CONVERSE CONSULTANTS WEST

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FINAL FEASIBILITY STUDY REPORT

Proposed Percolation System
Leased East Parking Lot
Arroyo Seco Spreading Grounds
Pasadena, California

PREPARED FOR

Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91109

CCW Project No. 90-31-300-42

January 6, 1995

A Wholly Owned Subsidiary of
The Converse Professional Group

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Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91109

Attention: Mr. J. D. Lafontan
Mail Stop 200-217R

Subject: FINAL FEASIBILITY STUDY REPORT
Proposed Percolation System
Leased East Parking Lot
Arroyo Seco Spreading Grounds
Pasadena, California
CCW Project No. 90-31-300-42

Gentlemen:

Converse Consultants West (Converse) is pleased to present this final report of the results of our percolation tests and geotechnical feasibility study for installation of water spreading/percolation facilities at the east parking lot for JPL, owned by the City of Pasadena. This lot is located adjacent to the existing Arroyo Seco spreading grounds upstream from the Devil's Gate Dam. Our services were performed in accordance with JPL Contract No. 959002, authorized under Work Order Nos. 69 and 69-1.

Our scope of work for this study was limited to meetings with the City of Pasadena and JPL representatives, research of available subsurface information for the Devil's Gate Spreading Ground area, percolation tests at two locations in the parking lot, geotechnical/geologic analyses and calculations, and preparation of this report. This study does not include any subsurface exploration other than the percolation tests. Percolation test procedures and results are documented in Appendix A, "Field Exploration."

PROJECT DESCRIPTION

This feasibility study was based on the following assumptions. The City of Pasadena, who currently owns the east parking lot, is interested in redeveloping the parking lot into additional spreading facilities. The City's intent is to receive credits from the Metropolitan Water District for operation of the proposed spreading grounds. It is the City's tentative plan to percolate storm water from the Arroyo Seco that exceeds the capacity of the existing adjacent John L. Behner Water Treatment Plant. The City has a goal of infiltrating 5 cubic feet per second (cfs) [0.14 cubic meters per second (cms)] of water. JPL does not wish to lose use of the east parking lot, and is interested in evaluating alternate spreading options that will meet the City's goal while retaining use of the east lot for parking.

Water for the spreading facility will be provided through the City of Pasadena's existing water system. This system collects runoff from the Arroyo Seco, upstream from the parking lot. The City currently has settling and desilting facilities in operation. Therefore, water proposed for spreading in the system will be relatively sediment free. The parking lot has an average southerly descending grade of about 2.5 percent, based on an elevation of 1126 feet (343.2 m) above Mean Sea Level (MSL) at the north end of the lot, and 1090 feet (332.2 m) above MSL at the southern gate.

PERCOLATION CAPACITY ANALYSES

Hydraulic conductivity (or soil permeability), commonly abbreviated as k, is defined as the rate that water will move through a unit cross-sectional area of earth under a given hydraulic gradient at standard temperature and pressure. In this report, hydraulic conductivity is listed in units of gallons per day per square foot (gpd/ft^2) and centimeters per second (cm/sec).

Research Results

Data available from operation of the adjacent Arroyo Seco spreading grounds was reviewed to attempt to define the hydraulic conductivity at the site. Several sources were reviewed, including:

- A spreading summary detailing and comparing calculations derived by both the City of Pasadena and JPL was reviewed, as documented in Appendix B, "Summary of Data and Calculations." Using data from the spreading summary, Converse calculated a hydraulic conductivity of 14.8 gpd/ft^2 (0.7×10^{-3} cm/sec) for the Arroyo Seco spreading grounds.

- A Technical Assessment of the Devil's Gate Multi-Use Project prepared by CH2M Hill in 1990 and 1992 was reviewed. CH2M Hill provided data from a 1986 report by Los Angeles County Department of Public Works (LACDPW) on the long-term percolation rate of the Arroyo Seco spreading grounds. To calculate the hydraulic conductivity, the estimated square footage of the spreading grounds taken from the spreading summary by the City of Pasadena and JPL was used, as documented in Appendix B. Hydraulic conductivities of 23.2 gpd/ft^2 (1.1x10^{-3} cm/sec) and 33.7 gpd/ft^2 (1.6x10^{-3} cm/sec) were calculated, respectively.

- The Los Angeles County Department of Public Works Hydrologic Report 1991-92, provided information on a short-term (5-day) percolation rate, area of wetted land, and storage capacity of the spreading grounds. Using this data, Converse calculated a hydraulic conductivity of 17.7 gpd/ft^2 (8.3x10^{-4} cm/sec). However, it should be noted that using the data provided by the LACDPW, the depth of the spreading basins was calculated by Converse to be about 2 feet (0.6 m) deep, which does not correspond to data provided by the City of Pasadena and JPL, indicating that the basins are 5 feet (1.5 m) deep, or visual observations of the ponds which shows them to be greater than 2 feet (0.6 m) deep.

Using these calculated hydraulic conductivity values, Converse calculated costs for installation of a trench system and a borehole system for percolation. These conceptual designs are described in further detail in the "Design Alternatives" section which follows. Cost estimates range from roughly \$0.5 million to \$1.5 million for the trench system based upon the range of hydraulic conductivities discussed above (0.7 to 1.6 x 10^{-3} cm/sec). Similarly, cost estimates based upon a conceptual design for the borehole system range from roughly \$1 million to \$3 million. These significant <u>variations</u> in estimated costs were based solely on the variation of the hydraulic conductivity (soil permeability). Therefore, it was considered prudent to perform percolation tests at the site, to develop a more accurate estimate of the site percolation capacity.

<u>Current Percolation Test Results</u>

Two percolation tests were performed in the east parking lot as documented in Appendix A. Test pit TP-1 was located in the southern portion of the parking lot and test pit TP-2 was located in the northern portion of the lot as depicted on Figure 1, "Location of Test Pits." Logs for each test pit are provided in Appendix A.

Based on the test results, hydraulic conductivities were calculated for each test pit, ranging from 170.9 to 188.6 gpd/ft^2 (8.1x10^{-3} to 8.9x10^{-3} cm/sec) for TP-1, and 348.3 to 377.7 gpd/ft^2 (1.6x10^{-2} to 1.8 x 10^{-2} cm/sec) for TP-2. The hydraulic conductivities were averaged together, resulting in an average hydraulic conductivity of 256.1 gpd/ft^2 (1.2x10^{-2} cm/sec).

It has been our experience that actual system efficiency is usually approximately 60 to 80 percent of the pilot test results. Therefore, a range of 153.7 to 204.8 gpd/ft^2 (7.3x10^{-3} to 9.7x10^{-3} cm/sec) more closely approximates the hydraulic conductivities that will likely be appropriate for percolation system design.

<u>Data Variations</u>

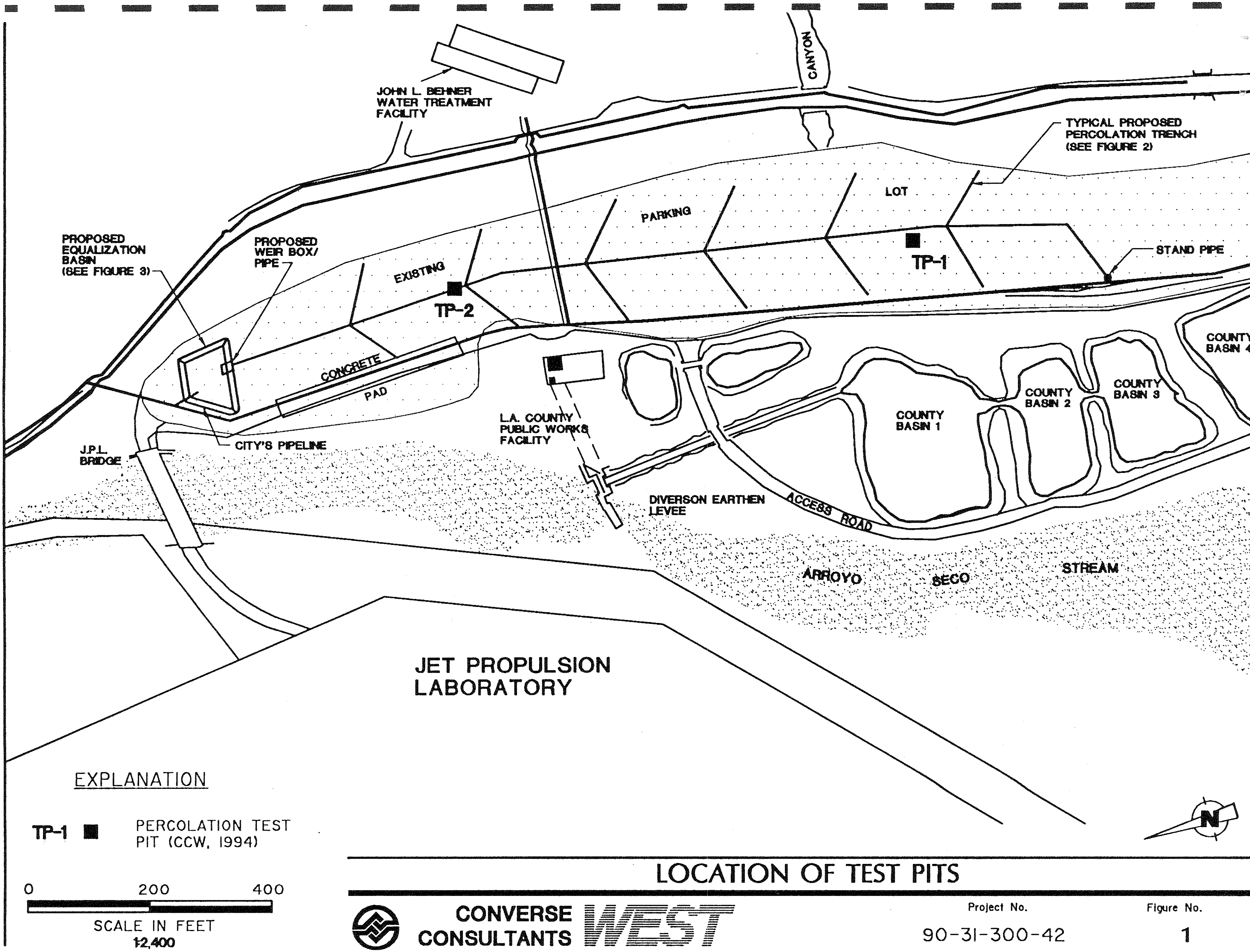
Actual hydraulic conductivities measured from the two percolation tests vary greatly from the hydraulic conductivities previously calculated based on information for the adjacent settling ponds. The discrepancy is most likely attributed to one or more of the following reasons:

- The existing settling ponds have been in operation for several years, and have most likely accumulated a large amount of sediment (siltation) at and below the base of the ponds. The water spread for settling in the existing ponds originates from storm water runoff from the arroyo, and most likely has a much larger amount of sediment than the water planned for spreading in the proposed JPL system. Therefore, it is likely that siltation rates for the proposed JPL system will be lower.

- Algae and other plant growth in the open basins (exposed to the sun) may be reducing soil permeability at and near the existing basin surfaces.

DESIGN ALTERNATIVES

The actual water infiltration quantity that will be achievable at the site is dependent on (1) the amount of area designated for spreading, (2) the hydraulic gradient (or pressure head), and (3) the hydraulic conductivity (permeability) of the underlying soil. The amount of area designated for spreading will depend on the shape and size of the subsurface structure(s)



LOCATION OF TEST PITS

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Project No.	Figure No.
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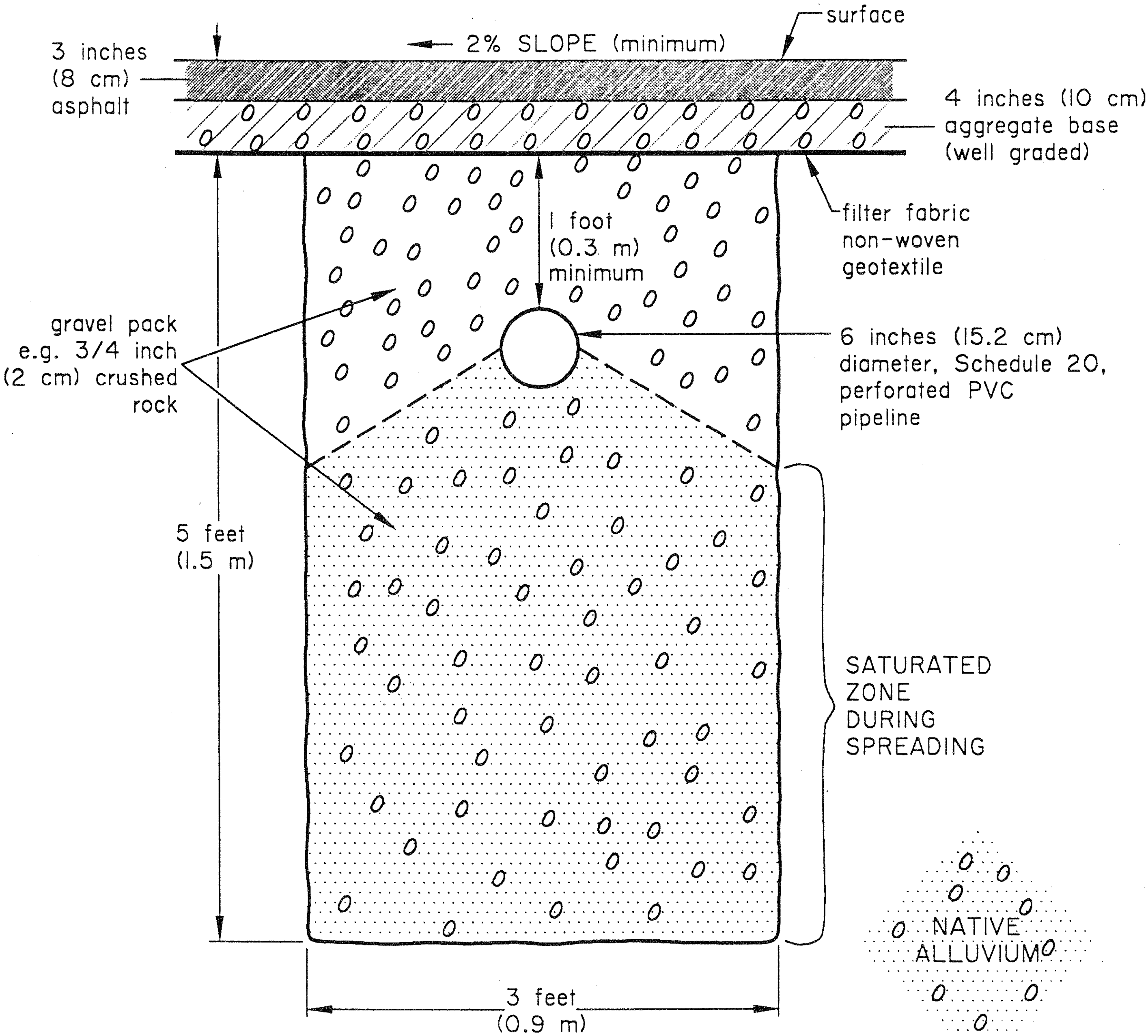
developed for spreading. Converse has considered at least three subsurface spreading structures including:

- Leach Field Trenches: A series of trenches would be excavated 5 feet (1.5 m) deep and 3 feet (0.9 m) wide, as depicted on Figure 2, "Typical Trench Detail." A "feeder" trench would be constructed in a north-south direction through the center of the property. This trench would feed water from a proposed equalization basin (or similar system) to be constructed at the north end of the parking lot, to a series of east-west trending lateral trenches constructed using a south-facing dendritic pattern. This system is illustrated schematically in plan view on Figure 1. The trench system would operate under gravity feed facilitated by the average 2.5 percent southern grade.

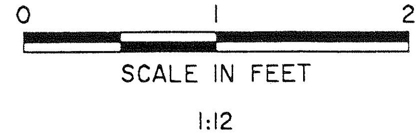
  Figure 3, "Conceptual Equalization Basin Design," depicts a schematic cross-section through the equalization basin proposed to be constructed at the north end of the parking lot as part of the percolation system. It is likely that this equalization basin system would be used for either the leach field trenches or for dry wells discussed in the following subsection, as a hydraulic control system and also to reduce silt in the water to be percolated. **The primary purpose of this equalization basin is to reduce silt in the water to be percolated.**

  Should the water from the Pasadena system be relatively free of silt, a much more economical equalization system could be constructed, rather than the relatively costly basin depicted on Figure 3. One possible alternative may include solely a vertical corrugated metal pipe, with an inlet and outlet pipe as a weir system (configured similar to the corrugated metal pipe weir system depicted on Figure 3). However, a secondary advantage of the equalization basin is that additional percolation would occur at the bottom of the basin. The basin would also likely extend the life of the system by allowing for additional settlement of suspended solids before water enters into the leach field piping system.

  As depicted on Figure 2, leach trenches would be backfilled with gravel, and contain a six-inch (15.2 cm) diameter, Schedule 20 perforated PVC pipeline located about one foot (0.3 m) below the surface. Near the surface, the trench would be covered with a filter fabric, and a conventional combination of aggregate base and asphalt pavement



SCHEMATIC CROSS SECTION



TYPICAL TRENCH DETAIL

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Project No.	Figure No.
90-31-300-42	2

would be restored. Nine square feet (0.8 m^2) of surface area available for spreading (walls and bottom) has been calculated for each lineal foot (0.3 m) of trench.

- "Dry" Wells: A series of deep, large-diameter boreholes could be constructed as a second alternative. We considered 4-foot (1.2 m) diameter boreholes drilled to a depth of about 100 feet (30.5 m). The boreholes would be connected using a similar trench system as described above, with a north-south direction feeder trench connected to a series of east-west trending lateral trenches (in a south facing dendritic pattern) that would connect the boreholes. Again, water movement through the pipelines would be by gravity feed using the average 2.5 percent southern grade.

  A six-inch (15.2 cm) diameter, Schedule 20 solid casing PVC piping would be installed in the trenches about 1.5 feet (0.5 m) below the surface and connected to each borehole. Boreholes would be spaced a minimum of 10 feet (3 m) apart for safety (caving) reasons during drilling. Each borehole would be backfilled with gravel from the base of the borehole to the surface. Calculated surface areas available for spreading in the 4-foot (1.2 m) diameter borehole is 1,256 square feet (116.7 m^2).

- Covered Basins: Some of the possible configurations available for a covered "basin" include the following:

  (1) A cast-in-place reinforced concrete "bridge" structure to support parking over a percolation basin,

  (2) A pre-cast concrete (such as "Span-Crete") structure,

  (3) A series of vertical, pre-cast concrete pipes on the order of 4 feet (1.2 m) in diameter or larger, with a pre-cast reinforced concrete cap, which in turn is covered with asphalt pavement,

  (4) Vertical corrugated metal pipe (CMP), galvanized, at a similar configuration as (2) above, or horizontal corrugated metal arches (bridges without bottoms) placed side-to-side, or

(5) A steel and wood frame structure consisting of driven steel piles, steel beams and wood planking between the beams, as a somewhat temporary structure.

These five alternatives are presented in anticipated decreasing costs, with the reinforced concrete structure being the most costly, and the driven steel and wood frame structure probably being the least costly. However, the reinforced concrete structure is expected to be the most durable with the longest design life. Several cost factors should be considered when evaluating these alternatives, including the design life of the project.

The approximate number of lineal feet of leach trenches (trenching scenario), and 100-foot (30.5-meter) deep, 4-foot (1.2 meter) diameter boreholes (borehole scenario) are summarized on Table 1, "Summary of Trench and Borehole System Requirements."

TABLE 1

SUMMARY OF TRENCH AND BOREHOLE SYSTEM REQUIREMENTS

Percolation Rate	Hydraulic Conductivity (k)	Trenches (1)			Number of Boreholes (2)
		Lineal Feet (Meters) of Trench	Number of Lateral Trenches	Lateral Trench Spacing	
5 cfs (*0.14 cms*)	153.7 gpd/ft² (*7.3x10⁻³ cm/sec*)	2,331 ft (*710 m*)	6	194 ft (*59 m*)	17
	204.8 gpd/ft² (*9.7x10⁻³ cm/sec*)	1,748 ft (*533 m*)	3	340 ft (*104 m*)	13

NOTES:

(1) Trenches based on an approximately 1,360-foot-long (414.5 m) feeder trench running north/south through the center of the parking lot, feeding east/west trending lateral trenches that will average approximately 150 feet (45.7 m) long. Trenches will be five feet (1.5 m) deep and three feet (0.9 m) wide.

(2) Borehole calculations based on 4-foot-diameter (1.2 m) borehole installed to a depth of 100 feet (30.5 m).

COST ESTIMATES

Using the data provided in Table 1, general cost estimates were prepared for the trenching alternative and the borehole alternative, based on a percolation rate of 5 cfs (0.14 cms). These cost estimates are presented in Appendix C, "Cost Estimates." Several assumptions were made for each cost estimate, and are detailed at the bottom of each table in Appendix C.

As shown on Tables C-1 and C-2 in Appendix C, the trenching system would be significantly less costly to install than a dry well system. At a percolation rate of 5 cfs (0.14 cms), costs for trenching would range from approximately $100,000 to $150,000, and costs for installation of the borehole system would range from $200,000 to $300,000. These cost estimates were based on several assumptions. One of the assumptions that is likely suspect is the drilling rate for the dry well system in the dense alluvium with cobbles and boulders. Drilling rates are expected to be very slow due to the cobble and boulder content in these materials, and could vary significantly. The estimated upper bound cost for the dry well system of $300,000 may be low, based upon drilling experience for other projects at JPL and adjacent the Arroyo Seco.

These cost estimates did not consider the cost of the equalization basin at the north end of the parking structure. As previously described, the equalization basin system would likely be required for either alternative. Should an extensive desilting system be necessary, and a large equalization basin constructed, it is possible that the equalization basin design could add several hundreds of thousand dollars to the project cost. However, if a simple equalization system consisting of a vertical corrugated metal pipe is sufficient as the upstream equalization system, then a nominal increase in the cost on the order of $5,000 to $10,000 would be appropriate for initial estimates.

In addition, it should be noted that higher costs would be associated with higher percolation quantities. If the City is interested in a percolation rate higher than 5 cfs (0.14 cms), the cost would be higher. Likewise, if the City would like to reduce the installation cost, they would have to install a system designed for a lower percolation quantity.

PERMITTING

A review of permitting requirements for installation and/or operation of additional spreading facilities was performed. The following agencies were contacted:

- City of Pasadena,
- Los Angeles County Department of Public Works,
- Raymond Basin Management Board,
- Metropolitan Water District (MWD),
- Regional Water Quality Control Board (RWQCB),
- U.S. Army Corps of Engineers, and
- United States Environmental Protection Agency (U.S. EPA).

Table 2, "Permit Requirements for Spreading Grounds Facilities," summarizes the people contacted and the permitting information provided.

TABLE 2

PERMIT REQUIREMENTS FOR SPREADING GROUNDS FACILITIES

Agency	Contact	Phone Number	Permit Requirements
Raymond Basin Management Board	Mr. Ron Palmer	(818) 790-4036	The Board has no existing requirements for installation of new spreading facilities. All of the existing spreading facilities were in place when the Board was created. The Board would like to be kept informed of the status of new installations.
Los Angeles County Department of Public Works, Hydraulic Water/Conservation Division	Mr. Eric Hitchman	(818) 458-6310	As long as the proposed spreading grounds are located on City property, the County has no jurisdiction over the installation or operation of the facility. As far as Mr. Hitchman knows, there are no permit requirements.
City of Pasadena, Water Department	Mr. Brad Bowman	(818) 405-4278	Comprehensive approach and design reviews required.
Metropolitan Water District (MWD)	Mr. Ken Kules	(213) 217-6792	MWD has no permit requirements unless the water being spread is their water.
Regional Water Quality Control Board, Los Angeles Region	Mr. Carlos Urrunaga	(213) 266-7598	The project may require a Construction Activity Stormwater Discharge Permit that covers erosion sediment controls.
Regional Water Quality Control Board, Los Angeles Region (RWQCB)	Ms. Lauma Jurkevics	(213) 266-7609	If the site is spreading water from US Waters as defined by the US Army Corps of Engineers, a Section 401 Water Quality Certification will be required. In addition, waste discharge (excavated soil and waste asphalt) must be approved by Mr. John Lewis with the RWQCB before disposal at a Class III (non-hazardous) landfill.
Regional Water Quality Control Board, Los Angeles Region	Mr. Dave Bacharowski	(213) 266-7546	As long as only stream diversion is performed as a water source, no waste discharge permit is required. However, if any contaminated water, or water originating from an urban source is used, a National Pollution Discharge Elimination System (NPDES) permit will be required.
US Army Corps of Engineers	Mr. Aaron Allen	(213) 894-0349	Approach and design reviews required.

RECOMMENDATIONS

Based on results of percolation tests performed at the site, and analyses of data collected from these tests, Converse recommends installation of a trench (leach) system for water percolation for the following reasons:

- Installation of a trench system would be less expensive than installation of a series of dry wells or covered basins.
- Installation of a trench system would likely constitute the shortest installation timeframes, with less uncertainties due to drilling.
- The trench system would require fewer engineering controls, and would be easier to clean out (for sediment, bacteria, algae, etc.) than the other two systems.

If the trench system is selected, Converse recommends that the following engineering controls be considered for inclusion in system design:

- Installation of a weir system within the proposed equalization basin is recommended to reduce the water velocity into the system, and allow for additional settling of solids that may remain suspended in the water.
- A metering system, installed between the City's pipeline and the percolation system, to record the amount of water diverted into the spreading facilities will be required for the City to document the amount of water percolated, for MWD credit.
- An automatic shut-off valve, from the City's pipeline into the system, will be required to avoid overflowing and upheaval of the overlying parking lot.
- A series of pipe clean-out bulkheads should be installed along the trenches, for periodic cleanout of sediment, etc. from the pipeline system. We recommend that clean-outs be installed at each pipe intersection, or at about 100 to 200 feet (30.5 to 61 m) along the pipe.
- A stand pipe on the order of 5 feet high (1.5 m) above the asphalt pavement should be provided at the southern (lower elevation) of the percolation piping system. This stand pipe should act as a "relief valve"

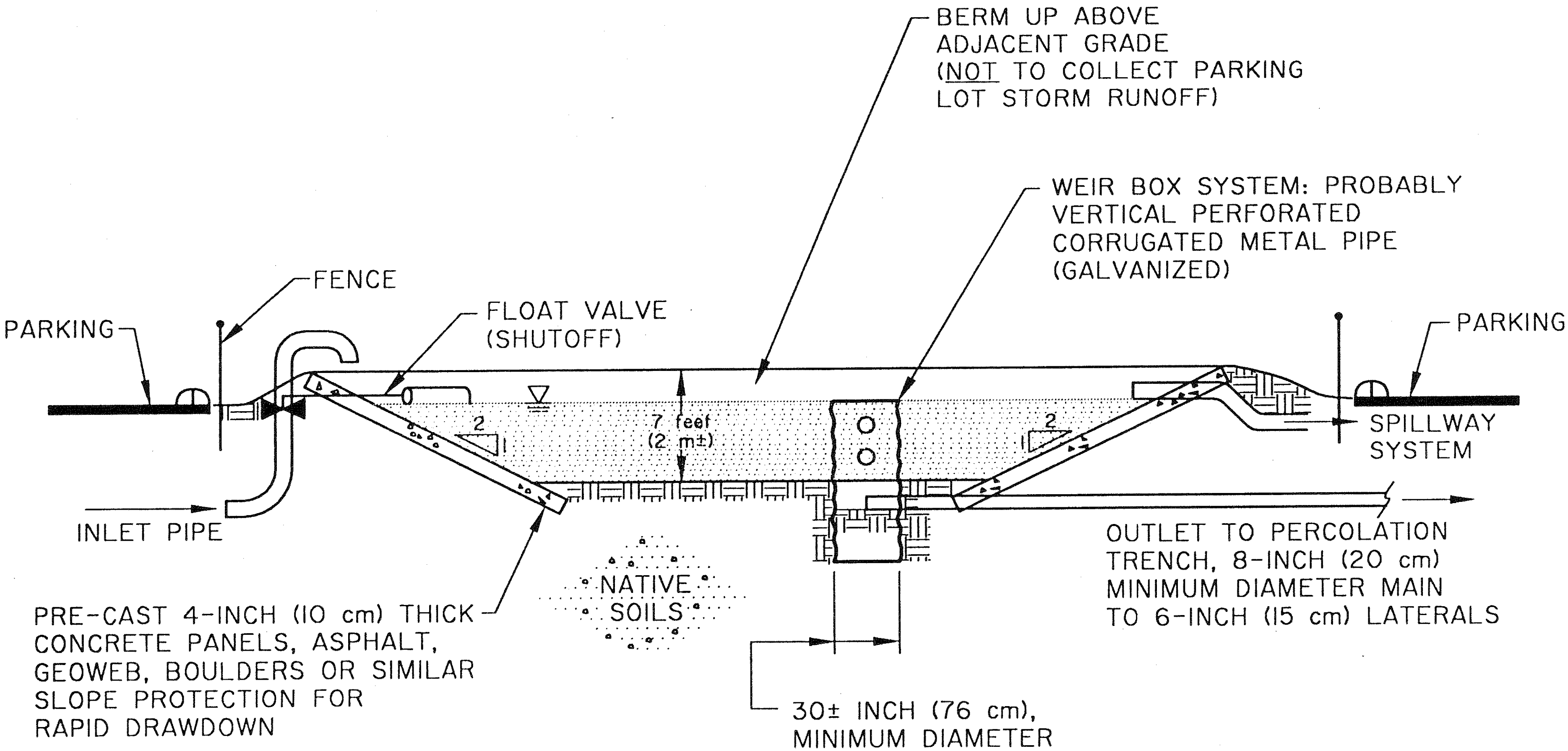
such that water head in the piping system does not build up to a pressure which may cause upheaval of the gravel trenches and overlying asphalt pavements. Stand pipes should have a curved or otherwise covered opening, to prevent fouling and to reduce the potential for vandalization. Further, the stand pipe should discharge to a suitable non-erosive drainage area, possibly draining into the County percolation basins, the Arroyo Seco Creek, or another City-approved collection point. The stand pipe will allow trapped air to be vented to the atmosphere instead of forced into the subsurface, where it may be trapped in pore spaces and reduce the permeability of the soil.

- The design should be relatively closed to prevent animal intrusion, algae and bacteria growth, and reduce the potential for vandalism. For these reasons, a large equalization basin may be undesirable, depending upon the sediment in the water to be percolated.

For the most part, operation and maintenance of the trench system should be similar to the costs associated with operation and maintenance of the existing percolation basins operated by the County. However, it is possible that some increased maintenance costs may be associated with cleaning the piping system. These costs can be reduced if the percolated water is relatively free of sediment, algae and other contaminants, and if the system is relatively closed and not exposed to open air. **Ultimately, the design life of the system will be a function primarily of the sediment in the water to be percolated. If there are a lot of suspended solids in the water, the suspended solids will percolate into the pour space of the alluvium (sand and gravel), reducing the permeability of the soils which underlie the parking lot.** If the water has a high silt content, then the extensive equalization basin depicted on Figure 3 is strongly recommended as an integral part of the percolation system, primarily to reduce silt content in the water to be percolated.

CLOSURE

Our findings and recommendations were prepared in accordance with generally accepted professional geotechnical engineering and geologic principles and practice^[in Los Angeles County at this time. We make no other warranty, either express or implied.



SCHEMATIC CROSS SECTION

NOT-TO-SCALE

CONCEPTUAL EQUALIZATION BASIN DESIGN

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Figure No. 3

We appreciate the opportunity to be of continued service to JPL. We recommend that Converse stay involved in this project and provide additional assistance during the design phase of the project. If you should have any questions or require additional service, please do not hesitate to contact either of the undersigned or others at our office. Voice mail for the undersigned Principal Engineer can be reached at (818) 666-1802.

Respectfully submitted,

CONVERSE CONSULTANTS WEST

Thomas C. Benson, Jr., GE 2091
Senior Vice President/Managing Officer

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STATE OF CALIFORNIA

Dist: 12/Addressee

Encl: Figure 1, "Location of Test Pits"
Figure 2, "Typical Trench Detail"
Figure 3, "Conceptual Equalization Basin Design"
Appendix A, "Field Exploration"
Appendix B, "Summary of Data and Calculations"
Appendix C, "Cost Estimates"

REGISTERED PROFESSIONAL ENGINEER
THOMAS C. BENSON, JR.
No. 2091
Exp. 3/97
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STATE OF CA...

APPENDIX A

FIELD EXPLORATION

APPENDIX A

FIELD EXPLORATION

General

Field exploration included excavation of two test pits for percolation testing. One test pit was located near the center of the northern portion of the parking lot, and the second test pit was located near the center of southern portion of the parking lot. The test pits were approximately located in the field using existing features as a guide.

Subsurface Exploration

Test pits were excavated using a rubber tire backhoe. Earth materials were continuously logged and classified in the field by visual/manual examination, in accordance with the Unified Soil Classification System.

Logs of the test pits are presented on Drawings A-1 and A-2 which also include descriptions of earth materials encountered and pertinent field data. Drawing A-3, "Exploration Log Key" describes symbols and nomenclature shown on the logs.

Field Percolation Tests

Each test pit was excavated to an approximate size of 9 feet (2.7 m) wide by 9 feet (2.7 m) long by 5 feet (1.5 m) deep. The actual test pit size was carefully measured so that the volume of the pit and surface area available for spreading was known. Approximately three inches (7.6 cm) of gravel was placed in the bottom of both test pits.

Before the actual tests were performed, each test pit was filled with water and allowed to saturate overnight so that the surrounding soils would "swell". Approximately 14,000 gallons (53 m^3) of water was added to TP-1 for saturation, and 27,000 gallons (102 m^3) of water was added to TP-2.

These percolation tests were performed by filling the test pits with a known volume of water, measured from the bottom surface to the top of the water. After exactly 10 minutes, the water level was measured from the same location on the surface, and the difference in water volume inside the pit was calculated. Four tests were performed at TP-1, and three tests performed at TP-2. Tables A-1 and A-2 summarize the test data.

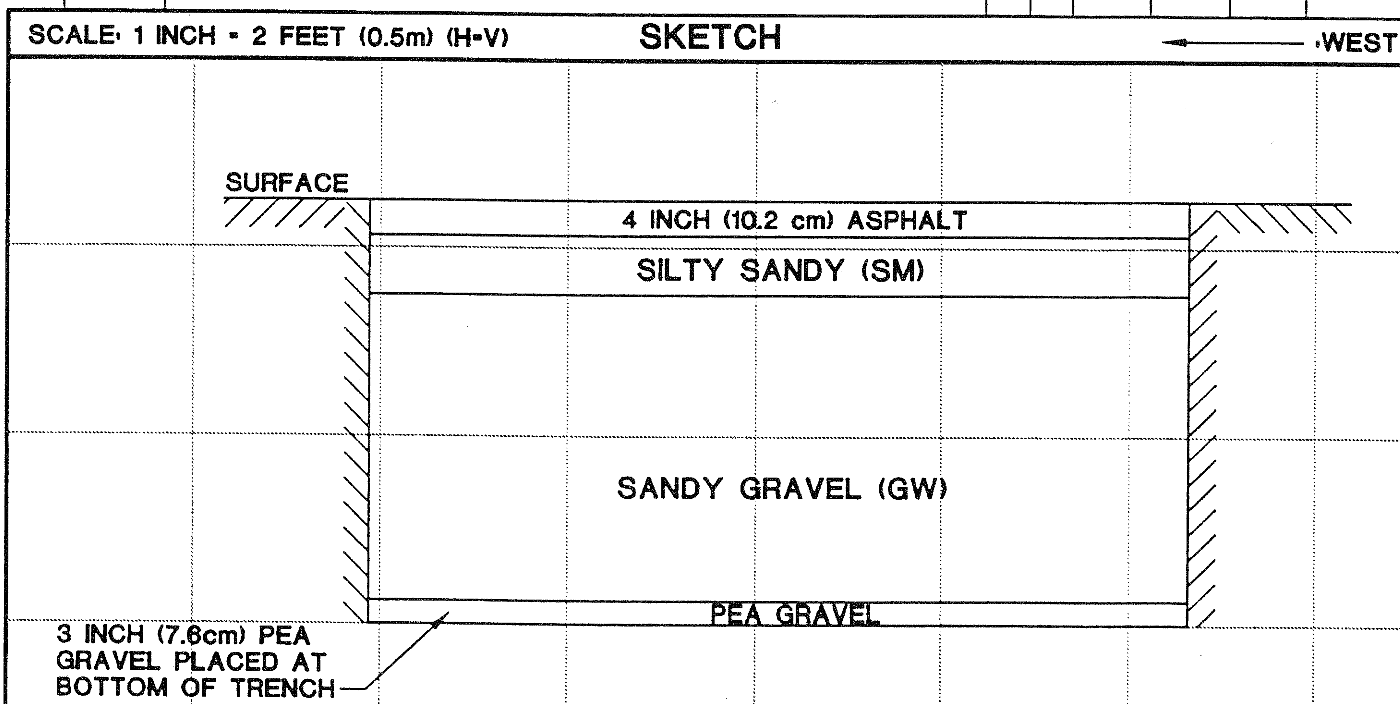
Log of Boring No. TP-1

Date Drilled: 11/29/94 Logged by: CJC Checked by: JRS

Equipment: Backhoe Driving Weight and Drop: pounds/ inches

Ground Surface Elevation: 1102 feet Depth to Water: none encountered

DEPTH (feet) (meters)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FOOT	MOISTURE (%)	DRY UNIT WT. (pcf)**	OTHER*
		0-4" (0-0.1m) ASPHALT						
		4"-1.5' (0.1-0.5M) **SILTY SAND (SM)**; fine sand, light to medium brown, slightly moist, slightly dense						
		1.5-4.5' (0.5-1.4m) SANDY GRAVEL (GW); fine to coarse, with cobbles up to ±10"-12" (25.4 - 30.48 cm), medium brown, slightly moist, very slightly dense, relatively cohesionless.						
		Bottom of Trench at 4.5 feet (1.4m).						



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Project No. 90-31-300-42

Figure No. A-1

Log of Boring No. TP-2

Date Drilled: 11/29/94 Logged by: CJC Checked by: JRS

Equipment: Backhoe Driving Weight and Drop: pounds/ inches

Ground Surface Elevation: 1118 feet Depth to Water: none encountered

DEPTH (feet) (meters)	GRAPHIC LOG	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read together with the report. This summary applies only at the location of the boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplification of actual conditions encountered.	SAMPLES DRIVE	SAMPLES BULK	BLOWS/FOOT	MOISTURE (%)	DRY UNIT WT. (pcf)**	OTHER*
		0-6" (0-0.2m) ASPHALT						
		6"=1.5' (0.2-0.5M) **SILTY SAND (SM);** fine, light to medium, brown, moist, slightly dense						
		1.5-4.6' (0.5-1.4m) **SANDY GRAVEL (SW);** fine to coarse, with cobbles up to ± 10" - 12" (25.4-30.48 cm), medium brown, slightly moist, very slightly dense, relatively cohesionless						
		Bottom of Trench at 4.6 feet (1.4m)						

SCALE: 1 INCH = 2 FEET (0.6m) (H=V) **SKETCH** ← WEST

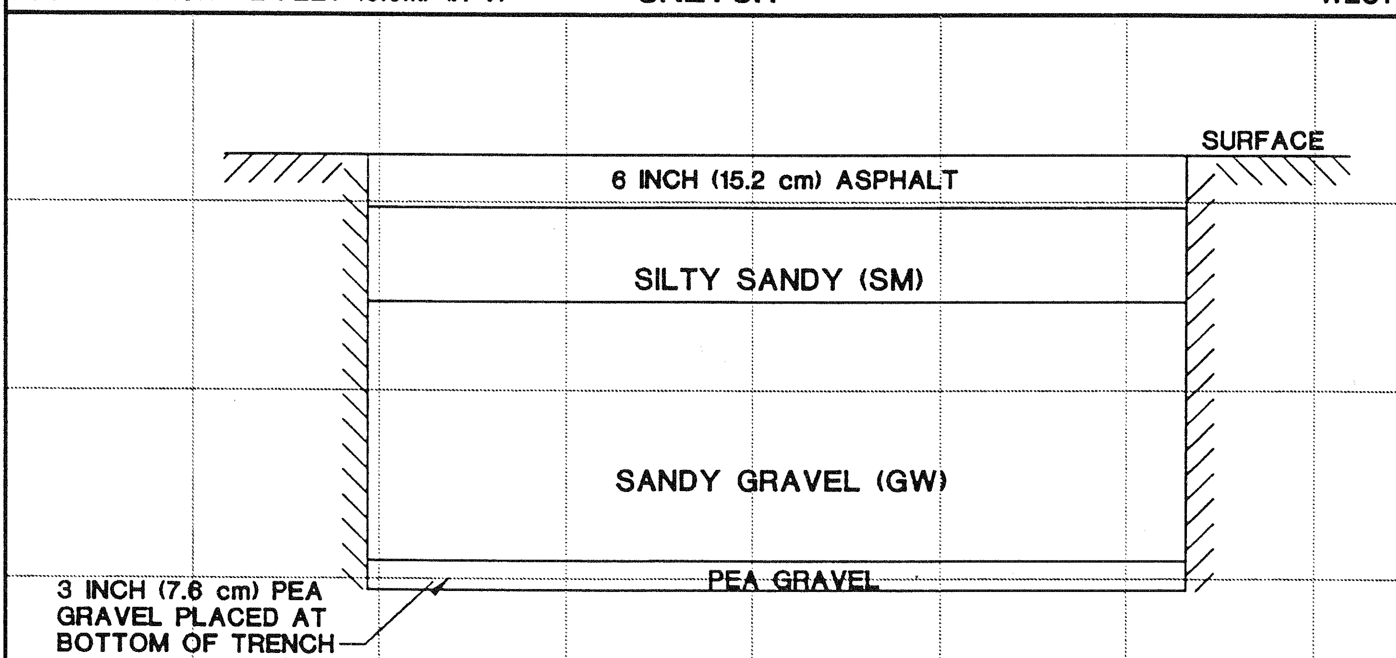

TABLE A-1

PERCOLATION TEST RESULTS FOR TRENCH TP-1

8.83 feet (2.69 meters) wide
9.29 feet (2.83 meters) long
2.58 feet (0.79 meters) from top of water to base of trench at beginning of test series

ENGLISH UNITS

Test	Drop in Water Level after 10 minutes (feet)	Beginning Water Volume (ft^3)	Ending Water Volume (ft^3)	Total Water Volume Percolated (ft^3/10 min)	Total Water Volume Percolated (cfs)	Volume of Water Percolated (gal/day)	Surface Area of Trench Available for Percolation (ft^2)	Hydraulic Conductivity (gpd/ft^2)
1	0.375	211.6	180.9	30.7	0.0512	33,091.2	175.5	188.6
2	0.313	180.9	155.2	25.7	0.0428	27,665.3	161.9	170.9
3	0.313	155.2	129.5	25.7	0.0428	27,665.3	150.6	183.7
4	0.271	129.5	107.3	22.2	0.0370	23,915.5	139.3	171.7

METRIC UNITS

Test	Drop in Water Level after 10 minutes (m)	Beginning Water Volume (m^3)	Ending Water Volume (m^3)	Total Water Volume Percolated (m^3/day)	Surface Area of Trench Available for Percolation (m^2)	Hydraulic Conductivity (m/day)	Hydraulic Conductivity (cm/sec)
1	0.1143	5.99	5.12	125.4	16.3	7.7	8.9×10^{-3}
2	0.0954	5.12	4.39	104.7	15.2	6.9	7.9×10^{-3}
3	0.0954	4.39	3.67	104.7	14.2	7.5	8.7×10^{-3}
4	0.0826	3.67	3.04	90.6	13.3	6.8	7.9×10^{-3}

TABLE A-2

PERCOLATION TEST RESULTS FOR TRENCH TP-2

9.25 feet (2.82 meters) wide
9.33 feet (2.84 meters) long
2.16 feet (0.66 meters) from top of water to base of trench at beginning of test series

ENGLISH UNITS

Test	Drop In Water Level after 10 minutes (feet)	Beginning Water Volume (ft^3)	Ending Water Volume (ft^3)	Total Water Volume Percolated (ft^3/10 min)	Total Water Volume Percolated (cfs)	Volume of Water Percolated (gal/day)	Surface Area of Trench Available for Percolation (ft^2)	Hydraulic Conductivity (gpd/ft^2)
1	0.625	186.4	132.5	53.9	0.0898	58,034.9	166.6	348.3
2	0.542	132.5	85.7	46.8	0.0780	50,414.4	143.3	351.8
3	0.500	85.7	42.5	43.2	0.0720	46,535.0	123.2	377.7

METRIC UNITS

Test	Drop In Water Level after 10 minutes (m)	Beginning Water Volume (m^3)	Ending Water Volume (m^3)	Total Water Volume Percolated (m^3/day)	Surface Area of Trench Available for Percolation (m^2)	Hydraulic Conductivity (m/day)	Hydraulic Conductivity (cm/sec)
1	0.1905	5.28	3.75	216.0	15.5	14.2	$1.6x10^{-2}$
2	0.1652	3.75	2.43	201.6	13.3	14.3	$1.7x10^{-2}$
3	0.1524	2.43	1.20	172.8	11.5	15.4	$1.8x10^{-2}$

APPENDIX B

SUMMARY OF DATA AND CALCULATIONS

APPENDIX B

SUMMARY OF DATA AND CALCULATIONS

(1) **From Spreading Grounds Summary (Pasadena Calculations):**

- Spreading Area/Pond Area: 9.58 acres (38,769 m^2)
- Pond Depth: 5 feet (1.5 meters)
- Daily Percolation per acre: 1.98 acre-feet (2,442 m^3)

[9.58 acres x 5 feet = **47.9 acre feet (59,084 m^3)**]

1.98 acre-feet/day x 325,900 gal/acre-feet = 645,282 gpd/acre x 9.58 acres = 6,181,801.6 gallons/day ÷ 7.48 gallons/ft^3 = 826,444.06 ft^3/day ÷ 24 hr/day ÷ 60 min/hr ÷ 60 sec/min = **9.56 cfs (0.27 cms)**

Average Hydraulic Conductivity (k) is calculated:

6,181,801.6 gal/day ÷ 9.58 acres x 43,560 feet ^{2}/acre = **14.8 gpd/ft^2 (0.7x10^{-3} cm/sec)**

(2) **From Spreading Grounds Summary (JPL Calculations):**

- Spreading Area: 9.58 acres (38,770.2 m^2)
- Pond Area: 6.60 acres (26,710.2 m^2)
- Pond Depth: 5 feet (1.5 meters)
- Daily Percolation per acre: 1.98 acre-feet (2242.3 m^3)

[6.60 acres x 5 feet = **33 acre feet (40,480.8 m^3)**]

1.98 acre-feet/day x 325,900 gal/acre-feet = 645,282 gpd/acre x 6.60 acres = 4,258,861.2 gallons/day ÷ 7.48 gallons/ft^3 = 826,444.06 ft^3/day ÷ 24 hr/day ÷ 60 min/hr ÷ 60 sec/min = **6.59 cfs (0.19 cms)**

Hydraulic Conductivity (k) is calculated:

4,258,861.2 gal/day ÷ 287,496 ft^2 = **14.8 gpd/ft^2 (0.7x10^{-3} cm/sec)**

(3) **From CH2M Hill Phase 1 and Phase 2 Reports on Devil's Gate Multi-Use Project:** (January 26, 1990 and July 14, 1992, respectively), the Arroyo Seco spreading basins have:

- Storage capacity of 30 acre-feet (121,410 m^2) (amount of stormwater the basin can hold/capture)
- Percolation Rate of 15 cubic-feet-per-second (cfs) (0.43 cms) (based on a 1986 study performed by LACDPW of long-term percolation rates)

- Intake (recharge) capacity of 75 cfs (2.12 cms)

15 cfs (0.42 cms)

Hydraulic Conductivity (k) is calculated:

Using Pasadena Calculations for square footage of spreading grounds:

9,694,080 gal/day ÷ 417,305 ft^2 = **23.2 gpd/ft^2 (1.1×10^{-3} cm/sec)**

Using JPL Calculations for square footage of spreading grounds:

9,694,080 gal/day ÷ 287,496 ft^2 = **33.7 gpd/ft^2 (1.6×10^{-3} cm/sec)**

(4) **From LACDPW's Hydrologic Report, 1991-92 (July 1993):** The Arroyo Seco spreading basins have:

- Area (Wetted) is 15.1 acres (61,109.7 m^2)
- Storage is 30 acre-feet (121,410 m^2)
- Percolation Rate of 18 cubic-feet-per-second (cfs) (0.51 cms) (estimate of infiltration rates which may be expected to occur during operations for up to five days - number does not reflect long-term spreading operations.
- Intake (recharge) capacity of 75 cfs (2.12 cms)

[15.1 acres x 43,560 ft^2/acre = 657,756 ft^2 (61,109 m^2)

30 acre-feet x 325,900 gallons/acre-feet = 9,777,000 gallons ÷ 7.48 gallons/ft^3 = 1,307,086 ft^3 ÷ 657,756 ft^2 = **1.98 feet (0.603 meters)** (depth of ponds)

15 cfs (0.42 cms)

Hydraulic Conductivity (k) is calculated:

11,632,896 gal/day ÷ 657,756 ft^2 = **17.7 gpd/ft^2 (8.3×10^{-4} cm/sec)**

CONVERSION FACTORS

1 gpd/ft^2	=	4.047 x 10^{-2} m/day
1 gpd/ft	=	4.716 x 10^{-5} cm/sec
1 gal	=	3.785 liters
1 gal/day	=	0.00379 liters/d
1 cfs	=	28.32 liters/sec
1 inch	=	2.54 cm
1 foot	=	.3048 m
1 ft^2	=	9.29 x 10^{-2}
1 ft^3	=	2.832 x 10^{-2} m^3
1 acre	=	4047 m^2
1 acre-foot	=	1233.46 m^3
1 ton	=	.9072 tonnes

TABLE B-1

SUMMARY OF DATA USING 5 cfs (0.14 m^3/s) PERCOLATION RATE

Hydraulic Conductivity (k)	Trenches [1]			Number of Boreholes [2]
	Lineal Feet of Trench	Number of Trenches	Trench Spacing	
Pasadena & JPL 14.8 gpd/ft² *(0.7x10⁻³ cm/sec)*	24,203 ft *(7,377 m)*	152	8.9 ft *(2.7 m)*	173
LACDPW/Pasadena 23.2 gpd/ft² *(1.1x10⁻³ cm/sec)*	15,440 ft *(4,706 m)*	94	14.3 ft *(4.4 m)*	115
LACDPW/JPL 33.7 gpd/ft² *(1.6x10⁻³ cm/sec)*	10,629 ft *(3,240 m)*	62	21.6 ft *(6.6 m)*	76

NOTES:

(1) Trenches based on an approximately 1,360-foot (414.5 m) long feeder trench running north/south through the center of the parking lot, feeding east/west trending lateral trenches that will average approximately 150 feet (45.7 m) long. Trenches will be five feet (1.5 m) deep and three (0.9 m) feet wide.

(2) Borehole calculations based on 4 ft (1.2 m) diameter borehole installed to a depth of 100 ft (30.5 m).

TABLE B-2

TRENCHING SCENARIO

Percolation Rate	Trench Length[1] Lineal Feet *(lineal meters)*	Total Estimated Trenching Period (Days)[2] at 640 feet/day and *195 m/day*	Cost for Trenching at $1,000/day[3]	Estimated Excavated Dirt/Import Gravel Amount[4] yds[3] *(m[3])*	Cost for Purchase and Import of Gravel[5] at $12/ton and *$10.8/tonne*	Cost to Cut old Asphalt and Repave Trenches[6] at $7.60/lineal foot and *$24.91/lineal meter*	Cost to Install PVC piping system and filter fabric[7] at $7.10/lineal foot and *$23.29/lineal meter*	Cost to Haul Excavated Dirt and Asphalt to Licensed Disposal Facility[8] at $25/ton and *$23.45/tonne*	Project Management 20% of Total Cost	Total Estimated Cost
5 cfs *(0.14 cms)*	24,203 *(7,377)*	37.82	$37,820	13,446 *(10,036)*	$225,892.80	$183,943	$171,841	$517,671	$219,870	$1,319,218
	15,440 *(4,706)*	16.61	16,610	8,578 *(6,403)*	144,110.40	117,344	109,624	330,252	140,266	841,596
	10,629 *(3,240)*	16.61	16,610	5,905 *(4,407)*	99,204.00	80,780	75,466	227,343	96,559	595,962

1 Data from Table B-1.
2 Based on an estimated 80 feet (24.38 meters) of trench excavated in one hour, and based on excavating 8 hours in the field.
3 Based on a 10-hour day (includes 1 hour mobilization and 1 hour demobilization each day) at an estimated cost of $100/hr.
4 Cubic yardage calculated based on a 3-foot (.91-meter) wide and 5-foot (1.5-meter) deep trench.
5 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material. Based on following average costs: $11.50/ton for disposal of soil at Bradley landfill as clean cover material only, $87/load for disposal of asphalt at Nu-Way in Irwindale (at about 14 cubic yards per load), and loading and transportation at $9.10/ton.
6 Based on following costs: saw cutting @ $1.10/lineal foot and repavement @ $6.50/lineal foot. Saw cutting based on 4 inch thick asphalt. Repavement costs based on surface being properly prepared for paving, and all pavement performed at the same time.
7 Based on following costs: Schedule 20 perforated piping @ $6.75/lineal foot, and filter fabric @ $0.35/lineal foot.
8 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material. Based on following average costs: $11.50/ton for disposal of soil at Bradley landfill as clean cover material only, $87/load for disposal of asphalt at Nu-Way in Irwindale (at about 14 cubic yards per load), and loading and transportation at $9.10/ton.

TABLE B-3a

BOREHOLE SCENARIO COST ESTIMATE
Costs for Boreholes

Percolation Rate	Number of Boreholes[1]	Cost to drill boreholes[2] at $100/ft and *$328.08/m*	Estimated Excavated Dirt/Import Gravel Amount[3] yds^3 and *(m^3)*	Cost for Purchase and Import of Gravel[4] at $12/ton and *$10.8/tonne*	Cost to Cut old Asphalt and Repave over borehole structures[5] at $43.50/borehole	Cost to install PVC piping system in boreholes ONLY (Schedule 20 PVC) at 6.75/lineal foot and *$22.14/lineal meter*	Cost to Haul Excavated Dirt to Licensed Disposal Facility[6] at $25/ton and *$23.45/tonne*	Total Estimated Cost to Drill and Install Boreholes (see Table B-3b for Trenching Costs)
5 cfs *(0.14 cms)*	173	$1,740,000	8,094 *(6,189)*	$135,979	$7,526	$116,775	$283,290	$2,283,570
	115	1,110,000	5,164 *(3,948)*	86,755	5,003	74,925	180,740	1,457,423
	76	770,000	3,582 *(2,739)*	60,178	3,306	51,975	125,370	1,010,829

1 Data from Table B-1.

2 Based on an 8-hour drilling day. Cost does not include mobilization and demobilization of equipment, which is estimated at between $2,000 and $5,000. Cost may be higher if difficult drilling conditions are encountered (i.e., extremely rock or dense soils).

3 Cubic yardage based on borehole radius and depth.

4 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material.

5 Based on following costs: saw cutting 4-inch thick asphalt @ $0.55/foot, repavement at $2.25/square foot. Repavement cost based on 4 inches of asphalt, and repavement performed at same time trenches are repaved.

6 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material. Based on following average costs: $11.50/ton for disposal of soil at Bradley landfill as clean cover material only, $87/load for disposal of asphalt at Nu-Way in Irwindale (at about 14 cubic yards per load), and loading and transportation at $9.10/ton.

TABLE B-3b

BOREHOLE SCENARIO COST ESTIMATE
Costs for Connecting Trenches

Percolation Rate	Number of Boreholes[1]	Number of Trenches of Boreholes[2]	Total Lineal Feet and *meters* of Trenches[4]	Estimated Excavated Dirt/Import Gravel Amount[5] yds^3 *(m^3)*	Cost for Purchase and Import of Gravel[6] at $12/ton or *$10.9/tonne*	Cost to Cut old Asphalt and Repave Trenches[7] at $7.60/lineal feet or *$24.91/lineal meter*	Cost to install PVC piping system and filter fabric[8] at $7.10/lineal foot or *$23.29/lineal meter*	Cost to Haul Excavated Dirt and Asphalt to Licensed Disposal Facility[9] at $25/ton or *$23.45/tonne*	Total Estimated Cost for Trenching (see Table B-3c for Total Cost of Boreholes and Trenches)
5 cfs *(0.14 cms)*	173	17.3	3,703 *(1,129)*	617 *(472)*	$10,366	$28,143	$26,291	$27,355	$163,010
	115	11.5	2,465 *(751)*	411 *(314)*	6,905	18,734	17,502	18,219	119,814
	76	7.6	1,636 *(499)*	273 *(208)*	4,586	12,434	11,616	12,100	90,807

1 Data from Table B-1.
2 Calculated based on 10-feet (3.0-meter) spacing between boreholes, and using an average property wide of 150 feet (45.7 meters) east-west
3 Calculated assuming east-west trending trenches feeding the boreholes will feed off of a 1,360-foot (414.5 meter) long, north-south trending feeder trench located along the western property boundary.
4 Calculated using a 1,360-foot (414.5 meter) long north-south trending feeder trench, and a series of east-west trending trenches averaging 150-foot (45.7 meters) long, and deducting the length along the trenches where boreholes will be located.
5 Calculated using a trench width of 3 feet (0.91 meters) and trench depth of 1.5 feet (0.46 meters).
6 Using a conversion factor of 1.4 tons per cubic-yard (2.017 tonnes per cubic meter) of material.
7 Based on an assumed asphalt thickness of 6 inches (15.2 centimeters).

Table B-3c

BOREHOLE SCENARIO COST ESTIMATE
Total Costs for Boreholes and Interconnecting Trenches

Percolation Rate	k Value (gpd/ft²) (*cm/sec*)	Number of Boreholes	Total Estimated Cost for Boreholes From Table B-3a	Total Estimated Cost for Connecting Trenches from Table B-3b	Project Management 20% of Total Cost	Total Estimated Cost
5 cfs (*0.14 cms*)	14.8 (*$0.7x10^{-3}$*)	173	$2,283,570	$163,010	$489,316	$2,935,896
	23.2 (*$1.1x10^{-3}$*)	115	1,457,423	119,814	315,447	1,892,684
	33.7 (*$1.6x10^{-3}$*)	76	1,010,829	90,807	220,327	1,321,963

APPENDIX C

COST ESTIMATES

90-31-300-42

TABLE C-1

COST ESTIMATE FOR TRENCHING SCENARIO

Percolation Rate	Trench length[1] Lineal Feet *(meters)*	Total Estimated Trenching Period (Days)[2] at 640 feet/day and *195 m/day*	Cost for Trenching at $1,000/day[3]	Estimated Excavated Dirt/Import Gravel Amount[4] yds[3] *(m³)*	Cost for Purchase and Import of Gravel[5] at $12/ton and *$10.80/tonne*	Cost to Cut old Asphalt and Repave Trenches[6] at $7.60/lineal foot and *$24.91/lineal meter*	Cost to Install PVC piping system and filter fabric[7] at $7.10/lineal foot and *$23.29/lineal meter*	Cost to Haul Excavated Dirt and Asphalt to Licensed Disposal Facility[8] at $25/ton and *$23.45/tonne*	Project Management 20% of Total Cost	Total Estimated Cost
5 cfs *(0.14 cms)*	2,331 *(710)*	3.6	$3,600	1,295 *(967)*	$21,756	$17,716	$16,550	$48,951	$21,715	$130,288
	1,748 *(533)*	2.7	$2,700	971 *(725)*	$16,313	$13,285	$12,411	$36,704	$16,283	$97,696

1 Data from Table 1.
2 Based on an estimated 80 feet (24.38 meters) of trench excavated in one hour, and based on excavating 8 hours in the field.
3 Based on a 10-hour day (includes 1 hour mobilization and 1 hour demobilization each day) at an estimated cost of $100/hr.
4 Cubic yardage calculated based on a 3-foot (.91-meter) wide and 5-foot (1.5-meter) deep trench with 9 cubic feet of area available for spreading.
5 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material.
6 Based on following costs: saw cutting @ $1.10/lineal foot and repavement @ $6.50/lineal foot. Saw cutting based on 4 inch thick asphalt. Repavement costs based on surface being properly prepared for paving, and all pavement performed at the same time.
7 Based on following costs: Schedule 20 perforated piping @ $6.75/lineal foot, and filter fabric @ $0.35/lineal foot.
8 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material. Based on following average costs: $11.50/ton for disposal of soil at Bradley landfill as clean cover material only, $87/load for disposal of asphalt at Nu-Way in Irwindale (at about 14 cubic yards per load), and loading and transportation at $9.10/ton.

TABLE C-2a

BOREHOLE SCENARIO COST ESTIMATE
Costs for Boreholes

Percolation Rate	Number of Boreholes[1]	Cost to drill boreholes[2] at $100/ft and *$328.08/m*	Estimated Excavated Dirt/Import Gravel Amount[3] yds^3 *(m^3)*	Cost for Purchase and Import of Gravel[4] at $12/ton and *$10.8/tonne*	Cost to Cut old Asphalt and Repave over borehole structures[5] at $43.50/borehole	Cost to Install PVC piping system in boreholes ONLY (Schedule 20 PVC) at $6.75/lineal foot and *$22.14/lineal meter*	Cost to Haul Excavated Dirt and asphalt to Licensed Disposal Facility[6] at $25/ton and *$23.45/tonne*	Total Estimated Cost to Drill and Install Boreholes (see Table 4b for Trenching Costs)
5 cfs *(0.14 cms)*	17	$170,000	791 *(605)*	$13,289	$740	$11,475	$27,693	$223,197
	13	$130,000	605 *(463)*	$10,164	$566	$8,775	$21,183	$170,688

1 Data from Table 1.
2 Based on an 8-hour drilling day. Cost does not include mobilization and demobilization of equipment, which is estimated at between $2,000 and $5,000. Cost may be higher if difficult drilling conditions are encountered (i.e., extremely rock or dense soils).
3 Cubic yardage based on borehole radius and depth.
4 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material.
5 Based on following costs: saw cutting 4-inch thick asphalt @ $0.55/foot, repavement at $2.25/square foot. Repavement cost based on 4 inches of asphalt, and repavement performed at same time trenches are repaved.
6 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material. Based on following average costs: $11.50/ton for disposal of soil at Bradley landfill as clean cover material only, $87/load for disposal of asphalt at Nu-Way in Irwindale (at about 14 cubic yards per load), and loading and transportation at $9.10/ton.

TABLE C-2b

BOREHOLE SCENARIO COST ESTIMATE
Costs for Connecting Trenches

Percolation Rate	Number of Boreholes[1]	Number of Trenches of Boreholes[2]	Total Lineal Feet (*meters*) of Trenches[4]	Estimated Excavated Dirt/Import Gravel Amount[5] yds^3 (m^3)	Cost for Purchase and Import of Gravel[6] at $12/ton or *$10.9/tonne*	Cost to Cut old Asphalt and Repave Trenches[7] at $7.60/lineal feet or *$24.91/lineal meter*	Cost to Install PVC piping system and filter fabric[8] at $7.10/lineal foot or *$23.29/lineal meter*	Cost to Haul Excavated Dirt and Asphalt to Licensed Disposal Facility[9] at $25/ton or *$23.45/tonne*	Total Estimated Cost for Trenching (see Table 4c for Total Cost of Boreholes and Trenches)
5 cfs (*0.14 cms*)	17	1.7	387 (*118*)	65 (*49*)	$1,092	$2,941	$2,748	$2,877	$9,658
	13	1.3	343 (*105*)	57 (*44*)	$958	$2,607	$2,435	$2,529	$8,529

1 Data from Table 1.

2 Calculated based on 10-foot (3.0-meter) spacing between boreholes, and using an average property width of 150 feet (45.7 meters) east-west. East-west trending trenches based on 100-foot (30.5 meter) distance apart.

3 Calculated assuming east-west trending trenches feeding the boreholes will feed off of a 1,360-foot (414.5 meter) long, north-south trending feeder trench located along the western property boundary.

4 Calculated using about 100-feet (30.5 meters) distance between 150-foot (45.7 meters) long lateral (east-west) trenches, and deducting the length along the trenches where 4-foot (1.2 meter) diameter boreholes will be located.

5 Calculated using a trench width of 3 feet (0.91 meters) and trench depth of 1.5 feet (0.46 meters).

6 Using a conversion factor of 1.4 tons per cubic-yard (2.017 tonnes per cubic meter) of material.

7 Based on following costs: saw cutting @ $1.10/lineal foot and repavement @ $6.50/lineal foot. Saw cutting based on 4 inch thick asphalt. Repavement costs based on surface being properly prepared for paving, and all pavement performed at the same time.

8 Based on following costs: Schedule 20 perforated piping @ $6.75/lineal foot, and filter fabric @ $0.35/lineal foot.

9 Using a conversion factor of 1.4 tons per cubic yard (2.017 tonnes per cubic meter) of material. Based on following average costs: $11.50/ton for disposal of soil at Bradley landfill as clean cover material only, $87/load for disposal of asphalt at Nu-Way in Irwindale (at about 14 cubic yards per load), and loading and transportation at $9.10/ton.

TABLE C-2c

BOREHOLE SCENARIO COST ESTIMATE
Total Costs for Boreholes and Interconnecting Trenches

Percolation Rate	k Value (gpd/ft^2) (*cm/sec*)	Number of Boreholes	Total Estimated Cost for Boreholes From Table 4A	Total Estimated Cost for Connecting Trenches from Table 4B	Project Management 20% of Total Cost	Total Estimated Cost
5 cfs (*0.14 cms*)	153.66 gpd/ft^2 (*$7.4x10^{-3}$ cm/sec*)	17	$223,197	$9,658	$46,571	$279,426
	204.88 gpd/ft^2 (*$9.6x10^{-3}$ cm/sec*)	13	$170,688	$8,529	$35,843	$215,060