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LOCKHEED MARTIN

November 29, 2012

Mr. Daniel Zogaib
Southern California Cleanup Operations
Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630

Subject: Submittal of the *Potrero Canyon Unit (Beaumont Site 1) – Hydraulic Testing and Reporting - Model Update (EESHRLP10068_R605, Task 01.050601), Technical Memorandum*

Dear Mr. Zogaib:

Please find enclosed one hard copy of the body of the report and two compact disks with the report body and appendices of the *Potrero Canyon Unit (Beaumont Site 1) – Hydraulic Testing and Reporting - Model Update (EESHRLP10068_R605, Task 01.050601), Technical Memorandum* for your review and approval or comment.

If you have any questions regarding this submittal, please contact me at 818-847-9901 or brian.thorne@lmco.com.

Sincerely,

Brian T. Thorne

Brian Thorne
Remediation Project Lead

Enclosure: *Potrero Canyon Unit (Beaumont Site 1) – Hydraulic Testing and Reporting - Model Update (EESHRLP10068_R605, Task 01.050601), Technical Memorandum*

Copy: Gene Matsushita, LMC (electronic and hard copy)
Sally Drinkard, CDM (electronic copy)
Tom Villeneuve, Tetra Tech (electronic copy)
Alan Bick, Gibson Dunn (electronic copy)

TECHNICAL MEMORANDUM
LOCKHEED MARTIN CORPORATION

November 29, 2012

TO: Mr. Brian Thorne, Lockheed Martin

FROM: Mr. Robert Johns, Tetra Tech

RE: Potrero Canyon Unit (Beaumont Site 1) – Hydraulic Testing and Reporting - Model Update (EESHRLP10068_R605, Task 01.050601), Technical Memorandum

EXECUTIVE SUMMARY

The Potrero Canyon (Beaumont Site 1) groundwater conceptual site model (CSM) and numerical flow and transport models were updated based upon the results of the hydraulic testing completed in 2011, which found much lower than expected hydraulic conductivity and transmissivity values in the Burn Pit Area (BPA). The numerical flow and transport model update also extended the previous 1992-2008 model calibration time period from 16 to 19 years, by incorporating water level and water quality data collected as part of the site groundwater monitoring program during 2008 through 2011.

The updated groundwater CSM shows a low hydraulic conductivity area near the BPA source as determined from the recent BPA slug and pumping tests, bounded to the northwest by the high hydraulic conductivity zone encountered near Fault F in BH-02 (well MW-112 location) and MW-26. Based upon the results of the 2011 hydraulic testing and the data from previous investigations, two alternative CSM interpretations are considered regarding how this change in hydraulic conductivity may be distributed: one alternative CSM assumes that the high hydraulic conductivity in wells MW-26 and MW-112 is isolated from the low hydraulic conductivity BPA high-concentration area zone encountered over the northwest trending bedrock high; and the other alternative CSM assumes that the high hydraulic conductivity zone in wells MW-26 and MW-112 is correlated with a potential permeable conduit created by the deformation/shear zone along Fault F. This second alternative CSM extends the high hydraulic conductivity in wells MW-26 and MW-112 directly into the BPA high-concentration area, providing a connection between the BPA high-concentration area with the permeable alluvial channel north of the BPA.

The 1992-2011 update to the groundwater flow CSM and updated numerical groundwater flow model had little impact on the flow model calibration, as the flow model water level error and the site water budget were very similar to the previous 1992-2008 model; this was true for both of the two alternative CSMs. Therefore, either of the two alternative CSMs is consistent with the site water level data, aquifer tests, and flow model, and it is not possible to choose between the two alternative CSMs based upon the numerical flow model results. The updated 1992-2011 water budget is as follows:

- Creek groundwater recharge of 147 acre-feet per year;
- Diffuse groundwater recharge of 119 acre-feet per year;
- Discharge of groundwater to Potrero Creek of 76 acre-feet per year;
- Evapotranspiration loss of groundwater in the riparian area of 139 acre-feet per year; and

- Extraction/reinjection at rates of 51 acre-feet per year during the operation of the RMPA groundwater extraction and treatment system (1994-2002).

The small change in the updated groundwater flow model water level error and water budget was to be expected based upon the results of the hydraulic testing, since the tests resulted in only a small change in the average Bedsprings and Potrero Creek aquifer transmissivity for either of the alternative CSMs. In effect, the extended three year period from 2008-2011 serves as a short validation period for the prior 1992-2008 flow model calibration, as either CSM used in the numerical model were generally consistent with the more recent 2008-2011 data.

However, the 1992-2011 update to the groundwater transport CSM and numerical COC transport model appears to significantly impact the numerical COC transport model calibration, as the 2011 plume mass and COC mass flux budgets were found to be quite sensitive to the changes in the site CSM. Significant differences in the model predictions are possible for the two alternative CSMs. In particular, the transport model update strongly implies that (1) a deformation/shear zone along Fault F may be providing a permeable conduit in the BPA, allowing COCs to flow out of the BPA high-concentration area and into the more permeable alluvium downgradient of the BPA and (2) a portion of the BPA groundwater source area appears to be located within this higher conductivity zone. This sensitivity in the COC mass and mass flux budget was to be expected based on the results of the recent hydraulic testing, since the test results meant a significant change in the aquifer transmissivity in part of the BPA COC high-concentration area. The updated numerical transport model COC mass flux budget for 1992 through 2011 is as follows:

- Influx from sources in the BPA and RMPA of 125 to 195 pounds per year;
- Extraction during the 8.5-year operation of the RMPA groundwater extraction system of 77 pounds per year (34 pounds per year average for 19 year simulation);
- Discharge to Potrero Creek of 1.5 to 1.6 pounds per year;
- Extraction due to evapotranspiration loss of groundwater in the riparian area of 36 to 38 pounds per year; and
- Loss due to degradation in the riparian area of 120 to 122 pounds per year.

Impacts on Site Remedial Alternatives

The changes in the BPA CSM and numerical flow and transport model could have an impact on any potential high-concentration area removal strategies evaluated for the Site. For example, a series of wells or a horizontal well located along a possible permeable deformation/shear zone paralleling Fault F in the BPA high-concentration area may serve as an effective means for establishing hydraulic control over COCs leaving the BPA to control the mass flux.

1.0 BACKGROUND AND OBJECTIVES

The objective of this task is to update the site numerical groundwater flow and transport models and bedrock maps based upon the data collected during the recent hydraulic testing at Lockheed Martin

Corporation's (LMC) Potrero Canyon (Beaumont Site 1), Beaumont, California. Updates to the numerical flow and transport models include the following:

- Modifying the previous 1992 through 2008 model calibration time period to the new calibration time period spanning from 1992 through 2011;
- Revising model parameters to account for the recent pumping and slug tests in the BPA near EW-20 (Figure 1), as well as the updated BPA bedrock map (Appendix A);
- Re-evaluating the numerical flow model calibration for validity and updating the site water budgets; and
- Re-evaluating the numerical transport model calibration for validity and updating the site COC mass flux budgets.

Prior to updating the model, the BPA and sitewide bedrock map was updated using data from investigations conducted since 2008.

The deliverable for this task order is to complete this technical memorandum (TM) summarizing the model update and bedrock map, and revised water and COC mass flux budgets.

Background

The Potrero Canyon numerical groundwater flow and transport models were previously developed using site data available through 2008, and calibrated for the time period from 1992 through 2008 (Tetra Tech, 2010 and 2011). Since the 1992 through 2008 model calibration, the following additional information has become available:

- Key additional data has been collected in the recent hydraulic testing program, which has altered the site conceptual site model (CSM) of the BPA COC high-concentration area (Tetra Tech, 2012b); and

- Three years of additional water level and water quality data has been collected as part of the site groundwater monitoring program during 2009, 2010, and 2011 (Tetra Tech, 2012a).

This memorandum summarizes the update of the Potrero Canyon numerical groundwater flow and transport model to make it current with the more recent 2009-2011 site groundwater monitoring data, the revised BPA CSM, and the updated BPA bedrock contour map.

2.0 MODIFY MODEL TIME PERIOD TO 1992 THROUGH 2011

The prior calibration numerical flow (MODFLOW) and transport (MT3D) model files covering the 16-year time period from October 1, 1992 through September 30, 2008 were modified by extending the number of quarterly stress periods from 64 to 76, which extends the model time period to cover from October 1, 1992 through September 30, 2011 (19 years). Numerical flow model head boundary conditions for October 2008 through September 2011 were set using data from the groundwater monitoring program (Tetra Tech, 2012a) - in particular wells MW-36 and OW-01 which are near the head boundaries. Recharge and evapotranspiration rates were set following the methodology outlined in the flow model report (Tetra Tech, 2010); this resulted in significant recharge occurring in both the Bedsprings Creek and Potrero Creek areas in the winter of 2011 and minor recharge also occurring in the Potrero Creek area during the winters of 2008, 2009, and 2010. This recharge is supported by the 2008 through 2011 rainfall data collected at the NWS Beaumont and San Jacinto Stations (Tetra Tech, 2012a; see also Figures 2 and

3), as well as the 2008 through 2011 site groundwater level measurements (Tetra Tech, 2012a). All other model parameters for Case A described below are identical to those used in the 1992-2008 Model calibration as presented in the flow model calibration report (Tetra Tech, 2010).

The flow model results using these changes to the model time period (herein referred to as “Case A”) are given in Figures 2 and 3 and Tables 1 and 2. The 1992-2011 water budget for Case A is given in Figure 2 (updated from the 1992-2008 model calibration report, Tetra Tech, 2010). The 1992-2011 water level hydrographs for Case A are given in Figure 3 (updated from the 1992-2008 model calibration report, Tetra Tech, 2010). Water level error statistics for Case A are given in Table 1, and the values for the 1992 through 2011 time period are similar to those previously given for the 1992 through 2008 time period, with the model water level error of 2.70 percent (versus 2.79 percent for the 1992 through 2008 time period). The average annual water budget for the 1992 through 2011 simulation (Figure 2) is as follows:

- Creek groundwater recharge of 147 acre-feet per year;
- Diffuse groundwater recharge of 119 acre-feet per year;
- Discharge of groundwater to Potrero Creek of 76 acre-feet per year;
- Evapotranspiration loss of groundwater in the riparian area of 139 acre-feet per year; and
- Extraction/reinjection at rates of 51 acre-feet per year during the operation of the RMPA groundwater extraction and treatment system.

The water budget for the 1992 through 2011 model time period is only slightly different from the water budget for the 1992 through 2008 simulation (creek recharge of 136 acre-feet per year; diffuse recharge of 110 acre-feet per year; creek discharge of 71 acre-feet per year; evapotranspiration of 139 acre-feet per year; and RMPA extraction/reinjection rates of 51 acre-feet per year). The small differences in the water budget between the 1992-2008 and 1992-2011 simulations are attributed to slightly wetter than average conditions during 2008-2011 in the Beaumont area, which resulted in some recharge in the Potrero Creek area each year during 2009, 2010, and 2011.

The transport model boundary conditions for 2008 through 2011 were set to be identical to those given in the previous 1992 through 2008 model, with constant concentration boundaries used for all four COCs to simulate underflow of all COCs from the BPA high-concentration area, where COC concentrations were based upon the site groundwater monitoring water quality data. Perchlorate flux in diffuse recharge was also used to simulate leaching of perchlorate from the soil zone in the BPA and RMPA perchlorate soil sources (Tetra Tech, 2011). COCs concentration error statistics for the 1992 through 2011 transport calibration are similar to those previously given for the 1992 through 2008 time period:

- For perchlorate, concentration error was 6.9 percent versus 6.5 percent for the prior 1992-2008 period;
- For 1,4-dioxane, concentration error was 6.2 percent versus 6.5 percent for the prior 1992-2008 period;
- For 1,1-DCE, concentration error was 6.0 percent versus 6.3 percent for the prior 1992-2008 period; and

- For TCE, concentration error was 6.4 percent versus 6.9 percent for the prior 1992-2008 period.

The annual COCs mass flux budget for the 1992 through 2011 model (Table 2) is as follows for all COCs:

- Influx from sources in the BPA and RMPA of 195 pounds per year;
- Extraction during the 8.5-year operation of the RMPA groundwater extraction system of 77 pounds per year (34 pounds per year average for 19-year simulation);
- Discharge to Potrero Creek of 1.5 pounds per year;
- Extraction due evapotranspiration loss of groundwater in the riparian area of 36 pounds per year; and
- Loss due to degradation in the riparian area of 122 pounds per year.

The annual mass flux budget is as follows for all perchlorate:

- Influx from sources in the BPA and RMPA of 164 pounds per year;
- Extraction during the 8.5-year operation of the RMPA groundwater extraction system of 50 pounds per year (22 pounds per year average for 19-year simulation);
- Discharge to Potrero Creek of 1 pounds per year;
- Extraction due evapotranspiration loss of groundwater in the riparian area of 17 pounds per year; and
- Loss due to degradation in the riparian area of 122 pounds per year.

The annual mass flux budget is as follows for all 1,4-dioxane:

- Influx from sources in the BPA and RMPA of 3.7 pounds per year;
- Extraction during the 8.5-year operation of the RMPA groundwater extraction system of 0.6 pounds per year (0.3 pounds per year average for 19-year simulation);
- Discharge to Potrero Creek of 0.1 pounds per year;
- Extraction due evapotranspiration loss of groundwater in the riparian area of 0.1 pounds per year; and
- Loss due to degradation in the riparian area of 0 pounds per year.

The annual mass flux budget is as follows for all 1,1-DCE:

- Influx from sources in the BPA and RMPA of 18.4 pounds per year;

- Extraction during the 8.5-year operation of the RMPA groundwater extraction system of 12 pounds per year (5.4 pounds per year average for 19-year simulation);
- Discharge to Potrero Creek of 0.2 pounds per year;
- Extraction due evapotranspiration loss of groundwater in the riparian area of 7.7 pounds per year; and
- Loss due to degradation in the riparian area of 0 pounds per year.

The annual mass flux budget is as follows for all TCE:

- Influx from sources in the BPA and RMPA of 8.7 pounds per year;
- Extraction during the 8.5-year operation of the RMPA groundwater extraction system of 14.4 pounds per year (6.4 pounds per year average for 19-year simulation);
- Discharge to Potrero Creek of 0.3 pounds per year;
- Extraction due evapotranspiration loss of groundwater in the riparian area of 11.2 pounds per year; and
- Loss due to degradation in the riparian area of 0 pounds per year.

The COC mass flux budget for the 1992 through 2011 model time period has only modest differences from the COC mass flux budget for the 1992 through 2008 simulation (source influx of 188 pounds per year; RMPA extraction of 79 pounds per year during operations; creek discharge of 1.7 pounds per year; evapotranspiration extraction of 42 pounds per year; and degradation of 134 pounds per year), with both the 1992-2008 and the 1992-2011 model simulations resulting in a near balance between the addition of COCs from BPA and RMPA sources, and the loss of COCs due to RMPA extraction, discharge to Potrero Creek, discharge as evapotranspiration, and removal by degradation. The 1992-2011 model predicted 2011 COC plume mass of 4,376 pounds is also similar to the prior 1992-2008 model predicted 2008 COC plume mass of 4,262 pounds, further supporting quasi-steady conditions within the site plume.

A comparison of the simulated and observed perchlorate contour maps is given in Appendix C, which shows how the simulated plume length of the 1,000 µµg/L contour line for Case A is similar to the observed plume length of the 1,000 µµg/L contour line (the other COCs are not shown, as they show trends similar to those given for perchlorate). This agreement between the simulated and observed length of the 1,000 µgL plume contour is attributed to the mass flux rate from the BPA high-concentration area being approximately balanced with the plume COC underflow rates, and the plume COC loss rates due to evapotranspiration, creek discharge, and degradation, creating a quasi-steady state condition within the site plume.

3.0 REVISED BURN PIT AREA CSM

Based on the results of the recent hydraulic testing (see Table 3 and Tetra Tech, 2012b), the following key revisions were made to the BPA site CSM:

- BPA MEF sandstone hydraulic conductivity and transmissivity values – The 1992-2008 model used MEF transmissivity values of approximately 60-80 $feet^2$/day and hydraulic conductivity values of approximately 1-2 feet/day in the BPA high-concentration area, which were based upon the BPA pumping test conducted in the MEF at MW-26 (Radian Corporation, 1992c; see also Table 3). However, the recent BPA pumping test of EW-20, slug tests, and FLUte conductivity profiling (Table 3) show that the BPA MEF transmissivity value is approximately 2 to 3 feet^2/day and hydraulic conductivity value is approximately 0.05 feet/day at the high-concentration area near EW-20, and these values increase to the northwest as observed in wells MW-26 and MW-112. Other notable BPA MEF transmissivity values are approximately 6.1 feet^2/day (hydraulic conductivity of 0.28 feet/day) at the MW-111 well series location based upon the FLUTe profile in BH-1, 68 feet^2/day (hydraulic conductivity of 1.8 feet/day) at the MW-112 well series location based upon the Flute Survey in BH-2; and 60 feet^2/day (hydraulic conductivity of 1.5 feet/day) at MW-26 based upon the 1990s pumping test by Radian. Thus, the aquifer transmissivity values of 2 to 3 feet^2/day (hydraulic conductivity of 0.05 feet/day) immediately near EW-20 in the BPA high-concentration area appear to be much lower than the aquifer transmissivity values of 60 feet^2/day (hydraulic conductivity of 1.8 feet/day) used for the entire BPA in the previous 1992-2008 model. However, the higher aquifer transmissivity values of 60 feet^2/day (hydraulic conductivity of 1.8 feet/day) used in the prior model do exist to the northwest of EW-20 near MW-26 and MW-112. A key issue of the CSM is, therefore, how these varied aquifer transmissivity values are distributed, especially with respect to the BPA COC high-concentration area. The BPA site CSM is thus revised, such that aquifer transmissivity values are 2 to 6 feet^2/day (hydraulic conductivity of 0.05 feet/day) near EW-20 and MW-111, transitioning to higher values of 68 to 80 feet^2/day (hydraulic conductivity of 1.8 feet/day) to the northwest near MW-112 and MW-26 (see model hydraulic conductivity values in Appendix B). Due to the limited data available to define the small scale spatial variation of aquifer transmissivity/hydraulic conductivity values in the BPA, two alternative CSM interpretations are considered regarding how this change in transmissivity/hydraulic conductivity may be distributed:

- One alternative CSM (Case B) assumes the 68 to 80 feet^2/day transmissivity value (hydraulic conductivity of 1.8-2.0 feet/day) primarily occurs in wells MW-26 and MW-112, with aquifer transmissivity dramatically increasing to 1,500 feet^2/day (hydraulic conductivity of 30 feet/day) to the north in the alluvial channel by well MW-30, and also dramatically decreasing to 2 to 3 feet^2/day (hydraulic conductivity of 0.05 feet/day) to the south-southeast of MW-26 at the MEF bedrock high by the BPA EW wells (see Figures B-1 and B-2); and
- The other alternative CSM (Case C) assumes the transmissivity/hydraulic conductivity values occurring in wells MW-26 and MW-112 extends southeast through the western portion of the BPA high-concentration area along the potential deformation/shear zone paralleling Fault F, with aquifer transmissivity/hydraulic conductivity dramatically increasing to the north in the alluvial channel by MW-30, and dramatically decreasing east of Fault F over the MEF bedrock high (see Figures B-3 and B-4).

- Bedrock Surface – The updated site bedrock surface map (see Appendix A) follows the general trends of the previous bedrock surface map, with a bedrock high in the BPA extending northwest towards the MW-112 series well location, and southeast to the edge of the Bedsprings Valley Floor. In addition to these stratigraphic changes, there are also structural changes in the bedrock surface, notably a fault (Fault F) has been identified trending northwest to southeast through the BPA. Fault F extends northwest of the MW-112A/B/C well locations to the edge of the bedrock high north of the BPA, and southeast of the MW-112A/B/C well locations to the edge of the Bedsprings Creek Valley. The transmissivity value of 68 feet^2/day measured in the FLUTe conductivity profile in BH-02 (the MW-112A/B/C well locations) and the loss of drilling fluid during drilling coincides with the location of this fault zone. One possible interpretation of the site data suggests that there may be a permeable conduit in the deformation/shear zone created by Fault F, which was intersected by BH-02. The permeability of this potential deformation/shear zone is illustrated by the 68 feet^2/day transmissivity value measured in the BH-02 FLUTe conductivity profile. A permeable conduit along Fault F could connect the BPA high-concentration area with the bedrock channel to the north of the BPA (see Figures B-3 and B-4). Note that the FLUTe conductivity profile (Tetra Tech, 2012b) shows inflows occurred over a rather thick zone in BH-02, which is not indicative of flow in a discrete fracture, but instead is indicative of flow in a thick porous zone along the fault. Thus, the Fault F permeable zone is expected to behave as a porous medium, as opposed to a discrete fracture or widely spaced fracture network.

Based upon these changes in the BPA CSM, the model parameters were revised as summarized in Section 4.

4.0 REVISED MODEL PARAMETERS

4.1 BURN PIT AREA HYDRAULIC CONDUCTIVITY/TRANSMISSIVITY VALUES AND BEDROCK ELEVATIONS

The model BPA hydraulic conductivity/transmissivity values were modified to depict the CSM revisions discussed above, where the permeable zone in MW-112 and MW-26 is not depicted to extend along Fault F. Thus, this scenario (Scenario B) coincides with the first alternative CSM discussed in Section 3.

The bedrock elevations given in Appendix A were used to update model parameters, following the model layering scheme outlined in the flow model report (Tetra Tech, 2010).

The hydraulic conductivity values for Layers 1 and 2 were also modified as shown in Figures B-1 and B-2 in Appendix B). The combined transmissivity values for layers 1 and 2 using the hydraulic conductivity values for Layers 1 and 2 (Figures B-1 and B-2) result in the following:

- Model transmissivity values of 3 feet^2/day and hydraulic conductivity values of 0.01 to 0.1 feet/day near the EW-20 pumping test pumping/observation wells and the BPA slug test locations (Table 3), matching the EW-20 pumping test and the BPA MEF slug tests in this area near the BPA source; and
- Model transmissivity values of 70 feet^2/day and hydraulic conductivity values of 3 feet/day near MW-112 and MW-26, matching the BH-2 FLUTe conductivity profile and the 1990s MW-26 pumping test.

This depiction of model hydraulic conductivity/transmissivity values isolates the MW-112/MW-26 hydraulic conductivity/transmissivity value from the BPA high-concentration area (see Figures B-1 and B-2). The hydraulic conductivity values for Layers 1 and 2 follow the CSM and approach outlined in the prior flow model calibration report (Tetra Tech, 2010), where the shallow alluvium (Layer 1) has lower hydraulic conductivity and the deep alluvium (Layer 2) has higher hydraulic conductivity; the converse is true for the MEF, where the shallow MEF has higher hydraulic conductivity and the deeper MEF has lower hydraulic conductivity.

The flow and transport model results using these changes to the BPA model parameters (herein referred to as "Case B") are given in Figures 2 and 3, Tables 1and 2, and Appendix C. The 1992-2011 flow model water budget for Case B (Figure 2) is essentially identical to that given for Case A, and the water level hydrographs (Figure 3) for Case B are essentially identical to those in Case A. Statistics for the Case B water level error (Table 1) differ only modestly from Case A, with the relative model water level error increasing from 2.70 percent to 2.93 percent. The fact that water level error is so similar while the Case B average annual water budget is essentially identical to Case A is to be expected, as the model parameter changes impact only a minute fraction of the overall aquifer transmissivity within the Bedsprings and Potrero Creek areas.

Statistics for the Case B transport model concentration error are similar to those previously given for Case A, with the relative error for the COCs concentrations as follows:

- For perchlorate, 6.7 percent for Case B versus 6.9 percent for Case A;
- For 1,4-dioxane, 5.5 percent for Case B versus 6.2 percent for Case A;
- For 1,1-DCE, 6.0 percent for Case B versus 6.0 percent for Case A; and
- For TCE, 6.1 percent for Case B versus 6.4 percent for Case A.

However, for Case B, the COC source term mass flux budget and the 2011 COC plume mass (Table 2) predicted by the numerical transport model differs considerably from both the model Case A values, and the site CSM values. For example:

- The total COCs source mass flux predicted by the model in Case B is only 40.8 pounds per year, versus 195 pounds per year for Model Case A and 189 pounds per year in the site CSM; and
- The total 2011 COCs plume mass predicted by the model for Model Case B is only 1,943 pounds, versus 4,376 pounds in Model Case A and 3,044 pounds in the site CSM (also note that the 2008 COCs plume mass predicted by the 1992-2008 model was 4,262 pounds versus 4,176 pounds in the site CSM).

The large difference between the Case B and Case A COC source mass flux and 2011 COC plume mass is due to the fact that the aquifer transmissivity in the high-concentration area has been greatly reduced, greatly reducing the underflow rate, and hence COCs mass flux from the high-concentration area. Note that the other components of the mass flux budget such as evapotranspiration, discharge to creek, and well extraction are changed very little from Case A within the 19 year simulation time period.

A comparison of the simulated and observed perchlorate contour maps is given in Appendix C (Figure C-2), which shows how the simulated plume length of the 1,000 µµg/L contour line for Case B is less than the observed plume length of the 1,000 µµg/L contour line (the other COCs are not shown as they show trends similar to those given for perchlorate). This difference between the simulated and observed length of the 1,000 µgL plume contour is attributed to the restricted mass flux rate from the BPA high-concentration area. Note how for Case A (Figure C-1), the simulated plume length of the 1,000 µg/L contour line is very close to the observed plume length of the 1,000 µg/L contour line.

4.2 BURN PIT AREA HYDRAULIC CONDUCTIVITY/TRANSMISSIVITY VALUES ALONG FAULT F (CASE C)

The model predictions for Case B (Section 3.1) result in a poor match to the site CSM COC source mass flux, the 2011 COC plume mass, and the 2011 COC plume shape. In addition, several factors discussed in the Hydraulic Testing Summary Report (Tetra Tech, 2012b) and above suggest that the deformation/shear zone associated with Fault F may be creating a conduit for MEF groundwater flow in the BPA, but the depiction of hydraulic conductivity values in the vicinity of Fault F for Case B does not conform to the presence of a permeable conduit. The existence of a permeable conduit in wells MW-112A/B/C and MW-26 is supported by the very high COC concentrations in these wells - even the MW-112 location which is a considerable distance from the COC hot spot in the center of the BPA high-concentration area. Thus, the model hydraulic conductivity values were modified to depict the presence of a permeable zone along Fault F, which may act as a conduit to groundwater flow through the MEF in this area, in order to investigate whether this alternative model would better match the site COC source mass flux budget, the 2011 plume mass, and the 2011 plume shape. Thus, this scenario coincides with the second alternative CSM discussed in Section 3.

The hydraulic conductivity values for Layers 1 and 2 were modified as shown in Figures B-3 and B-4 in Appendix B. The extent of the higher K values was set based upon the extent of Fault F, as well as the undulation of the bedrock surface relative to the water table, which causes the MEF to rise up into model layers 1 and 2 at the MEF high in the BPA. In the high-concentration area near EW-20, the combined transmissivity values for layers 1 and 2 is 3 feet^2/day and the hydraulic conductivity values are 0.01 to 0.1 feet/day, matching the EW-20 pumping test and BPA MEF slug tests, and along Fault F the transmissivity values for layers 1 and 2 are 70 feet^2/day model (hydraulic conductivity values of 3 feet/day) matching the FLUTe conductivity profile in MW-112 and 1990s pumping test in MW-26 (Radian Corporation, 1992c). Thus, this scenario connects the MW-112/MW-26 hydraulic conductivity/transmissivity value with the BPA high-concentration area via the conduit created by the potential deformation/shear zone along Fault F (see Figures B-3 and B-4). Note that the high hydraulic-conductivity zone along Fault F is outside the EW-20 pumping test area of influence, so this depiction of site conditions is consistent with the recent pumping test of EW-20.

The flow and transport model results using these changes to the BPA MEF hydraulic conductivity values (herein referred to as "Case C") are given in Figures 2 and 3, Tables 1 and 2, and Appendix C. The flow model 1992-2011 water budget for Case C (Figure 2) is essentially identical to that given for Cases A and B, and the water level hydrographs (Figure 3) for Case C are essentially identical to those for Cases A and B. Statistics for the Case C water level error (Table 1) differ only modestly from Cases A and B, with a relative model error of 2.93 percent versus 2.70 and 2.93 percent, respectively.

Statistics for the Case C transport model concentration error are similar to those previously given for Cases A and B, with the relative error for the COCs concentration as follows:

- For perchlorate, 6.5 percent for Case C versus 6.6 percent for Case B and 6.9 percent for Case A;
- For 1,4-dioxane, 5.6 percent for Case C versus 5.5 percent for Case B and 6.2 percent for Case A;
- For 1,1-DCE, 6.1 percent for Case C versus 6.0 percent for Case B and 6.0 percent for Case A; and
- For TCE, 6.8 percent for Case C versus 6.0 percent for Case B and 6.4 percent for Case A.

However, for Case C, the predicted COC source term mass flux budget and the 2011 COC plume mass (Table 2) differs considerably from Case B, and better matches that given in the prior 1992-2008 model calibration; model Case A; and the site CSM. For example:

- The total COCs source mass flux predicted by the model in Case C is 124.9 pounds per year, versus only 40.8 pounds per year for Case B; 195 pounds per year for Model Case A; and 189 pounds per year in the site CSM; and

- The 2011 total COCs plume mass predicted by the model in Model Case C is 3,614 pounds, versus only 1,943 pounds for Case B; 4,376 pounds in Model Case A and 3,044 pounds in the site CSM.

The large difference between Case B and C is due to the fact that the aquifer transmissivity/hydraulic conductivity in the high-concentration area along the trace of Fault F has been increased, increasing the underflow rate and hence mass flux through the western edge of the BPA COCs high-concentration area, and allowing that flow to reach the alluvial channel to the north of the BPA, where very high COCs concentration values have been observed.

A comparison of the simulated and observed perchlorate contour maps is given in Appendix C (Figure C-3), which shows how the Case C simulated plume length is more similar to the observed plume length than Case B (Figure C-2), which is attributed to the greater mass flux rate from the BPA high-concentration area as a result of the higher transmissivity values through the high-concentration area along Fault F.

5.0 RE-EVALUATE MODEL CALIBRATION AND WATER/MASS FLUX BUDGETS

Three updated model cases are presented in Sections 2 and 4 (Cases A, B, and C).

- Case A uses model parameters identical to the prior 1992-2008 model, but extends the model time period, recharge/evapotranspiration rates, and boundary conditions to cover the 2008 through 2011 period;

- Case B uses the 1992-2011 model given in Case A, and then updates the BPA model parameters based upon the results of the recent hydraulic testing. For Case B, the high hydraulic conductivity zone encountered near Fault F in BH-02/MW-112 and MW-26 is assumed to be isolated from the BPA source (Figures B-1 and B-2); and

- Case C uses the 1992-2011 model given in Case A, and then updates the BPA model parameters based upon the results of the recent hydraulic testing. For Case C, the high conductivity zone encountered near Fault F in BH-02/MW-112 and in MW-26 is assumed to extend along the projection of Fault F to a location on the western side of the BPA high-concentration area. This allows groundwater in the higher hydraulic conductivity zone encountered in BH-02/MW-26 to flow off the BPA bedrock high, providing a connection between the BPA high-concentration area and the alluvial bedrock channel north of the BPA encountered in well MW-30 (Figures B-3 and B-4). This interpretation places the projected higher hydraulic conductivity conduit along Fault F just west of the zone of influence from the recent EW-20 pumping tests.

All three cases (Cases A, B, and C) result in very similar water budgets and flow model water level error, with the updated water level error being between 2.70 and 2.93 percent and the updated water budget as follows:

- Creek groundwater recharge of 147 acre-feet per year;

- Diffuse groundwater recharge of 119 acre-feet per year;

- Discharge of groundwater to Potrero Creek of 76 acre-feet per year;

- Evapotranspiration loss of groundwater in the riparian area of 139 acre-feet per year; and
- Extraction/reinjection at rates of 51 acre-feet per year during the operation of the RMPA groundwater extraction and treatment system.

All three 1992-2011 cases (Cases A, B, and C) also have water level error and water budgets similar to the prior 1992-2008 calibration. Thus, the flow model appears to be relatively insensitive to both the extended time period of the 1992-2011 calibration, and the local changes in BPA model parameters. Thus, the three year extended time period (2008-2011) serves as a short validation period for the prior 1992-2008 flow model calibration, which in effect adds to the credibility of the flow model calibration.

Selection of an Appropriate 1992-2011 Model Calibration

The following key points summarize the selection of an appropriate 1992-2011 Model Calibration between alternative Cases A, B, and C.

- Model Cases A and C are both generally consistent with the COC mass flux budget, and the 2011 plume mass and the 2011 plume contour maps, however, Case B is not consistent with either the COC mass flux budget or the 2011 plume mass and 2011 plume contour maps; and
- Model Cases B and C are both consistent with the new BPA site CSM, with low hydraulic conductivity/ transmissivity values within the area of influence of the recent EW-20 pumping test (see Figures B-1 through B-4). However, Case A is not consistent with these new BPA hydraulic conductivity/transmissivity values, as the Case A BPA hydraulic conductivity/transmissivity values are up to 30 times those from the recent hydraulic tests.

Therefore, Case B is rejected as an appropriate model calibration, since the predicted COC mass flux budget and 2011 COC plume mass and 2011 plume shape do not match observed data very well, and Case A is rejected as an appropriate model calibration, since the model BPA high-concentration area hydraulic conductivity/transmissivity values do not match the updated site CSM and the recent BPA hydraulic test results. Thus, Case C is the most appropriate calibration model for the site, and the MODFLOW/MT3D model files for Case C are given in Appendix D.

Several other factors at the site support the choice of Case C as the most appropriate calibration, including:

- COC Mass Flux Transects downgradient of BPA support the higher BPA source mass flux rates of Cases A and C. The 1992-2008 transport CSM (Tetra Tech, 2011) calculated 1992-2008 average COC mass flux rates were over 258 pounds per year along a transect across the plume in the RMPA (mass flux rates were calculated using site underflow rates and measured site COC concentrations). Given the 5-year transport time between the BPA and the RMPA, the 1992-2011 average COC BPA source mass flux of 40.8 pounds per year for Case B is inconsistent with the 258 pounds per year RMPA transect mass flux calculations, while the Case A COC BPA source mass flux rates of 195 pounds per year and Case C COC BPA source mass flux rates of 125 pounds per year are more consistent with these transect mass flux calculations; and
- COC Mass Removal Rates during operation of the RMPA Extraction/Injection System support the greater BPA COC source mass flux rates of Cases A and C – The COC mass extraction rate from the RMPA Extraction/Injection System averaged 76 pounds per year during the 8.5 years of

operation from Summer 1994 to Fall 2002. The RMPA system was not designed to fully capture the entire plume (Radian Corporation, 1992b and 1992c), and the average pumping rate of 51 acre feet per year during operation is estimated to be only about one-third of the 147 acre-feet year rate that would be needed to fully capture the plume (Tetra Tech, 2010). During the operation of the RMPA system, monitoring data also supported that the RMPA system was not fully capturing the entire plume, as the plume downgradient of the RMPA system did not show signs of complete capture. These factors suggest that the COC mass flux rates from the BPA sources must have been considerably higher than the 76 pounds per year extracted during this period, since the RMPA system was extracting 76 pounds per year from a system that was not achieving complete capture. Note that the extraction occurred over a time period of 8.5 years at a location that was only a 5-year travel time downgradient of the BPA high-concentration area, which was long enough for the RMPA system to cut off the downgradient plume from the source if it was capturing all the source COC mass flux. Thus, the 40.8 pounds per year COC BPA source mass flux during 1992-2011 for Case B are inconsistent with the 76 pounds per year RMPA extraction rates and the incomplete plume capture by the RMPA extraction/injection system, while the Case A COC BPA source mass flux rates of 195 pounds per year and Case C COC BPA source mass flux rates of 125 pounds per year are generally consistent with the 76 pounds per year RMPA COC mass extraction rates and the incomplete plume capture by the RMPA extraction/injection system.

Recognizing, however, that (1) there are limited hydraulic data available to define the small scale distribution of the BPA hydraulic conductivity, and (2) the model results are quite sensitive to these parameters (see *Discussion* below), it is recommended that a range be adopted for the mass flux budget to reflect this uncertainty. Thus, the updated model COC mass flux budget is expected to be bounded by the range of Model Results for Cases A and C (Table 2), such that the annualized COCs mass flux budget for 1992 through 2011 is as follows:

- Influx from sources in the BPA and RMPA of 125 to 195 pounds per year;
- Extraction during the 8.5-year operation of the RMPA groundwater extraction system of 77 pounds per year (34 pounds per year average for 19-year simulation);
- Discharge to Potrero Creek of 1.5 to 1.6 pounds per year;
- Extraction due to evapotranspiration loss of groundwater in the riparian area of 36 to 38 pounds per year; and
- Loss due to degradation in the riparian area of 120 to 122 pounds per year.

As illustrated by the wide range in COC source mass flux (125 to 195 pounds per year), the model update indicates that there is considerable uncertainty in the site COC transport model and COC mass flux budget.

Discussion

Based upon these findings, there would appear to be less uncertainty in the flow model calibration and the site water budget than the transport model calibration and site COC mass flux budget. The transport model results appear to be quite sensitive to the small scale distribution of MEF hydraulic conductivity values in the vicinity of the BPA source. However:

- There is only one pumping test that has been conducted in this critical BPA high-concentration area; and

- The current flow and transport models are regional-scale models of the entire Bedsprings and Potrero Creek areas covering all of the BPA, the RMPA, the riparian zone, and the lower reaches of Potrero Creek, but the level of detail that is required for the hydraulic conductivity parameters in the BPA would likely be better handled using a smaller site-scale model of the BPA (i.e., a site-specific model constructed for the BPA from this regional scale model).

Impacts on Site Remedial Alternatives

The changes in the BPA CSM and numerical flow and transport model could have an impact on the evaluation of any BPA high-concentration area removal actions for the site. For example, a series of wells or a horizontal well located along the permeable deformation/shear zone paralleling Fault F may serve as an effective means for establishing hydraulic control over COCs leaving the BPA to control the mass flux. The source area control alternatives evaluated in the feasibility study took into consideration this more permeable feature that could be used to control mass flux out of the BPA. The source control alternatives evaluated in the feasibility study assumed that the source could be cutoff with wells located both within the high concentration area and immediately downgradient of the BPA utilizing either this higher permeability feature or the more conductive alluvium. Based on the high contaminant concentrations still remaining in the low permeability areas of the BPA, this feature could help to control the mass flux but still may not significantly decrease the time required to remove contaminant mass from the source due to the rate-limited mass transfer within the sandstone. Even with the more permeable shear zone, the source area control alternatives would not achieve the surface water remedial action objectives for approximately 25 years, which represents the time required for the existing plume to flush out and decrease existing concentrations in surface water by an order-of-magnitude without any additional mass flux from the BPA being added to the system. In comparison, the recommended groundwater alternative in the feasibility study (hydraulic containment in the Middle Potrero Creek Area) would control releases to surface water and the downgradient off-site aquifer and meet the surface water remedial action objectives in 1-2 years.

6.0 REFERENCES

Radian Corporation

1992a Lockheed Propulsion Company Beaumont Test Facilities Remedial Action Plan. February 1992.

1992b Lockheed Propulsion Company, Beaumont Test Facilities, Beaumont 1 Treatment Design Feasibility Study. March 1992

1992c Lockheed Propulsion Company Beaumont Test Facilities Hydrogeologic Study, December 1992.

Tetra Tech, Inc.

2010 Transient Groundwater Model Report, Numerical Flow Model Development, Beaumont Site 1, Lockheed Martin Corporation, Beaumont, California, January 2010.

2011 Numerical Groundwater Transport Model Development, Beaumont Site 1, Lockheed Martin Corporation, Beaumont, California, July 2011.

2012a Semiannual Groundwater Monitoring Report, Third Quarter and Fourth Quarter 2011, Potrero Canyon Unit (Lockheed Martin Beaumont Site 1), Beaumont, California, April 2012.

2012b Hydraulic Testing Summary Report, Potrero Canyon Unit (Lockheed Martin Beaumont Site 1), Beaumont, California, June 2012.

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Table 1 Statistical Summary for Water Level Calibration

Statistcal Parameter	1992 through 2008 Time Period Previous Calibration	1992 through 2011 Time Period Case A (New 92 - 11 Calibration with old hydraulic conductivity and bedrock data)	1992 through 2011 Time Period Case B (New hydraulic conductivity and bedrock data, without Conduit at Fault F)	1992 through 2011 Time Period Case C (New hydraulic conductivity and bedrock data, with Conduit at Fault F)
Residual Mean	3.56	3.03	3.39	1.71
Residual Standard Deviation	11.44	11.11	12.07	12.06
Absolute Residual Mean	8.10	7.66	8.69	8.21
Minimum Residual	-40.76	-48.00	52.47	-57.74
Maximum Residual	106.20	106.20	106.25	106.59
Range in Target Values	410.21	412.14	412.14	412.14
Residual Standard Deviation/Range	2.79%	2.70%	2.93%	2.93%

Table 2
Transport Model COC Mass and Mass Flux Summary

CONCEPTUAL MODEL VALUES											
	Perchlorate		1-4-Dioxane		1-1-DCE		TCE		ALL COCs		
	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Mass Flux during RMPA operation (pounds/year)
Sources	2,576	161	48	3.0	224	14.0	181	11.3	3,029	189.30	
Wells**	-443	-28	-8	-0.5	-93	-5.8	-99	-6.2	-643	-40.19	-75.65
Creek	-22	-1	-10	-0.6	-32	-2.0	-13	-0.8	-76	-4.75	
Evapotranspiration	-640	-40	-128	-8.0	-288	-18.0	-304	-19.0	-1,360	-85.00	
Degradation	-1,008	-63	0	0	0	0	0	0	-1,008	-63.00	
2008 Storage	3,400	NA	100	NA	362	NA	314	NA	4,176	NA	
2011 Storage**	2,555	NA	110	NA	230	NA	149	NA	3,044	NA	

** 2011 values taken from Tetra Tech, (2012c), and adjusted using model porosity values

TRANSPORT MODEL PREDICTIONS FOR PRIOR 1992-2008 CALIBRATION											
	Perchlorate		1-4-Dioxane		1-1-DCE		TCE		ALL COCs		
	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Mass Flux during RMPA operation (pounds/year)
Sources	2,501	156*	62	3.9	307	19.2	145	9.1	3,015	188.42	
Wells**	-439	-27	-5	-0.3	-105	-6.6	-125	-7.8	-674	-42.10	-79.24
Creek	-15	-1	-2	-0.2	-4	-0.3	-5	-0.3	-27	-1.70	
Evapotranspiration	-313	-20	-33	-2.1	-127	-8.0	-193	-12.1	-666	-41.63	
Degradation	-2,139	-134	0	0	0	0	0	0	-2,139	-133.71	
2008 Storage	3,217	NA	81	NA	537	NA	426	NA	4,262	NA	

* 144 for BPA, 12 for RMPA, and < 1 for F-33

TRANSPORT MODEL PREDICTIONS FOR 1992-2011 SIMULATION: CASE A Old Bedrock and Hydraulic Conductivity Parameters											
	Perchlorate		1-4-Dioxane		1-1-DCE		TCE		ALL COCs		
	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Mass Flux during RMPA operation (pounds/year)
Sources	3,114	164*	70	3.7	349	18.4	166	8.7	3,700	194.73	
Wells**	-423	-22	-5	-0.3	-102	-5.4	-122	-6.4	-653	-34.37	-76.82
Creek	-16	-1	-2	-0.1	-5	-0.2	-6	-0.3	-29	-1.52	
Evapotranspiration	-324	-17	-3	-0.1	-145	-7.7	-213	-11.2	-686	-36.08	
Degradation	-2,315	-122	0	0	0	0	0	0	-2,315	-121.86	
2011 Storage	3,312	NA	84	NA	550	NA	430	NA	4,376	NA	

* 152 for BPA, 12 for RMPA, and << 1 for F-33

TRANSPORT MODEL PREDICTIONS FOR 1992-2011 SIMULATION: CASE B New Transmissivity and Bedrock, without Fault F Conduit											
	Perchlorate		1-4-Dioxane		1-1-DCE		TCE		ALL COCs		
	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Mass Flux during RMPA operation (pounds/year)
Sources	663	35*	13	0.7	62	3.3	37	1.9	775	40.76	

Table 2
Transport Model COC Mass and Mass Flux Summary

Wells**	-392	-21	-4	-0.2	-93	-4.9	-119	-6.3	-608	-32.02	-71.58
Creek	-15	-1	-2	-0.1	-4	-0.2	-6	-0.3	-28	-1.47	
Evapotranspiration	-314	-17	-34	-1.8	-138	-7.3	-208	-11.0	-694	-36.54	
Degradation	-2,171	-114	0	0	0	0	0	0	-2,171	-114.25	
Oct 2011 Storage	1,334	NA	29	NA	276	NA	304	NA	1,943	NA	

* 23 for BPA, 12 for RMPA, and << 1 for F-33

TRANSPORT MODEL PREDICTIONS FOR 1992-2011 SIMULATION: CASE C New Transmissivity and Bedrock, with Fault F Conduit

	Perchlorate		1-4-Dioxane		1-1-DCE		TCE		ALL COCs		
	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Total Mass (pounds)	Mass Flux (pounds/year)	Mass Flux during RMPA operation (pounds/year)
Sources	1,908	100*	40	2.1	245	12.9	180	9.5	2,373	124.91	
Wells**	-446	-23	-5	-0.3	-107	-5.6	-125	-6.6	-682	-35.92	-80.29
Creek	-17	-1	-3	-0.1	-5	-0.3	-6	-0.3	-31	-1.61	
Evapotranspiration	-321	-17	-35	-1.9	-146	-7.7	-215	-11.3	-718	-37.77	
Degradation	-2,281	-120	0	0	0	0	0	0	-2,281	-120.03	
Oct 2011 Storage	2,551	NA	54	NA	506	NA	503	NA	3,614	NA	

* 88 for BPA, 12 for RMPA, and << 1 for F-33

** For TCE and 1,1-DCE wells, represents net loss due to removal in treatment, but for perchlorate and 1,4-dioxane wells doe not represent net loss since extraction is balanced by reinjection; rate values for the 8.5 year period of operation are proportionaltely higher as shown in column to right

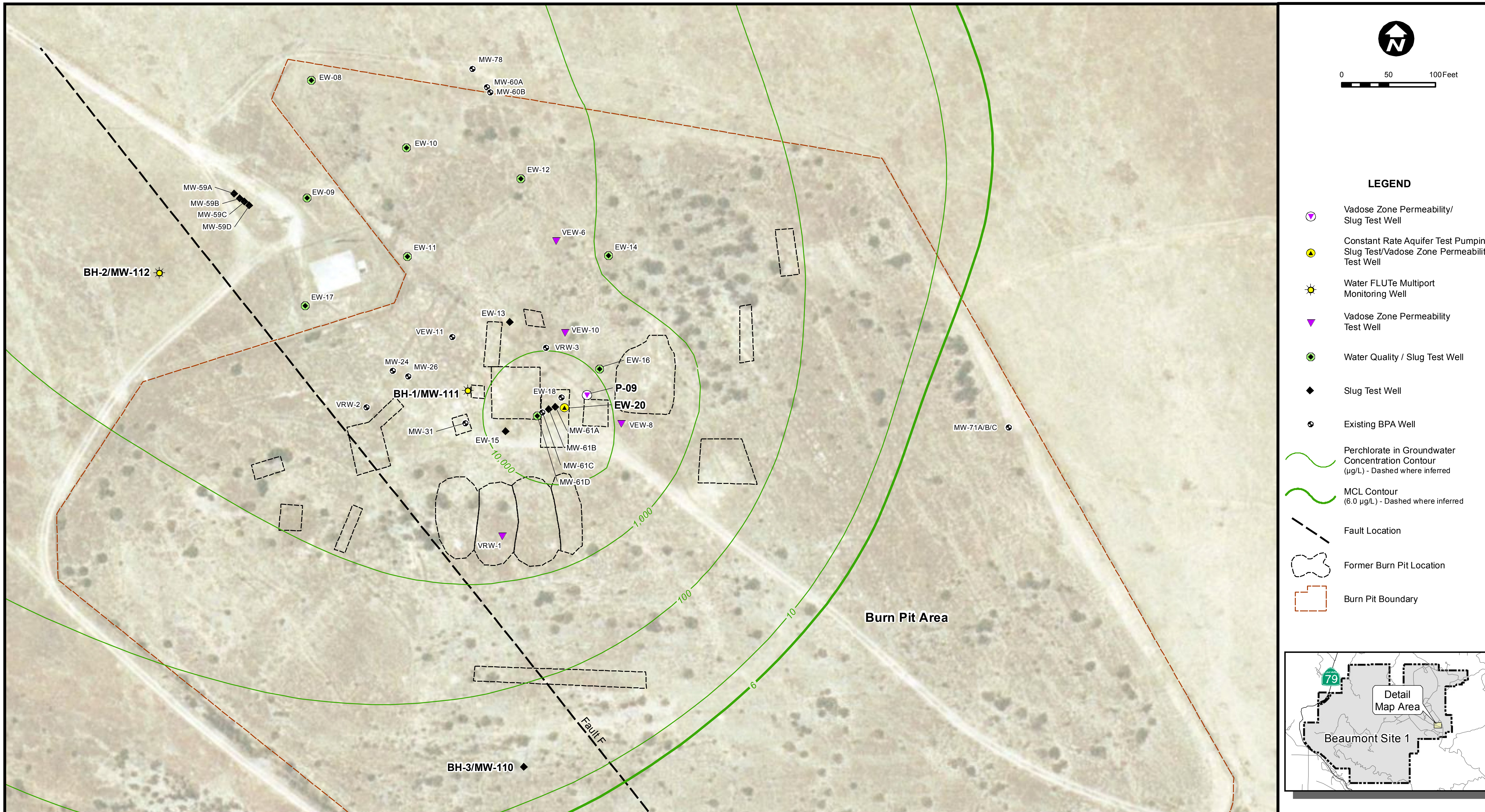
Table 3
Summary of Well Test Data in the Vicinity of the BPA

Well	Slug Tests		Pumping Test-Pumping Well		Pumping Test-Observation Well		Flute Survey	
	Transmisivity (feet²/day)	Hydraulic Conductivity (feet/day)	Transmisivity (feet²/day)	Hydraulic Conductivity (feet/day)	Transmisivity (feet²/day)	Hydraulic Conductivity (feet/day)	Transmisivity (feet²/day)	Hydraulic Conductivity (feet/day)
EW-08	6.224E-01	1.638E-02						
EW-09	2.051E+00	5.398E-02						
EW-10	4.325E+00	1.138E-01						
EW-11	7.446E-03	1.959E-04						
EW-12	3.842E+00	1.011E-01						
EW-13	4.699E-01	1.237E-02						
EW-14	7.630E-02	2.008E-03						
EW-15	1.902E-01	5.005E-03			1.680E+00	4.421E-02		
EW-16	6.626E-01	1.744E-02			4.210E+00	1.108E-01		
EW-17	2.862E+00	7.531E-02						
EW-18					1.690E+00	4.447E-02		
EW-20	2.694E+00	7.089E-02	6.357E-01	1.673E-02				
PZ-09					1.180E+00	3.105E-02		
MW-59A	2.778E-02	1.389E-02						
MW-59B	2.500E-01	2.500E-02						
MW-59C	5.484E-03	2.742E-03						
MW-59D	1.314E-01	6.572E-02						
MW-61A[1]	1.688E-04	8.438E-05						
MW-61B	1.074E+00	1.074E-01			1.910E+00	5.026E-02		
MW-61C[1]					3.920E+00	1.032E-01		
MW-61D[1]	3.454E-01	1.727E-01			4.570E+00	1.203E-01		
MW-111 Location							6.100E+00	2.800E-01
MW-112 Location							6.790E+01	1.787E+00
1990s Pumping Test by Radian								
MW-26					8.000E+01	2.000E+00		
MW-30					1.500E+03	3.000E+01		

[1] Deeper Well Screens

All Wells screened in Mt Eden and in BPA, except MW-30 which is in Alluvium and located downgradient of BPA towards the RMPA

FIGURES



X:\GIS\Lockheed 28535_01_0404\Burn Pit.mxd

Potrero Canyon
(Lockheed Martin Beaumont Site 1)

Figure 1

Hydraulic Testing and Bedrock Characterization Locations- Burn Pit Area

TETRA TECH

Figure 2. Groundwater flows predicted by the model for 1992-2011 transient calibration

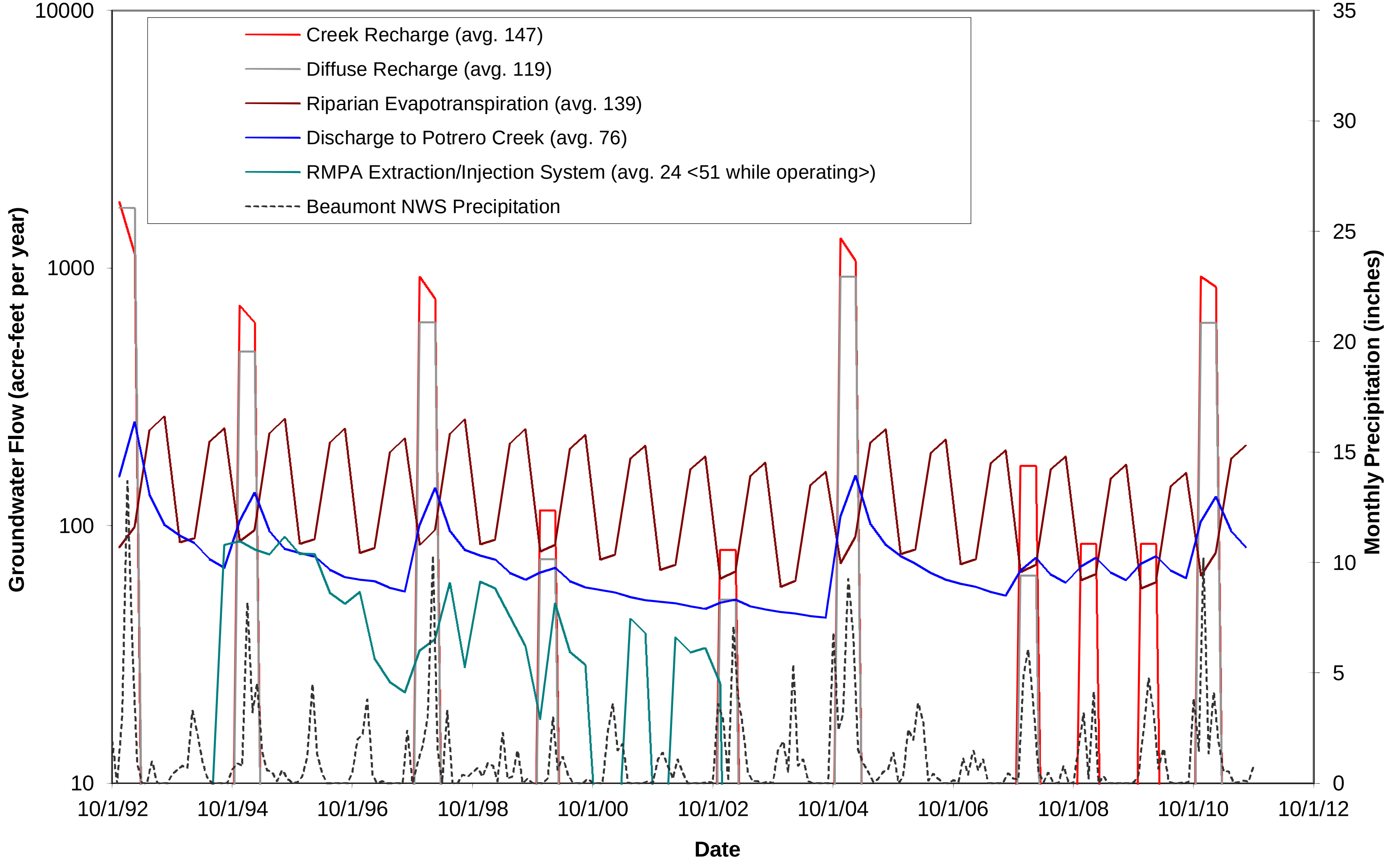


Figure 3. Simulated and Observed Hydrographs for Monitoring Wells OW-01, P-05, MW-48, and OW-08