ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

LAYTONVILLE LANDFILL
LAYTONVILLE, MENDOCINO COUNTY, CALIFORNIA
EPA FACILITY ID: CAD000065532
MARCH 22, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Additional copies of this report are available from:
National Technical Information Service, Springfield, Virginia
(703) 605-6000

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

PUBLIC HEALTH ASSESSMENT

LAYTONVILLE LANDFILL
LAYTONVILLE, MENDOCINO COUNTY, CALIFORNIA
EPA FACILITY ID: CAD000065532

Prepared by:

California Department of Health Services
Under a Cooperative Agreement with
The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia

Table of Contents

Summary

The California Department of Health Services (CDHS) prepared this public health assessment (PHA) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). PHAs provide communities with information on the specific hazardous waste sites that may affect the health of community members and identify populations for which further action is needed. The PHA process includes studying environmental data and identifying ways that people may be exposed (exposure pathways) to see if contaminants (chemicals) from a hazardous waste site or industrial facility might affect or has affected the health of people in the surrounding communities. An important part of the PHA process is identifying and responding to community health concerns. CDHS carried out numerous community outreach activities to gather and understand health concerns that community members believe are related to the Laytonville landfill operation and/or contamination.

The Laytonville landfill is 170 miles north of San Francisco and 20 miles north of the town of Willits, in Mendocino County, California. It is located near the town of Laytonville and next to the Laytonville Rancheria, home of the Cahto Tribe. The landfill operated as a municipal waste landfill between 1974 and 1993. During that time, the landfill received about 18,000 tons of waste. The specific contents of the landfill are unknown and were unregulated. Reports by community members and others claim that unlawful dumping of hazardous wastes occurred often. The landfill was closed in 1993 and capped in 1997. The landfill is not lined. There is no active leachate (water that trickles through the landfill waste and may contain chemicals from the waste) or collection systems for landfill gas (vapors formed from the breakdown of the landfill waste) on site. The site has five groundwater monitoring wells, passive gas vents, and gas monitoring wells along the edge of the landfill.

CDHS became involved with the landfill in February 2000 in response to the health concerns of residents of the Laytonville Rancheria. Rancheria residents were and are highly concerned about possible health effects from past and current exposures to contaminated air, surface (drinking and bathing) water, groundwater, and surface soil. Tribal members are afraid that people who scavenged and played on the property may have been exposed. They are also concerned about past and continuing exposures of tribal members and other neighbors who live next to the landfill. Members of the tribe expressed concern about playing, swimming and fishing in Cahto Creek. Nearby residents who do not live on the Rancheria also worry that they may be exposed to contaminants from the landfill and about their health. They are concerned about the drinking water they get from their private wells and about the trash burning that used to occur on the landfill. CDHS heard many health concerns, including breathing (or respiratory) problems, cancer, gall bladder disease and other stomach and gut (or gastrointestinal) problems, developmental disabilities, and reproductive difficulties. After reviewing available information, CDHS could not conclude that any of these health concerns and effects could have been caused by the landfill. Information gaps limit the conclusions for some exposures that were investigated. However, CDHS understands that residents have health concerns and makes recommendations to address their concerns.

CDHS evaluated twelve possible exposure pathways from the Laytonville landfill. CDHS had limited information upon which to decide if and how residents were affected by the landfill. The findings are below.

Before the cap was placed on the landfill, people who had contact with the trash may have been exposed to chemicals and live bacteria and viruses. Sharp, rusty objects in the trash are a hazard to anyone who scavenged or played at the landfill. CDHS could not account for these types of hazards because there are no records. After the cap was placed on the landfill in 1997, it was no longer possible for anyone to come into direct contact with the trash. However, the landfill has and continues to have a mental and emotional impact on community members.

Using existing information, CDHS believes that these activities pose no apparent health hazard:
1. playing in the leachate;
2. swimming in the sedimentation ponds on landfill property;
3. playing in Cahto Creek or in puddles that formed from surface water runoff; and
4. eating fish or eel from Cahto Creek.

However, being exposed for a long time to the liquid that periodically leaks from the edges of the cap could be hazardous to a person's health. The cap should be looked at and tested to see if it is working properly. Until the cap leaking problem ends, testing of any and all liquids that leak from the cap should be carried out. Even though Cahto Creek is not a public health hazard, tribal members are still worried about it. CDHS will work with the Cahto Tribe to access resources and the needed expertise to restore Cahto Creek so that tribal members can use it without worry for recreation, fishing, and other activities.

CDHS could not evaluate two pathways because of a lack of data:

1) The health hazard from breathing in outdoor air on and around the landfill from the 1960s to 1997 (before the cap was placed on the landfill) cannot be determined. This is because not enough sampling was done while the landfill was in operation, especially when trash was burned. Open burning of vegetation to reduce fire hazard sometimes occurs on the landfill. CDHS recommends alternatives to open burning be utilized to deal with vegetation control on the landfill and elsewhere. CDHS recommends that the air district and the Tribe raises the awareness within their communities of the environmental effects of garbage burning, the air district strictly enforces the current prohibition of garbage burning, and the Tribe regulates such activity.

2) Because of the lack of soil samples, skin contact and ingestion of off-site soil could not be determined and is considered a potential exposure pathway. Nearby residents who live northeast and southwest of the landfill might have been exposed to contaminants in the off-site soil. Those contaminants may have come from the surface water runoff from the landfill. Nearby community members have expressed concern about contamination from the runoff. CDHS recommends off-site soil sampling on the landfill where open burning occurred and the area is still exposed.

CDHS concludes that the levels of acrolein, α-pinene, and benzene found in outdoor air sampling are not a health hazard. They probably arise from sources such as wood-burning fireplaces and automobile traffic.

CDHS concludes that chemicals found in nearby city drinking water system do not come from the landfill. The levels of arsenic and manganese found in the untreated city water supply are natural. The treated water meets current drinking water standards for these chemicals.

CDHS concludes that the extent of contamination in the groundwater is unknown because of incomplete information. Several metals found in water samples from eight private wells near the landfill were above the drinking water standards. It is unclear what the source of these metals is. Aluminum, barium and manganese are naturally occurring in Laytonville water, making it difficult to know whether the landfill is affecting the adjacent private wells. CDHS recommends additional studies of the groundwater. To make sure that private well owners know if their water is affected by the landfill, we recommend a survey of wells near the landfill and sampling of private wells adjacent to the landfill as part of the quarterly groundwater monitoring program. CDHS will work with the county to share information with private well owners about water sampling results and possible health issues. Also, CDHS will give general public health information about private wells to nearby residents.

CDHS also looked at two sources of health outcome data; 1) a 1994 cancer cluster investigation by the Mendocino County Health Department (MCHD); and 2) a California Cancer Registry (CR) cancer case summary. The cancer cluster investigation was done to find out if the number of cancer deaths from 1974 to 1994 among people living near the landfill was higher than the expected rates for this community. The findings showed that cancer mortality rates within a 1-mile radius of the landfill were similar to those for Mendocino County as a whole. It is possible that inaccuracies in cancer mortality records limited the ability of the studies to estimate cancer rates for this population. Although the MCHD and CCR cancer estimates may be somewhat wrong, there is no way to get a more accurate estimate.

CDHS will meet with community members, including the Cahto Tribe, to communicate the findings of this PHA. CDHS will work with other agencies, the community, and the Cahto Tribe to carry out the recommendations previously described. Some of the recommendations are already being implemented.

Statement of Issue

The Agency for Toxic Substances and Disease Registry (ATSDR), located in Atlanta, Georgia, is a federal agency within the U.S. Department of Health and Human Services. ATSDR, under the Comprehensive Environmental Response, Compensations, and Liability Act (CERCLA) of 1980, is mandated to conduct public health assessments at hazardous waste sites on the National Priorities List (NPL). This public health assessment (PHA) was prepared as part of a cooperative agreement between the California Department of Health Services (CDHS) Environmental Health Investigations Branch (EHIB) and ATSDR.

In February 2000, the U.S. Environmental Protection Agency (U.S. EPA), Region IX, contacted ATSDR to follow up on community health concerns related to the Laytonville landfill. ATSDR asked CDHS-EHIB to investigate the source of these concerns. The conclusions of the investigation are presented in this PHA. Those conclusions derive from site visits, reviews of site-related environmental data, community interviews, evaluations of the potential for exposure to site-related contaminants, and consultations with relevant agencies.

In this document, CDHS and ATSDR evaluate exposures and determine whether health effects are likely to occur because of past, current, or future exposure to landfill contamination. The conclusions of this PHA for the Laytonville landfill site are based on three types of information collected or developed for the site: environmental data, cancer data for the area, and community concerns. These data were integrated with estimates of exposure, epidemiological, and toxicological data.

This document is divided into the following sections:

- Background information, with an overview of the historical operations and investigations at the landfill, a description of the landfill, its surrounding area, and its natural features and population;
    A. An evaluation of 12 exposure pathways and the likelihood that they occurred or are occurring;
    B. For those pathways that occurred or likely to have occurred, an estimation of exposure is developed;
- A toxicological review of the estimated exposures for non-cancer and cancer health effects;
- A summary of the outreach efforts for collecting community concerns and the community health concerns;
- A response to some of the community concerns, developed from the pathway exposures/toxicological evaluation and a groundwater health consultation;
- A review of previous cancer surveillance data collected in the Laytonville area;
- A conclusion section that describes the hazard posed by the site;
- Recommendations that outline suggested follow-up actions, including additional sampling, health education, and other public health actions;
- A public health action plan that describes completed, ongoing, or planned activities.

- The most pertinent information about potential health affects from the site is presented in the main body of text. Additional information is presented in the appendices, including a glossary of terms (Appendix A).

This PHA contains a great deal of information from a variety of scientific fields. Each section includes background information so that the text flows logically. For example, the beginning of the section about pathways describes the science and assumptions behind evaluating the risks related to that pathway. Sources of data and scientific information used in the preparation of the PHA are referenced in the text using a numbering system in parentheses. The references that correspond to those numbers are presented at the end of the main body of the text.

Background

Laytonville is 170 miles north of San Francisco and 20 miles north of the town of Willits, in Mendocino County, California (Figure 1). This is a mountainous, rural region with very low population density. The Laytonville landfill is located at 1853 Branscomb Road, 1.7 miles southwest of downtown Laytonville The Laytonville landfill is bordered to the north by a residential neighborhood with parcels typically 1–2 acres in size. To the east and south lies another residential neighborhood on the Laytonville Rancheria of the Cahto Tribe. Approximately 40 people live on the Laytonville Rancheria. To the west is a privately-owned cattle ranch. There are roughly 117 households within 1 mile of the landfill (Figure 2).

Site Description and Site History

The landfill forms a hill. The elevation of the site ranges from about 1,760 to 1,800 feet above mean sea level (Figure 4) (1, 2). Originally, the surface of the landfill was best described as a saddle, with upturned edges and a recessed bowl on top. The landfill waste was placed on top, in the bowl (Figure 4). As time progressed, the waste filled the bowl and gradually covered the sides of the hill. The angle of the southern slope is 21 degrees; that of the western slope is 26 degrees. Because the waste is on top of the hill, it is higher than the surrounding ground surface in all directions (Figure 4). The northeastern and southwestern corners of the landfill are especially low in comparison with the waste.

During the late 1960s and early 1970s, the landfill site was used as a “burn dump” for household and municipal waste. In 1974, the Mendocino County Department of Public Works (MCDPW) requested and received a permit to use 1 acre of the site for landfill waste. From 1974 to 1993, MCDPW was responsible for the landfill. Over the years the landfill expanded such that it now encompasses 4.7 acres of the 35 to 37 acres (Figure 3) (1, 2). From 1974 to 1993, the daily intake was about 2.5 tons per day (3). The total mass of waste is about 18,000 tons. The land under the waste was never lined and there was no leachate collection system built under the refuse. During operation of the landfill, MCDPW staff sporadically covered the waste with 6-inch layers of dirt. During the first few months of 1993, the waste was covered daily with 6 inches of dirt. Nearby residents reported continued burning of landfill wastes, often on a monthly basis, from 1974 to

1987. While the landfill was open there were sporadic reports of foul odors, litter, surface water runoff, and other issues (5, 6). The MCDPW, the Mendocino County Department of Environmental Health (MCDEH), and the North Coast Regional Water Quality Control Board (NCRWQCB) noted problems with the landfill on many occasions (7-10). For instance, MCDEH noted five violations occurring at the landfill in 1986. Those included uncovered refuse, leachate coming from recent disposal area, slope erosion, litter accumulation, and neighbors and dogs entering the site to scavenge and salvage (10).

Many reports from the first few years of the landfill's operation contain visual estimates of leachate amounts ranging from 3 to 20 gallons (9, 16). In 1986, several nearby residents wrote letters to MCDPW and NCRWQCB describing the leachate they saw reporting 'bright yellow' runoff water. This was confirmed by a NCRWQCB inspector (9). At that time, very limited water analyses were conducted. The results of these tests are described in the *Environmental Contamination* section. In 1991, 17 years after the landfill first opened, regular water analyses of the surface water runoff began. These were tested primarily for metals, inorganic compounds, VOCs, and pesticides.

In 1993, a group of residents exerted public pressure and persuaded the Mendocino County Board of Supervisors to close the landfill. Waste was no longer accepted and a 6-foot chain link fence was erected around the waste area of the landfill (2). Refuse at the Laytonville landfill is in a mound that extends 40 feet deep at its highest point.

Landfill Closure

In 1993, a draft closure plan was created (2). In 1993, the Mendocino County Solid Waste Management Division (MCSWMD) was created. One of its responsibilities was to close the landfill. The closure that occurred in 1997 included a) capping the landfill waste, b) surface water run-off control, c) placing pipes vertically through the cap to vent landfill gases, d) placing a pipe leading from the waste to outside the cap to drain leachate, e) installing and monitoring additional and existing landfill gas wells, f) ground-water monitoring plan, and g) site security. The following sections describe the various aspects of the closure and their status.

Cap

The cap consists of several layers that are a total of approximately 3.5 feet thick (Figure 4) (2, 13). The cap consists of 2 feet of foundation soil covered by a layer of geosynthetic components that is a few inches thick. The geosynthetic layer forms the barrier layer. A barrier layer is supposed to be impermeable to water and thus keep rainwater from reaching the waste and creating leachate. Above this, there is about 1.5 feet more of soil with vegetation growing in it (vegetative layer). The vegetative layer protects the integrity of the barrier layer.

Since 1993, the Mendocino County Health Department (MCHD), California Air Resources Board (CARB), California Department of Fish and Game (CDFG), U.S. EPA, Cahto Tribe and

California Office of Environmental Health Hazard Assessment (OEHHA) have also provided input on the landfill ‘s effects. The U.S. EPA Indian Programs Office currently funds an environmental grant for the neighboring Cahto Tribe. The grant has been used, in part, to determine the affect of the landfill on the Laytonville Rancheria.

The landfill is capped with approximately 3.5 feet of soil and vegetation (Figure 4) (2, 13). The cap consists of 2 feet of foundation soil covered by a layer of geosynthetic components that is a few inches thick. The geosynthetic layer forms the barrier layer. A barrier layer is supposed to be impermeable to water and thus keep rainwater from reaching the waste and creating leachate. Above this, there is about 1.5 feet more of soil with vegetation growing in it (vegetative layer). The vegetative layer protects the integrity of the barrier layer.

The California Integrated Waste Management Board (CIWMB) and MCSWMD have questioned the integrity of the cap, in particular the vegetative layer (11, 12, 94). In summer, the vegetative layer of the cap cracks because of the drying of the clay in the dry climate. There have also been reports of small burrowed holes in the cap, which may be caused by erosion or small rodents, such as voles (14).

The cap was supposed to block surface water and prevent it from seeping into and flowing through the refuse and resurfacing as contaminated leachate. However, swampy areas around the base of the steeply sloped landfill, primarily on the west side, but also on the east and south sides occur during the rainy season. VOCs released and/or produced in the landfill are thought to be dissolving in the rainwater at the bottom edges of the cap. MCSWMD and NCRWQCB have referred to this liquid as leachate. Because it is not true leachate, in that it is liquid that has not had contact with the waste, CDHS distinguishes it as “leachate.” A particularly bad episode of cap leaking along the slopes occurred in February 2000. A 30-feet-wide and 30-feet high seep, accompanied by foul-smelling air and “leachate,” was discovered by MCSWMD staff (or a nearby resident) at the base of the cap on the eastern slope (14, 15). A French drain (a trench filled with gravel) was placed on the east side to divert the “leachate” to the leachate tanks.

Apparently, the appearance of “leachate” at the bottom of the slopes occurs because there is no “daylighting” of the cap, which involves extending the plastic middle layer of the cap beyond the upper and lower layers of soil. This helps maintain the integrity of the underlying soil. Without this feature, the vegetative layer of the cap can erode and a landslide can occur. Because the cap was not properly “daylighted,” surface water backup occurred. The county corrected the cap edge on the eastern slope and fixed a similar problem on the north side. There were also concerns that some of the refuse was not covered with the barrier layer.

Apart from the problems with the leaking slopes, CIWMB and MCSWMD have concluded that the cap was not constructed properly and is not in compliance with California solid waste management regulations. The concern is related to slope stability under seismic conditions (95, 96). MCSWMD’s consultants conducted a slope stability evaluation (13). The slope stability analysis considered overall stability of the landfill and stability of the cap. The analyses considered both static and dynamic (earthquake) conditions by using data about the properties of

the native and fill materials and material strength of the barrier layer. The slope stability analyses indicate that the overall stability of the existing landfill is adequate. The slope stability conditions of the landfill's cap are considered problematic.

According to the NCRWQCB there are no practical tests to directly determine overall barrier layer integrity (97). If there is a crack or tear in the barrier layer, something would be suspected because the vegetation growing in the vegetative layer would be in distress (brown or dying). MCSWMD staff are supposed to regularly inspect the landfill.

Leachate

In 1993 and 1994, leachate tanks were installed in two locations on the east and west sides to collect the liquid that leaked out of the disposed waste (2). Previously, 55-gallon drums had been used for this purpose, with limited success. The west slope location was abandoned after the final cover installation. The eastside leachate tank system remains and has been improved to handle the water draining from the east slope French drain. MCSWMD refers to these tanks as leachate storage tanks. The collected liquid is tested and taken to Willits, California, for treatment.

In the mid-1990s when the landfill was being prepared for capping, a pipe was placed in the waste to drain leachate as it formed. The pipe exits on the eastern slope of the landfill. There has been no flow out of it but it could be blocked as an attempt to investigate its integrity failed.

Surface Water Runoff

In the mid-1980s, sedimentation ponds were constructed to collect some of the surface water runoff from areas of the landfill where the refuse was not located. There are five sedimentation ponds on the site. Since 1993, the surface water runoff has been directed more intentionally into two sedimentation ponds: one in the northwest corner, the other in the southwest corner (Figures 4 and 5). In 1997, several ditches and earthen barriers were constructed to direct some of the surface water runoff into the sedimentation ponds and away from residential lots on the eastern edge of the landfill. The southwest sedimentation pond discharges to Cahto Creek; the northeast sedimentation pond discharges to a nearby creek/ditch. Water sampling has occurred at the runoff areas in the southwest and northeast since the 1980s, but the samples were not analyzed for VOCs and metals until 1990. There is also a lily pond in the northeast corner, which has been sampled on occasion (2).

In 1997, as part of the closure of landfill, MCSWMD constructed culverts from 18-inch half-rounds of metal, to help carry the surface water toward the two sedimentation ponds. As expected with the settling of the soil after closure, 2–3 inch gaps were created. According to the NCRWQCB, "where the half-rounds were not functioning, the water appears to have flowed beneath the half-rounds, following their path to the sediment ponds (97). The half-round drainage system has been replaced in all critical drainage (main topdeck, south swale, and west sedimentation pond) areas by rock-lined ditches.

There have been specific instances in the past when the sediment ponds have overflowed. The 'CRWCB states, “there is not any rain water at the site which runs off a waste surface (97).

Landfill Gas

Each quarter, MCSWMD samples seven landfill gas monitoring wells around the perimeter of the waste site to check for landfill gas production (methane), using a hand held instrument (Figure 3) (2). MCSWMD installed five gas monitoring wells in 1994; two additional gas monitoring wells were added in 1997.

Passive vents allowing for the release of landfill gases were installed at the time of the cap construction. There is no landfill collection system. VOCs have been measured in the water coming off sides of the landfill. It has been suggested that the VOCs are from landfill diffusing across the barrier layer and becoming dissolved in the water draining off the barrier layer. This puts in question the effectiveness of the passive venting system to adequately resolve the landfill created by the waste as it ages.

Groundwater

The MCSWMD installed eight groundwater monitoring wells on the landfill property (Figure 3). Three of these wells have been decommissioned, and five are currently active. The wells are sampled quarterly for a variety of chemicals.

MCSWMD monitors groundwater on a quarterly basis, as state law requires. The NCRWQCB has regulated the groundwater and surface water runoff monitoring and analytical results since 1974. At no time has there been a decision by any regulatory agency to remove waste from the site.

Site Security

A six-foot fence surrounds the waster area of the landfill. A gate at the entrance to the property at Branscomb Road blocks vehicular traffic. Signs of trespassing onto the landfill have been noted. During U.S. EPA’s visit in August of 2002, they noted the top of the fence was bent in the south-west corner of the landfill area and noted a small trail in the grass leading from the corner. Also, the MCSWMD reported in 2002 that: vandals once rolled approximately one hundred of the used tires holding down the covering on the south side of the landfill down the steep slope and into the fence; one of the water treatment tanks was stolen; and 55-gallon drums attributed to Cahto Tribe sampling wastes were left on the landfill (98).

Burning on the Landfill

On occasion, MSWMD has obtained a permit to burn vegetation on the landfill as a means of fire hazard control. In 1997, a California Air Resources Board (CARB) staff person investigating

reports of a “burn,” witnessed a second burn while investigating the remains of the first burn (17). Though the county had obtained a permit for the open burn, CARB found non-approved materials in the burn pile (18). CARB ordered the county to cease burning debris or other non-vegetation waste on the property. According to the MCSWMD, vegetation was required to be cleared in preparation for the 1997 Final Cover installation. These large piles of vegetative material, or "slash", were added to preexisting slash piles. Unfortunately, the existing slash piles were not checked for other material prior to MCSWD employees adding more slash on-top and burning the piles.

Site Visit

From 2000 to 2003, CDHS staff visited Laytonville and/or the landfill site ten times (see the Community Concerns Evaluation Section for a summary of some of the visits). On May 23, 2000, CDHS staff examined the site. The site visit, led by the director and another staff member of the MCSWMD, included a walking tour across the entire breadth of the landfill. There were no structures on the site, which is mostly soil covered by grasses. CDHS staff visited the location of a seep on the eastern slope. They also observed the locations of the sedimentation ponds, gas wells, groundwater monitoring wells, and surface drainage culverts. The visit revealed no evidence of contamination nor any physical hazards. The waste-containing area of the landfill is surrounded by a 6-foot fence. The main gate located at Branscomb Road is designed to prevent automobile traffic and is easily passed by stepping over it. Signs alert people that the property is closed. The fence appeared to be in good repair and there were no signs of trespass. After the on-site tour, CDHS staff took a driving tour of the Laytonville Rancheria and Cahto Creek, led by a member of the Cahto Tribe. The rancheria is contiguous with the landfill on the east and south side. Cahto Creek flows within 500 feet of the landfill and through the rancheria. Staff also took a walking tour to visit the shared boundary between the rancheria and the landfill and to observe the proximity of rancheria houses to the landfill.

On August 9, 2000, CDHS staff conducted door-to-door interviews with residents of the neighborhood north of the site (Figure 2). CDHS staff also conducted a self-led driving tour of other pertinent features in the area. These included a dumping ground for household waste used during the 1950s and Cahto Lake, which is ¼ mile downgradient from the landfill, surrounded by numerous households. This lake was used by two pulp mills in the 1950s and 1960s for floating and storing timber. There is a broad plain of marsh around the lake. CDHS staff also visited Laytonville on three other occasions to gather community exposure and health concerns and to hold meetings with interested residents.

Demographics, Natural Resource Use of Surface Water and Groundwater

Demographics

According to the 2000 U.S. Census, Laytonville, California, is located in census tract 102, Mendocino County, and had a population of 1,301 (19). The female population was 647 (49.7%) and the male population was 654 (50.3%). The ethnic distribution was: White, 978 (75.2 %); American Indian/Alaska Native, 200 (15.4%); and other races or combination of races, 123 (9.4%). The total Hispanic or Latino population (of any race) was 108 (8.3%). The population by age groups was as follows: 381 (29.3%) were 0−19 years old, 763 (58.6%) were 19−64 years old, and 157 (12.1%) were older than 65 years. The Laytonville Rancheria, located in this census tract, is the home of the Cahto Tribe. The reservation boundaries shares two of its borders with the Laytonville landfill. The majority of American Indians in this census tract live on the rancheria.

Surface Water and Natural Resource Use

The climate of the Laytonville area is generally warm and dry in the summer, cool and rainy in the winter. The average temperature year round is 55°F (2, 20). The average high temperature is 70°F. The average low temperature is 40°F. The average annual precipation is 70 inches, which mostly falls between October and April (21).

The site is situated on a deeply-sloping area of high relief. The nearby peaks are about 4,300 feet above sea level, and the valley floor, which contains Cahto Creek, is about 1,600 feet above sea level. Mountain water drains into creeks and small tributaries. The small tributaries above the landfill join to form Cahto Creek. Cahto Creek flows around the west side of the landfill toward the south, then curves east and northeast, around the eastern edge of the landfill. This results in a general semicircle flow around the southern half of the landfill. At one point, the creek passes within 500 feet of the landfill (Figure 2) (1). The surface water runoff from one portion of the landfill flows into Cahto Creek at a point about 1,500−1,700 feet from the landfill. Cahto Creek joins with Ten Mile Creek in the eastern portion of Laytonville. Ten Mile Creek drains into the Middle Fork of the Eel river. The primary use of Cahto Creek is recreational and, within the rancheria, it is a dietary source of fish. It is not used as a source of drinking water or hydraulic power generation.

Cahto Creek is a spawning ground for king, silver, and sometimes steelhead salmon. Pacific lamprey (sometimes referred to as “eel” by local fisherman), yellow-legged frogs, crayfish, and the northwestern pond turtle also inhabit the creek (Personal communication, Scott Harris, fisheries biologist, California Department of Fish and Game, June 25, 2003). Fishing is not allowed under state law in the creek. This state law does not aply to the creek as it passes through the Laytonville rancheria and tribal members have described catching fish and eel in the creek.

In most years, Cahto Creek flows all year. In recent years, there have been times when it has not flowed in the summer. This was attributed to below normal precipitation during the rainy season, combined with surface water loss to groundwater. The groundwater is increasingly being pumped by new residents and a large ranch located downstream (Personal communication,

Warden Kucera, California Department of Fish and Game, June 19, 2003). The creek flow has also been affected by grazing of animals and other activities that produce erosion along the banks.

Area residents sometimes dump their garbage in the creek. The California Department of Fish and Game (CDFG) is responsible for cleaning up the illegal dumping, and in some cases they can find the responsible person. Within the rancheria, CDFG has no authority and according to the CDFG warden, the creek is littered with television sets and other litter (Personal communication, Warden Kucera, California Department of Fish and Game, June 19, 2003).

A trout farm is located on Cahto Creek above the rancheria. The creek was dammed in the 1940s to build the trout farm. The dam was eventually permitted, but it is not clear what changes have taken place to the dam and the impact the dam has downstream.

Groundwater and Natural Resource Use

The landfill lies in the Laytonville Valley. The Laytonville Valley was formed by geologic faults and is subject to erosion and continued fault movements (1, 13). Alluvial sediments were deposited and tilted following the valley formation. Later, the valley was widened by erosion and then filled with stream alluvium (sand, gravel, silt, and clay) to a depth of about 450 feet. Within 1 mile of the site, the alluvium is about 200 feet thick. Along the southern boundary of the landfill, an exposed hillside suggests that the alluvium is at least 150 feet thick at that point. The alluvium has the capacity to store and yield high volumes of groundwater. The municipal water supply draws mainly from this layer. The sand and gravel of the alluvium are relatively permeable. Construction logs from monitor wells suggest there are at least two aquifers within the alluvium on site. These aquifers may be unconfined or semi-confined. Underlying terrace deposits consist primarily of clay and silt. These terrace deposits are generally about 50 feet thick or less; one area near the landfill reaches a depth of 200 feet. Underneath the terrace deposits is Franciscan Melange bedrock. In drillings within 1–2 miles of the site, bedrock was about 320 feet below ground surface. The bedrock may contain a separate, additional aquifer in some areas.

Most of the groundwater in the Laytonville Valley comes from the 40-70 inches of rainfall the valley receives each year. About half the rainfall becomes stream runoff. The rest of the rainfall recharges the groundwater by infiltration from permeable stream beds, percolates into the bedrock, and evaporates.

The water table fluctuates seasonally, with the higher levels occurring in the spring. The lowest levels occur in the fall. The groundwater levels near the site tend to be about 1,625 feet above mean sea level in the spring, which is generally about 3–6 feet below ground surface. In the fall, the groundwater falls about 10–11 feet to 13–16 feet below ground surface.

The groundwater seems to flow radially away from the landfill but in a pattern complicated by diverse geology and aquifer configuration (2). The radial flow interpretation is consistent with

the topographic setting of the landfill's hilltop location. At present, the flow direction characteristics of the aquifers underlying the landfill have not been fully characterized. The current monitoring well arrangement does not allow a definitive conclusion about the flow direction of each aquifer (Appendix E, Health Consultation) (22).

Groundwater under the Laytonville Valley is the primary source of drinking water for Laytonville residents. The Laytonville County Water District was first created in 1979. The 1990 U.S. Census reports that 33% of the housing units get their water from the public water system or a private company (23). Until the late 1990s, the Laytonville County Water District obtained its water from two wells. The wells are located within 100 feet of each other in the eastern section of Laytonville, near Harwood Road (Figure 2). Well #1 is about 423 feet deep and was dug in 1951. Well #2 is about 528 feet deep and was dug in 1984. The use of Well #2 was discontinued September 1999, because of a low water level. It has not been used since. Therefore, Laytonville municipal water is supplied from one well now. The municipal water lines were first provided to some Laytonville residents in 1979 and to Laytonville Rancheria residents in 1984. In 1989, the municipal water lines were supplied to several houses in the area of North Road and Lakeview Avenue (Figures 2 and 5). In 1992, another seven houses toward the western end of North Road were supplied with municipal water (District manager, Laytonville County Water District, personal communication 2000).

According to the 1990 U.S. Census, 64% of the housing units (300 households) in census tract 102.05 (Mendocino County, California) obtain water from drilled and dug individual wells (23). Most of these wells draw from shallow aquifers that are around 30–50 feet deep. Very few residents, if any, have filtration systems other than water softening units.

There are approximately 73 private wells within a mile of the Laytonville landfill (24). Approximately 20 of these households use private wells, in addition to municipal water, for irrigation and gardening. Three households that directly border the landfill rely solely on private wells, not municipal water. Several other households across the street from the landfill use only private well water.

Environmental Contamination, Pathways Analysis, and Public Health Implications

This section examines the pathways for exposure to contamination from the Laytonville landfill. In it, CDHS examines each of the media (soil, landfill gas, air, groundwater, private well water, and municipal water) to determine whether or not contamination is present. (25). If people are exposed to contamination in any of the media, CDHS evaluates whether there is enough

contamination to pose a hazard to people in the community. This analysis systematically evaluates each of the media. Table C-1 in Appendix C presents a summary of the exposure situations identified at this site.

Exposure occurs when a chemical comes into contact with people and enters the body (25). For a chemical to pose a human health risk, a completed exposure pathway must exist. A completed exposure pathway consists of five elements:

- a source and mechanism of chemical release to the environment;
- a contaminated environmental medium (air, soil, or water);
- a point where someone contacts the contaminated medium (known as the exposure point);
- an exposure route, such as inhalation, dermal absorption, or ingestion; and
- an actual human exposure.

Exposure pathways are classified as either completed, potential, or eliminated. In completed exposure pathways, all five elements exist. Potential exposure pathways are either not currently complete (but could become complete in the future) or are indeterminate through lack of information. Pathways are eliminated from further assessment if one or more elements are missing and are never likely to exist.

A time frame given for each pathway indicates whether the exposure occurred in the past, is occurring now, or is likely to occur in the future (25). For example, a completed pathway with only a past time frame indicates that exposure is no longer occurring and is not likely to occur in the future.

CDHS reviewed all relevant, available environmental data to evaluate pathways of exposure. As with most sites, the owners of the property are responsible for sampling and monitoring as required by the oversight agency or agencies. Samples are collected using prescribed protocols, with agencies occasionally taking samples concurrently. Laboratories that conduct the analyses do so using prescribed protocols and are licensed by the state and the federal government. The licensed laboratories, unaware where the samples come from and which ones are sample blanks, use real samples and duplicates of real samples. Most of the data reviewed was produced by MCSWMD for NCRWQCB. Because of concerns about the landfill, agencies such as CARB, the Bureau of Indian Affairs (BIA), CDFG, and U.S. EPA have also conducted investigations at the site. More recently, under a grant from U.S. EPA, the Cahto Tribe has collected site characterization information. Data was also obtained from the law offices of Masry and Vititoe, Westlake Village, California.

To screen the contaminants for evaluation, CDHS compared contaminant concentrations to health comparison values. Health comparison values are media-specific contaminant concentrations used to screen contaminants for further evaluation (see Appendix A for a glossary of these terms). Noncancer health comparison values are called environmental media evaluation guides (EMEGs) or reference dose media evaluation guides (RMEGs) and are respectively based on ATSDR minimal risk levels (MRLs) or U.S. EPA reference doses (RfDs) (26, 27). Cancer risk evaluation guides (CREGs) are based on U.S. EPA chemical-specific cancer slope factors (27) and estimated excess lifetime cancer risk of one in a million persons exposed for a lifetime. CDHS also used several other environmental media standards, which include U.S. EPA Preliminary Remediation Guidelines (PRGs), California Action Levels for Drinking Water, U.S. EPA Suggested No Adverse Response Levels (SNARLs), State of California Reference Exposure Levels (RELs) and U.S. EPA and State of California Maximum Contaminant Levels (US MCLs and CA MCLs) (27-32).

These comparison values allow an investigator to quickly sort contaminants into two groups: those unlikely to cause health effects and those that need further evaluation. Contaminants that receive further evaluation exist at concentrations that exceed the comparison values; they are called “contaminants of concern” (COC). Exceeding a health comparison value does not imply that a contaminant represents a public health threat. It does suggest that the contaminant warrants further consideration.

When contaminants of concern are identified in a media, CDHS will evaluate the pathway by which people are being exposed to the contaminants. To determine whether adverse health effects are possible as a result of exposure to a contaminant, an exposure dose must be estimated for each pathway. This exposure dose can then be compared with appropriate toxicity values in order to evaluate the likelihood of adverse health effects occurring. Toxicity values used to evaluate noncancer adverse health effects include ATSDR minimal risk levels (MRLs) and U.S. EPA reference doses (RfDs) for ingestion, and reference concentrations (RfCs) for inhalation (26, 27). The MRL and RfD values are estimates of daily human exposure to a contaminant below which noncancer, adverse health effects are unlikely to occur. (See Appendix A for additional information about health comparison values.)

The National Toxicology Program (NTP), International Agency for Research on Cancer (IARC), and U.S. EPA have reviewed available information from human and animal studies to determine whether certain chemicals are likely to cause cancer in humans (27, 33, 34). The potential for cancer to occur in an individual or a population is evaluated by estimating the probability of an individual developing cancer over a lifetime as the result of exposure. U.S. EPA has developed cancer slope factor values for many carcinogens. A cancer slope factor is an estimate of a chemical ‘s potential for causing cancer. A cancer slope factor is derived from a study where the exposure is averaged over a lifetime, thus it is appropriate to calculate cancer risks from long periods of exposure. Cancer risks can not be appropriately calculated for short-term exposures (less than 7 or 9 years) using the U.S. EPA or California EPA cancer slope factors.

CDHS evaluated 12 pathways of possible exposure related to the Laytonville landfill (Table C-1, Appendix C). Those included two completed, three potentially completed, and four pathways that were eliminated. Because the closure and capping of the landfill altered the potential for exposure, several of the pathways are evaluated separately for "before cap" and "after cap." In some cases, this time distinction does not affect the evaluation of the pathway. For instance, in those cases when the closure and capping did not affect the potential for exposure or because we were unable to evaluate the differences the time distinction was not used. Presenting the information based on "before cap" and "after cap" allows an individual to read those sections that are most relevant to their situation. For instance, if someone once lived near the landfill and moved before the capping, the most important and relevant pathways for their exposure would be the ones related to "before cap."

Data in this section are presented in tables located in Appendix C. In the following pages, we describe our evaluation of these pathways. A brief summary of the toxicological characteristics of the contaminants of concern identified by CDHS is presented in Appendix D. The toxicological evaluation of the completed pathways involves the use of exposure assumptions. The authors used "high end" estimates and assumptions to ensure that any potential health hazards from the chemicals are recognized.

Direct Contact with the Landfill Waste While It Was an Open Landfill (1974–1993)

Summary: People living near the landfill, particularly the Cahto Tribe members, report that they used to visit the landfill when it was open and accepting waste. Coming into contact with the waste may have posed a risk from chemicals and live bacteria and viruses. Sharp, rusty objects in the waste may have posed a physical hazard. After the cap was placed on the landfill in 1997, direct contact with the waste was eliminated. The landfill has and continues to have a psychological and emotional impact on the community who see a large hill of garbage with closure problems.

The Laytonville landfill was permitted to accept solid waste. Solid waste is typically thought of as household waste. However, solid wastes generated by manufacturing or industrial processes, including agricultural chemicals, plastic products, and inorganic chemicals, may also have been disposed in the landfill, as these are not defined as 'hazardous waste" (35). In addition, a solid waste landfill can accept hazardous waste that comes from households and conditionally exempt small quantity generators. Small quantity hazardous waste generators are those businesses that produce small amounts of legally defined hazardous waste. For example, in 1985, if a small business generated less than 1,000 kilograms (approximately 2,200 pounds) of "hazardous waste" in a calendar month, it could dispose of that material in a solid waste landfill. In 1986, the allowable level of hazardous waste that could be sent to a solid waste landfill like the Laytonville landfill was decreased to 100 kilograms (220 pounds).

A detailed list of exact sources of landfill waste and chemicals that were dumped at the Laytonville landfill is not available. CDHS-EHIB obtained the following list of landfill contents: 90% residential, 5% commercial, and 5% demolition. The billing list shows that the California

Department of Transportation (1983–1987); Waste Enterprises, Inc.; Royal Haul Disposal, Inc.; and Laytonville Disposal Company, Inc., regularly dumped refuse into the landfill (MCSWMD billing list, personal communication, 2000).

Anecdotal reports also claim that there was illicit dumping, frequently late at night. These episodes resulted in transformers, photographic waste, and other hazardous waste being dumped in the landfill.

The U.S. EPA recently investigated some of these claims and provided the following explanations (35):

- Some commercial haulers were given their own keys so they could access the landfill when it was not typically open. For example, regular residential garbage collection operators who signed yearly contracts with Mendocino County were given keys. These contracts limited disposal to "garbage, refuse, and trash."
- Some non-commercial customers, e.g., Boy Scouts of America, school district landscapers, and California Department of Transportation (Caltrans), also had keys and had signed annual contracts agreeing to dump only "garbage, refuse, and trash."
- Remco Hydraulics of Willits was not a contractor who had a key to the dump. U.S. EPA's spot checks of cash customer invoices did not find evidence that wastes containing hexavalent chromium were brought to the dump.
- No one interviewed by the U.S. EPA had observed unmarked black helicopters using the landfill to dispose of wastes during the Vietnam era. Black Campaign Against Marijuana Planting (CAMP) helicopters were later granted temporary landing access on flat areas of the landfill, but it is not known if that temporary access was ever used.
- No record of waste at the Laytonville landfill from the U.S. Department of Energy 's Lawrence Livermore National Laboratory was found.
- Pacific Gas and Electric (PG&E) was an occasional customer of the landfill. The retired equipment operator of the landfill remembered burying transformers brought to the landfill by PG&E, but did not recall whether the transformers were empty or if they contained the dielectric fluids. Neither did he recall seeing either yellow "polychlorinated biphenyl" (PCB) labels or blue "No PCBs" labels on the transformers.
- U.S. EPA could not confirm if chemicals used in commercial photo developing were dumped at the site. Businesses generating small quantities could dump less than 1,000 kilograms (2,200 lbs) of such hazardous chemicals.

U.S. EPA concluded these investigations by saying that the "Laytonville landfill accepted solid wastes that contained hazardous constituents, such as hazardous wastes from household and conditionally exempt small quantity generators. We could not confirm some of the specific allegations about wastes disposed at the landfill" (35). They also state that they are in the process of conducting a site assessment (46). As a part of this investigation of migration of chemicals from the landfill, they will collect samples that will be analyzed for metals, VOCs, and semi-volatile organic compounds (SVOCs; including PCBs) mentioned in the allegations. (Other U.S. EPA investigations are described in the following sections (46, 52).)

It is not clear what types of waste make up the contents of the dump. It is likely that chemical, microbiological, and physical hazards existed for someone playing or spending time in direct contact with the refuse. However, it is not possible to evaluate the exposures that could have occurred because it happened in the past and there are no records.

In addition to these hazards, the landfill posed and still poses psychological, sociological, and mental burdens on nearby residents. For several nearby residents, particularly of the Cahto rancheria, the landfill looms outside their back doors. The landfill has added 40 feet to the height of the previous hill (1). Odors and trash blew from the landfill when it was open, reminding nearby residents that they lived next to a dump (9). Even after being closed and capped, odor problems still occur. While all sides of the capped landfill are steep, at least one side is structurally unstable because of faulty design (11, 12). Gaps are opening in one of the layers of the cap, and water has seeped from these gaps (14). These effects add to the burdens that the landfill places on the nearby residents. These additional burdens will be explored further in the community concerns and evaluation section.

Swimming in On-Site Surface Water Before the Cap Was Installed (1974–1997)

Summary: Residents who swam in surface water on or near the landfill, before the cap was installed in 1997, may have been exposed to contaminants. Sampling of the sedimentation ponds did not typically occur, though there was periodic sampling of the sedimentation ponds outfall. Metals, VOCs, and oil and grease were detected in the outfall sampling. Frequent swimming in the sedimentation ponds would not have resulted in noncancer health effects nor significantly increased cancer risk, judging from available data. These conclusions are confined by the limited extent that sedimentation pond discharge water—not sedimentation pond water—was tested every year.

Anecdotal reports say that residents walked on and around the landfill often, and may have played in the sedimentation ponds or lily pond until the landfill was fenced in 1997. Skin exposure and incidental ingestion would occur from swimming in the sedimentation ponds.

There is limited data to evaluate historical exposure to surface water. For instance, from 1974 to 1987, MCDPW tested the surface water/leachate for hardness, pH, turbidity, and total dissolved solids. These water quality tests are related to taste, water pipe conditions, etc., and not to human health. Therefore, these data are not helpful for interpretating past exposures.

Two sedimentation ponds were built in 1988, one on the east side and one on the southwest side of the landfill. The sedimentation ponds collected surface water runoff from the landfill, water that had theoretically not touched the refuse. In accordance with the NCRWQCB waste discharge requirement, the county began collecting water samples at the discharge point of the sedimentation ponds. These sampling locations continued to be referred to as SW-1 and SW-2

(36). The water at the discharge points of the sedimentation ponds was sampled four times a year (quarterly)(Table C-5, Appendix C). However, only one sample a year (the sample collected in April) was analyzed for more than the water quality parameters. The April samples were analyzed for VOCs, pesticides, and water quality parameters, and in 1993, metals were also added to the analysis.

Surface water data gathered by MCSWMD from 1990 to 1997 (37-43) revealed VOCs in several samples of sedimentation pond discharge water. Those included four detections of acetone (two in 1990, one in 1995, and one in 1996) and three detections of methyl ethyl ketone (two in 1990 and one in 1993). These levels do not exceed comparison values for drinking water. (We used drinking water standards as a public health protective measure even though we do not believe that the surface water/sedimentation pond water was used for drinking water purposes.)

The fact that there have been very few VOCs detected in the sedimentation pond discharge water is consistent with the highly volatile nature of VOCs. In other words, if VOCs are in the storm water or surface water runoff, they are likely to evaporate into the air before the water is discharged from the sedimentation ponds. The fact that any VOCs detections occurred in the outflow samples implies that upstream to these sampling points, VOCs must have been present at higher concentrations.

In the past, NCRWQCB required that surface water samples be analyzed for “oil and grease.” In 1993, oil and grease was detected at 3,000 parts per billion (ppb) (40). In 1995, “oil and grease” was measured in the sedimentation pond discharge water (5,100 ppb and 5,300 ppb) (39). It is not possible to know what kind of “oil and grease” was measured in those samples, e.g. cooking oil or petroleum products. The measurement of total petroleum hydrocarbons is more typically analyzed these days on surface water run-off samples. However, this data is not being collected for the surface water runoff at the Laytonville landfill. There is no “oil and grease” health comparison value with which to compare these levels.

From 1990 to 1997, several metals were found in the water from the sedimentation ponds at levels above health comparison values (arsenic, boron, lead, manganese, and vanadium). These will be considered contaminants of concern (COCs) in the surface water (37-43). Arsenic, lead, manganese, and vanadium have only been detected once each above their respective screening levels. Boron has been detected several times above levels of health concern. No pesticides were detected in the sedimentation pond discharge water.

If trespassers swam in this water during these years, they may have accidentally, or incidentally, ingested some water and absorbed some of the chemicals through the skin. To estimate exposure, we assumed the person swam twice a week in the sedimentation ponds during the warmer months (May to October). The estimates assume exposure occurred through skin absorption and incidental ingestion of the water. We assumed a child would have to be old enough (8–15 years of age) to play unattended on to the landfill. We assumed the adults may have been exposed the entire 24 years the site was open and not capped. The incidental ingestion of water that occurs during swimming is usually considered to be 50 milliliters (mL) per hour (or 5% of a liter) (44).

The standard swimming time is estimated at 1 hour per day. We assumed the swimmer was exposed to the maximum concentration of a chemical ever detected in the leachate before the installation of the cap (Table C-5, Appendix C)

The estimated doses for child/teenager and adult swimming in the sedimentation ponds before the cap was installed did not exceed health comparison values for any of the chemicals (Table C-6, Appendix C). Even the combined estimated exposure from the nine chemicals detected in the sedimentation pond discharge water would not be likely to cause noncancer health effects (Table 1). CDHS used a hazard index approach to look at combined toxicity (see glossary for definition of hazard index) (44). This means that, judging from the sedimentation pond discharge sampling data, someone swimming in the sedimentation ponds before the cap was constructed would not have been expected to experience noncancer health effects.

The lifetime increased cancer risk from exposure to contaminants while swimming in the sedimentation pond before the cap was installed is 5.2 in 10 million for adults and 1.6 in 10 million for a child/teenager (Table 1). These are considered no increased cancer risks.

Table 1. Health implications associated with exposure to surface waters on the Laytonville Landfill before the cap

		Noncancer Summary	Increased Cancer Risk
		If value less than 1: noncancer effects not expected	Based on 24-year exposure for adults and 8-year exposure for children
Swimming in the sedimentation ponds	Adult	0.027	5.2 in 10,000,000
	Child	0.036	2.5 in 10,000,000
Splashing and wading in the leachate	Adult	0.37	5.1 in 1,000,000
	Child	0.51	1.6 in 1,000,000

Wading and Splashing in the Leachate Before the Cap Was Installed (1974–1997)

Summary: Residents who waded and splashed in the leachate before the cap was installed in 1997 were exposed to contamination. Metals, VOCs, and petroleum hydrocarbons were detected in limited sampling of the leachate. If someone played in the leachate on a regular basis, the contaminants would not pose a noncancer health hazard. Frequent exposure to leachate over a period of many years results in a less than significant increased cancer risk. Inadequate leachate data limits the confidence CDHS has in drawing these conclusions.

Anecdotal reports say that residents walked on and around the landfill often. If they played in the leachate they could have inhaled and had skin exposure to contaminants in the leachate. Leachate is water that has percolated through refuse in the landfill. When the landfill was open and operating, leachate was observed near the active area of the landfill, i.e., the uncovered debris pile. MCDPW employees filled out self-monitoring reports from 1974 to 1993, in which frequent observations of leachate were noted (9). Starting in 1989, an occasional leachate sample was collected. Closing the landfill and installing the cap theoretically kept rainwater from direct contact with the waste, thus eliminating leachate generation.

From 1989 to 1991, leachate samples were tested for minerals only. In 1992, no leachate samples were collected. Starting in 1993, leachate samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (as a group called BTEX), total petroleum hydrocarbons (compounds that are similar to gasoline or diesel fuel), metals, and minerals (Table C-7, Appendix C). The complete set of VOCs, which includes chlorinated VOCs such as vinyl chloride, were not measured in most samples. Table C-7 in Appendix C shows the detections of organic chemicals and the metals that approached or exceeded health comparison values in the leachate. CDHS evaluated this available data, but finds it an inadequate representation of possible contaminant migration from the waste. More samples should have been collected and a wider variety of analyses should have been performed. This area of California receives 70 inches of rain, principally from October to April each year, and yet there were years when no leachate samples were taken or when only one or two were taken.

To be health protective, CDHS used the health comparison values for drinking water to screen the leachate data for *contaminants of concern* (COCs). The following chemicals were detected in the leachate water from 1993–1997 at levels that did not exceed their health comparison values: acetone, sec-butylbenzene, chloroethane, 1,1-dichloroethane, 1,2-dichloroethene, ethylbenzene, methylene chloride, methyl ethyl ketone, methyl isobutyl ketone, tetrachloroethylene (perc), toluene, trichloroethylene (TCE), 1,2,4-trimethylbenzene, and xylenes. The following chemicals detected in the leachate from 1990–1997 exceeded health comparison screening values: aluminum, benzene, boron, total chromium, lead, manganese, nickel, total petroleum hydrocarbons-diesel, total petroleum hydrocarbons-gasoline, and vinyl chloride (Table C-7, Appendix C). All these chemicals are considered COCs in the leachate.

The amount of exposure a person might have received from playing in the leachate depends on how often that person might have come near to or in contact with the leachate. Exposure also depends on the types of play and activity, i.e., splashing, wading, etc. If trespassers onto the landfill property splashed or played in the leachate, they could inhale VOCs that were off gassing from the leachate and potentially absorb through the skin the other chemicals found in the leachate.

Landfill leachate was present only during the rainy season/winter months. To estimate potential exposure, we assumed a person splashed and played in the leachate once a week during the wet months (November to April). Exposure would be through inhalation and skin absorption. Because

the leachate quantity was limited in volume, we assumed that the individual was not able to swim in it and incidentally ingest the leachate. We assumed a child would have to be old enough (8–15 years of age) to play unattended on the landfill. We assumed the adults may have been exposed the entire time the site was open and not capped (24 years). We assumed that the child/teenager and adult wore short sleeve shirts and shorts when playing in the leachate, resulting in skin absorption on their arms, hands, and lower legs. We assumed the person was exposed to the maximum concentration of a chemical ever detected in the leachate before the landfill was capped (Table C-7, Appendix C). Although this is an unlikely scenario, we conducted this analysis because of our dissatisfaction with the limited amount of leachate sampling data. It may be that additional sampling of the leachate may have detected even higher concentrations of chemicals.

The estimated doses for the child/teenager and adult being exposed to the maximum concentrations of the chemicals detected in the leachate before the capping did not exceed health comparison values, indicating that noncancer health effects from these chemicals would not be expected (Table C-7, Appendix C). Adding the exposure estimates for the maximum detections of these 20 chemicals does not result in a likelihood that combined exposure could cause noncancer health effects (Table 1). CDHS used a hazard index approach to look at combined toxicity (see glossary for definition of hazard index) (44). The lifetime increased cancer risk from exposure to contaminants while playing in the leachate before the cap was installed is 5.1 in 1 million for adults and 1.6 in 1 million for a child/teenager. These are considered no apparent increased cancer risks.

Playing or Swimming in Surface Water Runoff That Formed Puddles or Flowed into Cahto Creek (Before and After the Cap Was Installed, 1974–Present)

Summary: Surface water runoff occurred before and even after the sedimentation ponds were built and when the cap failed. Nearby residents report being exposed to the surface water runoff when swimming or wading in Cahto Creek or playing in puddles that formed from the runoff. The analysis of on-site data suggests that on-going exposure to leachate and surface water runoff would not have posed a health concern. Additionally, recent water and sediment sampling of Cahto Creek and other off-site water bodies does not indicate a current health hazard for recreational use of Cahto Creek. Therefore, CDHS concludes that exposure to past and current off-site surface water is a completed pathway. However, the available information suggests that it does not pose a public health hazard. Although we conclude that the landfill does not pose a health hazard to Cahto Creek, we understand that the creek is important to the Cahto Tribe. Therefore, CDHS proposes to work with the tribe to seek resources to address the creek's restoration.

According to anecdotal reports, residents frequently fished in Cahto Creek for salmon and eel (see next section for review of fish consumption pathway) and children used to play in the creek. We also heard nearby residents describe playing on the rancheria in puddles that formed from surface water runoff from the landfill. These people may have been exposed via skin exposure and ingestion of the water.

Surface water from the landfill site flows in many directions. It flows primarily off the landfill property in the northeast and southwest corners. Before the sedimentation ponds were constructed and during the episodes when the sedimentation ponds overflowed, the surface water runoff would flow onto the residential and ranch lands to the west, east, and north (1). Additionally, there have been documented releases of leachate flowing off the landfill (1, 99). Some of the water could follow drainage patterns and end up in Cahto Creek. Anecdotal reports state that off-site surface water runoff from the landfill was frequently observed on some properties next to the landfill. Approximately 50 residents reside within 500 feet of the northeast corner of the landfill. This is close enough to receive contaminated surface water runoff and sedimentation pond overflow.

There has been no historical sampling of the water or sediment in Cahto Creek. As described in the two previous pathway evaluations, the limited testing of surface water on site has documented low level VOCs and oils and grease. Testing has occasionally detected metals that could have traveled off site to Cahto Creek, also. In 2000, there were discharges to Cahto Creek from seeps that contained low level VOCs. In 1993, in response to community concerns, CDFG conducted visual inspections of the creek and landfill and specific tests of the surface runoff water (45). The tests, termed *acute toxicity bioassays,* did not determine the chemical constituency of the water. Rather the tests evaluated how well young brown trout could survive in water taken from various landfill runoff locations. A CDFG warden collected water from two storm water runoff locations of the landfill that flow into the creek. None of the water samples affected the survival of the young brown trout, indicating that the water did not contain anything acutely toxic to the fish. This kind of testing does not address the long-term effects of surface water runoff.

The law firm of Masry and Vititoe collected water samples from Cahto Creek in July 2000. Several metals (arsenic at 28 ppb and 20 ppb, barium at 1,440 ppb, and vanadium at 480 ppb) were detected at levels above health comparison values.

The law firm Masry and Vitittoe collected and analyzed sediment from a pond on the ranch that borders the landfill along the western border in July 2000. The sample was analyzed for metals, PCBs, VOCs, and SVOCs. The arsenic level [2.3 parts per million (ppm)] exceeds its health comparison value (CREG = 0.02 ppb), but not the noncancer health comparison values and is within what is considered background level for native soils. No other metals detected in the sediment sample exceeded health comparison values. No PCBs, VOCs, or SVOCs were detected. This data suggests that the landfill did not affect the pond.

The Cahto Tribe hired Secor International, Inc. to conduct a preliminary assessment/site inspection (PA/SI) to assess potential chemicals of concern that may be emanating from the landfill onto tribal lands. As part of the PA/SI, Secor International, Inc. took 10 samples of the sediment in Cahto Creek upstream and downstream of the landfill. At each location, samples were collected by removing the top layer of gravel-sized sand and larger cobbles, then collecting stream sediments from within 6-inches of the surface. The sediment samples were analyzed for metals including hexavalent chromium, VOCs, PCBs, PAHs, and radioactivity. No VOCs or PCBs were detected in the sediment samples. Several PAHs were detected in the sample collected

from Cahto Creek as it enters the tribal lands on the west end. The detections included several dimethyl and trimethyl naphthalene compounds and benzocycloheptane. There are no health comparison values for these compounds. Another sample collected on the western end of the tribal lands contained naphthalene (13 ppb) below its health comparison value. No other PAHs were detected in any of the samples. As with the previous sampling, arsenic was found above its health comparison value (CREG = 0.02 ppb) in all ten samples and there is no obvious influence of the landfill since the levels are typical of the amount of arsenic typically found in western soils. No other metals were found above their health comparison values.

U.S. EPA collected two water samples from Cahto Creek as a part of their site assessment in the fall of 2002 (Figure 5) (46). One of the samples was taken from a location in the creek upgradient of the landfill's possible influence. U.S. EPA termed this the "background" sample. They analyzed the water samples for metals including hexavalent chromium, SVOCs, VOCs, and pesticides/PCBs. Arsenic at 4.1 ppb was detected in the downgradient Cahto Creek water sample, but not in the upgradient water sample. The arsenic level (4.1 ppb) exceeds the CREG (0.02 ppb) but not the noncancer health comparison value (adult EMEG = 10 ppb) and is within what is considered background level for native soils. Total chromium, hexavalent chromium, cobalt, lead, mercury, and vanadium were not detected in either sample from the creek. Aluminum, barium, and manganese were detected at similar levels in both samples and below levels of health concern. The SVOC, di-(2-ethylhexyl) phthalate, was detected at 3 ppb in the "background" Cahto Creek sample. This is below a level of health concern (US MCL = 6 ppb). No other SVOCs, or any VOCs or pesticides/PCBs were detected in either Cahto Creek water sample.

We can speculate on what might have been in the creek several decades ago. If metals were present in the surface water and leachate that flowed off-site, the metals are likely to have moved downstream or settled into the sediment. If the water was contaminated with VOCs in the past, these would not be measurable in 2000 because VOCs evaporate out of moving water quickly. Many SVOCs, chlorinated pesticides, and PCBs are not water soluble, so they would not become dissolved in the surface water runoff. It is possible that the rainfall was heavy enough that soil or particulate matter to which the SVOCs are attached might flow off the landfill and enter the creek. The county tried to control the storm water runoff by creating sedimentation ponds in the mid-1980s. Metals and SVOCs were expected to settle in the ponds before the water discharged to Cahto Creek, and the VOCs would have evaporated. The analysis of the sediment from the on-site sedimentation ponds suggest that the ponds are concentrating metals and contain very little VOCs and SVOCs.

Essentially no information was collected when the landfill was still in operation about surface water runoff after it left the landfill. We can only infer what happened by using recent off-site sampling or the relatively sparse surface water and leachate data collected on the landfill (described in previous section). The analysis of on-site data suggests that on-going exposure to leachate and surface water runoff would not have posed a health concern. More recent water and sediment sampling of Cahto Creek and other off-site water bodies does not indicate a current health hazard for recreational use of Cahto Creek. Therefore, CDHS concludes that exposure to

past and current off-site surface water is a completed pathway, but available information suggests that it does not pose a public health hazard.

Although we conclude that the landfill does not pose a health hazard to Cahto Creek, we understand that the creek is important to the Cahto Tribe. The creek is in need of restoration involving removal of debris and litter, researching the water levels needed to sustain a healthy creek, and erosion control. CDHS proposes to work with the tribe to seek resources to address the creek's restoration.

Ingestion of Fish and Eel from Cahto Creek Before and After the Cap Was Installed (1974– Present)

Summary: Past, current, and future exposure to contaminants by ingestion of fish or eel taken from Cahto Creek is a possibility, but not a likely exposure route of concern. The chemicals detected in the surface waters on site or in sampling the creek do not build-up in fish. Thus, we eliminate this pathway of exposure.

Anecdotal reports state that residents have fished and continue to fish in Cahto Creek. According to the local CDFG warden, lamprey ("eel"), salmon, clams, and large mouth bass can be found in Cahto Creek (Personal communication, Warden Kucera, California Department of Fish and Game, June 19, 2003). Lamprey and salmon are not resident fish. Lamprey leave the creek and go downstream for a large part of their life. That means lamprey and salmon have less opportunity to be exposed to possible contamination in Cahto Creek. If the fish have built-up (termed *bioaccumulated*) chemicals in their tissue, the people who ingested fish from Cahto Creek would then be exposed to these chemicals. The levels of contaminants in fish from Cahto Creek have never been analyzed.

We know from fish contamination problems in other places that certain metals and some organic chemicals, such as PCBs, tend to bioaccumulate in fish. Mercury, for example, is more likely to bioaccumulate in fish than is lead. Neither PCBs or mercury have been a problem in the leachate or sedimentation pond sampling (Tables C-3, C-5, and C-7). However, the detection limits for the analyses for these compounds were not low enough to rule out concerns related to bioaccumulation. Future analyses of water that runs off the landfill and any sampling of the Cahto Creek that may be done should have low enough detection limits for chemicals that bioaccumulate. If such analyses indicate a potential bioaccumulation problem for biota, then biota testing should occur.

The metals that have been found in the leachate or sedimentation pond water (aluminum, arsenic, barium, and manganese) detected in the samples taken from Cahto Creek in July 2000 do not bioaccumulate. Therefore, it is unlikely that these chemicals would be found at levels of health concern in the fish. A detected low level of di-(2-ethylhexyl) phthalate might affect fish, but would not affect people consuming that fish. The fish that are in Cahto Creek are ephemeral (seasonal). Therefore, past, current, and future exposure to contaminants by ingestion of fish or eel taken from Cahto Creek is eliminated as an exposure route of concern.

Inhalation of Outdoor Air On Site and Off Site Before the Cap Was Installed (1974–1997)

Summary: Residents reported odors coming from the landfill when it was in operation and were concerned about what they were breathing. Landfill gas and air testing was conducted twice while the landfill was in operation. Seven chemicals (benzene, chloroform, 1,2-dichloroethane, methylene chloride, tetrachoroethylene, 1,1,1-trichloroethane, and vinyl chloride) were identified in the landfill gas. Vinyl chloride was measured in a surface emission. However, none of 10 suspect chemicals were detected during 5 days of ambient air sampling when the landfill was in operation. Sampling was inadequate while the landfill was in operation, especially during the times when open burning was being conducted. Therefore, this exposure pathway is an indeterminate health hazard.

There have been numerous anecdotal reports of foul-smelling air arising from the landfill in the past. Solid waste landfills are known to have odor issues. These air releases occur primarily as a result of the decomposition of biological material, such as food. Decomposition typically produces methane and sulfur dioxide. Methane has no odor, but it can explode, whereas sulfur dioxide is smelly at low concentrations. Odors pose a nuisance and can cause health effects. The other VOCs a landfill produces are minor in comparison to methane production.

Intermittent burning of waste occurred on the landfill over a period of years. Inhaling smoke from most fires can cause breathing problems. It can trigger asthma attacks and episodes of bronchitis. Burning waste could also release chemicals into the air capable of causing headaches, eye irritation, rashes, and other symptoms.

Past levels of on-site airborne contaminants were rarely measured, thus it is not possible to fully evaluate the effect of living nearby and breathing the air that may have contained emissions from the landfill. Air and landfill gas sampling was conducted in 1987 and 1993. Several VOCs were measured in the landfill gases (Table C-9, Appendix C). Landfill gases escape and mix with the air. On-site workers or trespassers could have been exposed to these gases. As air moves from the site and is further diluted, it may expose off-site residents to some of the chemicals from the landfill. However, no chemicals were detected in limited testing that occurred when the landfill was open. The following is a summary of those air studies.

Three air studies have been conducted on or near the Laytonville landfill. The first two air studies occurred in 1987 and 1993, before the site was capped. The 2000 sampling will be discussed in the section entitled, *Inhalation of contaminated air on site and off site after the cap was installed (1997–present).*

The first testing, in November 1987, was conducted by Ecoserve, Inc, a consultant to the county (47). Landfill gas within the waste, landfill gas around the perimeter, surface emissions, and ambient air were tested. On November 5, 1987, the following VOCs were tested for in the landfill gas: vinyl chloride, benzene, 1,2-dibromoethane, 1,2-dichoroethane, methylene chloride, tetrachloroethylene, carbon tetrachloride, 1,1,1-trichoroethane, trichloroethylene, and chloroform.

Eight of the 10 contaminants tested for were above detection limits in the landfill gas (Table C-9, Appendix C). Benzene, 1,2-dichloroethane, and methylene chloride were the chemicals measured in the highest concentrations in the landfill gas measurements.

Ecoserve sampled ambient air on November 23 and 24, 1987 (47). None of the 10 VOCs that were analyzed for were detected in the two samples. However, CARB concluded that the 1987 air sampling results may underestimate the contamination for several reasons:

- the air samples were not collected according to the Category I requirements;
- the air samples were conducted for 10 hours, instead of the required 24 hours; and
- the downwind sample was taken amid swirling winds from all directions and is not conclusively downwind (48).

The 1987 tests were those used for Category II landfills. Because houses are located within 1,000 feet of the landfill, the Laytonville landfill is a Category I landfill. As a result, the testing requirements were higher and were not fulfilled.

Trace amounts of methane were found in three of the seven landfill gas monitoring wells around the perimeter (47). This is consistent with landfills in general. While methane does not normally pose a health hazard, at very high levels it can spontaneously explode. Surface emission measurements showed organic vapors to be 500 part per million by volume (ppmv), which is below the explosive level. There are no health comparison values with which to compare these numbers.

A second round of air tests was conducted by CARB, for MCAQMD, from June 7 through 11, 1993 (49). As in 1987, gas samples were taken from three subsurface landfill gas monitoring wells around the landfill perimeter. Surface gas emissions and ambient air gas were also sampled. The samples were analyzed for the same contaminants as in 1987. According to CARB, the 1993 levels of 1,1,1-trichloroethane and carbon tetrachloride exceeded levels of the same gases in 95% of the 314 nonhazardous landfills in California. Levels of vinyl chloride, methylene chloride, chloroform, and 1,2-dichloroethane exceeded levels of the same gases found in 314 nonhazardous landfills in California.

Three perimeter landfill gas monitoring wells were also tested in 1993 (Figure 3) (49). None of the analyses exceeded the detection limit of 1 part per billion by volume (ppbv). Surface gas emission tests were performed at one location where the highest amounts of organic vapors were detected using a hand-held instrument. Vinyl chloride was detected at 0.712 ppbv. The other contaminants were below detection limits.

Ambient air tests found levels of all 10 contaminants to be below detection limits (49). Thus, landfill gases could serve as a source of contamination to the ambient air, but the ambient air tests did not find these chemicals at detectable levels.

The 1993 testing was compromised by several factors:

- the surface gas emission tests were not calibrated properly,

- testing was conducted only 1 week after rains dampened the soil,
- four of the seven perimeter landfill gas monitoring wells tested were not functional, and
- only three probes were used off site (49).

Only limited air sampling occurred when the landfill was in operation. The small amount of VOCs typically produced from a landfill, coupled with the dilution from air movement, makes it unlikely that such chemicals would typically pose a health hazard to nearby residents. Residents describe odors coming from the landfill when it was in operation. These odors indicate that sulfur-containing compounds were present in the air. However, the amount of these chemicals present would not pose a health hazard, separate from the bad smell. However, the open burning that occurred at the landfill from the late 1960s to 1987 could have greatly affected the air quality in the area. Unfortunately, there are no data available to evaluate this pathway. Therefore, inhaling the outdoor air on site and off site before the cap was installed (1974–1997) is an indeterminate health hazard.

Contact with Surface Soil Off Site

Summary: Contaminants may have been deposited on nearby land from surface water runoff from the landfill. Nearby residents who live northeast and southwest of the landfill may have been exposed in the past through skin contact and incidental ingestion of those soil contaminants. Because soil samples are lacking, skin contact and incidental ingestion of off-site soil is classified as a potential exposure pathway. Because of this data gap, CDHS recommends off-site soil sampling and analysis for SVOCs.

Contaminants from the landfill may have been deposited by surface water runoff onto land northwest and southwest of the landfill. Current and former nearby residents have expressed concern about runoff from the landfill. Residents who live in those areas may have been exposed to those contaminants in the soil through dermal contact and incidental ingestion. Unfortunately, there has been only one off-site soil sample collected and tested. Many of the chemicals found in the storm water and leachate would not necessarily be expected to be found in surface soil. For instance, the VOCs would evaporate from surface soils. Many of the metals detected in the storm water and leachate are water soluble and would not be likely to stay in the surface soil. Some chemicals (SVOCs) would be expected to stay longer; limited sampling has not indicated that certain SVOCs were found in the surface soil near areas of runoff. Additional off-site surface soil samples would help clarify this concern.

The following is a discussion of three sampling efforts of soil-type material.

- In response to allegations of past hazardous waste dumping, MCSWMD conducted a visual exploration of the landfill's surface in 1993. They identified the signs of a backfilled trench outside the bounds of the landfill waste area. They found a layer of soil surrounded by polyethylene sheeting. The plastic-covered soil measured about 13 x 2 feet, and laid in a trench about 3.5 feet below the ground surface. Three samples were taken of the soil inside the sheeting (50). The three samples were analyzed for the presence of total petroleum

hydrocarbons, VOCs, SVOCs (including PCBs), and waste oil metals (cadmium, chromium, nickel, lead, and zinc). The results showed high levels of diesel fuel (1,400 ppm) and motor oil (4,200 ppm) were present. Very low levels of chlorobenzene (3.1 ppm) and dichlorobenzene (2.1 ppm), and the two metals cadmium (1.5 ppm) and nickel (71 ppm), were also present. The levels of these chemicals do not exceed their health comparison values. Samples of soil taken from beneath the polyethylene sheeting did not contain detectable levels of gasoline, motor oil, diesel, VOCs, or SVOCs. This indicates that the contamination did not migrate outside the sheeting. MCSWMD removed the layer of soil and the sheeting from the landfill in 1993, eliminating its potential for exposure risk.

- In 1996, the U.S. Army Corps of Engineers, working for the BIA, collected and analyzed one soil sample taken on the Laytonville rancheria (51). The sample was analyzed for metals. No metals were detected above health comparison values.

- In March 2000, three soil samples from the landfill were analyzed by MCSWMD (14). One sample was collected near the southwest sediment pond, one near the northeast sediment pond, and one in the swale north of the refuse. There were no detections of 65 VOCs and 68 SVOCs. Barium (70 ppm, 140 ppm, 130 ppm), chromium (38 ppm, 28 ppm, 25 ppm), lead (7.3 ppm, 7.8 ppm, 5.8 ppm), nickel (40 ppm, 25 ppm, 25 ppm), and vanadium (10 ppm, 45 ppm, 38 ppm) were detected in all three soil samples. None of the levels of these metals exceeded their health comparison values or “background” levels for western soils.

As reported earlier, waste was burned on the landfill, yet there has not been any soil sampling of the areas where the burning occurred. This soil could have posed a hazard to trespassers before the area was fenced. If surface contamination exists, it could become airborne during windy days.

In response to the very limited soil samples, skin contact and incidental ingestion of off-site soil is classified as a potential exposure pathway. Because of this data gap, CDHS recommends off-site soil sampling and analysis. CDHS also recommends identification and surface soil testing of the burn areas that are exposed.

Inhalation of Outdoor Air On Site and Off Site After the Cap Was Installed

Summary: Capping the landfill in 1997 should have eliminated further uncontrolled air releases from the landfill. Air sampling conducted by the tribe indicated that low level VOCs were coming from the landfill. These levels do not pose a health hazard and the landfill does not seem to significantly impact local air quality. Air sampling conducted by U.S. EPA around the landfill detected low levels of several VOCs, including acrolein, α-pinene, and benzene, at levels that do not pose a health hazard. These chemicals could have arisen from the landfill. They are, however, more typically associated with sources such as automobile exhaust, fireplace combustion, and trees and wood products.

Landfill gas is generated during the natural process of bacterial decomposition of organic material contained in a landfill. By volume, landfill gas is about 50% methane and 50% carbon dioxide and water vapor. Less than 1% of gas by volume is made up of other chemicals, such as VOCs. Some of these volatile chemicals have strong, pungent odors, e.g., hydrogen sulfide. By law, the generation of methane must be monitored at the landfill perimeter. A number of pipes were placed vertically through the cap to act as a passive conduit for the release of the landfill gases that are constantly being formed by microbial and other breakdown processes occurring in the waste.

The possible migration of landfill gas from the sides of the landfill is monitored at seven landfill gas wells located around the perimeter of the waste area. MCSWMD monitors the landfill gas wells every quarter with a hand-held instrument that essentially measures methane. Methane is not a breathing hazard. However, at high enough levels it is explosive. Occasional landfill gas sampling has occurred and samples have been analyzed for VOCs. For instance, in March 2000, MCSWMD sampled the landfill gas well as a part of its investigation into the odor and seep problem on the east side of the landfill (14). The following chemicals were measured in the landfill gas sample: benzene (0.08 ppbv), chloroethane (0.77 ppbv), cis-1,2-dichloroethene (0.05 ppbv), toluene (0.05 ppbv), and vinyl chloride (0.52 ppbv). This information indicates that there are low levels of VOCs present in the landfill gas that could affect the ambient air.

Two ambient air sampling studies have been conducted around the landfill. These studies and their results are described in the following paragraphs.

Cahto Tribe

The Cahto Tribe hired Secor International, Inc. to conduct a preliminary assessment/site inspection (PA/SI) to assess potential chemicals of concern that may be emanating from the landfill onto tribal lands. As part of the PA/S, consultants to the Cahto Tribe took air samples around the landfill between October 23 and October 26, 2001. Three sampling locations were on the boundary of the landfill: at a residence on the rancheria property opposite the northeast corner of the landfill, on a rancheria residential property 250 meters east of the landfill boundary, and one on the southern boundary. A background sampling location was placed 350 meters to the west of the property. Twenty-four hour samples were collected at the sampling locations residential and background locations. The samples collected at the landfill boundary locations were collected using flow controllers interfaced with wind direction/wind speed sensors. The flow controllers

collected the sample when the wind was blowing from the landfill at greater than 0.4 meters per second. In this manner, the air samples represent chemicals coming primarily if not exclusively from the landfill. The sample being collected on the west side of the landfill ended up being collected in a different manner than was planned. Since the wind was not blowing in that direction, the sample location was moved north 200 feet and the sample was collected continuously regardless of wind direction. The air collected in the SUMMA canisters were analyzed for volatile organic compounds (VOCs). Six VOCs were detected in the sample collected from the south boundary of the landfill: chloromethane (6.6 ppb), tetrachloroethene (1.6 ppb), toluene (1.6 ppb), trichloroethene (1.6 ppb), ethanol (70 ppb) and acetone (*10 ppb*). One VOC (acetone 9.1 to 33 ppb) was detected in all the other samples. None of the VOCs were detected at levels above health comparison values. The sampling of the air during this time period did not show that the landfill was a major contributor to the air quality in the area. Since emissions from a facility can vary over time this limited set of data may not reflect the emissions from the facility over a longer period of time.

U.S. EPA

In response to concerns raised by the Cahto Tribe, U.S. EPA consultants sampled ambient air at multiple locations on and near the Laytonville Rancheria in August 2002 (52). The purpose of the sampling was to determine whether there are detectable levels of certain VOCs in the ambient air of the rancheria. U.S. EPA consultants collected three 24-hour samples at five locations. The consultants set-up a meteorological station on the rancheria. The meteorological station recorded wind speed and direction, temperature, relative humidity, and barometric pressure. The prevailing wind direction during the sampling was toward the south-southeast. In consultation with the tribe, four sampling locations were picked on the rancheria. A location was placed west of the landfill on nontribal land. This location was designated the upwind station. However, according to the data collected at the meteorological station sometime during each sampling period, the upwind location was not truly upwind. Because the samples were collected over a 24-hour period, it is not possible to tease out the times when wind shifts occurred. At times the “upwind” station may have been, in fact, a downwind station. Thus, CDHS was not able to draw conclusions on the source of the emissions (i.e., the landfill). In the following paragraphs, we evaluate the collected data for its public health impact and describe typical sources for the chemicals that were detected.

Nine VOCs were detected in the samples: acetone, acrolein, benzene, methyl ethyl ketone, dichlorofluoromethane, ethanol, isopropyl alcohol, α-pinene, and toluene (Table C-10, Appendix C) (52). In the following paragraphs, CDHS reviews the levels of the chemicals detected and the health hazard they pose from breathing them on a long-term basis.

- Five of the VOCs (acetone, dichlorofluoromethane, ethanol, isopropyl alcohol, and methyl ethyl ketone) were detected in all the samples at similar levels and not above health comparison values. All these compounds are typically associated with landfill gases, but are also associated with other sources such as commercial products and general human activity.
- Toluene—often found in landfill gas—was detected (1.9–4.9 ppbv) at four of the five sampling locations on the first day of sampling. Toluene is also commonly found in air as a result of its

high prevalence in many human activities. It was not detected (detection limit = 0.27 ppbv) in any of the samples on subsequent days. None of the measured levels exceed the health comparison value (80 ppbv).

- There was one detection of benzene (1.5 ppbv) in a sample collected on the rancheria property. The amount of benzene detected exceeds a health comparison value (0.03 ppbv). Another air sample collected at the same location and during the same time period (called a co-located sample) did not detect benzene. Benzene was not detected (detection limit = 0.31 ppbv) in any other samples collected. Benzene has been detected in the gas at the landfill, but there are other sources of benzene, such as automobile exhaust. Low levels of benzene, as measured in the one sample (1.5 ppbv), are of concern if someone breathed that amount of benzene over a long period. However, sampling on other days at the same location did not detect benzene. That indicates that a person living near that sampling station is not being exposed on a daily basis to levels of benzene that pose a health hazard.
- There were three detections (1.4 ppbv, 1.7 ppbv, and 1.9 ppbv) of α-pinene in samples collected on the rancheria. Samples that were co-located with two of the α-pinene detections did not detect the chemical. There is no health comparison value for α-pinene to help discern whether the α-pinene was measured at a level of health concern and thus CDHS considers it a COC in the air. Alpha-pinene is emitted from trees and wood products, especially pine, spruce, and citrus. It is used as a fragrance in household products and in some cases as a solvent. Construction material placed in landfills is a prime source of α-pinene found in landfill gas. CDHS reviewed the medical literature for an indication of the toxicity of α-pinene. The limited studies seem to indicate that airway irritation may occur when the levels of α-pinene reach 38,000 ppbv (53, 54). On the basis of this information, it does not seem that the low levels of α-pinene measured near the landfill would result in any airway irritation. A dearth of information about α-pinene toxicity prevents a more complete evaluation of the health implications.
- Acrolein was detected in eight samples (1.7−2.9 ppbv). Two of those are co-located samples. The levels of acrolein measured in the air exceed the health comparison value (0.009 ppbv) and will be considered a COC in the air. Acrolein is released during the combustion of fossil fuels. It is also found in tobacco smoke, pyrolyzed animal and vegetable fats, and in landfill gas. Human studies have demonstrated threshold levels for eye irritation (57 ppbv), nasal irritation (130 ppbv), and decreased respiratory rate (305 ppbv) (55). In comparison, the low levels of acrolein measured near the landfill would not likely result in any eye, nose, or lung irritation. From limited animal studies, eye, nose, and respiratory problems appear to occur at lower levels than do immunological and neurological effects. However, there is a lack of information about the long-term effects of breathing acrolein.

Based on the two rounds of ambient air sampling that have occurred it is not clear if and how much the landfill is contributing to the ambient air conditions around the site. In addition there are concerns about air quality when open burning occurs on the site. Since the closure of the landfill, the air district has permitted the burning of vegetation debris on the landfill. In 1997, a CARB staff person witnessed a second burn while investigating the remains of the first burn

(17). They found evidence of non-vegetation material in the burn pile.

Open burning for vegetation control is permitted in Mendocino County by California Department of Forestry, the Mendocino County Air Quality Management District, and the local fire agency depending upon the time of year (these agencies have no jurisdiction on tribal lands). According to the air district staff it is common place to have garbage burning throughout the county. In addition to VOCs, burning of garbage has been alleged to be the primary source of dioxin in the environment. This appears to be related to the incomplete combustion products formed when materials containing chlorine are burned openly without controls.

CDHS recommends that an alternative mechanism to deal with vegetation control be used at the landfill in place of open burning. CDHS recommends that the air district and the tribes raise the awareness within their communities of the environmental effects of garbage burning, the air district strictly enforce the current prohibition of garbage burning, and the tribes regulate such activity.

Swimming in On-Site Surface Water After the Cap Was Installed (1997–Present)

Summary: Residents who played, waded, or swam in surface water on or near the landfill after the cap was installed in 1997 may have been exposed to contaminants. Metals, VOCs, SVOCs, pesticides, and oil and grease have been detected in samples taken of the water as it leaves the sedimentation pond or sediment water samples. Based on this data, CDHS determined that swimming in the sedimentation ponds would not result in noncancer health effects and no significant increased cancer risk based on the available data.

Several pathways involving surface water runoff were supposed to be eliminated when the cap was installed in 1997. For instance, the cap was supposed to substantially decrease and effectively eliminate the spread of contaminants from the refuse into surface water runoff. However, there have been sedimentation pond overflows and seeps occurring at the bottom edges of the cap that contain chemicals above health comparison screening values. In the following paragraphs, is a summary of the data gathered on surface water, including “leachate,” since the landfill was capped. CDHS evaluated possible exposure to residents who played, waded, or swam in surface water on or near the landfill, after the cap was installed in 1997, and may have been exposed to contaminants.

Such exposure is less likely because the waste-containing part of the landfill was fenced before being capped and after the landfill closure. The MCSWMD maintains the fence to ensure that the cap is not disturbed by people going on the landfill. Additionally, MCSWD inspects the landfill weekly from October to May, and monthly in the dry weather months. In addition, the MCSWD is regularly on-site for maintenance work and the Mendocino County Division of Environmental Health inspects the Landfill every month. On these visits to the landfill Mendocino County staff have not observed person(s) swimming or fishing in on-site sedimentation ponds. The following is a summary of the on-site surface water data that has been collected since the landfill was capped.

MCSWMD Sampling

MCSWMD is under orders from NCRWQCB to continue to monitor surface water on site (36). The sedimentation ponds collect surface water runoff. At the point and times when these sedimentation ponds discharge, MCSWMD is required under NPDES permitting regulation to sample twice between December and February, at each of the two discharge locations. MCSWMD is required to have those samples analyzed for acetone, VOCs, BTEXs, oils and grease, and metals. Since the cap was installed, oils and grease have consistently been detected in the discharge water (Table C-5, Appendix C) (15, 56, 57). On occasion, arsenic has been detected above health comparison values. Barium and vanadium have each been detected once above health comparison values.

Masry and Vititoe Data

The law firm of Masry and Vititoe collected and analyzed a surface water sample from a sedimentation pond in July 2000. The sedimentation pond surface water sample was tested for metals, VOCs, and SVOCs, including PCBs. PCBs, VOCs, and SVOCs were not detected. Arsenic, barium, lead, and vanadium were detected (Table C-5, Appendix C) at levels that exceed their health comparison values.

The law firm of Masry and Vititoe sampled sediment from one of the sedimentation ponds on the landfill in July 2000. The sample was analyzed for metals, VOCs, and SVOCs, including PCBs. Arsenic (2 ppm) was detected slightly above its health comparison value. A few other metals were detectable, but were not above health comparison values. All other contaminants (SVOCs and VOCs) were not detected.

NCRWQCB Sampling

In July 2002, NCRWQCB sampled seven nearby private wells and the sedimentation pond located west of the landfill (58). The water samples were analyzed for metals, dissolved metals, PCBs, VOCs, and water quality parameters. The only chemical detected in the sediment pond water sample was toluene (0.79 ppb). In fact, all of the water samples had detectable levels of toluene. No field blank was taken. The lab blank did not contain toluene. The NCRWQCB suspected that the presence of toluene was a result of sampling procedures. Because of this, NCRWQCB resampled the same sedimentation pond in May 2003 (59). No toluene (detection limit = 0.50 ppb), benzene, ethyl benzene, or xylenes were detected in the resample. No other analyses were conducted.

U.S. EPA Site Assessment

In November 2002, as a part of their site assessment of the Laytonville landfill, consultants for the U.S. EPA collected six water samples from surface water on the landfill. Those included two samples from the northeast pond, three samples from the northwest pond, and one sample from the southwest pond (Figure 5) (46). U.S. EPA consultants also collected two samples from Cahto Lake, located north of Branscomb Road, which they considered a “background” surface water body. The samples were analyzed for metals,

VOCs, and SVOC (Table C-5, Appendix C). Arsenic and aluminum were detected at levels that exceed health comparison values in the northeast pond samples. Arsenic was detected at levels above health comparison values in one of the northwest pond samples. Arsenic was not detected (detection limit = 10 ppb) in either of the background samples. Methyl acetate, endrin aldehyde, endrin ketone, gamma-hexachlorocyclohexane (lindane), and di(2-ethylhexyl) phthalate were detected in the northeast pond and not in other samples. The levels of these organic chemicals are below their corresponding health comparison values. Di(2-ethylhexyl) phthalate was detected in two samples from northwest pond. These compounds were not detected in any of the background samples. DDT was detected in one of the background samples, but was not detected in any of the samples collected from the landfill. Both DDT and di(2-ethylhexyl) phthalate were detected at levels below health concern. Based on the U.S. EPA findings, arsenic and aluminum are considered COCs for on-site sediment pond water.

The U.S. EPA consultants also collected sediment samples from the landfill surface water bodies (sedimentation ponds) and the background lake at the same time they collected surface water samples (Figure 5) (46). Barium, chromium, lead, and manganese were found at lower or nearly the same levels in the background lake sediment as in the landfill surface water. Those amounts were below health comparison values (residential soil PRGs). Aluminum, arsenic, cobalt, magnesium, silver, and vanadium were found at higher levels in some or all of the landfill water bodies compared to the “background” lake. However, all these metal levels were below their corresponding health comparison values.

The U.S. EPA analyzed the sediment samples for 140 organic chemicals (SVOCs, VOCs, and PCBs/pesticides) (46). Eight detections of organic chemicals were measured in the “background” lake and 13 detections in the landfill surface water sediment. None of the organic chemicals were detected above health comparison values. Di(2-ethylhexyl) phthalate was detected in all nine sediment samples (“background” lake and landfill surface water bodies). U.S. EPA reported that this could be a laboratory contaminant. Acetone, chlorobenzene, and toluene were detected at low levels in Cahto Lake but not in any of the sediment samples from on the landfill. Two organic chemicals were detected in the landfill surface water body sediment, but not in any other samples including the Cahto Lake samples. Those included two detections of TCE and one detection of 4, 4'-DDT. Methyl ethyl ketone was detected twice in landfill surface water sediment at a 10-times higher concentration than one of the “background” samples. 4-Methylphenol was detected in one landfill surface water sediment sample at a level similar to the level found in one of the Cahto Lake sediment samples.

In summary, there are no COCs identified in sediment collected by the U.S. EPA on the landfill. Arsenic and aluminum are considered COCs in the landfill surface water bodies.

If trespassers swam in this water, they may have accidentally or incidentally ingested some water and absorbed some of the chemicals through the skin. Since there are not VOCs as COCs in the sedimentation ponds, the inhalation route was not included. We assumed that a child/teenager

may have gone swimming in the sedimentation ponds during the summer months for 7 years (ages 8–13). We assumed an adult went swimming in the sedimentation ponds twice a week during the summer months for 6 years (1998–2003). The incidental ingestion of water, which occurs during swimming, is usually considered to be 50 mL per hour, or 5% of a liter (44). The standard swimming time is estimated at 1 hour per day. We assumed the swimmer was exposed to the highest concentrations of the chemicals detected in the on-site surface water since the landfill was capped (Table C-5, Appendix C).

The estimated doses for children/teenagers and adults swimming in the sedimentation ponds after the capping did not exceed health comparison values for any of the chemicals (Table C-6, Appendix C). The estimated combined exposures for the maximum detections of the 10 chemicals measured in the sedimentation pond discharge water are not likely to cause noncancer health effects. (A hazard quotient approach was used to look at combined toxicity; see glossary for definition of *hazard quotient*) (Table 2). Judging from sedimentation pond data, noncancer health effects would not be expected to occur in someone from swimming in the sedimentation ponds after the cap was constructed. Cancer risk was not calculated for this short-term exposure.

Wading and Splashing in the "Leachate" After the Cap Was Installed (1997–Present)

Summary: Installation of the cap eliminated leachate formation (water that comes in contact with the refuse). However, contaminated water ("leachate") has occurred around the edges of the cap during some of the rainy seasons. During the 1999–2000 rainy season, "leachate" occurrences were particularly plentiful. Playing and splashing in the "leachate" would probably not have occurred on a regular basis. Even if someone had played in the 2000 "leachate" on a regular basis, the contaminants did not pose a health hazard. Longer exposure to such "leachate, should it continue to occur, may pose a health hazard for trespassers and nearby residents. Therefore, we recommend that the adequacy of the current cap be investigated.

Now that the cap has been installed, the term "leachate" is being applied to the contaminated water that is appearing along the bottom edges of the cap. MCSWMD is also under NCRWQCB orders to continue monitoring for "leachate" (36). The biggest seep problem occurred during the winter of 1999–2000 when seeps appeared along the eastern, southern, and western edges of the cap (14). A French drain was installed on the east side to deal with the seep. However, in the winter of 2000–2001, the French drain overflowed, compounding the problem instead of fixing it.

MCSWMD is required to test this "leachate" on a quarterly basis if it is present (36). Each of the quarterly samples are analyzed for standard water quality analytes and minerals. Metals, VOCs, and acetone analyses are also required for the "leachate" samples collected in the second quarter (April-June).

Table C-7 in Appendix C summarizes all "leachate" data gathered. (CDHS is summarizing "leachate," seep, drain, and French drain data in this section.) To be health protective, CDHS used the drinking water health comparison values for ingestion to screen the leachate data for contaminants of concern (COCs). The following chemicals detected in the leachate water from

1997–2002 did not exceed their health comparison values: acetone, *n*-butylbenzene, chloroethane, dichlorodifluoromethane, 1,1-dichloroethane, ethylbenzene, methyl ethyl ketone, toluene, 1,1,1-trichloroethane, 1,2,4-trimethylbenzene, and xylenes. The following chemicals were detected in the leachate from 1997–2002 at levels that exceed their respective health comparison screening value: aluminum, arsenic, barium, benzene, chloroethane, total chromium, lead, manganese, methylene chloride, vanadium, and vinyl chloride. All these chemicals are considered COCs in the leachate.

Potential exposure to chemicals in the "leachate" did occur after the landfill was capped. The site was fenced during this time, but we assumed that some people gained access, nevertheless. Trespassers could inhale the VOCs that were off gassing from the leachate, and if they splashed or played in the "leachate," they could absorb chemicals in the leachate through their skin. In order to estimate the amount of exposure a person might have received from leachate or surface water, it is necessary to understand how often someone might have come near to or in contact with the leachate and what they were doing, i.e., splashing, swimming, etc. Leachate was present only during the rainy season/winter months. Thus, we assumed that a person came on to the landfill twice a week during the 6 months of the rainy season. We assumed the person splashed and played in the leachate twice a week during the wet months (November to April). We assumed that the child/teenager and adult were wearing short sleeves and short pants (shorts) when playing in the leachate, resulting in skin absorption with their arms, hands, and lower legs. We assumed the person was exposed to the maximum concentration of a chemical ever detected in the leachate during the 1999–2000 rainy season (Table C-7, Appendix C). Though the leachate occurred for a limited time during the winter of 1999–2000, we assumed the child/teenager and adult were exposed 2 times per week for 6 months, for 1 hour each time.

The estimated doses for all chemicals detected in the 1999–2000 leachate did not exceed their long-term health comparison values. (Table C-8, Appendix C). Adding the exposure estimates from the 2000 "leachate" does not result in the likelihood (hazard quotient was less than 1) that the combined exposure to the 19 chemicals would cause noncancer health effects (Table 2). Thus, noncancer health effects would not have been expected from playing and splashing in the "leachate." Cancer risk was not calculated for this short-term exposure. If such "leachate" occurrences continue to occur and someone is exposed to the contaminated water over a longer period, it may pose a health hazard to exposed trespassers and nearby residents. Therefore, we recommend that the adequacy of the current cap be investigated.

Table 2. Health implications associated with exposure to surface waters on the Laytonville landfill after the cap

		Noncancer Summary
		If value less than 1: noncancer effects not expected
Splashing and wading in the leachate in 2000	Adult	0.20
	Child	0.35
Swimming in the sedimentation ponds	Adult	0.043
	Child	0.068

Groundwater

Summary: Groundwater samples have been collected for 13 years on a quarterly basis from five to eight monitoring wells. No VOCs have been detected at levels above health comparison values. Three metals have been identified as contaminants of concern: arsenic, boron, and manganese. These metals have been consistently detected in the groundwater above health comparison values. Barium, total chromium, cobalt, lead, and vanadium have at times been detected at levels that exceed their comparison values. They are not considered COCs in the groundwater at this time, but could become COCs if the levels consistently exceed comparison values. Groundwater is the primary source of drinking water in the Laytonville area. Based on a health consultation conducted by ATSDR, we recommend better characterization of the groundwater in the area including the installation of additional groundwater monitoring wells.

In this section, CDHS summarizes and evaluates the groundwater data collected in and around the landfill. Appended to this PHA is a groundwater health consultation conducted by ATSDR (Appendix E) (22). In the June 2001 health consultation, ATSDR recommends additional monitoring wells be installed to allow a better understanding of the groundwater movement. The NCRWQCB have ordered the county to install additional wells. MCSWMD has developed a plan for additional wells around the landfill, two of which were to be placed on the Cahto Rancheria. The plan was approved by the NCRWQCB. After a delay based on gaining access the Cahto Tribe lands, the MCSWMD will begin construction of the additional wells in late summer 2004.

Before the installation of monitoring wells in 1987, no groundwater sampling occurred. However, if a significant amount of groundwater contamination existed during the 1970s and 1980s, it would probably still be present at detectable levels in 1987.

Since 1987, MCSWMD has installed eight monitoring wells on the landfill property. Three of these wells have been decommissioned, and five are currently active. In 1987, MCSWMD drilled the first three groundwater monitoring wells (87-1, 87-2, 87-3) to detect the spread of

contamination from the refuse into the underlying groundwater (Figure 3). These three monitoring wells are screened at large intervals, 70 to 90 feet, and collect groundwater from at least two aquifers, which makes it difficult to interpret the test results (Table C-11, Appendix C). Therefore, their use was discontinued in 1992. From 1990 to 1994, MCSWMD drilled five more groundwater monitoring wells: 90-1, 91-1, 93-1, 93-2, 94-1 (the first number indicates the year the well was drilled) (Figure 3). These wells sample groundwater from shallow aquifers. These five wells remain active. Table C-11 in Appendix C lists the screening depths of all eight monitoring wells.

Beginning in late 1987, MCSWMD collected groundwater samples from on-site monitoring wells (Table C-12, Appendix C) (36, 60, 61). The water samples were tested for 26 metals and 30 VOCs. From 1987 to 1990, the water samples were tested for chlorinated pesticides and PCB mixtures called Arochlors. In 2000, the water samples were analyzed for pesticides and PCBs. In 1997, the number of VOCs that were analyzed for in the water samples expanded to 61.

In 1996, the U.S. Army Corps of Engineers drilled three wells on the rancheria property for the BIA: 96-1, 96-2 and 96-3 (Figure 6) (51, 62-65). The monitoring wells were installed to provide groundwater monitoring of the shallow aquifer. In June 1996, August 1997, November 1997, and April 1998, the U.S. Army Corps of Engineers sampled these monitoring wells on the rancheria. The samples were analyzed for VOCs, nitrogen, and coliform The results showed no chemicals were present at levels above health concern. However, nitrates and fecal coliform were present in the water. The nitrogen concentrations are indicative of organic waste that could come from the landfill or a septic field tank. Fecal coliform could be coming from a septic tank field, but is not something that would come from a landfill.

In July 2000, the law firm of Masry and Vititoe collected and analyzed a water sample from monitoring well 96-1 on the Cahto Tribe's rancheria. The sample was analyzed for metals, PCBs, VOCs, and SVOCs. No metals were present at levels above health concern for drinking water. No PCBs, VOCs, or SVOCs were detected.

In March 2002, Water Quality Technology, Inc., of Fort Collins, Colorado, took water samples from the two monitoring wells, 96-1 and 96-2, located on the tribes property (66). The consultants, hired by the Cahto Tribe, analyzed the samples for VOCs, radioactivity, chlorinated pesticides, and PCBs. No VOCs, chlorinated pesticides, or PCBs were detected in the groundwater samples and the levels of gross alpha and beta radioactivity were below drinking water standards. They also ran a test of mutagenicity, called the Ames test, on the water samples, with positive results. CDHS is very familiar with the Ames test being used as a screening tool for a chemical's ability to cause genetic mutations. CDHS is not aware of the utility of such an assay for water quality monitoring.

Gasch & Associates (G&A) a firm retained by the Cahto Tribe conducted a study in 2000 to identify such groundwater flow zones using a geophysical technique known as electrical resistivity. (The electrical resistivity survey included 3 transects located adjacent to the east, south and western boundaries of the landfill property. The objective was to map out areas of

lower resistivity, which according to Gasch & Associates indicates the presence groundwater bearing strata. As a result of the survey, the Gasch team was able to map out several flow channels.

The Cahto Tribe hired Secor International, Inc. to conduct a preliminary assessment/site inspection (PA/SI) to assess potential chemicals of concern that may be emanating from the landfill onto tribal lands. As part of the PA/SI, Secor International, Inc. punched holes into the ground and collected groundwater samples at ten locations along the east, south, and western boundaries of the landfill. Some of the locations were chosen based on the Gasch electrical resistivity study. The work was carried out in October 2001. A water sample was collected from uppermost groundwater bearing unit that was encountered in each boring. At the tribal staff's request, Secor International, Inc. took a water sample from an abandoned well on the eastern border of the landfill. The samples were analyzed the water samples for metals, VOCs, PCBs, PAHs, and alpha and beta radioactivity. The results were two detections of a VOC [di-(2-ethylhexyl) phthalate] and several detections of metals (aluminum, arsenic, barium, chromium, manganese and vanadium) exceeding their health comparison values (Table C-12, Appendix C).

In November 2002, consultants for the U.S. EPA sampled the five on-site monitoring wells (46). They analyzed the water samples for VOCs, SVOCs, pesticides/PCBs, and metals. U.S. EPA found a few detections of VOCs and SVOCs, some of which they attributed to laboratory contamination (Table C-12, Appendix C). They also detected several metals in the monitoring well water above comparison values.

The following discussion summarizes the findings of the groundwater analyses.

VOCs
As shown in Table C-12 in Appendix C, no VOCs have been detected at levels above health comparison values. From 1987 to 2002, 18 detections of 10 VOCs were recorded.

SVOCs (including pesticides/PCBs)
As shown in Table C-12 in Appendix C, no SVOCs have been detected at levels above health comparison values. From 1987 to 2000, 10 detections of 4 SVOCs were recorded.

Metals
As shown in Table C-12 in Appendix C, three metals (arsenic, boron, and manganese) have been consistently detected above health comparison values in the on-site monitoring wells and off-site monitoring wells.

The results of metal testing from 1987 to the present indicate the presence of arsenic in wells 87-2, 87-3, 91-1, and 93-2. The levels of arsenic in well 91-1 are the most important. This well was screened at a depth of 33–43 feet. This depth is consistent with private wells in the community. The arsenic levels in well 91-1 have ranged from non-detect to 16 parts per billion (ppb), with eight water tests from 1991 to 2000 showing arsenic levels above the health comparison value.

Arsenic is not a site-related contaminant but a naturally-occurring metal. However, because it exists at levels which may cause health effects in children after long-term ingestion, it is a COC in the groundwater.

Boron levels ranged from 120 ppb to 600 ppb in five monitoring wells. Boron exceeded the health comparison value during 6 of the 8 years from 1987 to 1994. Therefore, boron is a COC in the groundwater. It is also unknown if the boron is site-related. Since the level has declined since 1994, it may not be naturally-occurring. In contrast to arsenic, boron levels have not remained consistent throughout testing years. As described later, boron is present at similar levels in both sedimentation ponds whereas arsenic is not. This, too, suggests that it arrived in the sedimentation ponds in surface water runoff from the refuse before the landfill was capped.

The manganese levels ranged from 500 ppb to 5,300 ppb. The lower values exceed ATSDR's chronic EMEGs for children, and the higher values exceed ATSDR's chronic EMEGS for adults. It is present every year in all the groundwater monitoring wells at levels which exceed health comparison values. Therefore, manganese is considered to be a COC in the groundwater. The source of the manganese is unknown, since it is another naturally-occurring metal.

Barium, total chromium, cobalt, lead, and vanadium have at times been detected at levels that exceed their health comparison values (Table C-12, Appendix C). They are not considered COCs in the groundwater at this time, but could become COCs if the levels consistently exceed comparison values.

Evaluation of the groundwater conditions is limited by data gaps and hydrogeologic uncertainties. No groundwater analyses are available before 1987. Also, groundwater monitoring wells may not be drawing on all aquifers under the landfill. At this time, the flow direction characteristics of the aquifers underlying the landfill have not been fully characterized. This requires at least three monitoring wells in each aquifer. The current monitoring well arrangement does not allow a definitive conclusion about the flow direction of each aquifer. Nevertheless, it is likely that if a large amount of groundwater contamination existed, it would be detected by the current monitoring wells. However, it is unclear whether or not low-to-moderate contamination would be detected by the current groundwater monitoring arrangement. It is possible that low-to-moderate levels of contaminants may exist in semi confined aquifers under the landfill, which are not being sampled by the current groundwater monitoring wells. Proper monitoring and defining of the groundwater flow is critical in protecting current and future impacts to nearby private wells. For more detailed information on this issue, see the community concerns section and Appendix E, which contains a health consultation by an ATSDR hydrogeologist (22).

Exposure to Household Water for Residents Living Nearby the Landfill Who Use Private Wells

Summary: Occasional sampling of private wells revealed inconsistent detections of metals, SVOCs, and VOCs. None of the SVOCs and VOCs have been detected above health comparison values. Some of the metals (aluminum, arsenic, barium, boron, lead, manganese, and thallium)

have been found at levels above health comparison values in different wells. The metals may be from naturally occurring geology in the area. On the other hand, aluminum, barium, boron, and manganese are also found in the groundwater at the landfill at elevated levels. We recommend annual sampling of all adjacent property private wells. CDHS proposes to work with the county to identify and inform private well owners in the Laytonville area about health issues related to private wells in general. Particular emphasis will focus on sampling more wells adjacent to the landfill. We propose to discuss with the people using a private well that has elevated metals, the potential health hazard of using their well water for drinking water, showering, irrigating and other uses. We will work with the owners and others to identify water treatment systems that could be used to reduce or eliminate the contaminants in the well water.

According to the 1990 U.S. Census, 64% of the housing units (approximately 300 houses) in census tract 102.05 of Mendocino County obtain their water from individual wells (23). Most of those drilled and dug wells draw from shallow aquifers that are around 30–50 feet deep. Very few residents, if any, have filtration systems other than water softening units.

There are approximately 73 private wells within 1 mile of the Laytonville landfill. Approximately 20 of these households use private wells, in addition to municipal water, for irrigation and gardening. Three households that directly border the landfill rely solely on private wells, not municipal water. Several other households across the street from the landfill use only private well water.

The data from private wells are very limited. There are no records of private well tests before 1993 and private wells are not regulated or tested. Because of poor collection techniques, the results of those that were tested for VOCs may be artificially low. Of special interest for testing are private wells currently used for drinking water that are immediately adjacent to the landfill on the northern, western, and eastern sides. Several private wells are within 100 feet of the landfill boundary, but have never been tested.

Sampling of private wells is not part of the on-going quarterly monitoring regimen that MCSWMD follows as per an agreement with NCRWQCB (36, 60, 61). However, some private wells have been sampled by the Cahto Tribe, MCSWMD, NCRWQCB, or U.S. EPA. The findings from these sampling events are described in the following paragraphs.

Sampling Conducted in the 1990s

To address concerns from some residents nearby the landfill, the NCRWQCB tested 12 private wells in 1993 and 1997 (Table C-13, Appendix C) (7). In some cases, the MCSWMD took split samples of the well (7). Eight of these 12 wells were tested for VOCs. Of the eight, one was positive for VOCs. In 1993, a Branscomb Road well tested positive for toluene at very low levels (0.35 ppb and 4.1 ppb). During another sampling the same year, the same Branscomb Road well tested positive for 1,1,1-trichloroethane (0.5 ppb). These levels do not exceed health comparison values. This well immediately abuts the landfill on the northern edge. The other seven wells had no detectable levels of VOCs.

Five private wells were tested for arsenic (7). Two of the five private wells contained 16–17 ppb of arsenic. These values exceed health comparison values. In two of the five private wells tested for arsenic, arsenic was detected at levels that make it a public health concern. The arsenic levels in these two wells were 16 ppb and 17 ppb. These levels exceed ATSDR's chronic EMEGs for children and adults (3 ppb and 10 ppb, respectively).

The following three private wells had detectable levels of lead: Branscomb Road (33 ppb), non-drinking water well on the Cahto rancheria (5 ppb), and North Road (5 ppb) (7). The water from the well off Branscomb Road exceeded the state action level for lead in drinking water (15 ppb) when sampled in February 1993. The county/NCRWQCB sampled the same well three more times in 1993 and lead was not detected in any of those samples.

Two of the six private wells tested for manganese contained 500 ppb of manganese, which exceeds the health comparison value for children (RMEG = 500 ppb) (7). One of the six tested wells contained 2,500 ppb of manganese, which exceeds the health comparison value for adults (RMEG = 2,000 ppb). U.S. EPA has not promulgated a primary drinking water standard for manganese. It has issued a secondary drinking water standard for manganese, which is 50 ppb. This value is based on taste and staining, not on health effects, and is not enforceable by law.

Cahto Tribe Sampling

The Cahto Tribe hired Secor Environmental, Inc. to conduct a preliminary assessment/site inspection (PA/SI) to assess potential chemicals of concern that may be emanating from the landfill onto tribal lands. As part of the PA/SI, Secor International, Inc. collected a water sample from a well located to the southwest of the tribal lands. The sample was collected on October 22, 2001. The water sample was analyzed for metals including hexavalent chromium, VOCs, PCBs, PAHs, and radioactivity. No VOCs, PCBs, or PAHs were detected. No metals or radioactivity were detected above health comparison values.

NCRWQCB Sampling

In July 2002, the NCRWQCB sampled seven nearby private wells and one of the sedimentation ponds (58). NCRWQCB had previously sampled four of these wells. Water samples from the seven wells were analyzed for metals, dissolved metals, PCBs, VOCs, and water quality parameters. Most of this data is useful and summarized in Table C-13 in Appendix C. However, the reporting limits for some of these analyses are not low enough to rule out concern about certain chemicals. For instance, the reporting limit for lead was 75 ppb, yet the State of

California Action Level for lead is 15 ppb. Likewise, the reporting limit for arsenic was 100 ppb, whereas the current drinking water standard is 50 ppb and the future limit (enforceable by 2006) is 10 ppb.

Samples from two of the seven private wells (both on North Road) contained barium above levels of health concern (58). All of the water samples had detectable levels of toluene. No field bland was taken. The lab blank did not contain toluene. NCRWQCB suspected that the presence of toluene was a result of sampling procedures. Because of this, NCRWQCB resampled the same

wells, some in December 2002 and some in May 2003 (59, 67). On retesting, no toluene was detected (detection limit = 0.5 ppb) in any of the wells. This suggested that the previous detections of toluene were an artifact of the sampling, that toluene was not an actual contaminant in the private well water. They also did not have any detections of benzene, ethylbenzene, and xylenes (together referred to as BTEX) and methyl-tertiary-butyl ether (MTBE). No other analyses were conducted.

NCRWQCB also resampled the two wells with high barium (59, 67). The water, as it came from the well at both of these residences, was still high for barium (970 ppb and 2,500 ppb). In both cases, however, water samples from inside the residences showed that filtering systems installed on the wells by the owners reduced the amount of barium to below levels of health concern (child RMEG = 500 ppb). In one case, the barium was reduced by half (470 ppb); in the other case, the barium was reduced to below the level of detection (less than 5 ppb).

The resampling included a well that had not been sampled in the first round when a well at another location was mistakenly sampled instead (59, 67). Arsenic was detected at a level below the current drinking water standard. No VOCs, PCBs, or other metals were detected.

U.S. EPA Sampling

In November 2002, U.S. EPA consultants sampled 10 private wells in the Laytonville area (Table C-13, Appendix C) (46). Of these 10 wells, four wells are near the landfill and had previously been sampled (Figure 5). The other six wells are more than 2,000 feet from the landfill. The samples were analyzed for metals, VOCs, and SVOCs. Two low-level detections of VOCs and two-low level detections of SVOCs were recorded for three of the closest wells (Table C-13, Appendix C). Low level VOCs and SVOCs were also detected in two of the six more distant wells. None of the detections of VOCs or SVOCs exceed their health comparison values.

Eight of the 10 wells, including all the wells closest to the landfill, had levels of arsenic less than the reporting limit of 10 ppb (Table C-13, Appendix C) (46). The other two wells had levels of arsenic greater than the reporting limit (17.3 ppb and 36.9 ppb) and less than the current drinking water standard (50 ppb). Aluminum was detected in one of the close wells at levels above the state drinking water standard (1,000 ppb). Aluminum and thallium were detected in a distant well at levels above their health comparison values (1,000 ppb and 2 ppb, respectively). Manganese was detected in three of the close wells and three of the distant wells at levels that exceed the

health comparison value (500 ppb). U.S. EPA concluded that “no analyses attributable to the Laytonville dump site were detected at significant concentrations in hydraulically downgradient drinking water wells.”

Overview of Private Well Water Sampling

As previously described, the groundwater movement in the area under and around the landfill is not well defined. Thus, there is a concern that contamination could have spread to nearby private

drinking water wells. There has been no systematic monitoring of nearby private wells. The limited available data is confusing. For instance, the groundwater analyses for aluminum, barium, boron, manganese, and vanadium conducted by the tribe and U.S. EPA seem to show a pattern of higher concentrations nearer the landfill than farther away (48, 100, 101). Some of these same chemicals have been found at levels above drinking water standards in private wells near the landfill. However, these chemicals are also found naturally in the groundwater in the Laytonville area. CDHS/ATSDR recommends additional sampling and characterization of landfill hydrogeology and groundwater to better understand risks associated with the landfill. We also recommend sampling of all adjacent property private wells as a part of the quarterly groundwater monitoring program. CDHS proposes to work with the county to identify and inform private well owners in the Laytonville area about special health issues related to private wells, in general. Additionally, we will help private well owners to identify water treatment systems they can use to reduce or eliminate contaminants in their well water.

Exposure Concerns for Consumers of Municipal Water

Summary: The Laytonville County Water District obtains 100% of its water from a groundwater well that is naturally high in iron, manganese, and arsenic. These groundwater contaminants are not a result of the landfill or any contaminated sites or agricultural practices in the area. Since the 1980s, the water has been treated to lower the amount of iron and manganese in the water. The levels of iron and manganese in the treated water do not pose a health hazard from exposure through drinking, showering, bathing, cooking or irrigating, but are a problem related to staining of laundry and porcelain. The treatment also reduces the amount of arsenic in the water to a level below current drinking water standards. Additional treatment is planned as the water district strives to achieve the lower drinking water standard for arsenic that is slated to take effect in 2006.

The Laytonville municipal water is currently supplied by a well located 1½ miles east of the landfill, on the southwest side of downtown Laytonville. Before 1999, another well also supplied some of the water. Its use was discontinued in 1999 because of low water yield. Based on CDHS's review of the district monitoring data, the well water does not contain any VOCs or SVOCs. The well water has high levels of naturally occurring arsenic (55–65 ppb), iron (1,300–2,000 ppb) and manganese (1,400–1,900 ppb). Because of the high levels of these chemicals in the water, the water district is required to conduct monthly analyses for these chemicals (see arsenic monitoring results in Table C-14, Appendix C).

The arsenic drinking water standard of 50 ppb is being lowered to 10 ppb to better protect against the cancer causing potential of arsenic. The new federal standard comes into existence in 2006. Manganese and iron are of concern because of taste and because they stain laundry and porcelain fixtures. The drinking water standard for manganese (50 ppb) and iron (300 ppb) address these aesthetic concerns. In addition, the State of California has an action level of 500 ppb manganese because it can pose a neurotoxic hazard at higher levels.

Since 1980, the water from Laytonville's municipal wells has undergone treatment to reduce the iron and manganese levels. In addition to lowering the manganese (14 ppb to 140 ppb) and iron (150 ppb to 190 ppb), the treatment system reduces the amount of arsenic (35 ppb to 45 ppb). Thus, the treatment lowers the amount of these three contaminants to levels lower than current drinking water standards. However, the current treatment system is not sufficient to clean the arsenic from the groundwater to meet the new arsenic drinking water standard. In order to meet the new drinking water standards, the water district successfully received federal funding to upgrade the treatment system.

Additional Analyses of Laytonville County Water District Water

In July 2000, the law firm of Masry and Vititoe sampled from a tap served by the Laytonville County Water District. The water was tested for metals, PCBs, VOCs, and SVOCs. As with the water analyses conducted by the city, arsenic (42 ppb) was detected. No PCBs were detected. Three trihalomethanes (bromodichloromethane, chloroform, and chlorodibromomethane) were detected, but did not exceed ATSDR's health comparison values. All three compounds are typical by-products of water chlorination processes.

The Cahto Tribe hired Secor International, Inc. to conduct a preliminary assessment/site inspection (PA/SI) to assess potential chemicals of concern that may be emanating from the landfill onto tribal lands. As part of the PA/SI, Secor International, Inc. collected a water sample from the kitchen tap at the tribal office. The tribal land including the tribal office is served by Laytonville County Water District. The sample was collected on October 21, 2001. The water sample was analyzed for metals including hexavalent chromium, VOCs, PCBs, PAHs, and radioactivity. Several VOCs were detected in the sample: bromodichloromethane (11 ppb), bromoform (6.4 ppb), chloroform (4.4 ppb), and dibromochloromethane (15 ppb). None of these chemicals exceed their health comparison values. All of these compounds are typical by-products of water chlorination processes. Arsenic (41 ppb) was detected.

As part of their preliminary assessment/site inspection sampling in November 2002, U.S. EPA consultants sampled the municipal well (46). The water sample was taken before treatment. As in sampling conducted by the water district, the water, as it comes from the ground, contained elevated levels of arsenic (68.2 ppb), iron (2,140 ppb), and manganese (1,480 ppb). Two SVOCs, di(2-ethylhexyl) phthalate (2 ppb) and methyl ethyl ketone (0.4 ppb) were also detected at levels below health concern.

The Mendocino County Municipal Works yard is adjacent to the landfill, in the northeast corner. Since 1994, the water that serves the yard came from the municipal water district. In September 1993, a MCSWMD test of the water from a faucet on this property had detectable levels of VOCs. Specifically, the levels of trihalomethanes were as follows: bromodichloromethane, 6.8 ppb; bromoform, 22 ppb; chloroform, 1.6 ppb; dibromochloromethane, 19 ppb; and total trihalomethanes, 49 ppb. These levels do not exceed health comparison values (CA MCL). No other VOCs were detected. Anyone drinking this water would have been exposed to very low levels of VOCs. Upon retesting, no trihalomethanes were detected. In September and October

1993, the water was tested for arsenic. The levels were 66 ppb and 30 ppb, respectively. The amount of arsenic in September exceeded the current drinking water standard (50 ppb).

Child Health Considerations

ATSDR recognizes that infants and children may be more sensitive than adults to environmental exposures. This sensitivity is a result of several factors: 1) Children may have greater exposures to environmental toxicants than adults because pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults; 2) Children play outdoors close to the ground which increases their exposure to toxicants in dust, soil, surface water, and in the ambient air; 3) Children have a tendency to put their hands in their mouths while playing, thereby exposing them to potentially contaminated soil particles at higher rates than adults (also, some children ingest nonfood items, such as soil, which is called *pica* behavior); 4) Children are shorter than adults, which means they can breathe dust, soil, and any vapors close to the ground; 5) Children grow and develop rapidly and can sustain permanent damage if toxic exposures occur during critical growth stages; and 6) Children and teenagers may disregard "No Trespassing" signs and wander onto restricted locations. Because children depend on adults for risk identification and management decisions, CDHS and ATSDR are committed to evaluating their special interests at hazardous waste sites. CDHS considered children for each of the pathways evaluated.

Community Concerns Evaluation

The collection, documentation, and response to community health concerns are critical to the PHA process. This section describes the outreach activities for gathering community health concerns and summarizes community health concerns. It also evaluates those concerns and includes a response to groundwater concerns by an ATSDR hydrogeologist. (The complete health consultation can be found in Appendix E) (22).

Community Outreach and Community Health Concerns

CDHS became aware of community health concerns related to the Laytonville landfill when the Cahto Tribe presented results of an informal health survey of Laytonville Rancheria residents. The May 2000 meeting was held to discuss results of recent testing at the landfill. It was attended by representatives of the Cahto Tribe, county and other agency officials, and community members. The informal health survey, conducted by the Cahto Tribe's environmental department, showed serious illnesses in adults and children. Several people reported experiencing effects such as asthma, headache, nausea, and dizziness after walking on the landfill. The Tribal Chair expressed concern that children who played in the local creek might become ill. She stated that elderly neighbors and relatives have died of cancer and that she, herself, is ill. She wanted the soil and water tested for contaminants and the children tested for disease.

Other rancheria residents expressed concern about the landfill. One resident worried that cancer

deaths of relatives and an elderly relative's stroke might have been caused by drinking water contaminated by the landfill. She said plants and trees have failed to grow. Another resident attributed her elderly grandmother's death from leukemia to the landfill. Many people on the rancheria are related and the elders have valuable knowledge of the Cahto culture and language, she said. Consequently, the loss of the elders affects the entire community.

As CDHS staff members continued to gather community health concerns, discussions were held with members of 12 households immediately adjacent to or across the road from the landfill. Another 12 residents shared their concerns with CDHS staff during a public availability session held in Laytonville. Other concerns were gathered during discussions with health and social service professionals in Laytonville and representatives of the Cahto Tribe. Finally, several community members spoke with CDHS staff by phone.

Five households are situated next to the landfill, on the western, northern, and eastern boundaries. Seven more households are located across the road to the north of the landfill. Three families living on the western and northern boundaries have serious health concerns about the landfill, while nine families who live on the northern boundary do not. The landfill lies north and west of the Laytonville Rancheria and shares two borders. During these initial visits to Laytonville, representatives of the Cahto Tribe reported that many rancheria residents have serious health concerns. Four rancheria residents interviewed by CDHS expressed such concerns.

Health concerns about the landfill date back to the 1980s, when residents of three households bordering the landfill reported the presence of dust, odors, refuse, and health symptoms. There were descriptions of bright yellow or orange liquid runoff that smelled like sulfur, black bubbling liquid and garbage in residents' yards, and visible gases rising from the landfill. There were also unsubstantiated accounts of people being burned by landfill gases, of shoes dissolving from walking on the landfill, and of animals being born with deformities. Environmental degradation and numerous health problems were attributed to the landfill. A number of residents complained to county officials in letters, at public hearings, and finally, in acts of protest. The landfill was closed in 1993 and capped in 1997. With the recurrence of odors and questions regarding the integrity of the landfill cap, similar health concerns have surfaced.

As stated previously, a number of residents expressed their concern that the landfill contamination may have caused cancer. They believe there is a higher than normal cancer rate in Laytonville. The types of cancer attributed to the landfill by the residents include childhood leukemia, adult-onset leukemia, ovarian cancer, cervical cancer, lung cancer, esophageal cancer, and bone marrow cancer. According to two residents, there have been three cases of childhood leukemia in Laytonville in approximately 20 years.

Respiratory problems such as asthma, bronchitis, sore throats, difficulty breathing, shortness of breath, and sinus problems have also been attributed to the landfill by the residents, currently and in the past. The most specific of these complaints date to the time when there was regular burning of landfill waste. According to one resident, such burning occurred from 1974 through

the early 1990s, and was accompanied by respiratory symptoms and rashes. This resident experienced sore throats, sinus problems, nosebleeds, and/or rashes each time there was burning on the landfill. Her infant grandchild stopped breathing on several occasions and required mouth-to-mouth resuscitation and hospitalization. This occurred only at that location and ended completely when the family moved away from the landfill.

Members of one household near the landfill attributed the poor physical and emotional health condition, and eventual death, of a family member to contamination from the landfill. The family moved away, but continued to experience these health problems. The new property owners also experienced health problems, including nausea and vomiting, weight loss, and gall bladder disease, which they associated with the landfill. Their cattle have had several premature births. They worried that their child might develop cancer as an adult through living near the landfill.

Skin problems attributed to the landfill by the residents include rashes, several cases of granuloma anulare (a skin condition), and benign cysts in children and adults. There have been reports of rashes and a burning sensation on the skin after contact with Cahto Creek water.

Residents have attributed gastrointestinal problems (nausea, diarrhea, vomiting), chronic weight loss, and gall bladder disease to the landfill. Several residents stated that in the 1980s, there was a higher than normal incidence of gall bladder disease among young women on the rancheria. Three women living in households bordering the landfill had their gallbladders removed. Liver problems among young women and a child were also reported. Residents expressed concerns about a variety of other problems from landfill contamination Those include learning disabilities, attention deficit disorder in an adolescent, anxiety disorder in an adult, three cases of rheumatoid arthritis, two miscarriages, and two children with fecal incontinence.

A recurring theme among those residents who had health concerns was mistrust of county officials and disbelief in assurances that the landfill had been made safe. Many residents said they did not think there had been adequate testing of air, soil, or water. Some did not trust the validity of the tests that had been done. Several residents expressed outrage at the injustice of situating a landfill on a hill above tribal land and considered this lack of concern a sign of racism.

In 2001, the Cahto Tribe considered filing a lawsuit against responsible parties for illnesses caused by contaminants from the Laytonville landfill. During this time, a law firm had advised the tribe and its members not to discuss their health concerns with CDHS and other agencies. However, CDHS remained resolute in its responsibility to gather all community health concerns, including those of individual Cahto tribal members. When the law firm declined the case, the tribe obtained the assistance of an environmental advocacy firm, Tribal Association for Solid Waste and Emergency Response (TASWER), and contacted CDHS once again. In 2002, with assistance from TASWER, CDHS developed a protocol to collaborate with the Cahto Tribe in gathering community health concerns on the Laytonville Rancheria. ATSDR provided funding to the Cahto Tribe staff person could assist CDHS staff with collecting health and exposure concerns from Laytonville Rancheria residents As a result of the protocol and the funding, health

educators from CDHS and the Cahto Tribe successfully worked together in gathering community health concerns from tribal members living on the rancheria.

On two separate occasions in August and September 2002, informal discussions took place with 27 individual tribal members (eight adult men, nine adult women, and 10 youths) living on the Laytonville Rancheria. Many of their concerns are similar to those already noted, including those of nontribal Laytonville residents.

Of highest concern was the drinking water. Almost everyone stated that the water tastes terrible and that they are afraid to drink it for fear it might cause illness, including cancer. Most stated that they do not drink water from the tap at all and buy bottled water instead. One tribal member said the water is smelly and has particles floating in it. At least one tribal member said she sometimes can't get into town to buy bottled water, so she drinks tap water and is afraid it will make her sick.

Many of the adults said they do not currently wade or swim in Cahto Creek, but that they spent many hours wading and swimming in the creek when they were children. A few adults said they had read warning signs posted by the tribe's environmental department warning not to swim in or drink creek water because of landfill contamination. One adult said she noticed that the water is green and there are algae growing on the rocks. "This is not normal," she said. Some adults said they drank water from the creek when they were children. Despite two statements by adults that children are swimming in the creek, all 10 youths said they do not currently wade or swim in Cahto Creek. Some were told by their parents not to wade or swim there, others said they prefer the town swimming pool. A few said they do not like to swim. One 10-year-old said, "Our creek is poisoned. They said there was cancer in the water."

Adult tribal members commented that they no longer fish in Cahto Creek because of dwindling fish and eel populations. They do not eat fish or eel that are caught in the creek and will not allow their children to do so either. Some thought the lack of fish and eel was because of contamination from the landfill. Others felt it resulted from low water flow or over-fishing further downstream. Many of the adults were saddened that they can no longer practice the cultural activities of their tribe and their ancestors. Many noted that tribal culture, including fishing, hunting, and gathering, have been heavily compromised by increased human population, degradation of their natural habitat, and contamination from the landfill. One tribal member stated that at one time, there were many polliwogs (tadpoles) in the creek, but now they could not be found. One father was angry that he would not be able to pass onto his children the cultural knowledge that he learned from his own father. He said it was another form of genocide. Others were concerned about not being able to harvest indigenous food items and materials for the elders of the tribe. It was said that, at one time, many of these items were gathered and stored in such a way that they could be used year round, but that is no longer possible. One woman said they were losing their traditional herbal remedies and that the tea she used to pick and cook "wasn't there anymore."

Many of the tribal adults stated that, as children, they played at the landfill or gathered bottles

and cans for recycle. A woman said she saw “hospital stuff” and “refrigerators,” even though the landfill was supposed to be a household dump. One adult male talked about swimming in a bog near the landfill. Most of them said they do not go near the landfill now, even though it is not more than a mile away. Some reported that they heard about industrial chemicals being dumped there by “trucks driving in at night.” One adult said he saw a black substance coming through the cap at the dump. Another adult said he was told by a Mendocino County representative that there were no hazardous chemicals in the landfill, “but they capped it anyway.”

Health issues and concerns of the tribal members include headaches, migraines, coughs, bronchitis, asthma, nosebleeds, skin rashes, bone problems (including scoliosis), bleeding kidneys, gallstones, and ulcers. Additional concerns include nerve damage, chemical imbalances, rectal and vaginal problems, miscarriages, infertility, hemangiomas, and Turner’s Syndrome (an absence of the second sex chromosome in human females). One tribal member said she had her gallbladder and ovaries removed, adding that she swam in the creek “day in and day out” as a child. She noted that there were people all over town with skin rashes and that one child had been born with a hole in his heart.

Almost all of the adult tribal members noted a high cancer incidence, including cancer of the lung, uterus, bone, brain, and breast. One 35-year-old adult said cancer did not exist in his parents’ generation, but he now sees a “cluster of cancer” in residents living next to tributaries near the landfill. He also noted “high rates of leukemia” for “such a small area.” Another woman noted that families living right next to the landfill have “all died of cancer.” One woman lost both of her parents to cancer.

It is apparent from these concerns that both tribal and non-tribal residents have experienced serious illnesses. The existence of the landfill has produced a great deal of fear and stress for many community members.

Evaluation of Community Health Concerns

The following discussion addresses community health concerns in light of the PHA findings.

Did contamination from the landfill cause or contribute to the health problems described by community members?

Results of available environmental testing show that landfill contaminants to which people might have been exposed were not present in high enough amounts to be considered health risks. At the levels detected, these chemicals have not been demonstrated in scientific studies to cause health effects. This means that none of the information we have about the levels of the contaminants suggest that they were high enough to cause health problems.

However, because there are significant gaps in the testing that was done, we cannot rule out the possibility that at times, levels of landfill contaminants could have been higher. Higher levels would have been required for there to have been any effect on residents’ health. Without

adequate exposure information, we cannot assess what the risks might have been. Therefore, it is not possible to determine with any certainty whether or not environmental contamination from the landfill may have contributed to any of the residents' illnesses.

Even when reliable exposure information exists, it is rarely possible to establish whether a particular individual's illness was caused by a specific environmental exposure. Many illnesses have multiple causes that are sometimes not well understood. In most cases, there are no reliable biological tests (blood, urine, etc.) to determine past exposures to chemicals or to assess the degree to which individuals may have been affected by such exposure.

There is also a lack of scientific information regarding the health effects of many chemicals. Only 10% of the wide array of chemical contaminants in existence have been fully studied for their health effects in humans, and much remains to be learned. It is not well understood how chemicals interact with each other or how exposure to multiple chemicals may affect health. The interaction between stress and human illness is just beginning to be understood. It is known that stress can cause physiological changes that contribute to physical illness. In the future, new information may shed some light on the connection between certain illnesses and environmental contamination.

Could the presence of the landfill, as opposed to potential contamination from the landfill, cause or contribute to the health problems described by community members?

There is no question that the Laytonville landfill has been detrimental to the quality of life for nearby residents. For several nearby residents, the dump looms outside their back door. The landfill is now 40 feet higher than the original hill it was built on. When it was open, odors and trash blew from the landfill, causing worries about health and reminding nearby residents that they lived next to a dump. Even after it was closed and capped, odor problems still occur. In addition, the present cap has stability problems. All sides of the capped landfill are steep, and at least one side is seismically unstable because of poor design. Gaps are occurring at the edge of the landfill cap, and it is known that water containing VOCs has seeped from these gaps. These very real concerns add to the burdens that the landfill places on nearby residents.

The Cahto Tribe has especially been affected, because the Laytonville Rancheria borders the landfill on two sides. The psychological, cultural, ecological, financial, and social impacts on the Cahto Tribe and its neighbors have been tremendous. The dump was placed on land that is considered ancestral territory for the Cahto people. According to experts, "The indirect effects of hazardous waste exposure (e.g., cultural damage, socioeconomic impacts, and psychological distress) may have more severe health effects than the chemicals" (68).

Tribal peoples often experience the natural environment in relation to their subsistence and traditional lifestyles (69). This places an additional burden on them when the area in which they are hunting, fishing, gathering, praying, or recreating is contaminated with chemicals from hazardous waste sites. For example, significant levels of contaminants were found in the plants used by a northern California tribe for food, basketry, medicine, and ceremonial purposes.

Consequently, the California Department of Pesticide Regulation recommended that tribal peoples not gather these plants up to 130 weeks, or more than 2 years, from the time of pesticide spraying of the area by a lumber company (70). The affects on tribal lifestyles and cultures from findings like these are tremendous. Experts have pointed out that "Land has a different meaning for tribal peoples. Most U.S. residents would move away from a hazardous waste site without feeling that their religion has been affected" (68).

Is it safe to drink our water?

It is safe to drink the municipal water. Based on CDHS's review of the district monitoring data, the municipal well water does not contain any VOCs or SVOCs. The municipal well water, before treatment, has high levels of naturally occurring arsenic (55–65 ppb), iron (1,300–2,000 ppb), and manganese (1,400–1,900 ppb) (71). Since 1980, the water that is pulled from the Laytonville wells has undergone treatment to reduce the iron and manganese levels. In addition to lowering the manganese (14 ppb to 140 ppb) and iron (150 ppb to 190 ppb), the treatment system reduces the amount of arsenic (35 ppb to 45 ppb). Thus, the treatment lowers the amount of these three contaminants to levels lower than current drinking water standards. However, the current treatment system is not sufficient to clean the arsenic from the groundwater to meet the new arsenic drinking water standard. To meet the new drinking water standards, the water district successfully received federal funding to upgrade the treatment system.

Some of the private wells contain metals above health comparison values (Table C-13, Appendix C). The metals may be from naturally-occurring geology in the area. CDHS will communicate with each of these well owners and occupants of the residences served by these wells to make them aware of the health concerns. Sampling of private wells has occurred on occasion and found inconsistent detections of metals, SVOCs, and VOCs. None of the SVOCs and VOCs have been detected above health comparison values. Some of the metals (aluminum, arsenic, boron, lead, manganese, and thallium) have been found at levels above health comparison values in different wells.

ATSDR Health Consultation Response to Community Technical Questions About Groundwater

In gathering community health concerns for this assessment, CDHS learned that the community had numerous questions about possible contamination of local domestic drinking water wells, seepage from the groundwater to the surface, and surface water runoff into Cahto Creek. Community technical questions focus on whether existing monitoring wells are effective in determining the presence of groundwater contamination on the landfill site. If so, does detected contamination threaten public health off site of the landfill.

To answer these questions, CDHS scientists forwarded ATSDR excerpts of site-specific groundwater investigations conducted by consultants on behalf of MCSWMD. CDHS also forwarded excerpts of reports prepared by environmental consultants for the BIA and of U.S. Army Corps of Engineers' groundwater investigation and monitoring reports on Laytonville

Rancheria property east of the landfill. This technical information—including the drilling logs—was reviewed during preparation of the health consultation.

The responses to the questions were intended to be used for public health purposes, not for regulatory purposes nor as a peer review of environmental investigations at the site. The quality of the responses is limited by the quality and quantity of the technical information reviewed. The information used in preparing the health consultation did not include a site visit by its principal author. Neither does it include interviews with any California-licensed hydrogeologists who might have conducted site-specific investigations. The complete health consultation, which discusses these issues in more detail, can be found in Appendix E (22). The questions and answers are summarized below.

Are the monitoring wells properly located to detect groundwater contamination?

Past and current monitoring wells installed on-site probably would have detected contamination if a large and continuous volume of highly contaminated groundwater flowed from the landfill. However, the complex hydrogeology of the site reduces the capability of a few monitoring wells to detect low volume, low concentration, groundwater contamination.

If the answer to the above question is no, how many more wells are needed, and where?

For public health purposes, two additional monitoring wells are probably needed. Those would help provide an early warning if groundwater contamination exists and is moving toward private wells immediately north of the property boundaries. The monitoring wells should be screened at the same depth as the residential wells. One monitoring well could be located in the northwestern corner of the property and another near the center of the northern boundary. The wells could provide some indication if groundwater contamination is occurring at levels of concern and whether that contamination could reach private wells.

Are Laytonville Rancheria residents in danger of their groundwater becoming contaminated?

In 1996, monitoring by the U.S. Army Corps of Engineers did not detect landfill groundwater contaminants in the rancheria's groundwater (62). However, the monitoring of rancheria groundwater is limited. For example, the technical information reviewed indicates that past and existing drinking water wells in the Laytonville Rancheria have not been monitored for any specific contamination from the landfill.

Are contaminated groundwater or surface water runoff likely to enter Cahto Creek?

Judging from the technical information provided, Cahto Creek is unlikely to receive enough contaminated groundwater from the landfill to be discernible from other contaminants flowing from upstream sources, (i.e., mining operations). A portion of the surface runoff from the landfill property probably does drain into Cahto Creek.

A review of topographic maps and aerial photographs indicates surface water runoff from the southwestern side of the landfill could flow into a minor tributary of Cahto Creek. Also, the southeastern side of the landfill appears to drain toward Cahto Creek. However, the northern portion of the landfill property probably drains toward Cahto Lake north of Branscomb Road rather than into Cahto Creek. A review of the technical information provided did not indicate the presence of high levels of surface water contaminants flowing from the landfill into Cahto Creek.

Although some groundwater flowing from the landfill property probably reaches Cahto Creek, the marshy area on the northeastern side of the landfill property and Cahto Lake to the northeast are also likely receiving areas for groundwater flowing from the landfill site.

Are the private wells near Cahto Creek likely to become contaminated?

The U.S. Army Corps of Engineers report did not identify any site-specific chemical contaminant moving from the landfill to the uppermost groundwater zone on the Laytonville rancheria. Past and current on-site groundwater monitoring does not indicate sufficient concentrations or volume of groundwater contaminants to pose a problem for most off-site private wells. However, the information is too limited to predict the continued safety of nearby private wells. For example, a domestic well is reported in use immediately north of the central border of the landfill property. No analysis of that well water has been provided to determine if the well has been contaminated by landfill sources.

Health Outcome Data Evaluation

Community health concerns pertaining to the Laytonville landfill have included concerns about excess cancer, particularly in areas closest to the landfill. Cancer mortality (deaths) and, to a

lesser degree, cancer incidence (new cancer cases) in Laytonville have been evaluated through a Mendocino County cancer cluster investigation and a CCR cancer case summary. These investigations are summarized in this section.

Cancer is a collection of more than 200 different diseases caused by a combination of factors, including age, behavioral choices (cigarettes, diet, exercise), environment (sun, chemicals, viruses), and hereditary makeup (genetics). Cancer develops over many years and generally does not have a single cause. Different cancers have different causes and vary in the length of time they take to develop. For example, cigarette smoking, in concert with other unknown factors, can cause lung and other types of cancers. Drinking alcohol is part of a cause for several types of cancer, including liver cancer. Cervical cancer is caused in part by a virus that is sexually transmitted. Age is also a large risk factor for cancer. In general, the older a person is, the more likely he or she is to get cancer.

In May 1993, a local resident submitted to the MCHD a list of 71 individuals who had developed cancer during the previous 20 years, and a map of their residences. MCHD referred the list and

map to the Cancer Surveillance Section of CDHS. Both agencies contacted the local resident for additional information necessary to evaluate cancer rates in the area. Efforts to gather this additional information proved unsuccessful.

In July 1994, the MCHD undertook a cancer cluster investigation to address the issue of cancer in the area of Laytonville closest to the landfill. The purpose of the cancer cluster investigation was to determine whether the number of deaths from cancer among people living near the landfill between 1974 and 1994 was greater than what would be expected. The MCHD evaluated cancer mortality in an area located within a 1-mile radius of the landfill. This area (called the study area) consisted of residences on the Laytonville Rancheria, North Road, Stump Road, Lakeview Road, and on the 1.5 miles of Branscomb Road closest to the landfill.

Information on cancer deaths in the study area was collected from three sources: the community member' s list of 71 individuals purported to have cancer; a door-to-door, telephone, and mail survey of the residences in the study area; and the Longview Health Clinic in Laytonville. Cancer deaths were verified using medical records and death certificates.

Individuals on the community member's list who did not live in the study area were not included in the investigation. Of the original 71 individuals, 30 lived in the study area and were included in the investigation, 34 either lived outside the study area or did not have cancer, and seven could not be accounted for.

Cancer mortality rates for the study area were calculated and compared to cancer mortality rates for Mendocino County. (Cancer mortality rates are the number of people who die of cancer divided by the number of people in the population. They are most often expressed per 100,000 people.) To avoid an underestimation of the rate, the MCHD also calculated a cancer mortality rate that included the seven individuals they could not locate in the total count of cancer deaths. The total population of the study area was determined to be 550 per year, or 11,000 for the 20-year period.

The investigation confirmed 13 deaths from cancer in the study population over 20 years. This translates to a cancer mortality rate in the study area equal to 127 per 100,000. When the seven individuals for whom information was missing were included as cancer deaths, the cancer mortality rate increased to 191 per 100,000. In comparison, the cancer mortality rate for Mendocino County was 190.4 per 100,000 for the period 1985–1989 and 180 per 100,000 for the years 1988–1990. The investigation concluded that the cancer mortality rates in the 1-mile radius of the landfill were not increased over Mendocino County rates.

Cancer cluster investigations in general, and door-to-door surveys in particular, are time and resource-intensive. The Mendocino County cancer cluster investigation represents a concerted effort to respond to community concerns about cancer and its possible association with the Laytonville landfill. The methods used by MCHD to identify cancer deaths do leave open the possibility that some cancer deaths between 1974 and 1994 were missed. No information was collected about past residents in the study area. Thus, MCHD investigators may have missed any

past residents in the study area who died of cancer while living in Laytonville, but did not appear on the community member's list.

Community response to the investigation has included criticism that the study failed to ascertain all cancer deaths in the study area. Members of the Cahto Tribe indicated that tribal elders were unlikely to share information about their own or their family's health status with one of the County interviewers who was only 15 years old.

Because of the limitations in cancer mortality records, it is impossible to verify whether the MCHD investigation identified all of the cancer deaths occurring in the study area during the years 1974–1994. Information on the number of cancer deaths within a zip code area is only available from the California Center for Health Statistics starting with the year 1989. Similarly, the CCR did not begin collecting information on cancer incidence and mortality until 1988. Therefore, it is not possible to obtain an official count of the number of people who died of cancer in the Laytonville study area, or in the larger area that is covered by zip code 95454. Even if this information were available, the geographic area of zip code 95454 is too large to answer questions about the role of the landfill in cancer occurrence in the community.

The second source of information on cancer incidence in Laytonville is a cancer case summary prepared for the Cahto Tribe by the CCR in late 1999. The CCR collects information about all but three types of cancers diagnosed in California. Collecting information on cancer throughout the state allows health researchers to study geographic, ethnic, occupational and other differences that provide clues that point to risk factors for cancer.

In response to a community member's inquiry, the CCR of Northern California prepared a cancer case summary for zip code 95454 for the 10-year period 1988–1997. The cancer case summary lists the number of people who resided in zip code 95454 when they were initially diagnosed with cancer. Laytonville is the only city associated with zip code 95454. However, the zip code extends beyond the city boundaries, so the size of the population living in zip code 95454 is larger than that of Laytonville.

A total of 138 cancer cases among residents of zip code 95454 was diagnosed between 1988 and 1997. By year, the number of cases is 17 in 1988, 11 in 1989, 20 in 1990, 10 in 1991, 12 in 1992, 20 in 1993, 11 in 1994, 14 in 1995, 9 in 1996, and 14 in 1997. The average number of cancer cases for the 10 years was 13.8 cases per year. Tobacco-related cancers (oral cavity and pharynx; esophagus; stomach; pancreas; larynx; lung and bronchus; cervix; urinary bladder; kidney and renal pelvis) comprised 40.6% of the 138 cancer cases. The 10 most common cancer sites reported for the 10-year period were lung and bronchus (23%); prostate (14%); breast (12%); colon and rectum (9%); urinary system, including kidney and renal, pelvis, and urinary bladder (8%); female genital system, including cervix, uterus, and ovary (7%); other digestive system, including stomach, pancreas, esophagus, and liver (6%); and non-Hodgkins lymphoma (4%). For comparison, these types of cancers were also the 10 most commonly reported for Mendocino County during the years 1988–1997, while tobacco-related cancers comprised 47.7% of the total number of cases (California Cancer Registry, personal communication, 2000).

Cancer case summaries do not provide information on whether cancer is more common in the zip code 95454 than in other areas. This type of comparison can be made by looking at whether the number of cancer cases that occur is different from the range of numbers we would expect based on information on the size and demographics of the population, as well as historical rates of cancer occurrence. However, the way the expected number of cancer cases is calculated has many limitations and uncertainties when dealing with areas of small population. These limitations and uncertainties occur, in part, because accurate information on population size and demographics is often not available for sparsely populated areas. Another limiting factor is that Native Americans are often listed as non-Hispanic whites in the CCR. This type of demographic misclassification, combined with inaccurate population information, makes it more likely that the number of cancers we expect, based on our calculations, is wrong. A comparison between zip code 95454 cancer rates and other areas could be made. However, the result of this comparison—whether it is that zip code 95454 has normal rates, elevated rates, or decreased rates—would be unreliable.

Limitations of Evaluation

The identification and analysis of environmental exposure is difficult and inexact. This health assessment was prepared using different sources of information. There are varying degrees of uncertainty associated with each source of information. The following describes four broad areas where uncertainties may be found and provides examples of some of these uncertainties.

- **Environmental Data**
  In preparing this PHA, CDHS relied on information provided by the U.S. EPA, U.S. Army Corps of Engineers, CARB, MCSWMD, NCRWQCB, Laytonville County Water District, CDFG, Northern California Cancer Registry, the law firm of Masry and Vititoe, and contractors. CDHS assumes that adequate quality control measures were followed with regard to chain of custody, laboratory procedures, and data reporting. The validity of the analyses and conclusions reported in this PHA depend on the completeness and reliability of the referenced information. As stated previously, there are data gaps in understanding past exposures which can no longer be filled. We have recommended sampling that can help fill data gaps in understanding current or future exposure. One issue to address in the future is the adequacy of analytical detection limits for surface water, leachate, and sediment sampling. Detection limits for these media in past data collections were not low enough to address the issue of bioaccumulation in fish and other biota that may be affected. Future analyses for mercury and PCBs in particular should have detection limits sufficiently low to address this issue.

- **Exposure Assessment**
  Exposure assumptions were used to estimate exposure doses. The exposure assumptions used in the health assessment are meant to provide conservative (health protective) results for the exposure estimates.

- **Chemical Toxicity**
  Toxicity information for the COCs was generated mostly from animal studies at high doses and in some cases, epidemiological studies of adult worker populations. For most chemicals, we really do not know what effects will result from low level exposure to humans.

- **Cancer Rate Reviews**
  There are a number of reasons why it is difficult to tell from a review of cancer registry data whether specific exposures caused cancer in a community. Cancer takes a long time to develop (usually many years), so people may have cancer for a long time before they learn about it. If people moved away, their cancer would not be included in the cases recorded for the area they moved from but to the area where they moved. The expected numbers of cancers are based on the census, and if the census is inaccurate, the cancer estimate would be too. Finally, there is no information on whether any of the people diagnosed with cancer smoked, and smoking causes lung cancer (85% of lung cancer is caused by cigarette smoking).

Conclusions

People living near the Laytonville landfill, especially members of the Cahto Tribe, report that they used to go to the landfill when it was open and accepting waste. Coming into contact with the waste may have posed a risk from chemicals, from live bacteria and viruses, and from the physical hazards of sharp, rusty objects in the waste. After the cap was placed on the waste in 1997, direct contact with the waste was eliminated. The landfill has and continues to have a psychological and emotional impact on the community who see a large hill of garbage with a fault.

Using available data, CDHS concludes that playing in the leachate, swimming in the sedimentation ponds, playing in Cahto Creek or puddles formed from surface water runoff, and eating fish or eel from Cahto Creek in the past and currently pose a no apparent public health hazard. However, long-term exposure to the liquid that periodically leaks ("leachate") from edges of the cap could pose a health hazard in the future.

CDHS could not evaluate two pathways because of inadequate data. There was a lack of adequate sampling conducted while the landfill was in operation, especially during the times of open burning. Therefore, the health hazard posed by the inhalation of outdoor air on and around the landfill before the cap was installed (1960s–1997) is an indeterminate health hazard. Because of the lack of soil samples, skin contact and incidental ingestion of off-site soil is classified as a potential exposure pathway. Nearby residents and trespassers who live northeast and southwest of the landfill may have been exposed to contaminants in the soil deposited by surface water runoff from the landfill. There has been limited sampling and nearby residents are concerned.

CDHS concludes that the landfill does not significantly affect the air quality in the area. Low level VOCs may be coming from the landfill but do not pose a health hazard. The most significant impact to area air quality is open burning, wood-burning fireplaces and automobile

traffic.

CDHS concludes that chemicals found in nearby city drinking water system do not come from the landfill. The levels of arsenic and manganese found in the untreated city water supply are natural. The treated water meets current drinking water standards for these chemicals.

CDHS concludes that the extent of contamination in the groundwater is unknown because of incomplete information. Several metals found in water samples from eight private wells near the landfill were above the drinking water standards. It is unclear what the source of these metals is. Aluminum, barium and manganese are naturally occurring in Laytonville water, making it difficult to know whether the landfill is affecting the adjacent private wells.

Two sources of health outcome data were reviewed. CDHS found that the results of the 1994 cancer mortality report are inconclusive because of several important data gaps. The results, therefore, can not be used to assess cancer rates or cancer risks in Laytonville.

The level of concern about health effects from landfill contaminants is very high among residents of the Laytonville Rancheria, and among a few Laytonville residents who live near the landfill. Therefore, it is important to provide information regarding the lack of conclusive evidence about past landfill contamination and the need for future monitoring, improved closure efforts and diligent oversight to protect future exposure from occurring.

Recommendations

- CDHS/ATSDR recommends that NCRWQCB and CIWMB investigate the integrity of the cap and determine whether the present cap can be improved or some other step must occur. They should monitor for the possible transmission of air contaminants in the summer. In winter, they should check for surface water permeability and leachate contamination.

- CDHS/ATSDR recommends that NCRWQCB and CIWMB investigate the passive gas vents to ascertain their adequacy in preventing migration of dangerous landfill gases. The landfill gas monitoring system needs to be reevaluated for its adequacy in effectively monitoring landfill gas migration.

- CDHS/ATSDR recommends that NCRWQCB oversee additional sampling and characterization of landfill hydrogeology and groundwater to better understand risks associated with the landfill. Further, CDHS/ATSDR recommends placing one or two more groundwater monitoring wells in the central and northwest portion of the landfill's northern boundary at the depth of the nearby private domestic wells.

- CDHS/ATSDR recommends that MCSWMD increase its communication with community residents to keep them aware of activities at the Laytonville landfill. MCSWMD should provide three forms of public notification (i.e., newspaper, web site, flyer) before any moderate or major construction work on the landfill that would be of interest or concern to

the neighbors. They should work with the Cahto Tribe to distribute the information in the most effective manner.

- In order to best understand the wells that should be monitored, MCSWMD should undertake a well usage survey within a half-mile of the landfill. Further, a map showing the private wells within a half-mile of the landfill should be made available.

- CDHS/ATSDR recommends that the MCSWMD conduct yearly monitoring of the private drinking water wells located on adjacent and nearby properties to the landfill. The analysis of the well water samples should have low enough detections limits so the data can be used to help ensure that it is safe to drink or use the water. The analyses should include the basic constituents associated with landfill groundwater characteristics such as specific conductance, ph, total organic carbon, total dissolved solids, ammonia, chloride, as well as a metal survey that includes barium, manganese, boron, and vanadium. If any of these constituents are found in the private well water at levels that indicate migration of contamination from the landfill then additional analyses for a wider suite of chemicals including VOCs should then be conducted.

- CDHS/ATSDR recommends that NCRWQCB conduct periodic split-sample sampling of the same private wells (see recommendation #4), also using analysis techniques with low enough detection limits to be able to use the information for human health interpretation.

- CDHS/ATSDR recommends that the Cahto Tribe restore the Cahto Creek within the Laytonville Rancheria property. CDHS will work with the tribe to identify available resources and assist with applying for these funds.

- CDHS/ATSDR recommends that MCSWMD test surface soil on surrounding properties where surface water runoff occurred most frequently before the cap was constructed. Those include the rancheria to the east, the ranch immediately to the west, and the three private properties immediately adjacent to the landfill to the north. Testing should proceed with the input of inhabitants of each location, in at least three sampling sites in each direction. The analyses should be for chemicals such as metals and certain organic chemicals that persist for a long time in the surface soil.

- CDHS/ATSDR recommends that the areas of the landfill that were used for open burning and are still exposed, be identified and soil sampling occur in these areas.

- CDHS/ATSDR recommends that MCSWMD continue to test all “leachate” that appears around the landfill for VOCs, SVOCs, and metals. The samples should be analyzed using methods with low enough detection limits for bioaccumulative chemicals.

- CDHS/ATSDR recommends that an alternative to open burning be utilized to deal with vegetation waste on the landfill and elsewhere, including on tribal land.

- CDHS recommends that the air district and the tribes raise the awareness within their communities of the environmental effects of garbage burning, the air district strictly enforce the current prohibition of garbage burning, and the tribes regulate such activity.

Public Health Action Plan

The Public Health Action Plan (PHAP) for this site contains a description of actions taken, to be taken, or under consideration by ATSDR and CDHS at and near the site. The purpose of the PHAP is to ensure that this health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. CDHS and ATSDR will follow-up on this plan to ensure that actions are carried out.

Actions Completed

- CDHS reviewed all groundwater, surface water, leachate, soil, and air samples on-site and off-site for public health effects.

- ATSDR reviewed hydrogeological concerns associated with the landfill.

- CDHS reviewed water data for private wells located near the Laytonville landfill.

- CDHS met with community members, health care providers, and social service providers.

- CDHS conducted two public availability sessions that were conducted in Laytonville.

- CDHS developed a protocol for collection of community concerns of the Laytonville Rancheria residents. CDHS was assisted in developing the protocol by the environmental advocacy firm, Tribal Association for Solid Waste and Emergency Response (TASWER). The plan was reviewed and approved by the Cahto Tribe.

- ATSDR provided funding to the tribe so that a Cahto Tribe staff person could assist CDHS staff with collecting health and exposure concerns from Laytonville Rancheria residents.

- CDHS with Cahto Tribe assistance held two group meetings with Laytonville Rancheria residents to collect the health and exposure concerns of Cahto Tribe residents

- CDHS met with regulatory agencies and county and city officials.

- CDHS reviewed the data regarding contaminants in Laytonville municipal water.

- CDHS reviewed data and completed a PHA that addresses questions relevant to contamination at the site.

- CDHS held a public meeting in Laytonville to release the findings and recommendations of the PHA.

- CDHS sent the Summary from the public comment draft of the PHA to 1,760 post office boxes in the Laytonville area.

- CDHS presented the findings and recommendations of the PHA to the Cahto Tribe General Council.

Actions Planned

- CDHS will meet with community members, including the Cahto Tribe, to communicate the findings of this PHA.

- CDHS will share general information about health concerns and private wells with nearby residents.

- CDHS will work with the county and the NCRWQB to involve more owners of private wells near the landfill to allow periodic monitoring of their wells.

- CDHS will offer to assist the Cahto Tribe to restore the Cahto Creek as it flows through the Laytonville Rancheria. CDHS will work with the tribe to identify available resources and assist with applying for these funds.

- MCSWD is presently developing a remediation plan, which calls for the synthetic materials on the side-slopes to be removed, and installation of an enhanced landfill gas venting system.

- The MCSWD submitted and the NCRWQCB has approved a workplan to install a minimum of four new monitoring wells at the landfill. The workplan calls for two background monitoring wells on Tribal property to the south of the landfill. The Cahto Nation approved the installation of these wells over a year ago. With the recent approval from the Bureau of Indian Affairs, the MCSWD will complete the work in the late summer/fall 2004.

- The Laytonville County Water District is in the process of extending the drinking water system west along Brancomb Road.

- If new information becomes available that will help clarify exposure and health concerns, CDHS will evaluate that data. To the extent that resources allow, this review will be documented in a follow-up report.

Preparers of Report

Environmental and Health Effects Assessors

Marilyn C. Underwood, Ph.D.
Chief, Site Assessment Section
California Department of Health Services
Environmental Health Investigations Branch

Jackie Schwartz, M.P.H.
Epidemiologist
Impact Assessment, Inc., Consultant to
California Department of Health Services
Environmental Health Investigations Branch

Community Relations Coordinators

Jay LaPlante
Community Health Coordinator
Impact Assessment, Inc., Consultant to
California Department of Health Services
Environmental Health Investigations Branch

ATSDR Regional Representatives, Region IX

William Nelson, M.S.
Gwen Eng
Libby Levy
Regional Representatives

ATSDR Technical Project Officer

Tammie McRae, M.S.
Environmental Health Scientist
Division of Public Health Assessment and Consultation

Certification

This Public Health Assessment, Laytonville Landfill, Laytonville, California, was prepared by the California Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the public health assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

_____

Tammie McRae, M.S.
Technical Project Officer, Cooperative Agreement Team
Division of Public Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

The Division of Public Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with the findings.

_____

Roberta Erlwein
Cooperative Agreement Team Leader
Division of Public Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

References

1. Coast Range Geologic Consultants. Preliminary engineering geologic evaluation for Laytonville solid waste disposal site. Prepared for County of Mendocino Solid Waste Division. Ukiah (CA). 1993 Aug. Report No.: 202-01-R1.
2. Anderson Consulting Group. Final closure and postclosure maintenance plan for Laytonville landfill. Prepared for Mendocino County, Solid Waste Division. Ukiah (CA). 1996 Dec. Report No.: 3200-77.606.
3. EBA Wastechnologies. Water quality solid waste assessment test report for the Laytonville site. Santa Rosa (CA). 1989 Apr.
4. Cahto Tribe. Letter to Geral Davis, Director, Mendocino County Environmental Health Services from Bert Sloan, Jr., Chairman concerning observations of problems related to the Laytonville landfill. Laytonville, California. July 25, 1989.
5. Mendocino County Board of Supervisors. Memorandum to Jim Eddie from Norman de Vall concerning observations made at the Laytonville landfill on March 6, 1993. Laytonville, California. March 16, 1993.
6. Letter to Director, North Coast Regional Water Quality Control Board from S.G. Rubinow, Jr. concerning problems related to the Laytonville landfill. Laytonville, California. April 23, 1986.
7. Mendocino County Department of Solid Waste Management. Analytical laboratory data sheets concerning domestic well sampling results. Ukiah, California. 1993, 1997.
8. Mendocino County, Department of Public Works. Letter to Susan Miller, Sanitarian, Mendocino County Environmental Health Department from Terry Boyes concerning Laytonville refuse disposal site. Ukiah, California. January 16, 1986.
9. Mendocino County, Solid Waste Division. Data sheets concerning site inspection records for the Laytonville landfill. Laytonville, California. 1997-1998.
10. North Coast Regional Water Quality Control Board. Data sheets concerning inspection reports of the Laytonville landfill. Santa Rosa, California. 1984-2000.
11. California Integrated Waste Management Board. Proposed amendment to site's final closure. Sacramento, California. 2000 May.
12. GeoSyntec Consultants. Laytonville landfill final cover reports - response to comments: construction quality assurance report. Prepared for County of Mendocino Solid Waste Division. Ukiah (CA). 2001 Jan. Report No.: WL0364.
13. GeoLogic Associates. Slope stability evaluation for the Laytonville Landfill. Prepared for County of Mendocino, Solid Waste Division. Ukiah (CA). 2002 Feb.
14. Anderson Consulting Group. Geologic and hydrogeologic report. Prepared for Laytonville Sanitary Landfill. Ukiah (CA). 1995 Mar.
15. Mendocino County Solid Waste Division. Report of Investigation - detection of odors at the Laytonville landfill. Ukiah (CA). 2000 May.
16. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 2000. Ukiah, California.
17. Mendocino County, Department of Public Works. Reports of self-monitoring, Laytonville landfill. Laytonville, California. 1976-1988.
18. California Air Resources Board. Letter to Paul Cayler, Director of the Mendocino County Solid Waste Division from Kirk Oliver concerning complaints of illegal outdoor burning

at Laytonville landfill. Sacramento, California. November 25, 1997.
19. California Air Resources Board. Complaint investigation, Laytonville landfill. Sacramento, California. June 30, 1997.
20. Bureau of the Census. 2000 census population: Washington: U.S. Department of Commerce
21. Historical weather for Covelo, California. Weatherbase.com, Inc., producers. Great Falls, Virginia: Available online: http://www.weatherbase.com/weather/weather.php3?refer = &s = 180240. Accessed: 2003 Jul 06.
22. Agency for Toxic Substances and Disease Registry. U.S. Geological Survey water papers. Atlanta: U.S. Department of Health and Human Services: 1952.
23. California Department of Health Services. Health consultation-response to community questions about groundwater at the Laytonville landfill site. Atlanta: U.S. Department of Health and Human Services: 2001 Jun.
24. Bureau of the Census. 1990 census population: Washington: U.S. Department of Commerce
25. SHN Consulting Engineers and Geologists. Laytonville solid waste disposal site report of waste discharge. Prepared for Mendocino County, Department of Public Works. Ukiah (CA). 1991 Nov.
26. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual. Atlanta: U.S. Department of Health and Human Services: 1997.
27. Integrated Risk Information System (IRIS). U.S. Environmental Protection Agency, producers. Washington: Available online: http://www.epa.gov/iris/index.html. Accessed: 2003 Sep.
28. State of California primary drinking water standards. California Department of Health Services, producers. Sacramento: Available online: http://www.dhs.ca.gov/ps/ddwem/chemicals/mcl/primarymcls.htm. Accessed: 2003 Sep.
29. National drinking water standards. Office of Water, producers. Washington: U.S. Environmental Protection Agency; Available online: http://www.epa.gov/safewater/mcl.html#mcls or http://www.epa.gov/safewater/consumer/mcl.pdf. Accessed: 2003 Sep.
30. Preliminary remediation goals. U.S. Environmental Protection Agency Region IX, producers. San Francisco: Available online: http://www.epa.gov/region09/waste/sfund/prg/index.htm. Accessed: 2003 Sep.
31. State of California action level for lead in drinking water. California Department of Health Services, producers. Sacramento: Available online: http://www.dhs.ca.gov/ps/ddwem/chemicals/mcl/regextract.pdf. Accessed: 2003 Sep.
32. Chronic reference exposure levels. California Office of Environmental Health Hazard Assessment, producers. Sacramento: California Environmental Protection Agency; Available online: http://www.oehha.org/air/chronic_rels/AllChrels.html. Accessed: 2003 Sep.
33. Minimum risk levels (MRLs) for hazardous substances. Agency for Toxic Substances and Disease Registry, producers. Atlanta: US Department of Health and Human Services; Available online: http://www.atsdr.cd.gov/mrls.html. Accessed: 2003 Sep.
34. 10th report on carcinogens. National Toxicology Program, producers. Washington: U.S. Department of Health and Human Services; Available online:

http://ehp.niehs.nih.gov/roc/toc10.html#viewer. Accessed: 2003 Sep.
35. Overall evaluations of carcinogenicity. International Agency for Research on Cancer, producers. Lyon, France: World Health Organization; Available online: http://monographs.iarc.fr/monoeval/grlist.html. Accessed: 2003 Sep.
36. U.S. Environmental Protection Agency. Letter to Jeff Tomhave, Executive Director, Tribal Associate on Solid Waste and Emergency Response and Vernon Wilson, Tribal Chairperson, Cahto Tribe of the Laytonville rancheria from Jeff Scott concerning update of U.S. Environmental Protection Agency Region IX activities related to the Laytonville landfill. San Francisco, California. October 01, 2002.
37. North Coast Regional Water Quality Control Board. Waste discharge requirements for the Laytonville solid waste disposal site. Santa Rosa: 1990 Jun. Publication No.: 90-93.
38. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1990. Ukiah, California.
39. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1991. Ukiah, California.
40. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1992. Ukiah, California.
41. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1993. Ukiah, California.
42. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1994. Ukiah, California.
43. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1995. Ukiah, California.
44. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1996. Ukiah, California.
45. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1997. Ukiah, California.
46. U.S. Environmental Protection Agency. Risk assessment guidance for superfund volume I human health evaluation manual (part A). Washington (DC). 1989 Dec. Report No.: EPA/540/1-89/002.
47. California Department of Fish and Game. Memorandum to Warden Aldrich from Michael Rugg and Susan Mann concerning results of laboratory analysis. Yountville, California. June 17, 1993.
48. Weston Solutions. Preliminary assessment/site inspection report for the Laytonville dump. Prepared for U.S. Environmental Protection Agency. San Francisco (CA). 2003 Jun.
49. EBA Wastechnologies. Water quality solid waste assessment test report for Laytonville site. Santa Rosa (CA). 1990 Apr.
50. Mendocino County Air Quality Management District. Letter to Staff, Monitoring and Laboratory Division, California Air Resources Board from David Faulkner, Air Pollution Control Officer concerning Landfill testing request for assistance. Ukiah, California. March 10, 1993.
51. California Air Resources Board. Laytonville landfill evaluation test report. Sacramento (CA). 1994 Feb. Report No.: C-93-032.
52. Anderson Consulting Group. Letter to Paul Caylor, Mendocino County Solid Waste

Division from Daniel Dottai and Gery Anderson concerning results of limited soil sampling at the Laytonville site. Laytonville, California. September 01, 1993.
53. U.S. Army Corps of Engineers. Drilling logs and soil analytical results for the Laytonville rancheria. Prepared for Bureau of Indian Affairs. Sacramento (CA). 1996 Aug.
54. Portage Environmental. Ambient air monitoring for volatile organic compounds at the Laytonville rancheria. Prepared for US Environmental Protection Agency. San Francisco (CA). 2002 Aug.
55. Wolkoff P, Clausen P, Wilkins CK, Nielsen GD. Formation of strong airway irritants in terpene/ozone mixtures. Indoor Air 2000;10:82-91.
56. Molhave I, Kjaergaard SK, Hempel-Jorgensen A, Juto JE, Andersson K, Stridh G, Falk J. The eye irritation and odor potencies of four terpenes which are major constituents of the emissions of VOCs from Nordic soft woods. Indoor Air 2000;10:315-18.
57. Agency for Toxic Substances and Disease Registry. Toxicological profile for acrolein. Atlanta: U.S. Department of Health and Human Services: 1990 Dec.
58. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1998. Ukiah, California.
59. Mendocino County, Solid Waste Division. Quarterly monitoring reports for Laytonville disposal facility-year 1999. Ukiah, California.
60. North Coast Regional Water Quality Control Board. Letters to private well owners near the Laytonville Landfill concerning private well sampling results. Santa Rosa, California. 2002 Jun.
61. North Coast Regional Water Quality Control Board. Letter to owners of private wells located near the Laytonville landfill concerning private well resampling results. Santa Rosa, California. 2003 May.
62. North Coast Regional Water Quality Control Board. Waste discharge requirements for the Laytonville solid waste disposal site. Santa Rosa: 1975 Mar. Publication No.: 75-50.
63. North Coast Regional Water Quality Control Board. Revised waste discharge requirements for Laytonville solid waste disposal site. Santa Rosa (CA). 1988 Dec.
64. U.S. Army Corps of Engineers. Aquaeous samples data package for the Laytonville rancheria. Prepared for Bureau of Indian Affairs. Sacramento (CA). 1997 Aug.
65. U.S. Army Corps of Engineers. Second quarterly sampling and analytical report for the Laytonville rancheria. Prepared for Bureau of Indian Affairs. Sacramento (CA). 1997 Dec.
66. U.S. Army Corps of Engineers. Third round quarterly sampling and analytical report for the Laytonville rancheria. Prepared for Bureau of Indian Affairs. Sacramento (CA). 1998 May.
67. U.S. Army Corps of Engineers. Fourth round quarterly sampling and analytical report for the Laytonville rancheria. Prepared for Bureau of Indian Affairs. Sacramento (CA). 1998 Aug.
68. Water Quality Technology. An evaluation of contaminant sources at the Laytonville landfill in Mendocino County, California and the potential for contaminant exposure to Cahto Tribe of Laytonville rancheria residents and the environment. Prepared for Cahto Tribe, Environmental Department. Laytonville (CA). 2002 Jun.
69. North Coast Regional Water Quality Control Board. Letters to private well owners near

the Laytonville landfill concerning private well resampling results. Santa Rosa, California. 2002 Dec.
70. Agency for Toxic Substances and Disease Registry. Report of the expert panel workshop on the psychological responses to hazardous substances. Atlanta: U.S. Department of Health and Human Services: 2000 Sep.
71. Alaska Division of Public Health, Section of Epidemiology. Use of traditional foods in a healthy diet in Alaska: risks in perspective. Anchorage: State of Alaska Department of Health and Social Services. 1999 May.
72. Segawa R, Bradley A, Lee P, Tran D, Hsu J, White J. Residues of forestry herbicides in plants of importance to California Native Americans. Bull Environ Contam Toxicol 1997;59:556-63.
73. Laytonville community water district data. California Department of Health Services, producers. Oakland: Available online: http://www.dhs.ca.gov/ps/ddwem/. Accessed: 2003 Sep.
74. Mendocino County Solid Waste Division. 1994-1995 Laytonville landfill annual report for storm water discharge. Ukiah (CA). 1995 Dec.
75. Mendocino County Solid Waste Division. 1995-1996 Laytonville landfill annual report for storm water discharge. Ukiah (CA). 1996 Dec.
76. Mendocino County Solid Waste Division. 1996-1997 Laytonville landfill annual report for storm water discharge. Ukiah (CA). 1997 Dec.
77. U.S. Environmental Protection Agency. Exposure factors handbook. Washington. 1997 Jun.
78. U.S. Environmental Protection Agency. Child exposure factors handbook (draft). Washington. 2003 Sep.
79. Dragun J. Dragun analytical model - estimates the rate of vapor generation of pure chemicals. Greenbelt, MD: Hazardous Materials Control Research Institute;1988.
80. Agency for Toxic Substances and Disease Registry. Toxicological profile for aluminum. Atlanta: U.S. Department of Health and Human Services: 1997 Sep.
81. Agency for Toxic Substances and Disease Registry. Toxicological profile for arsenic. Atlanta: U.S. Department of Health and Human Services: 2000 Sep.
82. Agency for Toxic Substances and Disease Registry. Toxicological profile for barium. Atlanta: U.S. Department of Health and Human Services: 1992 Jul.
83. Agency for Toxic Substances and Disease Registry. Toxicological profile for benzene. Atlanta: U.S. Department of Health and Human Services: 1997 Sep.
84. Agency for Toxic Substances and Disease Registry. Toxicological profile for boron. Atlanta: U.S. Department of Health and Human Services: 1992 Jul.
85. Agency for Toxic Substances and Disease Registry. Toxicological profile for chloroethane. Atlanta: U.S. Department of Health and Human Services: 1997 Sep.
86. Agency for Toxic Substances and Disease Registry. Toxicological profile for chromium. Atlanta: U.S. Department of Health and Human Services: 2000 Sep.
87. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead. Atlanta: U.S. Department of Health and Human Services: 1999 Jul.
88. Agency for Toxic Substances and Disease Registry. Toxicological profile for manganese. Atlanta: U.S. Department of Health and Human Services: 1997 Sep.
89. Agency for Toxic Substances and Disease Registry. Toxicological profile for methylene

chloride. Atlanta: U.S. Department of Health and Human Services: 2000 Sep.
90. Agency for Toxic Substances and Disease Registry. Toxicological profile for nickel. Atlanta: U.S. Department of Health and Human Services: 1997 Sep.
91. Agency for Toxic Substances and Disease Registry. Toxicological profile for toluene. Atlanta: U.S. Department of Health and Human Services: 2000 Sep.
92. Agency for Toxic Substances and Disease Registry. Toxicological profile for total petroleum hydrocarbons (TPH). Atlanta: U.S. Department of Health and Human Services: 1999 Sep.
93. Agency for Toxic Substances and Disease Registry. Toxicological profile for vanadium. Atlanta: U.S. Department of Health and Human Services: 1992 Jul.
94. Agency for Toxic Substances and Disease Registry. Toxicological profile for vinyl chloride. Atlanta: U.S. Department of Health and Human Services: 1997 Sep.
95. California Integrated Waste Management Board. Letter to Paul Cayler, Director, Solid Waste Division, Mendocino County Department of Transportation, from Linda Moulton-Patterson, Chair, concerning the closure certification of Laytonville landfill. Sacramento, California. March 22, 2001.
96. GeoLogic Associates. Slope stability evaluation for the Laytonville Landfill. Prepared for County of Mendocino, Solid Waste Division. Ukiah (CA). 2002 Feb.
97. California Regional Water Quality Control Board, North Coast Region. Letter to Libby Levy, Regional Representative, ATSDR Region IX, from Gina Morrison concerning comments on the initial release of the public health assessment for the Laytonville landfill. Santa Rosa, California. May 03, 2004.
98. Agency for Toxic Substances and Disease Registry, Region IX. Electronic mail to Libby Levy, Regional Representative, from Barry Cofer concerning comments on the initial release draft of the public health assessment for the Laytonville landfill. San Francisco, California. April 21, 2004.
99. California Regional Water Quality Control Board, North Coast Region. Letter to Paul Cayler, Director, Solid Waste Division, Mendocino County Department of Transportation, from David Evans, Engineer, concerning an inventory of violations of state and federal laws at the Laytonville landfill. Santa Rosa, California. September 03, 1993.
100. Secor International, Inc. Preliminary Assessment/Site Investigation Report. Prepared for Cahto Tribe of Laytonville Rancheria. Laytonville (CA): Cahto Tribe. 2003 Sept.
101. Henry S. Cole & Associates, Inc. Comments on CDHS/ATSDR initial release draft public health assessment for the Laytonville landfill. Prepared for the Cahto Tribe. Laytonville (CA): Cahto Tribe of Laytonville Rancheria. 2004 Apr.