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93 NOV -8 PM 2:42

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TRANSMITTAL

TO: Ms. Juliett Shin
Alameda County Health Agency
Division of Hazardous Materials
80 Swan Way, Suite 200
Oakland, California 94621

DATE: November 5, 1993
PROJECT NUMBER: 170077.06
SUBJECT: Draft - Exxon Station 7-0104, Alameda, California

FROM: Mr. Dave Higgins
TITLE: Client Manager

WE ARE SENDING YOU:

COPIES	DATED	NO.	DESCRIPTION
1	11/04/93	170077.06	Work Plan for the Installation of Air-Sparging Wells and Performance of Air-Sparging Tests at the above subject site.

THESE ARE TRANSMITTED as checked below:

[ ] For review and comment
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REMARKS:

Copies: 1 to RESNA project file no. 170077.06

Client Manager Dave Higgins

EXXON COMPANY, U.S.A.
P.O. BOX 4032 • CONCORD, CA 94524-2032
MARKETING DEPARTMENT

FUEL PRODUCTS•BUSINESS SERVICES
ENVIRONMENTAL ENGINEERING
MARLA D. GUENSLER
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ALCO
HAZMAT
93 NOV 24 PM 12: 16

November 23, 1993

Nov 1993

Ms. Juliet Shin
Alameda County Environmental Health Department
Hazardous Materials Division
80 Swan Way, Suite 200
Oakland, California 94621

RE: EXXON RAS #7-0104, 1725 PARK STREET, ALAMEDA, CALIFORNIA

Dear Ms. Shin:

Attached for your review and comment is a report entitled Work Plan For Installation Of Air-Sparge Wells And Performance of Air-Sparging Tests for the above referenced site. This Work Plan details the methods which will be used to complete the installation of sparging wells and any performance of sparging tests which are proposed to be completed at the site in the near future.

This work is proposed for the purpose of providing data to determine whether or not air-sparging will be added to the existing groundwater remediation system located at the site to increase its efficiencies and to enhance the vapor extraction currently occurring there.

If you have additional questions or comments or require additional information, please contact me at the above referenced phone number.

Sincerely,

FOR Marla D. Guensler
Senior Environmental Engineer

MDG/pdp

enclosures: RESNA Work Plan dated November 4, 1993

cc: w/enclosures
Mr. Richard Hiett-San Francisco Bay Regional WQCB

w/o enclosures
Mr. Marc Briggs-RESNA, San Jose

0032

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WORK PLAN
for the
INSTALLATION of AIR-SPARGE WELLS
and PERFORMANCE of AIR-SPARGING TESTS
at
Exxon Station 7-0104
1725 Park Street
Alameda, California

170077.06

Prepared by
RESNA Industries Inc.

Prepared for
Exxon Company, U.S.A.
P.O. Box 4032
2300 Clayton Road
Concord, California 94520

November 4, 1993

RESNA
Working To Restore Nature

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November 4, 1993
0920MGUE
170077.06

Ms. Marla D. Guensler
Exxon Company, U.S.A.
P.O. Box 4032
2300 Clayton Road
Concord, California 94524

Subject: Work Plan for the Installation of Air-Sparging Wells and Performance of Air-Sparging Tests at Exxon Station 7-0104, 1725 Park Street, Alameda, California.

Ms. Guensler:

As requested by Exxon Company U.S.A. (Exxon), RESNA Industries Inc. (RESNA) has prepared this Work Plan for the Installation of Air-Sparging Wells and Performance of Air-Sparging Tests for review and approval by the California Regional Water Quality Control Board (CRWQCB), and the Alameda County Health Agency (ACHA). This work plan summarizes work previously performed by Harding Lawson Associates (HLA) and RESNA, and describes the project steps proposed to install air-sparge wells and perform air-sparge tests. This work will be performed according to guidelines stated in Exxon's "Phase II Environmental Investigation Scope of Work - Amendments Specific to California" and the CRWQCB Tri-Regional Guidelines (CRWQCB, August 10, 1990).

This proposed work includes: drilling four soil borings (B-11 through B-14); collecting and describing soil samples from two of the borings (B-11 and B-13); installing one 2-inch inner-diameter air-sparge well (SW-1) in boring B-11, one 2-inch inner-diameter sparge monitoring point (SM-1) in boring B-13, and two 2-inch inner-diameter vapor wells (VW-1 and VW-2) in borings B-12 and B-14; surveying the wellhead elevations; developing the new sparge wells (SW-1 and SM-1); performing a one-day air-sparging test; performing a one-day combination sparge/vapor extraction test (VET); submitting selected soil and groundwater samples for laboratory analysis; and preparing a report summarizing the methods, results, and conclusions of the investigation.

SITE DESCRIPTION

General

The site is located in a mainly commercial area, with scattered residential properties. The site location is shown on Plate 1, Site Vicinity Map. The locations of the existing gasoline underground storage tanks (USTs), pump islands, and other pertinent onsite features are shown on the Proposed Boring/Well locations (Plate 2). The site is at an elevation of approximately 17 feet above mean sea level.

Wells SW-1, SM-1, VW-1, and VW-2 will be installed in the northern portion of the site to facilitate performance of the air sparging test. This portion of the site appears amenable for sparge testing due to 1) relatively high concentrations of dissolved total petroleum hydrocarbons as gasoline (TPHg) in groundwater, 2) an absence of separate phase TPHg product, 3) relatively low concentrations of residual TPHg in vadose zone soil, and 4) relatively low TPHg vapor concentrations in vadose zone soil. Existing well MW-4 will be used as a crossgradient monitoring point, proposed well VW-1 will be used as the first downgradient monitoring point and existing MW-7 will be used as a second downgradient monitoring point.

PREVIOUS WORK

In 1988, HLA performed an initial environmental investigation that included drilling six borings (designated as MW-1 through MW-6), installing groundwater monitoring wells MW-1 through MW-6 in the borings, and analyzing soil and groundwater samples (HLA, 1989). In 1990, HLA drilled seven shallow soil borings and one deep boring, constructed one groundwater monitoring well onsite, installed five groundwater extraction wells, and conducted a series of aquifer slug tests (HLA, 1990). In September 1992, HLA performed an offsite groundwater survey (HLA, October 30, 1992). In October 1992, HLA performed a VET (HLA, December 28, 1992). In December 1992, HLA began construction of a groundwater removal and treatment system at the site. HLA began operation of the system in March 1993. RESNA assumed supervision of the system in March 1993 . HLA began groundwater monitoring at the site in June 1988: monitoring has been conducted by RESNA since January 1993. The results of these investigations are presented in the reports listed in the References section.

PROPOSED WORK

RESNA proposes performing Steps 1 through 4, listed below, to evaluate interim groundwater remediation alternatives beneath the subject site. Field work involved with the following project steps will be performed in accordance with RESNA's Field Protocol included in Appendix A, and a site specific safety plan.

The proposed scope of work includes the following tasks:

Step 1: After acquiring the proper Alameda County Water District Well Construction Permit, drill and collect soil samples from borings B-11 and B-13. Because vapor extraction wells VW-1 and VW-2 (borings B-12 and B-14) will be located immediately adjacent to borings B-11 and B-13, respectively, the soil stratigraphy, and the presence of gasoline hydrocarbons will be similar in the paired borings. As a result, in borings B-12 and B-14, soil samples will not collected or field screened. Soil samples from the borings will be submitted for laboratory analysis for the gasoline constituents benzene, toluene, ethylbenzene, and total xylenes (BTEX) using modified Environmental Protection Agency (EPA) Methods 5030/8020, and total petroleum hydrocarbons as gasoline (TPHg) using modified EPA Methods 5030/8015. Borings B-11 and B-13 will be drilled to a maximum depth of approximately 17 feet below the ground surface (approximately 10 feet below first encountered groundwater, which is anticipated to be at a depth of approximately 7 feet, based on previous site data). Borings B-12 and B-14 will be drilled to a maximum depth of approximately 6 feet below the ground surface (approximately 1 foot above first encountered groundwater). Soil samples collected from the borings during drilling will be subjectively analyzed in the field by a RESNA geologist for the presence of gasoline hydrocarbons, using visual observations and an organic vapor meter (OVM). Selected soil samples collected from each boring will be delivered with chain of custody records to an Exxon approved state-certified contract laboratory. Subsequent to well installation, the well locations and elevations will be surveyed relative to mean sea level by a licensed surveyor. The wells will then be developed using surge and bail, and pumping techniques until the water removed from the well is relatively free of sediments.

Air-sparge well SW-1 will be constructed in boring B-11 to a depth of approximately 17 feet below the groundwater surface, and will be constructed using 2-inch diameter PVC pipe with 0.020 slot for the bottom 2.5 feet. The well will be used to conduct a sparge test on the aquifer. Sparge monitoring point SM-1 will be constructed in boring B-13 to a depth of approximately 17 feet below the groundwater surface, and will be constructed using 2-inch diameter PVC pipe with 0.050 slot for the bottom 2.5 feet. The well will be used to collect pre-test and post-test water samples for analyses and to measure water levels. Vapor wells VW-1 and VW-2 will be constructed in borings B-12 and B-14, respectively, to a depth of approximately 1 foot above groundwater, and will be constructed using 2-inch PVC pipe with 0.020 slot (VW-1) and 0.050 slot (VW-2) for the bottom 2.5 feet. The vapor wells will measure soil gas pressure and collect soil gas samples for analyses.

Step 2: Perform a one-day air-sparge test to evaluate the feasibility of air-sparging as a groundwater remedial alternative. Data from the air-sparge test will be used to evaluate the optimal sparge air-flow rate necessary to perform a combined air-sparge/vapor extraction test, and the air-sparge capture zone associated with the selected air-flow rate.

Prior to performing the air-sparge test, static water levels and ambient soil gas pressures will be monitored in the air-sparge well, sparge monitoring point, and vapor wells. Groundwater and soil gas samples will also be collected from the air-sparge well, sparge monitoring point, and vapor wells to obtain baseline data.

Using an air compressor, air-sparging will be initiated at a flow rate of approximately 10 cubic feet per minute (cfm). Soil gas pressure at the air-sparge well, sparge monitoring point, and the vapor wells will be recorded periodically throughout the test. Air and/or water samples will be collected from the air-sparge well, sparge monitoring point, and the vapor wells during and after the test. The test procedure will then be repeated at a higher (approximately 15 to 20 cfm) air-sparge flow rate.

Additionally, a one-day combined air-sparge vapor extraction test will be performed. The vapor extraction test will be performed using an internal combustion (IC) engine while the air-sparge test is performed using an air compressor. Data collection during the combined tests will be similar to the air-sparging test and will include the collection of influent soil gas air samples to the I.C. engine and induced soil gas pressure (either positive or negative) readings at the air-sparge well, sparge monitoring point, and the vapor wells to evaluate sparge off-gas capture. The combined air-sparge vapor extraction test will demonstrate if vapor extraction is capable of capturing the air-sparge off-gas that is transmitted to the vadose zone.

Air and groundwater samples collected during the test will be submitted with chain of custody records to a State certified laboratory and analyzed for BTEX and TPHg using modified EPA Methods 5030/8020/8015.

Step 3: Prepare a report including results of the well installation, the air-sparge test, the combined air-sparge vapor extraction test, interpretations and conclusions.

Step 4: RESNA will arrange for proper disposal of the soil cuttings and purge water.

SCHEDULE OF OPERATIONS

A preliminary time schedule to perform steps 1 through 4 is shown on Plate 3, Preliminary Time Schedule. This time schedule is an estimate in weeks and is subject to change should circumstances dictate. Exxon and the appropriate regulatory agencies will be informed should there be delays and the Preliminary Time Schedule cannot be met. Initiation of this investigation is dependent on gaining regulatory approval of this Work Plan and incorporation of any changes requested by regulatory agencies. **RESNA has tentatively scheduled to begin work at the site on November 10, 1993.**

PROJECT STAFF

Mr. James L. Nelson, Certified Engineering Geologist in the State of California, will be in overall charge of hydrogeologic facets, and Mr. Jerry Wilski will be in overall charge of engineering facets of this project. Mr. Dave Higgins, Client Manager, will provide supervision of field and office operations of the project. Mr. Marc A. Briggs, Project Manager, will be responsible for the day-to-day field and office operations of the project. RESNA employs a staff of geologists, engineers, and technicians who will assist with the project.

If you have any questions or comments regarding this work plan, please call (408) 264-7723.

Sincerely,
RESNA Industries Inc.

Marc A. Briggs for
Project Manager

REGISTERED GEOLOGIST
JAMES LEWIS NELSON
No. 1463
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

James L. Nelson
Certified Engineering
Geologist No. 1463

Enclosures: References

Plate 1: Site Vicinity Map
Plate 2: Proposed Boring/Well Locations
Plate 3: Preliminary Time Schedule

Appendix A: Field Protocol

REFERENCES

California Regional Water Quality Control Board, San Francisco Bay Region. August 10, 1990. Tri-Regional Board Staff Recommendations for Preliminary Evaluation and Investigation of Underground Tank Sites.

Department of Health Services, State of California, October 24, 1990. Summary of California Drinking Water Standards.

Exxon Company, U.S.A. June 1991. Phase II Environmental Investigation Scope of Work - Amendments Specific to California.

Harding Lawson Associates. March 21, 1989. Phase II Evaluation of Petroleum Hydrocarbons, Exxon Station #7-0104, 41725 Park Street, Alameda, California.

Harding Lawson Associates. May 1, 1990. Phase III Evaluation of Petroleum Hydrocarbons, Exxon Station #7-0104, 41725 Park Street, Alameda, California.

Harding Lawson Associates. October 21, 1992. Groundwater Monitoring Results, Exxon Station #7-0104, 41725 Park Street, Alameda, California.

Harding Lawson Associates. October 30, 1992. Offsite Groundwater Survey, Exxon Station #7-0104, 41725 Park Street, Alameda, California.

Harding Lawson Associates. December 28, 1992. Pilot Soil Vapor Extraction Test, Exxon Station #7-0104, 41725 Park Street, Alameda, California.

RESNA Industries Inc. April 14, 1993. Groundwater Monitoring Report, Exxon Station 7-0104, 41725 Park Street, Alameda, California 170077.01

RESNA Industries Inc. June 30, 1993. Groundwater Monitoring Status Report, Exxon Station 7-0104, 41725 Park Street, Alameda, California 170077.01

United States Geological Survey, 1980. Oakland-East, California. 7.5-Minute Topographic Quadrangle Map.

Source: U.S. Geological Survey
7.5–Minute Quadrangles
San Jose West, San Jose East, California
Photorevised 1980

N

Approximate Scale

2000 1000 0 2000

feet

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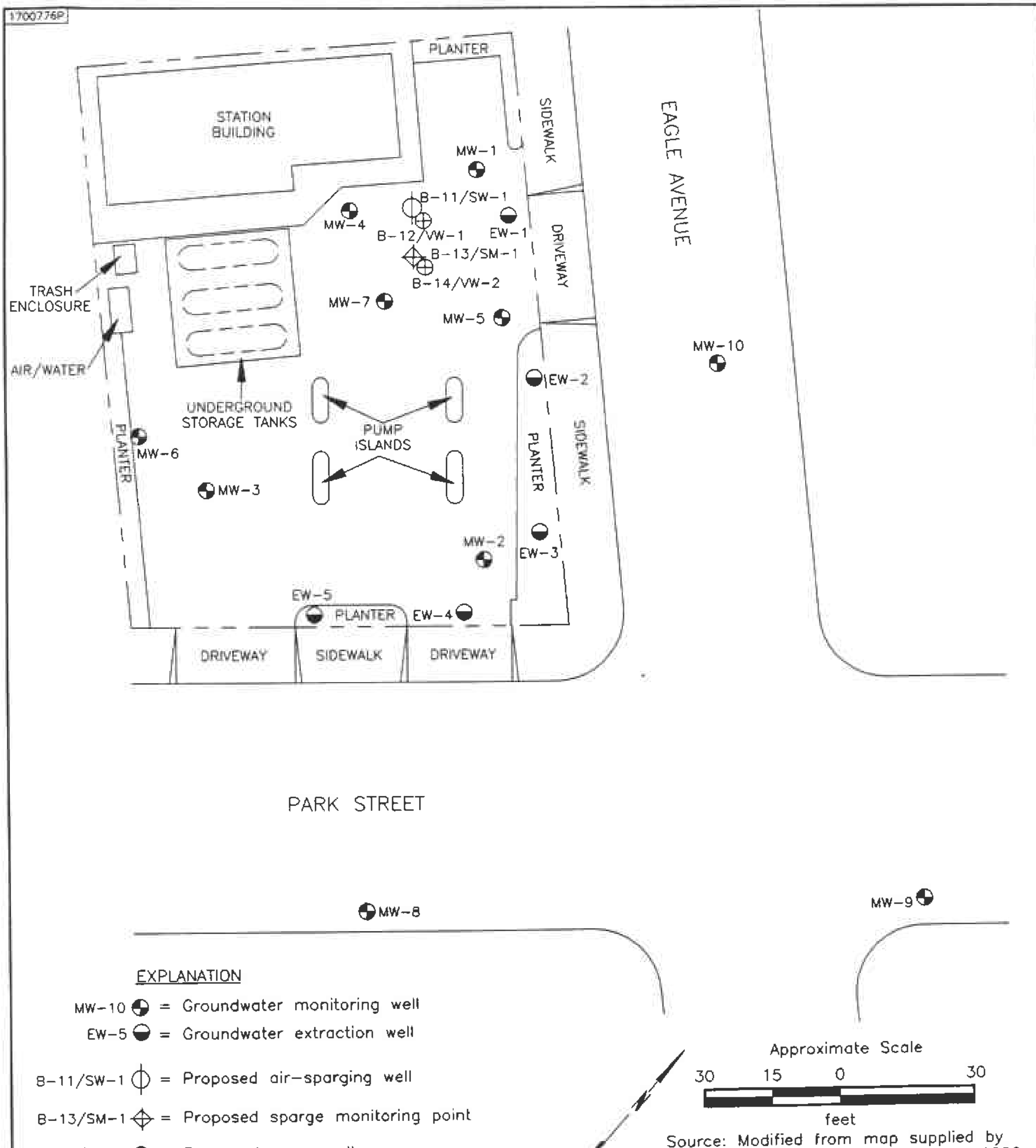
PROJECT 170077.06

SITE VICINITY MAP
Exxon Service Station 7-0104
1725 Park Street
Alameda, California

PLATE

1



EXPLANATION

MW-10 = Groundwater monitoring well

EW-5 = Groundwater extraction well

B-11/SW-1 = Proposed air-sparging well

B-13/SM-1 = Proposed sparge monitoring point

B-14/VW-2 = Proposed vapor well

Source: Modified from map supplied by Harding Lawson Associates, 1992; survey by Ron Archer, Civil Engineer, Inc., 1993

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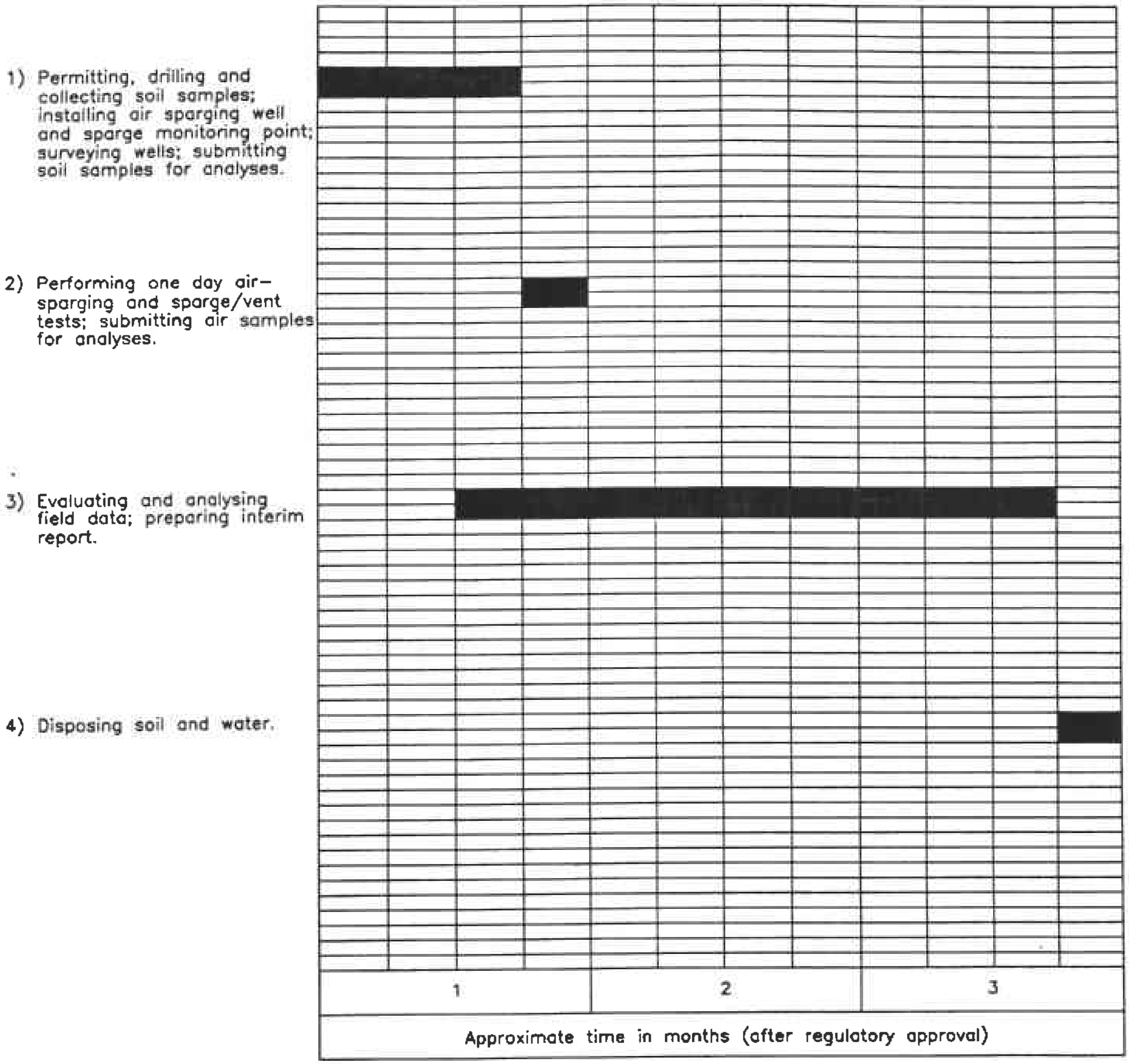
PROPOSED BORING/WELL LOCATIONS
Exxon Service Station 7-0104
1725 Park Street
Alameda, California

PLATE 2



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PROJECT 170077.06

PRELIMINARY TIME SCHEDULE
Exxon Station 7-0104
1725 Park Street
Alameda, California

PLATE 3

APPENDIX A

FIELD PROTOCOL

FIELD PROTOCOL

The following presents RESNA Industries' field protocol for a typical site investigation involving gasoline hydrocarbon-impacted soil and/or groundwater.

Site Safety Plan

The Site Safety Plan describes the safety requirements for the evaluation of gasoline hydrocarbons in soil, groundwater, and the vadose-zone at the site. The site Safety Plan is applicable to personnel of RESNA Industries and its subcontractors. RESNA Industries personnel and subcontractors of RESNA Industries scheduled to perform the work at the site are briefed on the contents of the Site Safety Plan before work begins. A copy of the Site Safety Plan is available for reference by appropriate parties during the work. A site Safety Officer is assigned to the project.

Soil Borings

Prior to the drilling of borings and construction of monitoring wells, permits are acquired from the appropriate regulatory agency. In addition to the above-mentioned permits, encroachment permits from the City or State are acquired if drilling of borings offsite on City or State property is necessary. Copies of the permits are included in the appendix of the project report. Prior to drilling, Underground Service Alert (USA) is notified of our intent to drill, and known underground utility lines and structures are approximately marked.

The borings are drilled by a truck-mounted drill rig equipped with 8- or 10-inch-diameter, solid-stem or hollow-stem augers. Other methods such as rotary or casing hammer may be used if special conditions are encountered. The augers, sampling equipment and other equipment that comes into contact with the soil are steam-cleaned prior to drilling each boring to minimize the possibility of cross-contamination. Sampling equipment is cleaned with a trisodium phosphate solution and rinsed with clean water between samples. After drilling the borings, monitoring wells are constructed in the borings, or neat-cement grout with bentonite is used to backfill the borings to the ground surface.

Borings for groundwater monitoring wells are drilled to a depth of no more than 20 feet below the depth at which a saturated zone is first encountered, or a short distance into a stratum beneath the saturated zone which is of sufficient texture, moisture, and consistency to be judged as a perching layer by the field geologist, whichever is shallower. Drilling into a deeper aquifer below the shallowest aquifer is begun only after a conductor casing is properly installed and allowed to set, to seal the shallow aquifer.

Drill Cuttings

Drill cuttings subjectively evaluated as containing gasoline hydrocarbons at levels greater than 100 parts per million (ppm) are separated from those subjectively evaluated as containing gasoline hydrocarbons at levels less than 100 ppm. Evaluation is based either on subjective evidence of soil discoloration, or on measurements made using a field calibrated OVM. Readings are taken by placing a soil sample into a ziplock-type plastic bag and allowing volatilization to occur. The intake probe of the OVM is then inserted into the headspace created in the plastic bag immediately after opening it. The drill cuttings from the borings are placed in labeled 55-gallon drums approved by the Department of Transportation, or on plastic at the site, and covered with plastic. The cuttings remain the responsibility of the client.

Soil Sampling in Borings

Soil samples are collected at no greater than 5-foot intervals from the ground surface to the total depth of the borings. The soil samples are collected by advancing the boring to a point immediately above the sampling depth, and then driving a California-modified, split-spoon sampler containing brass sleeves through the hollow center of the auger into the soil. (A standard penetrometer, which does not contain liners, may be used to collect samples when laboratory analysis for volatile components is not an issue. The sampler and brass sleeves are laboratory-cleaned, steam-cleaned, or washed thoroughly with Alconox® and water, prior to each use. The sampler is driven with a standard 140-pound hammer repeatedly dropped 30 inches. The number of blows to drive the sampler each successive six inches are counted and recorded to evaluate the relative consistency of the soil. When necessary, the sampler may be pushed by the drill rig hydraulics. In this case, the pressure exerted (in pounds per square inch) is recorded.

The samples selected for laboratory analysis are removed from the sampler and quickly sealed in their brass sleeves with aluminum foil, plastic caps, and plastic zip-lock bags or aluminized duct tape. The samples are then labeled, promptly placed in iced storage, and delivered to a laboratory certified by the State of California to perform the analyses requested.

One of the samples in brass sleeves not selected for laboratory analysis at each sampling interval is tested in the field using an OVM that is field calibrated at the beginning of each day it is used. This testing is performed by inserting the intake probe of the OVM into the headspace in the plastic bag containing the soil sample as described in the Drill Cuttings section above. The OVM readings are presented in Logs of Borings included in the project report.

Logging of Borings

A geologist is present to log the soil cuttings and samples using the Unified Soil Classification System. Samples not selected for chemical analysis, and the soil in the sampler shoe, are extruded in the field for inspection. Logs include texture, color, moisture, plasticity, consistency, blow counts, and any other characteristics noted. Logs also include subjective evidence for the presence of gasoline hydrocarbons, such as soil staining, noticeable or obvious product odor, and OVM readings.

Sampling of Stockpiled Soil

One composite soil sample is collected for each 50 cubic yards of stockpiled soil, and for each individual stockpile composed of less than 50 cubic yards. Composite soil samples are obtained by first evaluating relatively high, average, and low areas of hydrocarbon concentration by digging approximately one to two feet into the stockpile and placing the intake probe of a field calibrated OVM against the surface of the soil; and then collecting one sample from the "high" reading area, and three samples from the "average" areas. Samples are collected by removing the top one to two feet of soil, then driving laboratory-cleaned brass sleeves into the soil. The samples are sealed in the sleeves using aluminum foil, plastic caps, and plastic zip-lock bags or aluminized duct tape; labeled; and promptly placed in iced storage for transport to the laboratory, where compositing is performed.

Monitoring Well Construction

2Monitoring wells are constructed in selected borings using clean 2- or 4-inch-diameter, thread-jointed, Schedule 40 polyvinyl chloride (PVC) casing. No chemical cements, glues, or solvents are used in well construction. Each casing bottom is sealed with a threaded end-plug, and each casing top with a locking plug. The screened portions of the wells are constructed of machine-slotted PVC casing with 0.020-inch-wide (typical) slots for initial site wells. Slot size for subsequent wells may be based on sieve analysis and/or well development data. The screened sections in groundwater monitoring wells are placed to allow monitoring during seasonal fluctuations of groundwater levels.

The annular space of each well is backfilled with No. 2 by 12 sand or similar sorted sand (groundwater monitoring wells), or pea gravel (vapor extraction wells) to approximately two feet above the top of the screened casing for initial site wells. The sand pack grain size for subsequent wells may be based on sieve analysis and/or well development data. A 1- to 2-

foot-thick bentonite plug is placed above the sand as a seal against cement entering the filter pack. The remaining annulus is then backfilled with a slurry of water, neat cement, and bentonite to approximately one foot below the ground surface.

An aluminum utility box with a PVC apron is placed over each wellhead and set in concrete placed flush with the surrounding ground surface. Each wellhead cover has a seal to protect the monitoring well against surface-water infiltration and requires a special wrench to open. The design discourages vandalism and reduces the possibility of accidental disturbance of the well.

Groundwater Monitoring Well Development

The monitoring wells are developed by bailing or over-pumping and surge-block techniques. The wells are either bailed or pumped, allowed to recharge, and bailed or pumped again until the water removed from the wells is determined to be clear. Turbidity measurements (in NTUs) are recorded during well development and are used in evaluating well development. The development method used, initial turbidity measurement, volume of water removed, final turbidity measurement, and other pertinent field data and observations are recorded. The wells are allowed to equilibrate for at least 48 hours after development prior to sampling. Water generated by well development is stored in 17E Department of Transportation (DOT) 55-gallon drums on site, and remains the responsibility of the client.

Groundwater Sampling

The static water level in each well is measured to the nearest 0.01-foot using a Solinst® electric water-level sounder or oil/water interface probe (if the wells contain floating product) cleaned with Alconox® and water before use in each well. The depth of each well is also measured. The liquid in the wells is examined for visual evidence of gasoline hydrocarbons by gently lowering approximately half the length of a Teflon® bailer (cleaned with Alconox® and water) past the air-/water interface. The sample is then retrieved and inspected for floating product, sheen, emulsion, color, sediment, and clarity. Obvious product odor is recorded if noted. If floating product is present in the well, the thickness of floating product is measured using an oil/water interface probe and is recorded to the nearest 0.01 foot. Floating product is removed from wells on site visits.

Groundwater samples from the wells are collected in approximate order of increasing product concentration, as best known or estimated. Wells which do not contain floating product are purged using a submersible pump. Equipment which comes in contact with the interior of the well or the groundwater is cleaned with Alconox® and deionized or distilled water prior to use in each well. The wells are purged until withdrawal is of sufficient duration to result in stabilized pH, temperature, and electrical conductivity of the water. These parameters are measured to the nearest 0.1 pH unit, 0.1 degree F, and 10 umhos/cm, respectively, using portable meters calibrated daily to a buffer and conductivity standard, according to the manufacturer's specifications. A minimum of four well volumes is purged from each well. If the well becomes dewatered, the water level is allowed to recover to at least 80 percent of the initial water level. When recovery of the water level has not reached at least 80 percent of the static water level after two hours, a groundwater sample will be collected when sufficient volume is available to fill the sample container. Prior to the collection of each groundwater sample, the Teflon® bailer is cleaned with Alconox® and rinsed with tap water and deionized water, and the latex gloves worn by the sampler changed. Hydrochloric acid is added to the sample vials as a preservative (when applicable). Sample containers remain sealed until usage at the site. A sample method blank is collected by pouring distilled water into the bailer and then into sample vials. Method blanks are analyzed periodically to verify effective cleaning procedures. A sample of the formation water is then collected from the surface of the water in each of the wells using the Teflon® bailer. The water samples are then gently poured into laboratory-cleaned, 40-milliliter (ml) glass vials, 500 ml plastic bottles or 1-liter glass bottles (as required for specific laboratory analysis), sealed with Teflon®-lined caps, and inspected for air bubbles to check for headspace, which would allow volatilization to occur. If a bubble is evident, the cap is removed, more sample is added, and the bottle resealed. The samples are then labeled and promptly placed in iced storage, and the wellhead is secured. A field log documenting sampling procedures and parameter monitoring is maintained. Water generated by the purging of wells is stored in 17E DOT 55-gallon drums, and floating product bailed from the wells is stored in double containment onsite; this water and product remains the responsibility of the client.

Air-Sparge Testing

Air-sparging involves the injection of air below the water table surface so that dissolved hydrocarbons and adsorbed hydrocarbons are stripped from the groundwater and saturated soils and moved upward into the vadose zone. Vapors transmitted to the vadose zone are captured by applying a vacuum to the vapor extraction wells. The capture zone of an air-sparging well and the number of air-sparging wells necessary to provide site coverage is highly influenced by the permeability of the sediments below and above the groundwater surface. A field air-sparging test is necessary to evaluate a site specific capture zone for air-sparging, the number of air-sparging wells required to provide site coverage, optimal air-sparge flow rates and hydrocarbon removal rates.

The air-sparging well(s) typically consist of a 2-inch-diameter polyvinyl chloride (PVC) pipes with 0.020 inch, machine slotted PVC screen. The slotted sections of the pipes are limited to the bottom 2.5 feet of the pipe. The 2-inch diameter PVC pipe is installed to the bottom of the aquifer that is to be air-sparged. Sparge monitoring points typically consist of existing groundwater monitoring wells (4-inch Schedule 40 PVC pipe with 0.020 inch slots) that are screened at least 5 feet into the groundwater table, and existing vapor-extraction wells (4-inch Schedule 40 PVC pipe with 0.020 inch) that are screened above the water table. The groundwater monitoring wells are used to evaluate changes in water levels and dissolved hydrocarbon and oxygen concentrations during sparging and the vapor extraction wells are used to measure changes in soil-gas pressure and soil-gas hydrocarbon concentrations as a result of air-sparging.

To obtain baseline data, prior to performing the air-sparge test, static water levels and ambient soil-gas pressures are recorded from the air-sparging well(s), and vapor and groundwater monitoring wells. Other base-line data collected prior to the start of the air-sparging test include: soil-gas hydrocarbon concentrations in all vapor monitoring wells based on analytical results of air samples collected from these wells using an air sampling pump; and initial dissolved hydrocarbon and dissolved oxygen (DO) concentrations based on analytical results of water samples collected from all air-sparging and groundwater monitoring wells. Air and groundwater samples are analyzed for BTEX and TPHg in a laboratory while dissolved oxygen is measured using a field DO meter.

Using an oil-less air compressor, air-sparging is initiated at an air flow rate of 10 to 15 cubic feet per minute (cfm) into the air-sparging well. The test procedure is repeated applying at least two air-sparge flow rates to each air-sparge well. Tests are run for two hours at each flow rate. The results from the air-sparging test are used to evaluate optimum air-sparge flow rates that will be used during the combined air-sparging and vapor-extraction test and to evaluate the air-sparge capture zone associated with the selected air-sparging flow rate for each air-sparging well. To evaluate the radius of influence (capture zone) of the air-sparging well, soil-gas pressure at the air-sparge well and the vapor monitoring wells is recorded periodically (typically every half hour) throughout the 2-hour test on each well using magnehelic gauges.

Depth to water levels (DTW) are measured in the air-sparging well and groundwater monitoring wells during each test (every half hour) to evaluate changes in water levels as a result of air-sparging. Water samples are collected from the air-sparge well and groundwater monitoring wells after one and a half hours of operation at each air-sparging flow rate. These water samples are analyzed for BTEX and TPHg and dissolved oxygen (DO) to evaluate changes that may occur as a result of air-sparging. Air samples are also collected from the vapor monitoring points typically after one-half hour of operation at each air-sparging flow rate. Air samples collected are analyzed for BTEX and TPHg to evaluate any changes in soil-gas hydrocarbon concentrations as a result of air-sparging. Soil-gas concentrations in the vapor-monitoring wells before and during the air-sparging tests are also measured using a field organic-vapor measuring instrument, such as a PID or a flame-ionization detector (FID). Air and groundwater samples collected during the test are submitted with Chain of Custody Records to a State certified laboratory and analyzed for BTEX and TPHg using EPA Methods 5030/8020/8015.

Combined Air-Sparging and Vapor-Extraction Test

The combined air-sparging and vapor-extraction test is conducted to evaluate whether vapor extraction is capable of capturing the air-sparge off-gas that is transmitted from the aquifer to the vadose zone as a result of air-sparging. The combined test is conducted using an internal combustion (I.C.) engine and/or a vacuum blower with activated carbon to generate the necessary vapor-extraction air flow rates from the vapor extraction well(s) and abate extracted vapor. An oil-less air compressor is used to sparge the aquifer by introducing air into the air-sparge well (s) at the optimum air-sparge flow rates measured during the air-sparging-only tests. The combined test is conducted for a period of four hours on each vapor-extraction well. To create a vacuum zone that extends beyond the radius of influence of the air-sparge well, a vacuum is applied on the vapor extraction well closest to the air-sparge well to generate a vapor-extraction flow rate of at least two times the optimal air-sparge flow rate.

To obtain baseline data prior to performing the combined test, DTW levels and DO concentrations are measured and recorded using a water-level indicator and a DO meter in the air-sparge well(s) and groundwater monitoring wells. Initially, only the vapor-extraction well is and induced vacuum readings at the extraction well and at the vapor monitoring points are be recorded. Soil-gas samples from vapor-extraction and the vapor monitoring wells are collected for BTEX and TPHg to evaluate extracted hydrocarbon vapor concentrations prior to the start of sparging. Soil-gas concentrations are also be monitored using an FID or a PID. Sparging is then initiated in an air-sparge well located close to the vapor-extraction well using the optimum air-sparge flow rate measured during the air-sparging-only test for a period of four hours. The following measurements are recorded every half hour during the combined test; induced soil-gas pressure/vacuum readings in vapor-monitoring wells using magnehelic gauges, and DTW levels in air-sparging well(s) and groundwater monitoring wells. Air and water samples, as described in the air-sparging-only test, are collected after three hours of operation from air-sparging well(s), vapor-extraction well(s), vapor monitoring wells and groundwater monitoring wells and evaluated for changes in BTEX, TPHg, and DO concentrations as a result of air-sparging and vapor-extraction.

Data collected from the combined air-sparging and vapor-extraction test will be used to evaluate the following: the number of air-sparge and vapor-extraction wells necessary to affect areas of concern at the site; the optimum sparge and vapor-extraction flow rates necessary for vapor-extraction to effectively capture the air-sparge off-gas and limit offsite migration of dissolved hydrocarbons; the changes in extracted hydrocarbon vapor concentrations observed as a result of air-sparging; estimated initial hydrocarbon removal rates; and the sizes and types of blower and air compressors and vapor abatement devices necessary to extract and abate extracted hydrocarbon vapors.

Vadose-Zone Monitoring and Vapor Well Purging

Vapor readings are made with a field-calibrated OVM, which has a lower detection limit of 0.1 ppm. After the OVM is turned on, it is allowed sufficient warm-up time for stabilization. Prior to purging each vadose-zone monitoring well, a well cap with a hose barb drilled and tapped into the well cap is secured to the well. The inlet of the vacuum pump is connected to the hose barb with tubing. OVM readings are taken from the exhaust port of the vacuum pump as the well is purged. Each well is purged for approximately 2 to 5 minutes or until about five well volumes of air have been removed. Ambient readings of the air at the site are taken with the OVM after each well is purged.

Air Sampling

The vacuum pump is first purged with ambient air. Vadose-zone monitoring is then performed as described above. A new Tedlar sample bag is then placed on the outlet port of the vacuum pump with the valve closed. The valve is then opened to allow filling of the bag with an air sample. The valve is closed when the sample bag is 3/4-full (to allow for expansion of gas due to temperature changes), and the bag is removed. The sample pump is purged with ambient air after each sample is taken. A field log documenting sampling procedures is maintained. The samples are transported to the laboratory without exposure to sunlight or cooling, for analysis with 72-hour turnaround.

Sample Labeling and Handling

Sample containers are labeled in the field with the job number, unique sample location, depth, and date, and promptly placed in iced storage for transport to the laboratory. A Chain of Custody Record is initiated by the field geologist and updated throughout handling of the samples, and accompanies the samples to a laboratory certified by the State of

California for the analyses requested. Samples are transported to the laboratory promptly to help ensure that recommended sample holding times are not exceeded. Samples are properly disposed of after their useful life has expired.

Quality Assurance/Quality Control

The sampling and analysis procedures employed by RESNA for groundwater sampling and monitoring follow regulatory guidance for quality assurance/quality control (QA/QC). Quality control is maintained by site-specific field protocols and quality control checks performed by the laboratory. Laboratory and field handling of samples may be monitored by including QC samples for analysis. QC samples may include any combination of the following. The number and types of QC samples are selected and analyzed on a project-specific basis.

Trip blanks - Trip blanks are sent to the project site, and travel with project site samples. They are not opened, and are returned from a project site with the samples for analysis.

Field blank - Prepared in the field using organic-free water. Field blanks accompany project site samples to the laboratory and are analyzed periodically for specific chemical compounds present at the project site where they were prepared.

Duplicates - Duplicate samples are collected from a selected well and project site. They are analyzed at two different laboratories, or at the same laboratory under different labels.

Equipment blank - Periodic QC samples are collected from field equipment rinsate to verify adequate cleaning procedures.