

Chlorinated Solvents and other Volatile Organic Compounds Pollution in California Groundwater and Associated State Water Board Cleanup Programs

June 12, 2014

This fact sheet summarizes chlorinated solvents and other volatile organic compounds (VOCs) in California groundwater from polluted sites and the resulting impact to drinking water wells. It also summarizes the oversight implemented by the State Water Resources Control Board (State Water Board) and nine Regional Water Quality Control Boards (Regional Water Boards) (herein collectively described as Water Boards) to investigate and cleanup active and historic polluted sites. Excerpts from the draft *California Water Plan Update 2013* are included with additional information provided by recent studies from the State Water Board Groundwater Ambient Monitoring & Assessment (GAMA) Program, and Water Board groundwater cleanup programs.

VOCs in groundwater are an issue that needs to be addressed. They represent a direct risk to human health, as they are one of the most commonly detected pollutants in public supply wells and are a threat to indoor air quality. Many VOCs, particularly chlorinated VOCs, are environmentally persistent and do not readily degrade. Cleanup is complex and very expensive, which can be a financial challenge to small business owners or individuals.

Background

The following background information is an excerpt from the *California Water Plan Update 2013 – Public Review Draft, Chapter 16, Groundwater/Aquifer Remediation*, page 16-3 and 16-5. This excerpt focuses on chlorinated solvents and VOCs most commonly detected in public supply wells. This information will be updated when the final document becomes available. More information is available in the full document located at: <http://www.waterplan.water.ca.gov/cwpu2013/prd/index.cfm>.

Most groundwater extraction and treatment remediation systems are located at sites where volatile organic compound solvents, such as trichloroethylene (TCE) and [perchloroethylene or tetrachloroethylene] PCE, have contaminated groundwater. TCE has been used as an industrial cleaning and degreasing agent and PCE is a degreasing agent and has been the primary chemical used by dry cleaners for decades. Because TCE and PCE are [dense non-aqueous phase liquids] DNAPLs in free phase, they tend to sink to the bottom of aquifers or pool on top of low permeability units, they rarely can be excavated and removed. Both compounds are considered carcinogenic at low concentrations. Remediation systems to extract and treat groundwater contaminated with such solvents may be required. The total volume of water and the fraction of impacted water remain unknown.

Dry cleaning business operations present a significant threat to groundwater quality. Past practices commonly employed by dry cleaners resulted in PCE being discharged onto the ground at the business site or to the sewer. As many as 15,000 dry cleaning facilities have operated in California. Most of these sites, past and present, are small businesses in urban areas. The owners of these facilities typically do not have the resources necessary to fund an investigation and, if necessary, the remediation to remove PCE. Therefore, relatively few of the current and former dry cleaning sites have been investigated. Remediation at dry cleaning facilities

typically involves soil vapor extraction. Where groundwater has been affected, pump and treat systems are employed.

Recent studies seem to indicate that operating, non-operating, or poorly designed water wells and possibly oil and gas wells provide conduits whereby chlorinated solvents spread from shallow to deeper aquifers. The burden of dealing with PCE contamination of drinking water often falls on the water purveyor who pumps the groundwater and who may have to discontinue use of the well or install costly treatment equipment. The cost of dealing with the legacy of dry cleaning operations and other sources of chlorinated solvents is estimated to be in the billions of dollars. Treatment systems to remove PCE and other chlorinated solvents from groundwater may need to operate for decades.

Except for petroleum USTs, it is difficult to estimate the cost of cleaning contaminated sites. In 1989, the California Legislature established the Underground Storage Tank Cleanup Fund [USTCF] to reimburse petroleum UST owners for the costs associated with the cleanup of leaking petroleum USTs. The Fund disburses about \$200 million annually to eligible claimants. In the 1990s, the cost to clean up an individual UST site typically ranged from \$100,000 to \$200,000. The cleanup of UST sites contaminated with MTBE costs significantly more, with reimbursements as high as the Fund's limit of \$1.5 million per site. As of June 2011, the Fund disbursed more than \$3.1 billion to eligible claimants since its establishment.

A site where solvent contamination has reached groundwater may require continuous pump and treat operation for decades and cost millions of dollars. As previously discussed, most sites with solvent discharges (e.g., dry cleaning facilities) have yet to be investigated and remediated.

Based on cost data from the State Water Resources Control Board and the California Department of Public Health, Division of Drinking Water and Environmental Management, total groundwater remediation costs in California, excluding costs of salt management, could approach \$20 billion during the next 25 years. The estimate is based on current costs for remediation, estimated future costs for similar remediation, newly discovered contamination, and emerging contaminants. Almost all of these costs are associated with contaminants from previous human activities (legacy contaminants). Current pollution prevention strategies are expected to result in significantly less discharge of contaminants such as petroleum fuel, solvents, and perchlorate.

It should be noted that in addition to the pump and treatment remediation technique discussed in the above excerpt, there are additional remediation techniques used today including: in-situ chemical oxidation, bio-stimulation, permeable reactive barriers, and many others.

Vapor intrusion to indoor air is the primary risk to human health at many VOC-impacted sites. However, this fact sheet focuses on groundwater impacts and does not include a detailed discussion of vapor intrusion to indoor air.

Impacted Drinking Water Wells – Comparison of Petroleum and Chlorinated Solvents

The State Water Board prepared a report to the legislature, in accordance with Assembly Bill 2222 (AB 2222), titled: *Communities That Rely on a Contaminated Groundwater Source for Drinking Water* (AB 2222 Report), dated January 2013. The AB 2222 report used water quality data from the California Department of Public Health (CDPH) database, and identified public supply wells with two or more

detections of principal contaminants above drinking water standards between 2002 and 2010. A “principal contaminant” is defined as a chemical detected above a public drinking water standard on two or more occasions between 2002 and 2010. Figure 1 (below) shows the distribution of principal contaminants in public supply wells. The AB 2222 Report identified that of the 8,396 public supply wells, wells with VOC principal contaminants were: 168 wells with PCE; 159 wells with TCE; 6 wells with benzene; and 5 wells with methyl-tert butyl ether (MTBE). Using the AB 2222 Report dataset, AB 2222 report maps (Figures 2 & 3) show the statewide distribution of public supply wells with 1) petroleum-type contaminants, MTBE and benzene; and 2) two common solvent contaminants, PCE and TCE. Comparison of Figures 1 through 4 indicates there is higher probability that impacts to wells are from solvents and are two orders of magnitude greater than wells impacted with petroleum contaminants.

In addition to the public supply wells, the GAMA Program Domestic Well Project has sampled over 1,100 domestic wells since 2002. Of the domestic wells sampled, TCE, benzene, MTBE are detected in three different domestic wells. PCE was not detected above drinking water standards in any of the domestic wells sampled. It should be noted that the dataset for the domestic wells is limited, thus may not represent actual statewide groundwater conditions. As such, the CDPH dataset (discussed above) is considered to be more representative of public use groundwater source conditions in California. More information regarding the Domestic Well Project can be found at http://www.waterboards.ca.gov/water_issues/programs/gama/domestic_well.shtml.

Water Board Groundwater Cleanup Programs

The Water Boards oversee cleanup at multiple types of sites with various pollutants in both soil and groundwater including petroleum UST sites, public and private industrial sites, former and existing military sites, and land disposal sites. Water Boards oversight for cleanup is regulated by four separate programs: 1) the Underground Storage Tank (UST) Program, 2) Site Cleanup Program (SCP), 3) Department of Defense (DOD) Program, and 4) Land Disposal Program. The DOD Program and Land Disposal Program are not discussed in detail as part of this fact sheet.

As a comparison, Table 1 shows the typical type of cases regulated by the Water Boards under the UST Program and the SCP. The UST Program is limited to only petroleum-type sites where petroleum was stored in USTs. The SCP has a much wider range of type of sites and pollutants (largely solvents) associated with industrial/commercial uses.

Geographic Distribution of Sites – Comparison of LUST and SCP sites

Figures 4 and 5 show the distribution of open¹ sites in California for which the Water Boards oversee cleanup under the UST program and SCP. The figures show open Leaking USTs (LUST) sites (5,517) and SCP sites (5,667). These maps were generated from the GeoTracker database and ArcGIS™. The number and distribution of LUST and SCP sites are similar with the majority of sites located in urbanized areas.

¹ “Open” includes both active and inactive sites in the GeoTracker database.

Current Funding – Comparison of LUST and Site Cleanup Programs

LUST cases have benefited from the USTCF, which has greatly contributed to moving LUST cases through closure. The USTCF provides a means for petroleum UST owners and operators to meet the federal and state requirements of maintaining financial responsibility to pay for any damages arising from unauthorized releases of petroleum from their UST systems. Since implementation of the USTCF in 1989, the USTCF has disbursed over \$3.2 billion to eligible claimants for LUST cleanup. Additionally, the UST Program has overseen the cleanup of over 35,000 LUST cases since 1984. Cleanup for many of these cases, which are small businesses and individuals that could not normally afford cleanup in its entirety, were funded partially or fully with USTCF revenues up to \$1.5 million each.

In contrast, the SCP has very little revenues to assist small business owners and individuals with cleanup. The Water Boards' Cleanup and Abatement Account typically disburses between \$1 million to \$5.5 million per year for as few as 4 to 6 SCP cases for small business owners or individuals. For the vast majority of SCP cases, the responsible party is required to finance the cleanup of their site in its entirety and pay for agency oversight under the Water Boards' Cost Recovery Program. Of the 5,667 open SCP cases, only 2,366 (42%) are in the Cost Recovery Program. For oversight and administration of the program, the Water Boards receive approximately \$15 million of funding per year from the Cost Recovery Program for these 2,366 cases. For oversight of the remaining 3,301 cases that are not in the Cost Recovery Program, the Water Boards receive approximately \$2 million per year from the State General Fund (less than \$606 per case per year for oversight).

Cleanup Status – Comparison of the LUST & SCP Cases

Figures 6 and 7 show the case status trends for both the LUST and SCP cases, respectively. The LUST cases graph shows a distinct declining trend for open cases. This trend may be attributed to: 1) the USTCF revenues available for assisted site cleanup and agency oversight, 2) the propensity for natural attenuation of petroleum, and 3) the decrease in new LUST cases due to new secondary containment requirements.

In contrast, the SCP cases graph shows a gradual increasing trend for open cases that appears to have stabilized since 2011. The lack of a declining trend under the SCP may be attributed to: 1) the low percent of cases (42%) in the Cost Recovery Program, 2) limited resources for oversight of non-Cost Recovery Program cases, 3) high priority cases monopolizing oversight, and 4) complexity and high cost to cleanup SCP sites.

Conclusions

The USTCF demonstrates a successful funding model for moving cleanup sites through closure by providing funding for continuous oversight and assisting small business owners/individuals for cleanup. The direct cost recovery model used by the SCP has been less successful and the backlog of SCP sites and impacted wells will likely continue in the future unless additional funding for SCP can be identified.

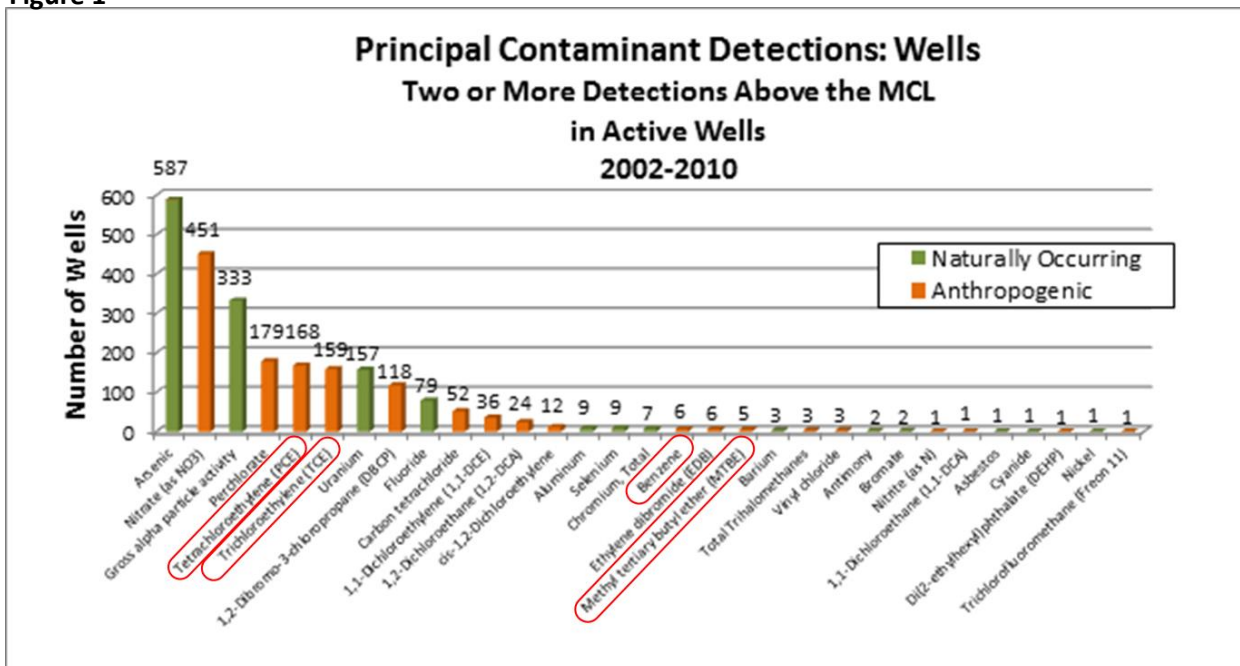
Tables and Figures

Table 1 – Case Types

LUST Case:	Contaminant(s):
Underground Storage Tanks (USTs)	Petroleum hydrocarbons

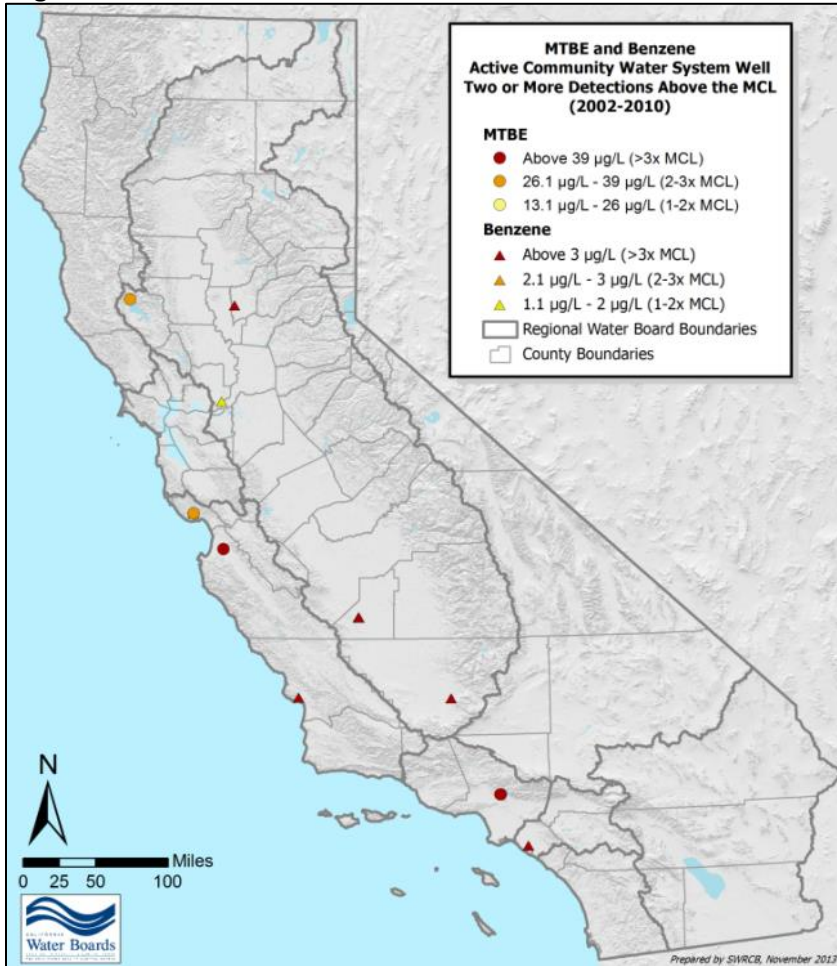
SCP Case:	Likely Contaminant(s):
Fireworks/Pyrotechnics/Weapon Sites:	Perchlorate
Agriculture:	Pesticides
Dry Cleaning:	PCE
Paints/De-Greasing:	Solvents
Metal Plating/Mine/Reclamation (Metals):	Metals
Fuel Storage/Waste Industrial/Waste Sewage:	Solvents and Petroleum
Tank Farms/Bulk Plants/Terminals/Spills:	Petroleum
Wood Treating:	PCBs, Metals

Figure 1



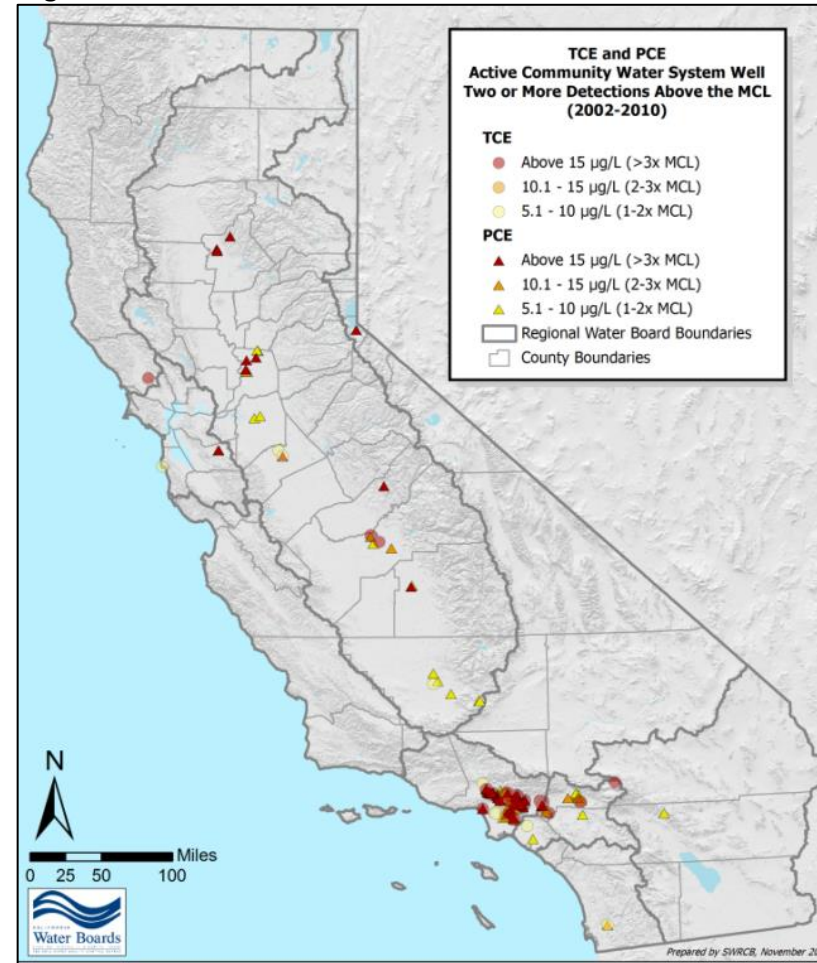
Source: AB 2222 Final Report to Legislature: *Communities That Rely on a Contaminated Groundwater Source for Drinking Water*, Figure 4 (page 16)

Figure 2



Source: AB 2222 Report dataset; locations are approximate.

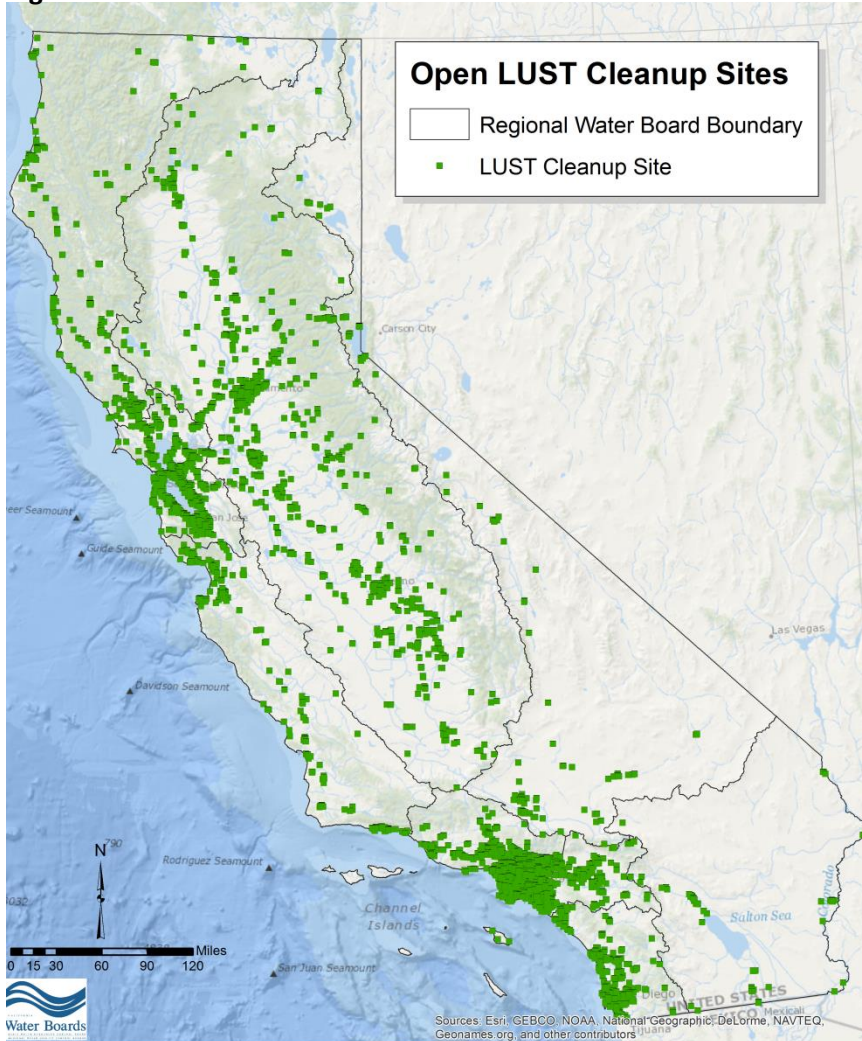
Figure 3



Source: AB 2222 Report dataset; locations are approximate.

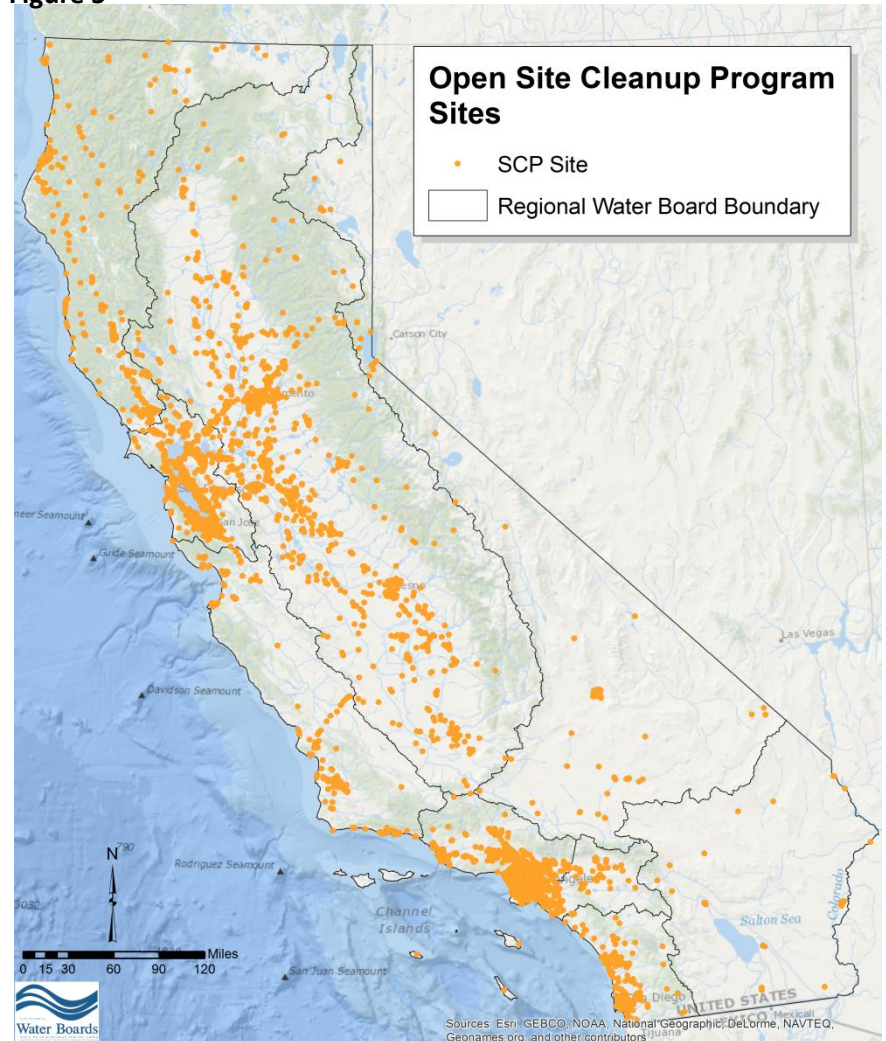
Note: The two above maps were compiled using the AB 2222 Report dataset. They were modified from the original report to show MTBE (5) and benzene (6) impacted wells on a single map, and to show TCE (159) and PCE (168) impacted wells on a single map.

Figure 4

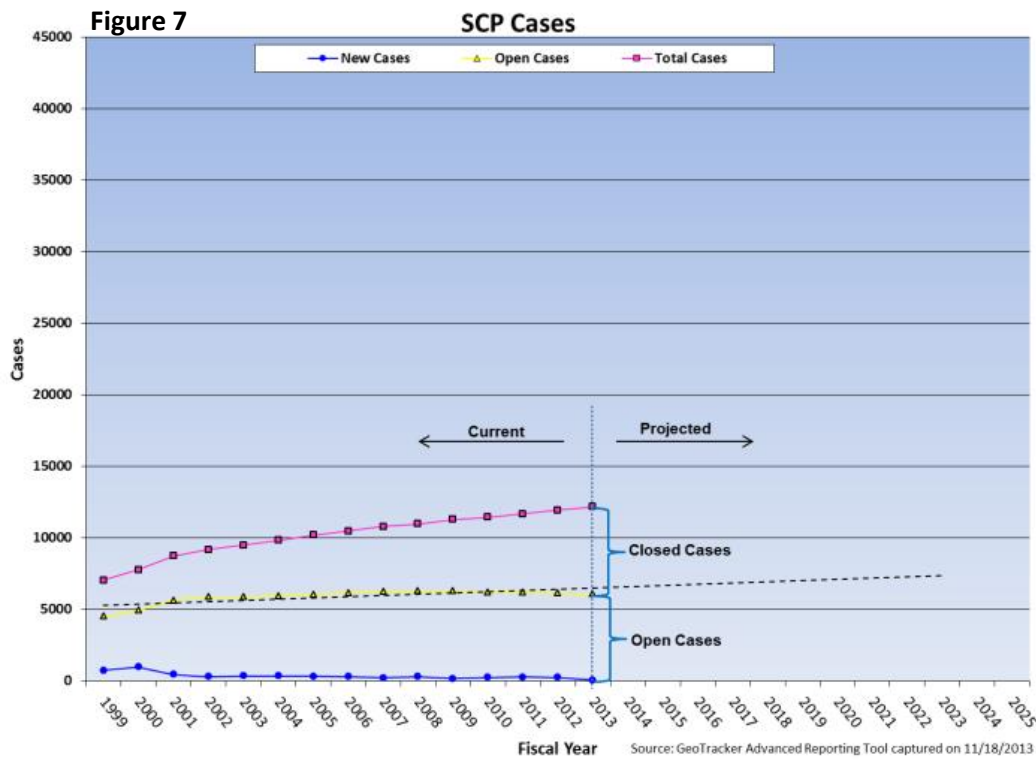
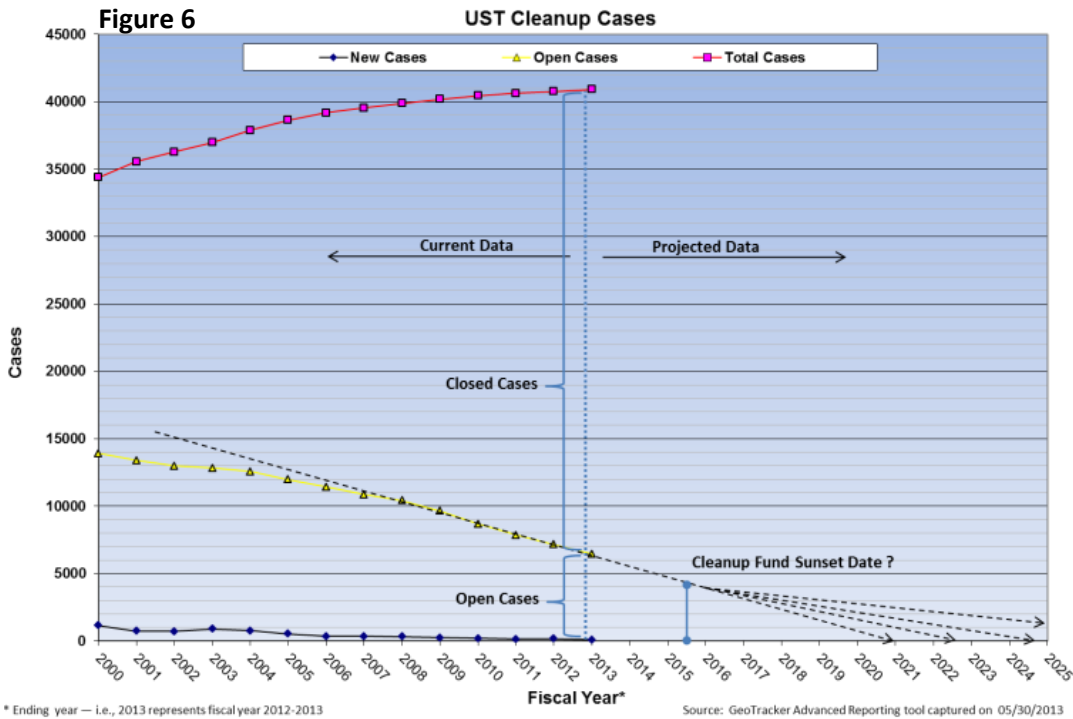


Source: GeoTracker as of 6/1/2014 (5,517 sites)

Figure 5



Source: GeoTracker as of 6/1/2014 (5,667 sites)



Note: New Cases are cases opened during the calendar year. Open cases include all active and inactive open cases and include new cases. Total Cases include all open and closed cases.