Response to GRAC Questions (April 25, 2013) regarding the Soil Root-Zone Water Balance Model and Hydrogeologic Characterization

Response to questions posed at the April 25, 2013 GRAC meeting regarding the level of confidence associated with the soil root-zone water balance model and hydrogeologic conceptualization and characterization performed by MBK Engineers and LSCE, respectively.

- Following the April 25, 2013 GRAC meeting, LSCE and MBK staff reviewed the GRAC questions and have provided an **updated map** depicting the average annual recharge throughout the studied watersheds and a **table** detailing the calculation of the average annual recharge per studied watershed, along with the estimated minimum and maximum annual recharge per studied watershed.
- The **soil root-zone water balance model** was designed and implemented to describe the natural processes that contribute to recharge throughout the county, where data are available. This point is critical to interpreting the recharge estimates. Rather than defining the rate that groundwater accrues in the county for any single year or at any single location within a studied watershed, the soil root zone water balance was designed to account for detailed precipitation, evaporation, streamflow, and land use data over a defined watershed to understand the processes affecting water as it moves from the ground surface to the groundwater below.
    - The results produced by the **soil root-zone water balance model** and subsequent sensitivity analysis presented to the GRAC and contained in the LSCE/MBK report *Updated Hydrogeologic Conceptualization and Characterization of Conditions,* indicate that the soil root-zone water balance model reliably considers these factors, up to a 20% confidence interval as stated at the April 25, 2013 GRAC meeting.
    - The updated map and table of estimated average annual recharge values provided to the County are not intended for application at spatial scales smaller than the watersheds for which they were developed. Caveats are included with the map and table to describe how variations in topography, land use or land cover, and soils can affect the distribution of precipitation, runoff, and infiltration within the studied watersheds and result in highly variable recharge from point to point within the watersheds.
- The GRAC also had questions regarding the level of confidence and probability associated with the hydrogeologic characterization and mapping of conditions in Napa Valley to depths of 500 feet below ground surface.
    - These questions appear to confuse the **updated hydrogeologic conceptualization** and the **soil root-zone water balance model** with a **groundwater flow model**. A groundwater flow model is a mathematical approach for calculating the flow of water into, out of, and within an aquifer system and calculating any changes in the amount of water stored in an aquifer resulting from those flows. That was not part of the recent scope of work for Napa County. The soil root-zone water balance model addresses processes that lead to water infiltrating below the soil root-zone and, by inference, into groundwater. The soil root-zone water balance model does not directly address what happens after infiltration below the soil root-zone. The soil root-zone water balance model provides a valuable point of reference with which to compare the infiltration process simulated by a groundwater flow model, but the root-zone soil water balance does not provide a representation of groundwater flow or changes in groundwater storage.
    - The hydrogeologic characterization provides a detailed assessment and synthesis of available geologic information to describe the physical setting that defines the aquifer systems of Napa Valley. **Statements of statistical confidence or probability associated with the updated hydrogeologic conceptualization are premature in that the hydrogeologic conceptualization is the framework of understanding upon which the "moving parts" of a mathematical groundwater flow model can be created.** Once a groundwater flow model has been created and calibrated it will produce results concerning groundwater conditions which can be statistically analyzed to judge the model's ability to reproduce known conditions.

Summary of Estimated Annual Recharge for Gaged Watershed Areas

Prepared for the Napa County Groundwater Resources Advisory Committee

Gaged Watershed	Total Gaged Watershed Area[1] (acres)	Total Area of Greatest Recharge Potential[2] (acres)	Total Area of Greatest Recharge Potential[2] (percent of gaged watershed)	Minimum Annual Recharge[3] (acre-ft)	Minimum annual recharge per total watershed area (acre-feet/acre)	Average Annual Recharge[3] (acre-feet)	Average annual recharge per total watershed area (acre-feet/acre)	Maximum Annual Recharge[3] (acre-ft)	Maximum annual recharge per total watershed area (acre-feet/acre)
Napa River near Napa	**139,819**	**59,809**	**43**	**8,300**	**0.06**	**70,600**	**0.50**	**185,900**	**1.33**
Conn Creek	35,502	8,338	23	4,300	0.12	21,100	0.59	40,700	1.15
Dry Creek	11,155	288	3	500	0.04	2,000	0.18	6,300	0.56
Napa River at St. Helena	50,984	28,321	56	2,500	0.05	22,000	0.43	60,900	1.19
Napa River at Calistoga	13,937	5,867	42	2,000	0.14	10,500	0.75	17,200	1.23
Milliken Creek	**11,112**	**2,947**	**27**	**100**	**0.01**	**2,500**	**0.22**	**7,100**	**0.64**
Tulucay Creek	**8,052**	**3,886**	**48**	**100**	**0.01**	**1,000**	**0.12**	**2,300**	**0.29**
Redwood Creek	**6,434**	**1,224**	**19**	**400**	**0.06**	**1,900**	**0.30**	**5,000**	**0.78**
Napa Creek at Napa	**9,886**	**2,802**	**28**	**600**	**0.06**	**3,600**	**0.36**	**6,900**	**0.70**

[1] Gaged watershed areas listed are limited to the drained watershed area upstream of the corresponding streamflow gaging station (see section 8.5.3 and Table 8-10 in LSCE and MBK (2013)).

[2] Total areas of greatest recharge potential correspond to the portion of the total gaged watershed with recharge conducive surficial geologic units (see section 8.6 and Table 8-10 in LSCE and MBK(2013)).

[3] Minimum annual, average annual, and maximum annual recharge values are calculated based on the soil root-zone water balance model (see Chapter 8 in LSCE and MBK (2013)). As indicated by the substantial range of recharge values, the values are strongly driven by hydrologic conditions. Some parameters in the soil-root zone water balance model are more sensitive than others (see section 8.8). Sensitivity analyses were performed to evaluate which parameters the model is most sensitive to and to understand how uncertainty in inputs creates uncertainty in recharge estimates. For example, there is a relatively greater uncertainty associated with the evapotranspiration of native forests compared to soil parameters (e.g., porosity, pore size distribution, field capacity, and root zone depth).

NOTE: These recharge values are estimates based on a watershed-scale analysis. The annual recharge per unit area is calculated from the annual recharge for each gaged watershed presented in Table 8-9 and the total gaged watershed acreage presented in Table 8-10 of LSCE and MBK (2013). These values do not account for variations in topography, land use, and soils that affect the distribution of precipitation, runoff, and infiltration within and among the gaged watersheds. Actual recharge per acre will vary significantly from the printed value within each gaged watershed and over time.

Reference: Luhdorff & Scalmanini Consulting Engineers (LSCE) and MBK Engineers (MBK). "*Updated Hydrogeologic Conceptualization and Characterization of Conditions", January 2013. Report prepared for Napa County.*