# GROUNDWATER INFORMATION SHEET

# 1,4 Dioxane

*The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The information provided herein relates to groundwater sources used for public drinking water, not water served at the tap.*

| GENERAL INFORMATION | |
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| **Constituent of Concern** | 1,4 Dioxane |
| **Synonyms** | 1,4 Diethylene dioxide, 1,4 Dioxacyclohexane, *p*-dioxane, Glycol ethylene ether, Diethylene ether, Dioxane |
| **Chemical Formula** | $C_4H_8O_2$ |
| **CAS No.** | 123-91-1 |
| **Storet No.** | A-032 |
| **Summary** | The State Water Resources Control Board - Division of Drinking Water (SWRCB-DDW) has adopted a drinking water notification level (NL) of 1 microgram per liter (µg/L). 1,4 Dioxane is primarily used as stabilizer and solvent. It is also a component of some cosmetics, detergents, and shampoos. The US Environmental Protection Agency (US EPA) classifies 1,4 Dioxane as a possible human carcinogen. 1,4 Dioxane is highly soluble in water. Exposure pathways include ingestion of drinking water, inhalation of vapors, and workplace contact. Maximum contaminant levels (MCLs) have not been established for 1,4 Dioxane.<br><br>Based on SWRCB-DDW data from 2006 to 2016, 184 active and standby public water wells (of 12,237 sampled) have had detections of 1,4 Dioxane above the NL. Most detections occurred in Los Angeles (154) and Orange (25) counties. There were also two detections above the NL in Sacramento county. |

| REGULATORY WATER QUALITY LEVELS[1]<br>1, 4 DIOXANE | | |
|---|---|---|
| **State and Federal MCLs have not been established for this constituent.** | | |
| **Type** | **Agency** | **Concentration** |
| Health Advisory Level, based on 1 in $10^{-6}$ cancer risk | US EPA[2] | 0.35 µg/L |
| State NL[3] | SWRCB-DDW[4] | 1 µg/L |
| Public Health Protective Concentration | OEHHA[5] | 3 µg/L |
| Source Removal (Response Level) | SWRCB-DDW[4] | 35 µg/L |

[1]These levels are generally related to drinking water. Other water quality levels may exist. For further information, see "A Compilation of Water Quality Goals", 17th Edition (Marshack 2016).
[2] US EPA – United States Environmental Protection Agency
[3] The NL is only for the ingestion of drinking water, and does not take in to consideration possible dermal or inhalation exposures resulting from typical household uses of water containing a specific constituent of concern. Prior to 2004, NLs were referred to as "Action Levels" in California.
[4] SWRCB-DDW – The California Department of Public Health Drinking Water Program was transferred to the State Water Resources Control Board, Division of Drinking Water in 2014.
[5] OEHHA – Office of Environmental Health Hazard assessment

| 1,4 DIOXANE DETECTIONS IN PUBLIC WATER WELL SOURCES[6] | |
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| Number of active and standby public water wells with 1,4 Dioxane[7] detections | 1,4 Dioxane was detected in 199 wells (12,237 wells tested). |
| Number of active and standby public water wells with 1,4 Dioxane concentrations >1 µg/L. | Concentrations detected above the NL in 184 public groundwater sources. |
| Counties with detections in wells above NL | Los Angeles (154), Orange (25), Sacramento (2) |

[6] Water from public active and standby public groundwater sources is typically treated to prevent exposure to chemical concentrations above MCLs. Data from private domestic wells and wells with less than 15 service connections are not available.
[7] Based on 2006-2016 public standby and active well (groundwater sources) data collected by the SWRCB-DDW.

| ANALYTICAL INFORMATION | | |
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| **Method** | **Detection Limit** | **Note** |
| **EPA 522** | 0.020-0.036 µg/L | Drinking water |
| **Modified EPA 8260** | 0.5-10.0 µg/L | Groundwater, hazwaste |
| **Known Limitations to Analytical Methods** | Measurement of 1,4 Dioxane at the micrograms per liter level (µg/L) can be difficult due to its high solubility in water. | |
| **Public Drinking Water Testing Requirements** | Testing is required, although an MCL has not been established for this constituent. Notification is recommended by SWRCB-DDW if concentrations above 1 µg/L are observed. | |

| 1,4 DIOXANE OCCURRENCE | |
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| **Anthropogenic Sources** | 1,4 Dioxane is primarily used as a stabilizer for chlorinated solvents. It is also used as a solvent for a number of compounds including resins, oils, fats, waxes, and greases. 1,4 Dioxane is also found as a byproduct in cosmetics and shampoos. 1,4 Dioxane is widely manufactured and distributed in the United States. Its occurrence as a byproduct in cosmetics is decreasing due to revised methodologies. |
| **Natural Sources** | 1,4 Dioxane is a manufactured chemical that does not occur naturally in the environment. |
| **History of Occurrence** | The compound has been manufactured since the 1950s. As of 2001, 22 different domestic suppliers have been identified for 1,4 Dioxane. Production of the chemical has fallen significantly from the nearly 15 million pounds produced in 1982, possibly because most uses of trichloroethane, to which it was added as a stabilizer, have been banned in this country. According to the Toxic Release Inventory for 2014, 96,437 pounds of 1,4 Dioxane were released to the air, 24,262 to surface water, none to land, and 422,943 pounds were transferred from the facility for off-site disposal. The occurrence of 1,4 Dioxane in the environment is thought to be related to the disposal of chemical solvents containing dioxane and from disposal of 1,4 Dioxane itself. Subsequent leaching of the chemicals from landfills has resulted in contamination of groundwater. |
| **Contaminant Transport Characteristics** | 1,4 Dioxane is a volatile, flammable, colorless liquid at room temperature. It is miscible with water and highly mobile in soils, where it can rapidly migrate to groundwater. 1,4 Dioxane has been observed above notification levels in groundwater and public groundwater sources in California. |

## REMEDIATION & TREATMENT TECHNOLOGIES

Some types of chemical treatment are highly effective in removing 1,4 Dioxane from water. Advanced oxidation processes, which use peroxide and Ultraviolet light (UV) or ozone, have been shown to destroy 1,4 Dioxane. Chlorination has also been found to be effective for the removal of 1,4 Dioxane. However, the byproducts that result from chlorination of 1,4 Dioxane are significantly more toxic than 1,4 Dioxane itself. Standard wastewater treatment methods and conventional activated sludge methods have proven to be ineffective. Air-stripping and granular activated charcoal do not remove 1,4 Dioxane from water.

Experimental remediation techniques include the use of specialized bacteria in bioreactors under specific conditions and phytoremediation, where trees are used to draw shallow groundwater towards the surface as well as remove the constituent of concern.

## HEALTH EFFECT INFORMATION

The primary exposure pathways for 1,4 Dioxane are through inhalation, ingestion, and dermal exposure. Inhalation of vapors can occur through occupational contact and through contact with water containing 1,4 Dioxane. Ingestion can occur through drinking contaminated water. Dermal exposure can occur at manufacturing facilities and through use of household products including cosmetics and shampoos. While trace amounts of 1,4 Dioxane are found in some cosmetics and shampoos, the levels observed in these products are generally very low.

Few studies are available that provide information about 1,4 Dioxane in humans. Deaths have been reported from accidental exposures to high amounts of vapors and skin absorption. Studies with workers exposed to lower levels of 1,4 Dioxane for longer time periods did not show significant harmful health effects. Controlled exposure of volunteers to the airborne contaminant for periods ranging from a few minutes to 6 hours produced eye, nose, and throat irritation.

Information was not available regarding reproductive, developmental, or immunological effects of 1,4 Dioxane in humans. However, available data is sufficient to clearly identify the liver and kidney as the target organs for 1,4 Dioxane toxicity following short-term exposure to relatively high concentrations regardless of the route of exposure. These findings have been corroborated in animal studies.

## KEY REFERENCES

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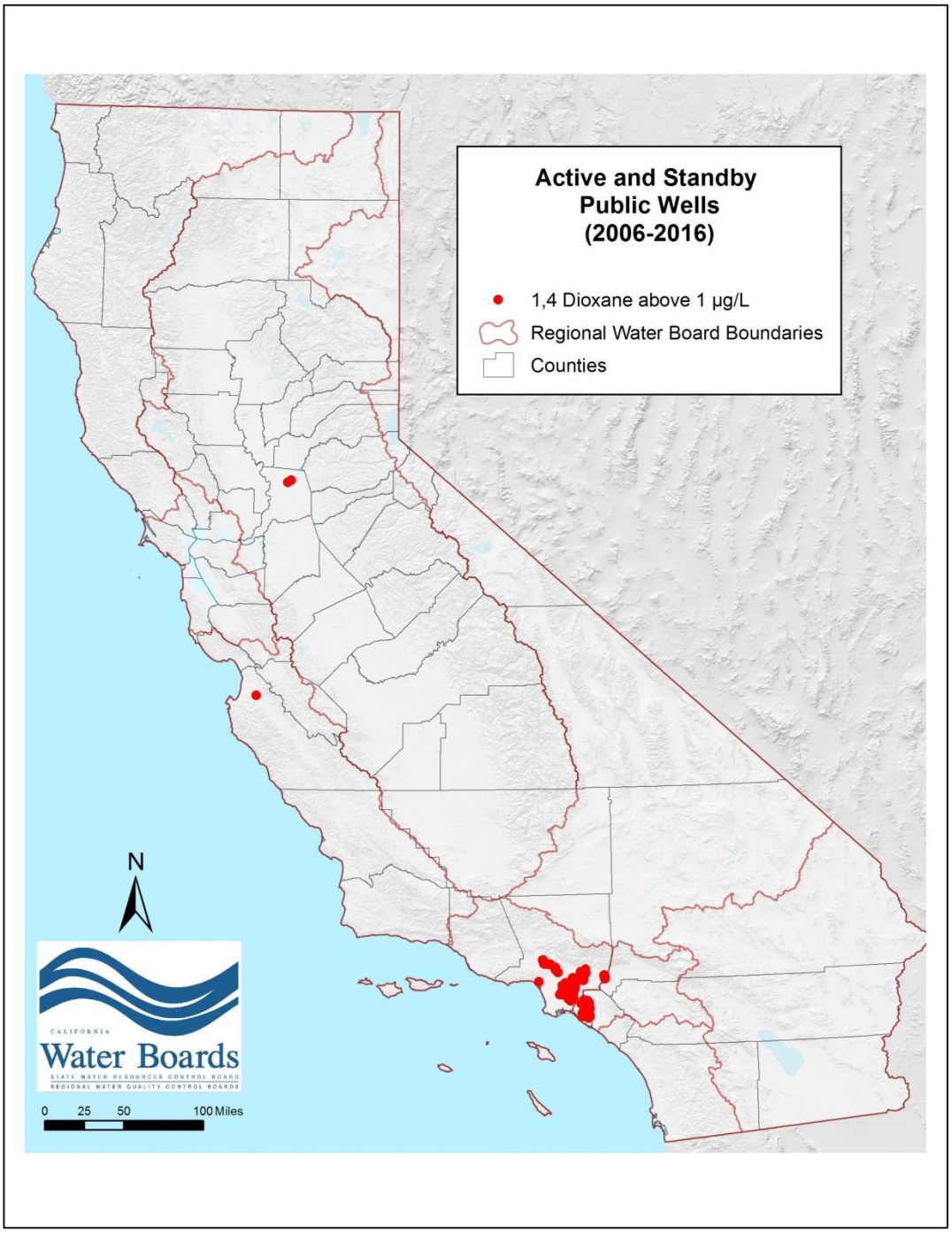


**Active and Standby Public Water Wells with at least one detection of 1,4 Dioxane above the NL, 194 wells.** *(Source: Public Well Data using GeoTracker GAMA).*