proposed final cover system for LF-2 at the CDS consists of the following from top to bottom:

- 18-inch vegetative layer
- Geocomposite drainage layer
- 60-mil thick high density polyethylene (HDPE) geomembrane (textured both sides)

- Geosynthetic clay liner (GCL)
- 24-inch compacted foundation layer

The LF-1 final cover is the same, except it does not have a GCL layer in its configuration. The corrective action cost estimate for six causal events is described below. The plan view area of the final cover system is 172 acres, however, because of the slope of the landfill the actual area of the final cover is 190 acres.

1 - Earthquake Causal Event

An earthquake is a reasonable foreseeable causal event in California. The Working Group on California Earthquake Probabilities predicts that California has more than a 99% probability of an earthquake with a magnitude of 6.7 or greater in the next 30 years. Earthquakes can cause damage to a landfill and associated structures due to ground motions, liquefaction, or fault rupture. Design standards are used to ensure that structures are designed to withstand the ground movement and shaking resulting from a certain size earthquake taking into consideration the proximity and the geology between the location of the structure and faults.

Pursuant to CCR Title 27 Section 20370, a Class III landfill must be designed to withstand the Maximum Probable Earthquake (MPE) and a Class II landfill must be designed to withstand the Maximum Credible Earthquake (MCE). The MPE is defined as, "The maximum earthquake that is likely to occur during a 100-year interval", and the MCE is defined as, "The maximum earthquake that appears capable of occurring under presently known geologic framework".

As shown in the JTD, the landfill is currently designed to MPE seismic standards, which was calculated by RMC Geosciences to be a magnitude 6.7 event on the Healdsburg-Rodgers Creek fault located 7.3 miles from the site that is capable of generating an estimated peak horizontal ground acceleration (PHGA) of 0.32 g. The slope stability of the final cover system under those seismic conditions was assessed by SCS Engineers to produce a displacement of approximately 6.7 inches. Because this displacement is less than 12 inches, the CDS is in conformance with current state-of-the-practice design standard for landfill cover systems.

To assess the MCE BMP requirement for the CAP, Shaw conducted the following different seismic evaluations:

- Deterministic evaluation using Caltrans ARS procedures that shows that the MCE for the Healdsburg-Rodgers Creek fault 7.3 miles from the site would have a magnitude of 7.1, and the San Andreas fault located 12.5 miles from the site would have a magnitude of 7.0
- Probabilistic MCE evaluations for a return period of 5% in 50 years using a USGS 2002 procedure that gave a PHGA of 0.51 g and a USGS 2008 procedure that gave a PHGA of 0.47 g for the Healdsburg-Rodgers Creek fault
- Deterministic evaluation using FEMA HAZUS-MH software for a moment magnitude 7.0 event on the Healdsburg-Rodgers Creek fault with an epicenter located 7.3 miles from the site that yielded a range of PHGAs of 0.30 to 0.42 g

A deterministic evaluation of a magnitude 6.7 MPE on the Healdsburg-Rodgers Creek fault was also run using the FEMA HAZUS-MH software to compare these seismic evaluations to the previous seismic evaluations contained in the JTD. This evaluation gave a range of PHGAs of 0.28 to 0.41 g, which is consistent with the 0.32 g value in the JTD. The seismic evaluation printouts for these assessments are contained in Attachment 1.

In addition, a joint study was conducted by the USGS, the California Office of Emergency Services, the California Geological Survey, and the Association of Bay Area Governments to assess loss from damaging earthquakes in the Bay Region. Their study ranked a magnitude 7.0 on the Healdsburg-Rodgers Creek fault as the highest with a 15.2% probability of occurring in a 30-year timeframe.

Therefore, the MCE for the CDS is a magnitude 7.0 to 7.1 event on the Healdsburg-Rodgers Creek fault. The PHGA for this event could range from a low of 0.30 g to a high of 0.51 g. The high MCE PHGA of 0.51 g increases the ground shaking at the site by a factor of 1.6 above the MPE design criteria.

The current MPE assessment calculated 6.7 inches of displacement to the final cover. We re-analyzed the seismic displacement using the same simplified approach used by SCS but using the MCE event as input. Note that this analysis is conservative in that the highest PHGA value was used and that SCS reduced the final cover system adhesion by 50% for seismic analysis. The results yield a range of calculated cover displacements from 2 inches for a general, large area slope failure to almost 24 inches for localized failures.

This displacement will likely occur at the top of each bench or the top of slope. This was the location of the damage observed to the liner system at the Chiquita Canyon Landfill after the Northridge Earthquake in 1994. It is believed that the anchor trenches at the landfill benches and top of slope may produce the points of greatest stress for the final cover system.

This displacement will cause damage to the following landfill features from a MCE event:

- Final cover systems
- Landfill gas control system
- Drainage systems
- Other potential damage may include shearing of wells and headers, and failure of roads

The closure cost estimates from the JTD for these features were used to assess the possible cost of repair resulting from the damage caused by the MCE. This conservative procedure of using the closure costs assumes that MCE event occurs after the site is closed and that the entire landfill has received its final cover. An MCE event that occurs before the entire site is closed would produce less damage, as lesser portions of the landfill would have received its final cover. The closure cost estimate is based on the placement of approximately 190 acres (slope area) of final cover at the CDS.

If the MCE event conservatively causes 2,000 linear feet of tearing to the HDPE/GCL cover system, an estimate of the area of cover repair can be calculated. Although the amount of displacement may only be 1 foot along a tear, it assumed that it will require at least 10 feet of additional repair on both sides of the tear in the final cover for a total of 21 feet. Therefore, 2,000 linear feet of torn final cover could require 42,000 square feet (sf) of final cover repair. The repair to the final cover would occur from the lowest damage location to the top of the landfill. The unit installation costs from the JTD for the following components of the final cover are as follows:

- Clearing back the vegetative cover to expose final cover geotextiles: $0.70 per sf, which is 10 times the closure cost estimate for grading for a total of $29,400
- Foundation layer soil, assuming 1 cubic yard (cy) of soil will be required for every 5 sf of repair (8,400 cy): $4.50 per cy for a total of $37,800 for the repair
- HDPE: $0.70 per sf for a total of $29,400 for the repair
- GCL: $0.70 per sf for a total of $29,400 for the repair
- Geocomposite drainage layer: $0.80 per sf for a total of $33,600 for the repair
- Vegetative cover soil, assuming 1 cubic yard of soil will be required for every 5 sf of damage (8,400 cy): $4.00 per cy for a total of $33,600 for the repair
- Hydoseeding: $0.21 per sf, which is 3 times the closure cost estimate, for a total of $8,800 for the repair

The total final cover repair costs are $202,000 ($29,400 + $37,800 + $29,400 + $29,400 + $33,600 + $33,600 + $8,800 = $202,000). Additional costs would also be incurred for

- Construction quality assurance testing and engineering
- Landfill gas well repair
- Landfill gas header system repair
- Road repair
- Leachate extraction well repair
- Drainage system repair

Costs for these repairs were assessed based on a percentage of the closure cost estimate for each item from the JTD. The closure cost estimates do not account for all potentially damaged items, because some of the items have already been constructed prior to closure. However, it does provide a bench mark value to assess a repair for a particular item. In addition, professional judgment was also used to assess the repair costs to the landfill items. The professional judgment was based on previous project work at a number of landfills across the State. The following are estimates of these damages and services:

- Construction quality assurance testing and engineering: $50,000, which is based on professional judgment of the level of effort from previous project work.

- Landfill gas well repair: Assuming 10% of the closure cost estimate $16,500. This is based on the assumption that most of the earthquake damage will be small disturbances with less than 24-inches of localized failures as determined in the seismic displacement analysis. Therefore, it is unlikely that a landfill gas well will need to be installed and only a few of the existing gas wells will require some surface repair. Based on professional judgment an additional $16,500 above and beyond the normal annual gas well maintenance costs should be sufficient to cover earthquake related damages.
- Landfill gas header system repair: Assuming 15% of the closure cost estimate $31,500. This is based on the assumption that most of the earthquake damage to the gas header system will occur at road crossings, similar to the assumed damage points for the cover system. Therefore, it is unlikely that a high percentage of the landfill gas header system will need to be replaced. Based on professional judgment an additional $31,500 above and beyond the normal annual maintenance costs should be sufficient to cover earthquake related damages to the header system.
- Road repair: Assuming 15% of the closure cost estimate $40,500. This is based on the assumption that most of the earthquake damage will be small disturbances with less than 24-inches of localized failures. Therefore, it is unlikely that a high percentage of the landfill roads will need to be repaired. Based on professional judgment an additional $40,500 above and beyond the normal annual road maintenance costs should be sufficient to cover earthquake related damages.
- Leachate extraction well repair: Assuming 10% of the closure cost estimate $16,500. This is based on the assumption that most of the earthquake damage will be small disturbances with less than 24-inches of localized failures. Therefore, it is unlikely that a leachate well will need to be installed and only a few of the existing leachate wells will require some surface repair. Based on professional judgment an additional $16,500 above and beyond the normal annual leachate well maintenance costs should be sufficient to cover earthquake related damages.
- Drainage system repair: Assuming 10% of the closure cost estimate $116,500. This is based on the assumption that most of the earthquake damage will be small disturbances with less than 24-inches of localized failures. Therefore, it is unlikely that a high percentage of the landfill's drainage system will need to be repaired. Based on professional judgment an additional $116,500 above and beyond the normal annual drainage system maintenance costs should be sufficient to cover earthquake related damages.

The total of the additional costs are $271,500 ($50,000 + 16,500 + $31,500 + $40,500 + $16,500 + $116,500 = $271,500). This brings the CAP earthquake damage total to $473,500 ($202,000 + $271,500 = $473,500).

However, a review of the postclosure cost estimate in the JTD indicates that an annual cost of $55,000 has been set aside for unassigned repair projects. The damage to landfill features such as the final cover, landfill gas, leachate, and drainage systems from an earthquake would qualify as a repair project that is already funded under the County's postclosure funding mechanism. Therefore, the CAP estimate for the MCE causal event is reduced by $55,000 to $418,500.

In addition to assessing the costs that would result due to landfill damages from a MCE event, the Non-water release CAP also requires an assessment of the following:

- Evaluate the potential effects of liquefaction if the landfill is located in a Seismic Hazard Zone
- Evaluate for the potential damage from fault ruptures if the landfill is located within 200 feet of Holocene fault zones

The CDS is not in a Seismic Hazard Zone or located within 200 feet of a Holocene fault zone.

2 - Precipitation Causal Event

According to landfill research there are case studies that document damage to landfills caused by storms. Damage to the cover, displacement or exposure of waste, damage and clogging of the drainage system, failure or erosion of slopes, and roads can occur due to erosion of soil and inundation by water. Although every landfill is unique in its design and location, precipitation is a reasonable foreseeable causal event.

Landfills are required to maintain systems to control run-on and run-off due to precipitation during its active life and through the postclosure period. The systems are required to protect against a 100-year, 24-hour storm event for Class III landfills. The theoretical return period is the inverse of the probability that the event will be exceeded in any one year. For example, a 10-year storm has a 1/10 = 0.1 or 10% chance of being exceeded in any one year and a 50-year storm has a 0.02 or 2% chance of being exceeded in any one year. The 24-hour refers to the length of the storm event.

The difference in the amount of rain between a 100-year and 1000-year storm event is not a tenfold increase in the amount of water, but may vary to less than 1 inch to several inches. BMP for precipitation as a causal event is the design standard for a Class II landfill, which is the 1000-year, 24-hour storm event.

The drainage systems at the CDS are designed to safely convey the 100-year, 24-hour storm event, which is 5.77 inches of rainfall. The 1000-year, 24-hour storm event is 11.3 inches of rainfall, which is based on data from the National Oceanic and Atmospheric Administration. The backup data for the 1000-year, 24-hour storm event is contained in Attachment 2. This indicates that an additional 5.61 inches of rain will fall on the site during this causal event. Because the drainage systems at the landfill are designed to the Class III standard of the 100-year storm event, it should be expected that some damage could occur to the following landfill features as a result of the 1000-year, 24-hour storm:

- Final cover
- Displacement of waste
- Damage and clogging of the drainage system
- Erosion of slopes and roads

The 1000-year, 24-hour storm event should not cause as much damage to the final cover as the earthquake causal event. However, based on professional judgment it is possible 70% of the damage caused by the MCE to the final cover could be a reasonable estimate of damage from the 1000-year, 24-hour storm event, which is $141,400.

Based on professional judgment the costs resulting from the displacement of waste and erosion of slopes and roads could be equal to the annual final cover postclosure maintenance cost in the JTD, which is $65,000. This would indicate the occurrence of a 1000-year, 24-hour storm event will double the normal final cover maintenance costs. The damage and clogging to the drainage system could be an additional doubling of the annual drainage postclosure maintenance costs in the JTD, or $37,800.

This brings the CAP cost for the 1000-year, 24-hour storm to $244,200 ($141,400 + $65,000 + $37,800 = $244,200). However, a review of the postclosure cost estimate in the JTD indicates that an annual cost $55,000 has been set aside for unassigned repair projects. The damage to landfill features such as the final cover, roads, and drainage systems from a 1000-year, 24-hour storm would qualify as a repair project that is already funded under the County's postclosure funding mechanism. Therefore, the CAP estimate for the 1000-year, 24-hour event is reduced by $55,000 to $189,200.

3 - Flooding Causal Event

Flooding is a reasonably foreseeable causal event. Flooding can be caused by storms, heavy rains, changes in the landscape due to fires or development, or failure of engineered flood control systems such as levees or dams. Other than failure of a levee or dam, unusually intense rainfall, such as the 1000-year, 24-hour storm, is typically the cause of flooding.

The BMP for the flood as a causal event is:

- Flooding is not considered a reasonable foreseeable causal event if the landfill is not located in the 500-year flood zone
- For the purposes of determining corrective action, any landfill located within the 500-year flood zone needs to assess the potential damage resulting from the 500-year flood

A review of the Federal Emergency Management Agency map for the area indicates the site is outside the 500-year flood zone. The map is contained in Attachment 3.

4 - Tsunamis Causal Event

A tsunami is a sea wave that may be generated by an earthquake, landslide, volcanic eruption, or a large meteor hitting the ocean. The California coast has experienced several tsunamis, some causing significant damage. It is anticipated that the types of damage caused by a tsunami would be similar to those resulting from a flood.

The BMP for the tsunami as a causal event is:

- Tsunamis are not considered a reasonable foreseeable causal event if the landfill is located in an area that is not designated to be prone to be inundated by a tsunami by the Department of Conservation or local emergency response agency.
- For landfills located in an area that is prone to be inundated by a tsunami, the CAP needs to address the potential impacts and damage that may result.

A review of California Geological Survey (CGS) tsunami inundation zone maps for Sonoma County indicates the site is not located in an area susceptible to inundation by a tsunami. The CGS tsunami inundation zone maps are contained in Attachment 4.

5 - Seiche Causal Event

A seiche is a wave on the surface of a lake or landlocked bay caused by atmospheric or seismic disturbances and may be defined as an occasional rhythmic oscillation of water above and below the mean level of lakes or seas, lasting from a few minutes to an hour or more. Seiches are uncommon, but have been known to have occurred on Lake Tahoe. Damages anticipated to result from a seiche would be similar to those from a flood or tsunami.

The BMP for the seiche as a causal event is:

- Seiche is not a reasonable foreseeable causal event, if the landfill is located greater than ½ mile away from a lake or a landlocked bay.
- Landfill that located within ½ mile of a lake or landlocked bay needs to identify the height of the wave and evaluate if the wave will inundate the landfill and cause any damage.

This does not appear to be a consideration for the CDS as there are no large land-locked bodies of water in the vicinity of the site.

6 - Fire Causal Event

Fires at landfills are either surface or subsurface fires. The potential for these fires to occur is dependent on the location of the landfill relative to wild fires, management of wastes that are still smoldering, accidents or arson, availability of vegetation or fuel for a fire.

Subsurface Fire: The most common cause of subsurface landfill fires is an increase in the oxygen content of the waste, which increases bacterial activity (aerobic decomposition) and raises temperatures creating “hot spots” that come into contact with pockets of methane gas resulting in a fire. Subsurface fires can cause damage to the landfill gas collection systems and potentially the final cover system.

The greatest cause for an increase in the oxygen content in the waste is the intrusion through the final cover. Since the final cover at CDS will contain a HDPE layer, which is air-tight, the probability for significant amounts of oxygen entering the waste will be mitigated. Therefore, the CDS final cover design will mitigate against significant fire damage from a subsurface fire.

Wild Fire: Wild fires have been documented to destroy or damage all or portions of a landfill gas collection and monitoring system, vegetation and irrigation systems designed to protect the cover system, drainage systems, and utility conveyance systems. The potential damage is dependent on mitigating circumstances such as whether the structures are buried to be protected from fires and if there are engineered mitigation measures such as fire breaks to protect against surface fires.

The use of fire breaks will be employed to lessen the chance of an off-site fire from spreading onto the CDS property and from on-site fires spreading throughout the property. The CDS design calls for a perimeter road that will act as a fire break to mitigate against off-site wild fires from entering the property.

An important aspect in the use of a road as a fire break is the type of fuel source (vegetation) for the fire that the road/fire break must provide protect from. At the CDS the off-site fuel source is grass, for which an adequate fire break needs to be at least 4 feet wide (Bolton, 2011 Western Regional SWANA Symposium). The perimeter and interior roads will all be at least 15 feet wide, which will provide a more that adequate fire break to mitigate the spread of wild fires at the CDS.

In addition, the final cover design in the JTD shows that the landfill surface will be divided into discrete parcels by benches along the side slopes. These benches are gravel topped roads, which will act as interior fire breaks to mitigate the spread of fires within the site property. Therefore, the CDS design will mitigate against significant fire damage from a wildfire.

The BMP for a fire as a causal event is that the landfill is located within or adjacent to fire hazard zones determined by California Department of Forestry and Fire Protection (Cal Fire) as moderate/medium, high, or very high. Based on the review Cal Fire Sonoma County Fire Hazard Map, which is contained in Attachment 5, the site appears to be within a zone designated as “medium” fire danger.

Because of the landfill design described above, the potential for either a subsurface or a wild fire to cause significant damage at the CDS has been mitigated. In addition, an inspection of the landfill and surrounding properties did not disclose a significant amount of unattended vegetative matter that would provide a ready fuel source for a significant wild fire. The landfill staff also has a written firefighting plan that describes the use of on-site equipment and water trucks to supplement local firefighting resources. The landfill staff has strategically placed firefighting water in the form of water tanks and ponds across the site. Landfill staff is also familiar with firefighting as they have used their prepared procedures to successfully distinguish a surface fire with minimal damage to the landfill cover and no damage to landfill structures. This indicates that CDS is well prepared and has contingencies for wild fires.

However, it is reasonable to expect that some damage will occur to landfill structures from the fire causal event. Based on professional judgment the costs to replace the fire damaged landfill structures could be equal to the repair costs from the earthquake causal event, which is $473,500.

However, a review of the postclosure cost estimate in the JTD indicates that an annual cost of $55,000 has been set aside for unassigned repair projects. The damage to landfill features such

as the final cover, landfill gas, leachate, and drainage systems from a fire would qualify as a repair project that is already funded under the County's postclosure funding mechanism. Therefore, the CAP estimate for the fire event is reduced by $55,000 to $418,500.

Evaluation of Final Cover System

The regulations require the non-water release CAP contain an evaluation of the long-term performance of the final cover system to ensure that the final cover system meets the requirements of CCR Title 27 Section 21140 without corrective action. Shaw's review of the final cover design indicates that it meets CCR Title 27 standards and that no addition costs need to be added to the CAP.

Degraded/Inadequate Containment or Environmental Monitoring and Control Systems

The regulations also require the non-water release CAP to provide an analysis of the adequacy of the design, capacity, or component useful life of the containment or environmental monitoring and control systems as a causal event. Shaw's review of the environmental monitoring and control systems indicates that they meet CCR Title 27 standards, that they have not exceeded their useful life, and that no additional costs need to be added to the CAP.

SUMMARY OF CAP COST ESTIMATES

These CAP estimates are based in part on using closure and postclosure cost estimates from the JTD as benchmark values to assess repair costs. In addition, professional judgment was also used to assess repair costs. The professional judgment was based on previous project work at a number of landfills across the State. The Non-water Release CAP cost estimates for each causal event are as follows:

- Earthquake causal event: $418,500
- Flood causal event: Zero
- Precipitation casual event: $189,200
- Tsunami causal event: Zero
- Seiche causal event: Zero
- Fire causal event: $418,500

The highest of these Non-water Release CAP causal events are the earthquake and the fire cost estimates, which are both $418,500. It is unreasonable to assume that these causal events will occur at the same time.

The Water Release CAP costs as determined in 2009 were $1,335,000. Using CalRecycle inflation factors of 1.012% for 2010 and 1.01% for 2011, the 2009 dollar Water Release CAP cost estimate is $1,362,130 in 2011 dollars. Because the requirement is to only fund the higher of the Non-water or the Water Release CAP estimates, the existing funding mechanism for the Water Release CAP is sufficient.

THIRD PARTY ASSESSMENT

According to the regulations, the CAP must be prepared by a third party because there is an enhanced risk of a conflict of interest, as a non-third party preparer could be less inclined to include potential corrective actions that could be the result of deficiencies in the original design.

Shaw would be considered an independent third party, as we are not the "Engineer-of-Record" for the landfill.

Please feel free to call either of the undersigned if you have any questions or comments.

Sincerely,

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Attachments: RMC Geoscience, Inc. - Existing Site Conditions Map
Attachment 1 - Seismic Evaluation Data
Attachment 2 - Flood Zone Information
Attachment 3 - Precipitation Information
Attachment 4 - Tsunami Information
Attachment 5 - Fire Hazard Information

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Rock Extraction Area and Landfill 2
Geologic and Seismic Siting Assessment
Central Landfill, Sonoma County, California

EXISTING SITE CONDITIONS

January 2011			FIGURE 1

Attachment 1
Seismic Evaluation Data

Procedures

Caltrans ARS Online

An initial deterministic and probabilistic evaluation was conducted by entering the site location coordinates into the Caltrans ARS Online tool Version 1.0.4. Caltrans ARS Online is a web-based tool that calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria (Caltrans, 2006)*. This tool also provides the distance to the nearest faults considered to be active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater. The probabilistic spectrum is obtained from the USGS (2008) *National Hazard Map for 5% probability of exceedance in 50 years.*

USGS 2002 and 2008 Probabilistic Seismic Hazard Analyses

The USGS 2002 and 2008 Interactive Deaggregations web based tools were used to run probabilistic seismic hazard analyses (PSHA) to determine Peak Horizontal Ground Acceleration with a 5% exceedence in 50 years (about 975 years). The USGS 2002 tool uses the current National Seismic Hazards Mapping Project (NSHMP) models (2002 edition). Site conditions are assumed to be rock, with average shear wave velocity of 760 meter/second in the uppermost 30 meters. The preliminary version of the 2008 NSHMP PSHA Interactive Deaggregation web site uses the 2008–update source and attenuation models of the NSHMP (Petersen and others, 2008) are used.

FEMA HAZUS-MH MR5

FEMA (2010) HAZUS-MH MR5 Release 10.0.0 software (HAZUS) was used to run a deterministic seismic hazard analysis. HAZUS was run as an extension in ArcGIS V.9.3.1. The deterministic analysis scenario selected was as an arbitrary event of moment magnitude 7.0 with an epicenter located on the Rodgers Creek fault zone, 7.3 miles from the site.

References

Caltrans, 2006, *Appendix B of Caltrans Seismic Design Criteria.*

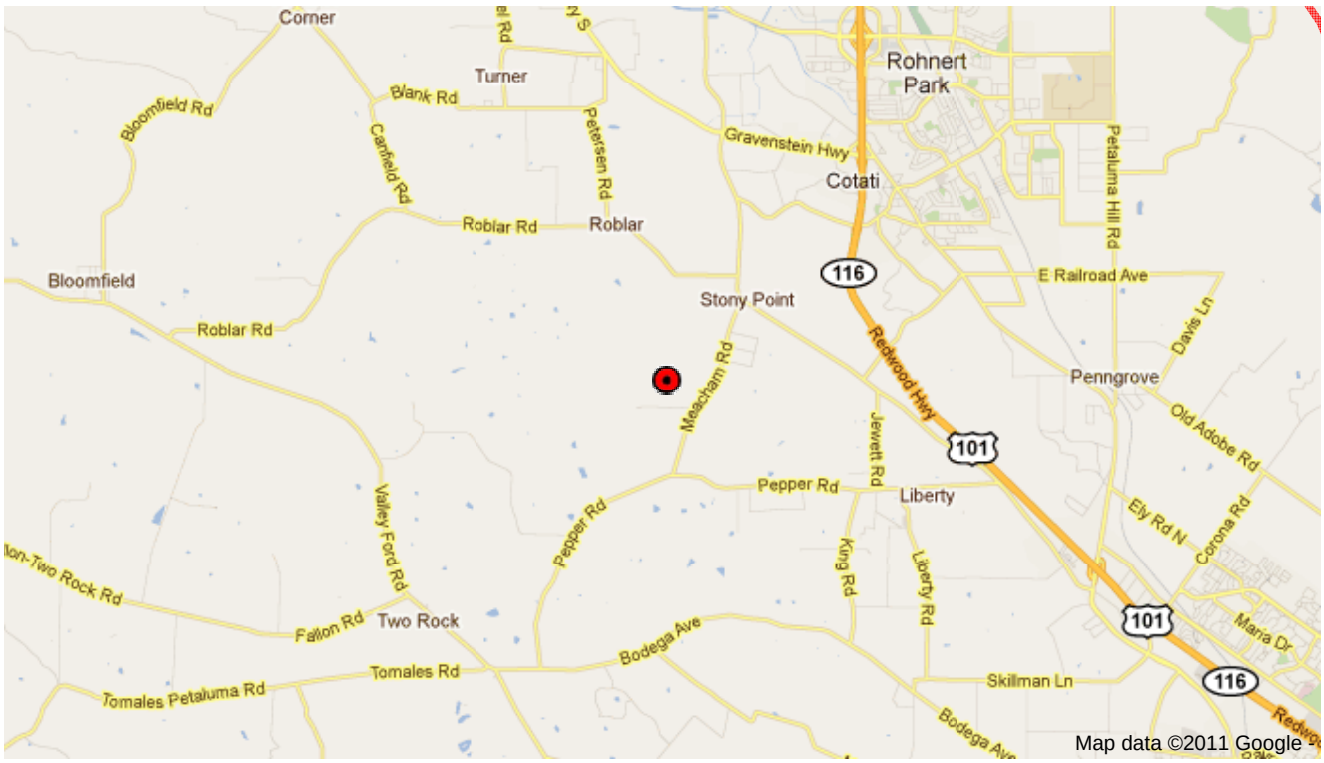
FEMA, 2010, HAZUS-MH MR5 Release 10.0.0

Petersen, M. and others, 2008, *Documentation for the 2008 update of the national seismic hazard maps,* USGS OFR 08–1128.

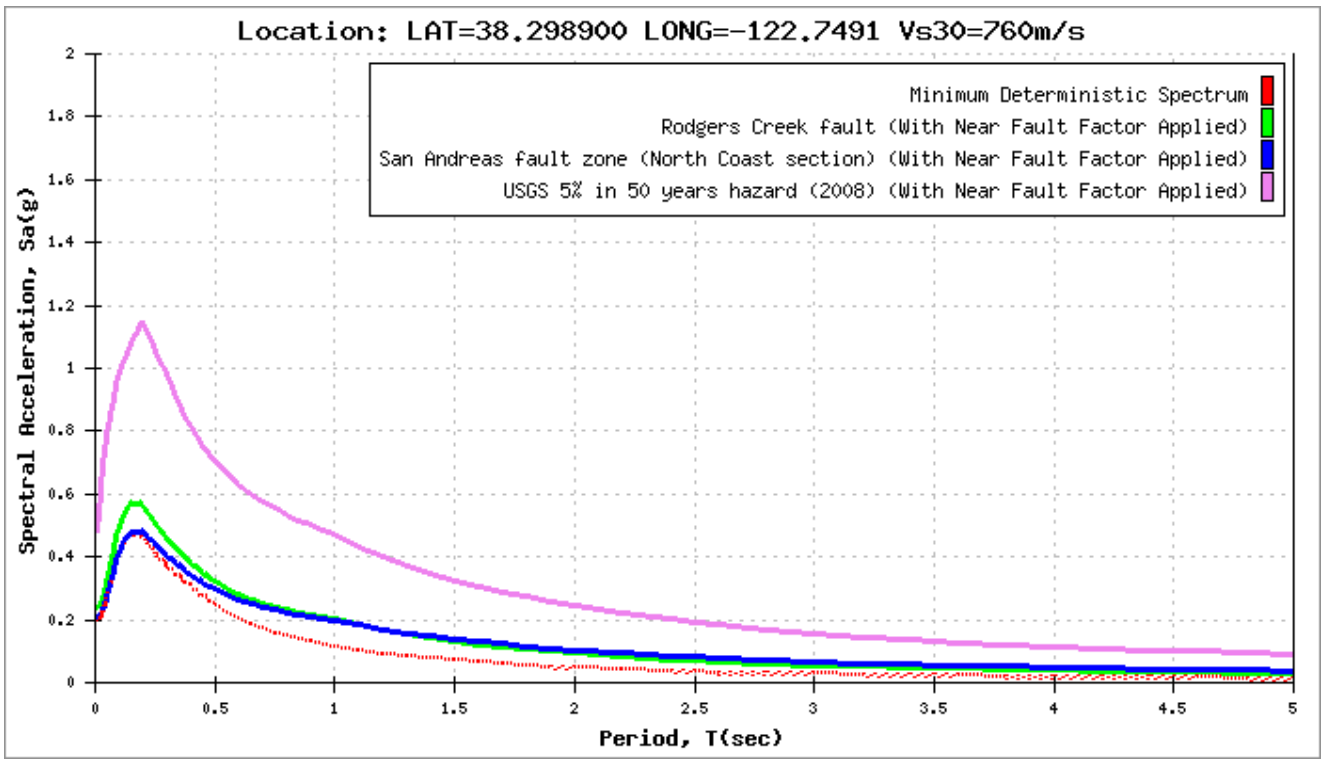
USGS, 2008, *National Hazard Map for 5% probability of exceedance in 50 years*

Caltrans Data

SELECT SITE LOCATION



CALCULATED SPECTRA



SITE DATA

Shear Wave Velocity, Vs_{30}:	760 m/s
Latitude:	38.298900
Longitude:	-122.749100
Depth to Vs = 1.0 km/s:	24 m
Depth to Vs = 2.5 km/s:	2.00 km

DETERMINISTIC

Rodgers Creek fault

Fault ID:	157
Maximum Magnitude (MMax):	7.1
Fault Type:	RLSS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	12.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	11.75 km
Rjb:	11.74 km
Rx:	11.74 km
Fnorm:	0
Frev:	0

Period	SA (Base Spectrum)	Basin Factor	Near Fault Factor (Applied)	SA (Final Spectrum)
0.01	0.240	1.000	1.000	0.240
0.02	0.244	1.000	1.000	0.244
0.022	0.248	1.000	1.000	0.248
0.025	0.253	1.000	1.000	0.253
0.029	0.261	1.000	1.000	0.261
0.03	0.263	1.000	1.000	0.263
0.032	0.269	1.000	1.000	0.269
0.035	0.277	1.000	1.000	0.277
0.036	0.281	1.000	1.000	0.281
0.04	0.293	1.000	1.000	0.293
0.042	0.299	1.000	1.000	0.299
0.044	0.305	1.000	1.000	0.305
0.045	0.308	1.000	1.000	0.308
0.046	0.312	1.000	1.000	0.312
0.048	0.318	1.000	1.000	0.318
0.05	0.324	1.000	1.000	0.324
0.055	0.344	1.000	1.000	0.344
0.06	0.363	1.000	1.000	0.363
0.065	0.382	1.000	1.000	0.382
0.067	0.390	1.000	1.000	0.390
0.07	0.401	1.000	1.000	0.401
0.075	0.419	1.000	1.000	0.419

0.08	0.435	1.000	1.000	0.435
0.085	0.451	1.000	1.000	0.451
0.09	0.466	1.000	1.000	0.466
0.095	0.481	1.000	1.000	0.481
0.1	0.495	1.000	1.000	0.495
0.11	0.516	1.000	1.000	0.516
0.12	0.534	1.000	1.000	0.534
0.13	0.548	1.000	1.000	0.548
0.133	0.552	1.000	1.000	0.552
0.14	0.560	1.000	1.000	0.560
0.15	0.569	1.000	1.000	0.569
0.16	0.571	1.000	1.000	0.571
0.17	0.570	1.000	1.000	0.570
0.18	0.569	1.000	1.000	0.569
0.19	0.566	1.000	1.000	0.566
0.2	0.563	1.000	1.000	0.563
0.22	0.539	1.000	1.000	0.539
0.24	0.516	1.000	1.000	0.516
0.25	0.506	1.000	1.000	0.506
0.26	0.495	1.000	1.000	0.495
0.28	0.475	1.000	1.000	0.475
0.29	0.465	1.000	1.000	0.465
0.3	0.455	1.000	1.000	0.455
0.32	0.438	1.000	1.000	0.438
0.34	0.422	1.000	1.000	0.422
0.35	0.415	1.000	1.000	0.415
0.36	0.407	1.000	1.000	0.407
0.38	0.393	1.000	1.000	0.393
0.4	0.380	1.000	1.000	0.380
0.42	0.366	1.000	1.000	0.366
0.44	0.354	1.000	1.000	0.354
0.45	0.348	1.000	1.000	0.348
0.46	0.342	1.000	1.000	0.342
0.48	0.331	1.000	1.000	0.331
0.5	0.321	1.000	1.000	0.321
0.55	0.293	1.000	1.020	0.299
0.6	0.271	1.000	1.040	0.281
0.65	0.251	1.000	1.060	0.266
0.667	0.245	1.000	1.067	0.262
0.7	0.234	1.000	1.080	0.253
0.75	0.220	1.000	1.100	0.242
0.8	0.207	1.000	1.120	0.232
0.85	0.196	1.000	1.140	0.224
0.9	0.186	1.000	1.160	0.216
0.95	0.177	1.000	1.180	0.209
1	0.169	1.000	1.200	0.202
1.1	0.153	1.000	1.200	0.184
1.2	0.140	1.000	1.200	0.168
1.3	0.128	1.000	1.200	0.154

1.4	0.118	1.000	1.200	0.142
1.5	0.109	1.000	1.200	0.131
1.6	0.101	1.000	1.200	0.122
1.7	0.094	1.000	1.200	0.113
1.8	0.088	1.000	1.200	0.106
1.9	0.082	1.000	1.200	0.099
2	0.077	1.000	1.200	0.093
2.2	0.069	1.000	1.200	0.083
2.4	0.062	1.000	1.200	0.074
2.5	0.059	1.000	1.200	0.070
2.6	0.056	1.000	1.200	0.067
2.8	0.051	1.000	1.200	0.061
3	0.047	1.000	1.200	0.056
3.2	0.043	1.000	1.200	0.052
3.4	0.040	1.000	1.200	0.048
3.5	0.039	1.000	1.200	0.047
3.6	0.038	1.000	1.200	0.045
3.8	0.035	1.000	1.200	0.042
4	0.033	1.000	1.200	0.040
4.2	0.031	1.000	1.200	0.037
4.4	0.029	1.000	1.200	0.035
4.6	0.028	1.000	1.200	0.034
4.8	0.027	1.000	1.200	0.032
5	0.025	1.000	1.200	0.030

San Andreas fault zone (North Coast section)

Fault ID:	308
Maximum Magnitude (MMax):	7.9
Fault Type:	RLSS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	11.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	20.10 km
Rjb:	20.10 km
Rx:	20.07 km
Fnorm:	0
Frev:	0

Period	**SA (Base Spectrum)**	**Basin Factor**	**Near Fault Factor (Applied)**	**SA (Final Spectrum)**
0.01	0.208	1.000	1.000	0.208
0.02	0.212	1.000	1.000	0.212
0.022	0.214	1.000	1.000	0.214
0.025	0.219	1.000	1.000	0.219
0.029	0.225	1.000	1.000	0.225
0.03	0.226	1.000	1.000	0.226
0.032	0.231	1.000	1.000	0.231
0.035	0.238	1.000	1.000	0.238

0.036	0.240	1.000	1.000	0.240
0.04	0.250	1.000	1.000	0.250
0.042	0.255	1.000	1.000	0.255
0.044	0.260	1.000	1.000	0.260
0.045	0.263	1.000	1.000	0.263
0.046	0.266	1.000	1.000	0.266
0.048	0.271	1.000	1.000	0.271
0.05	0.276	1.000	1.000	0.276
0.055	0.292	1.000	1.000	0.292
0.06	0.307	1.000	1.000	0.307
0.065	0.322	1.000	1.000	0.322
0.067	0.328	1.000	1.000	0.328
0.07	0.337	1.000	1.000	0.337
0.075	0.351	1.000	1.000	0.351
0.08	0.364	1.000	1.000	0.364
0.085	0.377	1.000	1.000	0.377
0.09	0.390	1.000	1.000	0.390
0.095	0.402	1.000	1.000	0.402
0.1	0.413	1.000	1.000	0.413
0.11	0.431	1.000	1.000	0.431
0.12	0.447	1.000	1.000	0.447
0.13	0.460	1.000	1.000	0.460
0.133	0.463	1.000	1.000	0.463
0.14	0.470	1.000	1.000	0.470
0.15	0.478	1.000	1.000	0.478
0.16	0.481	1.000	1.000	0.481
0.17	0.481	1.000	1.000	0.481
0.18	0.481	1.000	1.000	0.481
0.19	0.480	1.000	1.000	0.480
0.2	0.478	1.000	1.000	0.478
0.22	0.462	1.000	1.000	0.462
0.24	0.446	1.000	1.000	0.446
0.25	0.438	1.000	1.000	0.438
0.26	0.430	1.000	1.000	0.430
0.28	0.416	1.000	1.000	0.416
0.29	0.408	1.000	1.000	0.408
0.3	0.401	1.000	1.000	0.401
0.32	0.388	1.000	1.000	0.388
0.34	0.375	1.000	1.000	0.375
0.35	0.369	1.000	1.000	0.369
0.36	0.363	1.000	1.000	0.363
0.38	0.351	1.000	1.000	0.351
0.4	0.340	1.000	1.000	0.340
0.42	0.330	1.000	1.000	0.330
0.44	0.322	1.000	1.000	0.322
0.45	0.317	1.000	1.000	0.317
0.46	0.313	1.000	1.000	0.313
0.48	0.305	1.000	1.000	0.305
0.5	0.298	1.000	1.000	0.298

0.55	0.278	1.000	1.010	0.281
0.6	0.261	1.000	1.020	0.266
0.65	0.246	1.000	1.029	0.253
0.667	0.241	1.000	1.033	0.249
0.7	0.233	1.000	1.039	0.242
0.75	0.221	1.000	1.049	0.232
0.8	0.211	1.000	1.059	0.224
0.85	0.202	1.000	1.069	0.216
0.9	0.194	1.000	1.078	0.209
0.95	0.187	1.000	1.088	0.203
1	0.180	1.000	1.098	0.198
1.1	0.166	1.000	1.098	0.183
1.2	0.155	1.000	1.098	0.170
1.3	0.144	1.000	1.098	0.159
1.4	0.135	1.000	1.098	0.149
1.5	0.127	1.000	1.098	0.139
1.6	0.119	1.000	1.098	0.131
1.7	0.112	1.000	1.098	0.123
1.8	0.106	1.000	1.098	0.116
1.9	0.100	1.000	1.098	0.110
2	0.095	1.000	1.098	0.105
2.2	0.086	1.000	1.098	0.094
2.4	0.078	1.000	1.098	0.085
2.5	0.074	1.000	1.098	0.082
2.6	0.071	1.000	1.098	0.078
2.8	0.066	1.000	1.098	0.072
3	0.061	1.000	1.098	0.067
3.2	0.057	1.000	1.098	0.062
3.4	0.053	1.000	1.098	0.058
3.5	0.051	1.000	1.098	0.057
3.6	0.050	1.000	1.098	0.055
3.8	0.047	1.000	1.098	0.052
4	0.044	1.000	1.098	0.049
4.2	0.042	1.000	1.098	0.046
4.4	0.040	1.000	1.098	0.044
4.6	0.038	1.000	1.098	0.042
4.8	0.037	1.000	1.098	0.040
5	0.035	1.000	1.098	0.039

PROBABILISTIC

Probabilistic Model
USGS Seismic Hazard Map(2008) 975 Year Return Period

Period	SA (Base Spectrum)	Basin Factor	Near Fault Factor (Applied)	SA (Final Spectrum)
0.01	0.481	1.000	1.000	0.481
0.02	0.596	1.000	1.000	0.596

0.022	0.614	1.000	1.000	0.614
0.025	0.639	1.000	1.000	0.639
0.029	0.669	1.000	1.000	0.669
0.03	0.676	1.000	1.000	0.676
0.032	0.690	1.000	1.000	0.690
0.035	0.710	1.000	1.000	0.710
0.036	0.716	1.000	1.000	0.716
0.04	0.740	1.000	1.000	0.740
0.042	0.751	1.000	1.000	0.751
0.044	0.762	1.000	1.000	0.762
0.045	0.767	1.000	1.000	0.767
0.046	0.772	1.000	1.000	0.772
0.048	0.783	1.000	1.000	0.783
0.05	0.793	1.000	1.000	0.793
0.055	0.817	1.000	1.000	0.817
0.06	0.839	1.000	1.000	0.839
0.065	0.860	1.000	1.000	0.860
0.067	0.868	1.000	1.000	0.868
0.07	0.880	1.000	1.000	0.880
0.075	0.899	1.000	1.000	0.899
0.08	0.917	1.000	1.000	0.917
0.085	0.935	1.000	1.000	0.935
0.09	0.952	1.000	1.000	0.952
0.095	0.968	1.000	1.000	0.968
0.1	0.983	1.000	1.000	0.983
0.11	1.005	1.000	1.000	1.005
0.12	1.025	1.000	1.000	1.025
0.13	1.044	1.000	1.000	1.044
0.133	1.049	1.000	1.000	1.049
0.14	1.062	1.000	1.000	1.062
0.15	1.078	1.000	1.000	1.078
0.16	1.094	1.000	1.000	1.094
0.17	1.110	1.000	1.000	1.110
0.18	1.124	1.000	1.000	1.124
0.19	1.138	1.000	1.000	1.138
0.2	1.152	1.000	1.000	1.152
0.22	1.109	1.000	1.000	1.109
0.24	1.071	1.000	1.000	1.071
0.25	1.054	1.000	1.000	1.054
0.26	1.038	1.000	1.000	1.038
0.28	1.008	1.000	1.000	1.008
0.29	0.994	1.000	1.000	0.994
0.3	0.981	1.000	1.000	0.981
0.32	0.940	1.000	1.000	0.940
0.34	0.903	1.000	1.000	0.903
0.35	0.886	1.000	1.000	0.886
0.36	0.870	1.000	1.000	0.870
0.38	0.840	1.000	1.000	0.840
0.4	0.812	1.000	1.000	0.812

0.42	0.786	1.000	1.000	0.786
0.44	0.763	1.000	1.000	0.763
0.45	0.751	1.000	1.000	0.751
0.46	0.741	1.000	1.000	0.741
0.48	0.720	1.000	1.000	0.720
0.5	0.701	1.000	1.000	0.701
0.55	0.649	1.000	1.020	0.662
0.6	0.605	1.000	1.040	0.629
0.65	0.567	1.000	1.060	0.601
0.667	0.556	1.000	1.067	0.593
0.7	0.534	1.000	1.080	0.577
0.75	0.505	1.000	1.100	0.556
0.8	0.478	1.000	1.120	0.535
0.85	0.453	1.000	1.140	0.517
0.9	0.431	1.000	1.160	0.500
0.95	0.412	1.000	1.180	0.486
1	0.394	1.000	1.200	0.472
1.1	0.360	1.000	1.200	0.432
1.2	0.332	1.000	1.200	0.398
1.3	0.308	1.000	1.200	0.370
1.4	0.287	1.000	1.200	0.345
1.5	0.269	1.000	1.200	0.323
1.6	0.254	1.000	1.200	0.304
1.7	0.240	1.000	1.200	0.288
1.8	0.227	1.000	1.200	0.273
1.9	0.216	1.000	1.200	0.259
2	0.206	1.000	1.200	0.247
2.2	0.185	1.000	1.200	0.222
2.4	0.168	1.000	1.200	0.202
2.5	0.161	1.000	1.200	0.193
2.6	0.154	1.000	1.200	0.185
2.8	0.142	1.000	1.200	0.170
3	0.131	1.000	1.200	0.158
3.2	0.122	1.000	1.200	0.146
3.4	0.114	1.000	1.200	0.136
3.5	0.110	1.000	1.200	0.132
3.6	0.106	1.000	1.200	0.127
3.8	0.100	1.000	1.200	0.120
4	0.094	1.000	1.200	0.113
4.2	0.090	1.000	1.200	0.108
4.4	0.086	1.000	1.200	0.103
4.6	0.083	1.000	1.200	0.099
4.8	0.079	1.000	1.200	0.095
5	0.077	1.000	1.200	0.092

MINIMUM DETERMINISTIC SPECTRUM

Period	**SA**

0.01	0.197
0.02	0.201
0.022	0.204
0.025	0.208
0.029	0.214
0.03	0.216
0.032	0.221
0.035	0.228
0.036	0.231
0.04	0.241
0.042	0.246
0.044	0.251
0.045	0.254
0.046	0.256
0.048	0.262
0.05	0.267
0.055	0.284
0.06	0.300
0.065	0.317
0.067	0.323
0.07	0.333
0.075	0.348
0.08	0.362
0.085	0.376
0.09	0.389
0.095	0.401
0.1	0.414
0.11	0.430
0.12	0.445
0.13	0.458
0.133	0.461
0.14	0.468
0.15	0.476
0.16	0.476
0.17	0.474
0.18	0.472
0.19	0.469
0.2	0.466
0.22	0.444
0.24	0.423
0.25	0.413
0.26	0.403
0.28	0.386
0.29	0.377
0.3	0.369
0.32	0.354
0.34	0.340
0.35	0.333
0.36	0.327

0.38	0.315
0.4	0.303
0.42	0.291
0.44	0.279
0.45	0.273
0.46	0.267
0.48	0.257
0.5	0.248
0.55	0.223
0.6	0.203
0.65	0.185
0.667	0.180
0.7	0.171
0.75	0.158
0.8	0.148
0.85	0.138
0.9	0.130
0.95	0.122
1	0.115
1.1	0.103
1.2	0.093
1.3	0.084
1.4	0.076
1.5	0.070
1.6	0.064
1.7	0.059
1.8	0.054
1.9	0.051
2	0.047
2.2	0.041
2.4	0.037
2.5	0.035
2.6	0.033
2.8	0.030
3	0.027
3.2	0.025
3.4	0.023
3.5	0.022
3.6	0.021
3.8	0.020
4	0.018
4.2	0.017
4.4	0.016
4.6	0.015
4.8	0.015
5	0.014

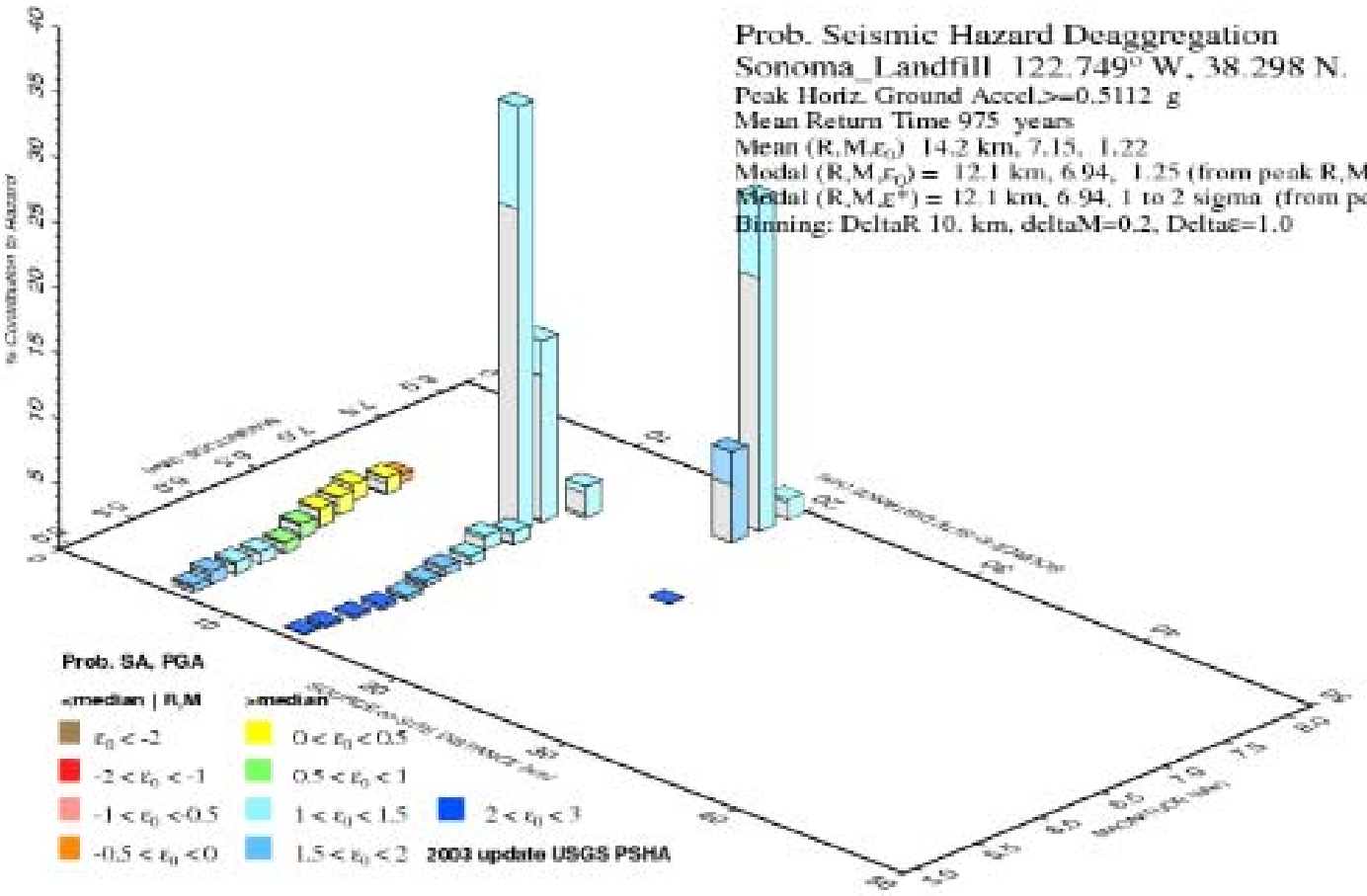
Envelope Data

Period	**SA**

0.01	0.481
0.02	0.596
0.022	0.614
0.025	0.639
0.029	0.669
0.03	0.676
0.032	0.690
0.035	0.710
0.036	0.716
0.04	0.740
0.042	0.751
0.044	0.762
0.045	0.767
0.046	0.772
0.048	0.783
0.05	0.793
0.055	0.817
0.06	0.839
0.065	0.860
0.067	0.868
0.07	0.880
0.075	0.899
0.08	0.917
0.085	0.935
0.09	0.952
0.095	0.968
0.1	0.983
0.11	1.005
0.12	1.025
0.13	1.044
0.133	1.049
0.14	1.062
0.15	1.078
0.16	1.094
0.17	1.110
0.18	1.124
0.19	1.138
0.2	1.152
0.22	1.109
0.24	1.071
0.25	1.054
0.26	1.038
0.28	1.008
0.29	0.994
0.3	0.981
0.32	0.940
0.34	0.903
0.35	0.886
0.36	0.870

0.38	0.840
0.4	0.812
0.42	0.786
0.44	0.763
0.45	0.751
0.46	0.741
0.48	0.720
0.5	0.701
0.55	0.662
0.6	0.629
0.65	0.601
0.667	0.593
0.7	0.577
0.75	0.556
0.8	0.535
0.85	0.517
0.9	0.500
0.95	0.486
1	0.472
1.1	0.432
1.2	0.398
1.3	0.370
1.4	0.345
1.5	0.323
1.6	0.304
1.7	0.288
1.8	0.273
1.9	0.259
2	0.247
2.2	0.222
2.4	0.202
2.5	0.193
2.6	0.185
2.8	0.170
3	0.158
3.2	0.146
3.4	0.136
3.5	0.132
3.6	0.127
3.8	0.120
4	0.113
4.2	0.108
4.4	0.103
4.6	0.099
4.8	0.095
5	0.092

USGS Data


Prob. Seismic Hazard Deaggregation
Sonoma_Landfill 122.749° W, 38.298 N.
Peak Horiz. Ground Accel.>=0.5112 g
Mean Return Time 975 years
Mean (R,M,ε0) 14.2 km, 7.15, 1.22
Modal (R,M,ε0) = 12.1 km, 6.94, 1.25 (from peak R,M bin)
Modal (R,M,ε*) = 12.1 km, 6.94, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0
% Contribution to Hazard
Prob. SA, PGA
<median | R,M
ε0 < -2
-2 < ε0 < -1
-1 < ε0 < -0.5
-0.5 < ε0 < 0
>median
0 < ε0 < 0.5
0.5 < ε0 < 1
1 < ε0 < 1.5
1.5 < ε0 < 2
2 < ε0 < 3
2003 update USGS PSHA

*** Deaggregation of Seismic Hazard for PGA & 2 Periods of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 2002 version ***
PSHA Deaggregation. %contributions. site: Sonoma_Landfill long: 122.749 W., lat: 38.298 N.
USGS 2002-03 update files and programs. dM=0.2. Site descr:ROCK
Return period: 975 yrs. Exceedance PGA =0.5112   g.
#Pr[at least one eq with median motion>=PGA in 50 yrs]=0.00113

DIST(KM)	MAG(MW)	ALL_EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
6.7	5.05	0.502	0.215	0.288	0.000	0.000	0.000	0.000
13.3	5.05	0.099	0.099	0.000	0.000	0.000	0.000	0.000
6.7	5.20	0.980	0.339	0.641	0.000	0.000	0.000	0.000
13.4	5.20	0.230	0.230	0.000	0.000	0.000	0.000	0.000
6.6	5.40	0.947	0.252	0.694	0.000	0.000	0.000	0.000
13.6	5.40	0.277	0.277	0.000	0.000	0.000	0.000	0.000
6.6	5.60	0.910	0.193	0.676	0.042	0.000	0.000	0.000
13.8	5.60	0.326	0.300	0.026	0.000	0.000	0.000	0.000
6.6	5.80	0.862	0.137	0.577	0.147	0.000	0.000	0.000
13.9	5.80	0.375	0.274	0.101	0.000	0.000	0.000	0.000
6.0	6.01	1.134	0.135	0.613	0.387	0.000	0.000	0.000
13.4	6.01	0.452	0.252	0.200	0.000	0.000	0.000	0.000
5.7	6.20	1.424	0.131	0.666	0.616	0.012	0.000	0.000
13.1	6.20	0.576	0.250	0.326	0.000	0.000	0.000	0.000
5.4	6.40	1.395	0.090	0.542	0.714	0.049	0.000	0.000
13.2	6.40	0.710	0.251	0.455	0.004	0.000	0.000	0.000
4.8	6.60	1.259	0.063	0.397	0.710	0.090	0.000	0.000
12.5	6.62	1.042	0.284	0.730	0.028	0.000	0.000	0.000
5.3	6.80	1.278	0.070	0.409	0.687	0.112	0.000	0.000
13.0	6.78	1.001	0.300	0.637	0.065	0.000	0.000	0.000
22.2	6.78	0.060	0.059	0.000	0.000	0.000	0.000	0.000
4.9	6.95	0.603	0.029	0.169	0.337	0.069	0.000	0.000
12.1	6.94	32.610	7.927	24.626	0.056	0.000	0.000	0.000
12.2	7.12	13.926	2.713	11.061	0.151	0.000	0.000	0.000
13.2	7.34	2.439	0.559	1.617	0.263	0.000	0.000	0.000
19.5	7.66	6.970	2.587	4.383	0.000	0.000	0.000	0.000
19.5	7.88	25.531	6.157	19.374	0.000	0.000	0.000	0.000
19.5	8.11	1.519	0.244	1.228	0.047	0.000	0.000	0.000

Summary statistics for above PSHA PGA deaggregation, R=distance, e=epsilon:
 Mean src-site R=   14.2 km; M= 7.15; eps0=   1.22. Mean calculated for all sources.
Modal src-site R=   12.1 km; M= 6.94; eps0=   1.25 from peak (R,M) bin
Gridded source distance metrics: Rseis Rrup and Rjb
 MODE R*= 12.1km; M*= 6.94; EPS.INTERVAL: 1 to 2 sigma % CONTRIB.= 24.626

Principal sources (faults, subduction, random seismicity having >10% contribution)

Source Category:	% contr.	R(km)	M	epsilon0 (mean values)
California SS faults	83.24	15.2	7.35	1.27
California shallow gridded	16.42	8.2	6.13	0.95

Individual fault hazard details if contrib.>1%:

7 ncs+ncn --san+sao -1-7 7 mags	7.99	19.5	7.70	1.49
6 scz+pn+ncs+ncn --sas+sap+san+sa	25.05	19.5	7.90	1.30
6 rc 2-7 6mags	37.96	12.1	6.97	1.23
6 nh+rc-- hn+rc 2-9 6 mags	6.35	12.1	7.08	1.17
6 sh+nh+rc-- hs+hn+rc 2-10 6mags	3.68	12.2	7.25	1.06

********** Northern California **********
PSHA Deaggregation. %contributions. ROCK site: Sonoma_Landfill long: 122.749 d W., lat: 38.298 N.
USGS 2002-2003 update files and programs. Analysis on DaMoYr:12/08/2011
Return period: 975 yrs. 1.00 s. PSA =0.5577   g.
#Pr[at least one eq with median motion>=PSA in 50 yrs]=0.00003

DIST(km)	MAG(Mw)	ALL_EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
6.7	5.61	0.057	0.057	0.000	0.000	0.000	0.000	0.000
6.6	5.81	0.093	0.071	0.021	0.000	0.000	0.000	0.000
5.2	6.02	0.224	0.098	0.126	0.000	0.000	0.000	0.000
13.4	6.01	0.064	0.064	0.000	0.000	0.000	0.000	0.000
4.7	6.20	0.400	0.108	0.292	0.000	0.000	0.000	0.000
13.3	6.21	0.119	0.114	0.005	0.000	0.000	0.000	0.000
4.7	6.40	0.513	0.088	0.381	0.044	0.000	0.000	0.000
13.3	6.41	0.203	0.147	0.056	0.000	0.000	0.000	0.000
4.1	6.60	0.616	0.061	0.373	0.182	0.000	0.000	0.000
12.6	6.64	0.487	0.243	0.243	0.000	0.000	0.000	0.000
4.6	6.80	0.733	0.068	0.359	0.305	0.000	0.000	0.000
12.7	6.80	0.778	0.540	0.238	0.000	0.000	0.000	0.000
22.8	6.78	0.070	0.069	0.000	0.000	0.000	0.000	0.000

4.4	6.95	0.390	0.028	0.158	0.202	0.002	0.000	0.000
12.2	6.94	21.533	7.322	14.211	0.000	0.000	0.000	0.000
23.1	6.95	0.073	0.070	0.003	0.000	0.000	0.000	0.000
36.1	6.93	0.122	0.122	0.000	0.000	0.000	0.000	0.000
12.2	7.13	11.063	2.637	8.426	0.000	0.000	0.000	0.000
35.0	7.14	0.058	0.058	0.000	0.000	0.000	0.000	0.000
13.6	7.34	2.384	0.493	1.775	0.116	0.000	0.000	0.000
34.4	7.37	0.103	0.102	0.001	0.000	0.000	0.000	0.000
58.8	7.41	0.097	0.097	0.000	0.000	0.000	0.000	0.000
19.5	7.65	12.391	2.589	9.696	0.106	0.000	0.000	0.000
34.4	7.54	0.181	0.162	0.019	0.000	0.000	0.000	0.000
44.0	7.57	0.082	0.082	0.000	0.000	0.000	0.000	0.000
60.7	7.55	0.067	0.067	0.000	0.000	0.000	0.000	0.000
73.9	7.61	0.050	0.050	0.000	0.000	0.000	0.000	0.000
19.5	7.85	20.257	3.427	16.829	0.000	0.000	0.000	0.000
34.2	7.72	0.062	0.037	0.025	0.000	0.000	0.000	0.000
19.5	7.91	23.796	2.560	16.260	4.976	0.000	0.000	0.000
19.5	8.11	2.509	0.237	1.505	0.768	0.000	0.000	0.000

Summary statistics for above 1.0s PSA deaggregation, R=distance, e=epsilon:
Mean src-site R= 16.7 km; M= 7.49; eps0= 1.16. Mean calculated for all sources.
Modal src-site R= 19.5 km; M= 7.91; eps0= 0.83 from peak (R,M) bin
Gridded source distance metrics: Rseis Rrup and Rjb
MODE R*= 19.5km; M*= 7.85; EPS.INTERVAL: 1 to 2 sigma % CONTRIB.= 16.829

Principal sources (faults, subduction, random seismicity having >10% contribution)

Source Category:	% contr.	R(km)	M	epsilon0 (mean values)
California SS faults	94.75	16.9	7.53	1.15
Individual fault hazard details if contrib.>1%:				
7 ncs+ncn --san+sao -1-7 7 mags	14.03	19.5	7.70	1.16
6 pn+ncs+ncn--sap+san+sao-1-9 6ma	1.09	19.5	7.81	1.04
6 scz+pn+ncs+ncn --sas+sap+san+sa	43.09	19.5	7.89	0.95
6 rc 2-7 6mags	26.24	12.1	6.98	1.41
6 nh+rc-- hn+rc 2-9 6 mags	4.87	12.1	7.09	1.31
6 sh+nh+rc-- hs+hn+rc 2-10 6mags	3.21	12.2	7.26	1.14

********** Northern California **********
PSHA Deaggregation. %contributions. ROCK site: Sonoma_Landfill long: 122.749 d W., lat: 38.298 N.
USGS 2002-2003 update files and programs. Analysis on DaMoYr:12/08/2011
Return period: 975 yrs. 0.20 s. PSA =1.2260 g.
#Pr[at least one eq with median motion>=PSA in 50 yrs]=0.00070

DIST(km)	MAG(Mw)	ALL_EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
6.7	5.05	0.481	0.202	0.279	0.000	0.000	0.000	0.000
13.3	5.05	0.108	0.108	0.000	0.000	0.000	0.000	0.000
6.7	5.20	0.926	0.309	0.617	0.000	0.000	0.000	0.000
13.5	5.20	0.259	0.259	0.000	0.000	0.000	0.000	0.000
6.7	5.40	0.886	0.226	0.660	0.000	0.000	0.000	0.000
13.7	5.40	0.313	0.313	0.000	0.000	0.000	0.000	0.000
6.7	5.60	0.847	0.177	0.654	0.016	0.000	0.000	0.000
13.9	5.60	0.366	0.339	0.027	0.000	0.000	0.000	0.000
6.6	5.80	0.801	0.136	0.565	0.101	0.000	0.000	0.000
14.0	5.80	0.418	0.314	0.104	0.000	0.000	0.000	0.000
6.0	6.01	1.044	0.136	0.615	0.293	0.000	0.000	0.000
13.5	6.01	0.501	0.290	0.212	0.000	0.000	0.000	0.000
5.7	6.20	1.305	0.129	0.681	0.496	0.000	0.000	0.000
13.2	6.20	0.633	0.279	0.354	0.000	0.000	0.000	0.000
22.6	6.20	0.077	0.077	0.000	0.000	0.000	0.000	0.000
5.3	6.40	1.268	0.089	0.553	0.601	0.024	0.000	0.000
13.2	6.40	0.775	0.272	0.500	0.003	0.000	0.000	0.000
23.6	6.40	0.074	0.074	0.000	0.000	0.000	0.000	0.000
4.6	6.60	1.124	0.062	0.393	0.623	0.046	0.000	0.000
12.5	6.62	1.121	0.292	0.803	0.026	0.000	0.000	0.000
22.8	6.60	0.079	0.078	0.001	0.000	0.000	0.000	0.000
5.3	6.80	1.145	0.069	0.412	0.598	0.066	0.000	0.000
12.8	6.78	1.020	0.266	0.691	0.062	0.000	0.000	0.000
22.4	6.78	0.096	0.091	0.006	0.000	0.000	0.000	0.000
4.9	6.95	0.530	0.028	0.170	0.288	0.044	0.000	0.000
12.2	6.94	34.887	7.895	26.938	0.054	0.000	0.000	0.000
22.5	6.95	0.071	0.068	0.003	0.000	0.000	0.000	0.000
12.1	7.12	14.292	2.686	11.115	0.491	0.000	0.000	0.000
13.2	7.33	2.338	0.480	1.537	0.321	0.000	0.000	0.000
19.5	7.65	7.234	2.422	4.812	0.000	0.000	0.000	0.000

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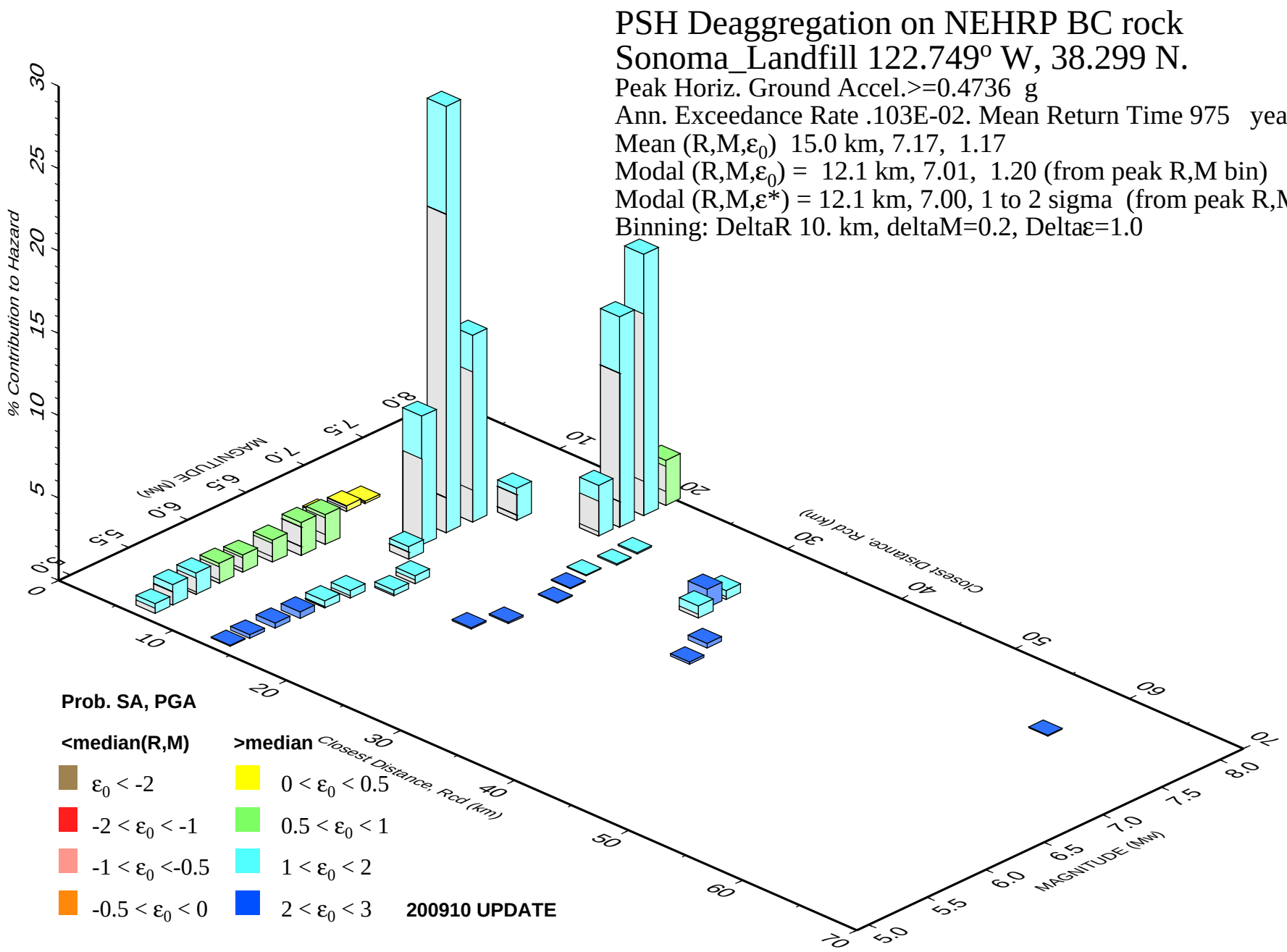
   19.5    7.87   21.453    5.325   16.128    0.000    0.000    0.000    0.000
   19.5    8.00    1.953    0.255    1.622    0.076    0.000    0.000    0.000
   19.5    8.11    1.250    0.215    0.946    0.089    0.000    0.000    0.000

Summary statistics for above 0.2s PSA  deaggregation, R=distance, e=epsilon:
 Mean src-site R=   14.1 km; M= 7.13; eps0=   1.20. Mean calculated for all sources.
Modal src-site R=   12.2 km; M= 6.94; eps0=   1.22 from peak (R,M) bin
Gridded source distance metrics: Rseis Rrup and Rjb
 MODE R*=  12.1km; M*= 6.94; EPS.INTERVAL: 1 to 2 sigma  % CONTRIB.= 26.938

Principal sources (faults, subduction, random seismicity having >10% contribution)
Source Category:                % contr.   R(km)    M   epsilon0 (mean values)
California SS faults              83.69    15.0   7.32    1.22
California shallow gridded        16.07     8.7   6.12    1.06
Individual fault hazard details if contrib.>1%:
7  ncs+ncn --san+sao -1-7 7 mags   8.03    19.5   7.70    1.40
6 scz+pn+ncs+ncn --sas+sap+san+sa 22.83    19.5   7.89    1.24
6 rc 2-7 6mags                    40.26    12.1   6.97    1.20
6 nh+rc-- hn+rc 2-9 6 mags         6.56    12.1   7.08    1.14
6 sh+nh+rc-- hs+hn+rc 2-10 6mags   3.62    12.1   7.25    1.04
******************** Northern California ***************************************
```

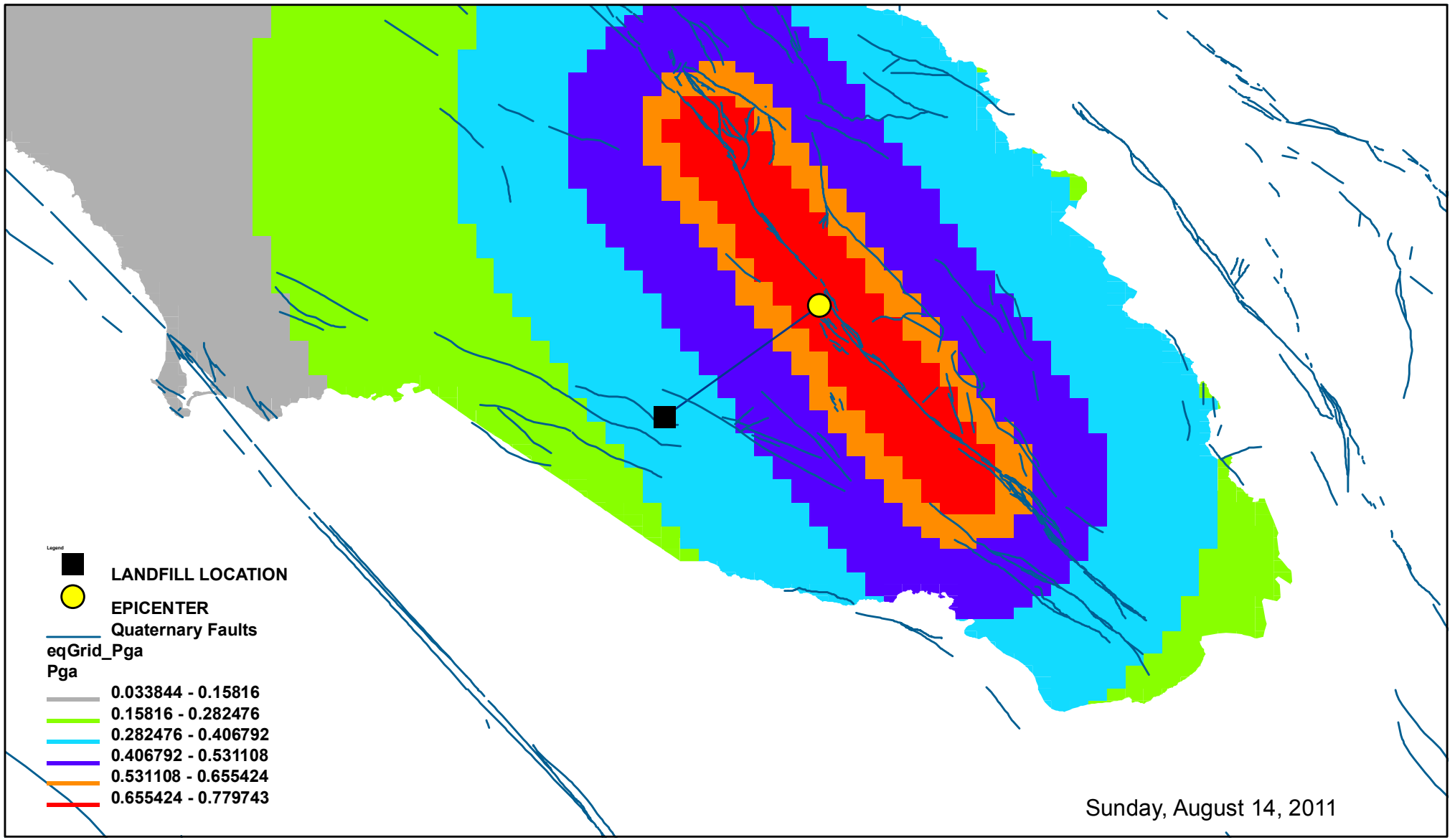
USGS Data


PSH Deaggregation on NEHRP BC rock
Sonoma_Landfill 122.749º W, 38.299 N.
Peak Horiz. Ground Accel.>=0.4736 g
Ann. Exceedance Rate .103E-02. Mean Return Time 975 years
Mean (R,M,ε0) 15.0 km, 7.17, 1.17
Modal (R,M,ε0) = 12.1 km, 7.01, 1.20 (from peak R,M bin)
Modal (R,M,ε*) = 12.1 km, 7.00, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0
% Contribution to Hazard
MAGNITUDE (Mw)
Closest Distance, Rcd (km)
Prob. SA, PGA
<median(R,M)
>median
ε0 < -2
-2 < ε0 < -1
-1 < ε0 <-0.5
-0.5 < ε0 < 0
0 < ε0 < 0.5
0.5 < ε0 < 1
1 < ε0 < 2
2 < ε0 < 3
200910 UPDATE

Study Region new : Sonoma Landfill

Hazard Scenario : 6.75 Quake

FEMA Data



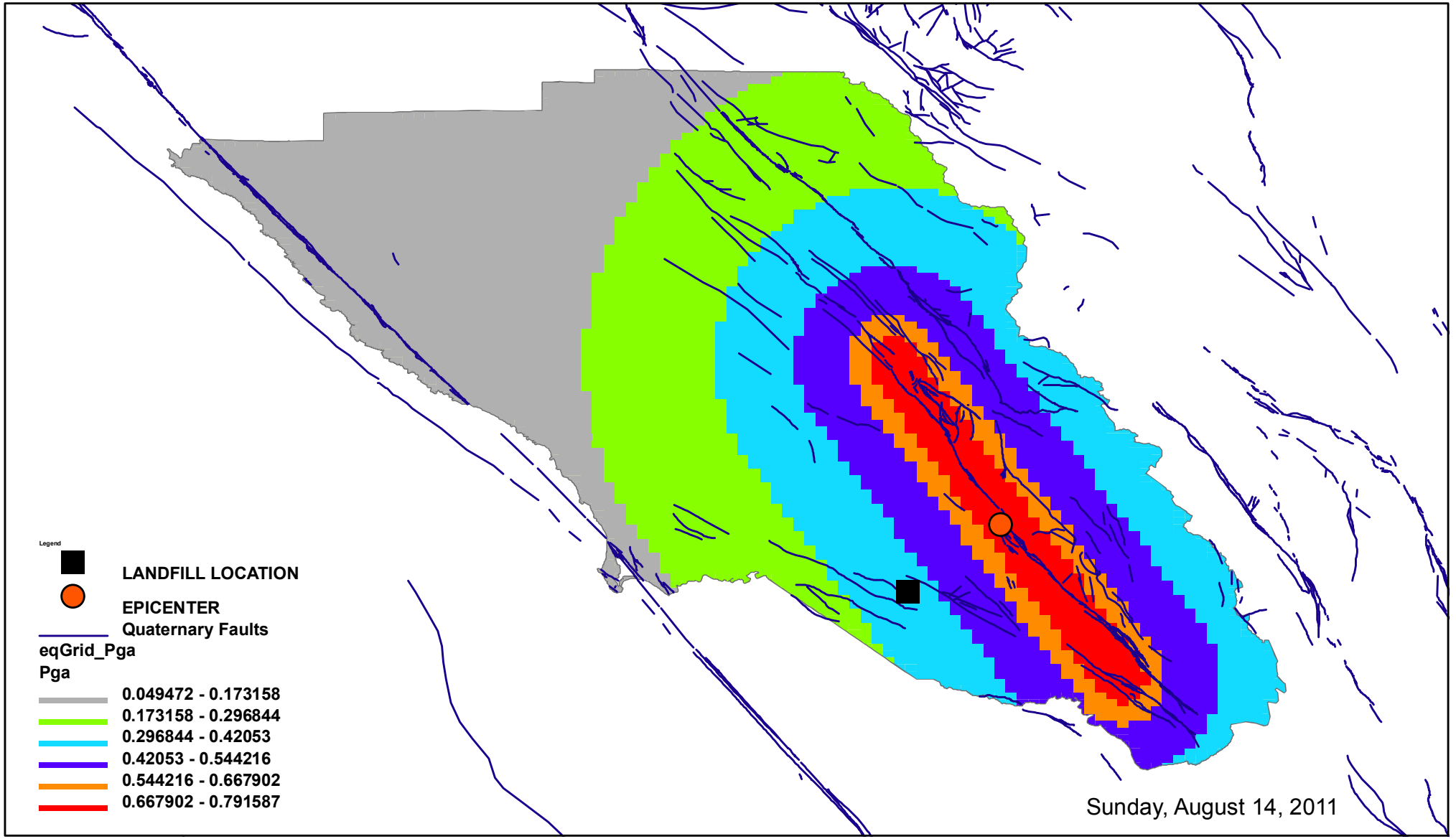
30 15 0 30 Kilometers

N

Study Region new : Sonoma Landfill RC Source

Hazard Scenario : RODGERS CREEK 7.0 SOURCE

FEMA Data



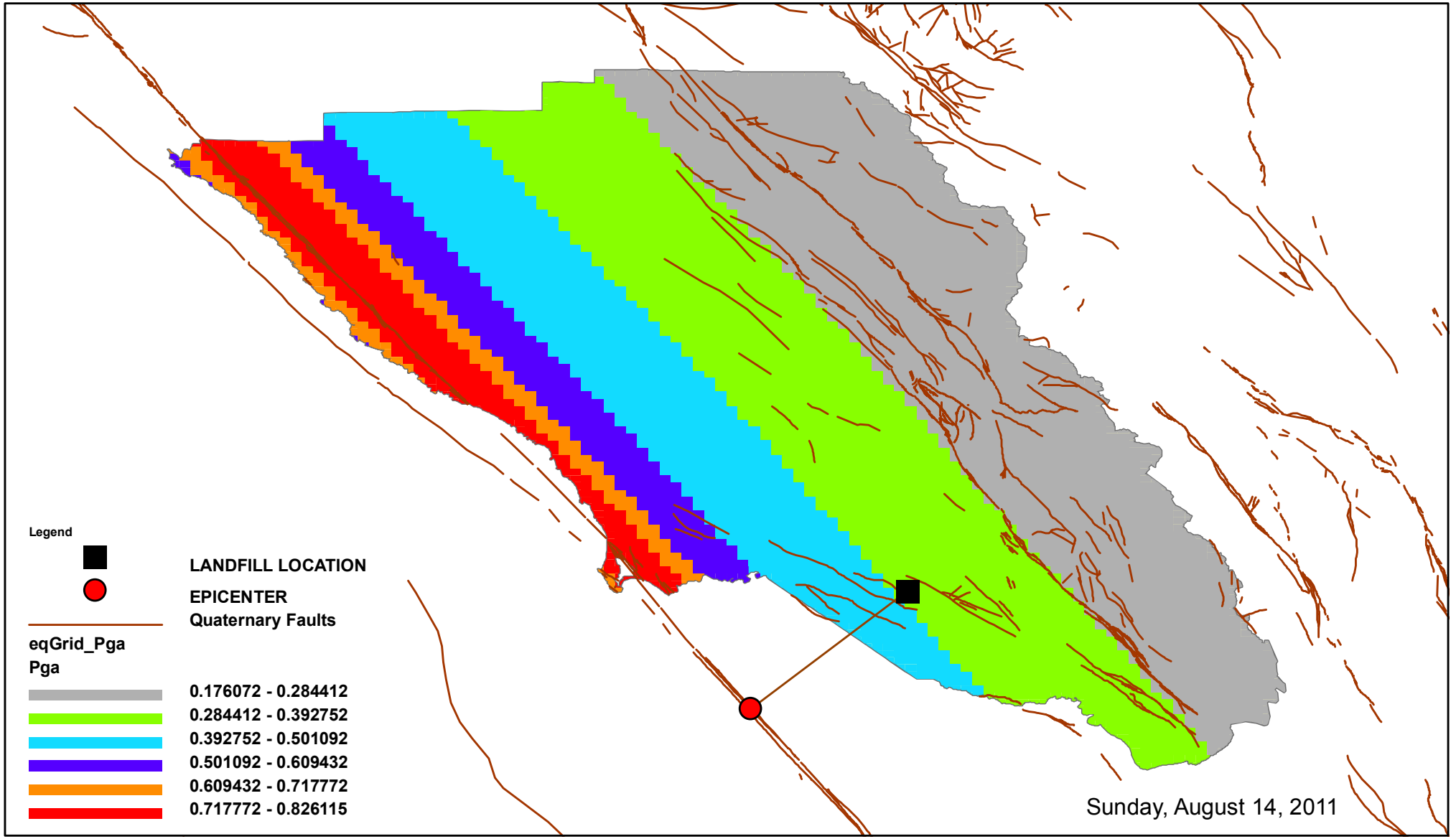
50 25 0 50 Kilometers

N

Study Region: San Andreas Fault Sonoma

Hazard Scenario : 7.9 Source Event

FEMA Data



50 25 0 50 Kilometers

N

Attachment 2
Flood Zone Information

Definitions of FEMA Flood Zone Designations

Flood zones are geographic areas that the FEMA has defined according to varying levels of flood risk. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area.

Moderate to Low Risk Areas

In communities that participate in the NFIP, flood insurance is available to all property owners and renters in these zones:

ZONE	DESCRIPTION
B and X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.
C and X (unshaded)	Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.

High Risk Areas

In communities that participate in the NFIP, mandatory flood insurance purchase requirements apply to all of these zones:

ZONE	DESCRIPTION
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas; no depths or base flood elevations are shown within these zones.
AE	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1-A30 Zones.
A1-30	These are known as numbered A Zones (e.g., A7 or A14). This is the base floodplain where the FIRM shows a BFE (old format).
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.

High Risk - Coastal Areas

In communities that participate in the NFIP, mandatory flood insurance purchase requirements apply to all of these zones:

ZONE	DESCRIPTION
V	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
VE, V1 - 30	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.

Undetermined Risk Areas

ZONE	DESCRIPTION
D	Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.

FEMA Map Service Center, P.O. Box 1038 Jessup, Maryland 20794-1038 Phone: (877) 336-2627

MAP SCALE 1" = 1000'

500 0 1000 2000

FEET

METER

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.

Attachment 3
Precipitation Information

www.nws.noaa.gov

NOAA's National Weather Service
Hydrometeorological Design Studies Center
Precipitation Frequency Data Server (PFDS)

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES

DATA DESCRIPTION

Data type: precipitation depth **Units:** english **Time series type:** partial duration

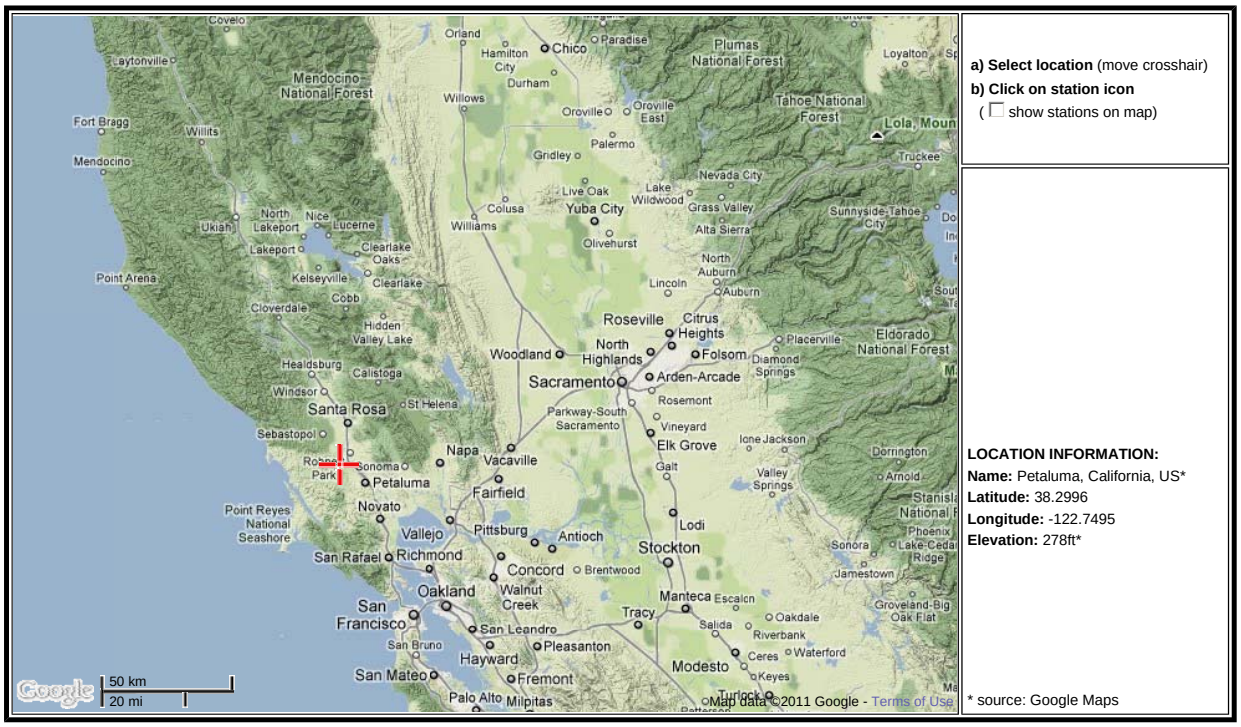
SELECT LOCATION

1. Manually:

a) Enter location (decimal degrees, use "-" for S and W): latitude: 38.29964 longitude: -122.74951 submit

b) Select station: select station

2. Use map:



a) **Select location** (move crosshair)
b) **Click on station icon**
(show stations on map)

LOCATION INFORMATION:
Name: Petaluma, California, US*
Latitude: 38.2996
Longitude: -122.7495
Elevation: 278ft*

* source: Google Maps

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 6, Version 2

PF tabular PF graphical Supplementary information Print Page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval(years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.171 (0.152–0.194)	0.209 (0.186–0.238)	0.261 (0.231–0.298)	0.305 (0.267–0.351)	0.366 (0.308–0.439)	0.415 (0.341–0.509)	0.465 (0.372–0.589)	0.520 (0.401–0.679)	0.596 (0.439–0.818)	0.658 (0.465–0.941)
10-min	0.245 (0.218–0.278)	0.300 (0.267–0.341)	0.375 (0.332–0.427)	0.437 (0.383–0.503)	0.525 (0.442–0.629)	0.594 (0.488–0.730)	0.667 (0.533–0.844)	0.745 (0.575–0.974)	0.854 (0.629–1.17)	0.944 (0.667–1.35)
15-min	0.296 (0.263–0.336)	0.363 (0.322–0.412)	0.453 (0.401–0.517)	0.529 (0.464–0.609)	0.634 (0.535–0.760)	0.719 (0.591–0.883)	0.807 (0.644–1.02)	0.901 (0.696–1.18)	1.03 (0.760–1.42)	1.14 (0.807–1.63)
30-min	0.418 (0.372–0.475)	0.513 (0.456–0.584)	0.641 (0.568–0.731)	0.748 (0.656–0.861)	0.898 (0.757–1.08)	1.02 (0.836–1.25)	1.14 (0.911–1.44)	1.27 (0.984–1.67)	1.46 (1.08–2.01)	1.62 (1.14–2.31)
60-min	0.591 (0.526–0.671)	0.725 (0.645–0.824)	0.905 (0.802–1.03)	1.06 (0.927–1.22)	1.27 (1.07–1.52)	1.44 (1.18–1.77)	1.61 (1.29–2.04)	1.80 (1.39–2.35)	2.07 (1.52–2.84)	2.28 (1.61–3.26)
2-hr	0.884 (0.787–1.00)	1.08 (0.957–1.22)	1.33 (1.18–1.52)	1.54 (1.35–1.78)	1.83 (1.54–2.19)	2.05 (1.69–2.52)	2.28 (1.82–2.89)	2.53 (1.95–3.30)	2.86 (2.10–3.93)	3.12 (2.21–4.47)
3-hr	1.12 (0.997–1.27)	1.36 (1.21–1.55)	1.68 (1.49–1.92)	1.94 (1.70–2.23)	2.29 (1.93–2.75)	2.56 (2.11–3.15)	2.84 (2.27–3.59)	3.13 (2.41–4.09)	3.52 (2.59–4.83)	3.83 (2.71–5.48)
6-hr	1.67 (1.48–1.89)	2.03 (1.80–2.31)	2.50 (2.22–2.85)	2.88 (2.53–3.32)	3.39 (2.86–4.07)	3.78 (3.11–4.65)	4.18 (3.33–5.28)	4.58 (3.54–5.99)	5.13 (3.77–7.04)	5.55 (3.93–7.94)
12-hr	2.33 (2.07–2.64)	2.87 (2.55–3.26)	3.56 (3.16–4.06)	4.12 (3.61–4.75)	4.87 (4.10–5.83)	5.43 (4.46–6.68)	6.00 (4.79–7.59)	6.58 (5.09–8.61)	7.37 (5.42–10.1)	7.98 (5.64–11.4)
24-hr	3.19	3.98	5.00	5.81	6.89	7.71	8.53	9.36	10.5	11.3

2-day	**4.30** (3.86–4.88)	**5.39** (4.84–6.12)	**6.77** (6.07–7.71)	**7.87** (7.00–9.03)	**9.33** (8.05–11.0)	**10.4** (8.83–12.6)	**11.5** (9.54–14.2)	**12.6** (10.2–15.9)	**14.1** (11.0–18.5)	**15.2** (11.5–20.6)
3-day	**4.96** (4.46–5.62)	**6.23** (5.59–7.07)	**7.83** (7.01–8.91)	**9.09** (8.09–10.4)	**10.8** (9.30–12.7)	**12.0** (10.2–14.5)	**13.3** (11.0–16.3)	**14.5** (11.7–18.3)	**16.2** (12.6–21.2)	**17.4** (13.2–23.6)
4-day	**5.51** (4.96–6.26)	**6.94** (6.24–7.89)	**8.73** (7.82–9.94)	**10.1** (9.02–11.6)	**12.0** (10.4–14.2)	**13.4** (11.3–16.1)	**14.7** (12.2–18.1)	**16.1** (13.0–20.3)	**17.9** (13.9–23.5)	**19.3** (14.6–26.1)
7-day	**6.73** (6.05–7.64)	**8.51** (7.64–9.67)	**10.7** (9.60–12.2)	**12.4** (11.1–14.2)	**14.6** (12.6–17.3)	**16.3** (13.8–19.6)	**17.9** (14.8–22.0)	**19.5** (15.8–24.6)	**21.6** (16.8–28.3)	**23.2** (17.5–31.3)
10-day	**7.72** (6.94–8.76)	**9.79** (8.80–11.1)	**12.3** (11.1–14.0)	**14.3** (12.7–16.4)	**16.8** (14.5–19.8)	**18.6** (15.8–22.4)	**20.4** (16.9–25.1)	**22.2** (17.9–28.0)	**24.4** (19.0–32.0)	**26.1** (19.7–35.4)
20-day	**10.3** (9.23–11.6)	**13.1** (11.8–14.9)	**16.5** (14.8–18.7)	**19.0** (16.9–21.8)	**22.2** (19.1–26.2)	**24.4** (20.7–29.4)	**26.6** (22.0–32.7)	**28.6** (23.1–36.1)	**31.3** (24.3–41.0)	**33.2** (25.0–44.9)
30-day	**12.5** (11.2–14.1)	**15.9** (14.3–18.0)	**19.9** (17.9–22.7)	**22.9** (20.4–26.3)	**26.6** (23.0–31.4)	**29.1** (24.7–35.1)	**31.6** (26.2–38.8)	**33.9** (27.4–42.7)	**36.7** (28.6–48.2)	**38.8** (29.3–52.5)
45-day	**15.4** (13.8–17.4)	**19.5** (17.5–22.2)	**24.3** (21.8–27.7)	**27.9** (24.8–31.9)	**32.1** (27.7–37.9)	**35.0** (29.6–42.1)	**37.6** (31.2–46.3)	**40.2** (32.5–50.7)	**43.2** (33.7–56.7)	**45.5** (34.3–61.5)
60-day	**18.3** (16.4–20.8)	**23.1** (20.8–26.3)	**28.7** (25.7–32.6)	**32.6** (29.0–37.4)	**37.4** (32.3–44.2)	**40.6** (34.4–48.8)	**43.5** (36.0–53.5)	**46.2** (37.3–58.3)	**49.5** (38.5–64.9)	**51.8** (39.1–70.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in csv format: precipitation frequency estimates Submit

Main Link Categories:
Home | OHD

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Page Author: HDSC webmaster
Page last modified: April 8, 2011

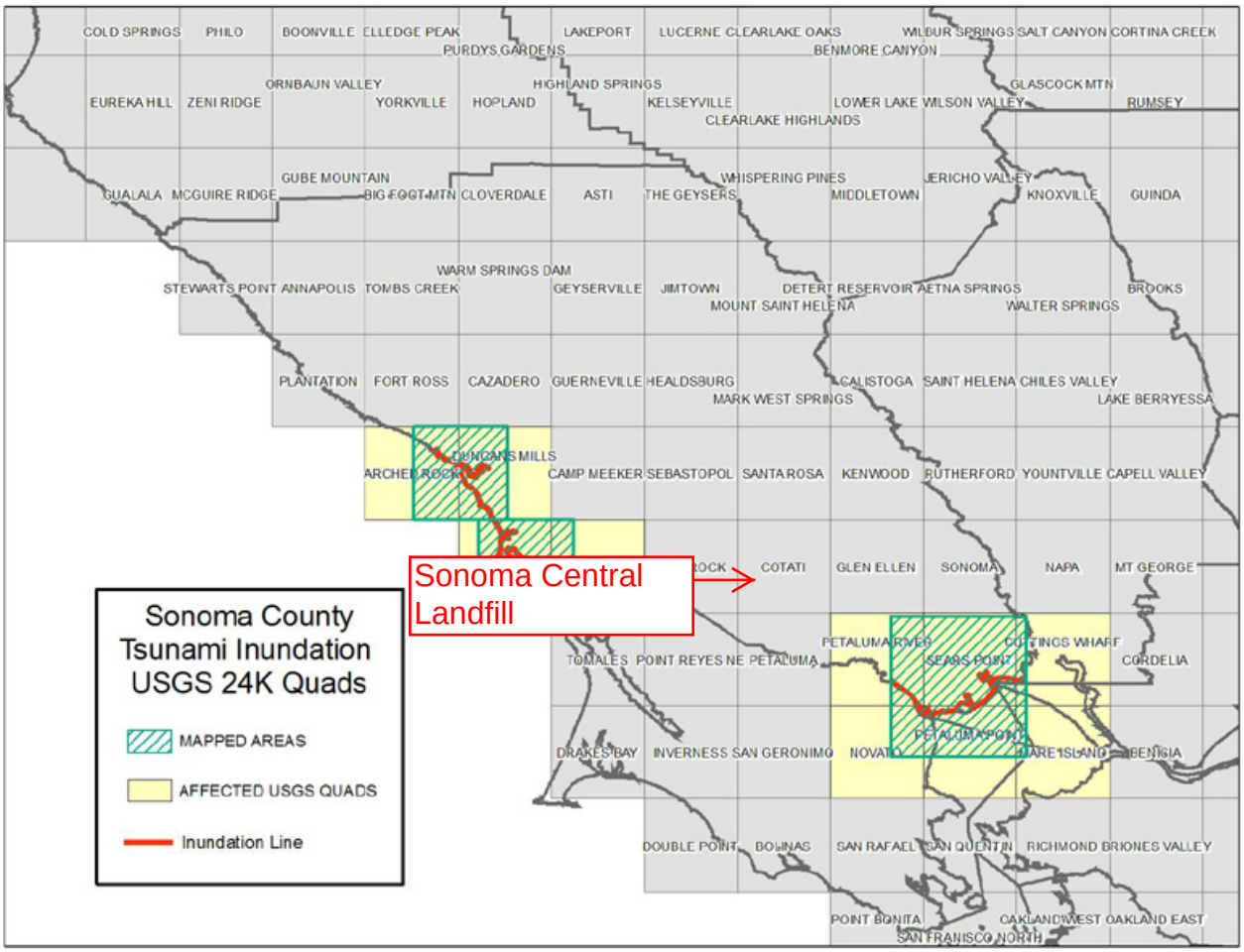
Attachment 4
Tsunami Information

State of California
Department of Conservation

CGS » Geologic Hazards » Tsunami » Inundation Maps » Sonoma

Sonoma County Tsunami Inundation Maps

Click on the map images to view/download the detailed tsunami inundation maps or click on the alphabetized list of quadrangles at the bottom of the image. Affected coastal cities/communities on each map are listed in parentheses. Click HERE to find out what to do during a tsunami, if you live in, work in, or visit Sonoma County.



Download Maps by Quadrangle Name

Bodega Head - Valley Ford (Salmon Creek, Bodega Bay)

Arched Rock - Duncan Mills (Jenner, Ocean View)

Sears Point – Petaluma Point

FIND OUT WHAT TO DO DURING A TSUNAMI, IF YOU LIVE IN, WORK IN, OR VISIT SONOMA COUNTY...

Sonoma County Tsunami evacuation information – Contact the County Department of Emergency Services: http://www.sonoma-county.org/des/index.htm

Attachment 5
Fire Hazard Information

SONOMA COUNTY

FIRE HAZARD SEVERITY ZONES IN SRA

Adopted by CAL FIRE on November 7, 2007

FRAP
Fire and Resource Assessment Program
California Department of Forestry and Fire Protection

MENDOCINO COUNTY
LAKE COUNTY
NAPA COUNTY
MARIN COUNTY
PACIFIC OCEAN
SAN PABLO BAY

Cloverdale
Annapolis
Geyersville
Kellogg
Healdsburg
Windsor
Fort Ross
Guerneville
Jenner
SANTA ROSA
Sebastopol
Bodega Bay
Rohnert Park
Cotati
Sonoma
Petaluma

Lake Sonoma
Russian River

SITE LOCATION
CENTRAL DISPOSAL SITE
MODERATE FIRE HAZARD

FIRE HAZARD SEVERITY ZONES in State Responsibility Area (SRA)
- Moderate
- High
- Very High

FIRE PROTECTION RESPONSIBILITY
- Federal Responsibility Area (FRA)
- Local Responsibility Area (LRA) - Unincorporated
- Local Responsibility Area (LRA) - Incorporated

Public Resources Code 4201-4204 direct the California Department of Forestry and Fire Protection (CAL FIRE) to map fire hazard within State Responsibility Areas (SRA), based on relevant factors such as fuels, terrain, and weather. These statutes were passed after significant wildland-urban interface fires; consequently these hazards are described according to their potential for causing ignitions to buildings. These zones referred to as Fire Hazard Severity Zones(FHSZ), provide the basis for application of various mitigation strategies to reduce risks to buildings associated with wildland fires. The zones also relate to the requirements for building codes designed to reduce the ignition potential to buildings in the wildland-urban interface zones.

These maps have been created by CAL FIRE's Fire and Resource Assessment Program (FRAP) using data and models describing development patterns, estimated fire behavior characteristics based on potential fuels over a 30-50 year time horizon, and expected burn probabilities to quantify the likelihood and nature of vegetation fire exposure to new construction. Details on the project and specific modeling methodology can be found at http://frap.cdf.ca.gov/projects/hazard/methods.htm.

The version of the map shown here represents the official "Maps of Fire Hazard Severity Zones in the State Responsibility Area of California" as required by Public Resources Code 4201-4204 and entitled in the California Code of Regulation, Title 14, Section 1280 Fire Hazard Severity Zones, and as adopted by CAL FIRE on November 7, 2007.

An interactive system for viewing map data is hosted by the UC Center for Fire at http://firecenter.berkeley.edu/fhsz/

Questions can be directed to David Sapsis, at 916.445.5369, dave.sapsis@fire.ca.gov.

0 5 Miles
0 10 Kilometers

Projection Albers, NAD 1927
Scale 1: 125,000
at 35" x 36"
November 06, 2007

Obtain FRAP maps, data, metadata and publications on the Internet at http://frap.cdf.ca.gov
For more information, contact CAL FIRE-FRAP, PO Box 944246, Sacramento, CA 94244-2460, (916) 327-3939.

Arnold Schwarzenegger, Governor,
State of California
Mike Chrisman, Secretary for Resources,
The Resources Agency
Ruben Grijalva, Director,
Department of Forestry and Fire Protection

MAP ID: FHSZS_MAP

DATA SOURCES
CAL FIRE Fire Hazard Severity Zones (FHSZS06_3)
CAL FIRE State Responsibility Areas (SRA05_5)
CAL FIRE Incorporated Cities (Incorp07_3)
PLSS (1:100,000 USGS, Land Grants with CAL FIRE grid)