STATE OF CALIFORNIA
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

STAFF REPORT FOR REGULAR MEETING OF SEPTEMBER 12, 2003
Prepared on August 14, 2003

ITEM NUMBER: 12

SUBJECT: Perchlorate Sites

DISCUSSION:

Background

Perchlorate is both a naturally occurring and man-made chemical, although it is rarely found naturally in the United States. One-third of all perchlorate used in the United States is used in California and 90% of California's perchlorate use is related to the aerospace industry. There are three major sources of perchlorate in the United States: ammonium perchlorate has been and continues to be used as an oxidizer in solid rocket propellant, sodium perchlorate is used in slurry explosives, and potassium perchlorate is used in road flares and air bag inflation systems. Wastes from the manufacture and improper disposal of perchlorate-containing chemicals are increasingly being discovered in soil and water.

Health Effects

Perchlorate is known to interfere with the natural function of the thyroid gland by inhibiting the uptake of iodide. Because iodide is an essential component of thyroid hormones, perchlorate disrupts how the thyroid functions. Such an effect decreases production of thyroid hormones, which are needed for prenatal and postnatal growth and development, as well as for normal body metabolism. Potassium perchlorate was used until recently to treat hyperthyroidism resulting from Grave's disease, and is still used diagnostically to test thyroid hormone production in some clinical settings.

Regulatory Standards

Currently there is no state or federal drinking water maximum contaminant level (MCL) for perchlorate. Both the U.S. Environmental Protection Agency (EPA) and the California Department of Health Services (DHS) are in the process of studying the occurrence and health effects of perchlorate. However, California is mandated by SB 1822 to develop a drinking water standard for perchlorate by January 1, 2004. Until an MCL is in place, DHS uses a 4 microgram per liter (µg/L) advisory action level to protect consumers from perchlorate's adverse health effects. An action level is an advisory level and is not an enforceable standard. When it is exceeded, a water system is required to notify local governing agencies and is recommended to issue a consumer notice. In addition, DHS recommends that a source of drinking water be taken out of service if perchlorate contamination exceeds 40 µg/L.

Treatment Methods

Treatment of perchlorate contamination in water is complicated because the perchlorate anion does not respond to typical water treatment techniques due to its fundamental physical and chemical nature. The perchlorate tetrahedron itself is structured such that the four oxygen atoms surround the central chlorine atom, effectively blocking reductants from directly attacking the chlorine. Although perchlorate is thermodynamically a strong oxidizing agent, it is a kinetically sluggish species, making its reduction generally very slow and rendering common reductants ineffective. It can persist in the environment for many decades under typical groundwater and surface water conditions because of its

resistance to react with other available constituents.

Perchlorate treatment technologies may be generally classified into categories of destruction or removal technologies. Destructive processes include biological reduction, chemical reduction, and electrochemical reduction. Physical removal processes include anion exchange, membrane filtration (including reverse osmosis and nanofiltration), and electrodialysis, which all require subsequent disposal of removed perchlorate. The optimum treatment technology for a given perchlorate occurrence may depend on several factors, including perchlorate concentration, the presence and concentration of co-contaminants, other water quality parameters and geochemical parameters. The presence of indigenous perchlorate-reducing microbes and substances inhibitory to their activity will also influence perchlorate treatment technology effectiveness. For in-situ treatment of perchlorate contamination, variables related to the site hydrogeologic setting, such as depth to and distribution of contaminants, soil permeability, groundwater flow velocity, etc. are also additionally important.

Updates on significant perchlorate sites within the region follow.

Olin Corporation Facility, 425 Tennant Avenue, Morgan Hill, Santa Clara County [John Mijares 805-549-3696]

The former Olin Corporation site is a 13-acre parcel located in southern Morgan Hill. Olin manufactured signal flares at the facility for about 32 years from 1956 to 1988. Standard Fusee leased the site and manufactured signal flares for seven years from 1988 to 1995. Potassium perchlorate was used in the manufacture of flares by both Olin and Standard Fusee. Perchlorate contamination at the site may have come from an unlined evaporation pond that received wastes from the cleaning of the ignition material mixing bowls, on-site incineration of cardboard flare coatings with residues on them, and accidental spills. The Regional Board never regulated waste disposal practices while the facility operated, but facility records do make reference to inspections by Regional Board staff.

Groundwater in the region typically occurs in alluvial sediments, at depths ranging from 20 to 400 feet below ground surface. The alluvial deposits are composed of heterogeneous layers of clay, silt, sand, and gravel. Interconnected multiple aquifers exists within the area. Groundwater underneath the site is generally unconfined, although there are identified confined zones within the sub-basin to the southeast of the property.

In March 2002, Olin investigated soil and groundwater at five potential source areas (former north septic tank, former hazardous material storage area, former wastewater evaporation pond, former production building 5 hopper, and former production building 5 mixer) to further assess the source and extent of perchlorate, lead, and chromium. Results of the investigation indicated that lead was not a chemical of concern. The investigation also indicated that total chromium was probably not a problem in soil; however, the groundwater concentration in the former north septic tank area slightly exceeded the 0.1 mg/L maximum contaminant level for chromium. Results of the follow-up Phase 2 soil and groundwater investigation show concentrations of chromium and hexavalent chromium in the former north septic tank area of the site did not exceed background levels or health based screening levels. Therefore, we do not consider chromium and hexavalent chromium to be chemicals of concern at this site. Perchlorate was detected at concentrations below EPA health-based screening levels in several shallow soil samples located on the perimeter of the former building 5 and the former hazardous material storage areas. Results of the soil analysis appear to indicate that the extent of perchlorate near portions of these two areas was still not completely characterized. In groundwater, perchlorate was detected above the 4 µg/L Department of Health Services (DHS) action level up to a maximum of 167 µg/L in water samples collected from five CPT borings advanced to a depth of 200 feet below ground surface (bgs). The groundwater data indicated

a potential for lateral migration of perchlorate in the shallow groundwater zones (less than 100 feet bgs). However, it was unclear how perchlorate is migrating laterally (between about 100 and 175 feet bgs) and vertically within the deeper groundwater zones (from 100 to about 400 feet bgs), requiring additional groundwater investigation.

To follow up on the March 2002 investigation, Olin completed a Phase 2 soil and groundwater investigation. The purpose of the investigation was to further determine the extent of perchlorate and chromium at the site and to fill data gaps. The fieldwork for the Phase 2 investigation was completed on October 2, and the final investigation report was submitted on December 2, 2002.

To determine whether perchlorate had migrated off of its property, Olin sampled 27 domestic water supply wells located within one-half mile downgradient of the site (Tier 1 wells). Perchlorate was detected in four wells at concentrations ranging from 9.5 to 98.4 µg/L. Olin informed the well owners and tenants of the perchlorate detections, advised them not to drink or cook with the water, and supplied them with bottled drinking water.

Since perchlorate was detected in four Tier 1 wells, Olin began sampling domestic wells located between one-half mile and one mile of the Olin site (Tier 2 wells) in October 2002. With assistance from the Santa Clara Valley Water District staff, 33 domestic Tier 2 wells were identified for sampling. Regional Board staff sent letters to all the well owners soliciting permission to sample the wells.

On January 16, 2003, Santa Clara Valley Water District hosted a press conference, with participation of Regional Board staff, to announce results of the offsite domestic well sampling and to answer questions on the potential effects of perchlorate contaminated water to human health and the environment. The District also announced they would sample private wells, if requested, for perchlorate in the potentially contaminated area. The District provided bottled drinking water to residents who requested it until their wells were tested. The original area of potential perchlorate groundwater contamination was south of Tennant Avenue, north of Masten Avenue, east of Monterey Road, and west of Center Avenue (see Attachment 1).

Since perchlorate was detected outside of the original study area shown on Attachment 1, Olin submitted a list of 320 wells included in a Tier 4 offsite well sampling program, which extended south to Leavesley Road in Gilroy. Olin selected these wells based on groundwater basin hydrogeologic data and historical groundwater flow. Olin sent letters on February 14, 2003, to the 320 well owners requesting permission to sample their wells. Olin also established a toll-free phone number to facilitate well sampling authorization and scheduling. Sampling teams also conducted door-to-door visits to obtain sampling authorization from well owners. Olin committed to supply bottled water for drinking and cooking to well users awaiting test results and to those with perchlorate detections of 4 µg/L and above.

In February 2003, West San Martin Water Works and San Martin County Water District reported perchlorate detections in their water supply wells. West San Martin Water Works is a private water system with 250-plus connections reported that two of its three water supply wells had perchlorate detections of 6 and 8 µg/L. San Martin County Water District reported a perchlorate detection of 7 µg/L in its Camping World well, which supplies water to about 200 customers. After perchlorate detections were confirmed, Olin provided bottled water to customers of both water districts.

Perchlorate Community Advisory Group meetings are held monthly in San Martin. The advisory group is a forum for public discussion of the perchlorate problem and potential solutions. Regional Board staff will solicit advisory group input at key decision points in the investigation and cleanup process.

As of June 24, 2003, Santa Clara Valley Water District has plotted results (Attachment 1) of 1,169 samples collected by the District and

Olin. The number of wells is slightly smaller than the number of samples collected because some wells serving multiple connections have samples collected from each connection. Results are broken down as follows:

- *Non-detect (< 4μgLl) – 750 samples*
- *4-9.9 μgLl – 399 samples*
- *10-19.9 – 15 samples*
- *20-39.9 μgLl – 3 samples*
- *40-100 μgLl – 2 samples*

Three City of Morgan Hill municipal wells (Nordstrom, Condit, and Dunne 2 located ¾ to 1 1/3 miles northeast of the Olin site) were temporarily off line because of perchlorate detections of 6, 5, and 4 μg/L. Nordstrom well was back on line on August 2, 2003, after installation of a wellhead treatment for the removal of perchlorate. Dunne 2 is on standby and used in an intermittent basis and no perchlorate has been detected since March 18, 2003. Condit well is still offline. Regional Board staff is evaluating whether these detections could be from the Olin site or are from some other, unknown source.

The City's Tennant well is still offline but projected to be back in service by September 1, 2003. Installation of a wellhead perchlorate removal system is about 95% complete. Olin has been sampling this well on a quarterly basis and no perchlorate has been detected above 4 μg/L since the first quarter of 2002.

On June 30, 2003, Olin submitted the Phase 3 Soil and Groundwater Investigation (SGI) Report. The purpose of the Phase 3 SGI was to gather information to fill data gaps identified in previous investigations, characterize the site's geology and hydrogeology, define the extent of soil and groundwater perchlorate contamination, and determine the hydraulic properties of the affected aquifers to predict perchlorate fate and transport design remedial measures. Since the submittal of the Report, Regional Board, Santa Clara Valley Water District, Olin and its consultants have discussed the Report. The investigation of perchlorate in soil had not been completed when the Report was submitted because of the discovery of additional source areas at the site. Olin's consultant has recently completed supplemental soil sampling to determine the extent of perchlorate contamination in soil. Olin submitted a supplemental report on August 12, 2003, containing results of the supplemental soil investigation, a proposed soil screening level for perchlorate, and a proposed remedial alternative for soil and groundwater remediation at the site.

Regional Board staff will review the supplemental report and will provide comments on this supplemental report and the Phase 3 Report.

McCormick Selph, 3601 Union Road, Hollister, San Benito County [John Mijares 805-549-3696]

McCormick Selph, Inc., designs, develops, qualifies, and manufactures state-of-the-art controlled pyrotechnics (electric igniters, electric primers, explosive bolts, gas generators, etc.) for the aerospace and automotive industries. In May 1971, McCormick Selph completed the Hollister facility and started manufacturing operations at the 270-acre site. In 1993, McCormick Selph, which was then a subsidiary of Teledyne, Inc., was realigned with Ryan Aeronautical and became Teledyne Ryan Aeronautical/McCormick Selph Ordnance. Allegheny Teledyne Incorporated was formed in August 1996 through the business combination of Teledyne, Inc. and Allegheny Ludlum Corporation.

In late 1999, Allegheny Teledyne sold the business and assets of McCormick Selph but retained certain liabilities related to the business, including liability for certain environmental issues at the Hollister facility. Subsequently, as part of a spin-off of two new entities, Allegheny Teledyne changed its name to Allegheny Technologies and Teledyne Industries changed its name to TDY Industries. Consequently, TDY Industries is considered the responsible party for environmental issues at the facility.

Prior to the sale of McCormick Selph, the prospective buyer sampled all existing onsite monitoring wells for various potential contaminants. In June 1999, Teledyne staff informed Regional Board staff that perchlorate

and volatile organic compounds (VOCs) had been detected in some monitoring wells.

Over the past ten years, total annual perchlorate use at the facility has averaged approximately 1,800 grams of potassium perchlorate and 300 grams of ammonium perchlorate with the following exceptions: (1) During a two-year period from 1998 through 2000, approximately 500 lbs (226,750 grams) of potassium perchlorate were used annually at the facility and (2) current projected use for 2003 includes approximately 5 lbs (2,260 grams) of ammonium perchlorate. Perchlorate wastes are thermally destructed at the facility.

TDY Industries, through its consultant PES Environmental, has conducted a series of soil and groundwater investigations to determine the source areas and extent of perchlorate and VOCs contamination at the site. These investigations found the geologic units underlying the site can be divided into two units: (1) sedimentary rocks of the Purisima Formation; and (2) recent alluvial deposits.

PES submitted a December 19, 2002 report titled *Corrective Action Plan, Soil and Water Investigation, McCormick Selph, Inc.* for Regional Board review and approval. The report contains information on the results of the October 2002 groundwater monitoring event and proposes corrective action to clean up perchlorate and VOCs in groundwater. Results of groundwater monitoring show that in wells where perchlorate was detected the concentrations range from 19 to 5,500 µg/L. In well IB-28 trichloroethylene (MCL of 5 µg/L) was at 110 µg/L and 1,1-dichloroethylene (MCL of 7 µg/L) was at 13 µg/L. Perchlorate was not detected in either water supply well W-1 or W-2 and the perchlorate plume appears to be contained on the site.

To clean up the perchlorate and VOCs contamination in groundwater, PES evaluated three remedial alternatives: monitored natural attenuation, groundwater extraction and treatment, and enhanced in-situ bioremediation. The criteria used in evaluating the remedial alternatives included effectiveness, feasibility, and cost. PES proposes to use monitored natural attenuation in areas with relatively low concentrations and limited extent of perchlorate and VOC plumes such as the perchlorate plume at the Sand Pit; the commingled perchlorate and VOC plume near SI-2, east of the lake; and the perchlorate plume within the Purisima Formation in the vicinity of the TSU-3/Thermal Destruct Facility. These areas are shown on Attachment 2 (Generalized Perchlorate Isoconcentration Map within the Purisima Formation). Monitoring will verify that contaminants do not migrate to supply wells or property boundaries.

To clean up the perchlorate plume within the alluvial deposits in the vicinity of the TSU-3/Thermal Destruct Facility, PES proposes to use enhanced in-situ bioremediation because of the relatively elevated levels of perchlorate within this plume and the presence of downgradient water supply wells. This process has been used with success at the Whittaker facility discussed below. Regional Board staff approved the cleanup plan on February 13, 2003. TDY will begin implementation by April 2003.

Three additional monitoring wells were installed on April 28 and 29, 2003. These monitoring wells were installed to monitor perchlorate concentrations along the margins of the perchlorate plume present within the alluvial deposits in the vicinity of the TSU-3/Thermal Destruct Facility area. TDY/PES conducted a baseline groundwater monitoring on May 2003 and aquifer tests in June 2003. A description of the procedures and results of the baseline groundwater monitoring and the aquifer tests will be included with the Workplan for Pilot-Scale Injection of Hydrogen Release Compound to be submitted on August 29, 2003.

Whittaker Ordnance Facility, 2751 San Juan Road, Hollister, San Benito County [John Mijares 805-549-3696]

The Former Whittaker Ordnance Facility is located on an approximately 94-acre site near Hollister, surrounded by farmland (see Attachment 3). Historical uses of the facility consist of an operating dairy farm prior to

1957 and an ordnance manufacturing facility from 1957 to present. In 1957, the property was acquired by the Holex Company, Inc. and developed to produce small explosives. The property became a division of the Whittaker Corporation in 1980 and was operated as Whittaker Ordnance from 1980 to 1993. Quantic Industries, Inc. obtained the property in 1994 and continued to manufacture explosive devices used for vehicular safety products. In 2001, Pacific Scientific Energetic Materials (operating under PacSci-Quantic) acquired the property from Quantic and continues to manufacture explosive devices used for vehicular safety products.

Groundwater directly beneath and adjacent to the Property occurs in three separate aquifers. The Unit 1 aquifer consists of interbedded silty sands and clayey silts to a maximum depth of approximately 68 feet below ground surface (bgs), the Unit 3 aquifer consists of a second silty sand layer from 40 to 125 feet bgs, and the Unit 4 aquifer consists of a thick coarse sand layer located 160 to 270 ft bgs. The aquifer is encountered between depths of 120 to 160 feet bgs in the Middle Facility. A discontinuous aquitard exists between Unit 1 and 3, which is identified as Unit 2. The presence of groundwater at approximately the same elevation in the Unit 1 and 3 aquifer zones indicates some hydraulic connectivity. In addition, faulting running southwest to northeast in the vicinity of the Lower Facility may also provide conduits to the deeper Unit 4 aquifer. The lithology encountered in Units 1 to 3 consists of interbedded clayed silts, with the silty sand layers identified as the preferential pathways and water bearing units.

Environmental assessment activities were initiated in 1991 after detections of volatile organic compounds (VOCs) in an onsite water supply well. Subsequent investigation activities identified several sources of soil and groundwater pollution throughout the property. Identified constituents of concern include trichloroethylene (TCE) and its breakdown products (e.g., vinyl chloride and 1,2-DCE), Freon 113, perchlorate, and hexavalent chromium. All of these constituents have been detected in soil and groundwater beneath and adjacent to the facility at concentrations above water quality standards. Table 1, below, summarizes relevant water quality data concerning the most significant constituents detected.

Table 1: Maximum Concentration Table

Constituent	Well	Maximum Conc.	MCL/ AL
TCE	MW-7	92,000	5
vinyl chloride	MW-3	3,800	0.5
hexavalent chromium	MW-20	260	50
perchlorate	MW-27	290,000	4 (AL)
Freon 113	MW-30	12,000	1,200

All units are parts per billion (ppb)
MCL – Maximum Contaminant Level
AL – Action Level

There are several likely sources areas at the site. They include areas where perchlorate was stored, milled, and used in manufacturing process. Areas where explosive devices were test fired and burned are also likely sources. Wash water throughout the facility was either disposed of on ground surface in or dry wells.

Two separate perchlorate plumes are found within the Unit 1 aquifer, one near the Building 23 area (Lower Facility) and a second near the south side of the Building 5 area (Middle Facility). Both of these plumes are commingled with the Lower Facility TCE plume. Two more perchlorate plumes are found in perched groundwater within the Middle Facility. The most significant is located directly beneath the Burn Area. The other plume is directly beneath and adjacent to the Building 22A area. The Middle Facility perchlorate plume extends approximately 1,000 feet (northeast to southwest). The Lower Facility perchlorate plumes extend approximately 1,000 feet from the Building 5 area.

Detectable concentrations of dissolved VOCs and perchlorate are also present in the Unit 3 and Unit 4 aquifers at significant concentrations. Groundwater containing VOCs and perchlorate may have migrated into these deeper water-bearing units by way of a

former water supply well, which was abandoned in May 1996, or in the area north and northwest (downgradient) of the Property where the shallow and deeper water-bearing units may be hydraulically connected. Down gradient to the north, the Riverside Irrigation Company well (screened within the Unit 3 aquifer) has reported TCE concentrations (1,200 ppb) exceeding drinking water standards. Perchlorate concentrations within the Unit 3 and 4 aquifer zones are much lower, but still above the action level of 4 ppb. The TCE plume's circumference within Unit 3 is approximately 1000 feet. TCE concentrations within Unit 4 are primarily restricted to areas near the Riverside and Christopher wells. The perchlorate plume within Unit 3 expands more than 1,000 feet in the northwest direction. Perchlorate detections in the Unit 4 aquifer zone are restricted to detections from the Riverside and Christopher wells, and the Burn Area. Detected contaminants within the Unit 4 aquifer zones are relatively low and significant plumes have not developed. Perchlorate has been detected in five off-site wells (Butler, Sanchez, Dike, Christopher, and Riverside) previously used for domestic or agricultural supply. Impacted wells are either treated before use or are no longer in service.

On July 9, 1999, the Regional Board issued Cleanup or Abatement Order (CAO) No. 99-006 to Whittaker. CAO No. 99-006 specifies cleanup actions that Whittaker must take to address soil and groundwater contamination at the site. A monitoring and reporting program ensures adequate sampling and monitoring of contaminated areas.

Whittaker is implementing several interim soil and groundwater remediation measures at various source areas throughout the facility. Regional Board staff approved a final risk assessment report addressing human health and safety throughout the site. On October 31, 2002, staff approved a final feasibility study report addressing all soil and groundwater remediation alternatives at all identified pollution source sites, including all groundwater plumes within each impacted water-bearing zone.

On March 17, 2003, Whittaker submitted a corrective action plan. (CAP). The CAP contains specific strategies for controlling groundwater plumes and restoring and protecting groundwater quality at seven contaminated source areas: North Building 5 Septic Tank Area, Building 23 Area, Lower Pond Area, Building 22A Area, Burn Area, South Building 5 Drywell Area, and the Waste Storage Pad Area. The proposed groundwater remedial actions were specifically designed to clean up groundwater impacted by VOCs, perchlorate, and hexavalent chromium. The CAP further included proposed remedial actions for cleaning up perchlorate-impacted soils at five of the seven contaminated areas.

On May 7, 2003, Regional Board staff informed Whittaker in writing that the CAP was acceptable for immediate implementation and established timelines for implementation and submittal of compliance reports. Regional Board staff further directed Whittaker to implement or to continue implementing all approved soil and groundwater remedial measures and to provide by June 30, 2003, a written response to staff comments. Whittaker submitted on July 11, 2003, a detailed written response to Regional Board staff comments that included a list of soil and groundwater corrective actions that are currently being implemented or proposed to be implemented with a revised implementation time schedule. Regional Board staff is currently reviewing the proposed revisions. Regional Board staff will provide a detailed description of the various remedial measures and pilot studies implemented at each of the contaminated areas in the next status report.

ATTACHMENTS:

1. San Martin Area Perchlorate Investigation
2. Site Location Map of the former McCormick Selph Facility
3. Site Map of the former Whittaker Ordnance Facility

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