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TRANSMITTAL

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To: Darren Newton **Date:** April 5, 2004

From: David Kelly DSK

Subject: Proposed Process for Assessing Risk from Petroleum Hydrocarbons in Soil at UST Site 109

Performance evaluation testing was conducted from March 21 through October 1, 2001 at the former location of underground storage tank (UST) CL-109 to evaluate the long-term effectiveness of active biovent treatment for remediating petroleum hydrocarbons in soil. Analytical results from soil samples that were collected on October 15, 2001, after testing, were compared to baseline concentrations to evaluate testing effectiveness. In general the concentrations of petroleum hydrocarbons (gasoline and diesel range) and volatile organic compounds (VOCs) decreased during the performance evaluation testing (IT, 2003). The data indicate that after the active biovent testing, the petroleum hydrocarbon concentrations remaining in soil are low. The only location where a significant concentration of petroleum hydrocarbons was detected was between the former location of the tank and Building 109. Further active biovent treatment may not be cost effective to remediate such a small quantity of contaminated soil considering that historic and current groundwater data indicates that the groundwater has not been impacted. An evaluation is being completed using the post performance evaluation testing soil sample results to determine the risk to human health and the environment associated with any compounds remaining in the soil.

This transmittal provides a proposed process that will be followed to assess risk from petroleum hydrocarbons in vadose zone soil at UST Site 109. This proposed process is a general framework that will be followed and includes some preliminary assumptions based on known site conditions. The process and assumptions may be adjusted as the risk assessment is completed to account for changes in planned site reuse and to adjust model inputs to match known site history and contaminant migration (adjust the model to meet actual site conditions).

The general process for assessing risk at UST Site 109 will include using the most recent field measurements of contaminant concentrations, contaminant type, plume distribution, soil properties, and current groundwater concentrations. These parameters will be used to evaluate the risk to human health and the environment by direct exposure to impacted soil and to evaluate the risk of impact to groundwater through leaching. It is assumed that the potential for direct exposure to contaminants in soil is limited to soil from ground surface to a depth of three feet

below ground surface (biotic layer) for residential human health and ecological risk, and from three feet below ground surface to ten feet below ground surface for industrial human health risk (exposure to maintenance workers). Historical records from the removal of UST CL-109 indicate that the release was at the base of the tank and that the tank removal excavation extended to 11 feet below ground surface. The data indicate that there is no impact to soils within the first ten feet below the ground surface; therefore, the risk of direct exposure to impacted soil is minimal. The risk assessment will focus on the risk of impact to groundwater by leaching.

The leaching potential for petroleum hydrocarbons remaining in the vadose zone soil at UST Site 109 will be evaluated using the VLEACH (version 2.2) model. The VLEACH model is a one-dimensional finite difference model developed for the US EPA. The model uses site parameters (measured or assumed) and chemical properties to describe the movement of an organic contaminant within and between three different phases: 1) as a solute dissolved in water, 2) as a gas in vapor phase, and 3) as an adsorbed compound in the solid phase (US EPA 1997). Initially, a conceptual model is developed using the known distribution of contaminants and site-specific parameters. The conceptual model is input into the VLEACH model within the computer model constraints (polygons and layers to represent plume distributions and generalized/averaged site specific parameters). The model is then run to determine the potential mass of contaminants that leaches into groundwater (mass loading) over a period of time. The Summer's model is then used to determine the potential concentration of contaminants in groundwater based on the mass leached at the groundwater interface.

Initially, the VLEACH/Summer's model results, developed using known site conditions, will be compared to groundwater cleanup goals to determine if the groundwater cleanup goals could potentially be exceeded by the leachate from impacted soil. If the results indicate that the groundwater cleanup goals would not be exceeded, then no additional corrective action would be required. If the modeling results indicate that the groundwater cleanup goals could be exceeded, then corrective action could be required and the model could be used to develop the maximum concentration of contaminants in soil (soil cleanup goal) that would not generate a leachate that would exceed the groundwater cleanup goals.

Contaminant Distribution at UST Site 109

The initial conceptual model of contaminant distribution at UST Site 109 will be developed using primarily the most recent soil analytical data from samples collected in October 2001. Additional data from previous sampling events will be used to refine the horizontal and vertical distribution of contaminants. The conceptual model will be input into the VLEACH model within the constraints of the computer model. Ground surface will be defined as the upper boundary of the model and the groundwater table will be defined as the lower boundary. Because the ground surface is open and the groundwater has not been impacted at the site, the concentrations at the boundaries will be set to zero. The number of polygons and cells (layers) will be determined to best represent the conceptual model. The concentrations in each cell of the model will be determined by actual analytical data (concentration from a specific boring and depth or averages based on the size and shape of polygons and cells).

Chemical Specific Parameters

The VLEACH model will be used to determine the mass loading over time from the leaching of contaminants consistently detected in soil at the site following the long-term active biovent testing. The contaminants include toluene and total petroleum hydrocarbons (TPH) in the gasoline and diesel ranges. The VLEACH model does not allow for mixtures of compounds to be modeled concurrently (i.e. TPH in the gasoline range). Instead, surrogate compounds are used to represent TPH ranges and chemical groups within those ranges. The surrogates are chosen that best represent the physical properties and risk of the type and range of compounds in the mixture.

Based on historical analytical results from soil samples collected at UST Site 109 and the historical use of the tank, the release at the site was likely TPH in the kerosene range. Kerosene is a refined petroleum distillate intermediate in volatility between gasoline and gas oil, comprised of hydrocarbons in the C_8 to C_{17} with the majority in the C_{10} to the C_{14} range (Analysis of Petroleum Hydrocarbons in Environmental Media, March 1998).

The Utah Department of Environmental Quality (DEQ) defines the gasoline and diesel fractions and surrogate compounds for risk analysis (Utah DEQ, 2001) as follows:

Gasoline Range Organics (GRO)

- $C_5 - C_6$ aliphatics (*hexane surrogate*)
- $C_7 - C_8$ aliphatics (*hexane surrogate*)
- $C_9 - C_{10}$ aliphatics (*nonane surrogate*)
- $C_9 - C_{10}$ alkyl benzenes (*methylnaphthalene surrogate*)

Diesel Range Organics (DRO)

- $C_{11} - C_{13}$ alkyl naphthalenes (*methylnaphthalene surrogate*)
- $C_{11} - C_{12}$ aliphatics (*nonane surrogate*)
- $C_{12} - C_{22}$ PAHs (*pyrene surrogate*)
- $C_{13} - C_{16}$ aliphatics (*nonane surrogate*)
- $C_{17} - C_{21}$ aliphatics (*eicosane surrogate*)
- $C_{22} - C_{35}$ aliphatics (*eicosane surrogate*)

Since kerosene is a petroleum hydrocarbon blend between gasoline and diesel, a combination of both TPH fractions within the kerosene range were selected for risk calculations.

TPH in the Kerosene Range

- $C_7 - C_8$ aliphatics (*hexane surrogate*)
- $C_9 - C_{10}$ aliphatics (*nonane surrogate*)
- $C_9 - C_{10}$ alkyl benzenes (*methylnaphthalene surrogate*)
- $C_{11} - C_{13}$ alkyl naphthalenes (*methylnaphthalene surrogate*)
- $C_{11} - C_{12}$ aliphatics (*nonane surrogate*)
- $C_{12} - C_{22}$ PAHs (*pyrene surrogate*)
- $C_{13} - C_{16}$ aliphatics (*nonane surrogate*)
- $C_{17} - C_{21}$ aliphatics (*eicosane surrogate*)

Initially the VLEACH model will be used to determine the mass loading over time of TPH contaminants to groundwater assuming that the concentrations and contaminant distribution developed in the conceptual model is entirely comprised of the surrogate compound. The model will be run for each of the surrogates to determine the theoretical maximum mass loading over time for that compound. The maximum mass loading will then be converted to a groundwater concentration using Summer's model. The theoretical maximum groundwater concentration for

each of the surrogates will then be multiplied by the mass fraction of the compound in kerosene. The mass fractions of the surrogates in kerosene (Analysis of Petroleum Hydrocarbons in Environmental Media, 1998) are:

	Mass Fraction in Kerosene
$C_7 - C_8$ aliphatics	0.0233
$C_9 - C_{10}$ aliphatics	0.055
$C_9 - C_{10}$ alkyl benzenes	0.011
$C_{11} - C_{13}$ alkyl naphthalenes	0.0183
$C_{11} - C_{12}$ aliphatics	0.12
$C_{12} - C_{22}$ PAHs	0.000722
$C_{13} - C_{16}$ aliphatics	0.095
$C_{17} - C_{21}$ aliphatics	0.011

The modeled concentrations of the surrogates in groundwater will be compared to groundwater cleanup goals for those compounds to determine if the actual current soil concentrations of TPH in the kerosene range pose a risk to human health.

Soil and Aquifer Parameters

The VLEACH and Summer's model require input of soil and aquifer parameters to determine leaching characteristics and contaminant mass mixing. The parameters required for the VLEACH model include soil density, effective porosity, moisture content, organic carbon fraction, unsaturated soil column thickness, and recharge rate. The aquifer parameters required for the Summer's model include aquifer thickness and mixing depth, Darcy velocity, hydraulic gradient, and transmissivity. The values of these parameters to be used in the models will be from measurements collected in the field at UST Site 109 during previous sampling events and pilot testing, where available. If the required data is not available from samples/measurements collected at UST Site 109, data from nearby sites (IRP Site 17, UST Site 117 or UST Cluster 1) will be used.

Groundwater Cleanup Goals

Groundwater cleanup goals are currently being developed for the Administration Area Plume at NASA Crow Landing Flight Facility as part of IRP Site 17. The Administration Area Plume includes the groundwater below UST Site 109. Contaminants potentially leached from soil at UST Site 109 would impact the Administration Area Plume.

A method for determining groundwater cleanup levels for the Administration Area Plume has not been developed; however, the future use of groundwater within the Administration Area Plume has been defined in property transfer documents associated with the transfer of the Facility property from NASA to Stanislaus County. The property transfer documents limit installing wells within the Administration Plume and a buffer zone extending 2000 feet around the edge of the Plume, and indicate that existing wells within this area are to be used for emergency fire protection only. These institutional controls will remain in place until IRP Site 17 is closed.

The groundwater cleanup goals used to determine the risk associated with leaching of contaminants from soil at UST Site 109 will be based the proposed future use of groundwater defined in the property transfer documents. These groundwater cleanup goals will only be used for the soil risk assessment and assume that the long-term groundwater cleanup goals for IRP Site 17 (the Administration Area Plume) will consider the potential leaching concentrations and durations developed in the VLEACH modeling. The assumptions used in developing these specific groundwater cleanup goals will be based on limited exposure to groundwater by maintenance/construction workers.

The surrogate specific reference doses (Analysis of Petroleum Hydrocarbons in Environmental Media, 1998) are included in the following table.

	Reference Dose (mg/kg-day)
toluene	0.2
hexane	0.06
nonane	0.1
methylnaphthalene	0.04
pyrene	0.03
eicosane	2

These reference doses (RfD) will be used with the ingestion rate (IR), exposure frequency (EF), exposure duration (ED), body weight (BW), and averaging time (AT) to calculate the acceptable concentration in water (CW) for each surrogate.

$$RfD = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

The assumed ingestion rate, exposure frequency, exposure duration, and averaging time will be based on limited ingestion of contaminated groundwater by maintenance/construction workers.

These groundwater cleanup goals (surrogate concentration in water) will be compared to the result from the VLEACH/Summer's model to determine if the contaminant concentrations in soil exceed an acceptable risk to human health. If the predicted leachable concentrations are below the calculated groundwater cleanup levels, no additional corrective action is required, and the data will be used to support site closure. If the predicted leachable concentrations exceed the calculated groundwater cleanup goals, the calculated groundwater cleanup goals will be used to back calculate a soil cleanup goal using the VLEACH/Summer's model with the same assumptions for input parameters.

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Project File