STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

STAFF REPORT FOR REGULAR MEETING OF JANUARY 26-27, 2017
January 4, 2016

ITEM NUMBER: **18**

SUBJECT: **Status Update for the Olin Corporation Site Cleanup Program Perchlorate Groundwater Cleanup Case, Morgan Hill, Santa Clara County**

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KEY INFORMATION:

Location:	Morgan Hill and San Martin in Santa Clara County
Discharge Type:	Historic discharge of perchlorate to soil and groundwater
Existing Orders:	Cleanup and Abatement Order No. R3-2004-0101 State Water Board Order No. WQ 2005-0007 Cleanup and Abatement Order No. R3-2007-0077 Monitoring and Reporting Order No. R3-2008-0028 Waste Discharge Requirements Order No. R3-2011-0209 Monitoring and Reporting Order No. R3-2015-0039
GeoTracker ID No.:	SL0608756247

This Action: **Status Update (Presentation at Board Meeting)**

SUMMARY

This report provides a status update on the perchlorate groundwater cleanup efforts associated with the historic releases from the Olin Corporation (Olin) facility located at 425 Tennant Avenue in Morgan Hill. The last update on this Site Cleanup Program cleanup case was five years ago, at the March 2012 Central Coast Water Board meeting.

Perchlorate migrated into groundwater below the site, resulting in a perchlorate plume that, at its largest, extended approximately 9.5 miles southeast of the site, 1.5 miles wide, and over 500 feet deep in some areas of the Llagas Subbasin. Perchlorate concentrations continue to decrease throughout the Llagas Subbasin due to successful onsite soil remediation, operation of a robust groundwater extraction and treatment system (GETS), and attenuation through natural physical processes of dilution and dispersion. Currently, six domestic supply wells exceed the drinking water standard for perchlorate in the Llagas Subbasin, as compared to 188 domestic and municipal wells during the first quarter of 2004.

Olin began hydraulic containment and treatment of the onsite groundwater perchlorate plume in 2004. An expanded GETS that also treats the offsite groundwater perchlorate plume began in 2012. To date, the GETS has treated approximately one billion gallons of water and removed 220 pounds of perchlorate from groundwater.

Water Board staff continues to evaluate Olin's gradient driven remediation pilot study results to determine if this remedial approach will be effective for containing and reducing perchlorate concentrations in the lower deep aquifer.

This report also provides general background information on perchlorate, including its fate and transport, health effects and routes of exposure, regulatory standards, and groundwater treatment options.

DISCUSSION

What is Perchlorate?

Perchlorate (ClO_4^-) is both a naturally occurring and man-made chemical that consists of one chlorine atom bonded to four oxygen atoms. A significant portion of perchlorate use in the United States takes place in California, mostly related to the aerospace and defense industries. There are three major man-made sources of perchlorate in the United States:

- Ammonium perchlorate, used as an oxidizer in solid rocket propellants,
- Sodium perchlorate, used in slurry explosives, and
- Potassium perchlorate, used in road flares and air bag inflation systems.

Perchlorate is highly soluble in water, and relatively stable and mobile in surface and subsurface aqueous systems. As a result, perchlorate plumes in groundwater can be extensive. For additional information on perchlorate such as natural occurrences, routes of exposure, health effects, fate and transport, and treatment methods, see Attachment 1.

Site Background

The former Olin Facility is a 13-acre parcel (Site) located in Morgan Hill in southern Santa Clara County. Olin (owned property from 1956 to present) and Standard Fusee (leased property from 1988 to 1995) used potassium perchlorate to manufacture flares from 1956 to 1995 at this facility. Perchlorate was first detected at the site in August 2000 during a due diligence investigation by a potential buyer. In 2003, following additional assessment, Olin discovered that perchlorate had migrated offsite. Since February 2001, Olin has continued to investigate, monitor, and clean up perchlorate impacts from this site.

Perchlorate migrated into groundwater below the site, resulting in a perchlorate plume that, at its largest, extended approximately 9.5 miles southeast of the site, 1.5 miles wide and over 500 feet deep in some areas of the Llagas Subbasin. Perchlorate has degraded groundwater in the shallow, intermediate, and deep aquifer zones of the Llagas Subbasin. Olin's extensive hydrogeological investigations show a division of the Llagas Subbasin sediments into three main aquifers 1) the shallow aquifer (surface to approximately 50 feet below ground surface [bgs]), 2) the intermediate aquifer (approximately 70 to 180 feet bgs), and 3) the deep aquifer (approximately 200 feet bgs to a maximum of over 500 feet bgs). The intermediate and deep aquifers are further subdivided into three water-bearing units apiece (upper, middle, and lower). These sand and gravel aquifers are separated by silt/clay layers (called aquitards). One named aquitard (A/B aquitard as named by Olin) separates the shallow and intermediate aquifers in the vicinity of the Site. The A/B aquitard retains a significant mass of perchlorate (such that it acts as a secondary source) dissolved within the pore spaces of this 30-foot thick clay/silt layer. The basin's alluvial sediments overlie relatively impermeable slope debris and bedrock at a maximum depth of over 500 feet beneath the center axis of the Llagas Subbasin southeast of the site. In general, regional groundwater flow is toward the southeast, except near large-

capacity pumping wells where strong, localized hydraulic gradient reversals exist in the deeper aquifers. The most comprehensive hydrogeologic site conceptual model is included in Olin's January 29, 2010 Annual Cleanup Progress Report and Characterization Update[1], with minor refinements presented in other more recent documents that are found on GeoTracker.

Most of the groundwater extracted for municipal, agricultural, and domestic use in the basin comes from the intermediate aquifer, including a substantial number of private domestic wells throughout the rural portions of this basin, south of the City of Morgan Hill. The recent drought and associated decline in groundwater levels has resulted in new domestic well installations with perforations into the upper deep and middle deep aquifers. With the exception of Morgan Hill's and Gilroy's municipal supply wells that are located away from the perchlorate plume, no supply wells tap into the lower deep aquifer where a substantial amount of perchlorate mass exists.

Site Investigations and Phased Cleanup

In response to the discovery of perchlorate in groundwater in 2000, and pursuant to requirements issued by the Central Coast Water Board's Executive Officer (including several 13267 requirements and Cleanup and Abatement Order R3-2005-0014), Olin began a phased cleanup action initially consisting of offsite groundwater plume characterization and monitoring, onsite soil investigations, and cleaning up of perchlorate impacted soil in the source area (onsite). Soil cleanup consisted of excavation and onsite biological treatment for shallow soils, and insitu biological treatment for deeper soils. Olin finished onsite soil cleanup efforts in 2006. In 2004, Olin also installed and began operating an onsite GETS to capture and treat perchlorate in the shallow and intermediate aquifer before it migrated beyond the Site property boundary.

In December 2007, the Central Coast Water Board's Executive Officer issued Cleanup and Abatement Order (Order) No. R3-2007-0077 (following a public hearing with the Board on the Order), requiring completion of all necessary characterization and investigation activities and implementation of remedial actions (hydraulic control and groundwater cleanup) associated with the perchlorate release to offsite areas. The Order requires Olin to cleanup perchlorate to background levels, and acknowledges a phased approach where Olin is required to actively cleanup and control Priority Zone A (groundwater with perchlorate concentrations greater than 24.5 micrograms per liter [µg/L]) in the deep aquifer and both Priority Zone A (PZA) and Priority Zone B (PZB, groundwater with perchlorate concentrations greater than 11 µg/L) in the intermediate aquifer. The more stringent requirements for the intermediate aquifer reflect that most of the water supply wells in the area are screened in this aquifer zone.

Olin's approved offsite cleanup strategy consists of hydraulic control and treatment of groundwater in the area of highest concentrations (termed "plume core" as defined above by priority zones) combined with monitored attenuation for areas outside of the plume core, with lower perchlorate concentrations.

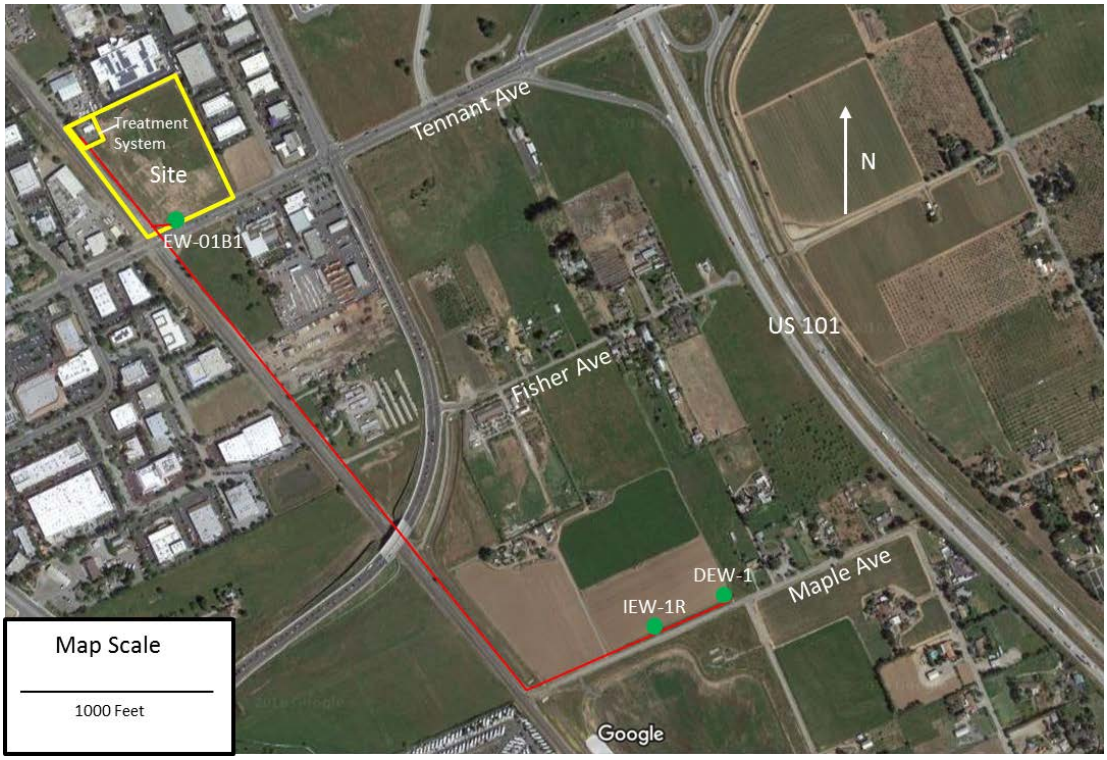
In 2009, Water Board staff concurred with Olin that site investigation work was sufficiently completed such that Olin could engineer the initial phase of the offsite GETS. At that point in the project, Olin had installed over 300 monitoring wells to monitor all three aquifers, including multi-depth monitoring wells as far south as Gilroy (10 miles south of the site/source) to a depth of over 500 feet below ground surface. Olin has also monitored approximately 200 domestic

[1] See GeoTracker website page at http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/5633332610/SL0608756247.PDF

supply wells for perchlorate as part of the replacement water program (discussed below). It should be noted that compared to similar projects in size and complexity statewide and nationally, the Olin project achieved complete characterization and onsite cleanup in a relatively short period of time and the rate of progress through the various characterization and soil and groundwater remdiation implementation phases has been very rapid.

Status of Cleanup Activities and Compliance with Cleanup and Abatement Order No. R3-2007-0077

GETS Status **–** Since Water Board staff's last update to the Board in March 2012, Olin completed the treatment system upgrades for the offsite GETS pursuant to CAO Order No. R3-2007-0077 (CAO), and started the upgraded system in September 2012. Work included expanding the treatment system concrete pad by 500 square feet to accommodate larger perchlorate treatment vessels, an office/control room, installation of three new onsite injection wells for disposal of treated groundwater, trenching/horizontal boring and installation of conveyance piping to intermediate extraction well IEW-1R and deep extraction well DEW-1 (located approximately 5,600 feet south from the onsite treatment system). IEW-1R was designed to hydraulically control and cleanup all PZA and PZB perchlorate in the intermediate aquifer downgradient of the Site. DEW-1 was designed to control and cleanup perchlorate concentrations above PZA in the upper and middle-deep aquifer. Because the onsite extraction wells have effectively cleaned up perchlorate in the shallow aquifer, no offsite shallow extraction wells were necessary. One onsite upper intermediate extraction well (EW-01B1) remains operational and two shallow onsite extraction wells (EW-1A and EW-2A) are on standby status. The following figure shows the locations of all the operational extraction wells in green and the conveyance pipeline in red.



The Water Board adopted Waste Discharge Requirements (WDR) Order No. R3-2011-0209 and associated California Environmental Quality Act (CEQA) Resolution R3-2011-0210 for the construction project that authorizes the operation of the offsite GETS discharge at the July 2011 Board Meeting. A site-specific WDR was needed to address anti-degradation issues associated with reinjecting treated groundwater having nitrate (not associated with Olin's discharge) above the receiving water concentrations in the shallow aquifer. The WDR established discharge/effluent limits for perchlorate treated by the GETS and nitrate (not treated by GETS) that is present in the treated groundwater, which is pumped from the intermediate and deep aquifers offsite, and re-injected into the shallow aquifer below the Site. The source of the nitrate is chiefly from agricultural sources in the area.

GETS Performance – Since Olin began operation of the GETS (2004 for onsite system and 2012 for expanded offsite system), the system has processed over one (1) billion gallons of polluted groundwater (approximately 1500 Olympic-size swimming pools or 1/5 of what is currently remaining in Cachuma Reservoir), removed approximately 220 pounds of perchlorate from influent groundwater, and treated it to non-detect levels using a perchlorate-specific ion exchange resin. The clean water is re-injected into the shallow aquifer along the northern (upgradient) portion of the Site. The upgraded GETS system has had nearly 100 percent operational time and during the first half of 2016 extracted groundwater from the two intermediate aquifer wells at approximately 245 gallons per minute, and the one deep aquifer extraction well at 125 gallons per minute. Influent concentrations have steadily declined since Olin started the upgraded system in July 2012, from approximately 22 µg/L to 14 µg/L in June 2016. The reduction in influent concentrations is a reflection of the continued attenuation of perchlorate concentrations in the plume as accelerated locally by groundwater withdrawal via the offsite extraction wells. During 2016, GETS extraction wells had the following typical production characteristics:

Well	Target Aquifer	Flow Rate (gpm*)	Perchlorate Concentration (µg/L)
EW-01B1	Upper Intermediate (onsite)	12	140
IEW-1R	Upper/Middle Intermediate (offsite)	240	8.5
DEW-1	Upper/Middle Deep (offsite)	124	14

*gpm = gallons per minute

Well EW-01B1 pumps groundwater at a relatively slow rate and at a high perchlorate concentration because it extracts from a less permeable aquifer near the Site source area where perchlorate concentrations remain elevated and the perchlorate molecules move slowly through the A/B aquitard and into the upper intermediate aquifer adjacent to EW-01B1. Operation of the offsite system has resulted in the PZB portion of the plume core to shrink downgradient of IEW-1R (south of Maple Avenue).

The recent drought has challenged the GETS ability to control PZB locally near IEW-1R due to a decline in water levels which have resulted in the well being able to pump less groundwater (i.e., smaller capture zone[2]) and a seasonally induced shift in groundwater flow direction. This caused the extraction well to sometimes not be ideally positioned downgradient of the perchlorate plume. However, Olin was able to increase the capture zone area of the well by lowering the pump to increase the well's production rate (i.e., increased capture zone); however,

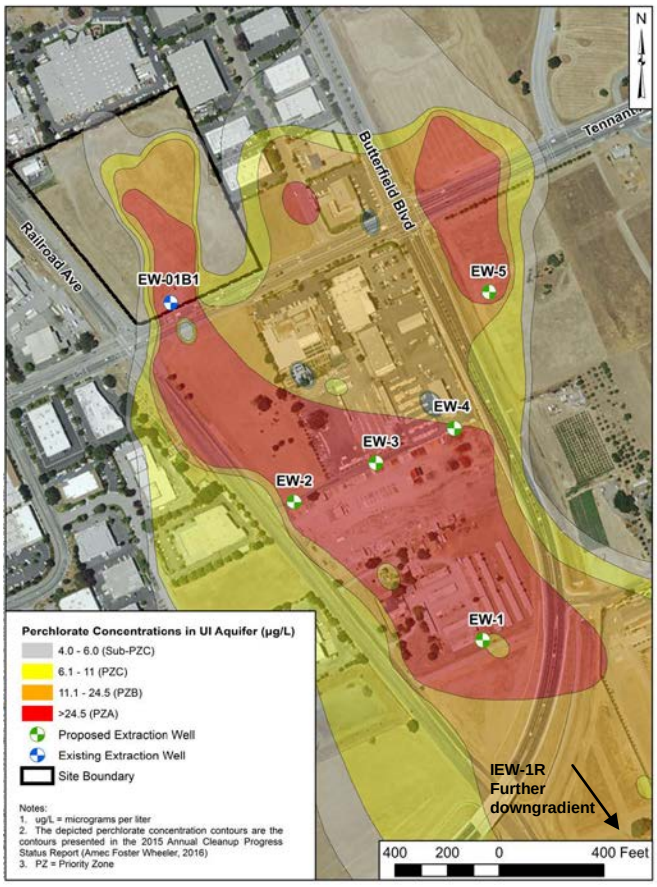
[2] Capture Zone – A three-dimensional region that contributes the groundwater extracted by a well.

the recent uncertainty in groundwater flow regimes due to the drought has prompted Olin to propose new extraction wells closer to the site in the upper intermediate aquifer to improve the robustness of the GETS (as discussed in more detail below).

To date, Olin has not had any violations of the discharge requirements of WDR for perchlorate and nitrate; the distribution of nitrate in the shallow aquifer is monitored as part of Olin's monitoring and reporting program. The shallow aquifer is too shallow to be used directly as a drinking water source because wells are required to have a minimum of a 50-foot sanitary seal; nevertheless, nitrate concentrations remain below effluent limits and the drinking water standard near the Site. Treated water eventually makes its way to deeper aquifers where it can be beneficially reused.

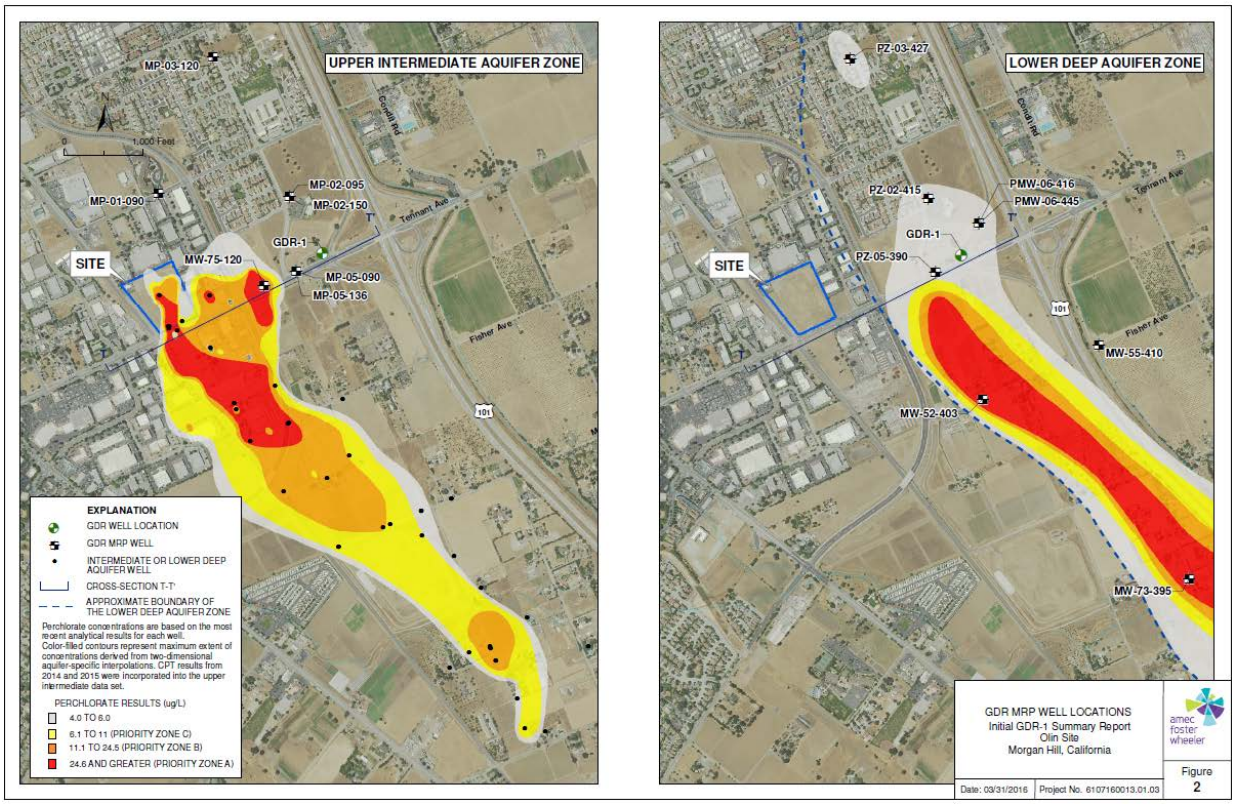
2017 GETS Enhancements for Upper Intermediate Aquifer

In 2015, Water Board staff required Olin to submit a Feasibility Study to evaluate the next phase of the cleanup strategy considering the most current information on the nature and extent of perchlorate in all of the impacted aquifer units. In June 2016, after a detailed comparative analysis of the available remedial options, Olin presented their plan for upgrading the GETS by adding five new upper intermediate extraction wells in the plume core area of the intermediate aquifer between the Site and IEW-1R (see the figure below). Olin plans to install five new off-Site extraction wells (EW-1 through EW-5) to more efficiently capture perchlorate as it migrates down from the A/B aquitard and into the upper intermediate aquifer and to control and cleanup PZA and PZB perchlorate in the intermediate aquifer. The current treatment system already has capacity to treat the additional volume of groundwater extracted by the new wells and to recharge the treated water into the shallow aquifer. Startup of these new extraction wells is anticipated in late 2017.



Pilot Study for Cleanup and Containment of Lower Deep Aquifer

The GETS upgrades do not address perchlorate in the lower deep aquifer, where a significant mass of perchlorate exists. The perchlorate plume in the lower deep aquifer is offset to the east from the location of the intermediate aquifer plume and is approximately 400 feet below ground surface. Therefore, for most areas, there is no perchlorate in groundwater in the intermediate aquifer overlying the perchlorate in the lower deep aquifer, as illustrated by the figure below.

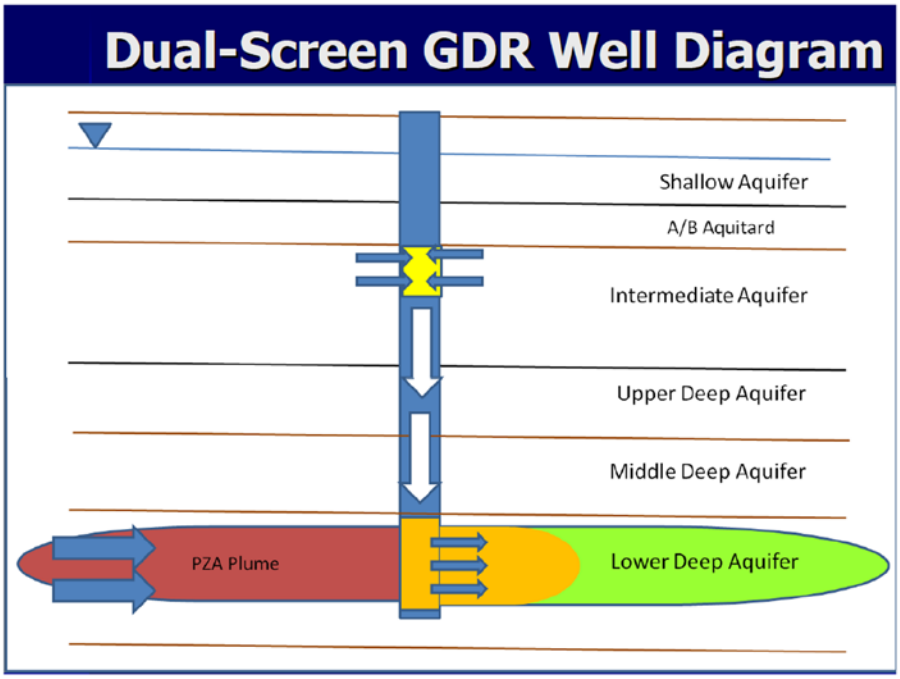


Due to the depth of the plume and the lower permeabilities in the lower deep aquifer, numerous deep extraction wells would need to be installed to remediate the plume using the conventional approach (GETS) and that approach would be very expensive and energy intensive for the lower deep aquifer. Considering that the lower deep aquifer is not commonly used for drinking water supply, no well is under threat of impact from the perchlorate plume in the lower deep aquifer (the closest drinking water supply well is located approximately 4,300 feet from the perchlorate plume), and there are no supply wells currently planned for this area, Water Board staff granted Olin time to evaluate their innovative proposal of a Gradient Driven Remediation (GDR) pilot study. After thorough review and consultation with the public, City of Morgan Hill, and the Santa Clara Valley Water District, Central Coast Water Board staff conditionally concurred with Olin's GDR pilot study approach for addressing perchlorate in the lower deep aquifer in 2012.

The objective of the GDR pilot study is to evaluate whether enhancing groundwater flow from the intermediate aquifer (source water) into the lower deep aquifer zone (receiving water) can provide hydraulic control and cleanup of perchlorate. Abundant hydrogeologic data collected during characterization efforts over the years indicate that an ambient downward vertical gradient (from the intermediate aquifer to the deep aquifer) occurs in the northern portion of the Llagas Subbasin. Based on the naturally occurring hydrogeologic conditions, the basic concept behind the GDR technology is to intentionally create a one-way vertical flow of groundwater from an aquifer without perchlorate or other pollutants[3] to an perchlorate-impacted aquifer under natural flow conditions using a groundwater well designed and constructed specifically for that

[3] In preparation for the GDR pilot test, Olin has tested groundwater for several hundred chemicals, including emerging contaminants, pharmaceuticals, pesticides and herbicides, in the proposed pilot test area to ensure that GDR, while cleaning up the perchlorate, will not inadvertently degrade other aspects of groundwater quality in the lower deep aquifer.

purpose. Olin's GDR well design consists of a well casing that has openings in both the intermediate aquifer (source aquifer) and the lower deep aquifer (perchlorate-impacted aquifer), with a solid (blank) pipe casing and annular well seal located between and above the two aquifers. The natural downward hydraulic gradient (pressure gradient) between the intermediate aquifer and the lower deep aquifer causes high-quality groundwater to enter the well screen in the upper intermediate aquifer, flow down the well's blank casing (pipe), and exit in the well screen in the lower deep aquifer, thereby diluting perchlorate in the lower deep aquifer without the use of a pump (see the conceptual figure below).



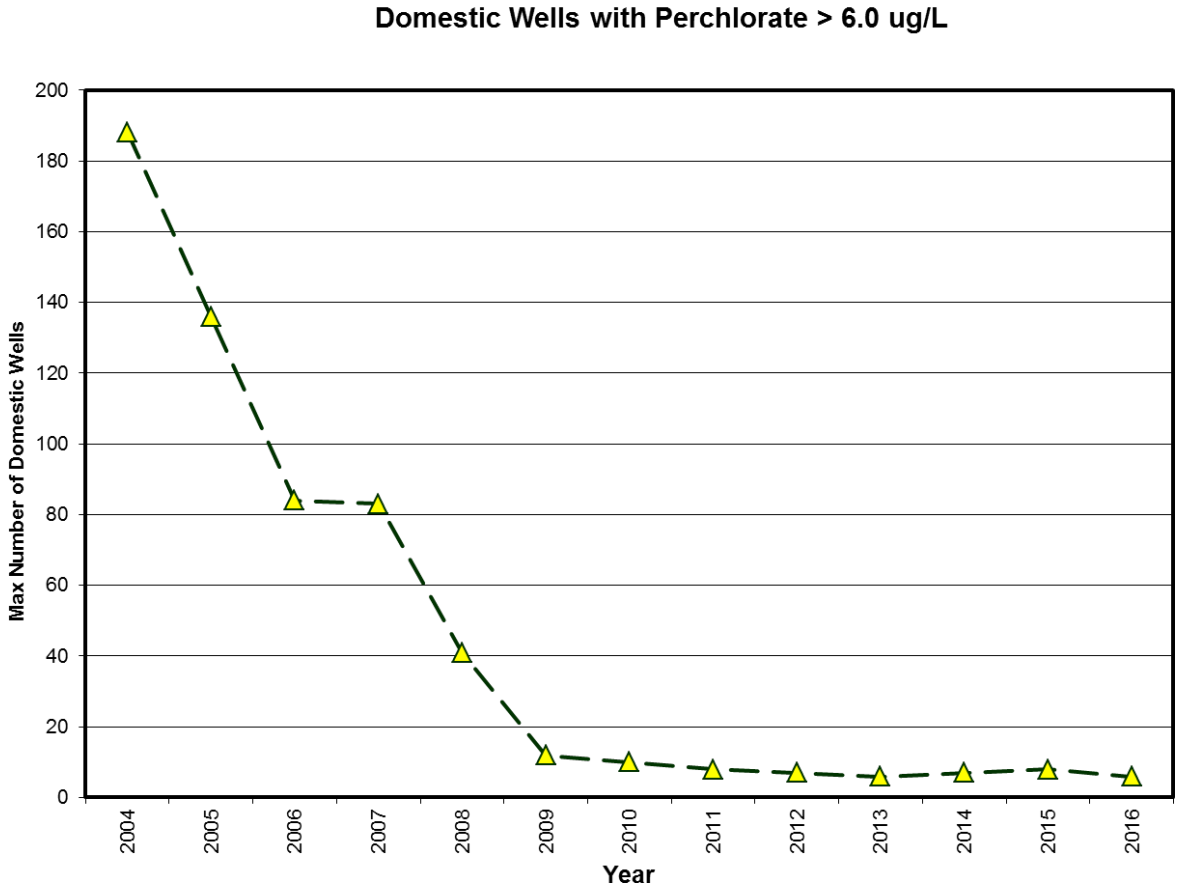
The process creates a local groundwater barrier in the lower deep aquifer to reduce the potential for perchlorate to flow towards the north were the City of Morgan Hill's (City) municipal wells pump from the lower deep aquifer. The GDR technology is a green technology that promises to locally cleanup and control perchlorate without the need for electric or hydrocarbon energy to operate pumps or for the construction of treatment system pipelines.

The first GDR well was installed in January 2016. Water Board staff are currently evaluating the monitoring results. Additional monitoring is needed through the first quarter of 2017 to determine if the pilot study is successful.

Perchlorate Concentration Trends in the Llagas Subbasin

Residents, agricultural operations, businesses, and communities near the former Olin site rely solely on groundwater for domestic, municipal, agricultural, and industrial supply purposes. Olin began monitoring perchlorate in offsite domestic supply wells in 2004. Since offsite monitoring of domestic wells began, perchlorate concentrations have decreased throughout the Llagas Subbasin, particularly south of the plume core area (Middle Avenue, approximately 1.5 miles south of the Site). Historically, over 800 domestic supply wells, predominantly screened in the intermediate aquifer, had detectable concentrations of perchlorate. In the first quarter of 2004, 188 domestic supply wells had perchlorate concentrations greater than the maximum contaminant level (MCL of 6 µg/L); this number has declined to six domestic supply wells with

perchlorate above the MCL in 2016 (see figure below). All of the wells with perchlorate above the MCL are within a mile and a half of the former Olin site, within the plume core area. The overall decreasing trends demonstrate that attenuation resulting from discontinuing the perchlorate discharge, onsite soil remediation, hydraulic control and cleanup of the plume, and natural physical processes (such as dilution and dispersion) has resulted in decreasing perchlorate concentrations throughout the Llagas Subbasin over the last 12 years. The remaining wells in the replacement water program occur near a secondary source of perchlorate that persists in low permeable soils (e.g., A/B aquitard consisting of clays and silts) above the intermediate aquifer. Olin is scheduled to begin enhancements to the GETS (addition of new extraction wells detailed above) in 2017 within the plume core area to target perchlorate concentrations below the secondary source of perchlorate in the A/B aquitard.



Attachment 2 proveides a series of plume maps that show the reduction in the perchlorate groundwater plume in the intermediate aquifer (70 to 200 feet below the surface) from 2007 to 2011. The sequence of figures in Attachment 2 shows a significant reduction in the size of the perchlorate plume outside the plume core (area with perchlorate concentrations above 24.5 µg/L within 1.5 miles of the site and colored red). By 2011, perchlorate concentrations had dropped to below 6 µg/L (e.g., areas in yellow no longer occur), south of the plume core area, with some areas above 4 µg/L remaining. As of 2016, perchlorate concentrations in monitoring wells remaining in the program south of the plume core have declined below 4 µg/L in the intermediate aquifer.

Plume Core Area

In response to Water Board staff's request for Olin to provide updated information on the perchlorate distribution and mass remaining in the A/B aquitard, Olin conducted a very detailed investigation of the A/B aquitard and upper intermediate aquifer in 2014 and 2015. The investigation consisted of advancing 47 soil borings and 51 cone penetrometer test soundings, and installation of additional monitoring wells in both onsite and offsite areas. As a result of the investigation, Olin found that PZA perchlorate concentrations occurred in the intermediate aquifer further east along and to the south of Tennant Avenue, and that approximately 390 pounds of perchlorate remain in the A/B aquitard. Figures showing the plume core area of the intermediate aquifer are provided for the period between 2011 and 2016 in Attachment 3. These figures show that the interpretation of the PZA area (colored red) expanded beginning second quarter 2014, as a result of the findings from the high resolution investigation.

Olin conducted a feasibility study with this new information from the investigation to evaluate whether GETS enhancements or other technologies could more efficiently address the remaining perchlorate mass in the A/B aquitard and intermediate aquifer, especially considering the potential future challenges resulting from drought and its effects on GETS performance. Fate and transport modeling for the feasibility study, calibrated to the vertical distribution of perchlorate detected in the A/B aquitard, indicated that the remaining perchlorate mass is migrating down more slowly than previously thought through the A/B aquitard and into the intermediate aquifer. This mass acts as a secondary source of perchlorate as the perchlorate is caught up in the pore spaces of the A/B aquitard. Therefore, the perchlorate that is caught in the A/B aquitard will continue to slowly leak out of the aquitard into the upper intermediate aquifer over time. The newly proposed extraction wells will target the perchlorate leaking into the intermediate aquifer underneath the A/B aquitard to prevent further migration beyond the upper intermediate aquifer.

Replacement Water Program

Olin is required to provide replacement water (e.g., bottled water or wellhead treatment) to well owners and tenants whose drinking water wells have perchlorate concentrations greater than 6.0 µg/L. Currently, Olin provides bottled drinking water to users of two domestic supply wells, and conducts post-bottled water termination monitoring at three domestic supply well locations where each well's perchlorate concentration has consistently dropped below 6.0 µg/L. Olin provides bottled water in accordance with Water Board Cleanup and Abatement Order No. R3-2004-0101 (CAO No. R3-2004-0101), as revised by the State Water Resources Control Board in its Order WQ 2005-0007 (State Water Board Order) and Water Board staff's letters dated October 6, 2006, December 8, 2006, and April 23, 2010. In accordance with these Orders, Olin may terminate replacement water service, with Executive Officer concurrence, for users of wells that have four consecutive quarters of perchlorate results less than or equal to 6.0 µg/L.

After replacement water service is terminated, Olin is required to monitor perchlorate in those wells in accordance with the requirements of the State Water Board Order. Since CAO No. R3-2004-0101 was issued to Olin (July 2004), approximately 180 wells have met the bottled water termination criteria in accordance with State Water Board Order requirements, because each of these wells had exhibited at least four consecutive quarters with perchlorate concentrations below the MCL. As with each of these previous bottled water terminations, Water Board staff will continue to review and evaluate all data submitted by Olin that is associated with bottled water terminations and post-bottled water termination monitoring. Additionally, Water Board staff evaluates monitoring data submitted in accordance with the monitoring and reporting program (separate from post-bottled water termination monitoring) to determine if

concentrations continue to decline even in areas that are no longer monitored through the post-bottled water termination monitoring requirements.

In addition to providing bottled water to well users, as described above, Olin continues to operate and maintain ion exchange systems on five private domestic supply wells and these systems continue to remove perchlorate as designed. All domestic supply wells that are actively used as a potable water source and have perchlorate concentrations above 7.9 µg/L in the past year are equipped with ion exchange systems, with the exception of one whose owner preferred bottled water because the well has bacteria counts that would potentially foul the IX system as they exceed Santa Clara County recommendations. All of the domestic wellhead treatment systems are located approximately one mile southeast and downgradient of the Olin site within the "plume core" area.

Olin also pays for ion-exchange wellhead treatment at one San Martin community well, although perchlorate concentrations have been below the Maximum Contaminant Level since the 2nd quarter 2010. In May 2016, Olin submitted a permit amendment to the Division of Drinking Water, to discontinue wellhead treatment.

Perchlorate Community Advisory Group
The Perchlorate Community Advisory Group (PCAG) last met on July 14, 2016. PCAG meets semiannually or annually in San Martin. The advisory group provides a forum for public discussion of the perchlorate impacts to groundwater and potential solutions. Water Board staff provides educational outreach regarding the cleanup project and solicits advisory group input at key decision points in the investigation and cleanup process and continues to update the public through participation at each PCAG meeting. PCAG has expressed appreciation to staff for the assistance provided through the years on this cleanup project.

Olin Reports and Correspondence can be accessed on our website at:
To view recent reports and other documentation related to the Olin Cleanup case please see our GeoTracker website at:
https://geotracker.waterboards.ca.gov/profile_report.asp?global_id=SL0608756247

CONCLUSION
The Olin groundwater cleanup efforts continue with the installation of five additional extraction wells this year to help expedite groundwater cleanup. Active remediation will hydraulically contain the perchlorate plume core and remove perchlorate from the drinking water aquifer. Water Board staff will also continue to work with Olin to effectively manage the replacement water program to protect users from perchlorate-impacted groundwater. This year will also provide the necessary results needed to determine whether the GDR pilot study is successful in providing an effective remedy for cleaning up the lower deep aquifer. Water Board staff will continue to update the Board regarding project progress and at significant project milestones.

ATTACHMENTS
Attachment 1: Perchlorate: Natural Occurrences, Routes of Exposure, Health Effects, Fate and Transport, and Treatment Methods
Attachment 2: Intermediate Aquifer Perchlorate Plume Maps, 2007, 2009, and 2011
Attachment 3: Intermediate Aquifer Plume Core Maps, 2011 - 2016