COUNTY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
WASTE MANAGEMENT DIVISION
UNDERGROUND STORAGE TANK LOCAL OVERSIGHT PROGRAM

GUIDELINES FOR REPORT SUBMITTALS

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(original signed by)

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I. PURPOSE OF GUIDELINES

The California Underground Storage Tank Regulations, January 1992, Article 11, require that Responsible Parties remediate any unauthorized releases from underground storage tanks (USTs). Petroleum releases from USTs within the jurisdiction of the County of Los Angeles must be remediated under the regulatory oversight of the UST LOP of the Department of Public Works, Waste Management Division.

All assessment and remediation activities at a given site are to be documented in reports submitted to the LOP. This set of Guidelines lists the standard information which is to be included in each report. Not all the recommended activities will be required at every site. The LOP will tailor requirements to reflect the remediation needs on a site specific basis. Where additional information is necessary to fully describe the situation, such data must also be included in the appropriate submittal. If deviations from these Guidelines are necessary, technical justification must be provided.

While these Guidelines are not to be considered criteria for the design and implementation of site assessment or remediation activities, or used in lieu of the services of a fully qualified professional consultant, they are meant to aid both consultants and Responsible Parties in the compilation and presentation of material for the LOP's review. Through such open communication, it is hoped that the process of regulatory oversight for site remediation due to leaking underground storage tanks can be facilitated for the benefit of the regulated community and the public by standardizing and streamlining requirements to assure comprehensive and expeditious site remediation.

These guidelines are a working document and will be updated as necessary to meet changes in regulations and technical requirements. Written comments concerning the current edition version are encouraged and should be mailed to this office.

II. LOCAL OVERSIGHT PROGRAM REVIEW PROCESS

A. Notification Letters

Once the LOP has determined that a site is eligible for inclusion in the LOP, the Responsible Party for the particular site is notified. A Notification Letter is sent by certified mail, and consists of the following:

- A letter titled "Notification of Responsibility For Reimbursement For Costs Incurred In Administering The Underground Storage Tank Cleanup Program"

    - This letter informs the owner(s) of their responsibility for the mitigation of all contamination at the prescribed location

- A letter titled "Notice of Reimbursement"

    - This letter advises the owner(s) of their responsibility to reimburse the State for all administrative costs incurred by both the County of Los Angeles and the State Water Resources Control Board during the review process

B. Report Reviews

Submittals will be reviewed by a Project Engineer assigned to the subject site. The results of the review will be presented to the Responsible Party and their consultant in the form of a "UST LOP Review Sheet" generated by the Project Engineer.

For cases where groundwater has been contaminated or potentially impacted, or where unusual geologic or hydrogeologic conditions exist at the site in question, an LOP hydrogeologist may also review submittals and provide comments which may be included in the LOP Project Engineer's review.

C. Variations from Guidelines

Procedures, protocols, and design differing from those discussed in these guidelines may be appropriate. Recommendations for alternate methods are to be included in workplans to the LOP Project Engineer and receipt of approval should be obtained prior to implementation. All alternate methods must be technically justified in the workplan. In addition, the Responsible Party is required to comply with the Underground Tank Regulations stated in Chapter 16, Title 23, of the California Code of Regulations.

III. SUBMITTALS - GENERAL CRITERIA

A. Report Descriptions

Submittals document various phases in the identification and cleanup of a contaminated site. Each submittal should be titled with one of the following names:

- "**Tank Removal Report**" - A report required in the Tank Closure Permit to document proper tank removal
- "**Health and Safety Plan**" - A report required by the California Occupational Safety and Health Administration (CALOSHA) covering all hazardous conditions and required protective equipment for assessment, remediation, and inspection at a site
- "**Site Assessment Plan**" - A plan for work to be completed to determine the vertical and horizontal extent of contamination at a site and the physical properties of the earth materials/groundwater in which it occurs
- "**Site Assessment Report**" - A report documenting activities which have been performed to determine the extent of contamination at a site and characterize the subsurface materials
- "**Remedial Action Plan**" - A plan for work to be completed to achieve the cleanup of site contamination
- "**Remedial Action/Final Closure Report**" - A report documenting activities which have been performed to remove the contamination from a site
- "**Quarterly Progress/Monitoring Report**" - A report documenting all activities that have taken place during a three month period (these reports are required when remedial activities continue for a time period longer than three months or when groundwater has been encountered)
- "**Additional Requirements**" - A report, frequently a letter, submitted to satisfy deficiencies or discrepancies identified by the LOP's review of a previous submittal (responses must address each question in the LOP's review in an item-by-item format)
- "**Post Remedial Monitoring Report**" - A report that must be submitted following remedial action when periodic groundwater or other monitoring of the site is required

B. General Requirements

- Unauthorized releases

    - The owner or operator of the UST must notify the Department of Public Works within 24 hours of the detection of the unauthorized release
    - The owner or operator must take immediate measures to stop the release and remove any remaining substances from the UST

- All submittals must clearly identify the names and addresses of the site and the Responsible Party

- Two copies (double sided whenever possible) of each document must be submitted

- Technical submittals must contain a wet ink signature and seal by one of the following California licensed professionals:

    - Registered Geologist (RG)
    - Certified Engineering Geologist (CEG)
    - Registered Civil Engineer (RCE)
    - Registered Geotechnical Engineer (GE)

- All work must be performed under the responsible charge of an RG, CEG, RCE, or GE. A statement is required in the report indicating that the licensed professional in responsible charge supervised or personally conducted all work associated with the project within the purview of the professional as defined in the Professional Engineers Act or the Registered Geologists Act of the California Code of Regulations

- Reports shall contain conclusions and recommendations based on the submitted data and documented analyses (clearly state any assumptions and interpretations made to analyze the data)

- Workplans must be approved by the LOP prior to conducting the work, unless a response is not received from the LOP within 60 days of submittal

- The LOP must be notified 72 hours prior to commencing any significant investigation, assessment, or remediation activities on-site (all attempts should be made to notify the LOP with respect to last minute changes)

- A Health and Safety Plan should be submitted prior to conducting any field work and must be available at the site

- The title page must contain the LOP file number (I-_____)

- Deviations from these Guidelines may be acceptable provided the alternative procedures are approved by the LOP as being equivalent to the standard provisions of the Guidelines

- Critical figures and tables must be submitted in each report to justify the conclusions and recommendations, if any, set forth in the report

C. Streamlining the Submittal Process

In accordance with United States Environmental Protection Agency (EPA) directives to streamline the regulatory review (oversight) process, the following changes in the report submitting procedures have been adopted by the LOP effective with the issuance of the current Guidelines:

- Once the initial report has been submitted (e.g., tank removal report), a site assessment plan for work to completely define the extent of contamination must be submitted
  - Protocol and procedures for all anticipated work, in addition to other information described in the Site Assessment Plan section, must be specified and comply with these Guidelines
- Upon completion of site assessment, a Site Assessment Report/Remedial Action Plan shall be submitted
  - The Remedial Action Plan must describe in detail the proposed cleanup method (See Remedial Action Plan Section)
- Upon completion of site remediation, a Remedial Action/Final Closure Report must be submitted
- Unless directed otherwise by the LOP Project Engineer, quarterly progress reports are required when site assessment or remedial activities take longer than three months or groundwater is encountered

D. Mailing Address

All correspondence should be submitted to the Los Angeles County Department of Public Works, UST Local Oversight Program, Second Floor, Annex Building, P.O. Box 1460, Alhambra, CA 91802-1460. Correspondence should also include the Project Engineer's name if it is known. A facsimile (FAX) number is available; however, original documents must be submitted as soon as possible.

IV. TANK REMOVAL REPORTS

Prior to removing any tank, a permit must be obtained from the Waste Management Division's Underground Storage Tank Unit. This permit will specify the number of samples to be collected and their locations, the required laboratory analyses, and a brief description of report requirements. The tank owner must comply with Articles 5 and 7 of the California UST Regulations, January 1992. A Tank Removal Report must include, but may not be limited to, the following detailed information:

A. Site Map

- Locations of all tank(s) (past and present), associated piping, chemical and waste storage and processing areas, transfer/drain lines, and dispensing areas
- Locations of man-made surface/subsurface structures (e.g., buildings, sewers, utilities, etc.)
- Locations of all samples taken in the tank excavation
- Location of any previous site assessment
- Scale, north arrow, legend, date
- Name and address of facility

B. Vicinity Map

- Site boundaries and adjacent streets
- Map including adjacent properties
- North arrow and legend
- Name and address of facility

C. Tank Information

- Number of tank(s) removed
- Tank capacity and stored material
- Age of each tank
- Type of tank (e.g., steel, fiberglass, etc.)
- Condition of tank upon removal
- Date removed and sampled
- Disposal facility manifest, signed through receiving facility

D. Tank Preparation

- Pump out all product and submit manifest, signed through receiving facility
- Triple rinse tank and submit manifest, signed through receiving facility
- Ice tank (10 pounds of dry ice per 1,000 gallons of tank capacity)
- Monitor lower explosive limit (LEL)
- Monitor UST emissions pursuant to South Coast Air Quality Management District (SCAQMD) Rule 1149

E. Tank Removal

- Describe removal procedure
- Monitor excavated soil for contamination pursuant to SCAQMD Rule 1166

F. Soil Sampling

- Soil samples must be taken two to four feet below the tank invert
    - One sample is taken at the center for tank volumes less than 1,000 gallons
    - Two samples, at the ends, for tanks between 1,000 and 12,000 gallons
    - Three samples, at the ends and center, for tanks greater than 12,000 gallons
- Soil samples must be taken two to four feet below the product lines (at 20 foot intervals) plus one sample at each dispenser (If possible, locate the sample near joint connectors)
- Follow sampling procedures for soil (core) samples or grab samples outlined in Sampling Procedures, Appendix C

G. Chain-of-Custody

- Dates and times of sampling and receiving
- Sample ID correlating to field ID and laboratory ID
- Signatures of personnel relinquishing and receiving sample
- Analysis methods to be used
- List nature of sample (solid/liquid/vapor)
- Size and type of container (e.g., 2" x 6" brass sleeve, 500 ml plastic jar, tedlar bag, etc.)

H. Laboratory Analysis of Samples

- Samples must be analyzed according to requirements in the Closure Permit
- Laboratory data must be reported using the Los Angeles Regional Water Quality Control Board's Laboratory Report Forms (See Laboratory Requirements, Appendix D)

I. Geology

- Submit geologic logs of exposures created by tank excavation illustrating the stratigraphy, structure, sampling points, and any unique site features
- Completely describe soil lithology

J. Hydrogeology

- Indicate (cite reference and include the well's total depth and screened interval) both the current depth to shallowest groundwater and historic high groundwater level (wells should be within one-quarter mile of the site)
- If water is encountered within the tank excavation or subsequent remedial excavation, a water sample must be obtained and analyzed (See Site Assessment Plan Section)

K. Disposal Documents (signed through receiving facility)

- Includes manifests, destruction receipts, and/or bills of lading for the following:
    - Tank disposal
    - Rinseate disposal (from triple rinse)

- Contaminated soil/groundwater disposal

L. Conclusions and Recommendations

- Indicate future uses of the area in which the former tanks were located
- Evaluate all data and state specific conclusions concerning any unauthorized release of chemicals and their distribution in the soil and groundwater
- Include photographic documentation of the removed tanks and pit excavation in the report
- Indicate the status of the excavated soil
- Recommend additional work (assessment or remediation)

V. HEALTH AND SAFETY PLANS

A site and job specific Health and Safety Plan should be submitted prior to conducting any field work and must comply with the Occupational Safety and Health Administration (OSHA) Health and Safety Code. The initial Health and Safety Plan should be submitted along with the Site Assessment Plan. An amended plan, updated as appropriate, should be submitted with the Remedial Action Plan. The Health and Safety Plan shall be signed by a Site Safety Officer. The signature of an Industrial Hygienist or Toxicologist may be required for sites with contamination other than motor vehicle fuel or if past or present site operations and on-site storage of hazardous material warrant. The Health and Safety Plan must be at the site during all field work. The plan should include, but is not limited to, the following:

A. Material Safety Data Sheets (MSDS)

- For all known hazardous contaminants at the site, as defined by the California Health and Safety Code, Division 20, Chapter 6.5

B. Site History

- List the highest concentrations of all contaminants
- Site use history describing all activities involving potentially hazardous material

C. Proposed Work

- Provide a description of the proposed work

D. Facility Map (site plan)

- Proposed work areas and appropriate site control zones
- Property boundary lines and cross streets

E. Wind Direction Indicator

- Discuss the type and location of an easily seen wind direction indicator (a wind velocity meter should also be used for excavations)

F. Excavations

- Vapor and dust suppression procedures
- Proposed vertical and horizontal limits
- Proposed slopes
- Possible impact on adjacent structures
- Proposed shoring

G. Hazardous Materials

- Identify all hazardous materials present which are known to the State to be carcinogenic, teratogenic, mutagenic, or radioactive

H. Personal Protective Equipment (PPE)

- Provide a list of the required personal protective equipment

V. HEALTH AND SAFETY PLANS

I. Chemical Hazard Analysis

- Required for all known and suspected hazardous materials that may be encountered
- The lowest published exposure limits shall be used to help establish the health and safety action levels. Include the following in tabular form:
  - Recommended Exposure Limits (REL)
  - Permissible Exposure Limits (PEL)
  - Threshold Limit Values (TLV)
  - Short-Term Exposure Limits (STEL)
  - Immediate Danger to Life and Health concentrations(IDLH)
  - Routes of exposure, symptoms, and target organs

J. Health And Safety Action Levels

- Tabulate action levels and the appropriate responses for all hazardous materials
- Address wind velocities when excavations and stockpiles are involved

K. Miscellaneous Health And Safety Risks

- Electrical lines, adjacent chemical bulk storage tanks, moving equipment, fire and explosion, adjacent chemical manufacturing operations, etc.

L. Air Monitoring Plan

- Frequency and location
- Name of equipment, model, detection method, specification sheet, and Underwriter Laboratories (UL) or Factory Mutual (FM) certification
- Calibration procedure and frequency
- Most LOP sites require either a photo-ionization detector (PID) or a flame-ionization detector (FID) and benzene calorimetric detector tubes
- A combustible gas indicator (CGI) may be required for confined space applications
- Include a blank copy of the health and safety air monitoring log

M. Decontamination Procedures

- Drilling and sampling equipment
- Personal protective equipment

N. Emergency Response Plan

- First Aid measures
- Location of nearest hospital with a map showing route

O. Qualifications

- A statement of qualifications is required for the person signing the Health and Safety Plan and for the Site Safety Officer

VI. SITE ASSESSMENT PLAN

A workplan must be submitted and approved prior to conducting any site assessment work; the Responsible Party shall modify the workplan, as necessary, at the direction of the LOP, pursuant to Article 11, Section 2722, Subsections C and D, of the California UST Regulations, January 1992. The workplan must describe all activities to be undertaken and appropriate protocols to be used.

A. Site Information

- Name and address of the site and the Responsible Party
- Summary of site history relative to all contamination in question
- Name and phone number of the appropriate contact person

B. Facility Map: include the following where applicable

- Site Map
  - Locations of all tanks (past and present), associated piping, chemical and waste storage and processing areas, transfer/drain lines, and dispensing areas
  - Locations of man-made surface/subsurface structures (buildings, sewers, utilities, etc.)
  - Locations of proposed borings/sampling points/wells
  - Locations of all samples taken in the tank excavation
  - Location of any previous site assessment
  - Scale, north arrow, legend, and date
  - Name and address of facility
- Vicinity Map
  - Site boundaries and adjacent streets
  - Adjacent properties
  - North arrow and legend
  - Name and address of facility
  - Appropriate references

C. Number of Borings

- Generally, a minimum number of borings is required for each tank or tank cluster as indicated below, plus one boring through the center of each tank pit or area of highest contamination:
  - Three borings around each single tank
  - Four borings around a double or triple tank cluster
  - Determined by the LOP Project Engineer for tank clusters or pits with more than three tanks

D. Geology and Hydrogeology

- Describe soil lithology and any bedrock formations, as best known (cite reference)

  - Obtain appropriate samples from the vadose and/or saturated zones for material property testing, as warranted

- Indicate both the current depth to shallowest groundwater and the historic high groundwater level (cite reference)

  - If LAC DPW Hydraulic/Water Conservation Division records are used, indicate the depth of the well and screening interval
  - If possible, referenced wells should be within one-quarter mile of the site

- Where groundwater is impacted or potentially impacted, additional geologic and hydrogeologic information will be required (See Site Assessment Reports Section)
- Utilize specific information for any proposed aquifer test, including justification for type of test and analytical method utilized, spacing of observation wells, duration of pumping, depth of pump intake, etc. (See Aquifer Tests, Appendix F)
- At least one boring should be continuously cored and logged completely through the zone of highest suspected contamination

  - All sites with "barrier horizons" or significant lithologic variability must have sufficient continuously cored and logged borings
  - All water-saturated zones should be continuously cored and logged in a <u>sufficient</u> number of monitoring well borings to describe the saturated medium

E. Boring Locations

- The following procedures may be utilized for screening purposes only, to determine boring locations during site assessment:

  - Soil gas survey
  - BAT probes
  - Cone penetrometer
  - Hydropunch
  - Previous monitoring well/soil samples

F. Vadose Zone Plume Definition

- Specify the number, location, and depth of the proposed borings
- For vertical definition (when depth to water is known and water is not impacted or potentially impacted), obtain and analyze samples five and 15 feet below known or suspected contamination, unless a competent clay is encountered (for definition of a competent clay, See Glossary)
- For horizontal definition, borings should "step out" into clean soil/water and encircle the contamination
- The final step out borings should be analyzed at five-foot intervals beginning at the same depth as the deepest non-detect sample, from the previous step out borings; that is, above the known contamination plume (determined by laboratory results)

G. Groundwater Plume Definition

- Specify the number, location, depth, screening interval, and design of proposed monitoring wells
- For horizontal definition, borings should "step out" into non-contaminated (non-detect) groundwater and encircle the contamination
- Propose specific sampling methods to vertically define chlorinated solvents, halogenated hydrocarbons, and other "sinkers" to a competent clay bed (barrier horizon) or to the bottom of the water-saturated zone (for definition of a competent clay, See Glossary)

H. Groundwater

- Accomplish the following when the depth to existing or historical high groundwater level has not been demonstrated on-site and the potential impact to groundwater resources cannot be evaluated

    - Complete a boring to groundwater <u>or</u> complete a boring which penetrates to a minimum depth of 25 feet below the deepest detectable contamination and is sampled and analyzed at five-foot intervals

        - All five samples below the deepest contamination must be nondetect
        - A vapor well and vapor sampling may be required when borings terminate in coarse-grained soils

- If groundwater has been, or is potentially impacted (contaminated vapor or soil within 25 feet of the existing or historical high groundwater level), a minimum of three monitoring wells must be installed in order to initiate groundwater assessment

    - If one of these wells is not directly down gradient of the contamination source and/or vadose plume, a fourth well must be constructed down gradient (See Well Construction, Appendix E)

I. Free Product

- Free product removal reports shall be submitted within 45 days of confirmation of free product on the site and prepared in compliance with Article 5 of the State Underground Tank Regulations

- If free product is encountered, product recovery must begin immediately and occur as frequently as possible

    - Submit a time schedule of product removal and quarterly recovery reports

    - A continuous product recovery system must be installed if the quantity of product and the soil type allow for it

J. Sampling

- Provide a sampling and analysis plan which includes the locations and number of samples to be obtained and analyzed

    - Samples must be taken at a minimum of five-foot vertical intervals, <u>and</u> at changes in soil lithology, <u>and</u> at areas of obvious contamination

- Continuous coring is required where low-permeability horizons or frequent lithologic changes are encountered and in water-saturated zones
- An FID/PID may only be used to indicate the presence of contamination

    - Samples must be analyzed in the laboratory to determine a level of contamination or to confirm the absence (non-detect) of contamination
    - Provide field procedures to be used for the operation of the FID/PID (See Sampling Procedures, Appendix C)

- Sampling and analysis should be conducted to determine the distribution, concentration, and presence or absence of the various phases of hydrocarbons and/or solvents within the vadose zone and saturated zone(s)

• Describe the standard sampling and handling protocol (See Sampling Procedures, Appendix C)

    - Identify procedures used to prevent cross contamination
    - Any modifications to the standard protocol must be approved by the LOP Project Engineer

K. Laboratory Analysis

• All laboratory analyses must be proposed according to Laboratory Requirements, Appendix D

VII. SITE ASSESSMENT REPORTS

A Site Assessment Plan must be submitted and approved prior to conducting any site assessment. Describe all assessment activities conducted. Address and justify any and all deviations from the Site Assessment Plan.

A. Site Information

- Name and address of the site and Responsible Party
- Summary of site history relative to the contamination
- Characterize past and present business activities
- Describe the surrounding community
- Describe the storage, handling, usage, and disposal procedures for all chemicals on-site
- Give dates of the completion of buildings and asphalt paving where possible
- Indicate any proposed future uses of the area relative to the contamination

B. Facility Map: include the following where applicable

- Site Map

  - Locations of all tanks (past and present), associated piping, chemical and waste storage and processing areas, transfer/drain lines, and dispensing areas
  - Locations of man-made surface/subsurface structures (buildings, sewers, utilities, etc.)
  - Locations of completed borings/sampling points/wells
  - Locations of all samples taken in the tank excavation
  - Location of any previous site assessment
  - Scale, north arrow, legend, and date
  - Name and address of facility

- Vicinity Map

  - Site boundaries and adjacent streets
  - Adjacent properties
  - North arrow and legend
  - Name and address of facility
  - Appropriate references

C. Geology

- Describe the lithology and structure of soil and bedrock encountered during assessment
- Determine soil and contaminant properties which affect mobility of vapor, water, and contaminants in the vadose zone, capillary fringe, and saturated zone(s)
- Identify any unique site features which may influence movement of contaminants or groundwater

  - Natural - faults, fractures, joints, soil horizons, bedrock materials, weathered zones, isolated lenses, fill materials, anisotropic sediments, buried channels, lateral clay barriers, channel bars, buried stream banks, pinch-outs, etc.
  - Artificial - sewer and other utility lines, footings, piles, wall backfills, etc.

- Provide stratigraphic interpretation between borings and/or pit excavations

D. Hydrogeology

- Regional setting (cite references)

    - Historic high groundwater level
    - Recharge/discharge areas and flow patterns
    - Groundwater basins and their geometry
    - Depositional basins and stratigraphy (formations, members, and lithology)
    - Surficial deposits
    - Aquifer system(s) and their hydraulic gradient(s)
    - Regional map depicting appropriate items from above

- Site specific setting (cite references)

    - Groundwater features

        - Vadose zone including perched water zones
        - Saturated zones and the capillary fringe
        - Potentiometric surface
        - Aquifers, aquitards, and aquicludes with lithologic descriptions
        - Recharge sources and discharge areas
        - Review of local well records and nearby sites under investigation
        - Hydraulic conductivity, gradient, porosity, velocity, etc. (a minimum of three wells required)

    - Aquifer characterization when groundwater is contaminated

        - Lithologic units within the saturated zone must be reported from a sufficient number of continuously cored and logged borings
        - Provide results of material property testing from appropriate samples
        - Provide results of appropriate aquifer tests to characterize the aquifer/aquitard/aquiclude system (See Aquifer Tests, Appendix F)
        - Determine the lithologic unit(s) that the majority of the groundwater flows through
        - Calculate groundwater velocity and utilize this data to estimate the extent of plume
        - Determine the vertical and horizontal components of the groundwater flow within the aquifer by utilizing nested or clustered wells, as warranted
        - Determine if the groundwater flow occurs down gradient or cross gradient as caused by pressure changes within the aquifer
        - Local uses and pumpage of groundwater and their affect on the groundwater elevations, flow direction, and velocity

    - Local uses of groundwater
    - Nearby wells that may affect or be effected by the subject contamination

E. Boring Logs

Provide complete and legible boring logs. Include the following information:

- Description of earth materials (use USCS)
- Lithographic column (graphical log) with a legend
- Sample localities at depth
- Depth to confined and/or unconfined groundwater and the potentiometric surface
- Depths in feet and termination depth
- Penetration in blows per foot (including hammer weight)
- Percent recovery of sample in coarse grained soils
- Surface elevation in feet
- Project name, boring number, drilling date, and scale
- Full name of the field geologist/engineer
- Type of equipment used for drilling, sampling, and field screening
- Field meter screening readings (See Sample Screening, Appendix C)
- If the boring is converted to a well, provide details of the well construction (See Well Construction, Appendix E)
- Angle (vertical or slant)
- Diameter of boring
- Abandonment material

F. Sampling

- Describe procedures used for obtaining samples (See Sampling Procedures, Appendix C)

G. Chain-of-Custody

- Dates and times of sampling and receiving
- Sample ID correlating to field ID and laboratory ID
- Signatures of personnel relinquishing and receiving sample
- Analysis methods requested
- Nature of sample (solid/liquid/vapor)
- Size and type of container (e.g., 2"x 6" brass sleeve, 500 ml plastic jar, tedlar bag, etc.)

H. Laboratory Results

- Laboratory data must be reported using the Los Angeles Regional Water Quality Control Board's Laboratory Report Forms (See Laboratory Requirements, Appendix D)
- Tabulate results with sample identification number, laboratory analysis results, depth of sample, and detection limits

I. Soil and Water

- Soil generated during the drilling of borings and water produced from development or purging activities must be adequately contained on-site
- The materials must be manifested and transported to a permitted disposal location within 90 days if they are found to be hazardous

J. Plume Illustration

- Depict the extent of the liquid-phase, adsorbed-phase, vapor-phase, and dissolved-phase contaminant plumes, as necessary

  - Plan view of the site, drawn to scale, including but not limited to:

    - USTs, connecting pipes, dispenser islands, buildings, and unique site features
    - Utility lines (e.g., water, gas, electric, sewer lines, etc.)
    - Isocon lines illustrating the extent of the plume(s) for TPH, benzene, and all other contaminants (the isocons on the plan and section views must correspond)
    - Trace of section lines, constituent concentrations, and legend (views at different depths may be required to illustrate the distribution of contamination with depth and/or horizontal changes in lithology, e.g., channel gravels traversing marsh clays)

  - Geologic cross-sections, drawn to scale, including but not limited to:

    - Interpretation between all borings/wells and excavations; include stratigraphy and structure, groundwater elevations (high, low, and current) and unique site features
    - Isocon lines illustrating the extent of the plume(s) for TPH, benzene, and all other contaminants (the isocons on the plan and section views must correspond)
    - Direction of section lines, scale, and legend
    - At least one cross-section in the down gradient and cross gradient direction, if groundwater is contaminated

K. Conclusions and Recommendations

- Specifically discuss and describe the various phases, distribution, and concentration of hydrocarbon contamination and its relationship to the medium in which it occurs (soil and/or water in the vadose zone, capillary fringe, and saturated zone)
- Recommend additional site assessment or remediation
- Justify why it is believed the plume is defined (refer to borings and samples)

L. References

- Reference all reports, including previous consultants reports, prepared for the site and any publications cited in the text

VIII. REMEDIAL ACTION PLAN

A workplan must be submitted and approved prior to conducting any site remediation work; the Responsible Party shall modify the workplan, as necessary, at the direction of the LOP, pursuant to Article 11, Section 2722, Subsection B, of the California UST Regulations, January 1992. The workplan must incorporate all comments from the LOP Project Engineer and describe all activities to be undertaken. Be advised that the failure of a particular approach to mitigate a site does not relieve the responsible party of the obligation to take additional action to mitigate the site to the satisfaction of the regulatory agencies.

A. Site Information

- Name and addresses of site and Responsible Party
- Summary of site history relative to contamination
- Describe surrounding community
- Indicate any proposed future uses of the area relative to the contamination

B. Facility Map (site plan): include the following where applicable

- Site Map
    - Locations of all tanks (past and present), associated piping, chemical and waste storage and processing areas, transfer/drain lines, and dispensing areas
    - Locations of man-made surface/subsurface structures (buildings, sewers, utilities, etc.)
    - Locations of completed borings/sampling points/wells
    - Locations of all samples taken in the tank excavation
    - Location of any previous site assessment
    - Location of proposed excavation
    - Locations of proposed treatment cells
    - Locations of proposed wells (monitoring, observation, and extraction).
    - Scale, north arrow, legend, and date
    - Name and address of facility
- Vicinity Map
    - Site boundaries and adjacent streets
    - Adjacent properties
    - North arrow and legend
    - Name and address of facility
    - Appropriate references

C. Contaminant Information

- Tabulate the contaminant levels and indicate their type (include any stockpile sample results)
- Show the plume configuration in plan view and in cross-section
- Estimate volume of the contaminated soil and/or groundwater

D. Geology and Hydrogeology

- Provide an overview of the geologic and hydrogeologic setting (See Site Assessment Report Section)

E. Justification

- Use appropriate laboratory and field tests, case studies, or manufacturers' manuals to justify applicability and selection of the proposed remediation method
- Use pilot studies, vent tests, or aquifer tests to demonstrate the effectiveness of the proposed remediation system
- Provide calculations for the remedial system's design (include references)

  - Indicate values used for all parameters (calculated and assumed) utilized in the system's design
  - Include data from vent/aquifer tests previously performed and discuss procedures of each test

F. Disposition of Treated Soil/Water

- Indicate the intended disposition of the treated soil or water
- Obtain permission from the LOP Engineer prior to backfilling

G. Sampling Plan

- Provide a plan which includes the locations and number of samples to be taken
- Describe sampling and handling protocol (See Sampling Procedures, Appendix C)
- Discuss plan for verifying when remediation is complete
- All laboratory analyses must be proposed according to Laboratory Requirements, Appendix D

H. Estimated Cleanup Timeline: include the following where applicable

- Permitting
- System Design and Installation
- Remediation

I. Quarterly Progress Reports

- Quarterly Progress Reports must be submitted if remediation is expected to take longer than three months (See Quarterly Progress Reports Section)

J. General Requirements

The Los Angeles County Department of Public Works does not approve or disapprove the use of any non-conventional technology. Achieving appropriate clean-up levels is the responsibility of the Responsible Party, thus, the choice of remedial technology utilized at a site is primarily at their discretion. Other remedial technologies than those listed below are available and may be appropriate for use at a site.

- Groundwater Remediation

  - Appropriate aquifer tests must have been completed in order to justify the remedial system
  - Submit a hydrologic model of the pumping system

    - Include artificial recharge if on-site reinjection\disposal is utilized
    - Include plan and section views of the cones of depression and predicted flow paths

- Evaluate effect of overlapping cones of depression, variable aquifer characteristics, and distribution of contamination, etc., on the remediation system
- Estimate and justify the duration of remedial pumping action
- Submit a monitoring plan that will demonstrate the effectiveness of the system during remediation (e.g., confirm formation of cone of depression, sustainable pumping rates, and the reduction of contaminant levels)

- Air Stripping

  - Indicate the packed tower's specifications/dimensions
  - Address design parameters such as temperature, pressure, air-to-water ratio, surface area available for mass transfer, flow rate, and size and type of packing
  - Submit monitoring and sampling plan for influent and effluent waste
  - Identify equipment to control and monitor emissions of mist and volatile organic compounds (VOCs) into the atmosphere
  - Provide detailed scaled drawings and schematic of the system layout
  - Include any supplemental treatment, such as carbon adsorption

- Carbon Adsorption

  - Include carbon specifications, such as type (virgin or regenerated), amount, and dimensions
  - Address design parameters, such as optimal empty bed contact time (EBCT), breakthrough characteristics, flow rate, and temperature
  - Identify system characteristics, such as single-stage or multi-stage filters, and up-flow or down-flow of liquid
  - Submit monitoring and sampling plan for influent and effluent waste
  - Submit detailed scaled drawings and schematic of the system layout
  - Include any supplemental treatment such as bioremediation

- Air Sparging

  - Submit a description of the method, including all assumptions and interpretations, used to analyze data from the pilot test
  - Submit all field data, calculations, graphs, etc., used to determine the radius of influence, the adequate sparge pressure of each well, and the estimated lateral versus vertical movement of the sparged air through the aquifer
  - Justify the proposed number and location of observation wells
  - Submit the results of permeability test(s) for the finest grained soil from a continuous cored boring (in most cases, the soil permeability must be greater than 10^{-3} cm/sec to be acceptable)
  - Identify any confining layers or fine grained lens which may cause increased lateral migration of volatilized contaminants
  - Remove all free product to at least a sheen prior to performing any sparging
  - A vapor extraction system must be used in conjunction with the air sparging system to extract all volatilized contaminants
  - Design a system to contain the groundwater contaminant plume, considering both the gradient/velocity of the groundwater and the increased contaminant movement from the added pressure of the sparging system

- Free Product Recovery

  - Free product removal reports shall be submitted within 45 days of confirmation and prepared in compliance with Article 5 of the State Underground Tank Regulations
  - One or two pump automatic recovery systems should be used when conditions allow
  - Remove free product prior to pumping dissolved product or conducting aquifer tests
  - Estimate amount and thickness of the free product present (discuss method used, both theoretical and empirical)
  - Product must be properly manifested and disposed

• Soil Remediation

- Excavation and Haul (Off-site Disposal)

  - Excavation should follow Excavation Procedures, Appendix B
  - Hazardous and non-hazardous waste must be sampled, analyzed, and appropriately manifested for disposal
  - Discuss backfilling procedures including the amount of time the pit will be left open and the source of backfill material

- Thermal Treatment Units (TTU) for petroleum contaminated soils

  - Excavation should follow Excavation Procedures, Appendix B
  - Submit description and schematic of the TTU
  - Indicate the operating temperature parameters
  - Estimate the soil residence time and feed rate

- Enhanced Bioremediation (Ex Situ)

  - Review of the physical, chemical, and biological properties for each contaminant
  - Soil toxicity study, if applicable
  - Monitoring plan for pH
  - Demonstration of the bioculture's efficiency (case history, manufacturers' brochures, indigenous plate count, etc.)
  - Name and type of bioculture and its effect on the native environment (specify whether the biocultures to be used are indigenous)
  - Laboratory enumeration process and results
  - Mechanism for introducing nutrients, biocultures, aeration, and moisture
  - Determine the nutrient mobility
  - Description of the method of bioremediation with drawings and details, (e.g., biological aeration processes, oxygen pathway, method of mixing and tilling, etc.)
  - Excavation should follow Excavation Procedures, Appendix B
  - Describe the method of containment used in treatment cells
  - Submit a scaled plot plan showing the treatment area, number of treatment cells, average thickness of the soil per cell, and dimensions
  - Irrigation and drainage plan for the entire treatment area
  - Submit confirmation sampling plan

VIII. REMEDIAL ACTION PLAN

- Vapor Extraction System (VES)

  - Wells should be installed following Well Construction, Appendix D
  - For sites with variable lithology/soil permeability, relate the vadose well screening to the soil lithology and ensure that lower permeable areas obtain adequate extraction pressure
  - Submit a schematic of the VES and a detailed drawing/description of all monitoring wells, vapor extraction and injection wells, and their associated piping
  - For above-ground treatment, include a complete description and a drawing of the treatment cells
  - Submit a description of the method, including all assumptions and interpretations used to analyze data from the pilot test
  - Submit all field data, calculations, graphs, etc., used to determine the radius of influence of each well and provide justification for the location and number of proposed wells
  - Submit a monitoring and sampling plan to measure the influent soil gas concentrations
  - Submit pump specifications
  - Document any computer programs used by including a description of the program, the limitations, and the input and output data requirements (list all assumptions/interpretations used in the analysis)
  - Submit confirmation sampling plan

IX. REMEDIAL ACTION/FINAL CLOSURE REPORTS

A Remedial Action Plan must be submitted and approved prior to conducting any remediation. The Remedial Action Report must describe all remediation activities conducted, as well as address and justify any deviation from the Remedial Action Plan. Be advised that the failure of a particular approach to mitigate a site does not relieve the Responsible Party of the obligation to take additional action to mitigate the site to the satisfaction of the regulatory agencies.

A. Site Information

- List the name and addresses of the site and Responsible Party
- Summary of site history relative to contamination
- Characterize past and present business activities
- Describe surrounding community
- Describe the storage, handling, usage, and disposal procedures for all chemicals on-site
- Give dates of the completion of buildings and asphalt paving where possible
- Indicate future uses of the area relative to the contamination

B. Facility Map: include the following where applicable

- Site Map
    - Locations of all tanks (past and present), associated piping, chemical and waste storage and processing areas, transfer/drain lines, and dispensing areas
    - Locations of man-made surface/subsurface structures (buildings, sewers, utilities, etc.)
    - Locations of completed borings/sampling points/wells
    - Locations of all samples taken in the tank excavation
    - Location of any previous site assessment
    - Scale, north arrow, legend, and date
    - Name and address of facility
- Vicinity Map
    - Site boundaries with adjacent streets
    - Map including adjacent properties
    - North arrow and legend
    - Name and address of facility
    - Appropriate references

C. Geology and Hydrogeology

- Provide an overview of the geologic and hydrogeologic setting (See Site Assessment Reports Section)
- Evaluate and discuss the effect of geologic conditions on the remedial action

D. Sampling

- Describe procedure used for obtaining, handling, and transporting samples

E. Chain-of-Custody

- Dates and times of sampling and receiving
- Sample ID correlating field ID and laboratory ID
- Signatures of personnel relinquishing and receiving sample
- Analysis methods requested
- Nature of sample (solid/liquid/vapor)
- Size and type of container (e.g., 2"x 6" brass sleeve, 500 ml plastic jar, tedlar bag, etc.)

F. Laboratory Results

- Provide laboratory data using the Los Angeles Water Quality Control Board's Laboratory Report forms, (See Laboratory Requirements, Appendix D)
- Tabulate results with sample location and quantification limits
- Make a Cartesian graphical plot of mass removal versus time, if applicable

G. Boring Logs

- Provide complete and legible boring logs (See Site Assessment Reports Section)

H. Permits

- Submit copies of all applicable permits

I. Manifests

- Submit completely filled out and signed hazardous waste manifests, as required by the California Health and Safety Code, Division 20, Chapter 6.5

J. Plume Illustration

- Show the vertical and horizontal extent of contamination/excavation on both a scaled plan view and cross-section view

K. Residual Contamination

- Justify, with supporting soil and groundwater analyses, why it is believed that all significant contamination has been removed
- Submit a post-remediation monitoring plan
- Relate residue with its long-term effect on groundwater quality

L. Quarterly Progress Reports

- Quarterly Progress Reports must be submitted if remediation is expected to take longer than three months or if groundwater is encountered

X. QUARTERLY PROGRESS/MONITORING REPORTS

Quarterly Progress Reports must be submitted if assessment or remediation is expected to take longer than three months or if groundwater has been encountered. Reports are due within 30 days after the end of the quarter. The report must contain, at a minimum, the appropriate information listed below, and a summary of activities that occurred during the indicated time period, as required by Subsection D, Section 2625, Article 5, of the California UST Regulations.

A. Groundwater Sampling

- Sample Collection
  - Groundwater samples must be collected and analyzed on a quarterly basis from all wells (See Groundwater Samples, Appendix C)
- Submit Groundwater Sampling Log, that includes, but is not limited to:
  - Measurements of temperature, pH, and conductivity that indicate stabilization, as well as quantitative turbidity measurements taken during purging (See Groundwater Samples, Appendix C)
  - Total volume of purged groundwater, method of purging, and groundwater recharge rate (wells should not be pumped dry unless they are slow to recharge)
  - Measurements of free product thickness and the total volume of product removed
  - Method of product removal, if applicable
  - Measurements of the depth to water and bottom of the well must be taken on a quarterly basis
- Data Tables
  - Current and all previous groundwater sample analytical results for TPH, benzene, toluene, xylene, ethylbenzene, and other necessary constituents
- Site Plans (to scale)
  - Plan views showing isocon lines of TPH and benzene
  - Plan view showing groundwater gradient and flow direction (evaluate causes for any change in groundwater elevation, flow direction, or hydraulic gradient)
- Documentation of legal disposal of purged groundwater

B. Vapor Extraction Systems (VES)

- Air sample results of the vapor extraction influent concentrations from each extraction well (include data from the present quarter and all previous quarters)
- Vapor pressure and flow rate at each well
- Total quantity of contamination removed versus time and total contamination remaining versus total contamination at the beginning of remediation, illustrated graphically

C. Enhanced Bioremediation (Ex Situ)

- Current and all previous soil sample analyses for TPH, BTXE, and other necessary constituents
- Site Plan to scale showing sample locations in the treatment cells

APPENDICES

A. Maximum Acceptable Levels

B. Excavation Procedures

C. Sampling Procedures

D. Laboratory Requirements

E. Well Construction

F. Aquifer Tests

G. Risk Assessment Analysis

APPENDIX A - MAXIMUM ACCEPTABLE LEVELS

The maximum acceptable level of contamination in soil or groundwater is determined on a site-by-site basis and reflects the policies of the local, State, and Federal agencies. It is the policy of the LOP that the strictest of these acceptable concentrations of contaminants shall be the limiting factor. An acceptable level of contamination cannot be determined until the extent of contamination has been fully defined.

Acceptable levels of contaminants in water are generally established through governmental regulations. The LOP uses the California Environmental Protection Agency's standards for maximum acceptable levels. Acceptable levels of contaminants in soil, however, are not always well established. For gasoline and diesel, the leaching potential is analyzed using the LUFT Manual Table 2-1. If any information is lacking for a proper analysis using Table 2-1, then the worst case will be assumed. If contamination in the soil exceeds the LUFT Manual values, then the soil contamination must be remediated.

All final maximum acceptable levels of contamination will be determined at the discretion of the LOP Project Engineer, regardless of levels determined by any other source.

APPENDIX A - MAXIMUM ACCEPTABLE LEVELS

Table 2-1 (LUFT Manual, 1989)
Leaching Potential Analysis for Gasoline and Diesel
Using Total Petroleum Hydrocarbons (TPH)
and Benzene, Toluene, Xylene and Ethylbenzene (BTX&E)

The following table was designed to permit estimating the concentrations of TPH and BTX&E that can be left in place without threatening groundwater. Three levels of TPH and BTX&E concentrations were derived (from modeling) for sites which fall into categories of low, medium, or high leaching potential. To use the table, find the appropriate description for each of the features. Score each feature using the weighting system shown at the top of each column. Sum the points for each column and total them. Match the total points to the allowable BTX&E and TPH levels.

SITE FEATURE		SCORE	SCORE 10 PTS IF CONDITION IS MET	SCORE	SCORE 9 PTS IF CONDITION IS MET	SCORE	SCORE 5 PTS IF CONDITION IS MET	
Minimum Depth to Groundwater from the Soil Sample (*feet*)			> 100		51-100		25-50[1]	
Fractures in subsurface (applies to foothills or mountain areas)			None		Unknown		Present	
Average Annual Precipitation (*inches*)			< 10		10-25		26-40[2]	
Man-made conduits which increase vertical migration of leachate			None		Unknown		Present	
Unique site features: recharge area, coarse soil, nearby wells, etc.			None		At least one		More than one	
COLUMN TOTALS ® TOTAL POINTS			+		+		=	
RANGE OF TOTAL POINTS		49 pts or more		41 - 48 pts		40 pts or less		
MAXIMUM ALLOWABLE B/T/X/E LEVELS (*PPM*)		1/50/50/50		.3/.3/1/1		NA[3]		
MAXIMUM ALLOWABLE TPH LEVELS (*PPM*)	GASOLINE	1,000		100		10		
	DIESEL	10,000		1,000		100		

[1] If depth is greater than 5 feet and less than 25 feet, score 0 points (If depth is 5 feet or less, this table should not be used)

[2] If precipitation is over 40 inches, score 0 points

[3] Levels for BTX&E are not applicable at a TPH concentration of 10 ppm (gasoline) or 100 ppm (diesel) (For explanation see step 6, page 27 [of the LUFT Manual])

NOTE: Minimum depth to groundwater must be historic high

APPENDIX B - EXCAVATION PROCEDURES

Site Assessment

- Perform site assessment to define the extent of contamination before excavation

Sampling Plan (pit)

- Follow the grab sample protocol in Appendix C, Sampling Procedures
- Obtain a minimum of one soil sample at the bottom and from the walls of the excavation every 100 square feet and at apparent high contamination "hot-spots"
- Additional samples may be required due to soil lithology and/or types of chemicals
- The vertical extent of the soil contamination must be defined (See Site Assessment Plan Section)
- At minimum, one boring must be drilled per source area, if borings were not performed beforehand to fully define the plume

Volume of Soil

- Estimated volume of excavated soil supported by calculations

Disposal

- It is the duty of the Responsible Party to properly dispose of the soil (the receiving facility will accept or reject material for disposal, depending on its permit and may require permission from the Regional Water Quality Control Board [RWQCB], Technical Support Unit)
- Submit disposal documents (manifests, disposal-destruction receipts, bills of lading, etc.) signed through receiving facility for soil disposed of as hazardous or non-hazardous material

Backfill

- Prevent water from entering the open excavation
- Obtain permission from LOP Project Engineer prior to backfilling
- Sampling plan for use of excavated soil as backfill

  - 1 to 100 cubic yards: one sample for every 10 cubic yards
  - 101 to 1000 cubic yards: one sample for every 25 cubic yards plus six samples
  - 1001 or greater: one sample for every 50 cubic yards plus 20 samples

Sample Screening

- Soil samples must be screened for VOCs and the results recorded on the boring logs
- The measuring instrument should be a PID or an FID
- Screening equipment must be operated according to the manufacturer's specifications
- Equipment must be calibrated before each day's use
- Report the calibration standard, time/date of last calibration, and voltage of lamp used
- Soil should be placed in a sealed container and allowed to set for 15 minutes prior to placing the probe tip into the container (describe specific procedures used)
- Samples must be analyzed in the laboratory to determine a level of contamination or to confirm the absence (non-detect) of contamination (field screening may only be used to indicate the presence of contamination)

APPENDIX C - SAMPLING PROCEDURES

Soil (Core) Samples

- Use split-barrel core sampler, modified California sampler, Shelby Tube, or other accepted sampling method
- Use clean stainless steel or brass cylinders
- No headspace is allowed in the cylinders
- Cover cylinder ends with foil or Teflon sheets, cap with an inert lid, and seal with a non-VOC tape (do not use duct or electrical tape)
- Place the sample in a sealable bag
- Label to identify boring number and depth
- Sample identification must correlate among all references (report, chain-of-custody, laboratory results, site plan)
- Place sample into ice chest at $4^{o}C$ for delivery to laboratory
- Decontaminate equipment between samples by washing with a non-phosphate detergent, rinsing twice, and air drying (final rinse should use deionized water)
- Follow proper chain-of-custody procedures
- Laboratory should receive samples within 24 hours of sampling
- Laboratory analysis must occur within the allowed holding time (See Laboratory Requirements, Appendix D)

Grab Samples

- Sample should be as close to undisturbed as possible
- Insert a stainless steel cylinder, brass cylinder, or glass jar into the soil
- No headspace is allowed in the container (do not hand pack soil into the sampler)
- Seal container
  - Cylinder
    - Cover ends with foil or Teflon sheets, cap with an inert lid, and seal with a non-VOC tape (do not use duct tape or electrical tape)
    - Label sample to identify its location and depth
    - Place the sample in a sealable bag
  - Glass jar (cannot be used for VOC soil contamination)
    - Close jar with Teflon coated lid
    - Label sample to identify its location and depth
    - Place the sample in a sealable bag
- Place sample into ice chest at $4^{o}C$ for delivery to laboratory
- Follow proper chain-of-custody procedures
- Laboratory should receive samples within 24 hours of sampling
- Laboratory analysis must occur within the allowed holding time (See Laboratory Requirements, Appendix D)

APPENDIX C - SAMPLING PROCEDURES

Groundwater Samples

- Introduction

  - Follow well installation procedures (See Well Construction, Appendix E)
  - An NPDES permit from the RWQCB is required for any discharge into the storm drain system
  - Any equipment entering the well must be made of an inert material, including the bailer cord
  - Include field QA/QC trip and equipment blanks

- Free Product

  - Allow the well to stabilize for at least 24 hours after development and then check the well for free product
  - If free product is encountered, a product removal plan must be implemented (See Remedial Action Plan Section)

- Well Measurements

  - Submit measurement of the depth to free product, if present
  - Submit measurement of the depth to water level
  - Submit measurement of the depth to the bottom of the well

- Well Purging

  - Bail or pump the well until a representative water sample is obtained

    - Report the rate of removal and volume removed (rate of removal should equal rate of recovery and should not purge the well dry unless it is a slow recharging well)
    - Generally, a minimum of four well volumes must be removed to achieve stabilization if recharge is fast (the water level recovers to 80 percent of the original level within two hours) or at least one bore volume must be removed if recharge is slow (the water level does not recover to 80 percent of the original level within two hours)
    - Report the measurements to show stabilization (three consecutive readings within 10 percent for conductivity, one degree for temperature, and 0.1 pH unit for pH) for temperature, conductivity, and pH
    - Report the quantitative turbidity field measurements in NTUs (turbidity must be less than 10 NTU, or meet the baseline level established during development, at the completion of the purging cycle or the well may need to be redeveloped)

- Submit a groundwater sampling log, that includes, but is not limited to:

  - Quantitative turbidity measurements
  - Measurements of parameters indicating stabilization
  - Time at each parameter reading
  - Volume of water removed at each stabilization reading
  - Total volume of water purged
  - Total time for recovery
  - Name of personnel performing sampling and date
  - Problems encountered, if any

- Type of sampler used

APPENDIX C - SAMPLING PROCEDURES

- Sample Collection

  - Use a clean hand bailer with a bottom release or a gas-actuated positive displacement pump to collect samples
  - Samples must be obtained as soon as well recharge occurs, but no later than two hours after purging is completed
  - For petroleum contamination, the sample should be taken from just below the interface of the air and water
  - For non-petroleum contamination where the density is greater than water, describe the method for obtaining discrete samples from various depths

- Sample Container

  - Use vials or special containers to prevent loss of volatiles (vials should not be filled at a rate faster than 100 ml/min and no headspace should be present)
  - Label the sample with a non-VOC custody seal to identify well number
  - Place the sample in a sealable bag

- Sample Transportation

  - Place the sample in ice chest at 4^{o}C for delivery to laboratory
  - Follow proper chain-of-custody procedures
  - Laboratory should receive samples within 24 hours of sampling

- Laboratory Analysis

  - Laboratory analysis must occur within the allowable holding time (See Laboratory Requirements, Appendix D)

- Decontamination

  - Decontaminate the equipment between samples by washing with a non-phosphate detergent, rinse twice (final rinse with deionized water), and allow to air dry

- Disposal

  - Identify method of disposal of the pumped water
  - Provide appropriate manifests
  - An NPDES permit from the RWQCB is required for any discharge into the storm drain system

APPENDIX D - LABORATORY REQUIREMENTS

Test Method References

- EPA SW 846 - "Test Methods for Evaluating Solid Wastes"
- EPA 600 - "Methods for Chemical Analysis of Water and Wastes"
- Federal Register
- LUFT Manual
- Title 22 (California Code of Regulations)

Sample Maximum Holding Time

EPA Method	Water	Soil
413.2	28 days	-
418.1	28 days	-
602	14 days	-
624	14 days	14 days
8010	7 days*	14 days
Cal EPA TPH Draft Method	14 days	14 days
8020	7 days*	14 days
8080	7 days**	14 days
8260	14 days	14 days
8270	7 days**	14 days

* Samples must be preserved with hydrochloric acid to extend the holding time to 14 days.
** Samples must be extracted within seven days and analyzed within 40 days thereafter.

Informal Policy

The chart on the following page is a listing of common chemicals stored in USTs and corresponding test methods used to analyze soil and water for these chemicals. **The chart is a guide and is not a list of required detection tests for a given chemical. The underlined analytical method(s) are commonly required for typical projects.** Actual required methods are to be determined on a site-by-site basis and must be approved by an LOP Project Engineer.

APPENDIX D - LABORATORY REQUIREMENTS

CHEMICAL NAME	SOIL SAMPLES: Applicable Analysis Methods[1]	GROUNDWATER SAMPLES: Applicable Analysis Methods[1]
Gasoline, JP-4	CAL-EPA TPH Draft Method, 8010, 8020, CAL-EPA Draft Method for Organic Lead	CAL-EPA TPH Draft Method, 503, 624, CAL-EPA Draft Method for Organic Lead
Diesel	CAL-EPA TPH Draft Method, 418.1, 8020	CAL-EPA TPH Draft Method, 418.1, 503.1
Waste Oil[2]	CAL-EPA TPH Draft Method, 418.1, 8010, 8020, 8260	CAL-EPA TPH Draft Method, 418.1, 503.1, 524.1
No. 2 Fuel Oil, Cutting Oil (fresh), Lube Oil (fresh), Hydraulic Oil (fresh), Transmission Oil (fresh), Kerosene	CAL-EPA TPH Draft Method, 418.1, 8260	CAL-EPA TPH Draft Method, 418.1, 524.1
Cutting Oil (used), Insulating Oil (Machining/Grinding)	CAL-EPA TPH Draft Method, CAM Metals, pH, 413.2, 418.1, 6010, 8010, 8020, 8260	CAL-EPA TPH Draft Method, CAM Metals, pH, 413.2, 418.1, 6010, 624, 524.1
Oil & Grease	CAL-EPA TPH Draft Method, 413.2, 418.1	CAL-EPA TPH Draft Method, 413.2, 418.1
Non-chlorinated Solvents: Paint Thinner, Lacquer, Chevron 225, 265 Thinners (Paraffins, Xylenes, Aromatic), Unocal Thinner, Mineral Spirits, Naphtha	CAL-EPA TPH Draft Method, 8020, 8260	CAL-EPA TPH Draft Method, 503.1, 524.1
Chlorinated Solvents: TCE, PCE, TCA, Vinyl Chloride, Methylene Chloride (Dichloromethane), Freon	8010, 8260	503.1, 524.1
Chlorinated Hydrocarbons: Chloroethanes, Chloroethenes, Vinyl Chloride	8010, 8260	503.1, 524.1
Methyl Ethyl Ketone (MEK), Methyl Isobutyl Ketone (MIBK), Acetone, Amides, Alcohols	8015	8015
Naphthalene (Dyes, Glues, Inks)	CAL-EPA TPH Draft Method, 8100	CAL-EPA TPH Draft Method, 502.1
Heavy Metals (Plating Operations)[3]	CAM Metals, pH, 418.1, 6010, 8010	CAM Metals, pH, 418.1, 6010, 503.1
Wastewater (From Chemical Processing)	CAL-EPA TPH Draft Method, CAM Metals, pH, 418.1, 6010, 8010, 8020, 8260, 8270	CAL-EPA TPH Draft Method, CAM Metals, pH, 418.1, 6010, 503.1, 524.1, 625
DDD, DDT, DDE, PCB, Aldrin, Heptachlor, Epoxide, Silvex (Farming), Creosote	8080, 8270	608, 625

Note: The underlined methods above are the most commonly required

1 Methods are not all inclusive. Other methods may be applicable, depending on site assessment requirements.
2 Due to the uncertainty of waste oil contents, include applicable methods for chemicals found on-site.
3 See EPA SW 846 or Title 22 CCR for individual metal test analysis method.

APPENDIX D - LABORATORY REQUIREMENTS

Quantification Limits

The following chart presents required method detection limits for some commonly encountered chemical constituents:

CHEMICAL CONSTITUENT	SOIL (mg/kg) ppm	WATER (ug/l) ppb
Benzene	0.005	0.3
Toluene	0.005	0.3
Xylene	0.015	0.6
Ethylbenzene	0.005	0.3
TPH (gasoline)	10	500
TPH (diesel)	10	500
TPH (heavy oil)	10	1,000
Organic Lead	0.5	NA

Laboratory Results

- Analysis must be performed by a State Certified laboratory
- All laboratory data must be reported using the Los Angels Regional Water Quality Control Board's laboratory report form, as presented on the following pages

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

LABORATORY REPORT FORM FOR PETROLEUM HYDROCARBONS

Laboratory Name:________________________
Address:____________________________
Telephone:___________________________
Laboratory Certification
(ELAP) No.:_______ Expiration Date: __________
Laboratory Director's Name (Print):______________
Laboratory Director's Signature:________________
Client:_____________________________Project No.:__________________________

Analytical Method: EPA 418.1 EPA 8015 (Modified)*
(Circle One)
Other _____ ____

Date Sampled: _____ ____
Date Received: _____ ____
Date Reported: _____ ____
Sample Matrix: _____ ____

Chain of Custody Received: Yes No

Sample Condition:

-- Sample Headspace Description (%):
-- Sample Container Material:

____
____
____
____

____
*=Use California Health Department Method SCL815 (8/90)

APPENDIX D - LABORATORY REQUIREMENTS

ANALYTICAL TEST RESULT[a]

Reporting Unit (Circle One): ìg/kg ìg/l

DATE ANALYZED						
DATE EXTRACTED						
EXTRACTION METHOD						
EXTRACTION MATERIAL						
EXTRACTION DURATION (hr/min)						
DILUTION FACTOR						
LAB SAMPLE I.D.						
CLIENT SAMPLE I.D.						
PETROLEUM HYDROCARBONS		**MDL**	**MB**			
Total Petroleum Hydrocarbons (EPA 418.1)						
Gasoline (EPA 8015M)						
Jet Fuel (EPA 8015M)						
Kerosene (EPA 8015M)						
Diesel (EPA 8015M)						
Other (identified below)						
SURROGATE	**SPK CONC**	**ACP%**	**MB %RC**	**%RC**	**%RC**	**%RC**

a = Report Any Value ³ MDL.
MDL = Method Detection Limit; MB = Method Blank; ND = Not Detected (Below MDL); NA = Not Analyzed
SPK CONC = Spiking Concentration; ACP % = Acceptable Range of Percent; %RC = % Recovery

REQUIREMENTS

1. Provide details of corrective actions in any out of control events (e.g., re-calibration, blank contamination, etc.).
2. Analytical results are not to be blank adjusted.
3. Lowest concentration injected for initial calibration should not exceed three times of laboratory MDL.
4. Chemical standards for QC check samples and calibration should be obtained from different supply sources.
5. Raw data for calibration standards, quality control check samples, and selected environmental samples must be submitted upon request.

APPENDIX D - LABORATORY REQUIREMENTS

QA/QC REPORT

Reporting Unit (Circle One): mg/kg mg/l

I. Matrix Spike (MS)/Matrix Spike Duplicate (MSD)

DATE PERFORMED:___________________
BATCH #:__________________________
LAB SAMPLE I.D.:

ANALYTE	SPK CONC	MS	% MS	MSD	% MSD	RPD	ACP %MS	ACP RPD

II. Laboratory Quality Control Check Sample

DATE PERFORMED:____________________
BATCH #:___________________________
LAB SAMPLE I.D.:

ANALYTE	SPK CONC	RESULT	%RECOVERY	ACP %
				80-120
				80-120

III. Calibration Standard

3a. Submit Copies of Calibration Curves and Reference Standards

3b. Fill in Table Below If Quantification of Sample Result Is Based On Response Factor (RF)

COMPOUND	INITIAL CALIBRATION DATE:__________		DAILY CALIBRATION DATE:__________	
	INITIAL RF_{ave}	**%RSD £20%**	**DAILY RF**	**%DIFF w/RF_{ave} £±15%**

SPK CONC = Spiking Concentration; %MS = Percent Recovery of MS; %MSD = Percent Recovery of MSD
RPD = Relative Percent Difference; ACP = Acceptable Range of Percent
INITIAL RF_{ave} = Average Response Factor From Initial Calibration
DAILY RF = Response Factor From Daily Calibration
%RSD = Percent Relative Standard Deviation; %DIFF = Percent Difference

ANALYST:_____________________________ DATE:_______________

APPENDIX D - LABORATORY REQUIREMENTS

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

LABORATORY REPORT FORM FOR VOLATILE ORGANIC COMPOUNDS

Laboratory Name:________________________
Address:____________________________
Telephone:___________________________
Laboratory Certification
(ELAP) No.:_______ Expiration Date: __________
Laboratory Director's Name (Print):_______________
Laboratory Director's Signature:________________
Client:_____________________________Project No.:__________________________
Analytical Method: EPA 502.1 EPA 503.1 EPA 502.2 EPA 524.1
(Circle One) EPA 524.2
EPA 601 EPA 602 EPA 624
EPA 8010 EPA 8020 EPA 8021 EPA 8240
EPA 8260
Other ___ ___ ___ __

Date Sampled: _____ _____ _____ ____
Date Received: _____ _____ _____ ____
Date Reported: _____ _____ _____ ____

Sample Matrix: _____ _____ _____ ____
Extraction Method:_____ _____ _____ ____
Extraction Material:_____ _____ _____ ____

Chain of Custody Received: Yes No
Sample Condition:

-- Sample Headspace Description (%):
-- Sample Container Material:

____
____
____
____

APPENDIX D - LABORATORY REQUIREMENTS

ANALYTICAL TEST RESULT[a]

Reporting Unit (Circle One): ìg/kg ìg/l

DATE ANALYZED					
DATE EXTRACTED					
DILUTION FACTOR					
LAB SAMPLE I.D.					
CLIENT SAMPLE I.D.					
COMPOUND[b]	**MDL**	**MB**			
Bromobenzene					
Bromodichloromethane					
Bromoform					
Bromomethane					
Carbon tetrachloride					
Chloroethane					
Chloroform					
1-Chlorohexane					
Chloromethane					
Dibromochloromethane					
Dibromomethane					
Dichlorodifluoromethane					
1,1-Dichloroethane (1,1-DCA)					
1,2-Dichloroethane (1,2-DCA)					
1,1-Dichloroethylene (1,1-DCE)					
trans-1,2-Dichloroethylene					
Dichloromethane					
1,2-Dichloropropane					
cis-1,3-Dichloropropylene					
trans-1,3-Dichloropropylene					
1,1,1,2-Tetrachloroethane					
1,1,2,2-Tetrachloroethane					
Tetrachloroethylene (PCE)					
1,1,1-Trichloroethane (111-TCA)					
1,1,2-Trichloroethane (112-TCA)					
Trichloroethylene (TCE)					
1,2,3-Trichloropropane					
Trichlorofluoromethane					
Vinyl chloride					
Benzene					
Chlorobenzene					

1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene					
Ethyl benzene					
Toluene					

ANALYTICAL TEST RESULT (cont'd)

COMPOUND[b]	MDL	MB			
m,p-Xylenes					
o-Xylene					
Acetone					
Acrolein					
Acrylonitrile					
Bromochloromethane					
n-Butylbenzene					
sec-Butylbenzene					
tert-Butylbenzene					
2-Chloroethylvinyl ether					
2-Chlorotoluene					
4-Chlorotoluene					
Dichlorodifluoromethane					
cis-1,2-Dichloroethylene					
1,3-Dichloropropane					
2,2-Dichloropropane					
1,1-Dichloropropylene					
Ethylene dibromide (EDB)					
Hexachlorobutadiene					
Isopropylbenzene					
p-Isopropyltoluene					
Methyl Ethyl Ketone					
Methyl Isobutyl Ketone					
Naphthalene					
n-Propylbenzene					
Styrene					
1,2,3-Trichlorobenzene					
1,2,4-Trichlorobenzene					
1,2,4-Trimethylbenzene					
1,3,5-Trimethylbenzene					
1,1,2-Trichloro-trifluoroethane					

SURROGATE	SPK CONC	ACP%	MB %RC	%RC	%RC	%RC

a = Report Any Value ^{3} MDL; **b** = Listed Compounds Are Ordered by Laboratory Analytical Methods: Halogenated, Aromatic, then Remaining Compounds Identified by GC/MS.
SPK CONC = Spiking Concentration (£5 x PQL); ACP % = Acceptable Range of Percent; %RC = % Recovery
MDL = Method Detection Limit; MB = Method Blank; ND = Not Detected (Below MDL); NA = Not Analyzed

QA/QC REPORT

Reporting Unit (Circle One): ìg/kg ìg/l

I. Matrix Spike (MS)/Matrix Spike Duplicate (MSD)

DATE PERFORMED:__________
BATCH #:_____________
LAB SAMPLE I.D.:

ANALYTE	SPK CONC	MS	% MS	MSD	% MSD	RPD	ACP %MS	ACP RPD

II. Laboratory Quality Control Check Sample

DATE PERFORMED:__________
BATCH #:_____________
LAB SAMPLE I.D.:

ANALYTE	SPK CONC	RESULT	%RECOVERY	ACP %
				80-120
				80-120
				80-120
				80-120

				80-120
				80-120
				80-120
				80-120

ANALYST:____________ DATE:_________

QA/QC REPORT

III. Calibration Standard

	MOST RECENT INITIAL CALIBRATION DATE:_____	DAILY CALIBRATION DATE:_____
SUPPLY SOURCE:	________	________

COMPOUND[c]	INITIAL RF_{ave}	%RSD[d]	DAILY RF	%DIFF[e] w/RF_{ave}
Bromobenzene				
Bromochloromethane				
Bromodichloromethane				
Bromoform×				
Bromomethane				
Carbon tetrachloride				
Chloroethane				
Chloroform*				
1-Chlorohexane				
Chloromethane×				
Dibromochloromethane				
Dibromomethane				
Dichloromethane (Methylene chloride)				
1,1-Dichloroethane× (1,1-DCA)				
1,2-Dichloroethane (1,2-DCA)				
1,1-Dichloroethylene* (1,1-DCE)				
trans-1,2-Dichloroethylene				
1,2-Dichloropropane*				
cis-1,3-Dichloropropylene				
trans-1,3-Dichloropropylene				

III. Calibration Standard (cont'd)

1,1,1,2-Tetrachloroethane				
1,1,2,2-Tetrachloroethane×				
Tetrachloroethylene (PCE)				

III. Calibration Standard (cont'd)

COMPOUND[c]	INITIAL RF_{ave}	%RSD[d]	DAILY RF	%DIFF[e] w/RF_{ave}
1,1,1-Trichloroethane (1,1,1-TCA)				
1,1,2-Trichloroethane (1,1,2-TCA)				
Trichloroethylene (TCE)				
1,2,3-Trichloropropane				
Trichlorofluoromethane				
Vinyl chloride* (VC)				
Benzene				
Chlorobenzene×				
1,2-Dichlorobenzene				
1,3-Dichlorobenzene				
1,4-Dichlorobenzene				
Ethyl benzene*				
Toluene*				
m,p-Xylenes				
2o-Xylene				
Acetone				
Acrolein				
Acrylonitrile				
n-Butylbenzene				
sec-Butylbenzene				
tert-Butylbenzene				
2-Chloroethylvinyl ether				
2-Chlorotoluene				
4-Chlorotoluene				
Dichloro-difluoromethane				
cis-1,2-Dichloroethylene				
trans-1,2-Dichloroethylene				

1,3-Dichloropropane				
2,2-Dichloropropane				
1,1-Dichloropropylene				
Ethylene dibromide(EDB)				
Hexachlorobutadiene				
Isopropylbenzene				

III. Calibration Standard (cont'd)

COMPOUND[c]	INITIAL RF_{ave}	%RSD[d]	DAILY RF	%DIFF[e] w/RF_{ave}
p-Isopropyltoluene				
Methyl Ethyl Ketone				
Methyl Isobutyl Ketone				
Naphthalene				
n-Propylbenzene				
Styrene				
1,2,3-Trichlorobenzene				
1,2,4-Trichlorobenzene				
1,2,4-Trimethylbenzene				
1,3,5-Trimethylbenzene				
1,1,2-Trichloro-trifluoroethane				

SPK CONC = Spiking Concentration (£5 x PQL); PQL = Practical Quantitation Limit
%MS = Percent Recovery of MS; %MSD = Percent Recovery of MSD; RPD = Relative Percent Difference;
ACP = Acceptable Range of Percent; INITIAL RF_{ave} = Average Response Factor From Initial Calibration;
DAILY RF = Response Factor From Daily Calibration; %RSD = Percent Relative Standard Deviation;
%DIFF = Percent Difference; **c** = Listed Compounds are Ordered by Laboratory Analytical Methods: Halogenated, Aromatic, then Remaining Compounds Identified by GC/MS.
d=Value £10% for GC EPA Methods 500 & 600 Series, £20% for GC EPA Methods 8000 Series, £30% for GC/MS Methods.
e=Value £20% for GC EPA Methods 500 & 600 Series, £15% for GC EPA Methods 8000 Series, £25% for GC/MS Methods.
*****=Calibration Check Compounds (CCC) for GC/MS Method;
×=System Performance Check Compounds (SPCC) for GC/MS Method

REQUIREMENTS

1. Indicate any modification made to the EPA Methods (e.g., testing constituent list, columns).
2. Provide details of corrective actions in any out of control events (e.g., re-calibration, blank contamination, etc.).
3. Co-elution must be resolved prior to reporting, except for xylenes.
4. Second column or MS confirmation must be performed for all compounds detected.
5. Analytical results are not to be blank adjusted.
6. Chemical standards for QC check samples and calibration should be obtained from different supply sources.
7. Any change of column, detector, chemical standard, etc. shall result in a new initial calibration.
8. Lowest concentration injected for initial calibration should not exceed three times of laboratory MDL.
9. Re-calibration is required whenever the RF from daily calibration is not within the range specified in item "**e**" above from initial calibration RF_{ave}.
10. Tentative identified compounds and all unidentified peaks must be reported.
11. Chromatogram for calibration standards, quality control check samples, and selected environmental samples must be submitted upon request.

APPENDIX E - WELL CONSTRUCTION

General Requirements

- Introduction

  - Obtain permit(s) from Los Angeles County Department of Health Services
  - Include diagram of, and justification for, the well design
  - Provide well construction details, including depths and dates of drilling
  - Provide appropriate logging of boring by qualified personnel

- Casing

  - Only new, clean, "commercially" slotted screens and blanks are acceptable
  - The casing must be inert and compatible with the soil, groundwater, filter pack, and contaminants
  - Casing must be suspended and centralized, as needed, such that it is not resting against the sides nor bottom of the hole prior to fixing in place

- Filter Pack

  - Characterize the aquifer materials and justify in writing the selection of filter pack and screen slot size

    - As warranted, complete and submit a sieve/hydrometer analysis of the finest-grained aquifer material. Plot the additional curve to estimate the grain-size distribution for the proposed filter pack, and compare the resulting estimated curve with the various manufacturer's filter pack curves to determine the appropriate filter pack (less than 20% of the formation material should enter the well)

  - Filter pack shall extend a minimum of two feet above the end of the screened interval. Use an appropriate method to avoid bridging or segregation during placement of the filter pack (e.g., tremie method)
  - Surge the well to settle the filter pack and add additional material, if necessary, prior to placing the annular seal

- Sealing Conditions (annular seal and transition seal)

  - A sodium bentonite transition seal, a minimum of three feet in thickness, must be placed upon the filter pack (only potable water may be used to hydrate the bentonite)

    - The transition seal should be allowed to properly hydrate before cement-based sealing materials are placed (usually one-half to one hour)

  - Place grout of either neat cement, sand cement, or bentonite clay in an appropriate manner to avoid bridging (e.g., tremie pipe)

APPENDIX E - WELL CONSTRUCTION

- Surface Construction Features

  - Install locking cover or equivalent level of protection on the top of the well to prevent unauthorized access
  - The top of the well casing should be fitted with a cap to prevent surface water, pollutants, or contaminants from entering the well bore
  - The top of the well casing should terminate above ground surface and above known levels of flooding, unless site conditions (vehicular traffic, etc.) will not allow

    - A structurally sound, watertight vault should be installed to house the top of the well that is below ground surface

  - A concrete base or pad should be constructed around the top of the well casing at ground surface and contact the annular seal, unless the top of the casing is below ground surface

- Development

  - Well development requires surging and pumping of the well (sometimes for multiple cycles) until the water has a reading of ten NTU, or less (If ten NTUs cannot be obtained, then report a sufficient number of turbidity readings in order to establish a baseline level)

  - Prior to placing the annular seal, surge the well in order to loosen fines at the formation/filter pack interface and settle the filter pack (add additional filter material if settlement occurs)

  - Place the annular seal and allow time for the grout to set and the bentonite to hydrate before commencing further well development (a minimum of 24 to 72 hours); to avoid the 24 to 72 hour waiting period, complete development may occur prior to the installation of the annular seal and grout

  - Pump or bail the well until the NTU criterion is met (a minimum of five well volumes) in order to remove sediment from the well (multiple cycles of surging and pumping may be required to achieve proper well development)

  - Submit a well development log that includes, but is not limited to, the following:

    - Method and length of time well is surged
    - Volume of water removed (each cycle and total)
    - Date(s) of development
    - Quantitative turbidity measurements in NTU
    - Type of water used to hydrate bentonite and mix grout, and the length of time the seal is allowed to hydrate prior to placing grout

- Elevations

  Establish benchmarks relative to mean sea level and provide benchmark location. Measure water levels to 0.01 foot and provide a map of well elevations

APPENDIX E - WELL CONSTRUCTION

Monitoring Well Construction

- Wells must be designed and constructed to obtain representative groundwater samples
- The screening should extend a minimum of ten feet above and 20 feet below the water table, except when a competent clay is encountered

  - A competent clay layer is a minimum of five feet in thickness, laterally continuous, and has a permeability less than 10^{-6} cm/s (provide laboratory permeability tests, as warranted)

- Wells must be properly developed in order to obtain representative samples from the aquifer; submit a well development log as per the development requirements

Vadose Well Construction

- Wells must be designed and constructed to obtain representative vapor samples
- Specify casing and screen slot size that will maximize vapor recovery
- Nested or clustered wells may be needed where variable lithologic conditions exist and may require specific wells to be screened only within that interval (e.g., a fine-grained bed within sand)

Groundwater Extraction Well Construction

- Propose a well design that meets the objectives of the Remedial Action Plan
- Specify size of well, depth, slot size, screening interval, and filter pack
- Large diameter wells may be appropriate in high-yield aquifers
- Wells must be properly developed in order to achieve maximum flow from the aquifer; submit a well development log as per the development requirements

Groundwater Observation Well Construction

- Observation wells are constructed to record the variation in depth to the water table due to pumping or natural conditions and are usually two inches in diameter
- It is suggested that at least one observation well is located such that its radial distance from the pumping well is less than the total depth of the pumping well
- Observation wells should be constructed to the same depth as the pumping well
- Wells should be located well within the anticipated cone of depression during initial tests
- Specify size of well, depth, slot size, screening interval, and filter pack
- Wells must be properly developed in order to achieve maximum communication with the aquifer and thus provide the representative water level within the formation; submit a well development log as per the development requirements

Groundwater Well Abandonment

- Permission from the LOP Project Engineer must be obtained in writing prior to abandoning any well constructed as a part of the assessment or remedial activities at a site
- A permit must be obtained prior to abandoning any well (contact the Los Angeles County Department of Health Services, Water and Sewage Program, 2525 Corporate Place, Monterey Park, CA 91754, phone (213) 881-4147)

APPENDIX F - AQUIFER TESTS

Well Installation

- Install any additional monitoring, observation, or extraction wells as necessary
- Follow Well Construction guidelines in Appendix E

Aquifer and Soil Characteristics

- Determine transmissivity, storativity, hydraulic conductivity, velocity, cone of depression, radius of influence, porosity, degree and extent of cementation and/or fracturing, clay and organic material content, specific yield and specific retention as warranted (include site specific test data and calculations to support results)

Aquifer Tests

- General Considerations
  - Wells must be constructed and appropriate tests and analytical methods utilized based on the geologic characteristics of the site
  - Slug tests may be used for initial characterization of the aquifer
  - When remediation is proposed that requires groundwater pumping, a constant rate test is required
  - Record and submit the depth at which the pressure transducer(s) was placed (pressure transducers (piezometers) with automatic dataloggers should be used for all tests)
  - Document all computer programs used
    - Include the aquifer test method utilized by the program
    - Discuss the limitations and the input and output data requirements
    - List all assumptions/interpretations used in the analysis
  - Submit properly annotated field data and calculations, especially datalogger record (list, with references, all assumptions and interpretations used in the analysis)
- Slug Tests
  - Water must not be added to the well
  - If an inert solid slug is utilized, water levels must return to static levels prior to removal of the slug
  - Falling head measurements require specially designed monitoring wells that are not screened above the static water levels
  - Recording water recovery levels at short time intervals early in the test is essential for analysis
  - Provide all water level recovery measurements in a tabular form
  - Show all work to derive constants, effective well radius, etc.
  - The aquifer thickness should be determined to provide aquifer properties (T or K) from test results
  - A sufficient number of slug tests must be conducted to characterize conditions throughout the site

APPENDIX F - AQUIFER TEST

- Step-drawdown Tests

  - A minimum six hour test is suggested for confined or unconfined aquifers
  - A minimum of six steps each lasting one hour should be completed
  - Pumping times must remain constant for each pumping rate
  - Water levels should be allowed to recover to static levels between each step (time permitting)
  - Provide water level measurements for each step and depth of well intake
  - Discuss and justify the rates of pumping used

- Pre-Constant Rate Test Considerations

  - Observation wells should be located close enough to the pumping well for significant drawdown to occur and constructed to the same depth as the pumping well

    - All appropriate on-site and nearby wells should be used as observation wells
    - Wells with free product cannot be used as observation wells

  - A sufficient number of tests must be performed to characterize the conditions throughout the site, particularly in aquifers of variable materials/characteristics and of significant areal extent
  - All proposed pumping (extraction) wells should be pumped for several hours prior to the actual pump test in order to determine: 1) acceptable pumping rates (well yield); 2) maximum anticipated drawdown; 3) volume of water produced at various pumping rates; 4) appropriate method to measure aquifer yield and; 5) to ensure that the location of observation wells are appropriate to observe sufficient drawdown and produce useable data
  - After pumping, a minimum of 48 hours is required for water levels to return to static levels

- Constant Rate Tests

  - A minimum 12-hour test is suggested for confined aquifers
  - A minimum 24-72-hour test is suggested for unconfined aquifers
  - Tests for aquifers in which primary flow is through fractures should last in excess of 72 hours and may need to continue for a week in order for drawdown to stabilize
  - These pumping times may need to be extended until water levels approach equilibrium or are maintained for a significant time period
  - Tests terminated prematurely may result in limited data producing unreliable aquifer parameters
  - Data from early in the test (first minutes to half hour) is required for proper determination of aquifer properties
  - All wells should be utilized as observation wells for constant rate tests
  - Discuss and justify the rate of pumping used and the depth of well intake

- Pump Specification

  - Indicate pump type and provide justification for its selection

- Purged Water Disposal
  - Identify method of disposal of the pumped water (an NPDES permit from the RWQCB is required for any discharge into the storm drain system)

APPENDIX G - RISK ASSESSMENT ANALYSIS[1]

Elements of the Risk Assessment Process

The complete removal of all contamination is often not technically nor economically feasible. In these situations, it may be reasonable to determine acceptable risks to human health and the environment and cleanup contamination to meet those risk levels. Risk Assessment (RA) is one tool which may be used to determine the risk to human health from contaminants in the soil and/or groundwater. In the risk assessment process, risk characterization combines the results from exposure and toxicity assessments to produce a measure of risk.

The UST LOP and the RWQCB may allow some level of contamination to remain on-site, provided that there are minimal risks of adverse effects to public health and the environment. These adverse effects include impacts to water resources such as groundwater and surface water, wildlife habitat, recreational and commercial activities, public utilities, property values, and future land uses.

Site usage is an important factor in assessing whether or not contamination may pose a public health threat or excess health risk. Therefore, if site usage changes, particularly to residential, the UST LOP may require additional characterization of risk.

Prior to beginning the risk assessment process, a complete site assessment must be performed, as defined in the Site Assessment Reports section. The risk assessment process includes three key elements:

Exposure Assessment (including fate and transport study)

- The purpose of the exposure assessment is to identify potential receptors (e.g. people) and evaluate potential exposure routes to each receptor, such as inhalation, ingestion, or dermal absorption. The exposure assessment should measure or estimate the intensity, frequency, and duration of exposure for the receptor. This is typically accomplished by a fate and transport study which estimates and quantifies the environmental fate and transport (migration potential) of the contaminant along all potential pathways to the receptor.

Toxicity Assessment

- The purpose of the toxicity assessment is to characterize the relationship between the dose of the contaminant absorbed by an individual and the adverse consequences that might result.

  Human health risks (carcinogenic and non-carcinogenic) are, in general, considered to be acceptable if the contaminant concentrations to which humans are exposed do not exceed health-based standards. Health-based standards are determined based on the contaminant type and exposure route. They include Applied Action Levels (AALs), Maximum Contaminant Levels (MCLs), and Reference Doses (RfDs). Health-based standards for carcinogens can be calculated from EPA cancer potency slope factors, such as those in the EPA's Integrated Risk Information System (IRIS).

Risk Characterization

- The purpose of the characterization is to produce measures of risk resulting from exposure to toxic contaminants. This is completed by integrating the results of the exposure and toxicity assessments.

[1] County of Los Angeles, Department of Public Works, UST Local Oversight Program, "Guidelines for Report Submittals," June 1993

Exposure X Toxicity = Risk

[1]*Site Assessment and Mitigation Manual, Environmental Health Services, County of San Diego, 1993*

County of Los Angeles, Department of Public Works, UST Local Oversight Program, "Guidelines for Report Submittals," June 1993

APPENDIX G - RISK ASSESSMENT ANALYSIS

In cases where the assessment of a chemical's toxicity has resulted in an established, accepted, and health-based standard or other standard, a characterization of risk may be quickly determined. In these cases, risk characterization is simply the comparison of the estimated exposure to the accepted health-based or other standard. If the exposure exceeds the accepted standard, then an unacceptable excess risk may exist.

Approaches to Risk Assessment

The UST LOP suggests that any risk assessment performed adhere to the format presented in the U.S. EPA's document entitled RISK ASSESSMENT GUIDANCE FOR SUPERFUND, Volume I, HUMAN HEALTH EVALUATION MANUAL, PART A, Interim Final, December 1989, EPA/540/1-89/002. CAL-EPA risk assessment personnel have recommended the use of this document as the basic reference for risk assessment preparation. The LOP strongly recommends contacting the Project Engineer prior to initiating a risk assessment.

The complexity (and expense) of the risk assessment will vary considerably depending on the site conditions, the type and extent of contamination, and the proposed site use. In an effort to conserve resources, risk assessments can be done in a phased approach. Available site data, simple calculations, and conservative assumptions can be used initially. If the risk is not acceptable, additional site-specific data, more complex calculations/models, and less conservative/more realistic assumptions should be used to characterize the risk. In order to provide a more realistic characterization of risk, some sites require the collection of additional site-specific data; however, other sites require the collection of site specific data that is too difficult or costly to obtain. Contaminant removal or treatment may be the best alternative in such cases.

The UST LOP suggests the use of simple calculations/models as a first phase, initial exposure assessment. The use of conservative assumptions in these calculations/models should produce results which are considered "worst case." More sophisticated fate and transport models can be used, but should conform to the fate and transport procedures in these Guidelines.

Risk Management

The risk assessment must contain an objective and technically defensible conclusion. The risk assessment must include a discussion of the strengths and weaknesses of the assessment by describing uncertainties, explicitly stating assumptions and limitations, as well as providing the scientific basis and rationale for each assumption. Model validation must be discussed. Conclusions regarding the potential risk to human health and/or the environment must be based on current Federal, State, and County guidelines (e.g., EPA Risk Assessment Guidance for Superfund, December 1989, EPA.540/1-89/002).

The UST LOP requires that a risk management decision be made if a potential, unacceptable excess risk to a receptor exists. Examples of some risk management decisions are:

- Removal and/or treatment of contaminants
- Creation of barriers to block migration or exposure pathways
- Other engineering controls to reduce or prevent exposure

APPENDIX G - RISK ASSESSMENT ANALYSIS

Fate and Transport

Fate and Transport models are designed to provide a method to objectively estimate the effects of natural processes on the stability and the distribution of contaminants in the environment. The interaction between natural processes are very complex. This means that fate and transport models must include many simplifying assumptions. Therefore, the output from models are treated as "estimates" rather than absolute "answers" from the regulatory viewpoint. The reliability of the "estimate" is directly linked to the appropriateness of the simplifying assumptions and the ability of the model to adequately simulate conditions at the site.

Fate and Transport modeling may be appropriate for several aspects of the Remedial Action process including:

- Demonstrating that existing contamination does not pose a threat to the public health and safety or environmental receptors (e.g., groundwater).
- Demonstrating that residual contamination, which remains after partial remediation of a site has been completed, does not pose a threat to public health and safety or environmental receptors.
- Assessing the impacts from residual contamination to nearby surface water and groundwater resources as part of a Remedial Action Plan.

Prior to initiating a fate and transport study, the Responsible Party must obtain concurrence from the UST LOP Project Engineer concerning the acceptability of the objectives of the study. The Responsible Party and their consultant must demonstrate to the LOP UST's satisfaction that the chosen model(s) can simulate the conditions of the site adequately to justify the conclusions drawn from the model(s).

Fate and Transport Models

This section presents guidance for posing and performing a fate and transport modeling analysis to assess the mobility and migration potential of contaminants in the subsurface. Due to the complexity of contaminant migration, computer simulations (models) are commonly used to estimate contaminant fate and transport. There are many different models available, therefore, the user must have a thorough knowledge of the model's limitations and assumptions and ensure that the model fits the conditions of the site being modeled.

SITE ASSESSMENTS FOR FATE AND TRANSPORT

In order to formulate a conceptual model and begin the fate and transport modeling process, a complete site assessment must be performed. A complete site assessment, for the purposes of fate and transport modeling, includes the following:

- **Chemical Properties of Contaminants**

  Determination of the types, concentrations, and chemical properties of the individual contaminants and contaminant mixtures present at the site. Chemical properties required for input into fate and transport models include, but are not limited to, aqueous solubility, organic carbon partition coefficient (Koc), effective diffusion coefficient, soil-water distribution coefficient (Kd), vapor pressure, and Henry's Law Constant.

- **Contaminant Volume**

  Delineation of the vertical and horizontal extent of soil and groundwater contamination along with an estimate of the mass and volume of the contaminant and contaminated matrix

- **Site Geology and Hydrogeology**

  See Site Assessment Plans and Site Assessment Reports sections, as well as appropriate Appendices.

- **Model Input Parameters**

  Sensitive model input parameters, as determined by a sensitivity analysis, must be site-specific. It is recommended that this data be collected during the site assessment phase (while the drill rig is on-site and samples are being collected for site assessment purposes), so that site-specific model input parameters are available for fate and transport modeling later. Samples collected for this purpose may be held and analyzed when the data is needed, as long as sample holding times are not exceeded. The site-specific data required for input into fate and transport models may include, but is not limited to, the following, depending on the model used:

  - soil bulk density, soil particle density, and soil moisture content
  - soil natural organic matter and organic carbon content
  - soil porosity, soil suction, matrix potential, capillary suction
  - unsaturated and saturated hydraulic conductivity and transmissivity
  - pH, redox potential, soil cation and anion exchange capacity
  - laboratory grain-particle size analysis of soil types to corroborate subjective soil classification performed in the field
  - stratigraphic sequence and spatial distribution of geologic materials (soil and rocks)
  - identification and analysis of fractures and faults in the subsurface, including analysis of fracture orientation and density at the site
  - site topography and ground surface conditions
  - depth to ground water and historic or current (tidal) water level fluctuation, locations of recharge and discharge areas, and groundwater flow directions and gradients
  - distance to receptors (for example, human, environmental, surface waters, groundwater, adjacent properties, etc.)
  - annual climatic variables (for example, annual rainfall, rainfall intensity, storm frequency, evapotranspiration, etc.)

  All physical and chemical analyses must be performed in accordance with documented and approved test methods (EPA, ASTM, CA-EPA, etc.). Analyses for chemical compounds must be performed by a California Department of Toxic Substances Control (DTSC) certified laboratory.

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Interaction with the UST LOP

Prior to the initiation of fate and transport modeling, justification for selecting this option must be discussed with the UST LOP Project Engineer. This justification must include an explanation of why contaminant removal or treatment is not feasible at the site. The UST LOP reserves the right to decide whether a site is a legitimate candidate for the fate and transport modeling option. When it has been determined that the fate and transport modeling option is acceptable, appropriate models must be selected. Use well documented and scientifically peer reviewed models that are available in the public domain.

A written workplan describing the model selection process and rationale must be submitted to the UST LOP for review. The Project Engineer will review the written workplan for fate and transport modeling. Comments and inquiries will be made to the Responsible Party and consultant of the workplan as necessary. In some cases, a meeting or presentation may be required. The UST LOP will provide a written response to the workplan. The workplan should discuss the following items concerning site conditions and the rationale for model selection:

- **Purpose and Scope of the Fate and Transport Modeling Analysis**

  Discuss the reasons for using fate and transport modeling at the site instead of removing or treating the contamination.

- **Statement of Qualification**

  Include relevant education and experience of persons performing the fate and transport modeling. Document previous Risk Assessments completed and approved by regulatory agencies, include relevant case histories.

- **Summary of Site Assessment Data**

  Include information on past, present, and future site uses and adjacent property uses.

- **Conceptual Model**

  Include a presentation of contaminant distribution in the context of site geology and in relation to receptors. Prepare plot plans and cross-sections based on data gathered during site assessment.

- **Model Selection Criteria**

  - List the objectives of the fate and transport analysis. Discuss whether the proposed models, given the site conditions, will accomplish the stated objectives.
  - Describe the concepts and calculations utilized by the models. The models must accurately simulate significant mass transport, partitioning, and transformation processes. Identify specific processes (e.g., biodegradation, gaseous diffusion, volatilization, advection, sorption, etc.) which the model is expected to simulate. A justification for the inclusion or exclusion of the various fate and transport processes must be given. If the model is a computer program, provide an explanation of the algorithms used in the computer code.

- Summarize the strengths, weaknesses, assumptions, and uncertainties of the fate and transport models. Identify the most sensitive model input parameters and describe how variations in these sensitive input parameters are likely to affect model results.

- **Data Requirements for Fate and Transport Modeling**

  Discuss the site-specific input parameters to be used in the models. Discuss the availability of such data from the site and describe any biases in the data which may be attributed to methods of collection or analysis. Discuss, justify, and document the source of all assumed values used for model input parameters. Reasonable extrapolations of site-specific data are preferred to generic data from published literature sources. Sensitive model input parameters must be site-specific.

  Commonly, fate and transport modeling is performed on one or more indicator compounds. Indicator compounds have specific chemical and physical properties which are used as model input parameters. Document the range of values found in the literature for physical and chemical properties of indicator compounds.

  Discuss the rationale for selecting the specific values used in the models. Correct the values that vary with temperature and pressure to the conditions found at the site being modeled. Ensure that the input parameters are used in the correct units. Make appropriate conversions as necessary and present all conversion factors.

- **Model Validation**

  Describe the methods (analytical, physical, experimental, etc.) that may be used to validate the results of the fate and transport model. If the model has been validated under similar conditions at another site, provide references and briefly outline the results. Discuss the applicability of the validation techniques used at another site to the site of concern.

Subsurface to Surface Vapor Phase Migration

This section includes a general discussion of a risk assessment (RA) for estimating the vapor phase migration of contaminants from subsurface contaminated soil or groundwater to the ground surface. The RA for contaminant vapor migration to the surface involves calculating the airborne contaminant concentration at the receptor and comparing it to health-based standards.

- **AIRBORNE CONTAMINANT CONCENTRATION AT THE RECEPTOR**

  Estimate the subsurface migration of vapor-phase contaminants by diffusive and/or advective processes and calculate the airborne contaminant concentration at the receptor. There are a variety of mathematical formulas and models that can be used. In a "worst-case" estimation, the following assumptions are used:

  Conservative Assumptions

  - The highest contaminant concentration detected is assumed to be at the shallowest depth at which contamination has been detected on the site

- Conservative data from referenced scientific literature can initially be used for soil properties (porosity, bulk density, organic carbon content, and moisture content) and contaminant properties (Henry's Law Constant and octanol-water partition coefficient)

- Soil is homogenous and isotropic (vapors obey the simple laws of diffusion, however, advective processes must be considered where applicable)

- Barriers to vapor migration, such as concrete slabs, asphalt, plastic vapor barriers, are not considered

- Engineering controls designed to reduce vapor migration, such as subsurface venting, are not considered

- Contaminant removal processes, such as biodegradation, chemical oxidation, or hydrolysis, are not considered

- If the contamination lies below undeveloped land, air modeling can be used to estimate downwind airborne contaminant concentrations (conservative values for wind speed and direction must be used)

- If the contamination presently lies beneath buildings or will lie beneath proposed buildings, the air volume of the building and ventilation rate (air exchange rate) are used to estimate airborne contaminant concentration within the building

Less-Conservative Assumptions

If the conservative RA fails, the following assumptions, which represent more site-specific and realistic data, may be used:

- A more complete site assessment may allow for more accurate estimates of concentration and geometry of contamination
- Soil and contaminant properties can be measured to provide more realistic input parameters
- Actual soil gas sampling or surface air sampling (using flux chambers) can be designed to determine airborne contaminant concentrations at the site (placement of the samplers, sampling frequency and duration, and data interpretation must be justified)
- Barriers to vapor migration may reduce contaminant concentrations at the receptor, however, data would be required to substantiate permanence and effectiveness of the barriers
- Engineering controls designed to reduce vapor migration would require data to substantiate their effectiveness
- Contaminant removal processes may be considered if the site conditions are conducive to these processes and data has shown that these processes are occurring at a stated rate (if these processes produce harmful intermediates, then these intermediates must also be assessed)
- Actual wind speed and direction measurements can be made to provide more realistic input to the air modeling

- Actual airborne contaminant concentrations inside the building can be measured, however, placement of the samplers, sampling frequency and duration, and data interpretation must be justified (it may not be possible, however, to differentiate airborne contaminants from subsurface contamination sources and ambient airborne contaminants from other sources)

• **COMPARISON TO HEALTH BASED STANDARDS**

Compare the calculated airborne contaminant concentration at the receptor to the appropriate health-based standards. If the airborne contaminant concentration exceeds the standard for any contaminant or the sum of all contaminants, then a potential unacceptable risk to a biological receptor may exist.

Fate and Transport Report

The fate and transport report submitted to the UST LOP must be complete and self-contained. Data obtained from other site assessment reports should be clearly presented and referenced. Include maps, plot plans, and cross-sections that clearly illustrate site conditions (surface and subsurface), contaminant distribution, and predicted future migration and distribution of contaminants in relation to receptors. Include copies of all model calibration runs and sensitivity analyses in the appendix.

Fate and transport modeling involves a great deal of interpretation concerning subsurface processes affecting contaminant migration and transformation. Interpretations of geologic and hydrogeologic data are required to be completed by a registered professional in the field of geology (RG/CEG) or civil engineering (RCE).

• **Modeling Analysis**

- Technical problems encountered and any new information concerning site conditions which resulted from the modeling analysis

- Model input parameters (e.g., hydraulic conductivity) used to calibrate the model should be within the range of measured site-specific values

- Methods used to validate the model at the site

- The conclusions of fate and transport modeling should include a synopsis of the important results with reference to the limitations and assumptions of the model used (include an assessment of how well the modeling achieved the desired objectives)

- The consultant and/or responsible party should discuss the case status, additional work required, and recommend a future course of action at the site

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Fate and Transport Check List

The following outline may be used to summarize the results of a fate and transport analysis. The intent is to provide a common format to facilitate the review of fate and transport/exposure assessment studies. Not all categories may be applicable to a particular site. The calculations generally refer to those performed for the indicator compound with the main exceptions being the calculations completed to estimate baseline hydrologic and meteorologic conditions.

- **Overview**

  - State why a Fate and Transport and/or Risk Assessment is being done instead of removing or treating the contamination
  - Setting and historical uses of the site
  - Estimated volume of contaminated soil and/or groundwater on-site and distribution of contaminants onsite
  - Contaminants of concern
  - Potential interaction of contaminants (e.g., cosolvency effects, synergistic or antagonistic effects)
  - Indicator compound(s) to be used for calculation
  - Rationale for selection of indicator compound(s)
  - Predominant mass transport mechanism(s)/pathway(s)
  - Selection criteria for predominant mass transport mechanism(s)/pathway(s)
  - Attenuation mechanisms simulated in the model(s) and rationale for calculations
  - Potential for biological and/or chemical transformation of contaminants
  - Potential onsite receptors (human, environmental)
  - Potential offsite receptors (human, environmental)
  - Health-based standards/maximum contaminant levels to be met and environmentally based standards to be met
  - Conceptual model of the site conditions (e.g., geological and hydrogeological characteristics, identification of preferential pathways of contaminant migration, identification of barriers to contaminant migration, etc.)
  - Model sensitivity and analysis of input parameters
  - Model calibration to site-specific conditions
  - Model validation

- **Calculation Parameters**

  - Contaminant source characterization

    - Source type and history
    - Chemical identification/fingerprint of contaminant
    - Contaminant concentration and extent
    - Basic chemical properties of each contaminant
    - Selection of indicator compounds and tabulation of chemical specific transport parameters (e.g., water solubility, vapor pressure, Henry's Law constant, molecular weight, octanol/water coefficient, organic carbon partition coefficient)

APPENDIX G - RISK ASSESSMENT ANALYSIS

- **Environmental pathway parameters**

  - Air/climate
    - General meteorological conditions (e.g., wind speed and prevailing direction, relative atmosphere stability, etc.)
    - Volatile/semi-volatile transport (e.g., temperature, relative humidity, potential for mixing, etc.)
    - Non-volatile/particulate transport (e.g., particle size distribution, potential for air-borne transport, etc.)
    - Surface water/runoff
    - Description of occurrence and frequency of runoff events
    - Description of site and regional topography
    - Connection/relationship of the site to the drainage systems, surface water bodies (streams, lakes, lagoons, etc.) and potential for surface water impacts

  - Soil/vadose zone
    - Stratigraphy (layers, depths, etc.)
    - Physical parameters (e.g., porosity, permeability, grain size distribution, soil/rock classification, hydraulic conductivity, matrix potential, bulk density, particle density, etc.)
    - Chemical parameters (e.g., cation exchange capacity, percent organic carbon, total carbon, etc.)
    - Soil moisture balance parameters (e.g., soil moisture by volume, soil moisture capacity, evapotranspiration rate, groundwater recharge rate, etc.)

  - Groundwater
    - Depth to ground water, groundwater flow direction and gradient
    - Aquifer description(s)/background water quality and usage
    - Hydraulic parameters (e.g., hydraulic conductivity, transmissivity, recharge, discharge, heterogeneities, etc.)
    - Contaminant transport parameters (e.g., effective permeability, total organic carbon content, Fickian diffusion coefficients, etc.)

  - Calculated Contaminant Release Rates Versus Receptor Location
    - Type of calculations performed and temporal variations considered
    - Calculation validation and calibration of model(s) to site specific conditions
    - On-site and off-site contaminant transport rates (not all may apply)

      - Air (gaseous, particulate)
      - Surface water/runoff (soluble, particulate)
      - Soil/vadose zone (soluble, non-aqueous phase liquids)
      - Ground water (soluble, non-aqueous phase liquids)

  - Assignment of Risk Factors/Health-Based Standards
    - Summary of factors/standards applicable to the site
    - Basis for selection of factors/standards

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- Site-Specific Impacts Versus Risk Factors/Health Based Standards

    - Expected site use and off-site activities
    - Site use with/without improvements
    - Engineered mitigation measures

- Supporting Information for Fate and Transport Models

    - Identification of most sensitive input parameters used in the Fate and Transport model(s)
    - Documentation of model calibration for site specific conditions
    - Literature references to peer-reviewed journal articles documenting model development, simplifying assumptions, limitations and use of the model at other sites

APPENDIX G - RISK ASSESSMENT ANALYSIS

Definitions

- **Model Calibration**
  The process of adjusting model input parameters, within ranges appropriate to site conditions to correlate model outputs to observed conditions at the site. The parameters are varied until an acceptable fit of the model output is achieved, which adds a degree of empiricism.

- **Model Sensitivity Analysis**
  A method of evaluating the effects of different model input parameters, or combinations of input parameters, on the model output solution so that the most sensitive input parameters can be identified. Sensitive model input parameters must be site specific.

- **Model Validation**
  A comparison of model output results to other data for the purpose of validating model predictions. Other data may include laboratory experiments (microcosm studies), field measurements and monitoring (lysimeters, wells, etc.), or data from other models, for example, a comparison of numerical model results to analytical model results.

- **Model Verification**
  A check of the model computer code for mathematical accuracy. The user must test various model components for internal consistency of results (mass balance, boundary fluxes, units, etc).

- **Conceptual Model**
  A qualitative description of the characteristics and dynamics of the geologic-hydrogeologic-contaminant system at the site. This description includes characterization of contaminant chemistry and characterization of the matrix in which the contaminant occurs or upon which the contaminant is adsorbed. Contaminant concentration and distribution in relation to receptors is required.

- **Mathematical Model**
  Translation of the conceptual model into the form of mathematical equations (analytical and numerical models) that represent the relevant site or system processes. Field data should be used whenever possible to verify that the underlying physical and chemical phenomena are correctly described by the model.

- **Indicator Compounds**
  Complex chemical mixtures, such as petroleum hydrocarbons, are composed of many different individual chemical compounds. These chemical compounds partition into multiple phases (liquid, vapor, adsorbed, and dissolved) based on specific chemical properties. This partitioning causes some chemical compounds in the mixture to migrate faster than others, thus the soil acts as a "chromatographic column." Indicator compounds are individual chemical compounds chosen for fate and transport modeling because of their relatively high migration potential and toxicity. For example, benzene is often used as an indicator compound for modeling gasoline migration due to its relatively high mobility and carcinogenicity.

REFERENCES

RCRA Groundwater Monitoring Technical Enforcement Guidance Document, September 1986, U.S. Government Printing Office; 1987 O-172-437

California Underground Storage Tank Regulations, California Code of Regulations Title 23 Chapter 16, January 1992

Leaking Underground Fuel Tank Field Manual, Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure, October 1989

California Well Standards, Bulletin 74-90, California Department of Water Resources, June 1991

Professional Engineers Act, California Code of Regulations; Title 16, Chapter 5, Sections 400-471, amended January 1992

Registered Geologist Act, California Code of Regulations: Title 16, Chapter 29, Amended 1991

Site Assessment and Mitigation (SA/M) Manual, Environmental Health Services, Hazardous Materials Management Division, County of San Diego, 1993

ASTM Standards on Groundwater and Vadose Zone Investigations, ASTM Committee D-18 on Soil and Rock, 1992

Groundwater and Vadose Zone Monitoring, ASTM STP 1053, David M. Nielsen and A. Ivan Johnson, American Society for Testing and Materials 1990

A Technology Assessment of Soil Vapor Extraction and Air Sparging, EPA Office of Research and Development, 600/R-92/173, September 1992

Groundwater and Wells, Fletcher G. Driscoll, Johnson Filtration Systems, Inc. 1986

Analysis and Evaluation of Pumping Test Data, G. P. Kruseman and N. A. deRidder, International Institute for Land Reclamation and Improvement, 1990

Practical Handbook of Groundwater Monitoring, David A. Nielsen, Editor, Lewis Publishers, 1991

Air Sparging - Extending Volatilization to Contaminated Aquifers, Richard A. Brown and Ricardo Fraxedes, Symposium on Soil Venting, Robert S. Kerr, Environmental Research Laboratory.

GLOSSARY

Aquifer - An underground water-bearing (saturated) geological formation that is capable of yielding water to a well or spring.

Aquiclude - An underground geological formation that is relatively impermeable to or impedes the movement of water (i.e., a barrier horizon or confining clay layer).

Aquitard - An underground geological formation of low permeability. A water-bearing formation of low yield.

Barrier horizon - A relatively impermeable layer (fat clay) of significant thickness and areal extent.

Bentonite grout - An aluminum silicate clay which, when a small amount of magnesium oxide is added, swells and forms a viscous suspension when mixed with water. Dried, it forms a hard cement-like material.

Bore volume - volume of water in a well based on the diameter of the auger used to install the well, generally eight or eleven inches.

Boring (Bore) - A hole created by a drilling device.

BTXE - Benzene; Toluene; Xylene; Ethylbenzene; primary compounds of concern in fuel products.

CAL-EPA - The California Environmental Protection Agency, formerly known as the State Department of Health Services.

Capillary fringe - The area that is between the saturated zone and the unsaturated (vadose) zone, where water is held by surface tension. The zone may be only one-half inch thick in gravels, but up to 40 feet thick in clays.

Casing - Stainless steel or plastic (PVC) tubing placed in a boring.

Chain-of-custody - Tracks samples from the point of collection to delivery at the laboratory. All persons that have physical custody of the samples shall sign and date acceptance and/or relinquishment. Samples are invalidated by an improper or broken chain-of-custody.

Cone of depression - Depression of water levels around a pumping well caused by withdrawal.

Confining bed - See barrier horizon.

Consultant - Any California licensed engineer or geologist who is involved in the assessment or cleanup of an underground tank leak. The consultant is hired by the Responsible Party.

Contamination - Any hazardous material which has not naturally occurred.

Dissolved product - The water soluble components of hydrocarbon or other chemicals.

EPA - The Federal Environmental Protection Agency.

Fracture - A break in a geological formation.

GLOSSARY

Free product - Liquid hydrocarbons or other chemical that accumulate on top of groundwater (capillary fringe).

Grab sample - Soil sample obtained without a coring device. Frequently used during tank removals.

Groundwater - Water beneath ground surface.

Head space - The air space at the top of a water or soil sample.

Hydraulic conductivity - The capacity of rock or soil to transmit water, expressed as the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

Hydraulic gradient - The inclination of the groundwater surface measured as the degree of deviation from horizontal in unconfined aquifers, which may be highly variable. Change in head per unit distance measured in the direction of the steepest change in confined and unconfined aquifers.

Hydrocarbon - Any compound which contains only atoms of carbon and hydrogen, e.g., benzene or toluene.

Hydrogeology - The study of the physical earth properties that control the distribution and occurrence of subsurface fluids and gases and the medium in which they occur.

Hydropunch - A water sampling tool that is forced to a depth of about five to 10 feet below the water table in order to retrieve a water sample through a one-way valve.

Industrial Hygienist - A qualified person who is responsible for: recognition of hazards, identification of controls, calibration of equipment, interpretation of standards, collection of samples, and preparation of Health and Safety Plans.

Isocon lines - lines of equal contaminant concentrations.

LACDOHS - Los Angeles County Department of Health Services.

LACDPW - Los Angeles County Department of Public Works.

LDI - Leak Detection Investigation - Part of the LDP to determine if contamination exists.

LDP - Leak Detection Program.

Leaching - Percolation of liquid or gases through soil or other materials.

LEL - Lower explosive limit.

Lithology - The study of the composition and texture of sediment or rock.
Local Oversight Program (LOP) - Unit established in the Los Angeles County Department of Public Works, Waste Management Division, in charge of overseeing cleanup of leaking UST.

GLOSSARY

LUFT - Leaking underground fuel tanks.

LUFT Manual - A State of California field manual to provide practical guidance to regulatory agencies with regard to the cleanup of contamination from underground tanks.

Manifest (soil, rinseate) - Documents hazardous material hauled away to a landfill or other disposal facility with generating, hauling and receiving facility operator's signature.

Maximum Contaminant Level (MCL) - The recommended maximum acceptable limits of contamination for drinking water, established by the California Environmental Protection Agency, Department of Toxic Substances Control Board.

ND - Non-detect.

NTU - Nephelometric Turbidity Unit.

NPDES - National Pollutant Discharge Elimination System.

OSHA - Occupational Safety and Health Administration.

OVA - Organic Vapor Analyzer, gives a preliminary indication of the presence of certain volatile contaminants.

Percolate - The movement of liquid through openings (interconnected voids) within soil, sediment, or the fractures in a rock.

Perforated casing - Well casings with holes or slots permitting the passage of fluids or vapors.

pH - A designation for the degree of acidity or alkalinity of any material.

Piezometer - A well with a short, slotted screen (one to five feet) for measuring a potentiometric surface or elevation of the water table.

Plume - A mass of contamination extending outward from a source.

Post remedial monitoring - work performed after cleanup completion.

ppb - Part per billion, ug/kg, ug/L.

ppm - Part per million, mg/kg, mg/L.

Project Engineer - An LOP engineer in charge of overseeing the cleanup process.

QA/QC - quality assurance and quality control.

GLOSSARY

Radius of influence - The horizontal distance from the center of a well to the outer limit of the cone of depression or to the limit of effective vacuum pressure.

Recharge area - The area where replenishment of an aquifer occurs by a natural process, such as rainfall, lakes, or streams, or by an artificial system such as a spreading ground, leaky pipe, or injection well.

Regional Board (RWQCB) - Los Angeles or Lahontan Regional Water Quality Control Board.

Remedial action - Activities taken to correct a problem such as fuel contamination of soil or groundwater.

Responsible Party - Operator of the underground storage tanks and/or owner or agent of the owner of the property responsible for the underground tank release.

Risk analysis - Relating residual contaminants with their long-term effect on groundwater quality and potential hazard to human life.

Saturated zone - A subsurface zone in which all the pore space or interstitial spaces in the zone are filled with water under pressure equal to or greater than atmospheric pressure.

SCAQMD - South Coast Air Quality Management District.

Site assessment - Activities taken to determine the extent of contamination and the physical properties of the soil and water in which it occurs.

State Board - California Water Resources Control Board.

Stratigraphy - The arrangement of sediment in layers or strata.

Subsurface contamination - Any type of contamination located below the ground surface.

Threshold limit - A chemical concentration above which adverse health or environmental effects may occur.

TPH - Total petroleum hydrocarbon.

Transition seal - A layer of sodium bentonite placed above the filter pack and below the annular seal in a monitoring well in order to prevent contamination from entering the filter pack.

Transmissivity - The transmission rate of water (based on a unit width of an aquifer) relative to hydraulic gradient and the saturated thickness of an aquifer.

Underground Storage Tank (UST) - Any containment device and associated piping made of non-earthen material which is situated partially or substantially below ground.

Unique site feature - Natural or man-made physical characteristic of the site which could influence the movement and direction of contaminants through the subsurface.

Vadose zone (unsaturated zone) - A zone that is not saturated by groundwater, but may have high moisture content and local areas of saturation (perched zones).

VOC - Volatile organic compound.

Well development - Surging and pumping water out of a well to remove drilling debris or sediment.

Well purging - Removing water to bring representative groundwater into the casing during sample collection activities.

Well volume - volume of water in a well based on the diameter of the well casing

REGULATORY ADDRESSES

California Environmental Protection Agency,
Department of Toxic Substances Control Board
Alternative Technology & Policy Development Section
714 P Street
Sacramento, CA 95814
(916) 324-1807

California Environmental Protection Agency,
Department of Toxic Substances Control Board
Procedures and Regulations Development Section
714 P Street
Sacramento, CA 95814
(916) 322-2337

California Environmental Protection Agency,
Department of Toxic Substances Control Board
Los Angeles Office (Region 3)
Toxic Substances Control Division
1405 North San Fernando Boulevard
Burbank, CA 91504
(818) 567-3000

California Regional Water Quality Control Board
Los Angeles Region 4
101 Centre Plaza Drive
Monterey Park, CA 91754-2156
(213) 266-7500

Los Angeles County Fire Department
Health/Hazardous Materials Division
5825 Rickenbacker Road
Commerce, CA 90040
(213) 890-4045
(213) 890-4317 (Emergency only)

Los Angeles County Department of Public Works
Waste Management Division

California Environmental Protection Agency,
Department of Toxic Substances Control Board
Office of Public Information and Participation
714 P Street
Sacramento, CA 95814
(916) 324-1789

California Environmental Protection Agency,
Department of Toxic Substances Control Board
Toxic Substances Control Division
714 P Street
Sacramento, CA 95814
(916) 324-1826

California Environmental Protection Agency,
Department of Toxic Substances Control Board
Long Beach Office (Region 4)
Toxic Substances Control Division
245 West Broadway, Suite 350
Long Beach, CA 90802
(310) 590-4882

California Regional Water Quality Control Board
Lahontan Region 6
15428 Civic Drive, Suite 100
Victorville, CA 92392
(619) 241-6583

Los Angeles County Department of Health Services
Water & Sewage Program (well permits)
2525 Corporate Place
Monterey Park, CA 91754
(213) 881-4147

South Coast Air Quality Management District
21865 Copely Drive

UST Local Oversight Program, Annex Building
900 South Fremont Avenue
Alhambra, CA 91803
(818) 458-3979

<u>State Water Resources Control Board</u>
Underground Storage Tank Program
Division of Loans and Grants
P.O. Box 944212
Sacramento, CA 94244-2120
(916) 739-4345

Diamond Bar, CA 91765
(909) 396-2000

County of Los Angeles, Department of Public Works, UST Local Oversight Program, "Guidelines for Report Submittals," June 1993