UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

December 5, 2012

Ms. Janis Hepel, Chair
Community Advisory Group
Aerojet General Corp. Superfund Site
4507 Marion Court
Sacramento, CA 95822

SUBJECT: Community Advisory Group Comments, Final Boundary OU RI Report

Dear Ms. Hepel:

We thank you and members of the Community Advisory Group (CAG) for reviewing and providing comments to the Final Remedial Investigation report for the Boundary Operable Unit at the Aerojet Superfund Site. The remedial response for this site is being conducted by the potentially responsible party under a Consent Decree with EPA and the State of California. As such, EPA directed Aerojet to provide the CAG with a response to your comments. This response is transmitted under separate cover by Aerojet.

Two specific issues have been raised in discussions at prior CAG meetings, and members of the community requested that the Agencies (EPA, California Department of Toxic Substances Control, and the Regional Water Quality Control Board) provide clarification and a response to these specific comments. These areas concern:

- Comment 2 and Comment 3 regarding the vapor intrusion pathway and trichloroethylene, and
- Comment 11 regarding calculating the potential (or "estimated") perchlorate exposure through the home gardening pathway.

The Agencies' project managers and toxicologists have reviewed the comments, conducted additional discussions with the CAG, and provide the attached responses.

We appreciate CAG members' interest and expertise as it informs the Superfund remedial process at this site, and value such input as the process moves forward. As you are aware, there will also be a formal public comment period on EPA's forthcoming Proposed Plan for the Boundary Operable Unit.

Should you have any questions on this correspondence, please contact me at (415) 972-3003, Alex Macdonald at (916) 464-4625, or Steve Ross at (916) 255-3694.

Sincerely,

Gary J. Riley, P.E.
Remedial Project Manager

cc: Steve Ross, DTSC
Alex Macdonald, RWQCB
Chris Fennessy, Aerojet

Comment 11. Perchlorate Exposure through the Home-Gardening Pathway: The CAG has concerns with the US EPA response regarding the quantitative evaluation of exposure to perchlorate via the home gardening pathway.

EPA/ Regulatory Response: Since the March 2012 AJ CAG meeting, EPA/regulatory agencies have been researching this issue further, and have identified a field study that could be used to estimate a bioaccumulation factor (BAF) for leafy vegetables. When we met in March, the biggest concern with the studies that were discussed were that the artificial conditions in a laboratory setting made it difficult to extrapolate these results to the field. In these lab studies, plants were not exposed to a continuous perchlorate concentration (a single spiking was used) and were grown in artificial media containing hydrosol, a colloidal suspension that is different than soil.

More recently, a literature search identified a study (Ellington et al., 2001) that was conducted in the field, included a continuous source of perchlorate in soils (loamy sand), and exposed plants throughout the growing season. This study noted that leafy plants provided the greatest estimate of a BAF (282 or 300 rounded), consistent with the lab studies (Yu et al., 2004).

To estimate a consumption rate (CR) for lettuce and other leafy vegetables, the agencies referred to the most recent version of EPA's Exposure Factors Handbook (2011) http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252 . The CR for lettuce and leafy vegetables was summed for "consumers" of lettuce and leafy vegetables. For a 70 kilogram adult, the CR is estimated to be 540 grams (70kg x 1.1 g/kg-day x 7 days) or 1.2 pounds per week. Similarly, for a 15 kilogram child, the CR is estimated to be 160 grams (15kg x 1.5 g/kg-day x 7 days) or approximately 1/3 pounds per week. This is a total consumption rate. For home gardeners, a high-end dietary fraction of 0.40 is recommended in EPA Exposure Factors Handbook and EPA Soil Screening Guidance http://www.epa.gov/superfund/health/conmedia/soil/index.htm.

Although the agencies recognize that there are still significant uncertainties with respect to an Aerojet-specific plant BAF for perchlorate, we have calculated a soil-screening level that we believe will be protective of the home-gardening pathway. Please find the calculations in the attachment. **Using available guidance, EPA/regulatory agencies derived a residential soil screening level for the soil-plant-human exposure pathway of 60 ppb perchlorate for children and 90 ppb perchlorate for women of child-bearing years.**

Literature Cited

Ellington, JJ, NL Wolfe, AW Garrison, JJ Evans, JK Avants, and Q Teng, 2001. Determination of Perchlorate in Tobacco Plants and Tobacco Products. Environmental Science and Technology, Vol. 35, 3213-3218.

Yu, L, JE Canas, GP Cobb, WA Jackson, and TA Anderson, 2004. Uptake of Perchlorate in Terrestrial Plants. Ecotoxicology and Environmental Safety, Vol 58, Issue 1 pp. 44-49.

Calculation of a Perchlorate Screening Level for Soil-Plant-Human Exposure Pathway

Acceptable daily intake (I)

$$I\ (mg/kg\text{-}day) = \frac{HQ \times RfD \times AT \times 365\ days/yr}{ED \times EF}$$

Parameter (unit)	**Value (reference)**
HQ/target hazard quotient (unitless)	1 (USEPA RAGS)
AT/averaging time (years)	2 (3 - 5 year old child) 36 (13 - 49 year old female)
ED/exposure duration (years)	2 (3 - 5 year old child) 36 (13 - 49 year old female)
EF/exposure frequency (days/yr)	350 (USEPA RAGS)
RfD/oral reference dose	7×10^{-4} mg/kg-day (USEPA IRIS)

$$I = \frac{1 \times 7 \times 10^{-4}\ mg/kg\text{-}day \times 2\ (or\ 36)yr \times 365\ day/yr}{2\ (or\ 36)\ yr \times 350\ day/yr} = 7.3 \times 10^{-4}\ mg/kg\text{-}day$$

Soil Screening Level (SSL)

$$SSL\ (mg/kg) = \frac{I \times 1000\ g/kg}{F \times CR \times DW \times BAF}$$

Parameter (unit)	**Value (reference)**
I/acceptable daily intake (mg/kg-day)	7.3×10^{-4}
F/fraction of vegetables assumed to be contaminated (unitless)	0.4 ("high end", EPA SSL Guidance 1996)
CR/vegetable consumption rate (g/kg-day)	1.5 (3 -5 year child "consumer" of lettuce + leafy vegetables in EPA Exposure Factors Handbook 2011) 1.1 (13 – 49 year female "consumer" of lettuce + leafy vegetables in EPA Exposure Factors 2011)
DW/wet to dry weight conversion factor	0.063 (average of lettuce + spinach in EPA SSL Guidance 1996)
BAF/soil-to-plant bioaccumulation factor	300 (Ellington et al. 2001)

SSL_{child} = 0.060 mg/kg or 60 ug/kg perchlorate **SSL_{woman} = 0.090 mg/kg or 90 ug/kg perchlorate**

Comment 2. **The CAG is concerned that the proposed soil gas to indoor air attenuation factor of 0.001 (RI Section 3.1.1.1 and RI Table 3.1-1) is not sufficiently conservative to represent residential buildings. EPA's Vapor Intrusion Database: Evaluation and Characterization of Attenuation Factors for Chlorinated Volatile Organic Compounds and Residential Buildings, shows that an attenuation factor of 0.001 is sufficient to cover only about 20 to 40% of existing residential structures, depending on the database screen used (EPA, 2012; Available at http://www.epa.gov/oswer/vaporintrusion/documents/OSWER_2010_Database_Report_03-16-2012_Final.pdf, See Table 8 and Figures 17 to 20). A soil gas to indoor air attenuation factor of about 0.3 (range of 0.097 to 0.6) would be required to include 95% of existing residential structures (see Table 8). The relatively coarse soils on much of the Boundary OU site would also tend to decrease the attenuation of vapors from soil gas to indoor air. Attenuation of vapors from soil gas to indoor air would likely be greater where ground water is deep but less where ground water is shallow. While these estimates are for existing residential structures, as new construction ages it will also develop foundation cracks and other points of entry for vapors from the soil below.**

These empirical studies by EPA show less attenuation of vapors from soil gas into indoor air than the default DTSC soil gas to indoor air attenuation factor of 0.001, e.g. 1E-03, used in the RI. The CAG recommends using multiple lines of evidence to establish soil gas to indoor air attenuation factors that are protective of at least 90% of the residential structure population to calculate Soil Vapor RI Screening Levels (RISL). The CAG has raised this issue at previous CAG meetings.

Also note that the U.S. EPA's Vapor Intrusion Database shows that a groundwater to indoor air attenuation factor of 1E-04 is protective of only about 50% of the population (Figure 5, Data Set 2). A soil gas to indoor air attenuation factor of about 1E-03 would be required to be protective of about 90% of the population (EPA, 2012, Figure 9, Data Set 2).

Comment 3. **Since AJ used a soil gas to indoor air attenuation factor (of 0.001) that studies by US EPA show to be overly optimistic to calculate Soil Vapor RISL, the CAG has concerns with the Soil Vapor RISLs shown in Table 3.1-1. The CAG recommends that these be recalculated with attenuation factors that are protective of at least 90% of the population as shown in the EPA's 2008 study or use multiple lines of evidence to establish soil gas to indoor air attenuation factors for the site.**

a) **Trichloroethylene (TCE): The CAG does not agree with the RI Soil gas Screening level of 961 ug/m3 TCE. The CAG is concerned that the protective Soil vapor screening level is far lower than the soil vapor SL**

used in the RI. EPA published new toxicity criteria for TCE September 28, 2011 (See http://www.epa.gov/IRIS/subst/0199.htm#refinhal), and has also published updated RSLs for TCE (See http://www.epa.gov/region9/superfund/prg/). EPA now classifies TCE as a mutagen. The residential air RSL (0.43 ug/m3) for TCE is less than half of the Cal-Modified PRG of 0.96 ug/m3 used by AJ. See comment 5a. The CAG recommends AJ use the residential air screening level of 0.43 ug/m3 for TCE and a soil vapor to indoor air attenuation factor which is protective of a least 90% of the population to establish indoor air screening levels. AJ should use the updated EPA toxicity criteria and RISLs in establishing screening levels for the RI and FS, and in the Human Health Risk Assessment (HHRA).4

EPA/Agency Response:

The agencies share the CAG's concerns regarding the potential for TCE and other soil gas plumes to move from the subsurface (soil and shallow groundwater) to overlying buildings, known as the vapor intrusion pathway (VIP). This prompted a 3-year Aerojet site study to better understand the ability of TCE/VOCs to migrate to the surface from deeper soils and shallow groundwater.

As recommended by the CAG, this Aerojet site-specific study evaluated multiple lines of evidence. This evidence included collecting and evaluating vertical soil cores down to the water table at several locations throughout Aerojet. For each location, soil types at different depths were logged, soil parameters that affect vapor migration were measured (e.g. total porosity, moisture content, grain size etc.), and TCE/VOC concentrations at multiple depths were analyzed. These measurements, known as vertical profiling, provided empirical evidence that helped inform site decision-making at Aerojet.

In parallel with the empirical studies of vapor migration, site-specific modeling was performed to assess the potential for TCE/VOCs to move from deeper soils and shallow groundwater. A comparison of empirical findings with the modeling data provided compelling evidence that risk estimates contained in the Human Health Risk Assessment are conservative (health-protective) and more likely to over-state actual risks due to vapor intrusion.

Based on these site-specific studies, the agencies disagree with the statement that an attenuation factor of 0.001 is "overly optimistic". EPA recommends that Aerojet share these site-specific VI studies with the CAG so that they have access to the same information. The agencies believe that site-specific VI studies are more relevant to Aerojet than a generic database of attenuation factors. The intent of EPA's VI attenuation database http://www.epa.gov/oswer/vaporintrusion/documents/OSWER_2010_Database_Report_03-16-2012_Final.pdf is to serve as a screening tool that encourages further investigations at sites across the country. It is not the intent of EPA's national database to discourage or replace site-specific study.

Further, it is noted that there are regional differences in vapor intrusion which are not accounted for in EPA's national database. According to California DTSC guidance (2011, Appendix B) DTSC averaged the OEHHA attenuation factors for 16 volatile organic compounds, including ethyl benzene (Cal/EPA, 2010) but excluding mercury and tetraethyl lead. The average attenuation factors for existing and future residential buildings are 0.002 and 0.001, respectively.

As Aerojet has indicated, the residential risk of VI is primarily due to contaminated shallow groundwater. In general, soil gas screening values are used at locations where VOCs were observed at "source areas" where VOCs were spilled on the ground. To prevent vapor intrusion in existing and future residential structures, the feasibility study will evaluate controls for vapor intrusion that will be required in areas where the TCE concentration in shallow groundwater exceeds 5 ppb plus a 100-foot buffer.

EPA's recent health risk assessment of TCE concluded that TCE is more toxic than previously believed. It is understandable that given this new information, that the CAG would question whether the 5 ppb level for TCE in groundwater plus a 100-foot buffer is still protective for indoor air exposures. Taking into account the new toxicity/mutagenicity information for TCE, both DTSC HERO and EPA Region 9 used the default Johnson and Ettinger (J&E) model with residential parameters to estimate potential indoor risks and concluded that a groundwater concentration of 5 ppb TCE at 30-foot depth (the shallowest depth observed at Aerojet site) would be unlikely to pose a lifetime risk greater than one in a million.

Recently, Aerojet has updated some of its risk estimates for the Boundary OU, taking into account EPA's new health risk assessment of TCE toxicity. The agencies are currently reviewing this information. It is further noted that Aerojet has updated the White Paper on how to perform Human Health Risk Assessments. Within that document it is stated that future risk assessments will utilize the most current toxicity criteria, including the recent update to TCE.