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NASA - Jet Propulsion Laboratory

SUPERFUND PROJECT

City of Pasadena

January 30, 1999

Presented by: Charles L. Buril, P.E.

00317

WHAT IS SUPERFUND?

- ESTABLISHED BY CONGRESS IN 1980
- OFFICIALLY KNOWN AS THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA)
- REAUTHORIZED IN 1986 BY THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA)
- ALLOWS THE FEDERAL GOVERNMENT TO RESPOND DIRECTLY TO RELEASES, OR THREATENED RELEASES, OF HAZARDOUS SUBSTANCES THAT MAY ENDANGER PUBLIC HEALTH OR THE ENVIRONMENT
- SUPERFUND IS ACTUALLY A TRUST FUND
    - FUNDED BY TAXES

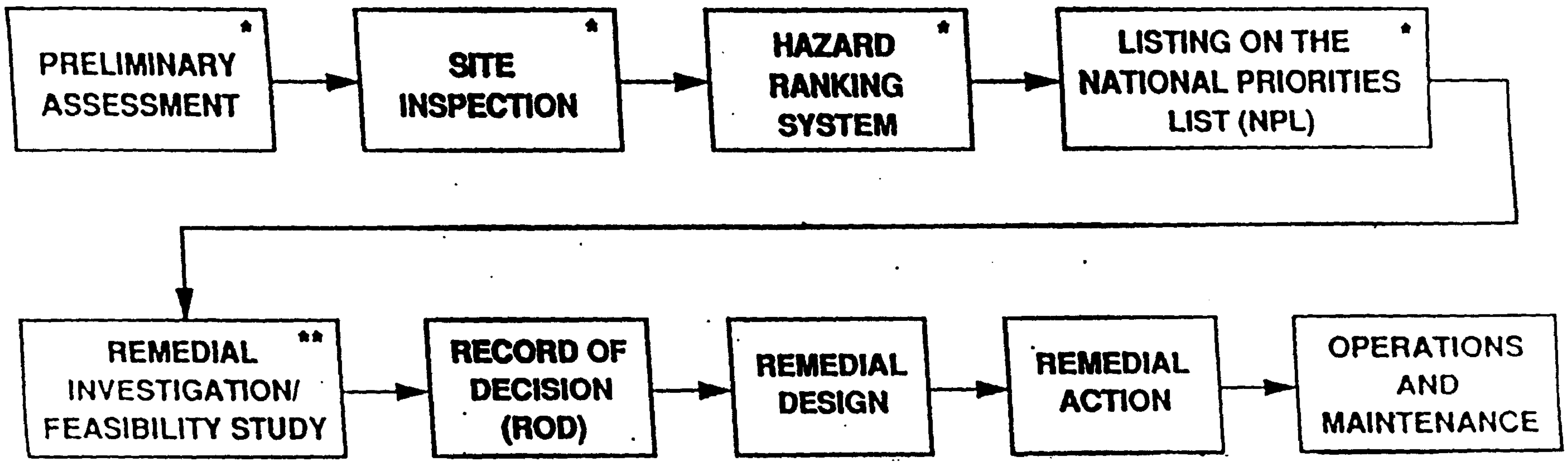
HOW DOES SUPERFUND WORK?

- BASED UPON DISCOVERY OF POTENTIALLY HAZARDOUS MATERIALS INCIDENT
  - ROUTINE REPORTING
  - CITIZEN COMPLAINTS
  - INSPECTIONS

- IF THE SITE POSES AN IMMINENT DANGER EMERGENCY ACTIONS ARE TAKEN
  - REMOVAL MATERIALS
  - RELOCATE RESIDENTS, etc.

- FOR NON-EMERGENCY SITUATION, OR AFTER EMERGENCY ACTIONS ARE COMPLETE, THE SITE ENTERS THE SUPERFUND "PROCESS"

THE SUPERFUND PROCESS



- **CALTECH IS IN COMPLIANCE WITH CERCLA AT THIS TIME**

* COMPLETED

** IN PROCESS

SUPERFUND PROGRAM FACTS*

- HOW MANY SITES?
  - 696 SITES IN STUDY OR DESIGN PHASE
  - 374 SITES IN CLEAN-UP PHASE
  - 109 SITES HAD CLEAN-UP COMPLETED

* *BASED ON 1992 DATA FROM THE TAUBMAN CENTER AT HARVARD UNIVERSITY, AND CORPORATION AND THE GAO*

OVERVIEW OF JPL SUPERFUND KEY EVENTS

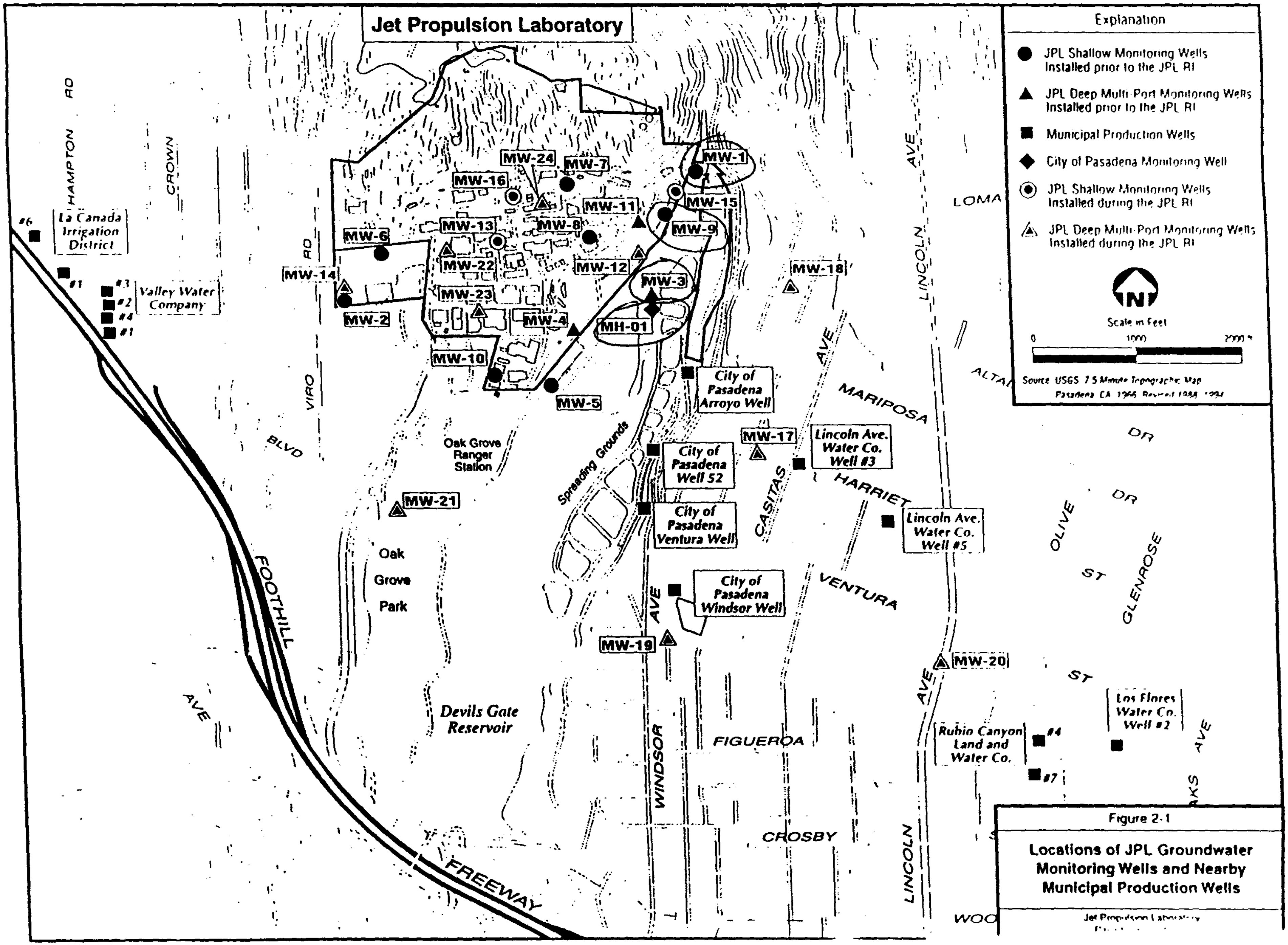
MID 8O'S	PASADENA WELLS SEE LEVELS OF VOLATILE ORGANIC COMPOUNDS (VOC)
12/90	JPL/NASA INSTALL VOC REMOVAL SYSTEM FOR 4 PASADENA WELLS KNOWN TO BE THREATENED
	- Public Protected from Volatile Organics
1990	EXPANDED SITE INSPECTION IS COMPLETED
	- 7 WELLS INSTALLED
10/14/92	JPL LISTED ON NATIONAL PRIORITIES LIST
12/92	WELLS #8 THROUGH #11 COMPLETED
6/93	FIRST SERIES OF DOCUMENTS SUBMITTED TO AGENCIES
11/98	REMEDIAL INVESTIGATION FOR GROUNDWATER NEARING COMPLETION

JPL CERCLA PROJECT "OPERABLE UNITS"

- AN OPERABLE UNIT IS A PORTION OF A GIVEN PROJECT THAT CAN BE DEALT WITH AS A DISCRETE UNIT OF THE ENTIRE SITE
- JPL HAS BEEN BROKEN DOWN INTO THREE (3) OPERABLE UNITS
  - OU-1: ON-SITE GROUNDWATER
  - OU-2: ON-SITE POTENTIAL SOURCES (PITS, CESSPOOLS)
  - OU-3: OFF-SITE GROUNDWATER

JPL

MAP - LOCATIONS OF JPL GROUNDWATER MONITORING WELLS AND NEARBY MUNICIPAL PRODUCTION WELLS FIGURE 2-1



CLB -
1/30/9

OPERABLE UNIT #1 APPROACH

- INSTALL A TOTAL OF 16 GROUNDWATER MONITORING WELLS ON-SITE AND IN THE ARROYO
    - WELLS ARE CAPABLE OF MONITORING BOTH HORIZONTAL AND VERTICAL EXTENT OF CONTAMINATION
- SAMPLE ALL WELLS IN WET AND DRY SEASONS FOR CONTAMINANTS
    - VOCs AND OTHERS
- DEVELOP 3-D UNDERSTANDING OF CONTAMINANT DISTRIBUTION
    - SUPPLEMENT WITH COMPUTER MODELING
- EVALUATE ALTERNATIVES FOR REMEDIAL ACTION NEEDED (IF ANY)

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OPERABLE UNIT #2 APPROACH

- PERFORM SOIL VAPOR ANALYSES AT IDENTIFIED SEEPAGE PIT LOCATIONS
  - ANALYZE FOR VOCs
- SAMPLE SOIL AT 24 LOCATIONS FOR NON-VOLATILE CONTAMINATION (METALS, etc.)
- INSTALL NESTED SOIL VAPOR WELLS AT THE SOIL SAMPLE LOCATIONS
  - HELPS TO DETERMINE VERTICAL DISTRIBUTION OF SOIL VAPORS
- DEVELOP 3-D UNDERSTANDING OF SOIL VAPOR AND SOIL CONTAMINATION
- EVALUATE REMEDIAL ALTERNATIVES REQUIRED (IF ANY)

OPERABLE UNIT #3 APPROACH

- INSTALL FIVE (5) WELLS IN ALTADENA AND PASADENA
  - WELLS ARE CAPABLE OF MONITORING BOTH HORIZONTAL AND VERTICAL EXTENT OF CONTAMINATION
- SAMPLE ALL WELLS IN WET AND DRY SEASONS FOR CONTAMINANTS
  - VOCs AND OTHERS
- DEVELOP 3-D UNDERSTANDING OF CONTAMINANT DISTRIBUTION
  - SUPPLEMENT WITH COMPUTER MODELING
- EVALUATE ALTERNATIVES FOR REMEDIAL ACTIONS (IF ANY)

COMMUNITY RELATIONS PREPARATIONS IN OU-3

- PROJECT WORKING GROUP DEVELOPED A FACT SHEET FOR GENERAL AREA RESIDENTS THAT EXPLAINED THE OVERALL PROGRAM

  JPL PUBLIC SERVICES OFFICE (PSO) DEVELOPED A SPECIFIC LETTER FOR AREA RESIDENTS DIRECTLY AFFECTED BY THE WELL CONSTRUCTION
  WAS HAND DELIVERED BY PSO

  MET WITH ALTADENA RESIDENTS TO ALLAY POSSIBLE CONCERNS

  MET WITH CITY OF PASADENA WATER AND POWER OFFICIALS TO ALLAY CONCERNS REGARDING WELL PLACEMENT ON PASADENA PROPERTY

DESIGN OF TYPICAL SHALLOW GW MONITORING WELL 2-2

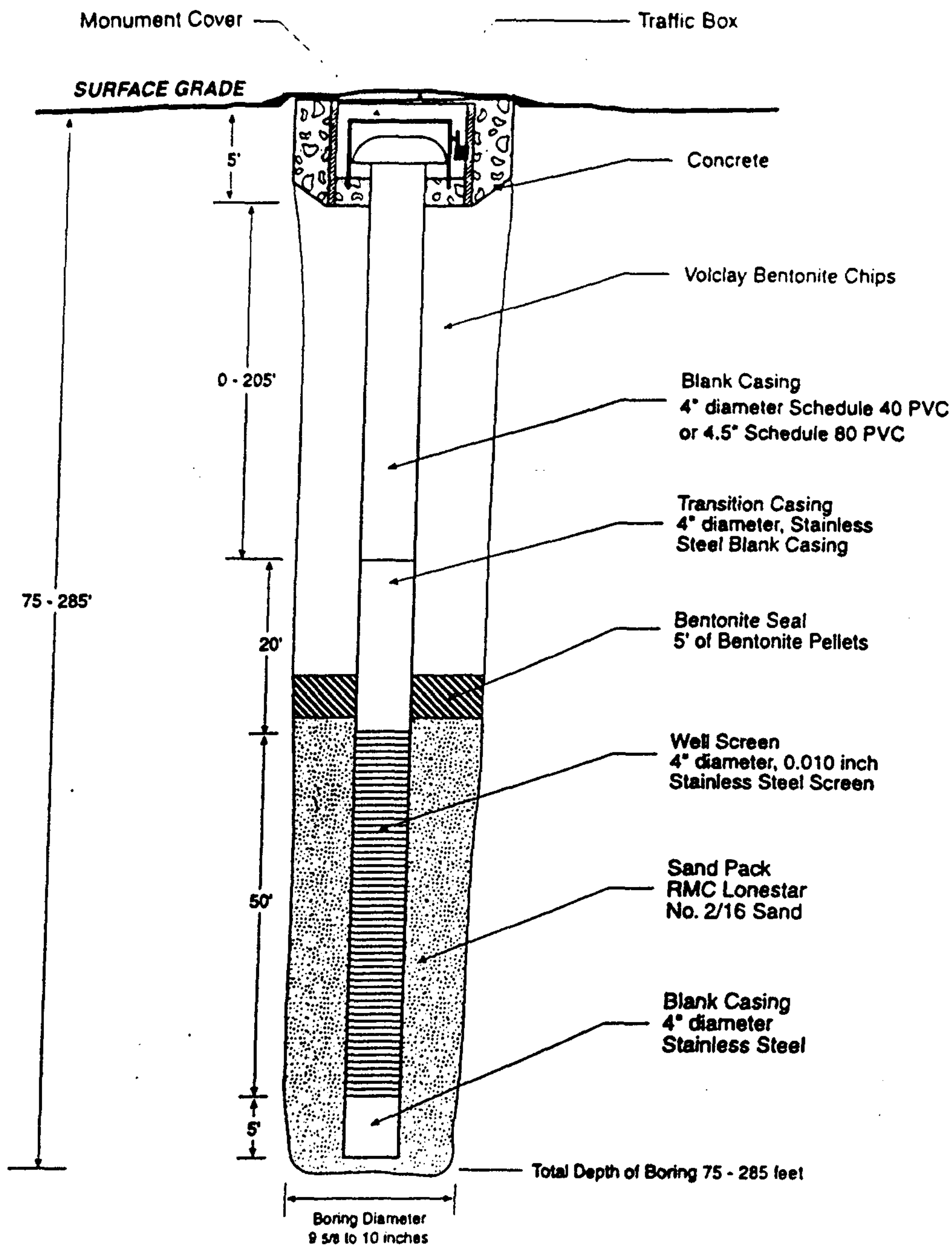

Figure 2-2

Design of Typical Shallow Groundwater Monitoring Well

Jet Propulsion Laboratory
Pasadena, California

1572 0223

Typical Multi-Port (MP) MW Casing Installation 2-4

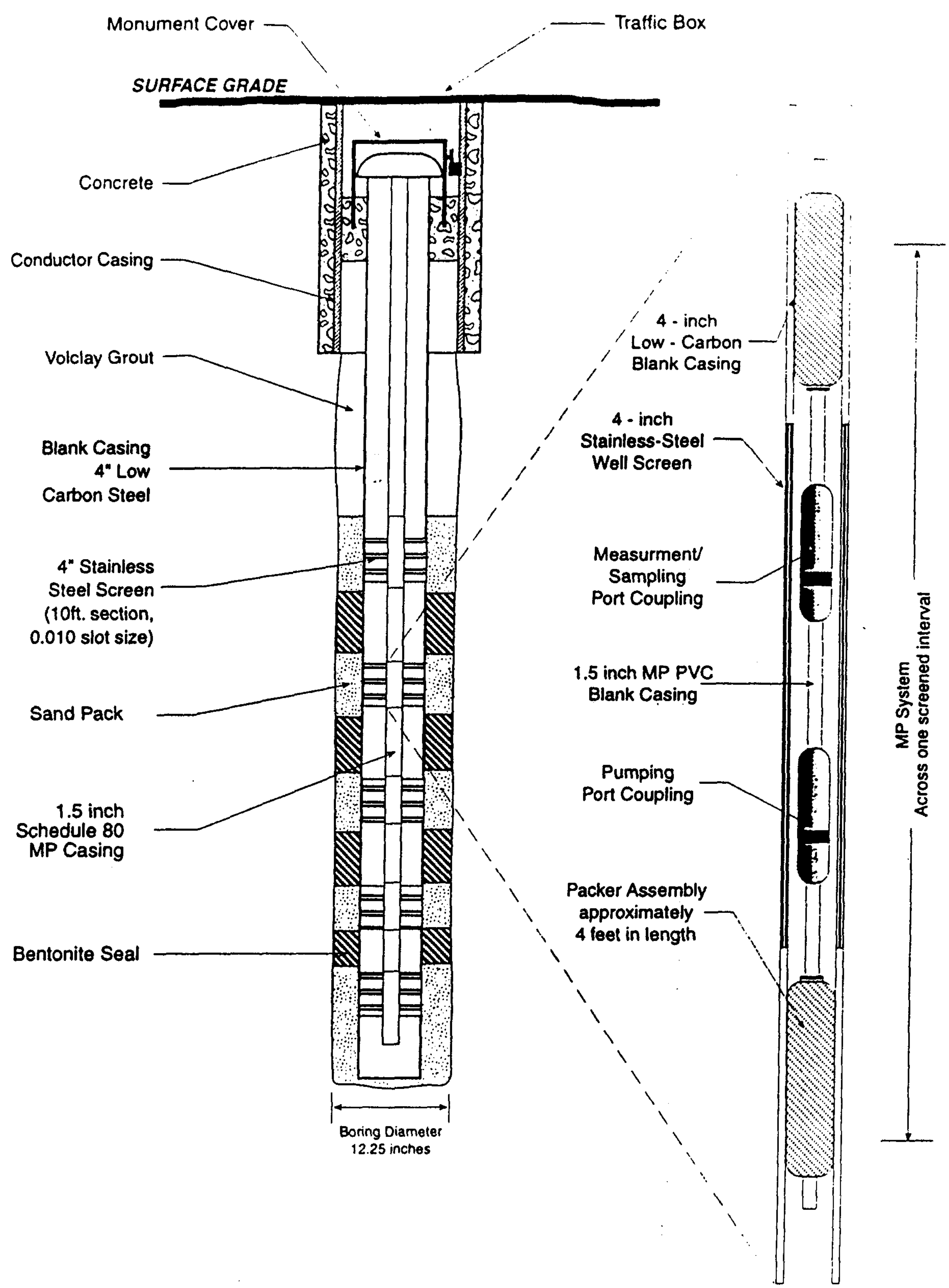

Figure 2-4

Typical Multi-Port (MP)
Monitoring Well Casing Installation

Jet Propulsion Laboratory
Pasadena California

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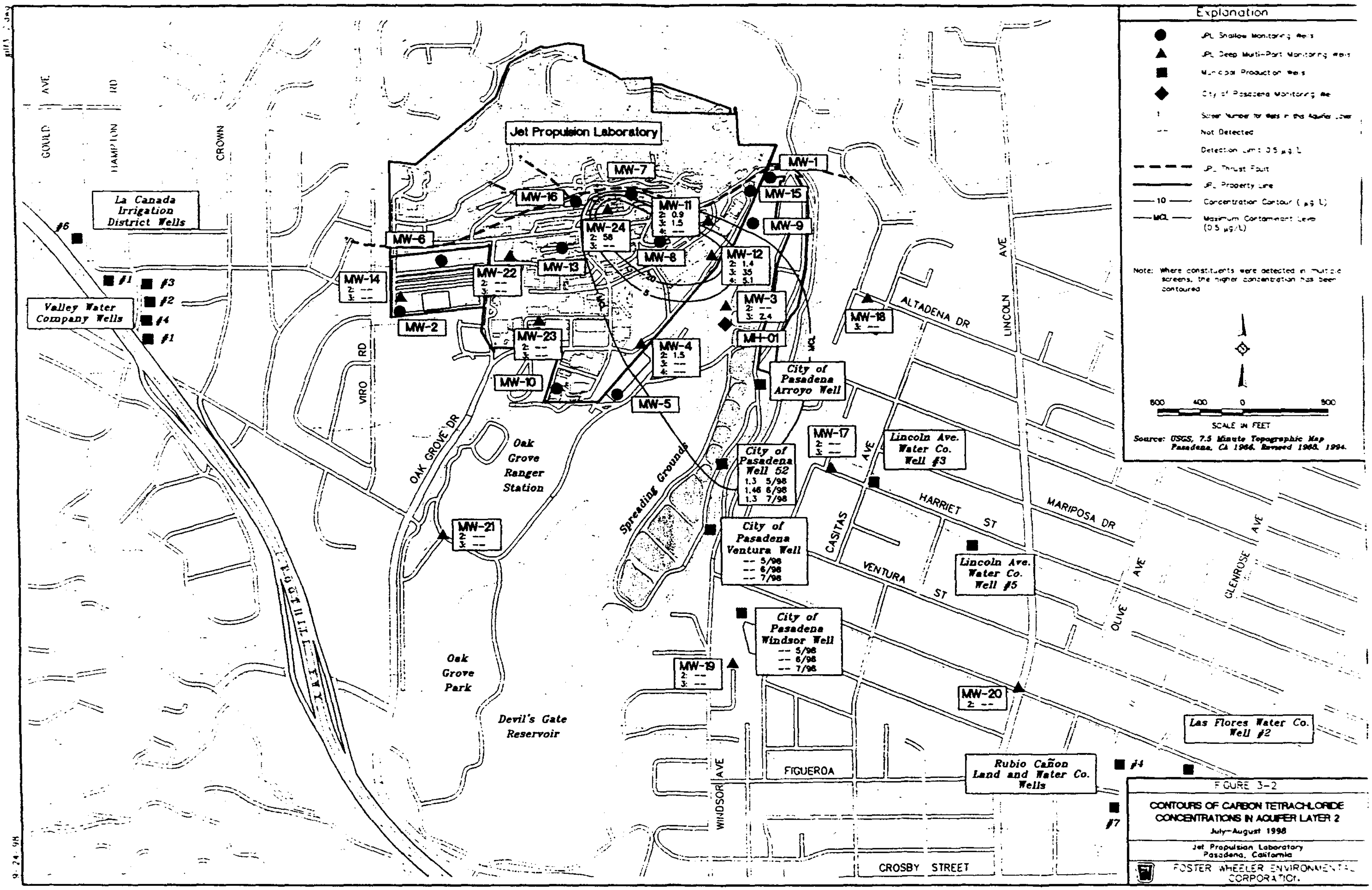
Contours of Carbon Tetrachloride 3-2



NEXT STEPS

- SUPERFUND PROCESS CALLS FOR DETERMINING FEASIBILITY OF VARIOUS REMEDIES
- JPL IS LOOKING AT SEVERAL POSSIBILITIES BY RUNNING PILOT PLANT STUDIES AND STUDYING FULL-SCALE OPERATIONS:
  - ION EXCHANGE FOR PERCHLORATE
  - CARBON/AIR STRIPPING FOR VOC'S
  - VACUUM EXTRACTION ON SOILS FOR VOC'S

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ION EXCHANGE TECHNOLOGY

- USES SPECIAL RESIN WHICH REMOVES PERCHLORATE FROM WATER
- RESIN CAN BE REGENERATED WITH BRINE FOR CONTINUED USE
- REGENERATE BRINE CAN BE TREATED TO REMOVE PERCHLORATE BEFORE DISPOSAL
  - JPL IS WORKING TO MINIMIZE THIS
- WATER QUALITY OF FINAL PRODUCT IS DRINKING WATER QUALITY

CARBON/AIR STRIPPING FOR VOCs

- BOTH ARE WELL KNOWN TECHNOLOGIES
  - BOTH USED BY LOCAL WATER PURVEYORS
- CARBON USES ACTIVATED CARBON TO REMOVE VOCs
  - SIMILAR PRINCIPLE TO HOME FILTERS, ONLY LARGER SCALE
- AIR STRIPPING
  - BREAKS SOLVENT CONTAINING WATER INTO A FINE SPRAY
  - THESE FINE PARTICLES OF WATER ARE DIRECTED THROUGH TURBULENT AIR FLOW
  - AIR FLOW CAUSES THE SOLVENTS TO EVAPORATE INTO THE AIR
  - THIS AIR IS THEN FILTERED TO REMOVE THE SOLVENTS
  - THE SOLVENT-FREE WATER EXITS THE SYSTEM

SOIL VAPOR EXTRACTION

- SMALL SPACES BETWEEN SOIL PARTICLES ARE FILLED WITH AIR ABOVE THE WATER TABLE
- VOC'S EVAPORATE AND FILL THESE AIR SPACES WITH VOC VAPOR
- VACUUM EXTRACTION USES A WELL AND A VACUUM PUMP TO PULL THESE VAPORS OUT OF THE SOIL
- VOCs IN THIS AIR STREAM ARE DIRECTED TO A SYSTEM TO REMOVE THE VOC FROM THE AIR

Environmental CLEANUP

Jet Propulsion Laboratory Information Sheet *August 1996*

GROUND-WATER WELLS

Subsurface INVESTIGATION

Study of the water and soil beneath the surface is nearly always required as part of the remedial investigation/feasibility study phase of a Superfund cleanup project. Therefore, in many cases, some sort of drilling into the soil or bedrock is needed. Drilling might be done for several reasons. It is often the only way to take samples of the subsurface, which can be analyzed for contamination in a laboratory. Or, it might be required to construct wells that allow continuous sampling of the air and water found in the subsurface.

This information sheet describes how water wells are constructed, or "completed," after drilling, and discusses some of the special features of the ground-water monitoring wells installed as part of the JPL Superfund Project. The purpose of these monitoring wells is to assess the nature and extent of ground-water contamination and provide data that will help in designing a process for controlling and cleaning up any contamination.

Water Well CONSTRUCTION

Wells for obtaining ground water from subsurface aquifers can be of many different types, ranging from small, hand-dug pits to large, deeply drilled, casing-lined wells used for city water supplies. The wells installed for the JPL project are generally between a few hundred and a thousand feet deep, and from four to six inches in diameter when completed.

Most modern ground-water wells are constructed in a manner similar to the well shown in the illustration at left. After the hole is drilled, a casing with a diameter several inches smaller than the drill hole is lowered down. The casing is usually made of either polyvinyl chloride (PVC) or steel pipe segments, which are fitted tightly together or welded into a single piece as they are lowered.

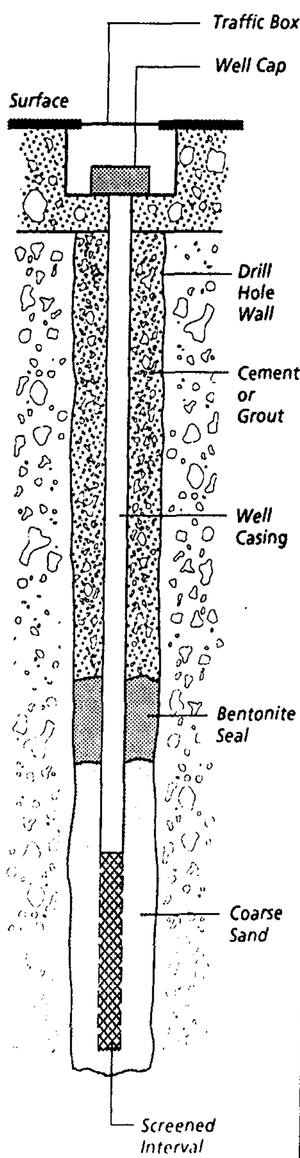
Obviously, the ground water needs a way to get into the well casing, so there is usually a screened interval at the bottom of the well. These well screens are often made of wire-wrapped stainless steel or perforated PVC pipe.

As the well is constructed, coarse sand is placed around and slightly above the screened interval to allow ground water to flow freely into the well screen. Bentonite is placed on top of the sand to isolate the screened interval from the rest of the drill hole. Bentonite is a naturally occurring clay mineral that expands when wet. As the bentonite is put into place, water is added, creating an impermeable seal above the sand.

The remainder of the open space between the well casing and the walls of the drill hole is filled with cement or grout to prevent cave-ins. This also serves to prevent any movement of water vertically within the drill hole.

Ground-Water Well

The JPL ground-water sampling wells are between a few hundred and a thousand feet deep.



Ground Water SAMPLING

One of the most important pieces of information we get from sampling ground water in wells is simply the depth of the water table. As water enters the well through the well screen, it rises up into the well to a level related to the height of the water table. When water-level data for a number of different wells are evaluated, we can determine the *ground-water gradient*, the direction in which the ground water is flowing. This helps to determine where any contamination may have originally come from and where it may be flowing.

Water samples are also taken from each well and sent to a laboratory for detailed chemical analysis. The Environmental Protection Agency has outlined strict procedures for the taking, transporting, and analysis of these samples. In addition, there are also detailed procedures for assuring the quality and reliability of the data obtained from each sample.

The ground-water monitoring wells installed for the JPL Superfund Project are of a special design that allows sampling at multiple levels below the water table. This is necessary because different types of contaminants behave in different ways. For example, some liquid contaminants float on water and therefore would be found on top of the water table. Other liquids are denser than water and sink downward through the ground water over time.

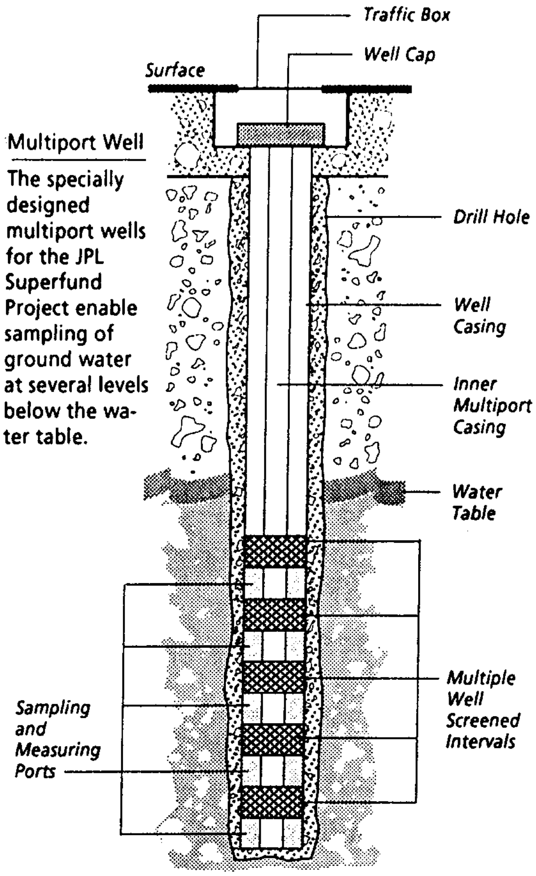
Multiport WELLS

The special multiport wells used in the JPL project have up to five screened intervals, approximately evenly spaced from just below the top of the water table to the bottom of the well, near the bedrock. Each screened interval is isolated from the others by a specially designed inner casing fitted with both sampling ports and measuring ports for each screened interval. Sampling ports allow the collection of water samples; measuring ports are used to collect other information (e.g., temperature).

Sampling is done with a special tool that is lowered down the inner multiport casing. This tool connects to an individual port and allows pumping or sampling of only one screened interval at a time. This way, only water from that particular depth is sampled.

Each time one of the multiport wells is sampled, data are obtained from the different levels below the water table. This allows more precise definition of the vertical extent of contamination within the ground-water aquifer.

These detailed data will be used to develop an accurate, three-dimensional picture of ground water in and around JPL. In turn, this enhanced understanding of our ground water will be used to design appropriate ways to deal with ground-water contamination.



Multiport Well

The specially designed multiport wells for the JPL Superfund Project enable sampling of ground water at several levels below the water table.

The following local contacts represent agencies involved in the Superfund process:

Agency CONTACTS

• Jon Bishop
L.A. Regional Water Quality Control Board (RWQCB)
101 Centre Plaza Drive
Monterey Park,
California 91754
(213) 266-7538

• Debbie Lowe
U.S. Environmental Protection Agency (EPA), Region IX
75 Hawthorne Street, M/S H-9-1
San Francisco, California 94105
(415) 744-2206

• Penny Nakashima
California EPA, Department of Toxic Substances Control (DTSC)
1011 N. Grandview Avenue
Glendale, California 91201
(818) 551-2881

SUPERFUND INFORMATION

For information on the environmental cleanup effort at JPL, and for ideas on how you can become involved, please contact:

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Jet Propulsion Laboratory, 186-113
4800 Oak Grove Drive
Pasadena, California
91109-8099

Tel: (818) 354-0112

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National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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Environmental CLEANUP

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GROUND WATER

The water in the ground beneath our feet is a valuable resource that we often take for granted. In fact, ground water serves as an important source of potable water for many communities in our area, including Pasadena, La Cañada–Flintridge, San Marino, Sierra Madre, Altadena, Alhambra, and Arcadia. This information sheet introduces some of the important concepts in ground-water hydrology by exploring how ground water moves through the subsurface.

Ground WATER

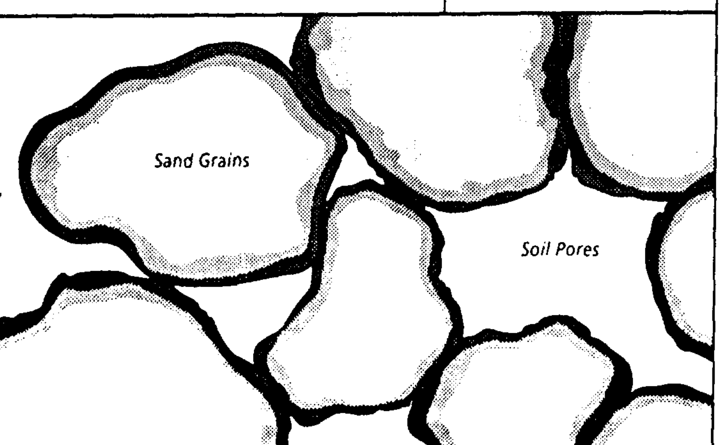
Contrary to popular belief, water does not often move in the subsurface through underground rivers or streams. Most of the time, ground water is confined to the very small amounts of open space found in rock and soil. Sometimes this open space is caused by fractures within solid rock such as granite, but usually it is simply the small amount of open space between the grains of gravel, sand, and silt that make up the soil.

The illustration below shows what this open space, called *soil pores*, might look like in a typical soil. Notice that because of their shape, sand grains cannot quite pack together tightly, thereby forming the pores. This seemingly small amount of open space is where most water is stored in the subsurface.

GROUND WATER IS A VALUABLE RESOURCE FOR MANY OF THE COMMUNITIES IN THE JPL AREA

Soil Pores

Ground water is often found in the pores, or open space, within soil.



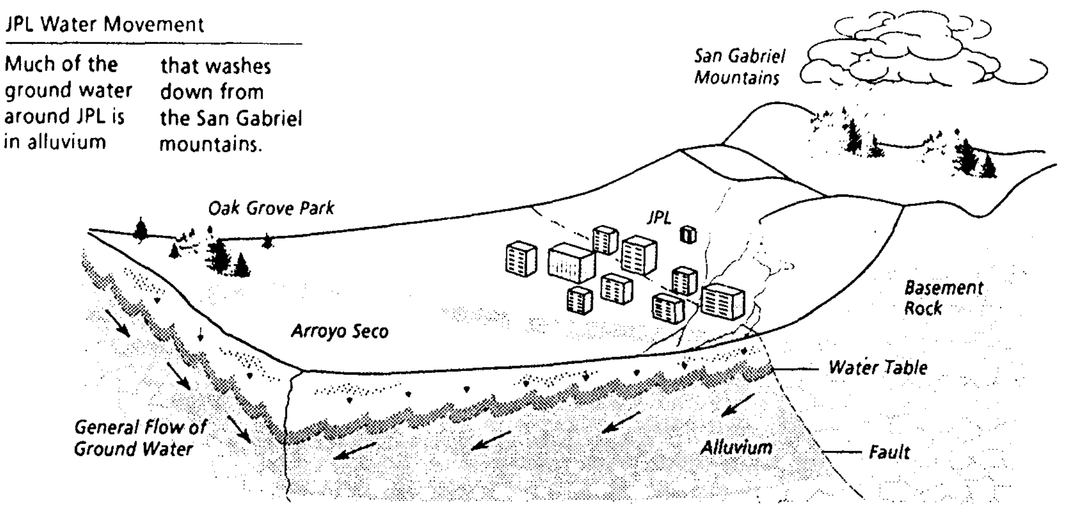
Soil pores alone, however, do not necessarily make for a good water-bearing material. It is important that the open spaces in the rock or soil be connected to each other. This property is called *permeability*. In a permeable substance, water can easily flow from one open space to the next. For example, a sponge is very porous and permeable, thus lots of water can flow through it easily. A styrofoam coffee cup is also very porous, that is, it contains lots of air space, yet fortunately, it is not very permeable.

Water TABLE

Water in the subsurface can be found either as soil moisture, where the pore space is only partially filled with water, or as ground water, where soil pores are completely filled with water. This latter part of the subsurface is referred to as the *zone of saturation*. A body of rock or soil that is porous, permeable, and contains ground water is called an *aquifer*. The top of the zone of saturation is known as the *water table*, and can rise and fall depending on how much water is in the aquifer.

In and around JPL, most of the ground water is stored in loose sand and gravel, called *alluvium*, which has washed down from the San Gabriel mountains north of the Laboratory. Because of its relatively high permeability and number of pores, this alluvium makes a good aquifer. Underlying the alluvium is solid, granite-like "basement" rock that has very low porosity. The thickness of the alluvium on top of the basement rock can range anywhere from zero feet in the mountains to over 1000 feet in some places near JPL.

GROUND WATER



Water MOVEMENT

The sketch above presents a generalized picture of the alluvium, basement rock, and water table underneath JPL. Drilling has shown the depth of the water table to be between 100 and 240 feet below the ground surface. Monitoring of water wells also indicates that this depth varies greatly depending on the amount of rainfall in the area, the amount of water in the Arroyo Seco, and the amount of ground-water pumping.

In addition to knowing the depth, extent, and behavior of the water table, it is important to understand how ground water moves in the subsurface. Surface water always flows downhill, or *down slope*. However, ground water always flows *down gradient* — not necessarily in the same direction as the surface water flow.

For example, the land that JPL is built on generally slopes to the south. Most of the time, ground water flows to the southeast, toward the Arroyo Seco (see the illustration). However, after periods of high rainfall, the direction of ground water beneath JPL reverses and flows toward the northwest. This occurs because stream water infiltrating down through the alluvium in the Arroyo Seco creates a source of ground water that reverses the ground-water gradient.

This example illustrates some of the complexities involved in understanding how ground water moves in the subsurface. Knowing the depth of the water table, the characteristics of the ground-water aquifer, and how water moves through that aquifer are important elements to consider in an environmental cleanup project.

Agency CONTACTS

The following local contacts represent agencies involved in the Superfund process:

- Jon Bishop
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Environmental CLEANUP

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HYDROLOGY

Viewed from space, Earth appears as a dark blue sphere, highlighted by enormous streaks of stark-white clouds. As a result, Earth is often referred to as the "blue planet," or the "water planet." The abundance of water on Earth is one of the features that make our planet truly unique in the solar system.

Water PLANET

Water on our planet is essential to life and occurs in a number of different places. The oceans account for about 97.2 percent of all liquid water on Earth; ice caps and glaciers account for about 2.14 percent; and the remainder is a combination of surface water (0.009 percent), underground water (0.615 percent), and atmospheric moisture (0.001 percent).

Since most of Earth's water is in the oceans, it is salty; only a small amount of the world's supply of water is fresh water. In addition, because much of this fresh water is "locked up" in the ice caps, only a very small fraction is actually available to humans and is therefore a valuable environmental resource.

ONLY A SMALL FRACTION OF EARTH'S FRESH WATER IS AVAILABLE TO HUMANS

Earth's water supply is constantly moving from one place to another, through the *hydrological cycle*. The Sun provides most of the energy for moving water around on Earth. Solar energy striking Earth's surface causes evaporation, which puts moisture into the atmosphere. Temperature differences, also caused by the Sun's uneven heating of our globe, are largely responsible for generating wind. As the wind blows, moist air and clouds are moved through the atmosphere. The force of gravity also plays a role by moving surface and underground water back toward the sea.

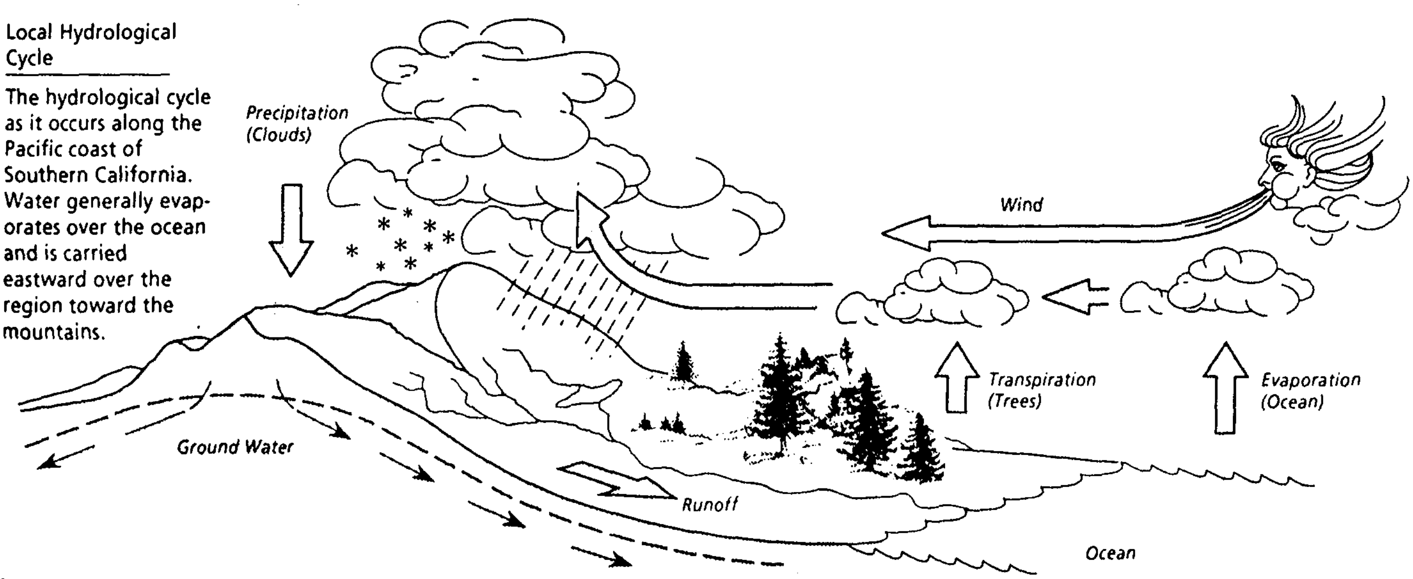
Water CYCLE

In the Southern California area, for example, water evaporates over the Pacific Ocean and is carried over the region by prevailing westerly winds. Moisture is added to the system by a small amount of evaporation over land and largely by plants through a process called transpiration.

As moist air encounters the San Gabriel mountains, it is forced upward, causing the air to cool and lose moisture. This results in either clouds forming along the mountain front, or, if there is enough moisture, precipitation in the form of rain or snow. The result of this so-called *topographic effect* is that areas on the south side of the mountains, such as La Cañada and Pasadena, receive more rain on average than places north of the mountains, such as Palmdale.

Local Hydrological Cycle

The hydrological cycle as it occurs along the Pacific coast of Southern California. Water generally evaporates over the ocean and is carried eastward over the region toward the mountains.



As precipitation falls on our mountains, one of three things occurs to the water: it infiltrates into the ground and becomes part of the ground-water system; it flows across the ground surface as runoff and becomes part of the surface-water system; or it is temporarily stored either as ice and snow or in puddles and ponds.

Surface WATER

Surface-water runoff accounts for only about 1 percent of the total volume of water moved from the land back to the ocean every year by gravity. Because of our particular climate in Southern California, many surface rivers and streams flow only during and shortly after the rainy season. During particularly wet years, however, tremendous amounts of water flow out of the mountains back toward the sea.

Ground WATER

Water that does not flow as surface water infiltrates downward into the subsurface to form ground water. Ground water, like surface water, eventually completes the hydrological cycle by flowing back toward the sea where it can again evaporate back into the atmosphere. Since ground water generally flows much more slowly than surface water, ground-water systems often require more careful study than surface river and stream systems.

In this simple example of the hydrological cycle, water moves from the oceans to the atmosphere by evaporation, from the atmosphere to the land through precipitation, and then flows from the land back into the ocean either as surface runoff in rivers and streams or ground water. Examining the process in more detail will reveal many different ways in which water moves about on Earth. A general understanding of the hydrological cycle can lead to a better overall understanding of one of our most precious resources — fresh, clean water.

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SOIL

THE COMPOUNDS BEING INVESTIGATED IN THE SOIL AT JPL ARE VOLATILE ORGANIC COMPOUNDS

Soil STUDIES

Contamination initially detected in ground water led to JPL's designation as a Superfund site. The most likely source for that contamination, however, probably resides on or within the soil above the water table. So, in addition to studying the ground water, it is necessary that we determine the nature and extent of contamination in this soil.

The part of the subsurface above the water table is referred to as the *vadose zone*. Investigating this vadose zone will help to determine where sources of contamination might still exist, how contamination is carried downward into the ground water, and how contamination might eventually be prevented from reaching the ground water.

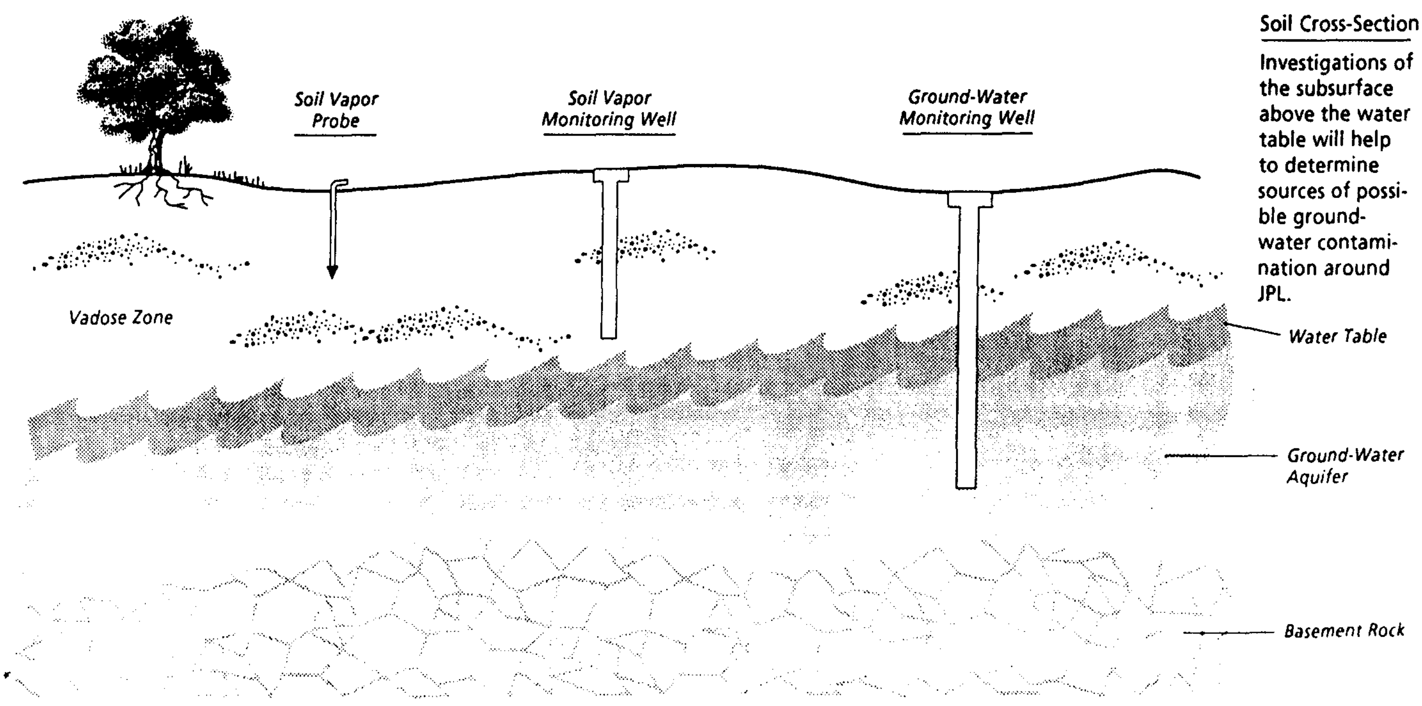
Soil DEFINED

For our purposes, *soil* refers to the unconsolidated sedimentary material that washes down from the mountains via rivers and streams. It is generally composed of sand, silt, and clay minerals in varying proportions, and is derived from the physical and chemical weathering of mountain rocks.

Soil SAMPLING

There are several ways to look for soil contamination. One is simply by obtaining a sample of the soil itself, which, in the case of soils exposed at the surface, is a relatively simple task. Collecting samples of subsurface soil, however, usually requires drilling. As a soil-sampling borehole is drilled, the chips of rock and soil produced by the drilling are monitored for any changes. At set intervals, drilling is stopped and a sample is taken by lowering a special sampling device down the borehole.

Soil-sample boreholes are generally drilled to just above the water table. Once the soil sampling is complete, the drill hole is either converted into a soil-vapor monitoring well or backfilled with bentonite, a clay material that effectively seals off the hole from bottom to top.



Soil Cross-Section

Investigations of the subsurface above the water table will help to determine sources of possible ground-water contamination around JPL.

Another way to detect volatile contamination in soils is to sample the air (usually referred to as soil vapor) surrounding the soil particles. This soil vapor resides in the open spaces, or *pores*, within the soil, much like ground water does below the water table. In addition, the soil vapor can move through the soil, again like ground water, if the soil is permeable.

The chemicals being investigated at JPL are primarily a group of chemicals called volatile organic compounds (VOCs). They are liquids, primarily solvents, that evaporate readily at room temperature. If liquid VOCs are present in the soil, then they will also be present in the soil vapor. VOCs are described in more detail in the information sheet on *Hazardous Chemicals*.

Soil VAPOR

At JPL, soil vapor is being sampled in two ways: by soil-vapor probes and by soil-vapor wells containing multiple soil probes at various depths. A soil vapor probe is first hammered into the ground, using a steel pipe to drive the tip of the probe downward. Inside the steel pipe is a flexible tube, which connects the probe tip to the surface. When the proper depth is reached (or the probe will go no deeper), the pipe is removed and the hole is backfilled with sand and bentonite.

The probe itself consists of a steel tip and a piece of tubing with openings just behind the tip. When the soil vapor is being sampled, the vapor is drawn in through the sampling tube by a pump connected to the tube on the surface.

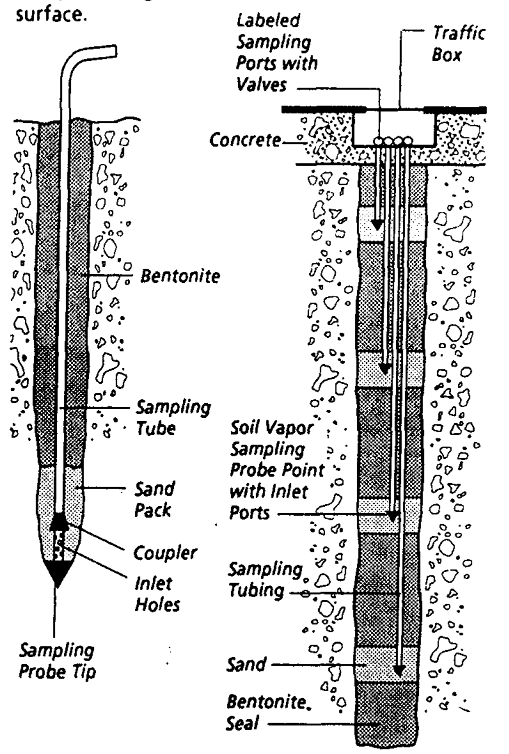
Bore holes drilled for soil sampling are sometimes converted into soil-vapor monitoring wells. In these small wells, soil-vapor probes are built into the wells at different levels below the surface. Each level at which a probe is placed is filled with coarse sand. The remainder of the well is filled with bentonite, sealing the well and ensuring that only vapor from the specified depth is sampled.

Soil-Vapor Probe

A typical soil-vapor probe. Soil vapor is drawn through the sampling tube by a pump on the ground surface.

Soil-Vapor Well

Bore holes drilled for soil sampling can be converted into small monitoring wells at different levels.



The following local contacts represent agencies involved in the Superfund process:

Agency CONTACTS

- Jon Bishop
L.A. Regional Water Quality Control Board (RWQCB)
101 Centre Plaza Drive
Monterey Park, California 91754
(213) 266-7538

- Debbie Lowe
U.S. Environmental Protection Agency (EPA), Region IX
75 Hawthorne Street, M/S H-9-1
San Francisco, California 94105
(415) 744-2206

- Penny Nakashima
California EPA, Department of Toxic Substances Control (DTSC)
1011 N. Grandview Avenue
Glendale, California 91201
(818) 551-2881

SUPERFUND INFORMATION

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Pasadena, California 91109-8099

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Pasadena Central Library
280 E. Walnut St.
Pasadena

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

JPL D-13036-4 8/96

Environmental CLEANUP

Jet Propulsion Laboratory Information Sheet *August 1996*

HAZARDOUS CHEMICALS

TO PROTECT PUBLIC HEALTH, THE GOVERNMENT ESTABLISHES MAXIMUM LEVELS FOR CHEMICALS IN PUBLIC DRINKING WATER

Chemical CONTAMINATION

The worldwide increase in chemical contamination in both surface and ground water has generated much public concern over the health risks associated with human exposure to contaminating substances. While much has been learned about the effects of chemicals on human and environmental health, there are still many uncertainties regarding the long-term effects of low levels of exposure to toxic chemicals. To protect human health, the federal government and the state of California have established standards for maximum levels of various chemicals in public drinking water systems.

Several chemicals have been detected at levels above state and federal drinking water standards in the ground water beneath and adjacent to JPL. These so-called "chemicals of concern" fall into two broad categories: volatile organic compounds (VOCs), which are carbon-containing substances usually manufactured by humans; and inorganic metals, which occur naturally in the environment at very low concentrations, but may be concentrated for human use. This information sheet describes some of the general characteristics of these chemicals and presents specific information on the chemicals of greatest concern to JPL's Superfund Project environmental cleanup efforts.

Volatile Organic COMPOUNDS

Six VOCs of primary concern (see the table on the next page) have been detected in the ground water beneath and adjacent to JPL. All six of these chemicals have several things in common. Compositionally, they are made of varying amounts of hydrogen (H), carbon (C), and chlorine (Cl). All are "volatile," that is, they evaporate easily at room temperature (as compared to water).

In addition, these VOCs are all solvents that are, or were, widely used commercially; all have been associated with potentially adverse health effects.

VOC ENVIRONMENT

Years ago, it was common practice for industry to dispose of waste liquids using seepage pits or cesspools, which were designed to collect liquid waste products and allow them to percolate gradually into the subsurface soil. It has since been recognized that this method of disposal is unsuitable for hazardous liquids because these waste products can eventually reach the ground-water system and cause contamination.

Organic compounds such as VOCs are particularly problematic in ground water for several reasons. Once VOCs are in the subsurface, they have limited contact with the air and cannot readily evaporate. Organisms living in the upper part of the soil have the potential to break down organic compounds into other, less-dangerous chemicals. However, deep ground-water aquifers are relatively free of such organisms. Finally, ground water moves relatively slowly as compared to surface water, and the temperature and rates of flow may remain relatively constant over long periods of time.

Fortunately, there are a number of effective ways to treat ground water contaminated with VOCs. Most involve pumping the water out of the ground, treating the water in one or more ways, then either re-injecting the water back into the ground or using it for some productive purpose. Typical treatment strategies include filtering, air or steam stripping, and chemical or biological treatment, among others. These "pump and treat" systems have proven quite successful in many previous ground-water cleanup projects in reducing or eliminating hazardous chemicals or containing the contaminated ground water.

Volatile Organic Compounds: Uses and Effects

COMPOUND	COMMON USES	EXPOSURE EFFECTS	MAXIMUM CONTAMINANT LEVEL*
Carbon Tetrachloride *CTC, CCl_4, Freon 10*	Used in manufacture of refrigerants, foam-blowing agents, and solvents; grain fumigant; as a dry-cleaning fluid, aerosol propellant, and pharmaceutical aid	Carcinogenic; can affect liver, kidneys, and central nervous system	0.5 µg/l
1,2–Dichloroethane *DCA, $C_2H_4Cl_2$, Ethylene dichloride*	By-product in manufacture of vinyl chloride, solvents, paints, coatings, and adhesives	Inhalation hazard: can affect central nervous system; is linked to liver and kidney damage; is a suspected carcinogen	5.0 µg/l
Dichloroethylene *DCE, $C_2H_2Cl_2$, Acetylene dichloride*	Solvent for fats, camphor, etc.; used as an agent to retard fermentation	Can cause eye and respiratory irritation; can cause nausea and vomiting; can affect central nervous system	7.0 µg/l
Tetrachloroethylene *PCE, C_2Cl_4, Perchloroethylene*	Solvent in dry-cleaning systems; used as a rug/upholstery cleaner and a spot, stain, and lipstick remover; used in printing ink; used as a metal degreaser; used as medical treatment for liver flukes and hookworm, tapeworm, and pinworm infections	Associated with central nervous system depression, kidney and liver dysfunction; is a suspected carcinogen	5.0 µg/l
1,1,1–Trichloroethane *TCA, $C_2H_3Cl_3$, Methylchloroform*	Solvent in cleaning metals and for removing adhesives; used in leather-tanning, inks, and shoe polish; used as a drain cleaner	An eye irritant; could lead to cardiotoxicity	200 µg/l
Trichloroethylene *TCE, C_2HCl_3*	Metal degreaser; used in spot removers, rug cleaners, air fresheners, and dry-cleaning fluids; used as an analgesic and inhalation anesthetic; used as a disinfectant to remove oil and tar from wounded animals	Can cause headaches, vomiting, nausea, seizures, paralysis, and blindness; may result in liver and kidney damage	5.0 µg/l

* *Maximum contaminant level allowable by federal or state government standards.*

Heavy METALS

The two metallic contaminants of greatest concern at JPL are mercury (Hg) and chromium (Cr). Both of these metals occur naturally, and can be found at very low levels in the environment even where no contamination by humans has taken place. Both metals are also widely used by people and industry, so there are numerous possible sources for mercury or chromium contamination of ground water and soil.

Mercury

Most people are familiar with mercury — an unusual metal because it remains liquid at room temperature. In fact, mercury does not become a solid until it is cooled to a temperature of 39 degrees Fahrenheit. Because of its particularly unique physical properties, mercury is widely used in many different kinds of applications: in thermometers and barometers; for gold and silver extraction; in fluorescent lamps; electrolysis; dentistry; mirrors; and in pharmaceuticals.

The primary hazard of mercury is in inhaling mercury vapors or dust. Because metallic mercury is slightly volatile at room temperatures, the potential for inhaling mercury vapors is particularly high. Once mercury enters the respiratory tract, it is then easily absorbed into the body. Contact with mercury can cause the corrosion of skin and membranes, nerve dysfunction, kidney damage, tremors, nervousness, personality change, and, in extreme cases, even death. State and federal regulations set the maximum contaminant level (MCL) for mercury in public drinking water at 2 µg/l.

Chromium

Although you may not realize it, most people are probably also familiar with chromium and its various "oxides" (chromium atoms combined with either two or three oxygen atoms). Chromium metal is used in making stainless steel and chrome–metal alloys, and as chrome plating on other metals. Chromium oxide (Cr_2O_3) is used in paint pigments on porcelain, fabric, and bank notes. Chromium trioxide (CrO_3) is used as a topical antiseptic and in chrome plating, batteries, and photography.

Chromium and many chromium compounds (such as CrO_3) are considered extremely toxic, especially if taken internally or applied externally in large doses. Symptoms of chromium exposure include skin irritation or ulceration; respiratory tract damage if vapors are inhaled; and nausea, vomiting, or gastroenteritis if ingested. The MCL for chromium in drinking water is 50 µg/l.

Metal TREATMENT

Treatment strategies for removing inorganic metals from water are substantially different than the treatment for VOCs. In some cases, chemicals that combine with the metals are added to the water being treated. This causes both the metals and the added chemicals to precipitate out of the solution, allowing for them to be safely removed from the water.

Other treatment techniques include ion exchange, in which metal atoms are chemically replaced with other, nonhazardous atoms; reverse osmosis, in which pressure forces water through a semipermeable membrane, leaving the contamination behind; or electrolysis, which actually uses electricity to recover the metal from water.

In any ground-water cleanup project, a thorough understanding of the nature of the contaminants, their concentration, and their distribution in the environment, is critical in the design and implementation of a treatment or cleanup plan. Such knowledge is only gained through detailed, systematic study of the ground-water problem and careful engineering of cleanup solutions.

SUPERFUND INFORMATION

For information on the environmental cleanup effort at JPL, and for ideas on how you can become involved, please contact:

Public Services Office
Jet Propulsion Laboratory, 186-113
4800 Oak Grove Drive
Pasadena, California
91109-8099

Tel: (818) 354-0112

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Altadena

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4545 W. Oakwood Ave.
La Cañada-Flintridge

Pasadena Central Library
280 E. Walnut St.
Pasadena

The following sources of information were used in preparing this Environmental Cleanup information sheet:

More READING

- *The Merck Index*, Merck & Co., New Jersey.
- *The NIOSH Pocket Guide to Hazardous Chemicals*, National Institute for Occupational Safety and Health, Cincinnati, Ohio, 1990.
- *Occurrence and Removal of Volatile Organic Chemicals From Drinking Water*, Cooperative Research Report, American Water Works Association Research Foundation, Denver, Colorado, 1983.
- *Safe Drinking Water Act*, Code of Federal Regulations (40 CFR 141).
- *Safe Drinking Water and Toxic Enforcement Act*, California Code of Regulations, Title 22.

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THE METALLIC CONTAMINANTS OF GREATEST CONCERN AT JPL ARE MERCURY AND CHROMIUM

National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California
JPL D-13036-5 8/96

Superfund Solutions

JPL's Environmental Cleanup Effort *Number 1* *August 1996*

Good NEIGHBORS

All of us involved in the Superfund Project at the Jet Propulsion Laboratory (JPL) want to express our sincere thanks to our neighbors in Altadena, La Cañada–Flintridge, and Pasadena for your patience and understanding over the past several months. For those of you who had to endure partially blocked streets, large tanks in your yards, or noisy drill rigs around the corner, we have some good news — we're finished! As of now, all of the scheduled offsite drilling for Superfund has been completed.

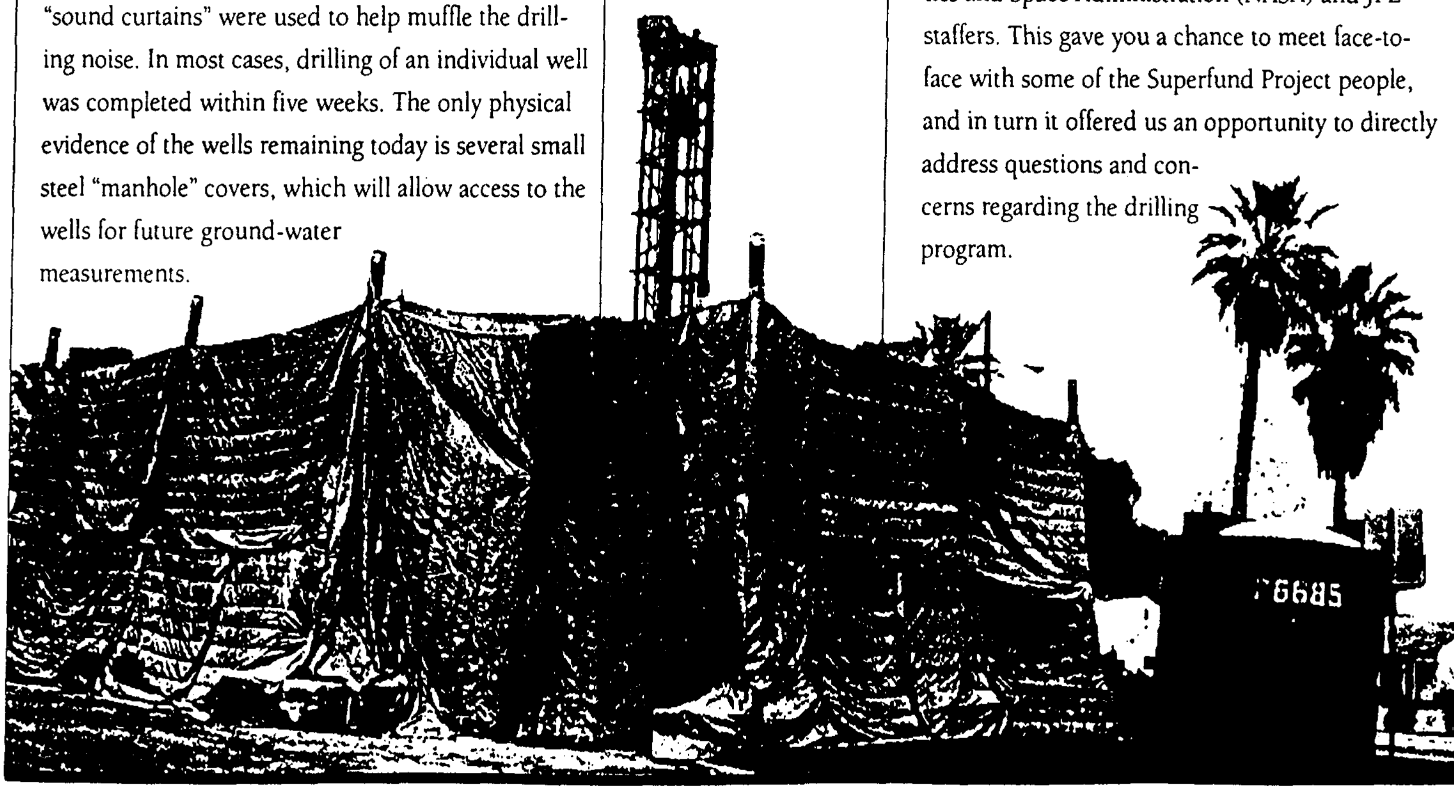
Those who encountered the drilling operation probably didn't see very much, because heavy "sound curtains" were used to help muffle the drilling noise. In most cases, drilling of an individual well was completed within five weeks. The only physical evidence of the wells remaining today is several small steel "manhole" covers, which will allow access to the wells for future ground-water measurements.

BETWEEN GOOD NEIGHBORS THERE IS COOPERATION, THERE ARE SOLUTIONS

Joint COOPERATION

The cooperation of the people who live in the neighborhoods surrounding JPL has really helped to make the drilling phase of the project possible. Throughout the Superfund process, the Laboratory has tried to foster this spirit of cooperation by maintaining open, two-way communication with all affected members of the community. The following paragraphs describe some of these communication avenues and tell you how to get involved in the environmental cleanup process.

Some members of the community were more affected by the drilling than others. Of the five wells that were drilled offsite, one was located in Oak Grove Park, two on city streets in residential areas, one in the Windsor Reservoir area owned by the City of Pasadena, and one in the parking lot of the Altadena Seventh-Day Adventist Church. When drilling occurred in residential areas, letters explaining specific working hours, completion schedules, and steps taken to minimize the inconvenience were hand-delivered throughout the community by National Aeronautics and Space Administration (NASA) and JPL staffers. This gave you a chance to meet face-to-face with some of the Superfund Project people, and in turn it offered us an opportunity to directly address questions and concerns regarding the drilling program.



ENVIRONMENTAL CLEANUP
FACT SHEETS

A series of fact sheets with the title, *Environmental Cleanup Review,* were mailed out to area residents to provide information related to the Superfund process. The first fact sheet gave a brief history of the environmental concerns that led up to JPL's selection as a Superfund site. Later fact sheets covered such topics as how the Superfund process works (No. 2); soil and ground-water testing done on the JPL site (No. 3); and the three principal operational units of the ongoing remedial investigation/feasibility study at JPL (No. 4). If you missed one of these fact sheets or would like more copies, please contact the JPL Public Services Office or visit any specially designated public information repository (see back page).

Special thanks go out to the clergy and congregation of the Altadena Seventh-Day Adventist Church. During the initial stages of the offsite drilling program, members of the JPL Environmental Affairs and Public Affairs offices met with church members to reach an agreement on drilling a well in the church parking lot. NASA and JPL project managers were on hand to answer questions relating to the JPL Superfund activity. In some cases, interested neighbors talked directly with field crews while drilling was taking place. Generally a positive experience both for the field crews and the members of the public, this represents the kind of cooperation that has helped to make the drilling program successful.

SUPERFUND INFORMATION

There are a number of ways to get more information about Superfund. Federal Superfund regulations require *public information repositories,* places where the general public has access to documents relating to the Superfund project. In all of these repositories you will find a number of planning documents such as the health and safety, community relations, and field sampling and analysis plans for each operational unit of the project. In addition, these repositories include the results of current sampling as these reports become available.

Since much of the information in the repositories is technical, the Laboratory has developed a series of *Environmental Cleanup* information sheets to help you understand some of the issues related to Superfund. At this point, information sheets are available on the following subjects: Hydrology, Ground Water, Ground-Water Wells, Soil, and Hazardous Chemicals. For copies of any of these information sheets, contact the JPL Public Services Office; we will send them to you free of charge.

AT THIS POINT, WE HAVE INFORMATION SHEETS ON

- HYDROLOGY
- GROUND WATER
- GROUND-WATER WELLS
- SOIL
- HAZARDOUS CHEMICALS

SOLUTIONS

WHAT HAPPENS NEXT?

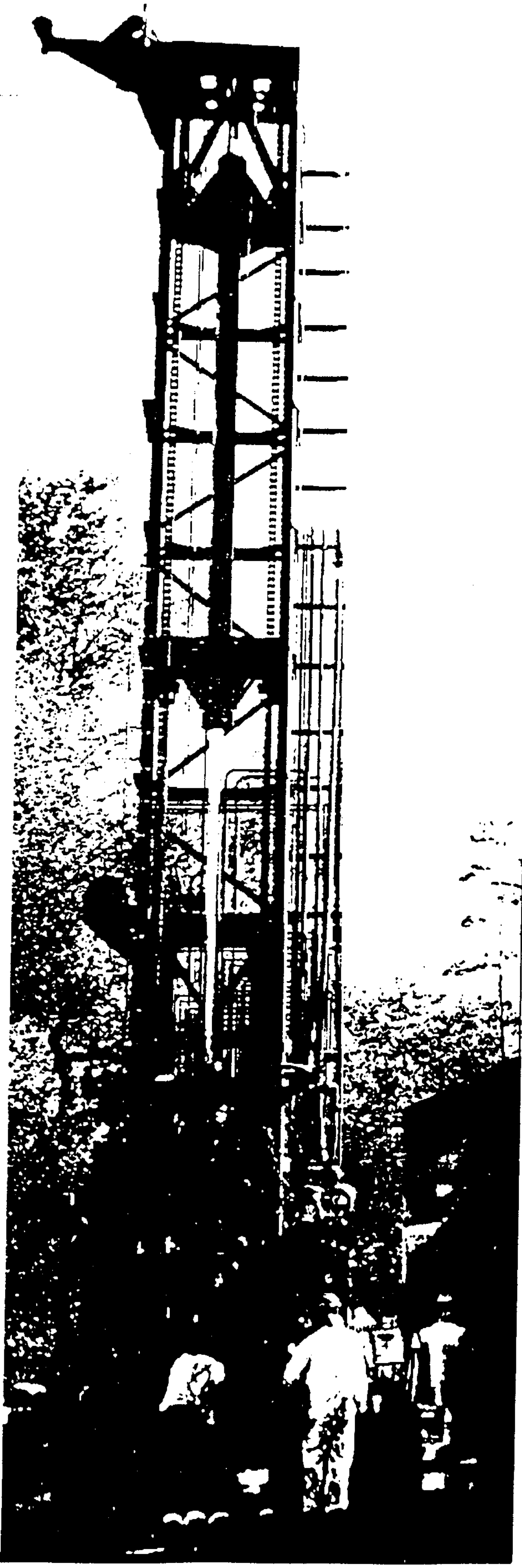
At JPL, the Superfund project is currently in the remedial investigation/feasibility study stage, designed to find out where the contamination is coming from, the extent of the contamination problem, and whether or not the contamination poses a risk to human health, and to determine the best options for dealing with the problem.

Now that the drilling of all off-site ground water–monitoring wells has been completed, the only remaining field work is to sample the ground water on a regular basis. This operation should take less than a day at each well, usually involving no more than a "pickup" truck mounted with some specialized sampling gear and a small electric generator. The purpose of this sampling is to help us understand how ground water is moving, what chemicals are involved, and in what quantities (if any) these chemicals are present.

As our understanding of soil and ground-water contamination in and around JPL improves, we will begin to conduct a Risk Assessment. This part of the project evaluates the information obtained through the remedial investigation to determine exactly what risk is posed to human health and the environment. Based on this potential risk, the need for remedies will be determined. Once completed and approved by the regulatory agencies, the results of this Risk Assessment will be available in the public information repositories.

Completion of the remedial investigation/feasibility study will mark an important milestone in the Superfund process. After the Environmental Protection Agency and the State of California have reviewed the report, there will be a 30-day period for open public comment on any proposed remediation plan. JPL will attempt to notify all parties interested in the Laboratory's Superfund process.

Local public meetings will be held with the community during the public comment period. The purpose of these meetings is to solicit formal public comment and testimony before adopting a specific plan for cleanup. Any concerns identified will be addressed prior to the adoption of a final renewal plan. These meetings are an extremely important part of the Superfund process. Public meetings will be announced in local newspapers and by direct mailing to local residents. To receive notice of these meetings, please contact the JPL Public Services Office and ask to be placed on the Superfund mailing list.



FURTHER INFORMATION

As the cleanup effort progresses, JPL will keep neighbors informed of developments and solicit community feedback. Copies of documents related to the cleanup will be maintained and updated at these local public information repositories:

Altadena Public Library
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NASA
National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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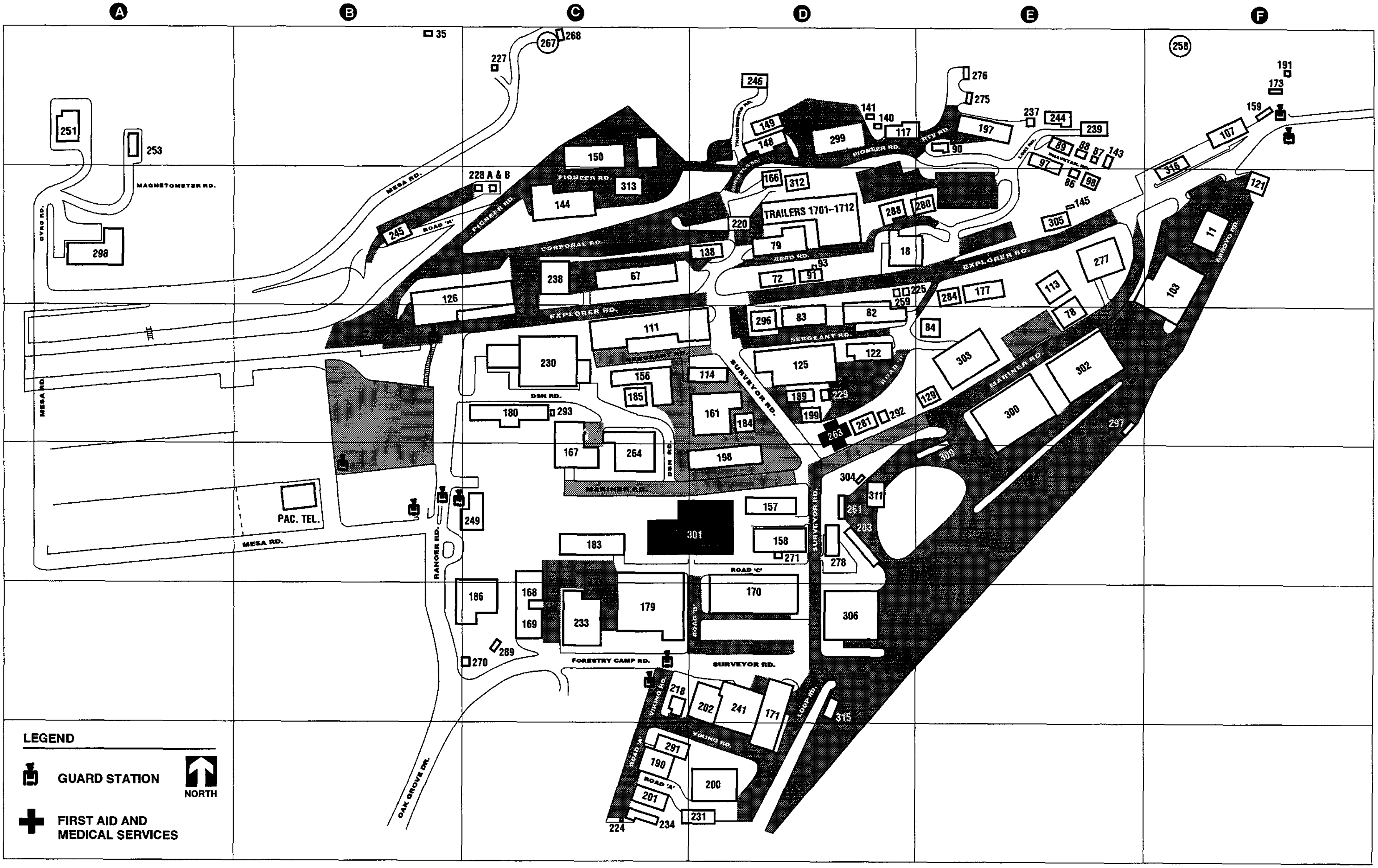

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MAGNETOMETER RD.
GYRO RD.
MESA RD.
PIONEER RD.
CORPORAL RD.
EXPLORER RD.
AERO RD.
SERGEANT RD.
SURVEYOR RD.
DSN RD.
MARINER RD.
RANGER RD.
OAK GROVE DR.
FORESTRY CAMP RD.
VIKING RD.
LOOP RD.
ROAD 'A'
ROAD 'B'
ROAD 'C'
ARROYO RD.
TRAILERS 1701–1712
PAC. TEL.
LEGEND
GUARD STATION
NORTH
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MEDICAL SERVICES

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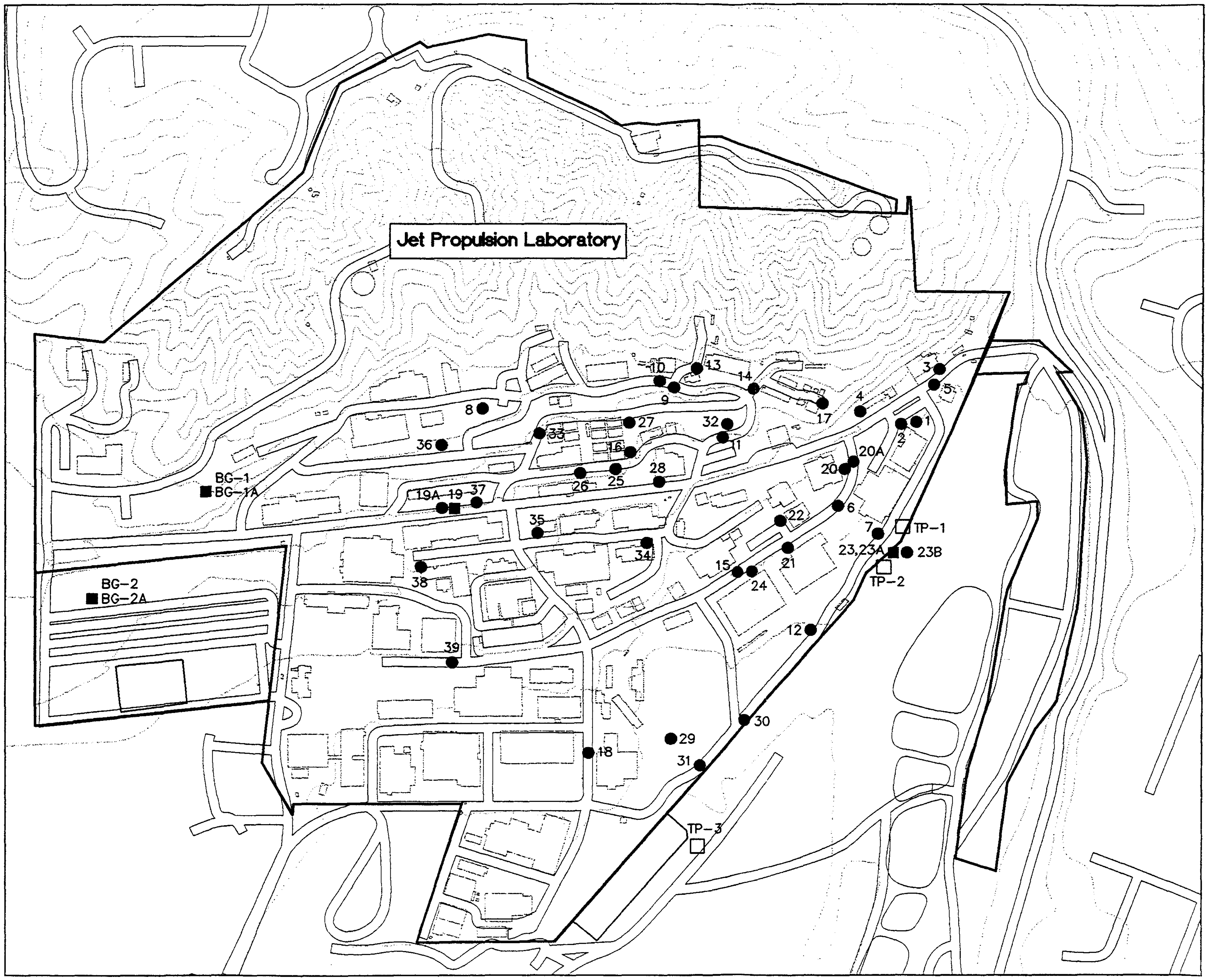


Explanation

■ 23 Soil Boring Drilled During RI Investigation

● 39 Soil Vapor Well Converted from Soil Boring During RI Investigation

□ TP-1 Test Pit Completed During RI Investigation

N

400 200 0 400

SCALE IN FEET

Source: USGS, 7.5 Minute Topographic Map Pasadena, CA 1966, Revised 1988, 1994.

FIGURE 2-13

LOCATIONS OF ALL SURVEYED SOIL VAPOR WELLS, SOIL BORINGS AND TEST PITS AT JPL

Jet Propulsion Laboratory
Pasadena, California

FOSTER WHEELER ENVIRONMENTAL CORPORATION

12-02-98

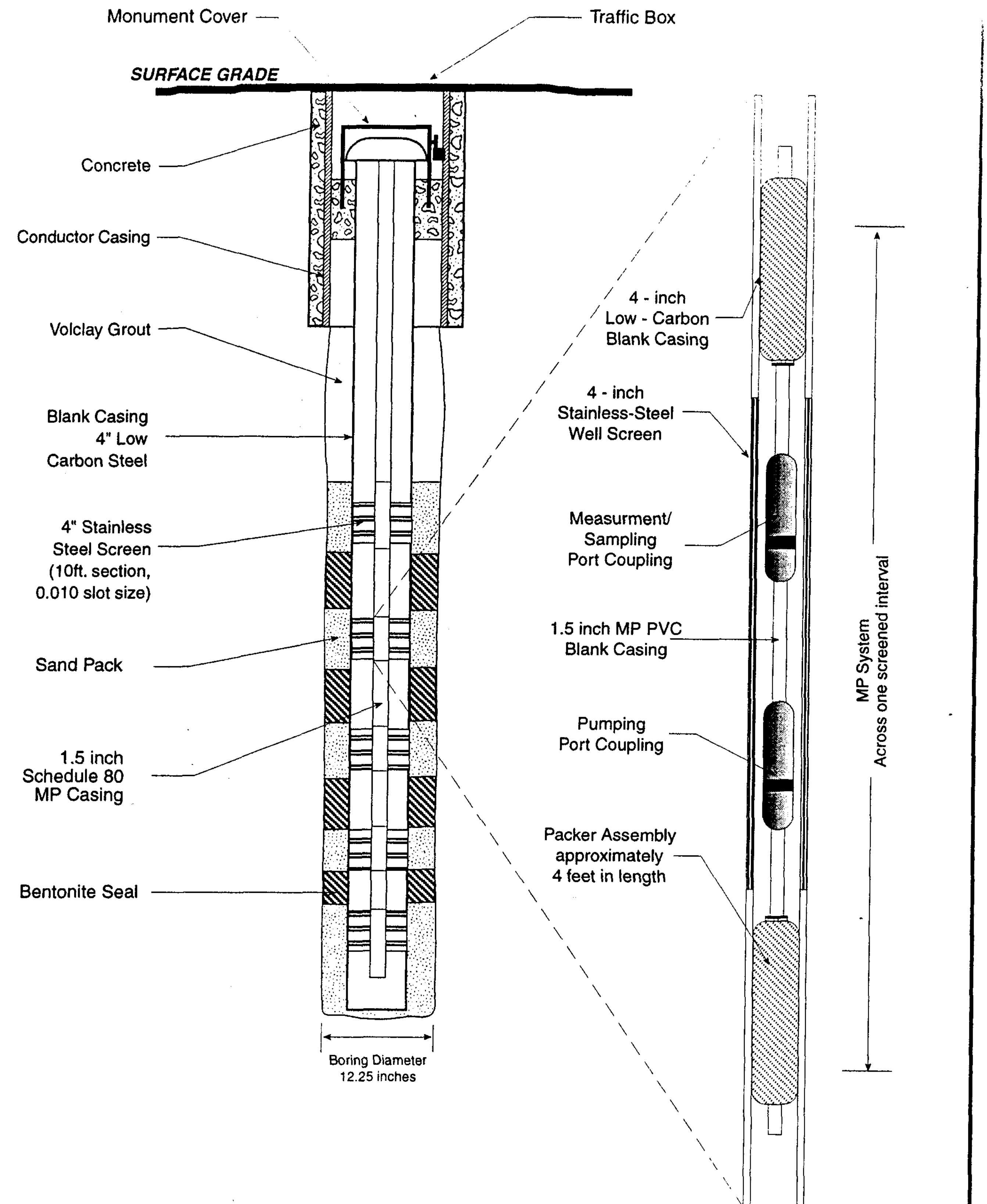


Figure 2-4

Typical Multi-Port (MP)
Monitoring Well Casing Installation

Jet Propulsion Laboratory
Pasadena, California

1572.0223

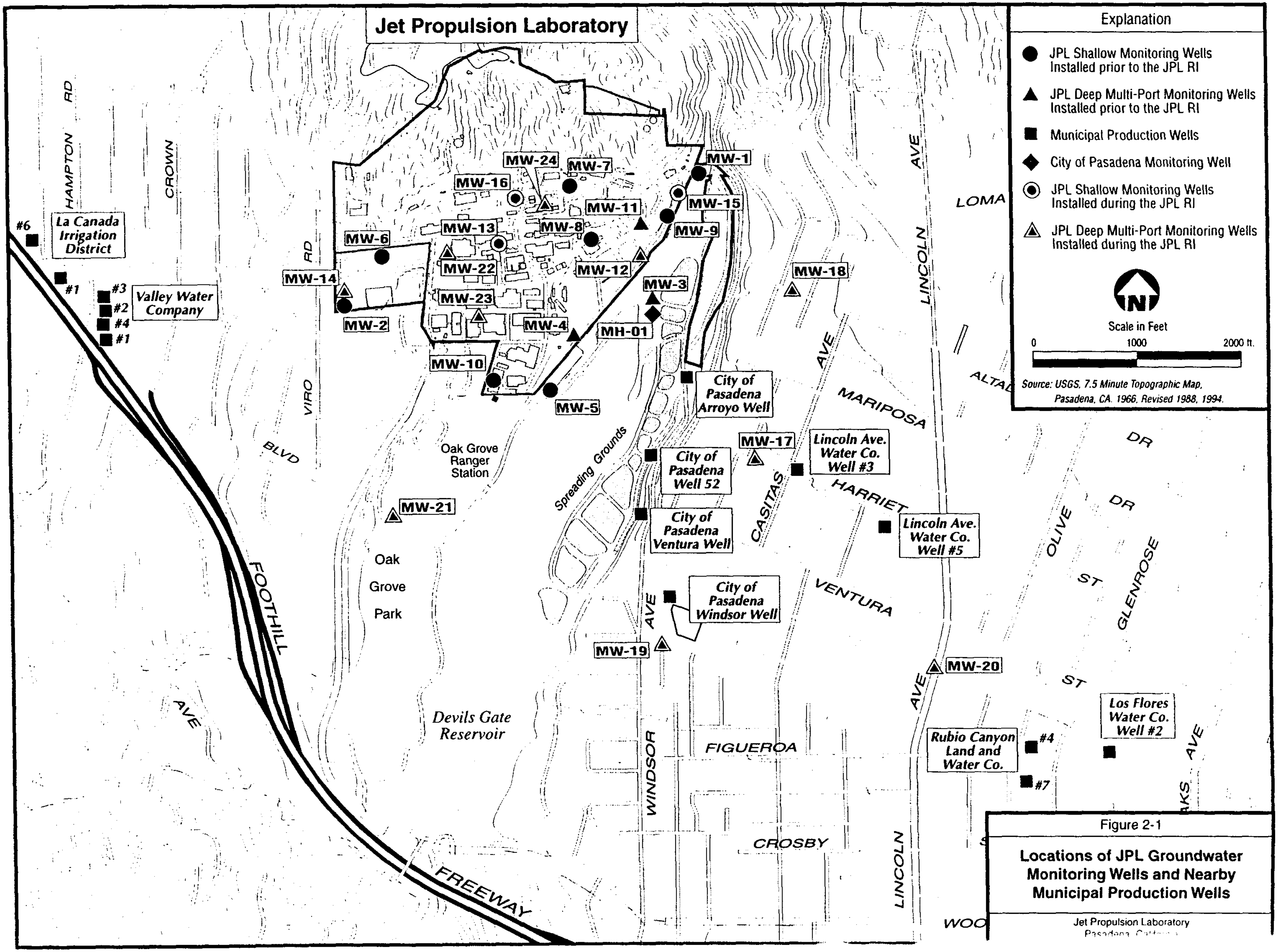


Figure 2-1

Locations of JPL Groundwater Monitoring Wells and Nearby Municipal Production Wells

Jet Propulsion Laboratory
Pasadena, California

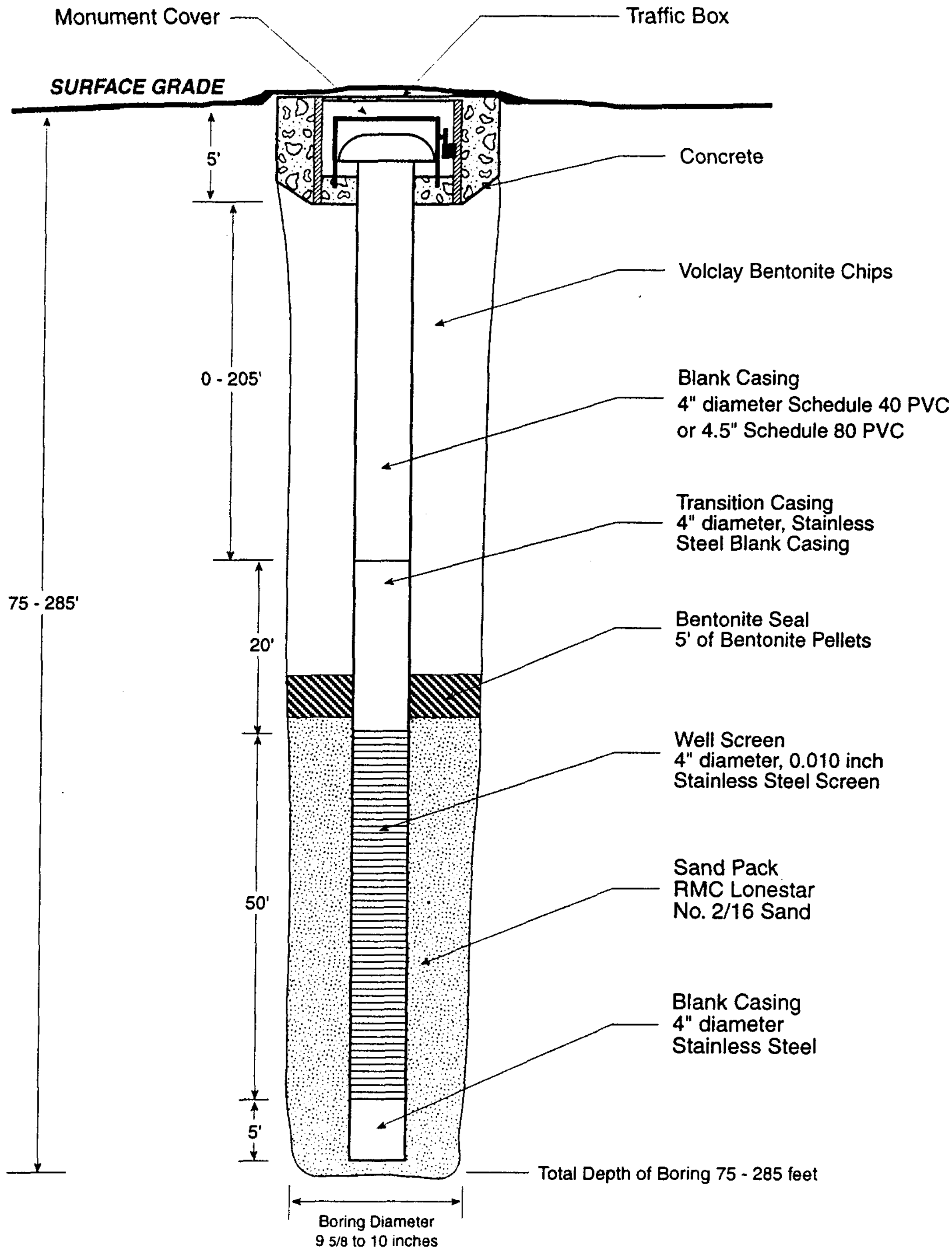
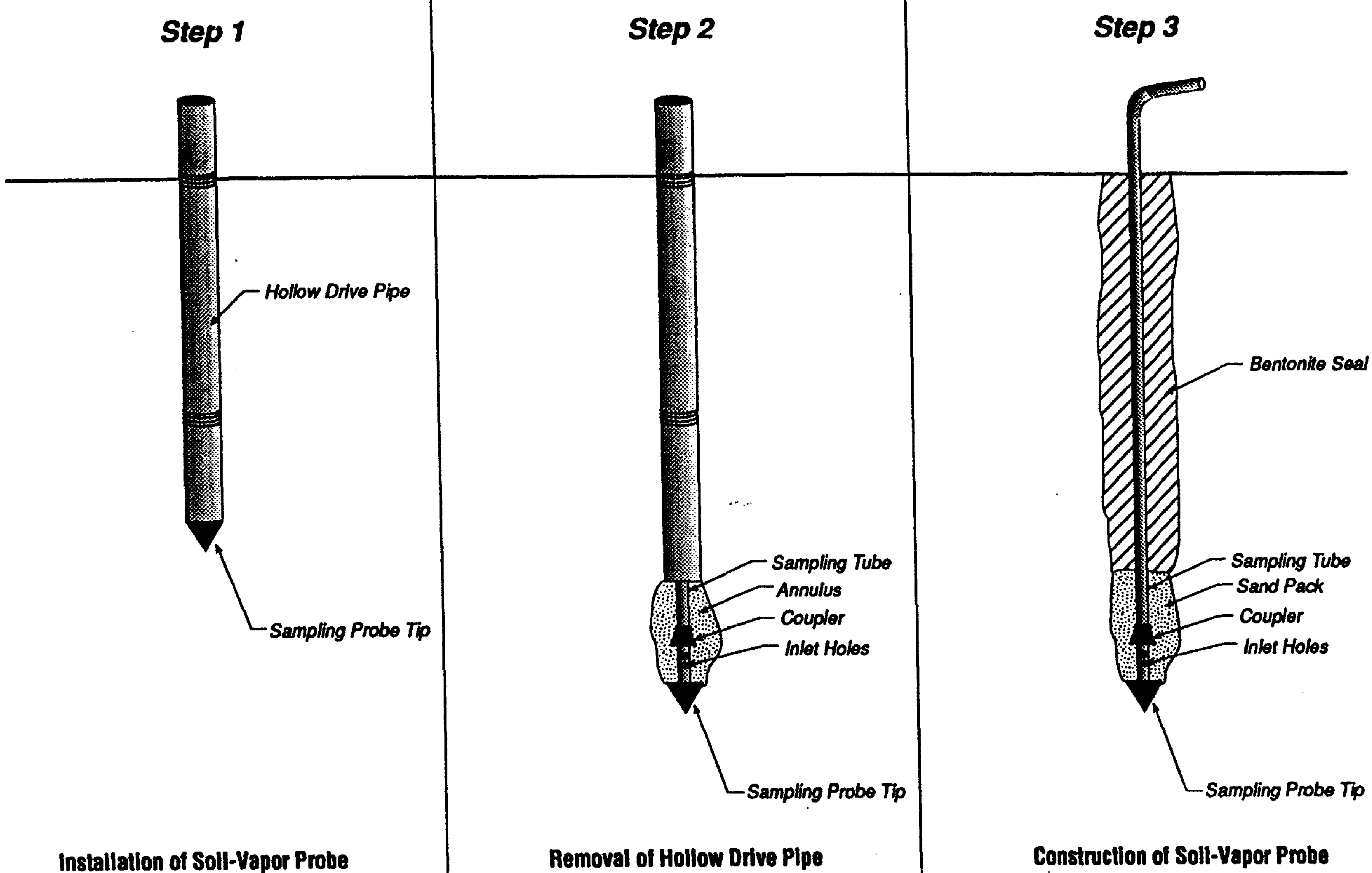


Figure 2-2

Design of Typical Shallow Groundwater Monitoring Well

Jet Propulsion Laboratory
Pasadena, California

1572.0223



Not to Scale

FIGURE 2-3

TYPICAL SCHEMATIC OF A
SOIL VAPOR PROBE INSTALLATION

Jet Propulsion Laboratory
Pasadena, California

FOSTER WHEELER ENVIRONMENTAL CORPORATION

BRDR2-3.DWG

11-17-98