Response to Nevada Division of Environmental Protection (NDEP) Comments, dated June 16, 2009, regarding Updated Groundwater Flow Model Calibration BMI Upper and Lower Ponds Area report dated May 14, 2009 NDEP Facility ID# H-000688

1. Section 4.2.1, pages 15 through 18. The NDEP has the following comments:
   a. Although extensive PEST simulations were run, the text in this section appears to indicate that the results were largely discounted due to lack of observed data to support the PEST hydraulic conductivity results. However the NDEP notes that the PEST values differed from used values by factors of less than one in most cases. Despite the lack of field evidence, and in cases of small changes, it should be acceptable to use PEST output where gains may be made in model performance.

Response: BRC notes that the results of the PEST simulations were used to a greater extent in the updated model calibration than may be surmised from the report text. Specifically, three final model input parameters were determined based on the results of PEST simulations; they are recharge beneath the Tuscany Golf Course, the hydraulic conductivity of the disturbed area beneath Tuscany Village and Golf Course, and the hydraulic conductivity of the paleochannel beneath and north of the CoH northern RIBs. Utilization of these input parameter values as identified by PEST led to improved model calibration, as evidenced by comparison of the model calibration statistics listed on Figure 15 to those provided in Table 10. The final calibrated model (Figure 15) has improved calibration statistics relative to the initial (starting, or interim) model and each of the three PEST simulations (Table 10).

   b. NDEP also notes that most of the PEST hydraulic conductivity results were higher than the used values. This may suggest that the model as a whole is being posed as less conductive than the actual environment. Alternatively, it may suggest that the initial water budgets were over estimated.

Response: As also noted below in RTC No. 3, it is possible that the upper end of some of the initial water budget components are overestimated. Available aquifer test information does not support the proposition that the model as a whole is less conductive than the actual environment; if such were the case it would imply that the available aquifer test information is biased toward lower than average values, which is not the case to BRC's knowledge.

2. Section 4.2.1.1, page 17, 1st paragraph, last sentence. Boundary fluxes were estimated in the initial technical memorandum; however they are not known or fixed to the extent that small changes can't be allowed. Depending on the magnitude of these changes, this should not be a rationale for discounting PEST results. Where higher conductivity values are generated by PEST, and where these results are on the order of a factor of difference (versus order-of-magnitude) it may be appropriate to use inputs that increase model performance as measured by head error.

Response: Boundary fluxes were initially estimated in the technical memorandum, but were subsequently updated during the model calibration based on updated values of hydraulic conductivity. The approach followed by BRC is equivalent to assuming that the hydraulic gradient and saturated thickness at the boundary is known, and the groundwater flux varies based on changes in hydraulic conductivity. PEST simulations where hydraulic conductivity values were adjusted without a corresponding change in boundary fluxes did not lead to a significant improvement in model calibration statistics, and therefore BRC does not believe that it is appropriate to update the model hydraulic conductivity (even with relatively small changes) based on these PEST simulation results.

3. Section 4.2.1.2, page 18. The recharge estimates used in the model for developed and undeveloped areas appears to run counter to available information.

   NDEP has reviewed the following reports and summarized our findings below:

   U.S. Geological Survey, 2007, Ground-Water Recharge in the Arid and Semiarid Southwestern United States, Professional Paper 1703. Ground-Water Resources Program. July.

   a. Table 4, Amargosa River, Upper Amargosa Basin – 0.74%
   b. Table 4, Trout Creek, Middle Humboldt River Basin – 1.46%

   Eakin, T.E., Price, D., and Harrill, J.R., 1976. Summary Appraisals, of the Nation's Ground-Water Resources – Great Basin Region, Geological Survey Professional Paper 813 – G, U.S. Government Printing Office, Washington.

   c. Table 8, we summarized 17 hydrographic areas for the Great Basin adjacent to Las Vegas Valley (Colorado River Basin) including: Emigrant Valley, Yucca Flat, Frenchmen Flat, Indian Springs Valley, Pahrump Valley, Mesquite Valley, Ivanpah Valley, Jean Lake Valley, Eldorado Valley, Three Lakes Valley, Tikapoo Valley, Mercury Valley, Rock Valley, Forty Mile Canyon, Oasis Valley, Crater Flat, and Amargosa Desert
      i. Max – 5.23% (Pahrump Valley)
      ii. Average – 1.22%
      iii. Min – 0.07% (Frenchmen Flat)

   Eakin, T.E. and Maxey, G.B., 1951. Ground Water in Ruby Valley, Elko and White Pine Counties, Nevada, Office of the State Engineer and U.S. Geological Survey. pg 80.

   d. "The estimates are as follows: No significant ground-water recharge is believed to occur in the zones having precipitation of less than 8 inches…"

   Considering this information NDEP would recommend the use of no more than 2% of precipitation for recharge to groundwater for work at the BMI Complex and Common Areas. BRC used 0.394 in/yr for the undeveloped areas of the model which equates to 9.85% of precipitation (estimated at 4 in/yr); none of the information that we reviewed supports a number that high. It was noted that recharge from precipitation ranked fifth in the sensitivity analysis (Section 5.1, pg 32).

Response: BRC acknowledges that undeveloped area recharge may be higher than expected, as are a number of the potential recharge numbers computed in the technical memorandum. BRC believes that this approach is conservative with regard to the predictive simulations considered in the modeling report, which were intended to evaluate the potential for the water table to intersect land surface under developed site conditions. BRC also notes the lack of runoff potential from the Upper Ponds area, which may lead to some amount of higher recharge than would be indicated by the above cited reports and studies. Regardless, PEST simulations indicate that simulated recharge to the undeveloped areas can be reduced to near zero, with a corresponding increase in developed area recharge to approximately 2 inches per year, without a significant change in model calibration statistics. BRC has agreed with NDEP that, prior to conducting additional predictive simulations for other purposes (e.g. solute transport), the groundwater model will be modified such that prescribed recharge to the currently undeveloped areas will be reduced 2% of average annual precipitation or less, and a corresponding increase in recharge beneath currently developed areas will be made to maintain model calibration.

4. Section 6, page 36. Please discuss the significance of the distribution and magnitude of head residuals (Section 4.2.2) with respect to future simulations, i.e., identifying areas of the model that under perform in the base case, and the potential of under performance in those areas in future scenarios. The purpose of this comment is to ensure that error and uncertainty measures are well documented for potential end uses such as risk assessment.

Response: There are two general regions illustrated in Figure 16 (difference between simulated and observed hydraulic heads) where the plotted values are significantly greater than the mean absolute error (MAE) of 5.2 feet. These areas are 1) in the vicinity of the former TIMET ponds (both north and south) and 2) near the center of and immediately adjacent to the Birding Preserve ponds. Simulation results and potential ramifications in each of these areas are described below.

In the Birding Preserve area, observation wells PC-103 and PC-104 each exhibit simulated water levels about two times the MAE, or about 10 feet higher than observed values (Figures 13 and 16). The differences between simulated and observed water levels at other wells closest to the Birding Preserve is generally significantly less at about 2 feet. Attempts to reduce the simulated discrepancy at these two wells were unsuccessful without sacrificing the goodness of fit at a significant number of other nearby observation wells. Simple combinations of changes to Birding Preserve recharge and underlying aquifer hydraulic conductivity, therefore, could not be identified such that the residual at wells PC-103 and PC-104 was significantly reduced. If there are local hydrogeologic conditions that affect the observed water levels in these wells, they are unknown. BRC notes that well PC-103 appears to occur within a paleochannel (higher hydraulic conductivity zone), while well PC-104 occurs on an inter-channel ridge (lower hydraulic conductivity zone). The observed water level at well PC-104, however, is lower than that which might be expected based on adjacent wells (e.g. PC-108 and PC-1) indicating a potential zone of high hydraulic conductivity. With regard to predictive simulations, solute concentrations may be underestimated in the immediate vicinity of these two wells due to a simulated saturated thickness greater than the observed saturated thickness (Figure 18). Alternatively, if solute concentrations are prescribed in the model in this region (e.g. as initial conditions) the overall mass of contaminant would be overestimated due to the greater saturated thickness.

In the former TIMET ponds area, three wells south of the former ponds (POU-3, DM-1 and AA-13) and two wells north of the east end of the former ponds (AA-09 and BEC-4) exhibit residuals that range from 7.9 to 16.9 feet (Figures 16 and 13). At each of these locations, the simulated water level is less than the observed water level. At another well north of the west end of the former ponds (POD-8), the simulated water level is 16.7 feet higher than the observed water level. In the same area near POD-8, there are three other wells, POD-4, POD-7 and AA-14, where the Qal is dry. The simulated residuals at the next series of closest observations wells are 1.2 feet at well AA-11 to the north and 2.4 feet at well

AA-01 to the south. Efforts made during the model calibration process to reduce the simulated hydraulic head residuals in this area led to conflicting results in the sense that changes undertaken to increase hydraulic heads at wells POU-3, DM-1, AA-13, AA-09 and BEC-4 generally led to higher hydraulic heads (and a worse match) at wells POD-8, POD-4, POD-7 and AA-14. The converse occurred when attempts were made to reduce the simulated residuals where simulated water levels are higher than observed water levels.

The local hydrogeology in the immediate vicinity of the former TIMET ponds appears to be very complex due to the occurrence of multiple paleochannels that have a significant influence on observed saturated thickness (Figure 18). Available information indicates that very narrow zones of saturation occur in this area along paleochannels. See for example, the saturated thickness near the east side of the former ponds, which ranges from about 6 to 13 feet at wells POD-8 and AA-13, respectively, to zero at wells POD-4, POD-7 and AA-14. These latter three wells where the Qal is dry apparently occur just outside or on the edge of the small channel exists beneath this area. Several paleochanels also occur beneath the west side of the former ponds (Figure 18). One of the channels that centered on well AA-09, crosses the model boundary immediately to the west. This boundary is a no-flow boundary in the model, as supported by observed hydraulic head data contours (Figure 6). However, additional information in this area might indicate some potential groundwater inflow along this paleochannel, which would raise simulated water levels in the vicinity of AA-09.

These observations indicate that it will be difficult to obtain highly accurate estimates of solute transport in the immediate vicinity of the former TIMET ponds using the model. In this area, solute concentrations may be over- or under-predicted depending on the simulated water level, and solute migration could be predicted to occur in some areas where the Qal is dry. BRC believes that groundwater flow in this area occurs primarily within narrow paleochannels, the saturated thickness of which is likely to be highly variable based on location and the nature and timing of recharge events.

<u>Figures</u>

5. Figure 7. Please post wells with hydraulic head for the Middle Zone.

6. Figure 8. Please post wells with hydraulic head for the Deep Zone.

7. Figures 1, 30, and 35. Please refer to comments above on recharge from precipitation.

8. Figure 38. Please identify the Tronox and AMPAC well fields.

Response: New versions of Figures 7, 8 and 38, updated as requested, are provided with this RTC. Figures 1, 30, and 35 are not updated because doing so would require numerous changes throughout the report to maintain consistency, and resubmission of the entire report was not the intent or request of NDEP. Prior to using the model to conduct additional predictive simulations, prescribed recharge will be updated as described under RTC No. 3.

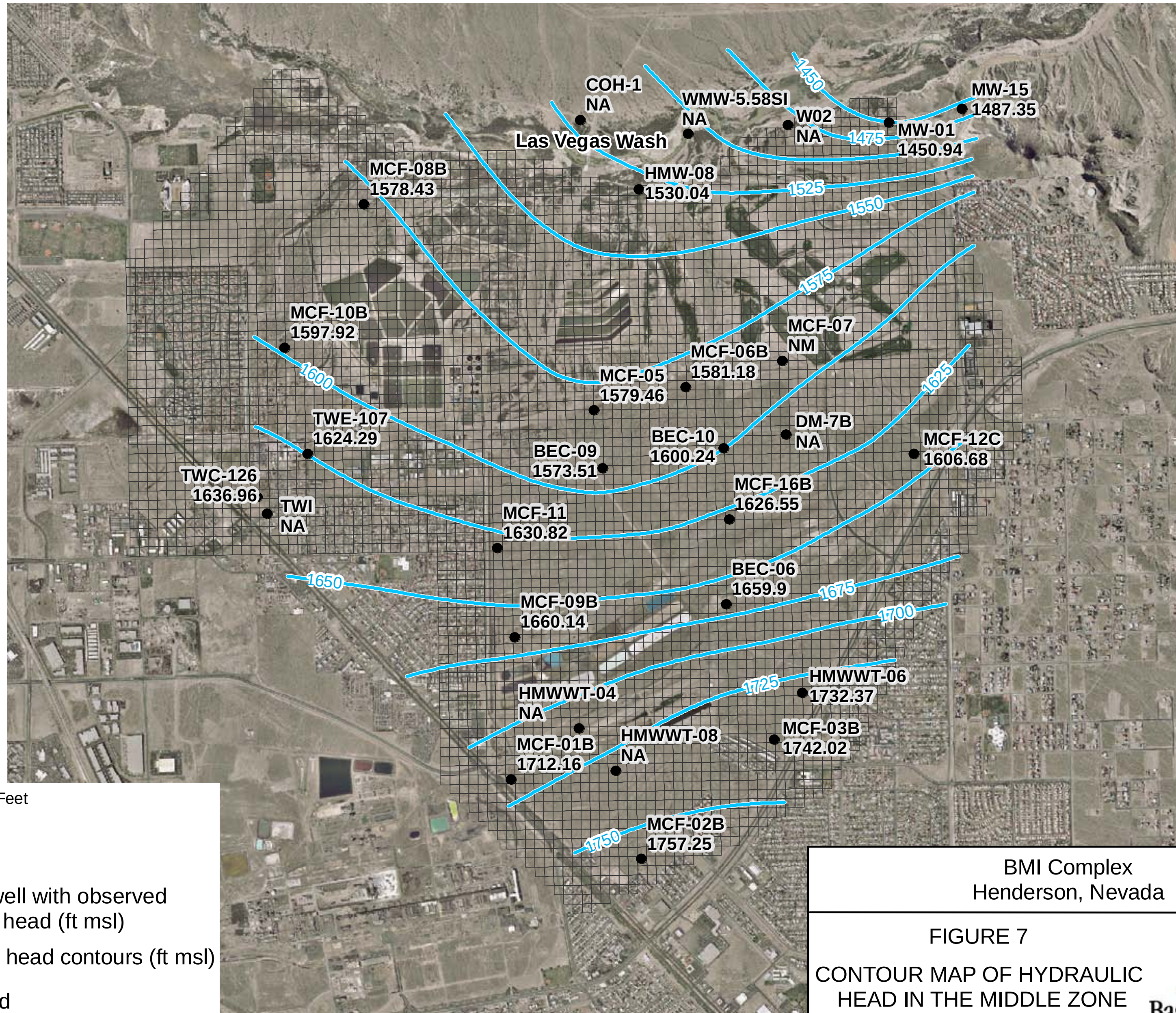
<u>Tables</u>

9. Table 6. TIMET pond seepage, given the head residuals in this area, please discuss if it would be useful to incorporate the TIMET pond seepage component into the PEST simulations.

Response: The current period simulation results are not sensitive to TIMET pond seepage (see Figure 32 in the modeling report), and therefore it would not be useful to incorporate this input parameter into PEST simulations.

10. Tables 8 and 9. Please discuss if the values for recharge from the City of Henderson Northern RIBs are correct and reasonable.

Response: BRC believes that the recharge value applied for the CoH Northern RIBs is reasonable. CoH data for the years 2005 and 2006 relied upon by BRC indicates an approximately even split of water sent to the Northern RIBs and the Birding Preserve. Differences in the volumetric amount of recharge used in the simulation are due to the difference in facility footprint areas, which affects calculated losses due to evaporation (see page 18 of groundwater modeling report). BRC acknowledges that in years previous to 2005 the amount of water sent to each facility was variable, and that the approximately even split may not be applicable for earlier periods.



N

0 1,750 3,500 Feet

Explanation

BEC-09 1573.51 ● Monitor well with observed hydraulic head (ft msl)

Hydraulic head contours (ft msl)

Model grid

Sources: 1. MWH, June 2006 data
2. Aerial photograph, April 2004

BMI Complex
Henderson, Nevada

FIGURE 7

CONTOUR MAP OF HYDRAULIC HEAD IN THE MIDDLE ZONE

Basic Remediation COMPANY

Prepared by: DBS&A GJ

Date 7/07/09

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JN ES09.0057

Figure 7

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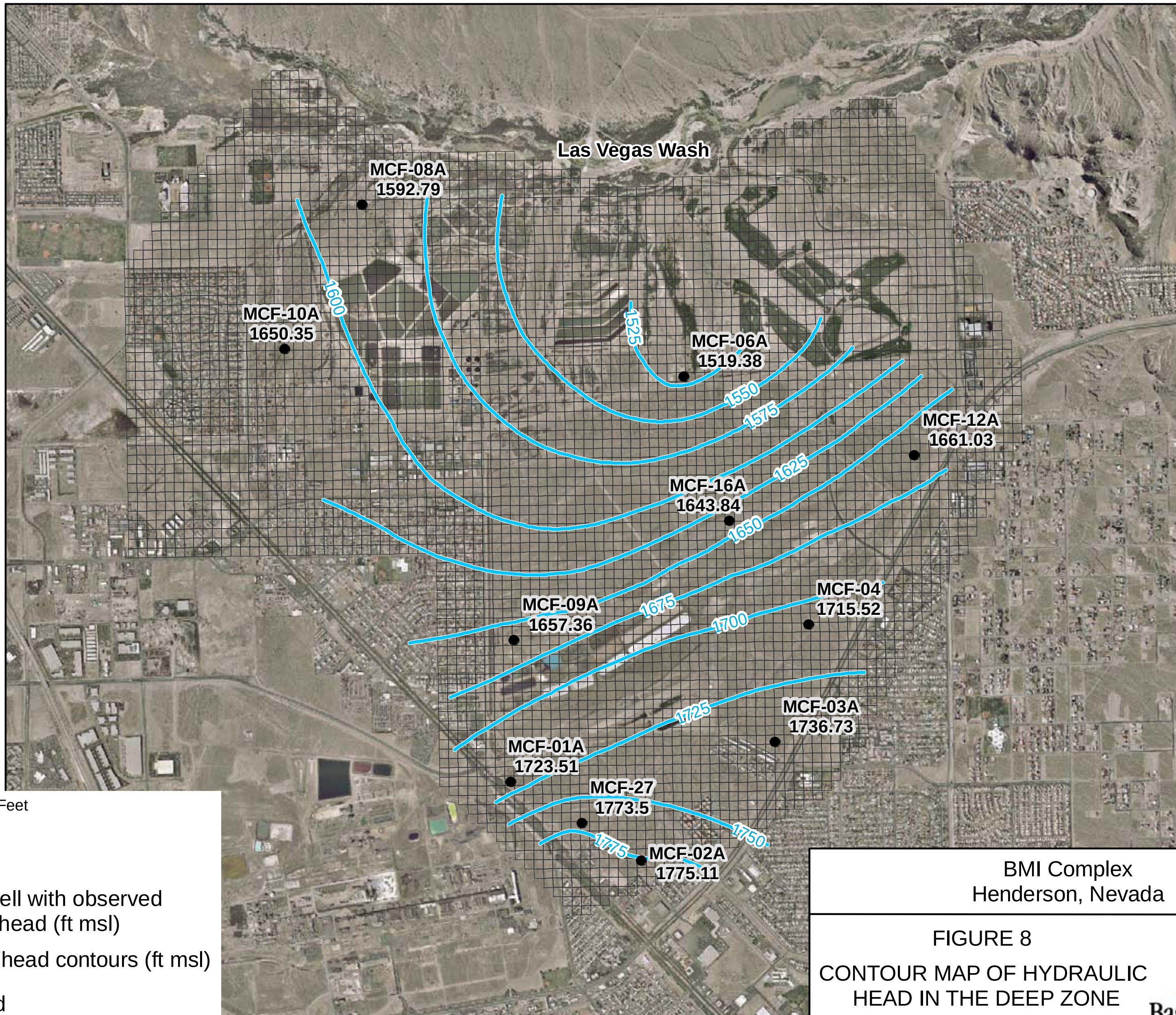

Explanation

MCF-04 1715.52 ● Monitor well with observed hydraulic head (ft msl)

Hydraulic head contours (ft msl)

Model grid

Sources: 1. MWH, June 2006 data
2. Aerial photograph, April 2004

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JN ES09.0057

BMI Complex
Henderson, Nevada

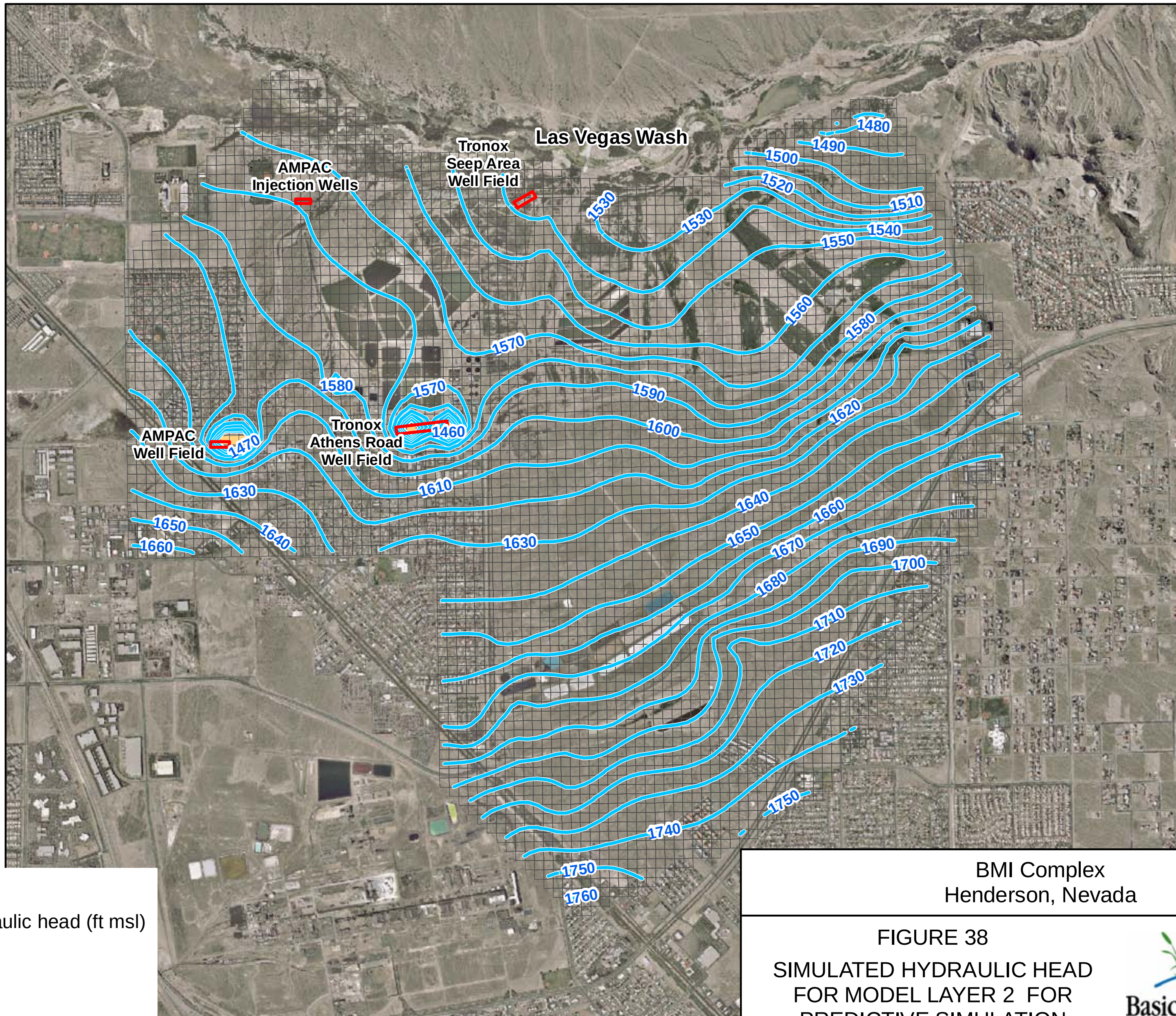
FIGURE 8

CONTOUR MAP OF HYDRAULIC HEAD IN THE DEEP ZONE

Basic Remediation COMPANY

Prepared by:		Date	
DBS&A	GJ	7/07/09	S:/PROJECTS/BRC/ES09.0057_MODEL_UPDATE/GIS/MXDS/REPORT_FIGURES_5-09/FIG08_CONTOUR_MAP_HYD_HEAD_AND_WATER_LEVELS_IN_THE_DEEP_ZONE.MXD 902//7

Figure 8



Explanation

- Simulated hydraulic head (ft msl)
- Dry cells
- Model grid

Source: Aerial photograph, April 2004

BMI Complex
Henderson, Nevada

FIGURE 38

SIMULATED HYDRAULIC HEAD FOR MODEL LAYER 2 FOR PREDICTIVE SIMULATION

Basic Remediation COMPANY

Prepared by: DBS&A MK

Date 6/25/09

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