June 30, 2014

Mr. Weiquan Dong, PE
Bureau of Corrective Actions, Special Projects Branch
Nevada Division of Environmental Protection
2030 E. Flamingo Rd., Suite 230
Las Vegas, Nevada 89119

Re: Errata to Semi-Annual Remedial Performance Report for Chromium and Perchlorate; Nevada Environmental Response Trust Site, Henderson, Nevada; July – December 2013; and Response to NDEP Comments dated April 9, 2014, on the Semi-Annual Remedial Performance Report for Chromium and Perchlorate; Nevada Environmental Response Trust Site, Henderson, Nevada; July – December 2013 (NDEP Facility ID #H-000539)

Dear Mr. Dong,

On behalf of the Nevada Environmental Response Trust (Trust or NERT), please find attached annotated responses to Nevada Division of Environmental Protection (NDEP) comments dated April 9, 2014 on the *Semi-Annual Remedial Performance Report for Chromium and Perchlorate,* for the period July to December 2013 and dated April 9, 2014 (the "2013 Semi-Annual Performance Report") for the NERT Site in Henderson, Nevada. As previously confirmed during a conference call with NDEP on April 22, 2014, it was decided to categorize comments as follows:

1. Editorial or minor comments that are addressed herein as part of the response to comments or errata.
2. More significant comments (e.g., modeling approach) that will be addressed in subsequent Annual and Semi-Annual Monitoring Reports, or other deliverables, as appropriate.
3. Comments related to specific analyses (e.g., analysis of the soil flushing at the retention basin) that will be addressed as part of the Remedial Investigation (RI).

Items placed into categories 2 or 3 will be addressed in subsequent reporting and/or work plans, depending upon the nature of the comment itself. The attached errata addresses items placed into category 1 and is being provided on 3-hole punched paper so these pages can be easily inserted into your hard copy of the 2013 Semi-Annual Performance Report, provided previously. Please find attached the following errata documentation:

- Revised Report Text
    - Revised text (page 31) to address NDEP Comment #18
- Revised Attachment A
    - Revised text (pages 5-8, 10, 11) to address NDEP Comments #22, #26, #29, #30, #32
    - Revised Table 1B to address NDEP Comment #25
    - Revised Table 2 to address NDEP Comment #27
- Revised Appendix C (CD Only)
    - Data Validation and Summary Report, Revision 1

Please replace the report text, Attachment A, Table 1B, and Table 2 in your hard copy of the report with the pages attached. Also attached is a revised CD with the complete report (with these errata incorporated) in electronic format, to replace the CD you previously received.

Please contact John Pekala at (602) 734-7710 or Allan DeLorme at (510) 420-2565 if you have any comments or questions concerning this report.

Sincerely,

John M. Pekala, PG
Senior Manager
CEM #2347, expires 9/20/2014

Allan J. DeLorme, PE
Principal

Attachments

cc: BMI Compliance Coordinator, NDEP, BCA, Las Vegas
NDEP c/o Brian Giroux, McGinley and Associates, Reno

ec: James Dotchin, NDEP
Greg Lovato, NDEP
Nevada Environmental Response Trust
Tanya O’Neill, Foley & Lardner LLP
Joe McGinley, McGinley and Associate

Attachment A

Responses to NDEP Comments Dated April 9, 2014
Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site, Henderson, Nevada, July – December 2013

NDEP Comment	Category[1]	Response
1. Section 2 Groundwater Conditions, Pages 4 and 5. “The continued presence of elevated water levels near the IWF is likely related to heavy rainfall between August and October of 2012 and the resulting infiltration, which was likely intensified in the area upgradient of the IWF due to the collection of storm water in the Central Retention Basin”. The NDEP suggests that the correlation analysis between the water volume collected in the detention basins and the increase of the groundwater volume in the aquifer for those storm events should be done in the future, because this water from the dentation basin was included into the water budget of the Phase I model in Appendix A and the information from this analysis should help to understand the soil flush process of perchlorate.	3	The water balance presented in Appendix A covers the period before the heavy rainfall in 2012, and no attempt was made to represent the heavy rainfall period later in 2012. ENVIRON recommends this be done as part of the RI when the transient groundwater model is developed.
2. Section 2.1 Interceptor Well Field Area, Page 6 first paragraph. The performance of the barrier wall, including what effects the operation of the former recharge trenches may have had, is being evaluated and it is anticipated that this evaluation will be discussed in the 2013-2014 Annual Performance Report. The NDEP expects to see a work plan for evaluating the effectiveness of the slurry wall on the down gradient migration of the perchlorate and other contaminants.	2 / 3	An initial evaluation of the barrier wall using existing data is planned for the 2013 GWETS Optimization Project Report and will also be discussed in the next Annual Report. However, a more comprehensive evaluation involving additional data collection would require a separate scope. ENVIRON will perform a comprehensive evaluation of the barrier wall’s performance as part of the RI/FS.

NDEP Comment	Category[1]	Response
3. Section 2.3 Seep Well Field Area, Page 7. "The wells comprising the SWF are screened across the full thickness of the Qal and across the deepest portion of an alluvial channel." Please provide data to support that the SWF wells are screened across the full thickness of the Qal.	1	Boring and well installation logs have been compiled for the SWF pumping wells and attached to this submittal. Screened intervals for the SWF wells are also shown on Plate 5 within the Annual Reports. The logs show that with the exception of PC-121, the SWF wells are effectively screened (including screens + filter packs) across the full thickness of the saturated Qal. PC-121, located on the far west end of the SWF line, is outside of the broad alluvial channel in this area and is not routinely pumped.
4. Section 3.1 Chromium Plume Configuration, Page 9, Paragraph 4. "The overall lower concentrations observed in on-site wells located downgradient of the barrier wall compared with those upgradient indicate that the IWF is generally an effective barrier to migration of the main portion of the chromium plume. However, concentrations of chromium observed in wells immediately downgradient of the wall, suggest that there could be some flow past the wall". The comment for item 2 above is applied to this item.	2 / 3	See response to comment 2.
5. Section 3.2 Chromium Treatment System, Page 11, Paragraph 4. "Based on an average influent total chromium concentration of 0.028 mg/L and an average flow rate of 904 gpm[13], the FBRs were receiving about 0.31 pounds of chromium per day from the equalization tanks". The footnotes state that the 904 gpm is the effluent flow rate. Furthermore, the volume diverted from and to GW-11 and the Lake Mead water used should be basic operation parameters, so this calculation should be accurately calculated either using the influent flow rate or effluent flow rate. Please explain why the influent flow rate to the FBRs or the effluent flow rate from the equalization tanks is not used for this calculation	1	The GWETS Operator reported that there is no influent flow meter for the FBRs. The flow rate from the equalization tanks is not used for this calculation because water can be diverted to the GW-11 pond after leaving the equalization tanks. Therefore, the effluent flow from the equalization tanks is not an accurate measure of total FBR throughput. In future reports, effluent flow from the GW-11 pond will be used in this calculation since GW-11 is now reconfigured to be used for equalization.

NDEP Comment	Category[1]	Response
6. Section 4 Perchlorate Capture and Treatment, Page 13, Paragraph 1. The flow rates, perchlorate concentrations that correspond to the daily perchlorate mass removal should be added to Table 7 or an Excel file with the calculation activated for Table 7 should be submitted with all future annual and semi-annual reports.	2	Future Annual or Semi-Annual Reports will include an average monthly flow rate and average monthly perchlorate concentration for each well field.
7. Section 4 Perchlorate Capture and Treatment, Page 13, Paragraph 2. The total perchlorate mass loading the FBRs can be calculated as the product of the flow rate and the perchlorate concentration of the influent to the FBRs and they should be close to the total perchlorate mass calculated from the three well fields if there is no division from GW-11. Because GW-11 will be used as the EQ basin, a full assessment on GW-11 including the mass inventory of chemicals including perchlorate, chlorate, nitrate, chloride, sulfate, ammonia, phosphorus, calcium, iron, total chromium, hexavalent chromium, TDS, TSS and other parameters including pH, water volume, water level elevation and the solids accumulated at the bottom should be done before starting GW-11 as EQ basin. The perchlorate mass from and to GW-11 should be reported in future annual and semi-annual performance reports. Once GW-11 serves as the EQ basin, the perchlorate mass from the three well fields, GW-11 and additional sources should be reported in future annual and semi-annual performance reports.	2	The requested analytical data (perchlorate, chlorate, nitrate, chloride, sulfate, ammonia, phosphorus, calcium, iron, total chromium, hexavalent chromium, TDS, TSS, pH) and other parameters (water volume and level) were collected immediately before the GW-11 pond began operating as an equalization basin. GW-11 will continue to be monitored on a monthly basis and reported in the Annual and Semi-Annual Reports. The Trust is currently working with Envirogen to develop treatment plant operational metrics and recommendations for treatment plant system control modifications, which will be presented in an upcoming Enhanced GWETS Operational Metrics Memorandum to NDEP. In future Annual and Semi-Annual Reports, loading to the GW-11 pond will be estimated using extraction rates and perchlorate concentration data collected at the three well fields. The perchlorate mass removed from the GW-11 pond will be estimated using FBR influent perchlorate concentrations and effluent flow from the GW-11 pond.
8. Section 5.1 Performance Metrics, Page 20. Water volume and elevation, the perchlorate concentration, the flow rate to and from of GW-11 should be added to the performance metrics in future annual and semi-annual performance reports.	2	This information will be added to the performance metrics section as part of the next Annual Report.

NDEP Comment	Category[1]	Response
9. Section 5.4.1 Mass Removal and Remaining Plume Mass, Page 22. Average perchlorate mass of the three methods in Table 9 is 7,036 tons in 2002, 4,323 tons in 2006 and 3,477 tons in 2012. The average perchlorate mass reduction in groundwater is 2,713 tons (7,036-4,323) and 3,559 tons (7,036-3,477), respectively for these two periods. The accumulated perchlorate mass removals in the three well fields are 2,153 tons as December 31, 2006 and 3,822 tons as December 31, 2012, the perchlorate reduction from the perchlorate plume mass estimates overestimated 560 tons or 26% for the period before 2006 and underestimated 223 tons or 6% for the period before 2012. The perchlorate plume mass estimates should be updated in next annual performance report and can be important basis to predict the perchlorate remediation.	2	The perchlorate plume mass estimates will be updated as part of the next Annual Report.
10. Table 9. The estimated perchlorate mass in alluvium from AWF to the Wash with Kriging is 11 tons in 2006 and 14 tons in 2012 and the estimated perchlorate mass in alluvium and UMCf of On-site with the contour method is 12 tons and 2,404 tons, respectively in 2006 and 18 tons and 2,530 tons in 2012, respectively. It doesn't make sense that the mass remaining is more in 2012 than in 2006. Please explain why the perchlorate mass remaining is higher after 6 years of perchlorate removal.	1	The perchlorate mass estimates are based on the interpolation over a large area from point measurements of perchlorate concentration. Inherently, there is uncertainty in the resulting mass estimates, which may explain why in several cases the mass estimate increases with time. However, it is possible that the mass of perchlorate in individual areas does increase with time due to flushing of additional perchlorate from the vadose zone (in the on-site area) or migration of perchlorate in groundwater from an upgradient area to a downgradient area (in the off-site areas). The mass estimates over the entire area are reasonably consistent with measured mass removal rates and provide a useful metric for GWETS performance.
11. Section 5.4.2 Capture Zone Evaluation and Estimated Mass Flux, Page 22. Both alluvium and upper Muddy Creek Formation capture zones (Figures 29a and 29b) show a gap in the eastern part of the downgradient plume area. The NERT should consider better capture in those capture gap areas. Please provide **three dimension** particle tracking maps in future annual and semi-annual performance reports.	2 / 3	ENVIRON is currently using 3D particle tracking to evaluate capture zones using the model. We will look into incorporating 3D maps into the Annual and Semi-Annual Reports, but request clarification from NDEP on what specific information should be included. Evaluation of gaps in capture will be part of ongoing remedial performance reporting, as well as the RI.

NDEP Comment	Category[1]	Response
12. Section 5.4.2 Capture Zone Evaluation and Estimated Mass Flux, Pages 22-23. The method used to calculate the total mass flux crossing transect could be underestimated because the calculation assumed that the mass flux of the extraction wells represents the total mass flux crossing transect inside of the capture zone. This assumption is true only if the extraction wells have 100% capture in both horizontal and vertical directions of the cross section. The NDEP suggest two methods to get the total groundwater flux crossing transects. The first method is to use the Darcy flux based on the hydraulic gradients crossing transect, saturated thickness and hydraulic conductivity from aquifer tests. The second method is to use zone budgets from the model. The mass flux will be a product of the groundwater flux and its corresponding perchlorate concentration. The mass flux calculation should use actual perchlorate concentration measurements first. If there is no actual perchlorate measurement, the interpolating method can be used. The capture efficiency will be the ratio of the mass flux from extraction wells to the mass flux calculated from the two methods above. If the two capture efficiencies are much different, the capture efficiency based on the Darcy flux should be used and the NERT should check why the model calculates much different groundwater flux from the Darcy flux method.	2	ENVIRON will evaluate using multiple methods to calculate mass flux in future Annual or Semi-Annual Reports.

NDEP Comment	Category[1]	Response
13. Section 5.4.3 Perchlorate Mass Loading to Las Vegas Wash, Page 24, Paragraph 3. “Thus, this instantaneous mass loading calculation method yields lower mass loading estimates than methods using a longer flow averaging time.” The instantaneous mass loading calculation method has been proven as the most accurate way to calculate mass loading at the Northshore Road because both flow rate and perchlorate concentration constantly fluctuates at this location. The flow measurements are much more than the perchlorate concentration measurements, which means that average flow rate has much better representative compared average perchlorate concentration. As a result, the mass loading calculated with average flow rate and perchlorate concentration is not as good as the mass loading calculated with the instantaneous measurements. Additionally the instantaneous mass loading calculation has been used to track perchlorate loading at the Northshore Road sampling point since the discovery of perchlorate in the Las Vegas Wash and modifying the calculation at this point would not be beneficial to the project.	2	For ease of comparison with previous mass loading totals, ENVIRON will use the historical mass loading calculation approach in future Annual and Semi-Annual Reports.

NDEP Comment	Category[1]	Response
14. Section 5.4.3 Perchlorate Mass Loading to Las Vegas Wash, Page 24, Paragraph 5. The contribution from quarterly perchlorate mass loading at the three stations (Northshore Road, Pabco Road and Las Vegas Wasteway) represents a relative perchlorate contribution of the reaches between the stations to the total perchlorate mass loading of Northshore Road. Because the groundwater from Sothern bank aquifer entering the Las Vegas Wash may not follow the geographic boundary at surface and it may not fully mix with surface water at the surface water sampling location, the relative perchlorate contribution calculated with the stream flow rate and the stream water perchlorate concentration cannot be used for the perchlorate contributions from each responsible party of the BMI region. The Darcy flux that is calculated based on the representative flow nets, particle tracking, cross section areas that are perpendicular to the groundwater flow direction and correct saturated aquifer thickness and hydraulic properties should be done first. The zone budgets from a well calibrated groundwater flow and transport model could be important way to find out the groundwater flux and the mass loading from each responsible party of the BMI region.	3	The calculation was not intended as a method to apportion perchlorate mass (or any other COC) to responsible parties, but rather to illustrate how mass loading in the Wash changes as you move downstream using data that is readily available. ENVIRON acknowledges that these mass loading estimates are an incomplete characterization of how perchlorate in groundwater from different source areas migrates to the Wash. One of the goals of the RI is to improve our understanding of groundwater-surface water interaction and to better characterize perchlorate loading to the Wash. As part of the RI, the groundwater model will be further refined and then used to generate an estimate of perchlorate loading from the NERT Site using the types of methods suggested by NDEP.

NDEP Comment	Category[1]	Response
15. Section 5.4.4 Surface Water and Groundwater Interaction Near the SWF, Page 25, Paragraph 2. The comparison of the gauge height of the USGS stream gage (USGS # 09419700) at the Pabco Road Weir and the groundwater elevation of Wells located in the SWF is based on that the assumption that the groundwater of the SWF has direct connection with the surface water in the Las Vegas Wash stream. This assumption is generally true but it is better to have more direct evidence to support it. The wells of PC-91, PC-92 are next to the pumping well PC-133, so the hydrography of these two wells may be significantly affected by the pumping. The groundwater elevation of the PC-94 started to decrease in 2003 that was almost same time starting to pump the PC-133, which means that the groundwater elevation immediately responded the pumping PC-133. The big drop on the groundwater elevation of PC-94 in 2008 could be also caused by stopping using Rapid Infiltration Basins (RIBs). The NDEP suggest that the NERT study all groundwater elevation data along entire northern model boundary with focus on the wells from SWF towards to east, because the groundwater flow direction changes to northeast in the southern bank of the Las Vegas Wash from approximately north in the area from AWF to SWF.	3	This requires additional data analysis outside of the scope of the Annual and Semi-Annual Reports. ENVIRON will perform this evaluation as part of the RI.
16. Section 5.4.5 Environmental Footprint, Page 26, Paragraph1. The NDEP suggest that the kWh used for per pound of perchlorate removal from each well field is reported for in future annual and semi-annual performance reports.	2	ENVIRON will include this information in future Annual and Semi-Annual Reports.

NDEP Comment	Category[1]	Response
17. Section 7 Proposed Future Activities, Page 29, Paragraph 1. "As part of the 2011-2012 Annual Groundwater Monitoring report, a preliminary analysis of current groundwater capture was performed that recommended both adjusting extraction rates of individual wells and bringing idle extraction wells online to improve capture efficiency and maximize mass removal." Most wells of the three well fields don't have variable speed pump. Please explain how the extraction rates will be adjusted if recommended.	1	As has been done in the past, the well flows can be controlled by the GWETS Operator via valves on the discharge piping.
18. Section 8. Reference, Page 31. The reference of Zheng, C 1990 was not used in the text.	1	This reference will be removed from the report and an erratum provided.
Appendix A Phase I Groundwater Model Refinement		
19. General Comments. The model files including input files, output files and graphic user interface (GUI) project files if used in the version for the report should be submitted with the report.	2	ENVIRON will send the modeling files in future deliverables on a CD.
20. General Comments. The Timet just installed a 3,000 ft x 60 ft slurry wall and the NERT should consider implementing it in the Phase I groundwater model.	3	ENVIRON will perform further refinements to the model such as this as part of the RI.
21. Section 4.1.2 Outflow to Las Vegas Wash, Page 5, Paragraph 1. The Timet effluent discharge is not right. The NERT should use correct numbers from the Quarterly Discharge Monitoring Report (DMR) for corresponding quarters.	2	ENVIRON has obtained additional data from TIMET on their discharges to the Las Vegas Wash. In the 2013 GWETS Optimization Project report, ENVIRON will refine the conceptual water balance to account for the correct TIMET effluent discharge rates.
22. Section 4.1.2 Outflow to Las Vegas Wash, Page 5, Paragraph 2. The USGS Three Kids Gauge number should be 09419753.	1	This correction will be made in an erratum.
23. Section 4.1.2 Outflow to Las Vegas Wash, Page 6, Paragraph 3. The second quarter streamflow data is used in the Las Vegas Wash water with annual evaporation rate from the stream reaches within the model. Please clarify it.	1	The evaporation rates for the 2012-Q2 are not available, but are not expected to be significantly different than 1997-1999.

NDEP Comment	Category[1]	Response
24. Table 1A: Conceptual Water Balance Summary. The AMPAC groundwater extraction for the second quarter is available in their annual or semi-annual performance reports, so the correct groundwater extraction for AMPAC should be used in this table and the model. The assumption of the small groundwater evapotranspiration in the model area is conceptual incorrect because a large area of shallow groundwater table and phreatophyte coverage along northern model boundary exists. This is also inconsistent with the water budget from the model that has 5,733 cfd of evapotranspiration rate.	3	Table 1a correctly shows the AMPAC pumping rates reported in their semi-annual performance report. Evapotranspiration over the entire model area is a small component of the water budget and so was not estimated separately for the conceptual water balance. Evapotranspiration is still simulated in the numerical model at a rate of 5,733 cfd. This represents less than 1% of the total conceptual water budget, which confirms that it is a small component. As part of the RI, the model will be refined if needed to better represent evapotranspiration.
25. Table 1B: Groundwater Inflows and Outflows At Las Vegas Wash. The water budget components of this table include surface water and groundwater, so the title of this table should be revised.	1	The title of this table will be revised in an erratum. ENVIRON suggests a title of the table to be "Inflows and Outflows at Las Vegas Wash".
26. Section 4.1.2 Outflow to Las Vegas Wash, Page 6, Paragraph 4. Please justify the assumption that the 80% of groundwater discharge is from the south side of Las Vegas Wash.	1	This will be clarified in an erratum.
27. Table 2. Areal Recharge Distribution. Please add column of the Recharge Volume (acre-ft per year) for each region.	1	This will be included in an erratum, subject to availability of data for each region.
28. Section 4.2.1 Areal Recharge From Precipitation, Page 7, Paragraph 2. The assuming 2.55% of precipitation as net areal recharge is probably overestimated. The classic groundwater recharge reference is the Maxey-Eakin method (Maxey and Eakin, 1949). The Maxey-Eakin method doesn't have any recharge for the area of precipitation less than 5 to 8 inches. Many publications on the precipitation recharge of southern Nevada have been published since 1949. The NERT should review the publications on the precipitation recharge of southern Nevada area to refine the precipitation recharge rate for the study area.	3	The areal precipitation in the model will be refined as part of the model update to be conducted during the RI.

NDEP Comment	Category[1]	Response
29. Section 4.2.3 Lateral and Vertical Boundary Inflows, Page 8, Paragraph 2. The calculated vertical boundary flow rate based on the information provided in this paragraph is 229,046 cfd instead of 220,000 cfd used in the report. Please explain the difference.	1	This will be clarified in an erratum.
30. Section 5.4 Spatial Discretization and Layer Refinement, Page 10, third bulletin. The resolution for the DEM used should be stated.	1	The DEM resolution will be included in an erratum.
31. Section 5.5 Areal Recharge, Page 11, Paragraph 1. The recharge rate from the unlined storm water retention ponds should be refined based on the comment item 1 above.	3	The areal precipitation in the model will be refined as part of the model update to be performed during the RI.
32. Section 5.5 Areal Recharge, Page 11, Paragraph 3. Two OSSM injection numbers are used in the report: Both 147 gpm and 148 gpm appeared on Page 11. This should be corrected.	1	This correction will be made in an erratum.
33. Section 5.6 Changes to the GWETS and Other Extraction Systems, Page 11, Paragraph 2. The AMPAC groundwater extraction rate should be corrected as mentioned in the comment item 24 above.	2 / 3	This change will be made in Phase II of the model updates. Further refinement of the model in the vicinity of AMPAC wells will be conducted as part of the RI in order to better represent the effect of AMPAC wells on the NERT plume.
34. Section 5.8.3 Model Boundary near Las Vegas Wash, Page 14, Paragraph 2. The stream conductivity should be based on the aquifer test data. The braided stream alone cannot be basis to assign the conductivity range of 0.05 to 0.55 ft/day.	3	ENVIRON will refine the stream properties as necessary in the future modeling work performed as part of the RI
35. Section 6.1 Modeled Groundwater Balance, Page 15, Paragraph 3. Although the Phase I Model is configured to allow reduced extraction to avoid dewatered conditions, the way handling the AMPAC groundwater extraction here is not appropriate, because the AMPAC groundwater extraction for the modeling period is known. The adjusting the pumping rates due to the dewatered conditions for an under calibrated model is generally not good way to do. However, the adjusting pumping rate is often used for the prediction simulation with a well-calibrated model.	2 / 3	This change will be made in Phase II of the model updates. Further refinement of the model in the vicinity of AMPAC wells will be conducted as part of the RI in order to better represent the effect of AMPAC wells on the NERT plume.

NDEP Comment	Category[1]	Response
36. Section 6.2 Calibration Statistics and Simulated Groundwater Elevations, Page 16, Paragraph 3. Besides Figure 9, please add residual error of the targets to Figure 9 or create a new map of the residual errors.	2	ENVIRON will add residual errors for each target well in the Phase II model report that will be included in the 2013 GWETS Optimization Project Report.

Notes:

1. The numbers in the "Category" column on this table indicate:
    - [1] Editorial or minor comments that will be addressed in a Response to Comments letter or in an erratum.
    - [2] More significant comments (e.g., modeling approach) that will be addressed in subsequent Annual or Semi-Annual Monitoring Reports, or other deliverables, as appropriate.
    - [3] Comments related to specific analyses (e.g., analysis of the soil flushing at the retention basin) that will be addressed as part of the Remedial Investigation (RI). These tasks will be included in the RI cost documentation currently under preparation.

References:

Maxey and Eakin, 1949. Ground water in White River Valley, White Pine, Nye, and Lincoln Counties, Nevada. Ground water in White River Valley, White Pine, Nye, and Lincoln Counties, Nevada. Nevada State Engineer, Water Resources Bulletin, pp. 59.

Attachment B

Seep Well Field Boring and Well Installation Logs

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMCC	LOCATION Henderson NV	BORING NUMBER PC 99R

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
	0-6 SDY GRAVEL. Brn, vf-vc sd matrix (40%) w/ volc gravel 1/8"-1" w/minor 2"-3". Sparce silt (10%)		GW							▽ @3 3'-6' perched WTR
6	6'-20' slty SAND lt brn. vf-fg, SA, w/ 30% silt in matrix.			7 4 14			☒	6'-7.5'	70%	6'-12' damp-partly dry
10	Locally com-abu sd size caliche nodules scattered throughout		SM							below 12' wet
15	13-18 abu caliche nodules			6 7 8			☒	16'-17.5	100%	
20	20-24 slty gravelly SAND. brown. 20-30% silt, 10-20% volc. A-SA pea gravel in vf-vc, SA sand		GM/SM							
24	24-30 sdy GRAVEL brn. 5% silt, 30-40% vf-vc SA sd in volc pea gravel to 1"		GW	5/ 18"			☒	26'-27.5	0%	major WTR zone
30	30-34 gravelly SAND, brn 10-15% volc A-SA pea gravel in m-cg sd w/ minor f-vf & vc, 10% silt		SW							
34	34-42 sdy GRAVEL, pale brn. Abu SR-R ls, & caliche clasts to 1½" (60% ls & 40% volc. 20-25% SA-SR f-vc sand. Locally calichified		GW							WITH LS.

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
▮ AUGER
▮ ROCK CORE
▮ THIN-WALLED TUBE
▮ CONTINUOUS SAMPLER
▧ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧ CLAY
▦ DEBRIS FILL
▥ SILT
▭ HIGHLY ORGANIC (PEAT)
▒ SAND
▧ SANDY CLAY
⁘ GRAVEL
▧ CLAYEY SAND
▧ SILTY CLAY
☐ ______
▥ CLAYEY SILT
☐ ______

DATE DRILLED 8/8/00
PAGE 1 of 2
DRILLING METHOD PERCUSSION
DRILLED BY LAYNE
LOGGED BY Ed KRISH
EXISTING GRADE ELEVATION (FT AMSL)
LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMCC	LOCATION Henderson NV	BORING NUMBER PC 99R

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
			GW							
42	42-52 sdy GRAVEL brn. Dec in ls clasts to 10-20% w/ inc in volc. ave size 1/4"-1 1/2" w/minor local 4"-7". 20% f-vcg SA-SR sand 42-46 ls &/or caliche clasts present 46-52 volc clasts only 48-50 more silty to 20% 50-52 Hard, totally calichified sdy pea/gravels 52-54 slty clay, lt grn w/ sm gypsum xtals throughout TD 54'		GW	30 50/ 4"			☒	46 - 47.5 -	50%	w/o LS.
50			SM							
52			CL							MUDDY CK @52'
54										

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
▮ AUGER
▮ ROCK CORE
■ THIN-WALLED TUBE
▮ CONTINUOUS SAMPLER
◺ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

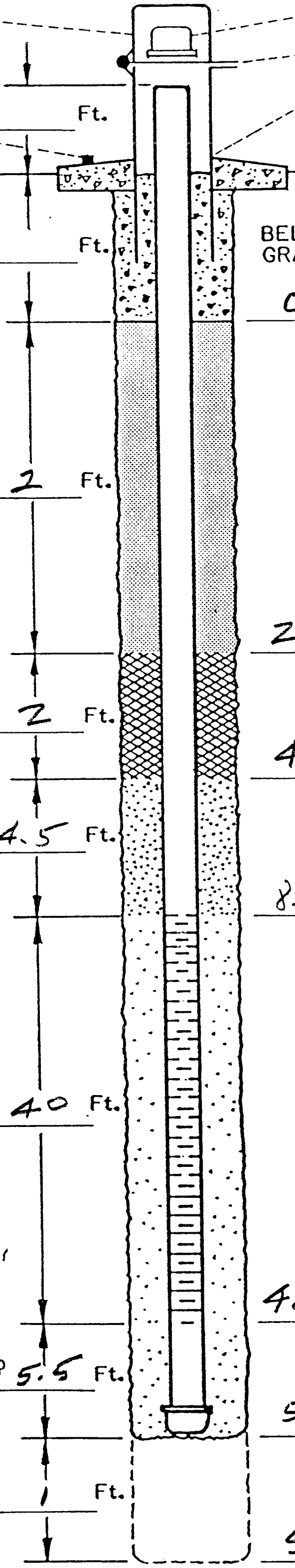
GRAPHIC LOG LEGEND

▨ CLAY	▩ DEBRIS FILL
▥ SILT	☐ HIGHLY ORGANIC (PEAT)
▒ SAND	▨ SANDY CLAY
⁘ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED: 8/8/00
PAGE 2 of 2
DRILLING METHOD: Percussion
DRILLED BY: Layne
LOGGED BY: Ed Krish
EXISTING GRADE ELEVATION (FT AMSL):
LOCATION OR GRID COORDINATES:

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM

FLUSH Mount



Protective Pipe
Yes ☐ No ☒
Steel ☐ PVC ☐
_____ Ft.
Surveying Pin ?
Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☐
Lock ? Yes ☐ No ☐
Weep Hole ? Yes ☐ No ☐
Concrete Pad _______ Ft. x _______ Ft. x _______ Inches

Concrete _____ Ft.

Cement/Bentonite Grout Mix
Yes ☒ No ☐
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder
2 Ft.
Other: _______

Bentonite Seal
Pellets ☒ Slurry ☐
2 Ft.

Filter Pack Above Screen
4.5 Ft.

FILTER PACK MATERIAL
Silica Sand ☒
Washed Sand ☐
Pea Gravel ☐
Other: _______
Sand Size 8-12 to 24'
12 to 4
40 Ft.

Dense Phase Sampling Cup
5.5 Ft.
Bottom Plug
Yes ☐ No ☒

Overdrilled Material Backfill
1 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Other: _______

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
0	
2	
4	
8.5	
48.5	
53	
54	

DRILLING INFORMATION:

1. Borehole Diameter= 9 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _______ to _______ Feet.
4. Borehole Diameter for Outer Casing _______ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _______
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _______
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _______
4. Diameter of Casing and Well Screen:
   Casing 4 Inches, Screen 4 Inches.
5. Slot Size of Screen: 0.04
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _______
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☐
   Air Surging (Air or Nitrogen) ☒ Other _______
2. Time Spent on Well Development ?
   _______ / 60 Minutes/~~Hours~~
3. Approximate Water Volume Removed ? 2500 Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _______
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _______

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)
During Drilling 3 Ft. Date 8-8-00
Before Development 2 Ft. Date 8-9-00
After Development _______ Ft. Date _______

Driller/Firm Layne
Drill Crew _______
Drill Rig Type AP-1000
Well No. PC 99R
Date Installed 8-8-00
Kerr-McGee Hydrologist Ed KRISH

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON, NV	BORING NUMBER PC 99R2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
	HOLE PC-99R2 drilled 10' EAST OF PC-99R SEE PC 99R for lithology									

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
◨ AUGER
◫ ROCK CORE
■ THIN-WALLED TUBE
◨ CONTINUOUS SAMPLER
⧄ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

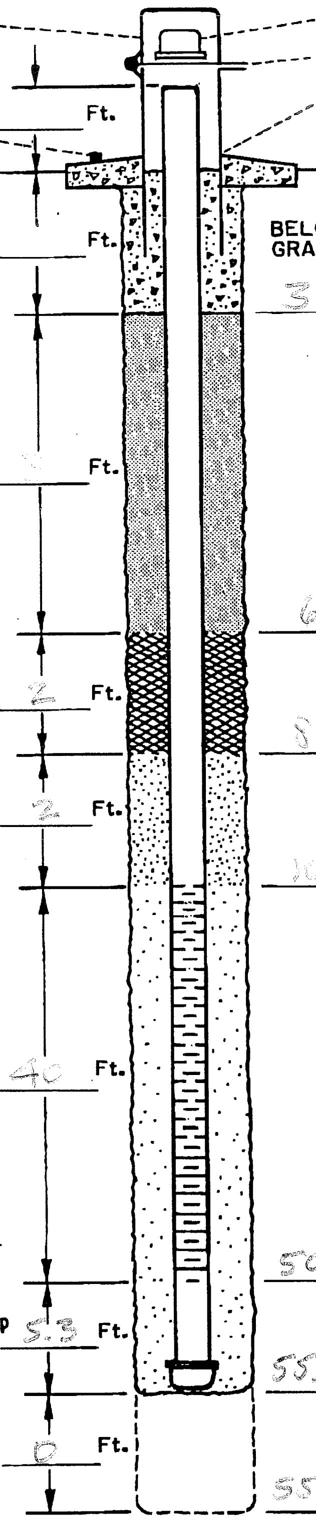
GRAPHIC LOG LEGEND

▧ CLAY
▥ SILT
▦ SAND
⁙ GRAVEL
▨ SILTY CLAY
▨ CLAYEY SILT
▩ DEBRIS FILL
≋ HIGHLY ORGANIC (PEAT)
▧ SANDY CLAY
▧ CLAYEY SAND
☐ _______
☐ _______

DATE DRILLED 5-24-01	PAGE 1 of 1
DRILLING METHOD PERCUSSION	
DRILLED BY LAYNE	
LOGGED BY ED KRISH	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM

FLUSH MOUNT IN VAULT



Protective Pipe
Yes ☐ No ☐
Steel ☐ PVC ☐
_____ Ft.

Surveying Pin ?
Yes ☐ No ☐

Concrete
VAULT
_____ Ft.

Cement/Bentonite Grout Mix
Yes ☒ No ☐
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder
Other: _____
_____ Ft.

Bentonite Seal
Pellets ☒ Slurry ☐
2 Ft.

Filter Pack Above Screen
2 Ft.

FILTER PACK MATERIAL
Silica Sand ☐
Washed Sand ☒
Pea Gravel ☐
Other: _____
Sand Size 8x12
40 Ft.

Dense Phase Sampling Cup
5.3 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill
0 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Other: _____

Casing Cap Vent ? Yes ☐ No ☐
Lock ? Yes ☐ No ☐
Weep Hole ? Yes ☐ No ☐

Concrete Pad _____ Ft. x _____ Ft. x _____ Inches

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
3	
6	
8	
10	
50	
55.3	
55.3	

DRILLING INFORMATION:

1. Borehole Diameter= 11.5 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 6 Inches, Screen 6 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☐
   Air Surging (Air or Nitrogen) ☒ Other _____
2. Time Spent on Well Development ?
   _____ / 60 Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm MARTIN / LAYNE
Drill Rig Type AP-1000
Date Installed 5-24-01
Drill Crew MARIAN / RON
Well No. PC-99R2
Kerr-McGee Hydrologist ED KRISH

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMCC LLC	LOCATION HENDERSON	BORING NUMBER PC 99R3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
5	0-5 SAND, lt brn, vf-vc w/ 10% 1" gravel and 10-20% silt		SW							0'-3' damp 3'-11' wet/moist
9	5'-9' GRAVEL, sdy w/ 10% silt. Volc gravel to 1½" w/ 20-30% vf-VC sd. brn		GW							
11	9'-11' SAND, slty, brn vf-m		SM							11-17 only damp
15 18	11-18 SAND, slty & SILT sdy, brn, vf-m. high % of silt (30-70%)		SM/ML							@17' wet/moist
25 30 35	18-52 GRAVEL, sdy brn, w/thin slty SAND layers Stacked sequence of fining-upward channel deposits.. GRAVEL → slty sand Gravels, ¼"-1" w/minor cobble zones Sand, vf-vc, 20-60% silt 20-40% in thin layers (slty 28'-29') 32-39 lg volc gravel to 6"-8"		GP							

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
◧ AUGER
◨ ROCK CORE
■ THIN-WALLED TUBE
◧ CONTINUOUS SAMPLER
◺ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY
▥ SILT
▩ SAND
⁙ GRAVEL
▨ SILTY CLAY
▥ CLAYEY SILT
▦ DEBRIS FILL
☰ HIGHLY ORGANIC (PEAT)
▨ SANDY CLAY
▨ CLAYEY SAND
☐ ______
☐ ______

DATE DRILLED 7-17-01
PAGE 1 of 2
DRILLING METHOD PERCUSSION
DRILLED BY LAYNE
LOGGED BY E. KRISH
EXISTING GRADE ELEVATION (FT. AMSL)
LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON, NV	BORING NUMBER PC99 R3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
45	43-52 - gravel to 1-2" w/ 10-30% sand, vf-vc	∴	GP							
50	51-52 v. slty	∴								
52	52-58 CLAY, slty, grnish	▨	CL							TOP MC @ 52' (damp)
55		▨								
58	TD 58'									

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
◨ AUGER
◨ ROCK CORE
■ THIN-WALLED TUBE
◧ CONTINUOUS SAMPLER
◪ NO RECOVERY

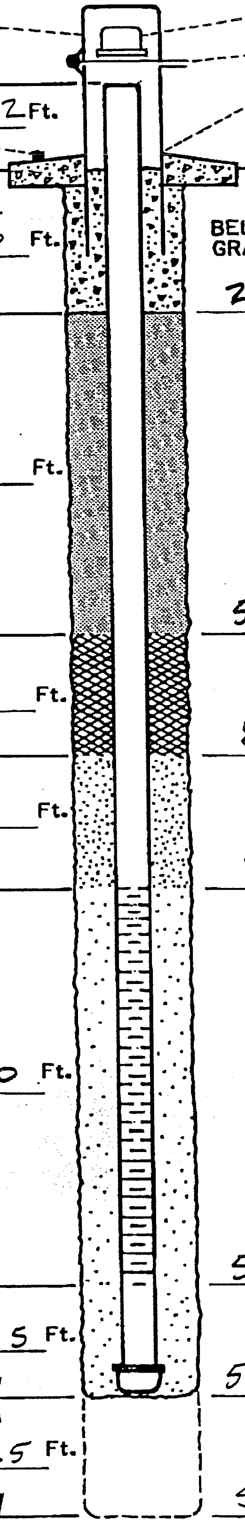
DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY	▩ DEBRIS FILL
▥ SILT	☐ HIGHLY ORGANIC (PEAT)
▦ SAND	▨ SANDY CLAY
∴ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED 7-17-01
PAGE 2 of 2
DRILLING METHOD
DRILLED BY
LOGGED BY
EXISTING GRADE ELEVATION (FT. AMSL)
LOCATION OR GRID COORDINATES

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe

Yes ☐ No ☒

Steel ☐ PVC ☐

1.92 Ft.

Surveying Pin ?

Yes ☐ No ☒

Concrete 0 Ft.

Cement/Bentonite Grout Mix

Yes ☐ No ☒

5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder

3 Ft.

Other: CONCRETE

Bentonite Seal 3 Ft.

Pellets ☒ Slurry ☐

Filter Pack Above Screen 2 Ft.

FILTER PACK MATERIAL

Silica Sand ☐

Washed Sand ☒ 40 Ft.

Pea Gravel ☐

Others:

Sand Size 8-12 MESH

Dense Phase Sampling Cup 5.5 Ft.

Bottom Plug

Yes ☒ No ☐

Overdrilled Material Backfill 2.5 Ft.

Grout ☐ Sand ☒

Caved Material ☐

Other:

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
2	
5	
8	
10	
50	
55.5 (5'blank)	
58	

Casing Cap Vent ? Yes ☐ No ☒

Lock ? Yes ☐ No ☒

Weep Hole ? Yes ☐ No ☒

Concrete Pad _____ Ft. x _____ Ft. x _____ Inches

DRILLING INFORMATION:

1. Borehole Diameter= 13¼ Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other
4. Diameter of Casing and Well Screen:
   Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☒ Other V-WIRE
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☒ Other SURGE BLOCK
2. Time Spent on Well Development ?
   3½ ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 2000 Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____

Before Development _____ Ft. Date _____

After Development 3.46 Ft. Date 7-23-01

Driller/Firm LAYNE

Drill Rig Type AP-1000

Date Installed 7-18-01

Drill Crew HORMAN

Well No. PC 99R3

Kerr-McGee Hydrologist ED KRISH

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON, NV	BORING NUMBER PC 115

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
	0-15 SAND, v. silty, brn, w/ 20-30% slt in matrix [illegible] Sd is vf-fg, SA-A									MOIST @ 1' PERCHED WTR 8'-12'
5			SM							
	8-15 mod-com wht caliche nodules to 3/4"									damp/wet 12'-18'
10										
15	15-18 SILT, sdy, brn, w/20-30% vfg sd		ML							
18	18-26 GRAVEL, lt brn, pea gravel to 1" w/10-20% f-vc sd in matrix, volc gravel SA-SR		GW							WTR @ 18'
26	26-28 SAND, slty, pale brn, 20% silt in vf-vc sd w/ 10-20% volc granules and caliche nodules		SM							
28			GP							
	28-42 GRAVEL, locally sdy and slty, pale brn, up to 6" cobbles, SR-SA, volc and ls.		GM							
35										
	28'-32' volc+ls to 2", 10-20% vf-vc sd		GP							

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL

◧ AUGER

◧ ROCK CORE

■ THIN-WALLED TUBE

◧ CONTINUOUS SAMPLER

◪ NO RECOVERY

DEPTH Depth Top and Bottom of Sample

REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧ CLAY

▥ SILT

▩ SAND

⁙ GRAVEL

▨ SILTY CLAY

▥ CLAYEY SILT

▦ DEBRIS FILL

☰ HIGHLY ORGANIC (PEAT)

▧ SANDY CLAY

▨ CLAYEY SAND

☐ ______

☐ ______

DATE DRILLED 5-16-01

PAGE 1 of

DRILLING METHOD PERCUSSION

DRILLED BY LAYNE

LOGGED BY E KRISH

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION Henderson NV	BORING NUMBER PC 115

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
42 43	32-36 Silty gravel, tan thin microbeds of silty vf-m sd w/ minor caliche nodules. 20-30% silt.	GP ML							
45	Cobbles to 4"	GM							
49	36-42' Smaller pebbles, ave 1/2"-2", volc + ls, SA-SR								Top MC @ 49
	42-43 SILT, sdy, lt brn, w/ 20-30% vfg sd	CL							
55	43-49 GRAVEL, sdy, pale brn w/ 25-35% vf-vc SR-SA sd and 10-15% silt. Gravel ave 3/4"-2" w/ minor 4"-6". volc + ls, SA-SR						TD	55'	
	48.5-49 Hard calichified gravel								
	49-55 CLAY, silty green. sp. root traces, tr-sp gyp xtals								

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
▮ AUGER
▮ ROCK CORE
■ THIN-WALLED TUBE
▮ CONTINUOUS SAMPLER
◹ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY	▦ DEBRIS FILL
▥ SILT	≋ HIGHLY ORGANIC (PEAT)
▩ SAND	▨ SANDY CLAY
⁘ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▨ CLAYEY SILT	☐ ______

DATE DRILLED 5-16-01
PAGE 2 of 2
DRILLING METHOD Percussion
DRILLED BY Layne
LOGGED BY E. Krish
EXISTING GRADE ELEVATION (FT. AMSL)
LOCATION OR GRID COORDINATES

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM

FLUSH
MOUNT
IN
VAULT

Protective Pipe
Yes ☐ No ☐
Steel ☐ PVC ☐

______ Ft.

Surveying Pin ?
Yes ☐ No ☐

Concrete
VAULT
3 Ft.

Cement/Bentonite Grout Mix
Yes ☒ No ☐
5.5 Gallons Water to 94Lb. Bag Cement & 3–5 Lb. Bentonite Powder
Other: ______
3 Ft.

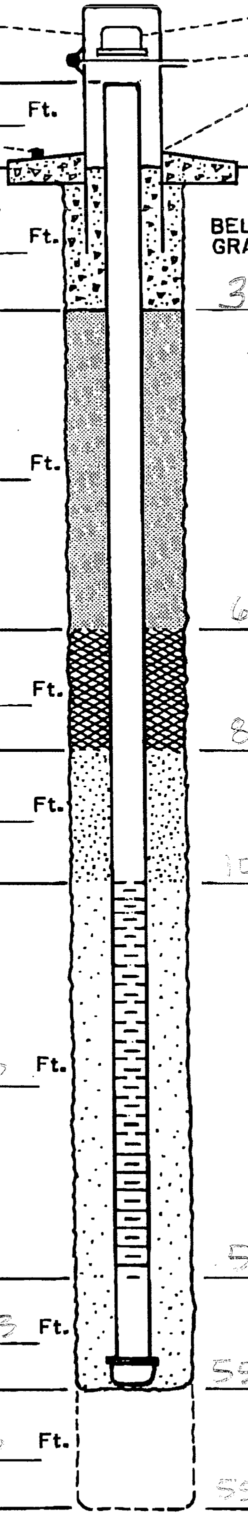
Bentonite Seal
Pellets ☒ Slurry ☐
2 Ft.

Filter Pack Above Screen
2 Ft.

FILTER PACK MATERIAL
Silica Sand ☒
Washed Sand ☐
Pea Gravel ☐
Other: ______
Sand Size 8-12
40 Ft.

Dense Phase Sampling Cup
5.3 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill
Grout ☐ Sand ☒
Caved Material ☐
Other: ______
0 Ft.



Casing Cap Vent ? Yes ☐ No ☐
Lock ? Yes ☐ No ☐
Weep Hole ? Yes ☐ No ☐
Concrete Pad ______ Ft. x ______ Ft. x ______ Inches

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
3	
6	
8	
10	
50	
55.3	
55.3	

DRILLING INFORMATION:

1. Borehole Diameter= 11.5 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= ______ to ______ Feet.
4. Borehole Diameter for Outer Casing ______ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other ______
2. Type of Casing Joints: Screw–Couple ☒ Glue–Couple ☐ Other ______
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other ______
4. Diameter of Casing and Well Screen:
   Casing 6 Inches, Screen 6 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other ______
7. Installed Protector Pipe w/Lock: Yes ☐ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☒ Other ______
2. Time Spent on Well Development ?
   ______ / 60 Minutes/Hours
3. Approximate Water Volume Removed ? ______ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe ______
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes , Describe ______

WATER LEVEL INFORMATION:
Water Level Summary (From Top of Casing)

During Drilling 18 Ft. Date 5-16-01
Before Development ______ Ft. Date ______
After Development ______ Ft. Date ______

Driller/Firm MARTIN / Layne
Drill Rig Type AP-1000
Date Installed 5-23-01
Drill Crew Jose / Don
Well No. PC 115
Kerr–McGee Hydrologist ED KRISH

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON, NV	BORING NUMBER PC 115R

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
	0-5 SAND, brn, m-VC w/ 10-20% silt		SM							0-4 damp
5	5-9 Gravel, sdy, f-vc sand 10-30%; gravel mostly ¼"-1"		GP							4-9 wet
9	9-27 SAND, slty w/ minor interbedded sdy SILT, brn, vf-m. Varying silt 20-50%									9-25 damp/moist
15			SM							
20	22-24 Com. sd size caliche nodules									@25' wet
27	27-44 Gravel, sdy w/minor local slty sd layers Series of fining-upward channel deposits		GP							
35	Gravel, volc, SA-SR, ¼"-1" w/ minor 4"-8" Sand 20-60% vf-VC silt 10-30% locally									

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
▐ AUGER
▐ ROCK CORE
■ THIN-WALLED TUBE
▐ CONTINUOUS SAMPLER
⧄ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY
▥ SILT
▩ SAND
⁞ GRAVEL
▨ SILTY CLAY
▥ CLAYEY SILT
▩ DEBRIS FILL
☐ HIGHLY ORGANIC (PEAT)
▨ SANDY CLAY
▨ CLAYEY SAND
☐ ______
☐ ______

DATE DRILLED: 7-18-01
PAGE: 1 of 2
DRILLING METHOD: PERCUSSION
DRILLED BY: LAYNE
LOGGED BY: ED KRISH
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON	BORING NUMBER PC 115R

<table>
<tr><th rowspan="2">DEPTH IN FEET</th><th rowspan="2">LITHOLOGIC DESCRIPTION</th><th rowspan="2">GRAPHIC LOG</th><th rowspan="2">UNIFIED SOIL FIELD CLASS.</th><th rowspan="2">BLOWS PER 6"</th><th rowspan="2">PID (ppm)</th><th colspan="4">SOIL SAMPLE</th><th rowspan="2">REMARKS OR FIELD OBSERVATIONS</th></tr>
<tr><th>NO.</th><th>TYPE</th><th>DEPTH</th><th>REC.</th></tr>
<tr><td></td><td></td><td>⁙</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>44</td><td>44-50 GRAVEL, sdy lt brn, inc in ls pebbles and caliche nodules no lg cobbles as above (max 2")</td><td>⁙</td><td>GW</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>50</td><td>50-58 CLAY, slty grnish + blue grnish</td><td>▧</td><td>CL</td><td></td><td></td><td></td><td></td><td></td><td></td><td>MC@ 50 moist</td></tr>
<tr><td>58</td><td>TD 58</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
◧ AUGER
◨ ROCK CORE
■ THIN-WALLED TUBE
◧ CONTINUOUS SAMPLER
⧄ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧ CLAY
▥ SILT
▒ SAND
⁙ GRAVEL
▧ SILTY CLAY
▥ CLAYEY SILT
▩ DEBRIS FILL
☐ HIGHLY ORGANIC (PEAT)
▧ SANDY CLAY
▒ CLAYEY SAND
☐ ______
☐ ______

DATE DRILLED	PAGE
7-18-01	2 of 2

DRILLING METHOD

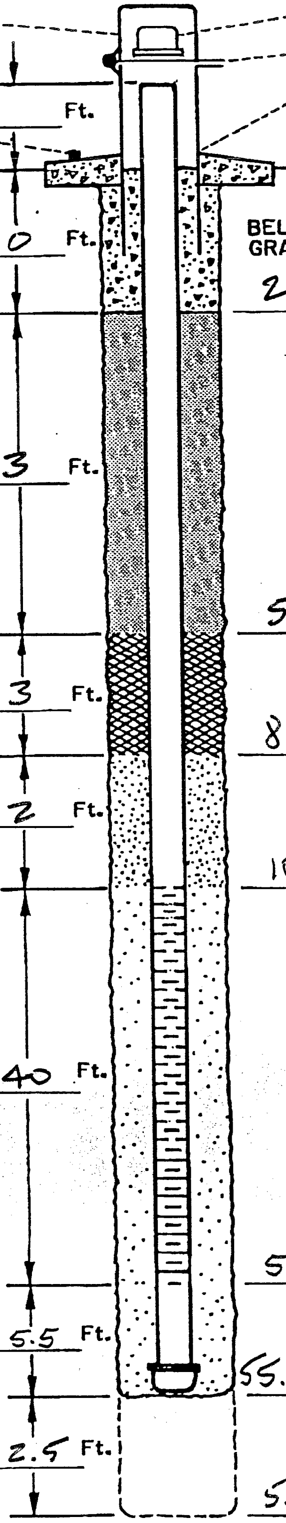
DRILLED BY

LOGGED BY

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes ☐ No ☒
Steel ☐ PVC ☐
_____ Ft.
Surveying Pin ?
Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☒
Lock ? Yes ☐ No ☐
Weep Hole ? Yes ☐ No ☒
Concrete Pad _____ Ft. x _____ Ft. x _____ Inches

Concrete 0 Ft.

Cement/Bentonite Grout Mix
Yes ☐ No ☒
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder
3 Ft.
Other: CONCRETE

Bentonite Seal
3 Ft.
Pellets ☒ Slurry ☐

Filter Pack Above Screen
2 Ft.

FILTER PACK MATERIAL
Silica Sand ☐
Washed Sand ☒
40 Ft.
Pea Gravel ☐
Other: _____
Sand Size 8-12 MESH

Dense Phase Sampling Cup
5.5 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill
2.5 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Other: _____

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
2	
5	
8	
10	
50	
55.5 (5'blank)	
5.8	

DRILLING INFORMATION:

1. Borehole Diameter= 13 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other V-WIRE
7. Installed Protector Pipe w/Lock: Yes ☐ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☒ Other SURGE BLOCK
2. Time Spent on Well Development ?
   / 3 1/2 ~~Minutes~~/Hours
3. Approximate Water Volume Removed ?2000 Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development 5.46 Ft. Date 7-24-01

Driller/Firm LAYNE
Drill Rig Type AP-1000
Date Installed 7-19-01
Drill Crew P. HORMAN
Well No. PC 115R
Kerr-McGee Hydrologist ED KRISH

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON, NV	BORING NUMBER PC 116

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
3	0-3 GRAVEL, sdy & slty, brn. 70% volc, SA-SR gran. + pebbles to 2" w/ 20% vf-vc SA-SR sd + 10% silt		GM							moist @ 1' Perched WTR 2-4'
9	3-9 SAND, grav. & slty, brn. 70% vf-vc, SA-SR sd w/ 10% volc grav. and 20% silt.		SP/SM							
18	9-18 SAND, slty, brn vf-fg w/minor m-cg w/ 20% silt in matrix and thin SILT interbeds. Contains dissem. ½"-1" caliche nodules		SM							damp/wet 9-20'
20	18-20 SILT, sdy, gry grn & wht. Com caliche nodules (sd size) and stringers. w/ 20% vf-fg sd in matrix		ML							WTR @ 20'
26	20-26 SAND, slty, brn 80% vf-m w/ minor c-vc + minor volc granules. 20% silt		SM							
30 35	26-47 GRAVEL, sdy & slty, pale brn, 70-80% volc + ls granules to cobbles w/ 20-30% vf-vc SA-SR sd + 10-20% silt 26-37 granules + pea grav to 1" 37-47 cobbles up to 6"		GM							

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL

▮ AUGER

▮ ROCK CORE

■ THIN-WALLED TUBE

▮ CONTINUOUS SAMPLER

⧄ NO RECOVERY

DEPTH Depth Top and Bottom of Sample

REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧ CLAY	▩ DEBRIS FILL
▥ SILT	≋ HIGHLY ORGANIC (PEAT)
▦ SAND	▧ SANDY CLAY
⁘ GRAVEL	▨ CLAYEY SAND
▧ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED 5-17-01	PAGE 1 of 2

DRILLING METHOD
PERCUSSION

DRILLED BY
LAYNE

LOGGED BY
ED KRISH

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON NV	BORING NUMBER PC116

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
45			GM							
47	<u>47-55</u> CLAY and silty Clay. Root traces & sm. gyp xtals <u>47-51</u> green <u>51-55</u> blu green		CL							MR @ 47'
50										
55	TD @ 55'									

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL

▐ AUGER

▐ ROCK CORE

■ THIN-WALLED TUBE

▌ CONTINUOUS SAMPLER

⧅ NO RECOVERY

DEPTH Depth Top and Bottom of Sample

REC. Actual Length of Recovered Sample in Feet

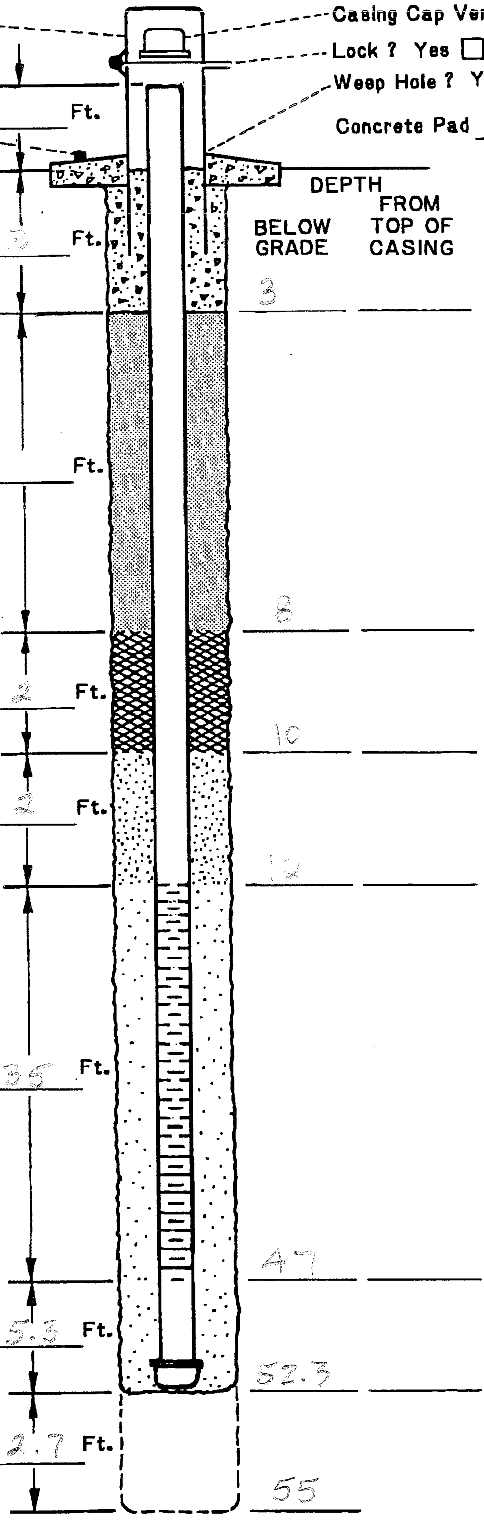
GRAPHIC LOG LEGEND

▧ CLAY	▩ DEBRIS FILL
▥ SILT	☐ HIGHLY ORGANIC (PEAT)
▦ SAND	▨ SANDY CLAY
⁞ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▨ CLAYEY SILT	☐ ______

DATE DRILLED	PAGE of
DRILLING METHOD	
DRILLED BY	
LOGGED BY	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM

FLUSH MOUNT & VAULT



Protective Pipe
Yes ☐ No ☐
Steel ☐ PVC ☐
Surveying Pin ? ______ Ft.
Yes ☐ No ☐

Concrete 3 Ft.
VAULT

Cement/Bentonite Grout Mix ______ Ft.
Yes ☒ No ☐
5.5 Gallons Water to 94Lb. Bag Cement & 3–5 Lb. Bentonite Powder
Other: ______

Bentonite Seal 2 Ft.
Pellets ☒ Slurry ☐

Filter Pack Above Screen 2 Ft.

FILTER PACK MATERIAL 35 Ft.
Silica Sand ☒
Washed Sand ☐
Pea Gravel ☐
Other: ______
Sand Size 8 X 12

Dense Phase Sampling Cup 5.3 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill 2.7 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Other: ______

Casing Cap Vent ? Yes ☐ No ☐
Lock ? Yes ☐ No ☐
Weep Hole ? Yes ☐ No ☐
Concrete Pad ______ Ft. x ______ Ft. x ______ Inches

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
3	
8	
10	
12	
47	
52.3	
55	

DRILLING INFORMATION:

1. Borehole Diameter= 11.5 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= ______ to ______ Feet.
4. Borehole Diameter for Outer Casing ______ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other ______
2. Type of Casing Joints: Screw–Couple ☒ Glue–Couple ☐ Other ______
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other ______
4. Diameter of Casing and Well Screen:
   Casing 6 Inches, Screen 6 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other ______
7. Installed Protector Pipe w/Lock: Yes ☐ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☐
   Air Surging (Air or Nitrogen) ☒ Other ______
2. Time Spent on Well Development ?
   ______ / 60 Minutes/Hours
3. Approximate Water Volume Removed ? ______ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe ______
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe ______

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling 20 Ft. Date 5-17-01
Before Development 8.90 Ft. Date 5-18-01
After Development ______ Ft. Date ______

Driller/Firm MARTIN / LAYNE
Drill Rig Type AP 1000
Date Installed 5-25-01
Drill Crew Jose / Don
Well No. 7C 116
Kerr–McGee Hydrologist Ed Krish

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON	BORING NUMBER PC 116 R

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE				REMARKS OR FIELD OBSERVATIONS
						NO.	TYPE	DEPTH	REC.	
5 10	0-10 GRAVEL, sdy and SAND, gravelly - interbedded. Minor thin slty layers. Brn. 50-80% gran → 2" peb. 10-30% silt in sdy matrix 20-50% vf-vc, SA sd.		GW/ SW							damp @ 1' Wet 2 - 18'
15 18	10'-18' SAND, slty brn, vf-c g, SA 10-30% silt in matrix locally com. sd-size caliche nodules		SM							
20	18-20 SILT, sdy, gry grn, Com calche nods, 20-30% vf-f sd		ML							damp
27	20-27 SAND, slty, lt. brn. vf-m g w/ minor c-vc. 20-30% silt in matrix		SM							WTR @ 20'
30 35	27-49 GRAVEL, sdy w/ minor gravelly sand and silty sand. pale brn. (Series of fining-up seq.) 70% volc + ls. granules → cobbles. 20-30% f-vc sd and thin layers w/ 20-30% silt in sdy matrix 27-38 pea gravel		GP/ GM							

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
▮ AUGER
▮ ROCK CORE
■ THIN-WALLED TUBE
▮ CONTINUOUS SAMPLER
▧ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY	▩ DEBRIS FILL
▥ SILT	≋ HIGHLY ORGANIC (PEAT)
▦ SAND	▨ SANDY CLAY
⁘ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED 7-25-01	PAGE 1 of 2
DRILLING METHOD PERCUSSION	
DRILLED BY LAYNE	
LOGGED BY ED KRISH	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-B

KERR-McGEE CORPORATION Hydrology Dept. - S&EA Division	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON, NV	BORING NUMBER PC 116R

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER 6"	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
~~45~~ 49	38'-49' com. cobbles to 6"	⁝	GP / GM							
58	49-58 CLAY & silty clay, w/ root traces & sm. gyp xtals. greenish and blue green	▧	CL							MC@49' damp
	TD 58'									

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL | ◧ AUGER | ◨ ROCK CORE

■ THIN-WALLED TUBE | ◧ CONTINUOUS SAMPLER | ⧄ NO RECOVERY

DEPTH Depth Top and Bottom of Sample

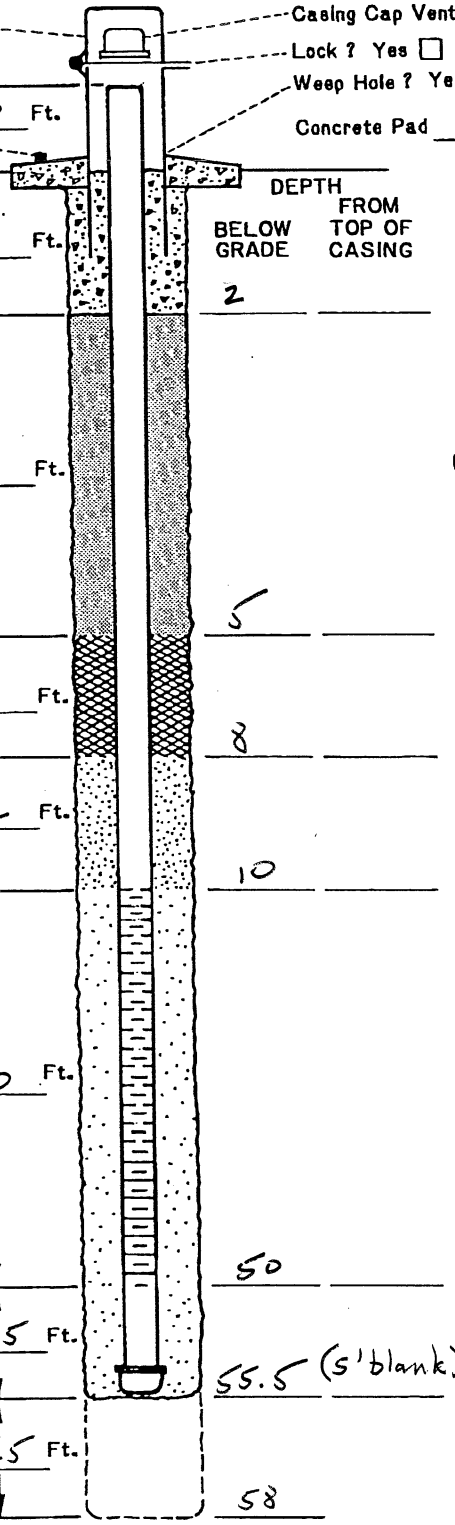
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧ CLAY	▩ DEBRIS FILL
▥ SILT	≋ HIGHLY ORGANIC (PEAT)
▒ SAND	▨ SANDY CLAY
⁝ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED 7-25-01	PAGE 2 of 2
DRILLING METHOD PERCUSSION	
DRILLED BY LAYNE	
LOGGED BY Ed Krish	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes ☐ No ☒
Steel ☐ PVC ☐
2.0 Ft.
Surveying Pin ?
Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☒
Lock ? Yes ☐ No ☒
Weep Hole ? Yes ☐ No ☐
Concrete Pad ________ Ft. x ________ Ft. x ________ Inches

DEPTH

	BELOW GRADE	FROM TOP OF CASING
Concrete 0 Ft.	2	
Cement/Bentonite Grout Mix Yes ☐ No ☒ 5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder Other: CONCRETE 3 Ft.	5	
Bentonite Seal Pellets ☒ Slurry ☐ 3 Ft.	8	
Filter Pack Above Screen 2 Ft.	10	
FILTER PACK MATERIAL Silica Sand ☐ Washed Sand ☒ Pea Gravel ☐ Other: ________ Sand Size 8X12 MESH 40 Ft.	50	
Dense Phase Sampling Cup 5.5 Ft. Bottom Plug Yes ☒ No ☐	55.5 (5' blank)	
Overdrilled Material Backfill Grout ☐ Sand ☒ Caved Material ☐ Other: ________ 2.5 Ft.	58	

DRILLING INFORMATION:

1. Borehole Diameter= 13 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= ________ to ________ Feet.
4. Borehole Diameter for Outer Casing ________ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other ________
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other ________
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other ________
4. Diameter of Casing and Well Screen:
   Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other V-WIRE
7. Installed Protector Pipe w/Lock: Yes ☐ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☒ Other SURGE BLOCK
2. Time Spent on Well Development ?
   ________/ 3 1/2 ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 2000 Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe ________
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe ________

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling ________ Ft. Date ________
Before Development ________ Ft. Date ________
After Development 4.20 Ft. Date 7-27-01

Driller/Firm LAYNE
Drill Rig Type AP 1000
Date Installed 7-26-01
Drill Crew P. NORMAN
Well No. PC116R
Kerr-McGee Hydrologist ED KRISH

SOIL BORING LOG

KERR-McGEE CORPORATION Hydrology Dept.	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON	BORING NUMBER PC 117

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
4	0-4 GRAVEL, sdy + silty, pebbles to 2" 30% vf-vc sd, 20% silt		GM							LOCATED 100' E of PC 116R WATER @ 2'
10	4-10 SAND, gravelly w/ 20% silt, 30% gravel up to 2"		SP/SM							
16	10-16 SAND, silty, vf-m w/minor c-vc, 20% silt		SM							10-16' damp
20	16-20 SILT, sdy. 20% vf-fg sd. Com sd size caliche nodules		ML							
25	20-25 SAND, silty 20% silt. vf-m w/minor c-vc.		SM							wet @ 20'
30 35 40	25-51' GRAVEL, locally sdy/silty, mainly clean w/ water. 0-20% silt, 0-40% vf-vc sd Abu volc. granules w/ local cobbles to 6"		GM							

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- ☒ SPLIT-BARREL
- ◧ AUGER
- ◧ ROCK CORE
- ■ THIN-WALLED TUBE
- ◫ CONTINUOUS SAMPLER
- ◸ NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- ▨ CLAY
- ◫ SILT
- ▩ SAND
- ⁘ GRAVEL
- ▨ SILTY CLAY
- ▨ CLAYEY SILT
- ▤ DEBRIS FILL
- ≋ HIGHLY ORGANIC (PEAT)
- ▨ SANDY CLAY
- ▨ CLAYEY SAND
- ☐ ______
- ☐ ______

DATE DRILLED 2-15-03

PAGE 1 of 2

DRILLING METHOD HAMMER

DRILLED BY LAYNE

LOGGED BY ED KRISH

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG

KERR-McGEE CORPORATION Hydrology Dept.	KM SUBSIDIARY KMCLLC	LOCATION HENDERSON	BORING NUMBER PC 117

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
45			GM							
51	51 – 57.5 CLAY, silty grn & blue grn, gypsum xtals		CL							MC @ 5
	TD 57.5 FEET									

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL

▮ AUGER

▮ ROCK CORE

■ THIN-WALLED TUBE

▯ CONTINUOUS SAMPLER

◿ NO RECOVERY

DEPTH Depth Top and Bottom of Sample

REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY

▥ SILT

▩ SAND

⁘ GRAVEL

▧ SILTY CLAY

▧ CLAYEY SILT

▤ DEBRIS FILL

≈ HIGHLY ORGANIC (PEAT)

▨ SANDY CLAY

▨ CLAYEY SAND

☐ ______

☐ ______

DATE DRILLED 2-15-03	PAGE 2 of 2

DRILLING METHOD HAMMER

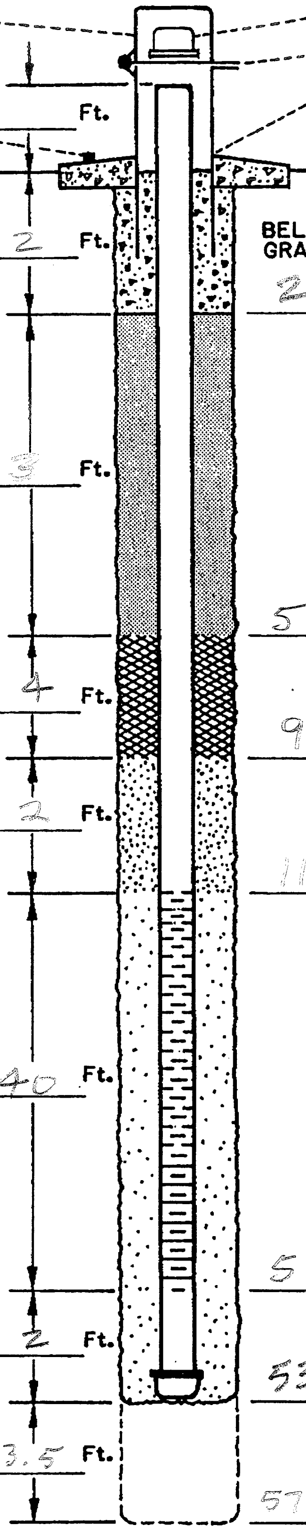
DRILLED BY LAYNE

LOGGED BY ED KRISH

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes ☐ No ☒
Steel ☐ PVC ☐
_____ Ft.
Surveying Pin ? Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☒
Lock ? Yes ☐ No ☐
Weep Hole ? Yes ☐ No ☒
Concrete Pad _____ Ft. x _____ Ft. x _____ Inches

Concrete VAULT 2 Ft.

Cement/Bentonite Grout Mix
Yes ☐ No ☒
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder 3 Ft.
Other: CONCRETE

Bentonite Seal 4 Ft.
Pellets ☒ Slurry ☐

Filter Pack Above Screen 2 Ft.

FILTER PACK MATERIAL 40 Ft.
Silica Sand ☒
Washed Sand ☐
Pea Gravel ☐
Others: _____
Sand Size 8-12

Dense Phase Sampling Cup 2 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill 3.5 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Others: _____

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
2	
5	
9	
11	
51	
53	
57.5	

DRILLING INFORMATION:

1. Borehole Diameter= 13 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☐
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☐
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☐ Galvanized ☐
   Stainless ☒ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☐
   Hacksaw ☐ Drilled ☐ Other VEE-WIRE
7. Installed Protector Pipe w/Lock: Yes ☐ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other _____
   SURGE BLOCK
2. Time Spent on Well Development ?
   4 / _____ ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 1000 Gallons
4. Water Clarity Before Development ? Clear ☒
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling 2.0 Ft. Date 2-15-03
Before Development _____ Ft. Date _____
After Development 4.50 Ft. Date 2-20-03

Driller/Firm PERRY / LAYNE
Drill Rig Type AP 1000
Date Installed 2-16-03
Drill Crew MARCO / BD
Well No. PC 117
Kerr-McGee Hydrologist ED KRISH

SOIL BORING LOG KM–5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KMCLLC	LOCATION HENDERSON NV	BORING NUMBER PC 118

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
	0-15 SAND, slty w/minor peg gravel zones. vf-vcg sd									water @ 2'
5			SM							DRILLED 12 FT NORTH OF PC 115
10										
15	15-18 SILT, sdy. 20-30% vf-mg sd		ML							
18	18-26 GRAVEL, sdy (20-30%) w/local slty zones		GM							
26	26-28 SAND, silty, vf-mg w/minor cg. 20-30% silt		SM							
28	28-49.5 Gravel, clean-sl. slty w/ 10-20% vf-vcg sd + granules		GM							
35										
40										

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL

◧ AUGER

◨ ROCK CORE

■ THIN-WALLED TUBE

◧ CONTINUOUS SAMPLER

◩ NO RECOVERY

DEPTH Depth Top and Bottom of Sample

REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY

▥ SILT

▩ SAND

⁘ GRAVEL

▨ SILTY CLAY

▥ CLAYEY SILT

▩ DEBRIS FILL

☰ HIGHLY ORGANIC (PEAT)

▨ SANDY CLAY

▨ CLAYEY SAND

☐ ______

☐ ______

DATE DRILLED 2-16-03

PAGE 1 of 2

DRILLING METHOD HAMMER

DRILLED BY LAYNE

LOGGED BY ED KRISH

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KMC LLC	LOCATION HENDERSON, NV	BORING NUMBER PC 118

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
45										
49.5	49.5-52 CLAY, silty green gry		CL							
52										
	TD 52									

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL

◧ AUGER

◫ ROCK CORE

■ THIN-WALLED TUBE

◨ CONTINUOUS SAMPLER

◺ NO RECOVERY

DEPTH. Depth Top and Bottom of Sample

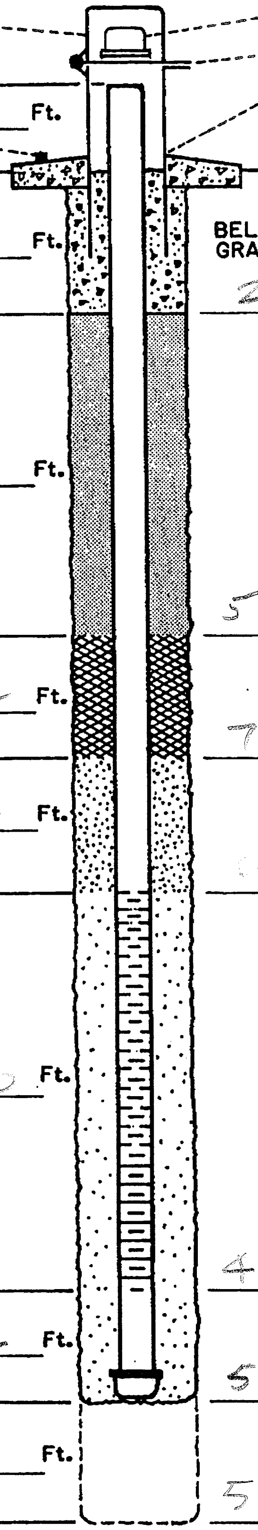
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY	▩ DEBRIS FILL
▥ SILT	≈ HIGHLY ORGANIC (PEAT)
▦ SAND	▧ SANDY CLAY
⁘ GRAVEL	▧ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED 2-16-03	PAGE 2 of 2
DRILLING METHOD HAMMER	
DRILLED BY LAYNE	
LOGGED BY ED KRISH	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes ☐ No ☒
Steel ☐ PVC ☐
_____ Ft.
Surveying Pin ?
Yes ☐ No ☒

Concrete VAULT 2 Ft.

Cement/Bentonite Grout Mix
Yes ☐ No ☒
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder 3 Ft.
Other: CONCRETE

Bentonite Seal 2 Ft.
Pellets ☒ Slurry ☐

Filter Pack Above Screen 2 Ft.

FILTER PACK MATERIAL
Silica Sand ☒
Washed Sand ☐ 40 Ft.
Pea Gravel ☐
Other:
Sand Size 8-12

Dense Phase Sampling Cup 2 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill 1 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Others:

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
2	
5	
7	
9	
49	
51	
52	

Casing Cap Vent ? Yes ☐ No ☒
Lock ? Yes ☐ No ☒
Weep Hole ? Yes ☐ No ☒
Concrete Pad _____ Ft. x _____ Ft. x _____ Inches

DRILLING INFORMATION:

1. Borehole Diameter= 13-1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other
3. Type of Well Screen: PVC ☐ Galvanized ☐
   Stainless ☒ Teflon ☐ Other VEE WIRE
4. Diameter of Casing and Well Screen:
   Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other SURGE BLOCK
2. Time Spent on Well Development ?
   4 / _____ ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 1000 Gallons
4. Water Clarity Before Development ? Clear ☒
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes , Describe

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)
During Drilling 2.0 Ft. Date 2-16-03
Before Development _____ Ft. Date _____
After Development 4.64 Ft. Date 2-20-03

Driller/Firm PERRY / LAYNE
Drill Rig Type AP 1000
Date Installed 2-17-03
Drill Crew MARCO / BO
Well No. PC 118
Kerr-McGee Hydrologist ED KRISH

SOIL BORING LOG

KERR-McGEE CORPORATION Hydrology Dept.	KM SUBSIDIARY KMCLLC	LOCATION HENDERSON, NV	BORING NUMBER PC 119

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
	0-15 silty SAND, 20% silt, vf-fg w/m		SM							water @ 3'
15	15-20 GRAVEL, minor sd + silt, pegravel up to 2"		GM							
20	20-29 SAND, silty, vf-vc w/20% volc granules. 20% silt		SM							
29	29-47 GRAVEL locally sdy/silty. clean w/ cobbles to 6"		GM							
40										

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
◨ AUGER
◫ ROCK CORE
■ THIN-WALLED TUBE
◫ CONTINUOUS SAMPLER
⧄ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY	▤ DEBRIS FILL
▥ SILT	≋ HIGHLY ORGANIC (PEAT)
▩ SAND	▧ SANDY CLAY
⁘ GRAVEL	▧ CLAYEY SAND
▧ SILTY CLAY	☐ ______
▧ CLAYEY SILT	☐ ______

DATE DRILLED: 2-17-03
PAGE: 1 of 2
DRILLING METHOD: HAMMER
DRILLED BY: LAYNE
LOGGED BY: ED KRISH
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG

KERR-McGEE CORPORATION Hydrology Dept.	KM SUBSIDIARY KMCLLC	LOCATION HENDERSON NV	BORING NUMBER PC 119

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE				REMARKS OR FIELD OBSERVATIONS
						NO.	TYPE	DEPTH	REC.	
	46-47 compact brn clay as gravel matrix								-	
47	47-49 CLAY, silty grn		CL							

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
◧ AUGER
◧ ROCK CORE
■ THIN-WALLED TUBE
◫ CONTINUOUS SAMPLER
⧄ NO RECOVERY

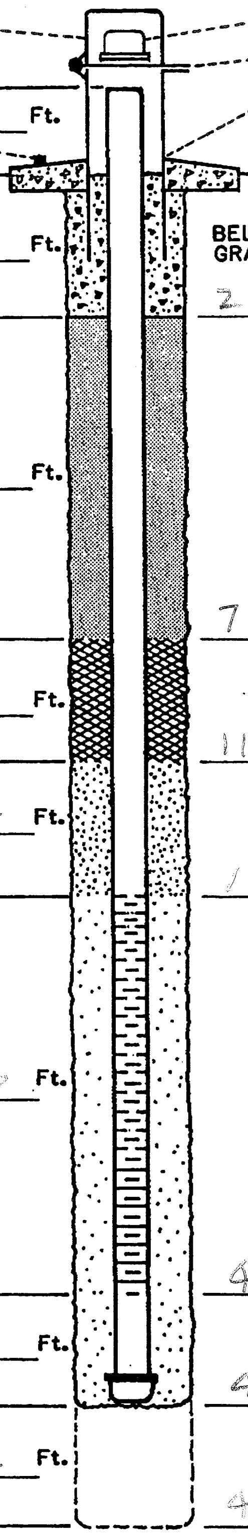
DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧ CLAY	▤ DEBRIS FILL
▥ SILT	≋ HIGHLY ORGANIC (PEAT)
▩ SAND	▧ SANDY CLAY
⁘ GRAVEL	▧ CLAYEY SAND
▧ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED: 2-17-03
PAGE: 2 of 2
DRILLING METHOD: HAMMER
DRILLED BY: LAYNE
LOGGED BY: E KRISH
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe Yes ☐ No ☒

Steel ☐ **PVC** ☐

_______ Ft.

Surveying Pin ? Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☒

Lock ? Yes ☐ No ☒

Weep Hole ? Yes ☐ No ☒

Concrete Pad _______ Ft. x _______ Ft. x _______ Inches

Concrete VAULT 2 Ft.

Cement/Bentonite Grout Mix Yes ☐ No ☒

5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder 5 Ft.

Other: CONCRETE

Bentonite Seal 3 Ft.

Pellets ☒ **Slurry** ☐

Filter Pack Above Screen 4 Ft.

FILTER PACK MATERIAL 30 Ft.

Silica Sand ☒

Washed Sand ☐

Pea Gravel ☐

Other: _______

Sand Size 8-12

Dense Phase Sampling Cup _______ Ft.

Bottom Plug Yes ☒ No ☐

Overdrilled Material Backfill 2 Ft.

Grout ☐ **Sand** ☒

Caved Material ☐

Others: _______

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
2	
7	
11	
15	
45	
47	
49	

DRILLING INFORMATION:

1. Borehole Diameter= 13.25 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _______ to _______ Feet.
4. Borehole Diameter for Outer Casing _______ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _______
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _______
3. Type of Well Screen: PVC ☐ Galvanized ☐
   Stainless ☒ Teflon ☐ Other VEE-WIRE
4. Diameter of Casing and Well Screen:
   Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _______
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other SURGE BLOCK
2. Time Spent on Well Development ?
   4 / _______ ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 1000 Gallons
4. Water Clarity Before Development ? Clear ☒
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _______
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _______

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling 3 Ft. Date 2-18-03

Before Development 3.45 Ft. Date 2-20-03

After Development 3.40 Ft. Date 2-21-03

Driller/Firm PERRY / LAYNE **Drill Rig Type** AP 1000 **Date Installed** 2-18-03

Drill Crew BO / MARCO **Well No.** PC 119 **Kerr-McGee Hydrologist** E KRISH

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION	BORING NUMBER
	KMCLLC	HENDERSON NV	PC 120

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
5	0-10 SAND, gravelly w 10-20% volc granules. st. silty		SW							water @ 3' DRILED 10 FT EAST OF PC 87
10 15 20 25	10-27 SAND, silty w/ 30% silt and 10-20% granules and pea gravel		SW/SM							
27 30 35	27-45 GRAVEL, sdy 30-40% vf-vcg, w/ local slty zones		GP							
	37-45 Calichified gravel. v. hard.									

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
◧ AUGER
◫ ROCK CORE
■ THIN-WALLED TUBE
◨ CONTINUOUS SAMPLER
◩ NO RECOVERY

DEPTH. Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY	▦ DEBRIS FILL
▥ SILT	≈ HIGHLY ORGANIC (PEAT)
▩ SAND	▨ SANDY CLAY
⁘ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▨ CLAYEY SILT	☐ ______

DATE DRILLED: 2-18-03
PAGE: 1 of 2
DRILLING METHOD: HAMMER
DRILLED BY: LAYNE
LOGGED BY: ED KRISH
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION	BORING NUMBER
	KMCLLC	HENDERSON, NV	PC120

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
45	45-48 CLAY, silty w/gyp xtals. greenish		CL							
48	TD									

EXPLANATION

▼ Water Table (24 Hour)

▽ Water Table (Time of Boring)

PID Photoionization Detection (ppm)

NO. Identifies Sample by Number

TYPE Sample Collection Method

☒ SPLIT-BARREL

◧ AUGER

◨ ROCK CORE

■ THIN-WALLED TUBE

◧ CONTINUOUS SAMPLER

⧄ NO RECOVERY

DEPTH. Depth Top and Bottom of Sample

REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧	CLAY	▩	DEBRIS FILL
▥	SILT	≈	HIGHLY ORGANIC (PEAT)
▦	SAND	▧	SANDY CLAY
⁘	GRAVEL	▧	CLAYEY SAND
▧	SILTY CLAY	☐	______
▥	CLAYEY SILT	☐	______

DATE DRILLED: 2-18-03

PAGE: 2 of 2

DRILLING METHOD: HAMMER

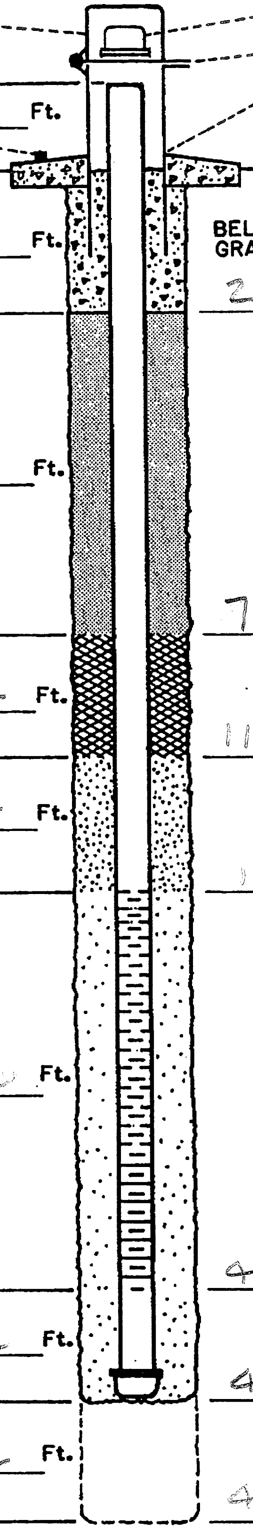
DRILLED BY: LAYNE

LOGGED BY: ED KRISH

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe Yes ☐ No ☒
Steel ☐ PVC ☐
______ Ft.
Surveying Pin ? Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☒
Lock ? Yes ☐ No ☒
Weep Hole ? Yes ☐ No ☒
Concrete Pad ______ Ft. x ______ Ft. x ______ Inches

Concrete VAULT 2 Ft.

Cement/Bentonite Grout Mix
Yes ☐ No ☒
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder 5 Ft.
Others: CONCRETE

Bentonite Seal 4 Ft.
Pellets ☒ Slurry ☐

Filter Pack Above Screen 4 Ft.

FILTER PACK MATERIAL
Silica Sand ☒
Washed Sand ☐ 30 Ft.
Pea Gravel ☐
Others: ______
Sand Size 8-12

Dense Phase Sampling Cup 2 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill 1 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Others: ______

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
2	
7	
11	
15	
45	
47	
48	

DRILLING INFORMATION:

1. Borehole Diameter= 13.25 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
Revert ☐ Bentonite ☐ Water ☐
Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
Depth= ______ to ______ Feet.
4. Borehole Diameter for Outer Casing ______ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
Stainless ☐ Other ______
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other ______
3. Type of Well Screen: PVC ☐ Galvanized ☐
Stainless ☒ Teflon ☐ Other VEE-WIRE
4. Diameter of Casing and Well Screen:
Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
Hacksaw ☐ Drilled ☐ Other ______
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
Air Surging (Air or Nitrogen) ☐ Other ______
SURGE BLOCK
2. Time Spent on Well Development ?
4 / ______ ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 1000 Gallons
4. Water Clarity Before Development ? Clear ☒
Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☒
Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
If Yes, Describe ______
7. Did Water have any Color ? Yes ☐ No ☒
If Yes, Describe ______

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)
During Drilling 3 Ft. Date 2-19-03
Before Development 3.40 Ft. Date 2-21-03
After Development ______ Ft. Date ______

Driller/Firm PERRY / LAYNE
Drill Rig Type AP 1000
Date Installed 2-19-03
Drill Crew BW / MARCO
Well No. PC120
Kerr-McGee Hydrologist ED KRISH

SOIL BORING LOG

KERR-McGEE CORPORATION Hydrology Dept.	KM SUBSIDIARY KMCLLC	LOCATION HENDERSON, NV	BORING NUMBER PC121

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
	0-9 SAND, sl. silty w/ 10-20% granules. vf-vcg.		SW						-	water @ 3'
9	9-25 SAND, silty w/ minor pea gravel. 20-25% silt. vf-cg		SM/SW							
25	25-40.5TD GRAVEL, clean-sl silty, w/10-20% vf-vc sand		GW							
	38.5-40.5(TD) V. HARD calichified gravel. fractured									REFUSAL @40.5'

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
▯ AUGER
▯ ROCK CORE
■ THIN-WALLED TUBE
▯ CONTINUOUS SAMPLER
◫ NO RECOVERY

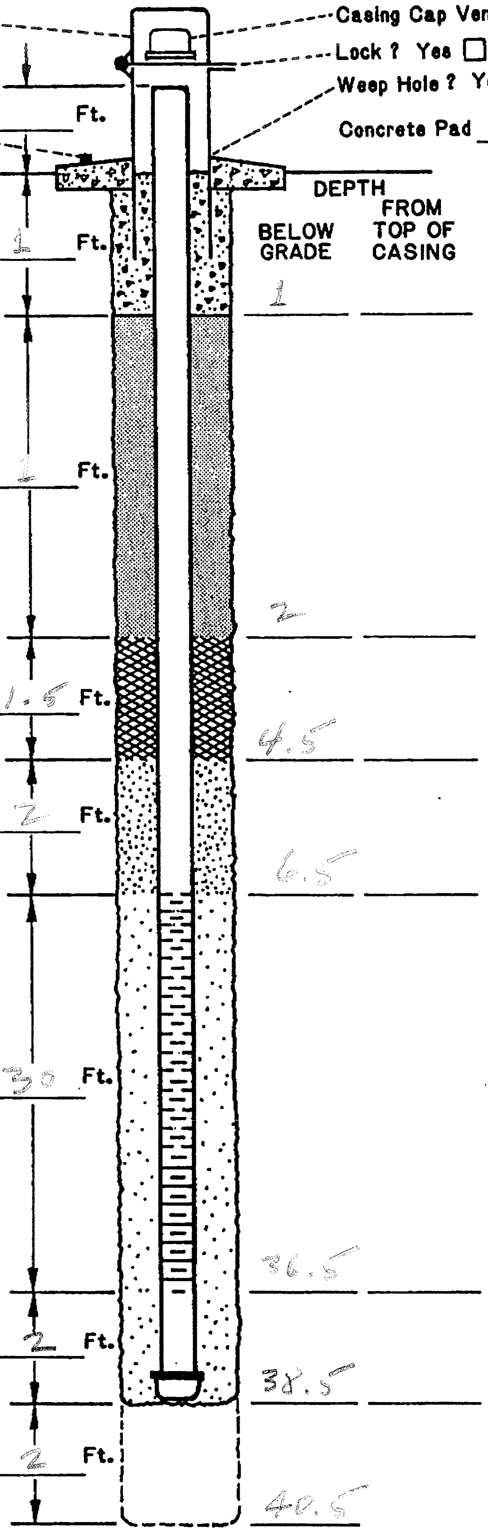
DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▧ CLAY	▤ DEBRIS FILL
▥ SILT	≋ HIGHLY ORGANIC (PEAT)
▩ SAND	▧ SANDY CLAY
⁘ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED 2-19-03
PAGE 1 of 1
DRILLING METHOD HAMMER
DRILLED BY LAYNE
LOGGED BY ED KRISH
EXISTING GRADE ELEVATION (FT. AMSL)
LOCATION OR GRID COORDINATES

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes ☐ No ☒
Steel ☐ PVC ☐
_____ Ft.
Surveying Pin ? Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☒
Lock ? Yes ☐ No ☒
Weep Hole ? Yes ☐ No ☒
Concrete Pad _____ Ft. x _____ Ft. x _____ Inches

Concrete VAULT 1 Ft.

Cement/Bentonite Grout Mix
Yes ☐ No ☒
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder 1 Ft.
Other: CONCRETE

Bentonite Seal 1.5 Ft.
Pellets ☒ Slurry ☐

Filter Pack Above Screen 2 Ft.

FILTER PACK MATERIAL 30 Ft.
Silica Sand ☒
Washed Sand ☐
Pea Gravel ☐
Other: _____
Sand Size 8-12

Dense Phase Sampling Cup 2 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill 2 Ft.
Grout ☐ Sand ☒
Caved Material ☐
Other: _____

DEPTH BELOW GRADE	FROM TOP OF CASING
1	
2	
4.5	
6.5	
36.5	
38.5	
40.5	

DRILLING INFORMATION:

1. Borehole Diameter= 13.25 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐ Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☐ Galvanized ☐ Stainless ☒ Teflon ☐ Other VEE-WIRE
4. Diameter of Casing and Well Screen:
   Casing 8 Inches, Screen 8 Inches.
5. Slot Size of Screen: 0.040
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☒ Other _____
   SURGE BLOCK
2. Time Spent on Well Development ?
   4 / _____ ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 1000 Gallons
4. Water Clarity Before Development ? Clear ☒
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes , Describe _____

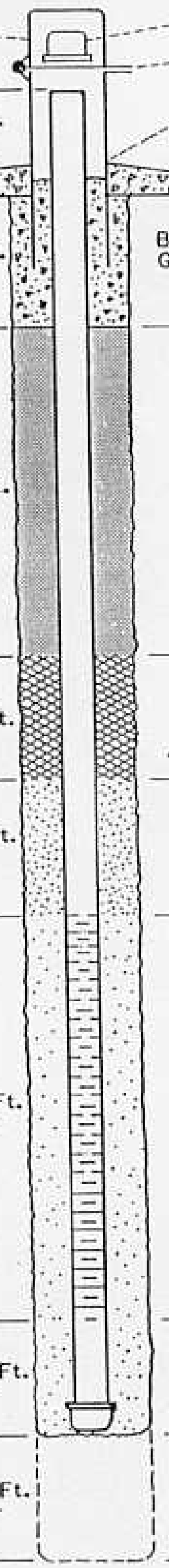
WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling 3 Ft. Date 2-19-03
Before Development 2.95 Ft. Date 2-21-03
After Development _____ Ft. Date _____

Driller/Firm PERRY / LAYNE
Drill Rig Type AP1000
Date Installed 2-20-03
Drill Crew BO / MARCO
Well No. PC 121
Kerr-McGee Hydrologist ED KRUSH

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes ☐ No ☒
Steel ☐ PVC ☐
______ Ft.
Surveying Pin ?
Yes ☐ No ☒

Casing Cap Vent ? Yes ☐ No ☒
Lock ? Yes ☐ No ☒
Weep Hole ? Yes ☐ No ☒
Concrete ~~Pad~~ VAULT Ft. x ______ Ft. x ______ Inches

Concrete 0 Ft.

Cement/Bentonite Grout Mix
Yes ☐ No ☒
5.5 Gallons Water to 94Lb. Bag Cement & 3–5 Lb. Bentonite Powder 0 Ft.
Other: Will be protected by CONCRETE VAULT

Bentonite Seal 3 Ft.
Pellets ☒ Slurry ☐

Filter Pack Above Screen 2 Ft.

FILTER PACK MATERIAL
Silica Sand ☐
Washed Sand ☒ 35 Ft.
Pea Gravel ☐
Other: ______
Sand Size 8 - 12

Dense Phase Sampling Cup 0.2 Ft.
Bottom Plug
Yes ☒ No ☐

Overdrilled Material Backfill ______ Ft.
Grout ☐ Sand ☐
Caved Material ☐
Other: ______

DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
3	
5	
40	
40.2	

DRILLING INFORMATION:

1. Borehole Diameter= 10 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☐
   Depth= ______ to ______ Feet.
4. Borehole Diameter for Outer Casing ______ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other ______
2. Type of Casing Joints: Screw–Couple ☒ Glue–Couple ☐ Other ______
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other ______
4. Diameter of Casing and Well Screen:
   Casing 4 Inches, Screen 4 Inches.
5. Slot Size of Screen: 0.020 "
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other ______
7. Installed Protector Pipe w/Lock: Yes ☐ No ☒

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other SURGE BLOCK / AIR LIFT
2. Time Spent on Well Development ? ADD 5 gal AQUA-CLEAR
   6 ~~Minutes~~/Hours
3. Approximate Water Volume Removed ? 2000 Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe ______
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes , Describe ______

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)
During Drilling 6 Ft. Date 12-8-04
Before Development ______ Ft. Date ______
After Development 6.60 Ft. Date 12-9-04

Driller/Firm TENV
Drill Rig Type MOBILE B-61
Date Installed ______
Drill Crew KENT/SHIM/RICK
Well No. PC 133
~~Kerr-McGee~~ Hydrologist Ed KRISH (ENSR)

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY: KMC LLC

LOCATION: HENDERSON, NV

BORING NUMBER: PC-133

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
5 10	0-10 SAND, gravelly, mod brn, poorly sorted, SA-SR, vf-vc. with 20% volc granules + pebbles to 2". Slightly silty		GM/ SM							wet @6'
15 20 25 30	10-30 SAND, silty + gravelly, mod brn. 40-50% vf-cg, SA-SR sand w/ 25-30% silt and 25-30% volc granules + pebbles to ½"		SM/ GM							
38	30-38 GRAVEL, silty and sandy, mod brn. 40% volc granules to ½" w/ 40% silt + 20% sand (vf-cg)		GM							
	38-40 CLAY, sl. silty pale grn yell,	▨	CL							MC @ 38'

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

☒ SPLIT-BARREL
▯ AUGER
▮ ROCK CORE
■ THIN-WALLED TUBE
▯ CONTINUOUS SAMPLER
⧅ NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

▨ CLAY	▩ DEBRIS FILL
▥ SILT	▭ HIGHLY ORGANIC (PEAT)
▦ SAND	▨ SANDY CLAY
⁘ GRAVEL	▨ CLAYEY SAND
▨ SILTY CLAY	☐ ______
▥ CLAYEY SILT	☐ ______

DATE DRILLED: 12-8-04
PAGE: 1 of 1
DRILLING METHOD: HSA
DRILLED BY: TENV
LOGGED BY: E. KRISH / R. FOXX
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES:

Attachment C

Revised Report Text
Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site, Henderson, Nevada, July – December 2013

NDEP. 2013b. Nevada Division of Environmental Protection (NDEP) Response to: Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust, Henderson, Nevada, July 2012 – June 2013. October 10.

NDEP. 2013c. Nevada Division of Environmental Protection (NDEP) Response to: 2013 GWETS Optimization Project Work Plan, Revision 1; Date November 22, 2013. December 3.

Pollock, D.W. 1994. User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U.S. Geological Survey finite difference ground-water flow model: U.S. Geological Survey Open-File Report 94-464, 6 Ch.

RCI Engineering. 2010. Technical drainage study for Tronox soil remediation treatment basins. RCI Engineering, Las Vegas, NV. October 2010.

United States Environmental Protection Agency (USEPA). 2008. A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems: U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/003.

Attachment D

Revised Attachment A Text
Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site, Henderson, Nevada, July – December 2013

Phase I Groundwater Model Refinement

Nevada Environmental Response Trust Site; Henderson, Nevada

Prepared for:
Nevada Environmental Response Trust
Henderson, Nevada

Prepared by:
ENVIRON International Corporation
Emeryville, California

Date:
February 28, 2014

Project Number:
21-34800H

ENVIRON

Contents

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1 Introduction

On behalf of the Nevada Environmental Response Trust (the Trust), ENVIRON International Corporation, Inc. (ENVIRON) has prepared this report describing refinements made to the groundwater flow model of the Nevada Environmental Response Trust Site (the Site), located in Clark County, Nevada. The initial purpose of the groundwater model is to support the optimization of the existing groundwater extraction and treatment system (GWETS) at the Site, as described in the 2013 GWETS Optimization Work Plan (ENVIRON 2013b), approved by the Nevada Division of Environmental Protection (NDEP) on December 3, 2013 (NDEP 2013). In addition, the groundwater model will be used to support the remedial investigation and feasibility study (RI/FS), as described in the RI/FS Work Plan (ENVIRON 2014a).

The initial version of the groundwater model for the Site was developed by Northgate Environmental Management Inc. (Northgate) and was approved on April 4, 2013 by NDEP for use in capture zone evaluation and is referred to as the “Northgate Model.” The Northgate Model is a steady-state flow model calibrated to Site conditions in 2008/2009, which is documented in the Capture Zone Evaluation Report (Northgate 2010). As described in the 2013 GWETS Optimization Project Work Plan, modifications to the Northgate Model are being implemented by ENVIRON in two phases. The first phase of modifications, which is discussed in this report, includes: 1) an update of the model to reflect more recent conditions and pumping and injection rates of the GWETS, American Pacific Corporation (AMPAC) and Olin/Stauffer/Syngenta/Montrose (OSSM) remediation systems; 2) preliminary refinement of the model representation of stream-aquifer interactions near Las Vegas Wash; and 3) other changes to the model requested by NDEP or necessary to support the 2013 GWETS Optimization Project. In addition, a conceptual water budget for the model area was developed as part of the first phase activities.

The updated model resulting from this work is referred to as the “Phase I Model”. This report documents the updates and refinements to the Northgate Model made to develop the Phase I Model. The components of the Phase I Model that were not modified from the Northgate Model are generally not described in this report since they are described in the Northgate Model documentation (Northgate 2010). The Phase I Model has been used to support the calculation of GWETS performance metrics that are presented in the 2013 Semi-Annual Remedial Performance Report for Perchlorate and Chromium (ENVIRON 2014b).

The second phase of modifications will involve updating and recalibrating the model to incorporate the results of aquifer testing and the conceptual water balance, and further refine the representation of stream-aquifer interactions at Las Vegas Wash. This “Phase II Model” will then be used to evaluate the performance of alternative extraction scenarios at the Site well fields as part of the 2013 GWETS Optimization Project.

2 Site Background

A brief summary of Site background relevant to the discussion of the groundwater model is provided in this section. A complete background summary is provided in the RI/FS Work Plan (ENVIRON 2014a).

The Site is located within the Las Vegas Valley in the southern region of Clark County, Nevada. Las Vegas Valley is bordered by a set of mountains that includes the Spring Mountains to the west, the Sheep Range and Las Vegas Range to the north, the Frenchman Mountains and Sunrise Mountains to the east, and the River Mountains and McCullough Mountains to the south (Figure 1). The most significant stream in the valley is the Las Vegas Wash, which flows generally from west to east before discharging into Lake Mead. The climate in the area varies from semi-arid in the mountains to arid in the lowlands. Rainfall averages about 4.5 inches per year and occurs in storms of high intensity and short duration that often lead to floods. Evaporation in the area is significant and can be higher than 80 inches per year in the lower portion of the valley (UNLV 2003).

NDEP has defined three water-bearing zones (WBZs) that are of interest in the vicinity of the Site: the Shallow, Middle, and Deep WBZs (NDEP 2009). Groundwater flow occurs predominantly in shallow quaternary alluvium (Qal) which overlies the much lower hydraulic conductivity Upper Muddy Creek formation (UMCf). A distinct paleo-channel drainage network is present in the shallow aquifer system. The ground surface across the Site generally slopes downward to the north. The Shallow WBZ extends to approximately 90 feet below ground surface (bgs), and consists of saturated portions of the Qal and the uppermost portion of the UMCf. The Shallow WBZ is unconfined to partially confined, and is considered the water table aquifer. The groundwater in the shallow aquifer flows to the north and the groundwater gradient generally mimics the surface topography. There is generally an upward vertical gradient from the UMCf to the alluvium. The extraction wells at the Site are screened in the Shallow WBZ.

There are currently three operating extraction wells fields that are associated with the Site: 1) the on-site Interceptor Well Field (IWF) with downgradient barrier wall; 2) the off-site Athens Road Well Field (AWF); and 3) the off-site Seep Well Field (SWF). These well fields are operated to remove perchlorate and hexavalent chromium from shallow groundwater and reduce the amount of perchlorate discharged to Las Vegas Wash. In addition to these well fields, neighboring companies AMPAC and OSSM operate separate groundwater capture systems west of the Site. Groundwater monitoring is being conducted at the Titanium Metals Corporation (TIMET) site, located to the east of the Site. TIMET's groundwater remediation system construction began in 2009 and is expected to be operational in March 2014 (GEI 2014).

3 Previous Groundwater Models

The Phase I Model is based on the original groundwater flow model developed for the Site by Northgate. The Northgate Model is a steady-state model calibrated to Site conditions existing during 2008/2009 (Northgate 2010). The primary focus of developing the Northgate Model was to carry out capture zone analyses of the IWF and AWF. The Las Vegas Wash in the model is beyond these two regions of interest and was simulated using a constant head boundary for simplicity. Hence, the surface-groundwater interactions that occur along the Las Vegas Wash were not simulated in detail in the model.

The active area of the Northgate Model domain is wedge-shaped, narrowing from south to north towards the Las Vegas Wash and covering an area of about 10,000 acres. From south to north, the model domain extends from south of Lake Mead Parkway to the Las Vegas Wash, an area approximately 20,000 feet (about 4 miles) in total length. Laterally, the model extends west of the Site to include the existing AMPAC and OSSM groundwater capture systems, and east of the Site to include the monitoring wells at the TIMET site. The model is discretized laterally into 200 by 200 foot grid cells. In the vertical direction, the model domain extends downwards from Shallow WBZ, and through the Middle WBZ and ends near the top of the Deep WBZ. These units were discretized vertically into six model layers.

In addition to the Northgate Model, several other groundwater flow models have been developed and documented for the Black Mountain Industrial (BMI) Complex and surrounding region. The subsections below describe groundwater flow models pertinent to the Site.

3.1 United States Geological Survey Model

A regional groundwater model of the valley-fill aquifer system of the Las Vegas Valley was developed by the United States Geological Survey (USGS) to evaluate possible groundwater management alternatives related to overdraft problems, while maximizing use of groundwater resources (USGS 1996). The model incorporates processes such as land subsidence due to groundwater withdrawal, discharges to washes, evapotranspiration, and springflow. The four-layered model consists of 60 columns and 72 rows with uniform grid size of 3,000 feet by 3,000 feet. The model was developed in two phases. In the first phase, the predevelopment groundwater conditions, representing a period from 1912 through spring 1972, were simulated. The second phase model simulated the period from summer 1972 through spring 1981, representing development conditions. As a part of the modeling efforts, a conceptual water budget was compiled for the two simulation phases.

3.2 University of Nevada at Las Vegas Model

A groundwater model to study perchlorate transport from several contaminated sites to the Las Vegas Wash was developed by a team at the University of Nevada at Las Vegas (UNLV) on behalf of the United States Environmental Protection Agency (USEPA) (UNLV 2003). The computer model was developed for saturated conditions using the software Visual MODFLOW 2.8 and was calibrated using WinPEST, an automated calibration tool. The model results included an evaluation of the time of travel and potential perchlorate migration pathways from the contaminant sources to the Las Vegas Wash. In addition to the time of travel and concentration distribution, the transport model also evaluated the influence of domestic and industrial wastewater disposal via the infiltration ponds on the development of the plumes.

3.3 Las Vegas Wash Model

A groundwater transport model was developed by NDEP to study groundwater/surface water interactions and perchlorate transport along the Las Vegas Wash (McGinley 2003). The purpose of the modeling work was to develop a predictive tool to address temporal distributions of perchlorate in the Las Vegas Wash. MODFLOW was used to simulate groundwater flow, with the Las Vegas Wash simulated using the River Package. Only the alluvium aquifer system was simulated in the model.

3.4 Athens Road Well Field Model

A solute transport groundwater model was developed by McGinley & Associates to quantify the efficiency of capture at the AWF (McGinley & Associates 2007). The model predicted capture efficiency of 99.5% at the AWF. However, the perchlorate concentration data for downgradient wells did not appear to indicate complete capture was being achieved. The disparity between observations and calculations was attributed to limitations of the conceptual site model developed for the study area.

3.5 Basic Remediation Company Model

A groundwater transport model for the BMI Common Areas was developed by Daniel B. Stephens & Associates on behalf of the Basic Remediation Company (BRC) (BRC 2009). As part of the modeling effort, historical, present, and future conceptual water balances of the study area were developed. A series of predictive solute transport simulations were also conducted for perchlorate, arsenic, hexavalent chromium, and selenium.

3.6 AMPAC Model

On behalf of AMPAC, Geosyntec Consultants (Geosyntec) developed a conceptual and numerical model of groundwater flow in the area north of the former Pacific Engineering and Production Company of Nevada (PEPCON) facility in Henderson, Nevada (Geosyntec 2010). A steady-state numerical model was developed to validate the conceptual model against available site data and to develop quantitative estimates of design parameters and operations to remediate the perchlorate plume in groundwater that originates at the PEPCON site. The model was implemented in MODFLOW 2000 and used to simulate saturated groundwater conditions.

4 Conceptual Water Balance

A conceptual water balance was derived for groundwater within the Phase I Model domain. The model domain is shown on Figure 2. The purpose of the water balance is to provide an independent evaluation of the inflows and outflows of groundwater within the model domain that can be used to guide model refinement. The Phase I Model represents the approximately steady-state period in second quarter of 2012. The conceptual water balance incorporates data from the same time period to allow comparison of water balance components. Vertically, the model domain includes the Shallow and Middle WBZs, but does not include deeper portions of the UMCf.

The methods and data sources for individual water balance components are listed in Table 1a and are described in the following sub-sections.

4.1 Groundwater Outflow

The major groundwater outflow components in the model area are groundwater extraction, groundwater outflow to the Las Vegas Wash, and evapotranspiration from groundwater, each of which are discussed in this section.

4.1.1 Groundwater Extraction

Groundwater extraction is presently conducted from five well fields at three sites within the model area: the Site, OSSM, and AMPAC. The total groundwater extraction at these sites was aggregated from available data for second quarter 2012. At the Site, the combined average extraction rates for second quarter 2012 for the IWF, AWF and SWF were 62 gallons per minute (gpm) (12,012 cubic feet per day [cfd]), 275 gpm (52,885 cfd), and 577 gpm (111,018 cfd), respectively (ENVIRON 2012a). The combined average extraction rate for this time period was 148 gpm (29,125 cfd) for the OSSM system (Hargis and Associates, 2012) and 512 gpm (98,560 cfd) for the AMPAC system (AMPAC 2013).

4.1.2 Outflow to Las Vegas Wash

Since the rate of groundwater discharge from the Site and neighboring areas to the Las Vegas Wash cannot be directly measured, this quantity was indirectly estimated by comparing measured sources of inflows and outfalls along the reach of the Las Vegas Wash that forms the northern model boundary. The data compiled for this estimate includes streamflow data from USGS gauging stations, City of Henderson (COH) treated wastewater outflows, and treated effluent discharge rates from the Site, AMPAC, and TIMET. This data is presented in Table 1b, and the locations of various stream gauge and outfall locations are shown in Figure 1.

For this analysis, the reach of Las Vegas Wash adjoining the model domain was divided into two sub-reaches bounded by USGS stream gauges. Reach A extends from the Las Vegas Wasteway Gauge (#09419679) to the Pabco Road Gauge (#09419700), and includes a tributary of Las Vegas Wash (Duck Creek, #09419696) and inflows from several wastewater outfalls. Reach B extends from the Pabco Road Gauge to the Three Kids Gauge (#09419753). Conceptually, the calculation performed for each sub-reach involved summing all known inflows and outflows of surface water and groundwater. Groundwater inflow to Las Vegas Wash was assumed to be composed of underflow and lateral discharges. Since there was relatively little precipitation during the water balance period, it was assumed that there was no significant rainfall runoff to Las Vegas Wash. After performing the summation, any missing flow was assumed to originate from groundwater discharges along the length of the sub-reach. The groundwater inflow to each of these sub-reaches was estimated separately, scaled to exclude groundwater inflow to Las Vegas Wash beyond the model boundary, and then summed together for entry into the overall water balance. This calculation did not separately estimate potential seepage from Las Vegas Wash due to pumping at the SWF, instead presenting overall groundwater discharge to Las Vegas Wash as a net outflow.

The streamflow data was downloaded from the USGS[1] for the above mentioned stream gauge stations. For the second quarter of 2012, the average streamflow during the water balance period was 250 cubic feet per second (cfs) at the Las Vegas Wasteway Gauge, 5.6 cfs at the Duck Creek Gauge, 281 cfs at the Pabco Road Gauge, and 285 cfs at the Three Kids Gauge. The COH wastewater outfall reportedly discharged 14 cfs to Las Vegas Wash during second quarter 2012[2]. The AMPAC outfall location is approximately 40-50 yards south of the Site discharge location and reportedly produces effluent at a rate roughly equal to the combined extraction rates from the AMPAC wells[3]. The average Site, AMPAC, and TIMET outfalls to Las Vegas Wash were 2.0 cfs[4], 1.1 cfs[5], and 1.0 cfs[6] in second quarter 2012, respectively.

A portion of the streamflow in Las Vegas Wash is lost to evaporation. The total area of Las Vegas Wash (including Duck Creek) is approximately 450 acres between the Las Vegas Wasteway and Pabco Road gauging stations. Available daily evaporation data from 1997-1999 for four stations located in or near Lake Mead indicate an average evaporation rate of 81 inches per year (Westenburg et al. 2006). Multiplying the area of Las Vegas Wash by the evaporation rate results in an estimated 4.2 cfs of surface water evaporated from Las Vegas Wash within the model area. The outflow due to evaporation was allocated to Reaches A and B based on the relative area of each reach.

As shown in Table 1b, after accounting for known and estimated flows, the estimated groundwater inflow to Las Vegas Wash along Reaches A and B from both sides of Las Vegas Wash was 16.1 cfs. Since there was no significant runoff during the water balance period, this inflow was assumed to originate from groundwater discharges to Las Vegas Wash from adjacent regions to the north and south. The allocation of groundwater inflow between the two sides of Las Vegas Wash was roughly estimated by comparing for each side of the wash: 1) the contributing area of the watershed; 2) the relative alluvial thickness as inferred from a review of USGS Geologic Maps; and 3) land use, with the assumption that in the absence of precipitation, more developed land uses would result in higher groundwater recharge (from landscape irrigation, etc.). Based on this qualitative evaluation, it was estimated that roughly 80% of the

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[1] Data downloaded from http://waterdata.usgs.gov/usa/nwis/sw

[2] Per data received via email from Howard Analla of the City of Henderson, dated 7/09/2013.

[3] Per email communication with Gary Carter of AMPAC, dated 9/10/2013.

[4] NERT Effluent Records, NPDES Permit number – NV0023060.

[5] Equivalent to the combined AMPAC pumping as per email communication with Gary Carter of AMPAC, dated 9/10/2013.

[6] Based on the maximum permissible flow rate for TIMET's effluent outfall, NPDES Permit number- NV0000060

groundwater discharge to the Wash originates from the south side of Las Vegas Wash, resulting in an estimated groundwater discharge of 8.0 cfs (693,000 cfd) within the model area.

4.1.3 Evapotranspiration From Groundwater

Evapotranspiration from shallow groundwater may occur in the areas of phreatophytes found along Las Vegas Wash. Given the limited areal extent of phreatophytes, evapotranspiration from groundwater is expected to be very small compared to other water balance components. Hence, no estimate of evapotranspiration was developed for the water balance.

4.2 Groundwater Inflow

The major groundwater inflow components in the groundwater model domain are areal recharge, mountain block recharge from the southern edge of the model, seepage from Las Vegas Wash, and vertical inflow from the UMCf.

4.2.1 Areal Recharge From Precipitation

Areal recharge rate from rainfall was estimated from published values for arid and semi-arid regions, which have been found to range between 0.1% and 5% of average total rainfall (Scanlon et al. 2006). Based on interpolated climate data produced by Oregon State University's PRISM Climate Group (PRISM 2013), the average precipitation rate near the Site was 4.32 inches per year for the period 1990-2012. Assuming 2.55% (average of 0.1% and 5%) of precipitation as net areal recharge, the total areal recharge for the model area (4 X 10^8 square feet) is expected to be 11,000 cfd.

4.2.2 Recharge from Surface Water Bodies

Recharge from several surface water bodies in the model domain were evaluated separately and incorporated into the water balance. A significant source of surficial recharge to groundwater is a series of unlined ponds operated by COH as a bird viewing preserve. An average of 1.22 million gallons per day (MGD) of inflow to the ponds was recorded by COH for the period from 2008 to 2013. The ponds have an area of approximately 110 acres. Assuming COH is maintaining a relatively constant level of surface water in the ponds, and assuming an evaporation rate of 81 inches per year (see Section 4.1.2), the recharge from the ponds to the shallow groundwater aquifer is estimated to be 5.6 feet per year. The total pond recharge rate was estimated to be 74,000 cfd.

Several facilities near the Site operate infiltration ponds and trenches that present potential sources of focused recharge. The OSSM treatment system discharges treated groundwater to recharge trenches located north of the OSSM extraction wells (Figure 1). Based on the OSSM third quarter 2012 monitoring report, an average of 147 gpm (29,000 cfd) of water was discharged to the trenches between January and September 2012 (Hargis and Associates 2012). Other historical sources of focused recharge, including the former recharge trenches at the Site, former COH Rapid Infiltration Basins (RIBs), BMI Pond, TIMET Pond, and the AMPAC reinjection system were not active during the Phase I Model period.

4.2.3 Lateral and Vertical Boundary Inflows

The southern lateral boundary inflow was estimated using the hydraulic conductivity of the UMCf and the head gradient at the southern boundary of the Site. The alluvium is unsaturated along the southern boundary, and the UMCf is partially saturated. Within the water balance domain, the UMCf consists of two distinct interbedded units, composed of either coarse-grained sediments (UMCf-cg) or fine-grained sediments (UMCF-fg) (ENVIRON, 2014a)[7]. Plate 6 of the RI/FS Workplan (ENVIRON 2014a) is a cross-section illustrating the orientation of these units near the southern model boundary. As shown in the Plate 6, the shallowest interval of the UMCf-fg pinches out before reaching the IWF.

Based on the depiction of the saturated portion of the UMCf-fg and UMCf-cg in Plate 6, 30% of the southern boundary thickness was allocated to the UMCf-fg, and 70% was allocated to the UMCf-cg. The horizontal hydraulic conductivity for the UMCf from the Northgate Model (0.72 feet per day [feet/day]) was used for the UMCf-fg, and the hydraulic conductivity of the UMCf-cg (6 feet/day) was obtained from the AMPAC model (Geosyntec 2010). The horizontal head gradient measured during second quarter 2012 upgradient of the Site boundary was approximately 0.0077 feet per foot (feet/foot) (ENVIRON 2014a). The southern model boundary is 20,000 feet in length and the thickness of UMCf is 267 feet in the model. Using these values, an inflow of approximately 183,000 cfd is expected from the southern boundary.

The vertical boundary inflow consists of upward flow from the deeper portion of the UMCf in the Deep WBZ. The average vertical head gradient between pairs of wells in the IWF and the AWF was about 0.11 feet/foot during second quarter 2012. The well pairs used for this purpose are M-71/M-163, M-74/M-165, PC-135A/PC-134A, and PC-136/PC-137. Using this head gradient, a total surface area of 4.33 X 10^8 square feet in the model, and a representative UMCf vertical conductivity of 4.8 X 10^{-3} feet/day, a vertical inflow of approximately 229,000[8] cfd is expected from the Deep WBZ.

Because the model area is oriented along the general direction of groundwater flow, net inflows and/or outflows along the eastern and western lateral boundaries of the conceptual water balance area are expected to be minimal. However, in the vicinity of Las Vegas Wash, there will be groundwater underflow into the model area on the western boundary and out of the model area on the eastern boundary. These underflows were estimated by roughly estimating the width and depth of saturated alluvium, the hydraulic gradient, and hydraulic conductivity at the model area boundaries. The width of the alluvium was estimated based on the USGS geologic map shown in Figure 1. The depth and hydraulic conductivity of the alluvium were based on McGinley (2003). A hydraulic gradient of 0.005 was assumed for this estimate. The inflow from the western boundary was estimated to be 510,000 cfd, and the outflow at the eastern boundary was estimated to be 31,000 cfd.

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[7] The Phase I Model doesn’t represent the UMCf-fg and UMCf-cg as separate units.

[8] Vertical inflow is rounded to nearest thousand. The calculated value is 228,624 cubic feet. The total model area is also rounded for these calculations. The calculated model area is 433,016,249.793 square feet.

5 Phase I Groundwater Model Update

To support the 2013 GWETS Optimization Project, the Northgate Model was updated to reflect the more recent configuration and extraction and injection rates of the Site, AMPAC, and OSSM remediation systems. A regional water balance was prepared (as discussed in Section 4) to guide further model refinements. An initial evaluation of the stream-aquifer interaction in the vicinity of the SWF was also conducted and the model was updated accordingly. The key model components revised in this phase are described in the following sections.

5.1 Model Solver

The Northgate Model was developed using an early and unpublished version of the MODFLOW-NWT code. Minor revisions were made to the model so it can be run using MODFLOW-NWT version 1.0.7 (Niswonger 2011), a recent version of the code that is available on the USGS website[9]. MODFLOW-NWT is a version of MODFLOW-2005 with a Newton formulation of the groundwater flow equation that is designed to solve problems that are nonlinear due to unconfined aquifer conditions and/or some combination of nonlinear boundary conditions.

5.2 Model Extent

The model extent was revised at the northern boundary of the model to more accurately represent Las Vegas Wash. This boundary was revised based on the Las Vegas Stream centerline shape file available at the Clark County Regional Flood Control District (CCRFCD) website[10]. The model boundary was also extended in the northwestern part of the model area to incorporate the Duck Creek tributary stream channel in the simulation. With these changes, the total model area has increased by about 40 acres as compared to the Northgate Model. The revised model extent is shown in Figure 2.

5.3 Selection of Steady-State Time Period

The Northgate Model was calibrated to Site conditions existing during 2008/2009 (Northgate 2010). A goal of the Phase I Model development was to update the groundwater model to reflect more recent hydrologic and pumping conditions. Groundwater hydrographs and other hydraulic records (rainfall and evaporation rates) were reviewed to identify a relatively stable period to use for steady-state modeling. The data reviewed suggests that steady state groundwater conditions existed at the Site between late 2010 and 2012 (Figure 2a through 2d of the 2013 Semi-Annual Report; ENVIRON 2014b). Higher water levels were measured starting in November 2012 due to higher than average rainfall during fourth quarter 2012 through first quarter 2013. Between April and June 2013, many of the active IWF extraction wells, which are located directly upgradient of the barrier wall, had water levels that were approximately 5 to 15 feet higher than the same period in 2012 (ENVIRON 2013a). Therefore, the Phase I Model was revised to represent the most recent observed steady-state period of second quarter 2012.

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[9] Available from http://water.usgs.gov/nrp/gwsoftware/modflow_nwt/ModflowNwt.html
[10] Available from ftp://www.ccrfcd.org/Shapefiles/

5.4 Spatial Discretization and Layer Refinement

The following refinements were made to the model layer elevations to better represent the Site topography and stratigraphy:

- Model layers 1 and 2 in the Northgate Model, representing the Qal, were combined together in a single layer in the Phase I Model since the saturated thickness of the alluvium is relatively thin throughout the model area. The revised model has five layers, with the top layer representing the Qal and the lower four layers representing the shallow and deeper parts of the UMCf.
- The layer thicknesses of top two layers were adjusted to match the geometry of the slurry wall as discussed in Section 5.7.1. The updated layer thicknesses are given in Table 4.
- The top surface of model layer 1 was updated to use elevation values from the USGS Digital Elevation Model (DEM) with the spatial resolution of 10 meters for the Site area.
- The Qal and UMCf contact elevation surface was refined by performing an interpolation using LeapFrog Hydro 3D geological modeling software (LeapFrog). The source data used for the interpolation included Qal/UMCf contact elevations reported for more than 1,000 wells within the model domain (McGinley 2014), and geological cross-sections for the Site well fields and other areas within the model domain.[11] The contact elevation was manually adjusted near the UMCf ridge in the AWF area to produce a more realistic surface. The revised contact elevation was then imported into the model as the bottom elevation of layer 1.

The grid size was further refined within the study area boundary around three well fields as shown in Figure 4. The grid was also refined near Las Vegas Wash to more accurately simulate surface water-groundwater interaction.

5.5 Areal Recharge

The Northgate Model has spatially distributed recharge rates assigned to different areas based on land use. These land use areas were retained in the Phase I Model and are shown in Figure 3.

The areal recharge rates for residential, industrial, undeveloped, and golf course areas selected by Northgate were not changed in the Phase I Model update. Recharge rates that have been updated include:

- Based on the calculations described in Section 4.2.2, an estimated recharge of 5.61 feet/year was applied to the area of the COH Bird Viewing Preserve in the Phase I Model. This estimated value is higher than the recharge rate of 2.43 X 10^{-3} feet per day or 0.9 feet per year (Appendix E, Table 1E, Northgate 2010) used in the Northgate Model to represent recharge from these ponds.

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[11] Particular cross sections incorporated in the interpolation included: Plate 6 from the RI/FS Workplan (ENVIRON, 2012b); Plates 3, 4 and 5 from the 2012 Annual Remedial Performance Report (ENVIRON 2013a); cross-sections presented in the geophysical investigation of Las Vegas Wash (McGinley 2003); and Figure 4-8 of the BRC Closure Plan (BRC 2007) .

- Additional recharge of 0.01 feet/day was assigned in the areas of unlined storm water retention ponds on the Site. It was assumed that 75% of the rainfall falling on the Site will become recharge. No recharge was applied in the lined pond areas around the IWF.
- The former on-site recharge trenches, former COH RIBs, BMI Pond, TIMET Pond, the AMPAC reinjection system are inactive; therefore, no focused recharge is applied in those locations in the Phase I Model.
- The OSSM remediation system discharges treated groundwater to recharge trenches located north of the OSSM extraction wells (Figure 2). Based on the OSSM third quarter 2012 monitoring report, an average of 151 gpm (29,125 cfd) of water was discharged to the trenches from Jan-Sept 2012 (Hargis and Associates 2012). The model was updated to incorporate this recharge rate.

The spatial distribution of recharge rates in the Phase I Model is shown on Figure 3 and listed in Table 2. These preliminary recharge rates may be revised during the next phase of model calibration, as needed.

5.6 Changes to the GWETS and Other Extraction Systems

The Phase I Model was updated to use the available second quarter 2012 extraction and injection rates for on-site and off-site wells. The combined average extraction rates for second quarter 2012 for the IWF, AWF and SWF were 62 gpm (12,012 cfd), 275 gpm (52,885 cfd) and 577 gpm (111,018 cfd), respectively. The combined average extraction rate for the OSSM wells was 151 gpm (29,125 cfd) (Hargis and Associates 2012). The on-site recharge trenches downgradient of the IWF were no longer in use in 2012. The total injection of treated water through OSSM recharge trenches was assumed to be equal to the OSSM combined pumping rate of 151 gpm (29,125 cfd).

For the AMPAC extraction system, the combined average extraction rate for all wells, shown in Figure 2, was 512 gpm for the Phase I Model period (AMPAC 2013). The AMPAC injection wells that were active in the Northgate Model are no longer in use and so are inactive in the revised model. Five new AMPAC extraction wells (AMEW wells) were constructed in the first quarter of 2012. These wells are not active in the revised model because they are screened in a coarse-grained UMCf that is not currently represented in the model. The total AMPAC extraction initially configured in the model is about 237 gpm (46,000 cfd). It is unknown whether this system rate is sustainable over the long-term. Hence, the AMPAC wells were configured in the model to allow extraction to reduce automatically based on the water level at each pumping well. The final modeled flow rate for the AMPAC system is presented in the water balance in Table 5.

The extraction well screen elevations were adjusted based on the revised model layers as discussed in Section 5.4 of this report. The locations of a few wells in the IWF were revised based on the updated coordinates provided by McGinley and Associates (McGinley 2014). The revised extraction rates applied to the Phase I Model are listed in Table 3. The overall extraction rates in the revised model are similar to the Northgate Model.

5.7 Hydraulic Properties

The hydraulic properties of the slurry wall and the alluvium aquifer layer were revised in the Phase I model. The effective porosities of the aquifer material were also updated in the model based on available values.

5.7.1 IWF Barrier Wall

The conductivity of the hydraulic flow barrier (barrier wall), located immediately north of the IWF, was revised based on the reported hydraulic conductivity value of the material used to construct the wall by Vector Engineering. The reported range of conductivities used during construction was 4.7×10^{-8} centimeters per second (cm/sec) to 8.0×10^{-7} cm/sec (Vector 2001). This range is similar to the average hydraulic conductivity measured by permeability testing of the barrier wall at four locations of 8.8×10^{-7} cm/sec, as reported in the Capture Zone Evaluation Report (Northgate 2010). For modeling purposes, the value of 4.7×10^{-8} cm/sec was used to represent the barrier wall's hydraulic conductivity.

According to the conceptual site model developed by ENSR International Corporation (ENSR), the slurry wall is about 1,600 feet long, 3 feet wide, and 60 feet deep, and was constructed to tie into approximately 30 feet of UMCf (ENSR 2005). The layer thicknesses were adjusted in the Phase I Model to accurately represent the slurry wall configuration.

5.7.2 Hydraulic Conductivity Distribution

The hydraulic conductivity distribution in the Phase I Model is mostly unchanged from the Northgate Model. The horizontal and vertical hydraulic conductivities for layers representing the UMCf were not changed. For layer 1 (Qal), areas adjoining Las Vegas Wash were updated with horizontal conductivity values ranging between 250 to 485 feet/day. A horizontal-to-vertical anisotropy ratio of 10:1 was used to define the vertical hydraulic conductivity in the area near Las Vegas Wash. The hydraulic conductivity zones were adjusted to extend the paleochannels in model layer 1 up to the Las Vegas Wash. The hydraulic conductivity values for paleochannels were kept unchanged.

In the area of UMCf ridge in the AWF, the conductivity value of layer 1 was modified to match that of layer 2 since there the alluvium is not saturated in this area. The horizontal hydraulic conductivity values remained unchanged for the remainder of the Qal. The spatial distribution of hydraulic conductivity values in the alluvial aquifer is shown on Figure 4.

5.7.3 Aquifer Porosity

The effective porosities were modified for all model layers in order to produce accurate estimates of groundwater velocities and particle travel times. In the Northgate Model, the porosities for the Qal and UMCf aquifers were set to 0.4 and 0.54, respectively. For the Phase I Model, the Qal layer was set to have a uniform porosity of 0.1, which is the same value used in the UNLV and BRC Models (see Section 3). The effective porosity of layers representing the UMCf was reduced to 0.2, consistent with the value used in the BRC Model and similar to the value used in the UNLV Model (0.25).

5.8 Boundary Conditions

The groundwater model has lateral inflows from the upgradient (southern) boundary and vertical inflow from the bottom boundary of the model. These inflow components were revised as described in the following sections.

5.8.1 Vertical Inflows from Bottom Boundary

The vertical inflow from the bottom boundary is simulated in the model using the general head boundary (GHB) package. The Northgate Model included an area of downward flow from the Qal to UMCf near the downgradient area of the Las Vegas Wash. Since there are no definitive data that show vertically downward flow from the Qal to the UMCf anywhere in the model area, the area of downward flow was removed from the Phase I Model.

The GHB reference heads were refined in certain areas of the Phase I Model to match observed vertical head differences measured at well clusters. It was assumed that these head differences vary along the general direction of groundwater flow, but not transverse to groundwater flow. Near the IWF, the reference heads were revised using the measured head differences between well pairs M-135/M-161 and M-71/M-162, where a vertical head difference of about 11 feet was measured in second quarter 2012. Near the AWF, well pair PC-136/PC-137 showed a vertical head difference of about 2.4 feet measured in second quarter 2012. For areas between the IWF and AWF, the vertical head difference between the alluvium and UMCf was interpolated from values determined from well clusters at the IWF and AWF. This linear relationship was also extrapolated to estimate the head differences in the model domain to the north and south of these well fields. The estimated head difference at each model location was then subtracted from the water table surface from second quarter 2012 to determine the reference head. The resulting reference heads in the Phase I Model now range from 1906 feet at the southernmost boundary to 1530 feet at the northernmost boundary. A constant GHB conductance value of 0.0636 square feet per day was assigned throughout the model domain.

5.8.2 Lateral Boundary Inflows

The upgradient boundary inflows were not changed except for the addition of extra inflows in several cells added to the model due to grid refinement as discussed in Section 5.4. The boundary inflows may be adjusted during the next phase of model calibration.

5.8.3 Model Boundary near Las Vegas Wash

In the Northgate Model, the downgradient model boundary at Las Vegas Wash was simulated using constant head cells. As part of the Phase I Model update, this boundary is now implemented with the MODFLOW Stream Package (Prudic 1989). The Stream Package is intended for modeling stream-aquifer interactions, and can be used to simulate the flow entering and exiting the model domain through Las Vegas Wash.

As described in Section 5.2, the geometry of Las Vegas Wash has been updated in the Phase I Model to align with the centerline of Las Vegas Wash (Figure 5). To implement the Stream Package, the stream stage elevations along Las Vegas Wash were interpolated from the average stream stages recorded in 2012 for the three USGS gauging stations shown in Figure 6. The streambed elevations were interpolated from the streambed elevation profiles given in the Flood Insurance Study Report, Clark County, Nevada (FEMA 2011b). The interpolated streambed elevations along the northernmost model boundary are also shown on Figure 6.

The other important inputs required for the stream boundary were the stream width, thickness of streambed, stream length in each boundary cell, streambed conductivity, and the net flow of surface water entering at each segment of the stream boundary. The stream length within each boundary cell is the actual length of the stream falling in the individual model cell. A uniform stream width of 50 feet was used in the model. The streambed conductivity range of 0.05 feet/day to 0.55 feet/day was used in the model, with lower values in the upstream portion above the Duck Creek confluence. The stream in this area is braided and the streambed is expected to have lower conductivity. The higher conductivity values were applied in the downstream portion of Las Vegas Wash. The streambed conductivity values may be revised during the next phase of model calibration.

Four segments of Las Vegas Wash are simulated in the model. The main segment (Segment #1) extends across the entire downgradient model boundary. Three minor segments that flow to Las Vegas Wash are also simulated, including Duck Creek (Segment # 2), a small tributary stream carrying surface water discharges near Pabco Road (Segment # 3), and the C-1 Channel (Segment # 4) (Figure 5). The inflows entering each stream segment were estimated from various measured sources of discharge to Las Vegas Wash, including streamflow data from USGS gauging stations, COH treated wastewater outflows, and effluent discharge rates from the Site, AMPAC, and TIMET outfalls.

The Las Vegas Wasteway and Duck Creek stream gauges are located upstream of the model boundary, and recorded average streamflows of 250 and 5.6 cfs, respectively, for second quarter 2012. The average rate of COH treated water discharge to Las Vegas Wash was 14 cfs (obtained from COH via e-mail) during the second quarter 2012. The average Site, AMPAC and TIMET outfalls to the Las Vegas Wash were 2.0 cfs, 1.1 cfs and <1 cfs respectively for 2012. For Segment # 3, a combined flow of 16.6 cfs from Site, AMPAC, TIMET, and COH was assigned.

The reported average streamflow at the Pabco Road gauging station for second quarter 2012 was approximately 281 cfs. This value was not used as input to the model, but may be used for calibrating boundary parameter values during the future calibration phase.

6 Model Results

To evaluate the model calibration, the head targets from the Northgate Model were updated with measured groundwater elevation data from the second quarter of 2012. In addition to the 263 targets from the Northgate Model, data from an additional 193 targets were added to the Phase I Model to increase the calibration dataset[12] (Figure 7). There are 12 target locations in the Northgate model that fall in the same cells as the additional targets. These 12 targets were deleted in the Phase I Model. The revised list of target wells and their groundwater elevations for second quarter 2012 is provided in Appendix A. The measured groundwater elevations were also presented in the 2012 Annual Performance Report (ENVIRON 2012a).

6.1 Modeled Groundwater Balance

Table 5 presents a comparison of the major flow components of the conceptual water balance to the Northgate Model and updated Phase I Model. These models simulate different extraction and other boundary conditions. Although the water balances are not directly comparable, they provide confirmation that the major model flow components remain generally similar after the changes made for the Phase I Model update.

A significant difference between the Northgate Model and Phase I Model results is the net outflow to Las Vegas Wash from the model area. This outflow increased by 54,000 cfd in the Phase I Model. The difference may be attributed to the modified stream stage elevations which are about 10 feet higher in the Phase I Model, as compared to the constant head boundary cells in the Northgate Model.

As previously mentioned, the Phase I Model is configured to allow reduced extraction to avoid dewatered conditions. The initial total AMPAC pumping input to the model (46,000 cfd) was automatically reduced by the solver to 33,000 cfd. The conceptual water balance incorporates all AMPAC extraction within the boundary during the second quarter of 2012, including extraction from the deep UMCf wells, and is therefore a higher number (99,000 cfd).

Table 5 demonstrates that the Phase I Model has increased inflow to groundwater due to infiltration from the COH Bird Viewing Preserve, relative to the Northgate Model. This change results from increasing the infiltration rate from 0.8 to 5.6 feet/year. Primarily due to higher heads near the stream boundary, there is also an increase in groundwater outflow due to evapotranspiration in the Phase I Model.

6.2 Calibration Statistics and Simulated Groundwater Elevations

Figure 8 shows a plot characterizing the match between modeled and observed heads at wells used as calibration targets. The plot illustrates that there is generally good agreement between modeled and observed heads, with points generally falling close to the 1:1 correlation line. The simulated heads appear to be biased low near the upgradient model boundary, particularly in layer 5. This deviation will be addressed when the upgradient boundary is recalibrated for the

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[12] The groundwater elevations for the extra target wells were obtained from data files received from APMAC, TIMET, and OSSM via email in August 2012.

Phase II Model. No other global bias in the modeled heads is evident. The “goodness-of-fit” R^2 value is 0.98, demonstrating an acceptable fit to the observed heads.

Table 6 provides a comparative summary of calibration statistics for the Northgate Model and updated Phase I Model. A positive residual mean value indicates that the simulated heads are lower than the observed heads. The calibration statistics for the Phase I Model have been presented for both the original set of target wells from the Northgate Model, and the 444 observation wells in the updated target list. However, the results with different target sets and from different calibration periods are not directly comparable.

Figure 9 shows the simulated heads in the Shallow WBZ. The overall heads are generally consistent with the contoured groundwater elevations for second quarter 2012 presented in Plate 2 in the 2012-2013 Annual Performance Report (ENVIRON 2012a).

7 Conclusions

The Phase I Model reasonably simulates groundwater conditions at the Site and can be used to begin evaluating the performance of the GWETS. Upon completion of the aquifer testing program of the 2013 GWETS Optimization Project, the Phase I Model will be recalibrated and verified against the field data and aquifer testing results. In the recalibration phase, the hydraulic parameters of the Site geologic materials will be updated, as needed. The calibration may also require adjusting other parameter values and boundary conditions to improve the overall accuracy of the model. The conceptual water balance will be used to guide model development.

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Attachment E

Revised Table 1B
Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site, Henderson, Nevada, July – December 2013

TABLE 1B: INFLOWS AND OUTFLOWS AT LAS VEGAS WASH

Nevada Environmental Response Trust Site
Henderson, Nevada

Flows along Reach A (Las Vegas Wasteway to Pabco Road)

	Flow (cfs)	Flow (cfd)	Source
Inflows to Reach A			
Surface inflows to Reach A:			
Las Vegas Wasteway	250	22,000,000	Average flow second quarter 2012 at USGS stream gauge
Duck Creek	5.6	490,000	Average flow second quarter 2012 at USGS stream gauge
COH Wasteway	14	1,200,000	Data provided by COH
NERT Outfall	2.0	180,000	Data collected by NERT
AMPAC Outfall	1.1	98,000	Equal to total pumping
TIMET Outfall	1.0	86,000	Max. permissible flow rate in NPDES permit
Groundwater inflows to Reach A:			
Groundwater inflow along Reach A	*9.8*	850,000	Adjusted to balance Reach A inflow with outflow
Total Surface Water and Groundwater Inflow	**284**	**25,000,000**	

Outflows from Reach A			
Evaporation from Wash	2.4	210,000	Estimated based on the surface area of Wash and recorded evaporation rates
Surface flow at Pabco Road Gauge	281	24,000,000	Average flow second quarter 2012 at USGS stream gauge
Total Surface Water and Groundwater Outflow	**284**	**25,000,000**	

TABLE 1B: INFLOWS AND OUTFLOWS AT LAS VEGAS WASH

Nevada Environmental Response Trust Site
Henderson, Nevada

Flows along Reach B (Pabco Road to Three Kids)

	Flow (cfs)	Flow (cfd)	Source
Inflows to Reach B			
Surface flow at Pabco Road Gauge	281	24,000,000	Average flow second quarter 2012 at USGS stream gauge
Groundwater inflow along Reach B	*6.2*	540,000	Adjusted to balance Reach B inflow with outflow
Total Surface Water and Groundwater Inflow	**288**	**25,000,000**	

Outflows from Reach B			
Surface flow at Three Kids Gauge	285	25,000,000	Average flow second quarter 2012 at USGS stream gauge
Evaporation	1.7	150,000	Estimated based on the surface area of wash along Reach B and recorded evaporation rates
Total Surface Water and Groundwater Outflow	**288**	**25,000,000**	

Total Groundwater Inflow to Reaches A and B	**16.1**	**1,390,000**
Total Groundwater Inflow Within Study Area [a]	**8.0**	**693,000**

Notes

cfs = cubic feet per second   cfd = cubic feet per day

[a] Assumes: 80% of groundwater discharge is from the south side of Las Vegas Wash; 71% of Reach A is within model domain; and 48 % of Reach B is within model domain.

Attachment F

Revised Table 2
Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site, Henderson, Nevada, July – December 2013

TABLE 2: PHASE I GROUNDWATER MODEL - AREAL RECHARGE DISTRIBUTION

Nevada Environmental Response Trust

Henderson, Nevada

Region	Recharge Rate (ft/d)	Recharge Volume (ft^3/d)	Recharge Volume (AFY)	Source
Residential areas	5.6×10^{-5}	$2.3 \text{ X } 10^{3}$	$1.9 \text{ X } 10^{1}$	Original Value, not revised
Industrial areas	4.3×10^{-4}	$1.5 \text{ X } 10^{4}$	$1.3 \text{ X } 10^{2}$	Original Value, not revised
Tuscany Golf Course	$1.78 \text{ X } 10^{-3}$	$1.7 \text{ X } 10^{4}$	$1.4 \text{ X } 10^{2}$	Original Value, not revised
Undeveloped areas	1.83×10^{-5}	$4.7 \text{ X} 10^{3}$	$3.9 \text{ X } 10^{1}$	Natural recharge rate - Original Value
COH Birding Preserve	$1.5 \text{ X } 10^{-2}$	$7.3 \text{ X } 10^{4}$	$6.1 \text{ X } 10^{2}$	COH data sent from Howard Analla on 7/9/13
Northern RIBs	1.83×10^{-5}	--	--	No longer active, Natural recharge rate - Original Value
TIMET ponds	None	--	--	No longer active
NERT ponds	None	--	--	Ponds are double-lined; recharge is insigificant
Stormwater retention basins	$1.2 \text{ X } 10^{-2}$	$7.6 \text{ X } 10^{3}$	$6.4 \text{ X } 10^{1}$	Assumes 75% of rainfall falling on Site becomes recharge

Notes:

ft/d = feet per day

ft^3/d = cubic feet per day

AFY = acre-feet per year

COH = City of Henderson

NERT = Nevada Environmental Response Trust

RIB = Rapid Infiltration Basin

TIMET = Titanium Metals Corporation

Residential areas, industrial areas, and recharge from Tuscany Golf Course were not revised from the Northgate Model (Northgate 2010).

Attachment G

Revised CD with Complete Report Copy (Including Errata)
Remedial Investigation and Feasibility Study Work Plan, Revision 1, Nevada Environmental Response Trust Site, Henderson, Nevada