NAVY RESPONSES TO ENVIRONMENTAL PROTECTION AGENCY COMMENTS

The following presents the Navy's responses to the Environmental Protection Agency's (EPA's) comments to the Phase I Aquifer Testing Results/Recommendations for Phase II Aquifer Testing, as presented in EPA's letter memorandum from Herb Levine, EPA, to Roberta Blank, EPA and in Bechtel's letter to the EPA dated December 20, 1991.

GENERAL COMMENTS, EPA LETTER MEMORANDUM DECEMBER 31, 1991

1. The slug test report never states the assumptions made. At this point in the project, cross sections have probably been generated. I recommend showing the areas where the slug tests were conducted in cross section and describe the hydrogeology and the assumptions for the test.

Response:

Interpretation and evaluation of aquifer testing results relative to site hydrogeology will be provided in the RI report for each Operable Unit.

2. No real justification for the analyses were made, other than that the data best fit the analysis chosen. This is an incorrect approach. I have the impression that the software was used as a "black box". I do recommend checking the use of the software.

Response:

For justification of the analyses used for slug test analysis, see responses to DTSC Specific Comments 2 and 3. The AQTESOLV software was not used as a "black box," but was used by hydrogeologists and hydrologists trained in aquifer test analysis. Calculations performed by the AQTESOLV software were verified by checking the results for both the Bouwer & Rice and Cooper methods against manually calculated values for the same data sets. The verification calculations are available for review and will be provided upon request.

3. I agree with the approach of estimating hydrogeologic characteristics with slug tests prior to conducting pumping tests. I would like to see the calculations for zone of influence. It would be appropriate to show calculated drawdown in cross section along with locations and screened intervals of observation wells.

Response:

The equations used and calculations performed for zone of influence are included as Attachment 1. Radius-of-influence calculations have been updated to better represent aquifer storativity at each well location. Aquifer storativities of 0.0001 (dimensionless) were used for confined conditions, 0.001 (dimensionless) were used for semiconfined conditions, and 0.15 (dimensionless) for unconfined conditions. These storativity values are estimates based on published values for different aquifer conditions and geologic materials. Note that the estimated radii of influence are based on a drawdown of 0.1 feet. In general, estimated radii of influence for confined and semiconfined conditions are much greater than are anticipated during constant-rate discharge testing due to the effects of localized variability in aquifer transmissivity and storativity (ie., heterogeneity), hydrologic boundary effects, as well as other interferences.

With regard to cross sections, additional data analysis will be performed in conjunction with the RI report for each Operable Unit.

SPECIFIC COMMENTS, BECHTEL LETTER TO THE EPA DATED DECEMBER 20, 1991

1) General. The analytical methods applied may not be the most appropriate for the data collected. The Cooper method is designed for use on fully penetrating, confined aquifers. Neither of these conditions are met on most of the wells on the site. Both methods used, the Cooper method and the Bouwer & Rice method, assume a homogeneous, isotropic aquifer which is definitely not the case at HPA. The text should provide a more thorough discussion of the validity of the analytical methods chosen, along with a discussion of other methods such as the Hvorslev method.

Response:

As stated in the response to Part 1 of DTSC Specific Comment 2, the Cooper method is appropriate for unconfined aquifer conditions under certain circumstances. The application of all analytical methods requires assumptions that deviate in varying amounts from hydrogeologic conditions. It is acknowledged that the heterogeneous fill materials at HPA are not conducive to the application of most analytical methods. Nonetheless, the uncertainty associated with the use of these analytical methods were deemed acceptable relative to the objectives of the slug testing program. (See response to DTSC General Comment 4 for objectives.) Consequently, the Bouwer & Rice and Cooper methods were considered appropriate for analysis of the slug test data.

2) General. The document does not address whether the saturated or unsaturated hydraulic conductivity was measured. Due to the number of wells in which the well screen was only partially saturated (screened zone extending above water table), this could substantially influence the results. Inclusion of raw data in an appendix would permit a more thorough review of this and other aspects of the data.

Response:

Slug tests were performed by lowering the slug into a well and allowing water levels to equilibrate (i.e., falling head portion of test). Following water-level equilibration to greater than 85 percent of pre-test levels, the slug

was removed from the well (i.e., rising head portion of test). Only the rising head (slug out) portion of the slug test data set was analyzed to estimate aquifer hydraulic properties. Consequently, estimates of aquifer hydraulic properties are representative of only saturated aquifer materials. Raw data and other slug-test related information was submitted to DTSC and the EPA on February 6, 1992.

3) Page 8, Section 3.1. The extreme range of hydraulic conductivities for the clay to gravel fill is clearly an artifact of encompassing a wide range of fill materials into a single unit. If possible, this grouping should be further subdivided into primarily clay and silt fill and sand and gravel fill. This might yield more meaningful results.

Response:

Comment acknowledged. A more detailed analysis of estimated aquifer hydraulic properties relative to lithology will be presented in the RI report for each Operable Unit.

4) Page 13, Section 3.3. The maximum hydraulic conductivity (k) for IR-17 is misprinted. It should be 1,140 ft/day.

Response:

Comment acknowledged. The maximum hydraulic conductivity for IR-17 calculated using the Cooper method should be 1,140 ft/day. The maximum hydraulic conductivity for IR-17 calculated using the Bouwer & Rice method remains 140 ft/day.

5) Page 13, Section 3.5. The hydraulic conductivity numbers cited for weathered bedrock do not match the values presented in Table 3 which are 12.5 ft/day (Cooper method) and 6.99 ft/day (Bouwer & Rice method).

Response:

Comment acknowledged. Values presented in Table 3 are correct.

6) Page 14, Section 3.6. Thirteen wells are listed for the Bouwer & Rice method for industrial fill, but only twelve wells are listed for the Cooper method.

Response:

Comment acknowledged. The table on Page 14 is supported by Table 3, which indicates that Well IR01MWI-5 was analyzed using the Bouwer & Rice method, but not the Cooper method. The Cooper method was not used because the small number of data points did not allow for adequate curve matching.

7) Page 14, Section 3.6. Presentation of only maximum and minimum k values is misleading. Inclusion of the average and standard deviation would provide a better insight on the hydraulic conductivity differences between the various groupings. For example, averages for the Cooper method are:

Clay to Gravel Fill	**32.7 ft/day**
Boulder Fill	**235 ft/day**
Industrial Fill	**63.3 ft/day**
Undifferentiated Upper Sands	**298 ft/day**
Undifferentiated Sedimentary Deposits	**6.7 ft/day**
Weathered bedrock	**12.5 ft/day (See Comment 5)**

Response:

A summary of a statistical analysis of the hydraulic parameters is presented in Attachment 2. Note that this analysis assumes that hydraulic conductivity values are log-normally distributed. Because of the log-normal distribution, the only geometric means and the standard deviation of the log transform values are presented. Comparison of the standard deviation of log transform values for each lithologic group between the Cooper and Bouwer & Rice methods show similar results for both methods (Attachment 2).

8) Page 15, Top of page. Based on range of concentrations only, as given on page 15, it would seem that Industrial Fill should be included with the other two high permeability groupings. As noted in Comment 7 above, average concentrations provide a better picture of the relationships between the groupings.

Hydraulic conductivity values are presented on page 15. The industrial fill is comprised primarily of non-native materials such as refuse, debris, and possible sandblast materials. In contrast, the clay to gravel fill and boulder fill consist of dredge materials, excavated Bay Mud, and bedrock-derived fill. Geometric means and standard deviations are presented in Attachment 2, as described in the response to EPA Specific Comment 7.

9) Page 17, Section 4.1, Paragraph 2. The criteria for piezometer placement should be presented.

Response:

Criteria to be used for the placement of piezometers and placement of the piezometer screened intervals are as follows:

(1) The distance from the pumping well to the piezometers shall be:

- o greater than 25 times the radius of the well borehole (i.e., greater than or equal to 12.5 feet given a well borehole diameter of 1 foot);
- o less than 1.5 times the saturated aquifer thickness to reduce the effects of partially penetrating pumping wells.

(2) Piezometers will be placed in opposite directions from the pumping well, when possible, to provide water-level data in more than one direction from the pumping well.

(3) The placement of the screened intervals of the piezometers shall be such that:

- o the piezometer monitors the primary production zone of the pumping well. The production zone will be assumed to be the coarser-grained sediments in which the pumping well is screened and will be determined on the basis of review of boring logs and the preparation of "working " geologic cross sections at each proposed aquifer test location;

- o the top of the piezometer screen will be placed above the water table as measured in an adjacent well(s);

- o the bottom of the piezometer screen will extend to the total depth of the screened interval of the pumping well or to a depth equivalent to the bottom of the primary production zone, whichever is deeper.

10) Table 3. Why was well IR01MWI-7 tested when it does not meet the stated criteria (its water level was less than 5')?

Response:

The stated criteria on page 4 of the report indicates that the wells must have had at least 5 feet of water in the well casing. The information supplied to the EPA on February 6, 1992, indicates that Well IR01MWI-7 had approximately 10.9 feet of water in the casing at the time of slug testing. The measurement presented in Table 3 is incorrect. A revised Table 3 is attached.

11) Table 3. Why was well IR09MW-37A tested when it does not meet the stated criteria (its water level was less than 5')?

Response:

The stated criteria on page 4 of the report indicates that the wells must have had at least 5 feet of water in the well casing. The information supplied to the EPA on February 6, 1992, indicates that Well IR09MW37A had 5.17 feet of water in the casing at the time of slug testing. A revised Table 3 is attached and indicates that the saturated thickness adjacent to the well screen was 4.2 feet.

12) Plate 3. Hydraulic conductivity results for the Bouwer & Rice method could be included on this plate.

Response:

Comment acknowledged. However, it was not within the objectives of this report to provide a comprehensive evaluation of Phase I data. The Cooper method was viewed to provide an adequate representation of results for the Phase I program. Additional presentation of aquifer testing results will be provided in the RI report for each Operable Unit.

NAVY RESPONSE TO DTSC COMMENTS

The following presents the Navy's response to specific DTSC comments from its letter dated January 17, 1992 regarding the Draft Phase I Aquifer Testing Results.

GENERAL COMMENTS

General Comment 1:

The Quality Assurance/Quality Control (QA/QC) utilized in the gathering, processing and evaluation of data shall be included in the draft final report.

Response:

This information (Field Daily Reports, Slug Test Data Forms, Datalogger Records, Slug Testing Procedures, Slug Testing Procedures Addendum, Raw Data from the Dataloggers on Disk, and Slug Volumes) was submitted to DTSC and the EPA on February 6, 1992. The Phase I Aquifer Testing Report is a secondary document; therefore, a draft final report is not planned. Comments regarding secondary documents are to be addressed in a written response to comments and subsequent primary reports.

General Comment 2:

Include all data used to support the results from the slug testing in the draft final report. This will allow the Department to perform an independent analysis of the slug testing results.

Response:

These data were submitted to DTSC and the EPA as indicated above. In addition, revised Tables 2 and 3 are included as attachments and include slug test information for wells tested in December 1991 at IR-14 and IR-15.

General Comment 3:

There is a lack of consistency throughout the report between methods of data analysis and evaluation.

Response:

This comment does not present specifics that require a response. However, subsequent responses address specific comments.

General Comment 4:

The objectives of the pump tests should be more clearly defined. Utilize contour maps and other information gathered from the slug testing to determine which wells to use for the pump tests. For each pump test, make a preliminary determination of the analysis which would best evaluate the aquifer conditions. Careful evaluation of site conditions which would affect the pump tests must be incorporated into the planning process.

Response:

The objective of the HPA Aquifer Testing program was described in both the Aquifer Testing Work Plan (*HLA, 1992*) and the Phase I Aquifer Testing report (*HLA, 1991*) as follows.

> *The objective of the aquifer testing program at HPA is to estimate the hydraulic properties (i.e., transmissivity, hydraulic conductivity, and storativity) in the major aquifer zones. Aquifer hydraulic properties will be used to: 1) estimate groundwater flow and contaminant transport velocities, 2) quantify groundwater fluxes, and 3) provide data for the development of groundwater flow and contaminant transport models for the Public Health and Environmental Evaluation (PHEE) and Feasibility Studies (FS).*

The approach for achieving this objective was described in the Draft and Draft Final Aquifer Testing Work Plan (*HLA, 1991, 1992*).

The HPA Aquifer Testing program included two phases of aquifer testing. Phase I slug testing of monitoring wells provided preliminary data for the planning of Phase II aquifer testing. Phase II aquifer testing will consist of constant-rate discharge and recovery testing to provide more reliable estimates of aquifer hydraulic properties.

Site-specific conditions were considered when planning Phase II aquifer tests. Slug test results were used to: (1) estimate the radius of influence of pumping wells (see response to EPA General Comment 3) and evaluate the need for observation wells in the vicinity of the pumping well, and (2) qualitatively estimate the ability of wells to sustain a flow rate of at least 1 gallon per minute (gpm), thus enabling the selection of wells with the highest likelihood of providing useful constant-rate discharge (Phase II) aquifer test data.

Site-specific conditions will also be considered when analyzing data from constant-rate aquifer tests. Factors to be considered include, but are not limited to:

(1) Localized aquifer conditions (confined vs. unconfined)

(2) Well characteristics (partially or fully penetrating)

(3) Aquifer characteristics (i.e., lithology, heterogeneities, hydraulic boundaries)

(4) Measured aquifer response relative to theoretical response

(5) Other influences on water levels and aquifer hydraulic response (i.e., influences resulting from tides, barometric pressure changes, sanitary sewers, storm sewers, and groundwater recharge from infiltration of precipitation).

Harding Lawson Associates, 1991. *Draft Phase I Aquifer Testing Results, Recommendations For Phase II Aquifer Testing, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California.* November 21.

Harding Lawson Associates, 1992. *Draft Final Aquifer Testing Work Plan, Remedial Investigation/Feasibility Study, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California.* February 19.

General Comment 5:

The data derived from the slug testing may have to be reassessed based on specific comments given below.

Response:

See DTSC Specific Comments 1, 2, 3, and 4 listed below and the associated responses.

SPECIFIC COMMENTS

Specific Comment 1:

Page 2: Slug testing was apparently performed prior to the distribution of a work plan and QA/QC standards. Therefore, please provide the documentation to address these issues:

- **Were the slug tests coordinated with the tidal fluctuations at the Site? This is important as rises in water levels in some wells may change the aquifer conditions from unconfined to semi-confined to confined, thus altering the data curves from the wells. Evaluating tidal influence information is also important while planning pump tests to determine which areas will be affected by tidal influx.**

Response:

Slug tests were not coordinated with tidal cycles. The purpose of the slug tests was to determine wells that could be used for pumping tests. The influence of tides on the aquifers at Hunters Point is being addressed in the Tidal Influence Monitoring Program (TIMP). Nearly complete water-level recovery during slug testing occurred in the majority of tested wells in less than 10 minutes; consequently, the influence of tides on slug test results appears to be negligible.

- **How and how often was equipment checked? If the tests were conducted with potentially uncalibrated equipment, the accuracy of the tests might be in question.**

Response:

The transducers used for the slug test program were new and calibrated by the manufacturer. Proper operation of each pressure transducer was checked prior to slug testing by obtaining

measurements at two specified depths in the well. If the measured distance was not within ± 0.02 foot of the specified distance, the transducer was replaced with a properly operating transducer. In addition, pre- and post-test depth to water measurements were taken using a steel tape or electric sounder to verify the water levels recorded by the datalogger. This information was included on the Slug Test Data Forms, copies of which were submitted to DTSC and the EPA on February 6, 1992.

- **What steps were implemented to ensure that the eighty-nine slug tests were conducted in a consistent manner?**

Response:

All work performed followed the protocol established by the Aquifer Testing Work Plan (*HLA, 1992*) and the Quality Assurance Project Plan (*HLA, 1988*). In addition, field personnel were supplied with written instructions (ie., Slug Testing Procedures and Slug Testing Procedures Addendum) and onsite field training by personnel experienced in aquifer testing and the use of dataloggers.

Harding Lawson Associates, 1988. *Work Plan Volume 3, Quality Assurance Project Plan, Remedial Investigation/Feasibility Study, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California.* May 27.

Harding Lawson Associates, 1992. *Draft Final Aquifer Testing Work Plan, Remedial Investigation/Feasibility Study, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California.* February 19.

- **What level of precision was applied to data analysis?**

Response:

Precision as defined by R.O. Gilbert (*1987*), "is a measure of the size of the closeness of agreement among individual measurements." Because only one individual measurement of hydraulic conductivity is obtained for each well location for a given analytical method, it is not possible to estimate the level of precision associated with estimates of hydraulic conductivity.

Gilbert, R. O., 1987. *Statistical Methods For Environmental Pollution Monitoring.* Van Nostrand Reinhold Company.

Specific Comment 2:

Page 5, last paragraph: page 6, last paragraph: The report states that data was analyzed using AQTESOLV, which is a program which uses both the Bouwer and Rice, and Cooper methods for solving slug tests. The use of the Cooper method is probably inappropriate. Even though the tests were short term, the Cooper method is not valid for unconfined aquifers. If certain conditions are met, the Cooper method can be used for semi-confined aquifers. However, these conditions are neither specified nor are they defined in the report.

Response:

The assumptions of the Cooper method of slug test analysis are understood and were presented in the form of Cooper, Bredehoeft, and Papadopulos' paper in Appendix A of the Phase I Aquifer Testing report. The Cooper method is appropriate for slug test analyses where water-level recovery is relatively rapid. As stated by Neuman (1975), Walton (1978), Prickett (1965), and others, unconfined aquifers respond similarly to confined aquifers during the early portion of the drawdown data when elastic aquifer response predominates. Therefore, because slug tests were of relatively short duration, the Cooper method is appropriate for the analysis of slug test data from wells screened in unconfined aquifer materials. In addition, please note that it was not within the objectives of this report to provide a complete description of aquifer conditions at each well location. This information will be provided in the RI report for each Operable Unit. (Also see response to DTSC General Comment No. 4.)

Neuman, S. P., 1975. *Analysis of pumping test data from anisotropic unconfined aquifers considering delayed gravity response.* Water Resources Research, Vol. 11, No. 2, pp 329-342.

Prickett, T. A., 1965. *Type-curve Solution to Aquifer Tests Under Water-Table Conditions.* Ground Water, Vol. 3, No. 5.

Walton, W. C., 1978. *Comprehensive Analysis of Water-Table Aquifer Test Data.* Ground Water, Vol. 16, No. 5, pp 311-317.

Comment: Since the degree of confinement varies, depending on tidal height and location of the wells, the degree of accuracy from the Cooper analysis varies. Similar materials show up to six orders of magnitude difference in permeability using the Cooper method. Additionally, up to one-third of the data curves provided questionable matches.

Response:

See response to Part 1 of DTSC Specific Comment 2.

The large difference in estimated hydraulic conductivity values, nearly five orders of magnitude for the clay to gravel fill lithologic group (Attachment 2 to Navy Response to EPA Comments), is consistent with the wide range of materials that comprise this group. The clay to gravel fill category includes fill materials that range from relatively low hydraulic conductivity sandy clay and silt to relatively high hydraulic conductivity sand and sandy gravel.

It is acknowledged that the use of different analytical methods and the associated fit to observed data provide results in varying amounts of uncertainty. Phase I slug testing was performed to obtain order-of-magnitude estimates of aquifer hydraulic properties for the planning of constant-rate discharge aquifer testing. The results of slug test analyses are intended to be used in conjunction with data from more reliable constant-rate discharge tests to evaluate the hydraulic properties of aquifer materials. This evaluation will be presented in the RI report for each Operable Unit.

Comment: The Department would like to conduct an independent analysis of the results. To facilitate this process, please provide the following information in the draft final report: the volume of the

slug, the aquifer parameters at the wells and the value of the alpha curve, beta and the corresponding matching point.

Response:

As described above, this information was furnished to DTSC and the EPA on February 6, 1992.

Recommendation: Evaluate the Cooper method results to determine the degree of confinement of the wells which the tests were performed upon. Using the wells for which the Cooper method is determined to be valid, draw a permeability contour map.

Response:

Refer to response to Part 1 of DTSC Specific Comment 2. In addition, contour maps are only valid if data show regional trends. The fill materials comprising the uppermost aquifer at HPA do not show regional trends in hydraulic conductivity. Attempts to contour the data were unsuccessful; therefore, contouring was not completed or presented in the report.

Specific Comment 3:

The Bouwer and Rice method should have been the primary analysis upon which the conclusions and recommendations were based upon. This method can be applied for unconfined, semi-confined and confined aquifer conditions and doesn't require curve matching technique. Hence, the method does not contain the inherent errors of curve matching. Consequently, the method is more statistically precise for the Site's conditions. Note that the Bouwer and Rice method yielded permeabilities which varied one to two orders of magnitude less than those from the Cooper analysis.

Response:

As described in the response to DTSC Specific Comment 2, the Cooper method is an appropriate method for the analysis of slug tests in unconfined aquifers when the tests are of short duration. The Bouwer & Rice method utilizes only a linear portion of the slug test data when fitting a straight line to the data. The Cooper method, however, fits a type curve to the majority of the data. Consequently, the Cooper method provides a higher confidence level relative to the results and involves less subjectivity in the analysis. In addition, the AQTESOLV program that was used for slug test analysis directly calculates type curves using the analytical solution described by Cooper et al (1967). Therefore, the subjectivity introduced by interpolation between a finite number of type curves is eliminated.

Also note that the standard deviations of log transform values for the Bouwer & Rice and Cooper methods are very similar (Attachment 2). In other words, both methods resulted in hydraulic conductivity values that were of similar variability. Please see response to EPA Specific Comment 7 for further discussion of statistical analysis of the data.

Cooper, H. H., J. D. Bredehoeft, I. S. Papadopulos, 1967. *Response of a Finite-Diameter Well to an Instantaneous Discharge of Water*, U.S.G.S. Water Resources Research, Vol 3., No. 1, pp 263-269.

One problem with the Bouwer and Rice analysis presented in the report is the inconsistent use of the data curves as described below:

The data curves from several of the slug tests had a double straight line, while others used the first straight line (which generally reflects the characteristics of the filter pack) or the second straight line (which generally reflects the characteristics of the undeveloped aquifer). For example, the slug tests from IR06MW23A and IR05MW77A show very similar plots of displacement versus time and both show a double straight line. In determining K for MW23A, the first straight line was used. In MW77A, the second straight line was used. Consequently, K for MW23A was calculated to be four times that of MW77A. This would appear to be unlikely since MW77A had recovered to 90% by five and a half minutes, while MW23A still had not recovered by 90% by ten minutes.

Recommendation: Establish a criteria for determining when to use the first straight line vs. the second straight line for the Bouwer and Rice method of analysis. Reevaluate the slug test results using this criteria. Draw a permeability contour map using this new information.

Response:

The criteria for using the first versus the second straight line portion of the curve for the Bouwer & Rice analysis depended upon whether effects of gravel-pack drainage were present (*Bouwer, 1989*). If the first straight line portion of the curve occurred with the first 10 to 20 seconds after the water level had been lowered, this was considered to be the result of gravel-pack drainage, and the second straight line portion of the curve was used to estimate hydraulic conductivity. If the first straight line portion occurred over an interval of several minutes, this portion of the curve was used to estimate hydraulic conductivity. Gravel pack drainage probably occurred in this case, but it was too quick to be observed. In the case of Well IR06MW23A, the first straight line portion was interpreted to be the top 4 or 5 data points of the curve and occurred within the first 10 seconds; the second straight line portion was therefore used to estimate hydraulic conductivity.

It is acknowledged that the use of different analytical methods and the associated fit to observed data provide results in varying amounts of uncertainty. The objective of the Phase I slug testing was to obtain order-of-magnitude estimates of aquifer hydraulic properties for the planning of constant-rate discharge aquifer testing. The results of the Bouwer & Rice and Cooper methods for calculating transmissivity in the stated wells verify that results are within one order of magnitude. The results for these two wells are summarized below and are also presented in Table 3.

	TRANSMISSIVITY (ft/min)	
	Bouwer & Rice	Cooper
IR06MW23A	1.60×10^{-2}	1.18×10^{-2}
IR05MW77A	3.97×10^{-3}	5.34×10^{-3}

Bouwer, H., 1989. *The Bouwer and Rice Slug Test - An Update.* Groundwater, Vol. 27, No. 3, pp 304-309.

Specific Comment 4:

Section 4: Recommendations for Phase II Aquifer Testing: To further utilize the large volume of slug testing data, the Department recommends that further analysis is performed. Contour maps showing

apparent permeabilities can be drawn to indicate where areas of relatively high and low permeabilities are located. These contour maps could also show where filled stream channels and preferential flow zones are located. By superimposing the monitoring well locations over these contour maps, the wells which would show the best response to a pump test can be identified. Areas where additional wells are needed can also be identified.

Response:

Additional data analysis will be performed in conjunction with the RI report for each Operable Unit. Data analysis performed to date is adequate to fulfill the objectives of the Phase I Aquifer Testing program. As described in the response to Part 4 of DTSC Specific Comment 2, attempts to contour the data were unsuccessful. Consequently, contour maps were not completed nor presented in the report.

ATTACHMENT 1. RADIUS OF INFLUENCE CALCULATIONS

Radius of influence calculations were performed using the following equation developed by Theis (1935):

$$T = \frac{Q\,W(u)}{4\pi s(7.48)}$$

where, T = transmissivity, in ft^2/min

Q = pumping rate, in gpm

W(u) = the well function of u

s= drawdown, in ft

In the well function W(u), u is equal to:

$$u = \frac{r^2 S}{4Tt(1440)}$$

where r = distance, in ft, from the center of a pumped well to a point where the drawdown is measured

S = storativity, dimensionless

T = transmissivity, in ft^2/min

t = time since pumping started, in days.

The values used for calculation of the radius of influence are shown in the attached table.

Theis, C.V., 1935. "The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground water storage." *Transactions, American Geophysical Union*, Washington, D.C., pp 518-524.

Attachment 1. Radius of Influence Calculations - Cooper Method Data

OU	IR Site	Well #	Discharge (gpm)	Transmissivity (ft^2/min)	Storage Coefficient (dimensionless)	Time (days)	Radius of Influence (ft)	s = (ft)	u =	W(u) =
I	IR-1	IR01MW03A	7.5	5.17E-01	0.15	1	95	0.1	4.55E-01	6.19E-01
I	IR-1	IR01MW38A	2	2.89E-02	0.15	1	38	0.1	1.30E+00	1.35E-01
I	IR-1	IR01MW53B	3.5	1.07E-01	0.0001	1	2300	0.1	8.59E-01	2.80E-01
I	IR-1	IR01MW58A	7.5	3.67E-01	0.001	1	1100	0.1	5.72E-01	4.81E-01
I	IR-2	IR02MW126A	1.5	9.79E-02	0.15	1	42	0.1	4.69E-01	5.99E-01
I	IR-2	IR02MW175A	4.5	2.12E-02	0.15	1	40	0.1	1.97E+00	4.45E-02
I	IR-2	IR02MW206A2	4.5	6.83E-01	0.0001	1	2500	0.1	1.59E-01	1.41E+00
I	IR-2	IR02MW93A	7.5	1.93E+00	0.15	1	65	0.1	5.70E-02	2.34E+00
I	IR-2	IR02MW97A	7.5	6.78E+00	0.15	1	6	0.1	1.38E-04	8.31E+00
I	IR-3	IR03MW228B	3.5	5.92E-02	0.0001	1	2000	0.1	1.17E+00	1.65E-01
III	IR-4	IR04MW31A	3	4.82E-01	0.0001	1	2000	0.1	1.44E-01	1.50E+00
III	IR-4	IR04MW35A	3	2.19E+00	0.15	1	6	0.1	4.28E-04	7.18E+00
III	IR-4	IR04MW38A	6	7.64E-01	0.15	1	80	0.1	2.18E-01	1.15E+00
III	IR-5	IR05MW77A	4.5	1.24E-01	0.15	1	65	0.1	8.85E-01	2.67E-01
II	IR-6	IR06MW30A	2	5.23E-02	0.15	1	45	0.1	1.01E+00	2.16E-01
II	IR-6	IR06MW40A	2	7.57E-02	0.0001	1	1800	0.1	7.43E-01	3.45E-01
IV	IR-7	IR07MW19A	4	7.53E-01	0.15	1	55	0.1	1.05E-01	1.78E+00
IV	IR-7	IR07MW20A1	4.5	2.22E+00	0.15	1	20	0.1	4.69E-03	4.79E+00
IV	IR-7	IR07MW21A2	0.75	4.06E-02	0.15	1	30	0.1	5.77E-01	4.76E-01
II	IR-8	IR08MW37A	5.5	1.37E-01	0.15	1	70	0.1	9.31E-01	2.47E-01
II	IR-8	IR08MW39A	7.5	NC			NA			
II	IR-8	IR08MW40A	4	4.16E-02	0.001	1	600	0.1	1.50E+00	9.86E-02

Attachment 1. Radius of Influence Calculations - Cooper Method Data

OU	IR Site	Well #	Discharge (gpm)	Transmissivity (ft^2/min)	Storage Coefficient (dimensionless)	Time (days)	Radius of Influence (ft)	s = (ft)	u =	W(u) =
II	IR-9	IR09MW35A	2	3.14E-01	0.15	1	40	0.1	1.33E-01	1.57E+00
II	IR-9	IR09MW36A	2	1.34E-02	0.0001	1	1200	0.1	1.87E+00	5.45E-02
II	IR-10	IR10MW13A1	5.5	2.58E-01	0.15	1	75	0.1	5.67E-01	4.86E-01
II	IR-10	IR10MW15A	2	9.34E-03	0.001	1	325	0.1	1.96E+00	4.50E-02
V	IR-12	IR12MW12A	3.5	6.08E-01	0.15	1	55	0.1	1.30E-01	1.59E+00
V	IR-12	IR12MW14A	3.5	3.86E-01	0.001	1	750	0.1	2.53E-01	1.03E+00
V	IR-12	IR12MW15A	10	9.98E-01	0.15	1	100	0.1	2.61E-01	1.01E+00
V	IR-13	IR13MW12A	3.5	6.98E-01	0.15	1	50	0.1	9.33E-02	1.89E+00
V	IR-17	IR17MW12A	12.5	8.08E+00	0.15	1	20	0.1	1.29E-03	6.08E+00

Storage Coefficient: Unconfined = 0.15
Semiconfined = 0.001
Confined = 0.0001

NC = Not Calculated
NA = Not Available

ATTACHMENT 2. SUMMARY OF SLUG TEST RESULTS

COOPER METHOD

Lithologic Group	No. of Wells Analyzed	Minimum K (ft/day)	Maximum K (ft/day)	Geometric Mean (ft/day)	Standard Deviation of Log Transform Values
Clay to Gravel Fill	44	0.00294	232	6.15	2.53
Boulder Fill	12	29	513	176.63	0.89
Industrial Fill	12	2.73	186	19.91	1.38
Undifferentiated Upper Sands	12	2.49	1140	70.64	2.17
Undifferentiated Sedimentary Deposits	4	0.47	15.4	3.49	1.55
Weathered Bedrock	1	12.5	12.5	12.50	NA

BOUWER & RICE METHOD

Lithologic Group	No. of Wells Analyzed	Minimum K (ft/day)	Maximum K (ft/day)	Geometric Mean (ft/day)	Standard Deviation of Log Transform Values
Clay to Gravel Fill	44	0.0248	95.1	4.05	2.07
Boulder Fill	12	6.98	128	43.08	0.86
Industrial Fill	13	0.707	49.7	8.46	1.23
Undifferentiated Upper Sands	12	1.93	253	21.01	1.55
Undifferentiated Sedimentary Deposits	4	0.15	4.54	1.31	1.52
Weathered Bedrock	1	6.99	6.99	6.99	NA

NA = Not Applicable

Table 2. Wells Selected for Slug Testing and Date Tested

Operable Unit	IR-Site	Well#	Well Diameter (inches)	Screen Interval BTOC (ft)	Total Depth	Borehole Diameter (inches)	Sandpack Interval (feet)	Date Slug tested
OU-I	IR-1	IR01MW02B	4	28.5-38.5	38.5	10	27.5-38.5	9-Jul-91
OU-I	IR-1	IR01MW03A	4	13-28	28	10	11.5-28	9-Jul-91
OU-I	IR-1	IR01MW07A	4	5-22	22	12	4-22	9-Jul-91
OU-I	IR-1	IR01MW26B	4	42-52	52	10	41-52	10-Jul-91
OU-I	IR-1	IR01MW38A	4	8-21	21	10	6.5-21	10-Jul-91
OU-I	IR-1	IR01MW42A	4	18-26.5	26.5	12	16-26.5	8-Jul-91
OU-I	IR-1	IR01MW43A	4	5-22.5	22.5	12	4-23	9-Jul-91
OU-I	IR-1	IR01MW44A	4	4-8	8	12	3-8	NT
OU-I	IR-1	IR01MW48A	4	7-20	20	12	6.5-20	10-Jul-91
OU-I	IR-1	IR01MW53B	4	35-45	45	10	34-45	10-Jul-91
OU-I	IR-1	IR01MW58A	4	4-16.5	16.5	12	3-16.5	10-Jul-91
OU-I	IR-1	IR01MWI-2	2	6.5-21.5	22	8	4.5-21.5	7-Aug-91
OU-I	IR-1	IR01MWI-3	2	5-18	19	8	4-10	7-Aug-91
OU-I	IR-1	IR01MWI-5	2	4.5-19.5	20.5	8	3-19	14-Aug-91
OU-I	IR-1	IR01MWI-6	2	4.5-12.5	13	8	4-9	NT
OU-I	IR-1	IR01MWI-7	2	3.5-13.5	14	8	3-10.5	13-Aug-91
OU-I	IR-1	IR01MWI-9	2	3.5-13.5	14.5	8	3-15	14-Aug-91
OU-I	IR-2	R02MW101A	4	9-19	19	12	7.5-19	3-Jul-91
OU-I	IR-2	R02MW101A	4	29-36	36	12	27.5-36	3-Jul-91
OU-I	IR-2	R02MW114A	4	5-10	15	12	3.5-10	NT
OU-I	IR-2	R02MW114A	4	14-26	26	12	13-26	3-Jul-91
OU-I	IR-2	R02MW114A	4	43.5-50.5	50.5	12	42-50.5	3-Jul-91
OU-I	IR-2	IR02MW126A	4	6-15	15	12	5-15	8-Jul-91
OU-I	IR-2	IR02MW147A	4	5-10	10	12	4-10	NT
OU-I	IR-2	IR02MW149A	4	7-22	22	12	5.5-22	8-Jul-91
OU-I	IR-2	IR02MW175A	4	10.5-32.5	32.5	12	10.5-32.5	3-Jul-91
OU-I	IR-2	IR02MW179A	4	6-19.5	19.5	12	4.5-19.5	3-Jul-91
OU-I	IR-2	IR02MW183A	4	5.5-35.5	35.5	12	4.5-35.5	3-Jul-91
OU-I	IR-2	IR02MW196A	4	4.5-11.5	16.5	12	3-11.5	NT
OU-I	IR-2	R02MW206A	4	2.5-7.5	7.5	12	2-7.5	NT
OU-I	IR-2	R02MW206A	4	11.5-21.5	21.5	12	11-21.5	8-Jul-91
OU-I	IR-2	IR02MW209A	4	10-20	20.5	12	8-20.5	8-Jul-91
OU-I	IR-2	IR02MW87A	4	4-14	14	12	3.25-14.5	8-Jul-91
OU-I	IR-2	IR02MW93A	4	3.5-18.5	18.5	12	2.5-18.5	8-Jul-91
OU-I	IR-2	IR02MW97A	4	7.5-24.5	24.5	12	6.5-24.5	8-Jul-91
OU-I	IR-2	IR02MWB-1	2	5-20	20.5	8	4-20	7-Aug-91

Table 2. Wells Selected for Slug Testing and Date Tested

Operable Unit	IR-Site	Well#	Well Diameter (inches)	Screen Interval BTOC (ft)	Total Depth	Borehole Diameter (inches)	Sandpack Interval (feet)	Date Slug tested
OU-I	IR-2	IR02MWB-2	2	4.5-19.5	20.5	8	4-13	7-Aug-91
OU-I	IR-2	IR02MWB-3	2	5-20	20	8	4-15	8-Aug-91
OU-I	IR-2	IR02MWB-5	2	3-17	18	8	3-18	7-Aug-91
OU-I	IR-2	IR02MWC5-W	2	4.5-14.5	14.5	8	3.5-14.5	NT
OU-I	IR-3	R03MW218A	4	5-11	11	12	4-11	NT
OU-I	IR-3	R03MW218A	4	13.5-18.5	18.5	12	12.5-18.5	11-Jul-91
OU-I	IR-3	R03MW218A	4	21-31	31	12	19.5-31	11-Jul-91
OU-I	IR-3	IR03MW228B	4	59-69	69	10	57.5-69	11-Jul-91
OU-I	IR-3	IR03MWO-1	2	3.5-18.5	18.5	8	3-18.5	NT
OU-I	IR-3	IR03MWO-2	2	4.5-21	21	8	4-21	NT
OU-I	IR-3	IR03MWO-3	2	5-20	20	8	4-20	NT
OU-III	IR-4	IR04MW09A	4	4.5-19.5	19.5	12	3.7-19.5	2-Jul-91
OU-III	IR-4	IR04MW31A	4	12.7-27.7	27.7	12	10.7-27.7	2-Jul-91
OU-III	IR-4	IR04MW35A	4	8.7-28.7	28.7	12	6.7-28.7	2-Jul-91
OU-III	IR-4	IR04MW36A	4	5.5-25.5	25.5	12	4.0-25.5	2-Jul-91
OU-III	IR-4	IR04MW37A	4	6.8-21.8	21.8	12	4.3-21.8	2-Jul-91
OU-III	IR-4	IR04MW38A	4	5.3-20.3	20.3	12	3.3-20.3	2-Jul-91
OU-III	IR-4	IR04MW39A	4	4-24	24	12	2.75-24	2-Jul-91
OU-III	IR-4	IR04MW40A	4	4.2-26.2	26.2	12	2.2-26.2	2-Jul-91
OU-III	IR-5	IR05MW73A	4	4.1-9.1	9.1	12	2.6-9.1	NT
OU-III	IR-5	IR05MW74A	4	5.8-22.8	22.8	12	4.1-22.8	1-Jul-91
OU-III	IR-5	IR05MW76A	4	4.5-13.5	13.5	12	3-13.5	1-Jul-91
OU-III	IR-5	IR05MW77A	4	6.4-34.2	34.4	12	8.4-34.2	1-Jul-91
OU-II	IR-6	IR06MW22A	4	3.4-8.4	9	12	2.4-8.4	NT
OU-II	IR-6	IR06MW23A	4	4.4-12.4	12.5	12	3.4-13.4	28-Jun-91
OU-II	IR-6	IR06MW27A	4	4.4-11.1	11.5	12	3.9-11.4	NT
OU-II	IR-6	IR06MW30A	4	6.4-16.4	16.5	12	4.4-16.9	28-Jun-91
OU-II	IR-6	IR06MW32A	4	5.9-13.4	13.5	12	4.4-13.4	28-Jun-91
OU-II	IR-6	IR06MW34A	4	6.4-11.4	12	12	4.4-11.9	NT
OU-II	IR-6	IR06MW35A	4	5.4-14.4	15	12	3.4-14.9	28-Jun-91
OU-II	IR-6	IR06MW40A	4	6.4-19.9	20	12	4.4-19.9	8-Aug-91
OU-II	IR-6	IR06MW41A	4	6.4-16.4	17	12	5.4-16.9	8-Aug-91
OU-II	IR-6	IR06MW42A	4	8-13	13.5	12	5.5-13.5	NT

Table 2. Wells Selected for Slug Testing and Date Tested

Operable Unit	IR-Site	Well#	Well Diameter (inches)	Screen Interval BTOC (ft)	Total Depth	Borehole Diameter (inches)	Sandpack Interval (feet)	Date Slug tested
OU-IV	IR-7	IR07MW19A	4	5.5-15.5	15.5	12	4-15.5	2-Jul-91
OU-IV	IR-7	IR07MW20A1	4	5.6-23.6	23.6	12	4.1-23.6	2-Jul-91
OU-IV	IR-7	IR07MW20A2	4	38-43	43	12	36-43	3-Jul-91
OU-IV	IR-7	IR07MW21A1	4	7.5-17.5	17.5	12	5.5-17.5	NT
OU-IV	IR-7	IR07MW21A2	4	30.5-35.5	35.5	12	29-35.5	2-Jul-91
OU-IV	IR-7	IR07MW23A	4	6.4-16.4	16.4	12	4.2-16.4	NT
OU-IV	IR-7	IR07MWP-1	2	4-19	19	8	2.5-19	12-Aug-91
OU-IV	IR-7	IR07MWP-2	2	3.7-18.7	18.7	8	2.2-18.7	12-Aug-91
OU-IV	IR-7	IR07MWS-1	2	4.6-17.6	17.6	8	3.6-17.6	12-Aug-91
OU-IV	IR-7	IR07MWS-2	2	2.5-17.5	20	8	1.5-30.5	12-Aug-91
OU-IV	IR-7	IR07MWS-3	2	4.4-19.4	19.4	8	2.9-19.4	9-Aug-91
OU-IV	IR-7	IR07MWS-4	2	6-21	21	8	4-32.5	9-Aug-91
OU-II	IR-8	IR08MW37A	4	6.7-22.2	22.5	10	4.7-22.7	27-Jun-91
OU-II	IR-8	IR08MW38A	4	6.3-24.3	24.5	10	4.8-24.3	26-Jun-91
OU-II	IR-8	IR08MW39A	4	5.8-35.8	36	10	4.8-35.8	27-Jun-91
OU-II	IR-8	IR08MW40A	4	7.4-27.4	28	10	6.4-27.4	27-Jun-91
OU-II	IR-8	IR08MW41A	4	5.1-25.1	25.5	10	4.1-25.5	27-Jun-91
OU-II	IR-8	IR08MWW6	2	10-20	9-20	8	20	NT
OU-II	IR-9	IR09MW31A	4	6.3-11.3	12.5	10	4.3-11.3	NT
OU-II	IR-9	IR09MW35A	4	7.3-18.3	19.5	10	4.5-19.3	26-Jun-91
OU-II	IR-9	IR09MW36A	4	10.5-20.5	21.5	10	8.5-20.5	26-Jun-91
OU-II	IR-9	IR09MW37A	4	7-13.5	14.5	10	4.5-13.5	26-Jun-91
OU-II	IR-9	IR09MW38A	4	7-12	13	10	5.0-9.2	NT
OU-II	IR-9	IR09PPY1	2	6.8-16.8	17	8	4.8-16.8	14-Aug-91
OU-II	IR-10	IR10MW12A	4	2.4-17.4	18	10	1.4-18.4	27-Jun-91
OU-II	IR-10	IR10MW13A1	4	4.8-19.8	20	10	2.8-20.3	27-Jun-91
OU-II	IR-10	IR10MW13A2	4	24.7-39.7	40	10	22.7-39.7	27-Jun-91
OU-II	IR-10	IR10MW14A	4	4.6-19.6	20	11	2.6-20.1	27-Jun-91
OU-II	IR-10	IR10MW15A	4	4.6-17.6	17.5	10	2.6-17.6	28-Jun-91
OU-V	IR-11	IR11MW25A	4	5-11	11	11	4-11	NT
OU-V	IR-11	IR11MW26A	4	6-10	10	11	5-10	NT
OU-V	IR-11	IR11MW27A	4	6-11	11	11	4-11	NT

Table 2. Wells Selected for Slug Testing and Date Tested

Operable Unit	IR-Site	Well#	Well Diameter (inches)	Screen Interval BTOC (ft)	Total Depth	Borehole Diameter (inches)	Sandpack Interval (feet)	Date Slug tested
OU-V	IR-12	IR12MW11A	4	6-19	19	11	5-19	13-Aug-91
OU-V	IR-12	IR12MW12A	4	3.5-16.5	16.5	11	2.5-16.5	14-Aug-91
OU-V	IR-12	IR12MW13A	4	7-22	22	11	5.5-22	13-Aug-91
OU-V	IR-12	IR12MW14A	4	4.5-19.5	19.5	11	3.5-20.5	12-Aug-91
OU-V	IR-12	IR12MW15A	4	6-21	21	11	5-21	12-Aug-91
OU-V	IR-12	IR12MW16A	4	5.5-15.5	15.5	11	5-16.5	12-Aug-91
OU-V	IR-13	IR13MW10A	4	3.5-17.5	17.5	11	3-17.5	9-Aug-91
OU-V	IR-13	IR13MW11A	4	3.5-9	9	11	3.5-9.5	NT
OU-V	IR-13	IR13MW12A	4	4.5-17.5	18	11	3.5-18.5	9-Aug-91
OU-V	IR-14	IR14MW09A	4	6.7-14.7	14.7	11	5.7-14.7	5-Dec-91
OU-V	IR-14	IR14MW10A	4	5-17	17	11	7-17	12-Aug-91
OU-V	IR-14	IR14MW11A	4	NA	NA	NA	NA	NT
OU-V	IR-14	IR14MW12A	4	7-18.5	18.5	10	6-18.5	5-Dec-91
OU-V	IR-15	IR15MW06A	4	8-21	21	10	7-21	5-Dec-91
OU-V	IR-15	IR15MW07A	4	7-20	20	10	6-20	5-Dec-91
OU-V	IR-17	IR17MW11A	4	4-17	17	11	2.5-17	9-Aug-91
OU-V	IR-17	IR17MW12A	4	4-17	17	11	2.5-17	8-Aug-91
OU-V	IR-17	IR17MW13A	4	4-17	17	11	2.5-17	9-Aug-91
wwmtab2								

BTOC = Below top of casing
NA = Not Available
NT = Not Tested

Table 3. Results of Slug Testing

Operable Unit	IR-Site	Well#	Screen Interval BTOC (ft)	Saturated Thickness adjacent to well screen (ft)	Cooper Method Transmissivity (ft2/min)	Cooper Method Hydraulic Conductivity (ft/min)	Cooper Method Hydraulic Conductivity (ft/day)	Bouwer&Rice Hydraulic Conductivity (ft/min)	Bouwer&Rice Hydraulic Conductivity (ft/day)	Predominant Lithology
OU-I	IR-1	IR01MW02B	28.5-38.5	10.0	1.69E-02	1.69E-03	2.43E+00	9.23E-04	1.33E+00	undiff sedimentary deposits (SW)
OU-I	IR-1	IR01MW03A	13-28	12.4	5.17E-01	4.17E-02	6.00E+01	1.38E-02	1.99E+01	industrial fill
OU-I	IR-1	IR01MW07A	5-22	7.5	4.61E-01	6.15E-02	8.85E+01	1.68E-02	2.42E+01	industrial fill/bedrock fill
OU-I	IR-1	IR01MW26B	42-52	10.0	3.23E-03	3.23E-04	4.65E-01	1.07E-04	1.54E-01	undiff sedimentaray deposits (SM, SP)
OU-I	IR-1	IR01MW38A	8-21	13.0	2.89E-02	2.22E-03	3.20E+00	8.34E-03	1.20E+01	industrial fill (GW)
OU-I	IR-1	IR01MW42A*	18-26.5	8.5	1.23E+00	1.45E-01	2.08E+02	4.12E-02	5.93E+01	boulder fill
OU-I	IR-1	IR01MW43A	5-22.5	14.1	7.50E-02	5.32E-03	7.66E+00	3.78E-03	5.44E+00	industrial fill/sands
OU-I	IR-1	IR01MW44A	4-8	1.4	NT					industrial fill/sands
OU-I	IR-1	IR01MW48A	7-20	11.8	5.28E-02	4.47E-03	6.44E+00	1.14E-02	1.64E+01	industrial fill (SM)
OU-I	IR-1	IR01MW53B	35-45	10.0	1.07E-01	1.07E-02	1.54E+01	3.15E-03	4.54E+00	undiff sedimentary deposits (SM, SP)
OU-I	IR-1	IR01MW58A	4-16.5	9.4	3.67E-01	3.90E-02	5.62E+01	2.39E-03	3.44E+00	industrial fill/bedrock fill
OU-I	IR-1	IR01MWI-2*	6.5-21.5	9.0	1.99E+00	2.21E-01	3.18E+02	4.76E-02	6.86E+01	boulder fill
OU-I	IR-1	IR01MWI-3	5-18	7.5	1.42E-02	1.89E-03	2.73E+00	4.91E-04	7.07E-01	industrial fill/sand
OU-I	IR-1	IR01MWI-5*	4.5-19.5	8.3	NC	NC	NC	7.86E-03	1.13E+01	industrial fill/sand
OU-I	IR-1	IR01MWI-6	4.5-12.5	6.0	NT					industrial fill/sand
OU-I	IR-1	IR01MWI-7	3.5-13.5	10.0	1.29E+00	1.29E-01	1.86E+02	3.45E-02	4.97E+01	industrial fill/clay
OU-I	IR-1	IR01MWI-9	3.5-13.5	8.3	3.03E-02	3.65E-03	5.26E+00	8.00E-04	1.15E+00	industrial fill/clayey sand
OU-I	IR-2	IR02MW101A1	9-19	7.3	6.16E-03	8.44E-04	1.22E+00	1.03E-02	1.49E+01	clay to gravel fill (SM)
OU-I	IR-2	IR02MW101A2	29-36	7.0	4.14E-04	5.91E-05	8.51E-02	6.51E-05	9.37E-02	clay to gravel fill (SP)
OU-I	IR-2	IR02MW114A1	5-10	3.3	NT					clay to gravel fill (CL)
OU-I	IR-2	IR02MW114A2	14-26	12.0	1.16E-02	9.67E-04	1.39E+00	3.81E-04	5.48E-01	clay to gravel fill (CL)
OU-I	IR-2	IR02MW114A3	43.5-50.5	7.0	1.52E-03	2.17E-04	3.13E-01	1.33E-04	1.91E-01	clay to gravel fill (SM, GW)
OU-I	IR-2	IR02MW126A	6-15	5.8	9.79E-02	1.69E-02	2.43E+01	5.70E-03	8.21E+00	industrial fill (SM, GP)
OU-I	IR-2	IR02MW147A	5-10	4.3	NT					clay to gravel fill (CH, SW-SM)
OU-I	IR-2	IR02MW149A	7-22	16.8	3.43E-05	2.04E-06	2.94E-03	2.27E-05	3.27E-02	clay to gravel fill (CL)
OU-I	IR-2	IR02MW175A	10.5-32.5	22.7	2.12E-01	9.34E-03	1.34E+01	6.47E-03	9.32E+00	undiff upper sands (SM)
OU-I	IR-2	IR02MW179A*	6-19.5	10.0	2.01E+00	2.01E-01	2.89E+02	3.72E-02	5.36E+01	boulder fill
OU-I	IR-2	IR02MW183A	5.5-35.5	25.8	4.46E-02	1.73E-03	2.49E+00	1.34E-03	1.93E+00	undiff upper sand (SP)
OU-I	IR-2	IR02MW196A	4.5-11.5	3.6	NT					undiff upper sand (SP)
OU-I	IR-2	IR02MW206A1	2.5-7.5	0.5	NT					clay to gravel fill (SP, CL)
OU-I	IR-2	IR02MW206A2*	11.5-21.5	11.0	6.83E-01	6.21E-02	8.94E+01	1.85E-02	2.66E+01	undiff upper sands (SP) > 50% shells
OU-I	IR-2	IR02MW209A*	10-20	10.0	9.24E-01	9.24E-02	1.33E+02	1.53E-02	2.20E+01	undiff upper sands (SP, SM)
OU-I	IR-2	IR02MW87A	4-14	7.1	2.43E-02	3.42E-03	4.93E+00	3.43E-02	4.94E+01	clay to gravel fill (ML, SM)
OU-I	IR-2	IR02MW93A	3.5-18.5	10.9	1.93E+00	1.77E-01	2.55E+02	3.70E-02	5.32E+01	boulder fill
OU-I	IR-2	IR02MW97A*	7.5-24.5	15.1	6.78E+00	4.49E-01	6.47E+02	1.76E-01	2.53E+02	undiff upper sand/bedrock fill (SP)

Table 3. Results of Slug Testing

Operable Unit	IR-Site	Well#	Screen Interval BTOC (ft)	Saturated Thickness adjacent to well screen (ft)	Cooper Method Transmissivity (ft2/min)	Cooper Method Hydraulic Conductivity (ft/min)	Cooper Method Hydraulic Conductivity (ft/day)	Bouwer&Rice Hydraulic Conductivity (ft/min)	Bouwer&Rice Hydraulic Conductivity (ft/day)	Predominant Lithology
OU-I	IR-2	IR02MWB-1	5-20	14.6	4.20E-03	2.88E-04	4.14E-01	2.85E-04	4.10E-01	clay to gravel fill (CL)
OU-I	IR-2	IR02MWB-2*	4.5-19.5	10.4	2.04E-01	1.96E-02	2.82E+01	7.14E-03	1.03E+01	industrial fill/sand
OU-I	IR-2	IR02MWB-3*	5-20	9.8	3.05E-01	3.13E-02	4.50E+01	1.15E-02	1.65E+01	industrial fill/sand
OU-I	IR-2	IR02MWB-5	3-17	12.4	NC	NC	NC	NC	NC	bedrock derived fill/sand/glass (CL-CH, SP)
OU-I	IR-2	IR02MWC5-W	4.5-14.5	NA	NT					clay to gravel fill (SP, CL)
OU-I	IR-3	IR03MW218A1	5-11	2.9	NT					bedrock derived fill (CL)
OU-I	IR-3	IR03MW218A2	13.5-18.5	5.0	7.10E-03	1.42E-03	2.04E+00	3.39E-04	4.89E-01	clay to gravel fill/industrial
OU-I	IR-3	IR03MW218A3	21-31	10.0	7.22E-05	7.22E-06	1.04E-02	1.72E-05	2.48E-02	clay to gravel fill (SP)
OU-I	IR-3	IR03MW228B	59-69	10.0	5.92E-02	5.92E-03	8.52E+00	2.17E-03	3.13E+00	undiff sedimentary deposits (SP,SC,ML/CL)
OU-I	IR-3	IR03MWO-1	3.5-18.5	NA	NT					clay to gravel fill (CL, GC)
OU-I	IR-3	IR03MWO-2	4.5-21	NA	NT					clay to gravel fill (SW-SC, GC-CL)
OU-I	IR-3	IR03MWO-3	5-20	NA	NT					clay to gravel fill (SC-GC, SP)
OU-III	IR-4	IR04MW09A	4.5-19.5	11.2	1.03E+00	9.20E-02	1.32E+02	3.75E-02	5.40E+01	boulder fill
OU-III	IR-4	IR04MW31A	12.7-27.7	16.4	4.82E-01	2.94E-02	4.23E+01	7.86E-03	1.13E+01	boulder fill
OU-III	IR-4	IR04MW35A*	8.7-28.7	18.0	2.19E+00	1.22E-01	1.75E+02	4.78E-02	6.89E+01	boulder fill
OU-III	IR-4	IR04MW36A*	5.5-25.5	16.1	5.72E+00	3.55E-01	5.12E+02	8.90E-02	1.28E+02	boulder fill (ML)
OU-III	IR-4	IR04MW37A*	6.8-21.8	12.5	2.10E+00	1.68E-01	2.42E+02	3.48E-02	5.01E+01	boulder fill (ML)
OU-III	IR-4	IR04MW38A	5.3-20.3	10.5	7.64E-01	7.28E-02	1.05E+02	1.39E-02	2.00E+01	boulder fill
OU-III	IR-4	IR04MW39A	4-24	16.0	3.22E-01	2.01E-02	2.90E+01	4.85E-03	6.98E+00	boulder fill/bedrock fill (ML)
OU-III	IR-4	IR04MW40A*	4.2-26.2	13.3	4.74E+00	3.56E-01	5.13E+02	6.51E-02	9.37E+01	boulder fill (ML)
OU-III	IR-5	IR05MW73A	4.1-9.1	2.6	NT					boulder fill
OU-III	IR-5	IR05MW74A	5.8-22.8	16.0	2.20E-01	1.38E-02	1.98E+01	1.80E-02	2.59E+01	clay to gravel fill (GC, CH)
OU-III	IR-5	IR05MW76A*	4.5-13.5	8.6	NC	NC	NC	NC	NC	clay to gravel fill (SW)
OU-III	IR-5	IR05MW77A	6.4-34.2	23.2	1.24E-01	5.34E-03	7.70E+00	3.97E-03	5.71E+00	clay to gravel fill (SC, GW)
OU-II	IR-6	IR06MW22A	3.4-8.4	4.0	NT					clay to gravel fill (CL, SM)
OU-II	IR-6	IR06MW23A	4.4-12.4	7.2	8.50E-02	1.18E-02	1.70E+01	1.60E-02	2.31E+01	clay to gravel fill (CL, SP)
OU-II	IR-6	IR06MW27A	4.4-11.1	3.5	NT					clay to gravel fill (SM)
OU-II	IR-6	IR06MW30A	6.4-16.4	10.8	5.23E-02	4.84E-03	6.97E+00	1.93E-03	2.78E+00	clay to gravel fill/boulder (SC, SP)
OU-II	IR-6	IR06MW32A	5.9-13.4	7.5	3.65E-01	4.87E-02	7.01E+01	6.60E-02	9.51E+01	clay to gravel fill (CH, ML)
OU-II	IR-6	IR06MW34A	6.4-11.4	4.5	NT					clay to gravel fill (ML)
OU-II	IR-6	IR06MW35A	5.4-14.4	9.0	6.12E-02	6.80E-03	9.79E+00	5.78E-03	8.32E+00	clay to gravel fill (SC, GW)
OU-II	IR-6	IR06MW40A	6.4-19.9	11.2	7.57E-02	6.76E-03	9.73E+00	2.09E-03	3.00E+00	clay to gravel fill/sand (ML, CL, SP)

Table 3. Results of Slug Testing

Operable Unit	IR-Site	Well#	Screen Interval BTOC (ft)	Saturated Thickness adjacent to well screen (ft)	Cooper Method Transmissivity (ft2/min)	Cooper Method Hydraulic Conductivity (ft/min)	Cooper Method Hydraulic Conductivity (ft/day)	Bouwer&Rice Hydraulic Conductivity (ft/min)	Bouwer&Rice Hydraulic Conductivity (ft/day)	Predominant Lithology
OU-II	IR-6	IR06MW41A	6.4-16.4	8.0	1.94E-03	2.43E-04	3.49E-01	1.12E-03	1.61E+00	clay to gravel fill (CL, SP-SC)
OU-II	IR-6	IR06MW42A	8-13	2.6	NT					clay to gravel fill/industrial (ML)
OU-IV	IR-7	IR07MW19A	5.5-15.5	5.5	7.53E-01	1.37E-01	1.97E+02	2.28E-02	3.29E+01	clay to gravel fill (GC, CL, SC)
OU-IV	IR-7	IR07MW20A1*	5.6-23.6	13.8	2.22E+00	1.61E-01	2.32E+02	5.17E-02	7.44E+01	clay to gravel fill (SW, GW)
OU-IV	IR-7	IR07MW20A2	38-43	5.0	4.05E-02	8.10E-03	1.17E+01	3.91E-03	5.63E+00	clay to gravel fill (GM, CH, GC)
OU-IV	IR-7	IR07MW21A1	7.5-17.5	4.0	NT					clay to gravel fill (SP, SW)
OU-IV	IR-7	IR07MW21A2	30.5-35.5	5.0	4.06E-02	8.12E-03	1.17E+01	4.09E-03	5.89E+00	clay to gravel fill (SP, GW)
OU-IV	IR-7	IR07MW23A	6.4-16.4	2.0	NT					clay to gravel fill (SM)
OU-IV	IR-7	IR07MWP-1	4-19	11.5	1.02E-02	8.87E-04	1.28E+00	3.32E-04	4.79E-01	clay to gravel fill (CL)
OU-IV	IR-7	IR07MWP-2	3.7-18.7	10.0	8.78E-01	8.78E-02	1.26E+02	6.31E-03	9.09E+00	clay to gravel fill (GW, CL)
OU-IV	IR-7	IR07MWS-1	4.6-17.6	10.2	8.87E-02	8.70E-03	1.25E+01	4.85E-03	6.99E+00	weathered bedrock
OU-IV	IR-7	IR07MWS-2	2.5-17.5	9.8	7.47E-03	7.62E-04	1.10E+00	4.44E-04	6.39E-01	clay to gravel fill (CL)
OU-IV	IR-7	IR07MWS-3	4.4-19.4	11.5	1.04E-01	9.04E-03	1.30E+01	3.89E-03	5.60E+00	clay to gravel fill (SC)
OU-IV	IR-7	IR07MWS-4	6-21	9.5	2.60E-01	2.74E-02	3.94E+01	3.26E-03	4.70E+00	clay to gravel fill (GW)
OU-II	IR-8	IR08MW37A	6.7-22.2	15.5	1.37E-01	8.84E-03	1.27E+01	3.24E-03	4.66E+00	undiff upper sand (SP)
OU-II	IR-8	IR08MW38A	6.3-24.3	17.6	3.01E-01	1.71E-02	2.46E+01	7.72E-03	1.11E+01	undiff upper sand (SP)
OU-II	IR-8	IR08MW39A*	5.8-35.8	30.5	NC	NC	NC	NC	NC	boulder fill
OU-II	IR-8	IR08MW40A	7.4-27.4	21.5	4.16E-02	1.93E-03	2.79E+00	1.65E-03	2.38E+00	undiff upper sand (SP)
OU-II	IR-8	IR08MW41A*	5.1-25.1	18.0	2.26E+00	1.26E-01	1.81E+02	3.19E-02	4.60E+01	undiff upper sand (SP)
OU-II	IR-8	IR08MWW6	10-20	NA	NT					boulder fill/sand
OU-II	IR-9	IR09MW31A	6.3-11.3	2.4	NT					clay to gravel fill (CL)
OU-II	IR-9	IR09MW35A	7.3-18.3	10.6	3.14E-01	2.96E-02	4.27E+01	2.44E-02	3.52E+01	clay to gravel fill (SP, SC)
OU-II	IR-9	IR09MW36A	10.5-20.5	11.7	1.34E-02	1.15E-03	1.65E+00	7.90E-04	1.14E+00	clay to gravel fill (GM, CH)
OU-II	IR-9	IR09MW37A	7-13.5	4.2	3.99E-04	9.50E-05	1.37E-01	9.66E-05	1.39E-01	clay to gravel fill (SM, CH)
OU-II	IR-9	IR09MW38A	7-12	2.7	NT					clay to gravel fill (MH, SC)
OU-II	IR-9	IR09PPY1	6.8-16.8	8.0	6.99E-03	8.74E-04	1.26E+00	5.55E-04	7.99E-01	clay to gravel fill (GW)
OU-II	IR-10	IR10MW12A	2.4-17.4	11.4	1.27E-01	1.11E-02	1.60E+01	4.45E-03	6.40E+00	clay to gravel fill (GP)
OU-II	IR-10	IR10MW13A1	4.8-19.8	12.3	2.58E-01	2.10E-02	3.02E+01	1.07E-02	1.54E+01	clay to gravel fill (GP)
OU-II	IR-10	IR10MW13A2	24.7-39.7	15.0	1.94E-01	1.29E-02	1.86E+01	8.39E-03	1.21E+01	clay to gravel fill (GC, GM)
OU-II	IR-10	IR10MW14A	4.6-19.6	11.9	1.53E-01	1.29E-02	1.85E+01	3.62E-03	5.21E+00	clay to gravel fill (GM)
OU-II	IR-10	IR10MW15A	4.6-17.6	11.9	9.34E-03	7.85E-04	1.13E+00	3.64E-04	5.24E-01	clay to gravel fill (ML/CL, SM)

Table 3. Results of Slug Testing

Operable Unit	IR-Site	Well#	Screen Interval BTOC (ft)	Saturated Thickness adjacent to well screen (ft)	Cooper Method Transmissivity (ft2/min)	Cooper Method Hydraulic Conductivity (ft/min)	Cooper Method Hydraulic Conductivity (ft/day)	Bouwer&Rice Hydraulic Conductivity (ft/min)	Bouwer&Rice Hydraulic Conductivity (ft/day)	Predominant Lithology
OU-V	IR-11	IR11MW25A	5-11	2.0	NT					clay to gravel fill (SP, MH)
OU-V	IR-11	IR11MW26A	6-10	0.9	NT					clay to gravel fill (SP, MH)
OU-V	IR-11	IR11MW27A	6-11	2.4	NT					clay to gravel fill (SP, MH)
OU-V	IR-12	IR12MW11A	6-19	9.4	6.35E-02	6.76E-03	9.73E+00	7.99E-03	1.15E+01	clay to gravel fill (GP, GC)
OU-V	IR-12	IR12MW12A	3.5-16.5	10.1	6.08E-01	6.02E-02	8.67E+01	8.97E-03	1.29E+01	clay to gravel fill, boulder fill (SC)
OU-V	IR-12	IR12MW13A	7-22	9.7	7.12E-01	7.34E-02	1.06E+02	1.20E-02	1.73E+01	clay to gravel fill (GC)
OU-V	IR-12	IR12MW14A	4.5-19.5	10.7	3.86E-01	3.61E-02	5.19E+01	1.78E-02	2.57E+01	clay to gravel fill (SM, CL)
OU-V	IR-12	IR12MW15A	6-21	13.0	9.98E-01	7.68E-02	1.11E+02	2.03E-02	2.92E+01	clay to gravel fill (GM, GW, GC)
OU-V	IR-12	IR12MW16A	5.5-15.5	6.2	2.04E-01	3.29E-02	4.74E+01	6.22E-03	8.96E+00	clay to gravel fill (GW-GM, CL)
OU-V	IR-13	IR13MW10A	3.5-17.5	13.5	2.82E-02	2.09E-03	3.01E+00	1.32E-02	1.89E+01	clay to gravel fill (SC)
OU-V	IR-13	IR13MW11A	3.5-9	4.8	NT					clay to gravel fill (CL)
OU-V	IR-13	IR13MW12A	4.5-17.5	12.9	6.98E-01	5.41E-02	7.79E+01	3.20E-02	4.60E+01	clay to gravel fill (GW-GM, CL)
OU-V	IR-14	IR14MW09A	6.7-14.7	4.6	NC	NC	NC	NC	NC	boulder fill
OU-V	IR-14	IR14MW10A	5-17	7.9	1.59E-01	2.01E-02	2.90E+01	6.72E-03	9.67E+00	clay to gravel fill
OU-V	IR-14	IR14MW11A	NA	NA	NT					NA
OU-V	IR-14	IR14MW12A	7-18.5	9.6	NC	NC	NC	NC		boulder fill
OU-V	IR-15	IR15MW06A	8-21	9.6	NC	NC	NC	NC		boulder fill
OU-V	IR-15	IR15MW07A	7-20	8.5	NC	NC	NC	NC		boulder fill
OU-V	IR-17	IR17MW11A*	4-17	10.1	7.01E+00	6.94E-01	9.99E+02	4.65E-02	6.69E+01	undiff upper sands (SP)
OU-V	IR-17	IR17MW12A*	4-17	10.3	8.08E+00	7.88E-01	1.14E+03	9.73E-02	1.40E+02	undiff upper sands (SP)
OU-V	IR-17	IR17MW13A*	4-17	11.1	2.58E+00	2.32E-01	3.35E+02	3.64E-02	5.24E+01	undiff upper sands (SP)
wwmtab3										

BTOC = Below top of casing
NA = Not Available
NT = Not Tested
NC = Not Calculated
* = Well recovered to within 0.01 foot in one minute or less; data are of questionable quality