Technical Memorandum

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Subject Review of Capture Evaluation presented in the M52 OU1 2009 Effectiveness report

On behalf of Arizona Department of Environmental Quality (ADEQ), URS Corporation reviewed the groundwater capture evaluation presented by Clear Creek Associates, Inc. (CCA) in the *Operable Unit No. 1 Effectiveness Report, 2009 Operations at the 52nd Street Superfund Site, March 2010*. URS reviewed comments by ADEQ and the Environmental Protection Agency (EPA) on the 2009 Effectiveness Report, and the results of the *Bedrock Pilot Study Preliminary Findings Report, April 2010.* URS also reviewed the Environmental Protection Agency (EPA) Guidance Documents, *Methods for Monitoring Pump and Treat Performance, 1994,* and *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems, 2008*, that form the basis of the CCA capture evaluation.

The capture evaluation by CCA concluded that the OU1 groundwater remedy is effective at containing the contaminant plume at the Old Crosscut Canal (OCC). URS found the capture evaluation by CCA to be generally consistent with the EPA guidance documents and the 6-step systematic approach (EPA, 2008) was used to develop converging lines of evidence to support the conclusions of the evaluation. In some cases, simplifying assumptions were required that increase the uncertainty of results in a complex hydrogeologic environment. The uncertainty is reduced by comparing converging lines of evidence that support similar conclusions.

<u>Step 1 – Review data, site conceptual model, and remedy objectives.</u>

CCA included a review of site data, site conceptual model, and the remedy objectives. The new data developed during the Bedrock Extraction Pilot Study were generally consistent with the site conceptual model and supported the conclusion that the bedrock fractures were mostly filled and the unit responded more like a low permeability porous medium than a fracture-based flow system.

<u>Step 2 – Define site-specific Target Capture Zone</u>.

The stated remedial objective is to create a hydraulic capture zone that contains contaminated groundwater at the Motorola 52nd Street Superfund Site east of the OCC. CCA defines the Target Capture Zone (TCZ) as the 5 micrograms per liter (µg/l) Trichloroethene (TCE) concentration isocontour line for areas upgradient of the Old Crosscut Canal. During this Five-Year Review Period, installation of new wells DM609 and DM610 provided better definition of the TCZ to the north of the OU1 OCC extraction system, indicating the 5 ug/L TCE isocontour is located south of these wells. New wells DM611, DM612, and DM613 were installed in between two of the OCC extraction wells (DM307 and DM308) to provide better definition of the 5 ug/L TCE isocontour and the TCZ in the vertical direction at the OCC. DM607, a new FLUTe multi-port well, and provided better definition of the TCZ in the downgradient direction.

Step 3 – Interpret Water Levels.

Interpretation of water level data was the primary tool used by CCA to demonstrate capture. Groundwater elevation contour maps were constructed in plan and section views. Groundwater flow lines are perpendicular to groundwater elevation contours. Horizontal capture was estimated by approximating the location of a bounding flow line within which all flow lines converge towards extraction wells.

Potential Concern: Groundwater elevation data used to construct the contour maps included estimated water levels for extraction wells. Pumping water levels in extraction wells are lower than water levels in the surrounding aquifer and were adjusted based on estimates of well efficiency. Well efficiency results from 2002 testing were used for offsite extraction wells. A reference for review of this testing should be provided. Large efficiencies of approximately 90% were used for calculating drawdown at two of the northernmost extraction wells along the OCC, DM305 and DM307, and potentially overestimate drawdown in the immediate vicinity of the extraction wells. However, the construction of isocontours and interpretations of capture in the vicinity of these two wells are supported by measured water levels in nearby monitor wells DM602, DM603, and DM611. Estimates for well efficiency and pumping water levels should be re-evaluated periodically and compared to observations in nearby monitor wells.

Preliminary results of the Bedrock Extraction Pilot Study indicate pumping from bedrock extraction well DM314 has a very limited area of influence. Localized changes were observed after six months of extraction; however, additional data for a longer period will be required to evaluate the effect of bedrock extraction on water quality.

Step 4 – Calculations and modeling.

EPA guidance documents recommend conducting simple horizontal analyses to estimate the flow rate though the contaminated section of the aquifer and the pumping rate required to achieve capture. One or more of the simplifying assumptions required for the calculations is typically violated at a site. CCA states that for OU1, most of the simplifying assumptions are violated due to the complex hydrogeology at the site.

The estimated flow rate calculation was conducted using reasonable estimates for aquifer parameters and a series of estimated saturated thicknesses ranging from 5 to 35 feet. These calculations resulted in flow rates ranging from 68 to 477 gallons per minute (gpm), with a best estimate of 136 gpm based on an average thickness of 10 feet.

The capture zone width calculation was conducted for a single well, in accordance with EPA guidance that states that a single well capture zone width is identical to the capture zone width of pumping distributed to multiple wells at a far enough distance upgradient. Based on the complexity of the site and the limited average saturated thickness, a single well analysis may not be appropriate. A calculation that superimposes drawdown for multiple wells would provide a more accurate estimate of capture zone width in critical areas closer to the extraction wells. Capture zone width was estimated for a range of saturated thicknesses. The saturated thickness of 10 feet resulted in an estimated capture zone width of 5,775 feet, which is slightly larger than the width estimated based on the water level contour map.

A site-specific numerical groundwater flow model was developed in 2005 by CCA using field data and knowledge from several previous models for the site. Water levels predicted by the model are in close agreement with observed water levels in key monitor wells. The capture zone estimated from water level contours compares favorably with the predicted capture zone. The capture zone predicted by the numerical model is considered to be more accurate than the

capture zone width calculation mentioned in the preceding paragraph for either a single or multiple wells.

Step 5 – Evaluate concentration trends.

CCA evaluated concentration trends for TCE to assess effectiveness of OU1 in capturing contamination at the OCC. Data from September 2009 were compared to historical water quality data and Baseline data for 1992. Concentrations of TCE in source areas upgradient from the OCC have remained relatively unchanged, while downgradient of the OU1 OCC capture zone, the plan extent of areas with TCE concentrations above 10, 100, and 1000 ug/L have decreased significantly over time. The overall concentration trends are consistent with the site conceptual model. Concentration trends are relatively constant in the source areas, relatively constant or increasing in downgradient wells within the capture zone, and decreasing in alluvial and bedrock monitoring points downgradient of the capture zone. These trends for TCE concentrations indicate the OU1 OCC extraction system is containing the plume.

Notable changes observed in monitoring wells in the vicinity of the OCC extraction system (since 1992 baseline levels) include an increasing trend in TCE concentrations at DM602 (which is a conventional, bedrock interface screened well sampled at 120 ft bgs) and a decreasing trend in TCE concentrations observed in deep bedrock ports of DM603 (a Westbay well). Both wells are within the estimated Capture Zone for the extraction system. These trends are attributed by CCA to changes in flow patterns as the plume is pulled laterally through the alluvium and upward through the bedrock in the direction of the extraction wells. The rising trend for TCE concentrations in DM602 is not a concern as long as groundwater contours indicate that groundwater flow through this point is within the estimated Capture Zone.

Step 6 - Interpret actual capture, compare to Target Capture Zone, assess uncertainty

CCA described a bounding flow line that defines the estimated Capture Zone based on water level data. The estimated Capture Zone encompasses the Target Capture Zone which is defined as the 5 ug/L isocontour for TCE upgradient of the OCC for the Baseline period. The estimated Capture Zone is in close agreement with the predicted capture zone using a numerical flow model. The estimated Capture Zone analysis is generally supported by concentration trends showing decreasing concentrations in wells downgradient from the OU1 OCC extraction system and concentration trends that are relatively constant or increasing in areas upgradient from the OU1 system.

The use of estimated water levels in pumping wells introduces uncertainty in the water level contour map used to estimate the Capture Zone. This uncertainty is reduced by supporting lines of evidence from the numerical groundwater flow model and the evaluation of concentration trends in downgradient monitor wells. Uncertainty in estimates for well efficiency and water levels near pumping wells could be further reduced by verifying estimates for similar wells in the areas where monitor wells are available or by installing additional monitoring points near extraction wells in critical areas.

Capture in bedrock is more difficult to interpret due to the complexities of groundwater flow in low-permeability, fractured rock and the limited amount of available data. In general, the cross-sectional areas defined by the 5 10, 100, and 1000 ug/L isocontours for the 2009 data are significantly smaller than comparable isocontours for the Baseline 1992 period, indicating effective capture.

Wells DM611, DM612, and DM613 were installed as a well set with increasingly deeper screened intervals in response to concerns that downward gradients observed in DM606 could

indicate the possibility of TCE moving in intervals below the deepest ports in DM603. Results indicate that the deepest well DM613 has not been impacted by TCE and that the 5 ug/L isocontour occurs above this interval. An upward gradient is observed between DM612 and DM611, and TCE concentrations are increasing in DM611, the upper well, and decreasing in DM612 the middle screened interval, comparable to trends observed in DM603, indicating capture in the bedrock. A slight downward gradient is indicated between DM612 and DM613; however, water levels in nearby OCC extraction wells are significantly lower than in both these wells, and the water level is higher in DM603, indicating that the general groundwater flow in these intervals would be towards the extraction wells. New well DM607 provided further confirmation that contamination was not migrating below the base of DM603 and low concentrations in the upper part of the bedrock and in the alluvium indicate that the OU1 OCC are providing capture.