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Date: 2025.10.02 12:56:15 -06'00'

subject: Memo for the Identification of Data Errors in the Analysis Report Documenting the Data, Generation, and Calibration of T-fields for CRA-2024.

This Memorandum is being written as an addendum to "Analysis Report Documenting the Data, Generation, and Calibration of T-fields for CRA-2024" (Bowman et al., 2023) in response to an EPA comment given prior to the 2025 WIPP site inspection. The EPA inquiry indicated that the observed steady-state head value displayed in Table 3 of the report did not match those displayed in Figures 4 and 24 for well WIPP-25. Investigation into this matter revealed that the observed steady-state value for WIPP-25 was correctly listed in Table 3, but an old value from a previous iteration of T-field calibrations was used for WIPP-25 in error for two calculations, which permeated to the two indicated figures. Further investigation into the matter also revealed that an incorrect observed steady-state head value for WIPP-30 was also used, but the magnitude of the error was to a lesser degree and avoided detection through the same graphics. The content of this memorandum describes where the incorrect values were used and characterizes their impact to the products of the initial report.

The correct observed steady-state values and the values that were used in error for WIPP-25 and WIPP-30 are given in Table 1.

Table 1: Steady-State Target Values

	Observed Steady-State Freshwater Head Values (in meters)		
	Correct	Incorrect Value Used	Difference
WIPP-25	933.65	937.57	3.92
WIPP-30	938.66	939.37	0.71

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The incorrect values for wells WIPP-25 and WIPP-30 were used in two calculations: the multi-variate regression of heads calculation used to set model boundary conditions, and the calculation used to create optimization targets for T-field calibration. The multi-variate regression is given by:

$$\boldsymbol{h_{x,y} = a + b(y + d * sin(y) * |y|^{exp}) + c(e * x^3 + f * x^2 - x),}$$

where $h_{x,y}$ is the head at a flow model cell, x and y are the coordinates of the center of the cell, and a, b, c, d, e, f, and exp are free variables that allow the shape of the water table to adjust. This equation is used to prescribe boundary conditions for the flow modeling used in T-field calibration. Effectively, this regression uses 47 observed steady-state head values from each well to generate a best-fit planar surface.

Two factors minimized the impact of using the two incorrect values:

1) 45 of the steady-state observations were correctly represented in the calculation
2) The two wells are not adjacent spatially (Figure 1)

Given these two factors, it is unlikely that the observed value errors for two wells produced a meaningful change to the multi-variate regression model.

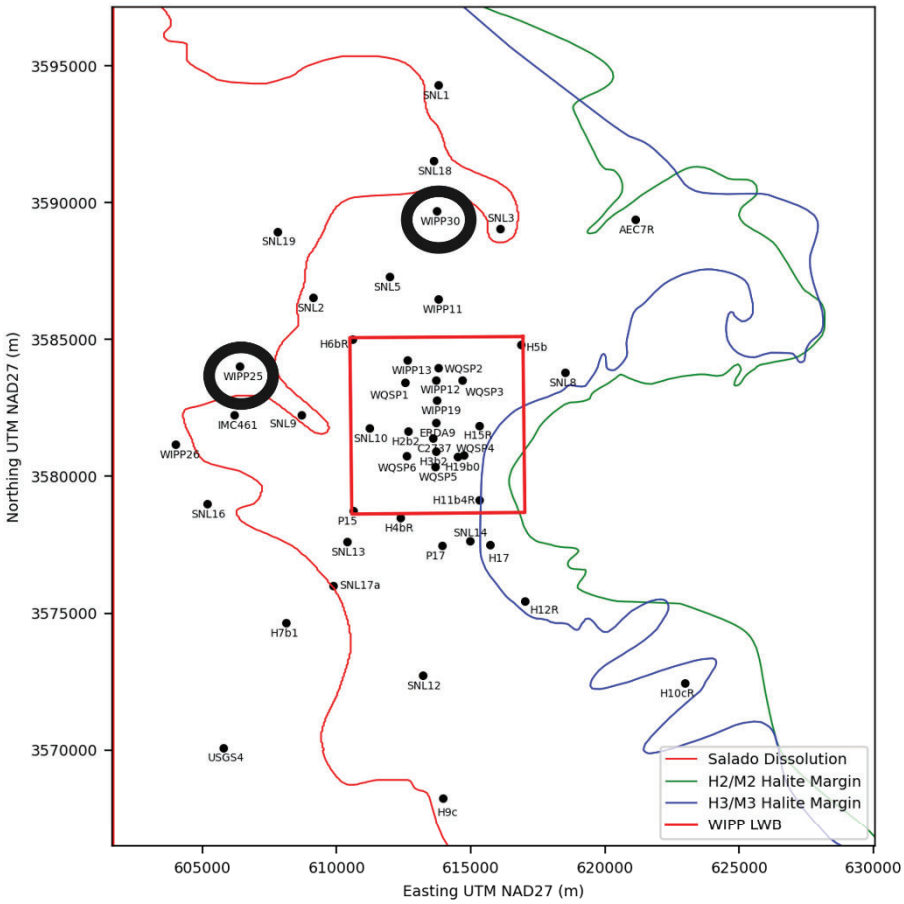

Figure 1: A map of the WIPP monitoring network with wells WIPP-25 and WIPP-30 circled in black.

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The second calculation in which the incorrect observed steady-state head values were used was during the T-field calibration targets. T-field calibration did not explicitly use the incorrect values, but rather, used them in the calculation of a distribution of calibration targets, and the calibration method minimized the impact of utilizing the incorrect observation value. In all T-field steady-state calibration cases, a set of PEST optimization targets was generated through the inclusion of noise distributed about the observed value for each well. These targets were constrained by the minimum and maximum head values observed at the well, and the distribution of noise followed the distribution modeled from the histogram of water level data observed at each well.

Figure 2 illustrates the WIPP-25 freshwater head observation value (Obs), calculated calibration targets (Obs+Noise), and calibrated T-field head results (Posterior). In an ideal version of Figure 2, the observed value would represent the mean of the Obs+Noise distribution and subsequently would be surrounded by the Obs+Noise histogram. Posterior values would then correlate to some degree with the Obs+Noise histogram depending on the goodness of fit of model results. In the case of WIPP-25, the incorrect (938 m) observation value was used to calculate observation targets (Obs+Noise), while utilizing the min/max values that bracket the correct observation value (934 m). The resulting PEST optimization target is less of a distribution of values and more of a singular value at approximately 934.45 m. Effectively, this shrunk the distribution of observation targets with a bias to a higher-than-normal value, though still inside the correct head observation value range. The posterior results of WIPP-25 surround the correct 934 m observation value.

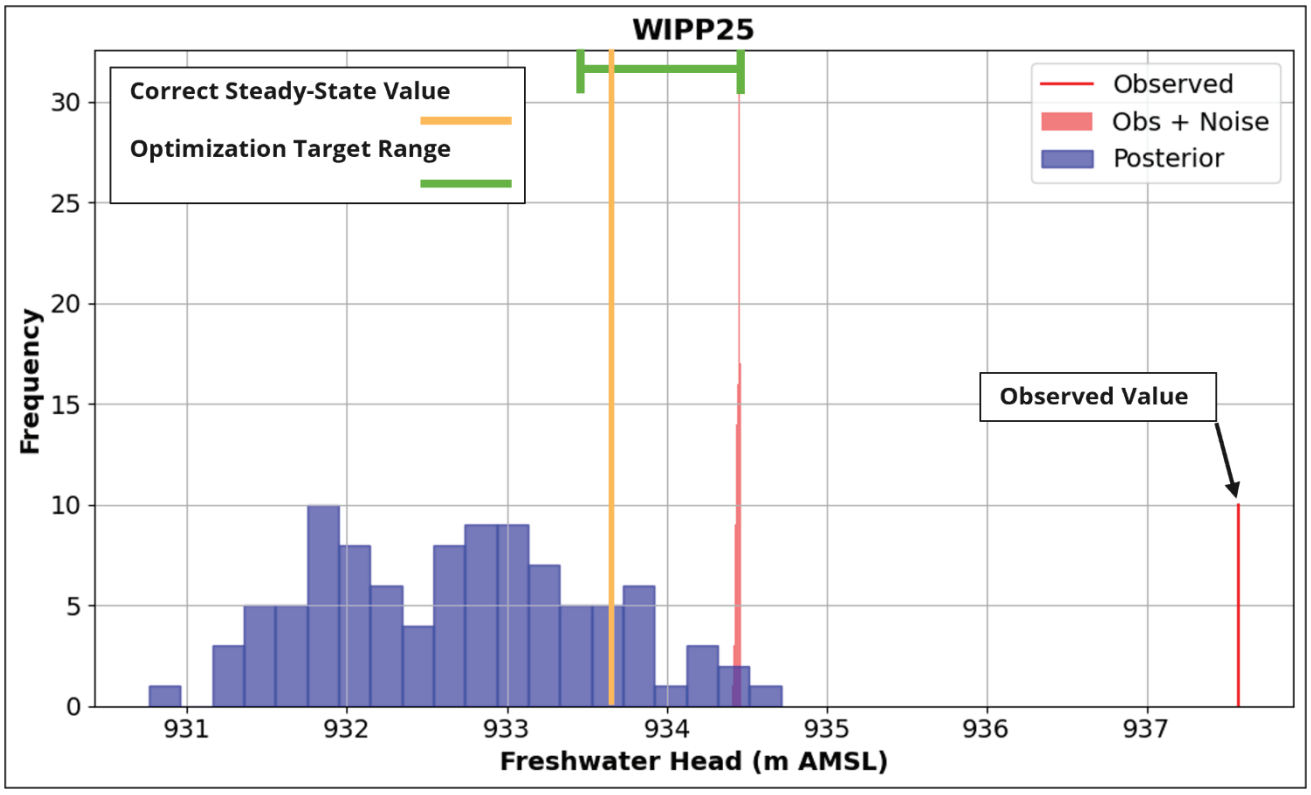

Figure 2: The correct (maroon) and utilized (red line) observed steady-state values used to generate observation targets (red histogram) within a correct range of values (green bracket). Posterior values

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which describe the resulting heads at WIPP-25 post calibration (blue histogram) surround the correct observation target.

In the case of WIPP-30, the incorrect observation value was also used to calculate similar observation targets, also bracketed with the correct min/max values. The resulting PEST optimization target still remains a distribution of values but is offset to a higher-than-normal value. Effectively, this increased the mean of the distribution by approximately 0.7 m, though still inside the correct head observation value range. The posterior results of WIPP-30 surround the correct observation value.

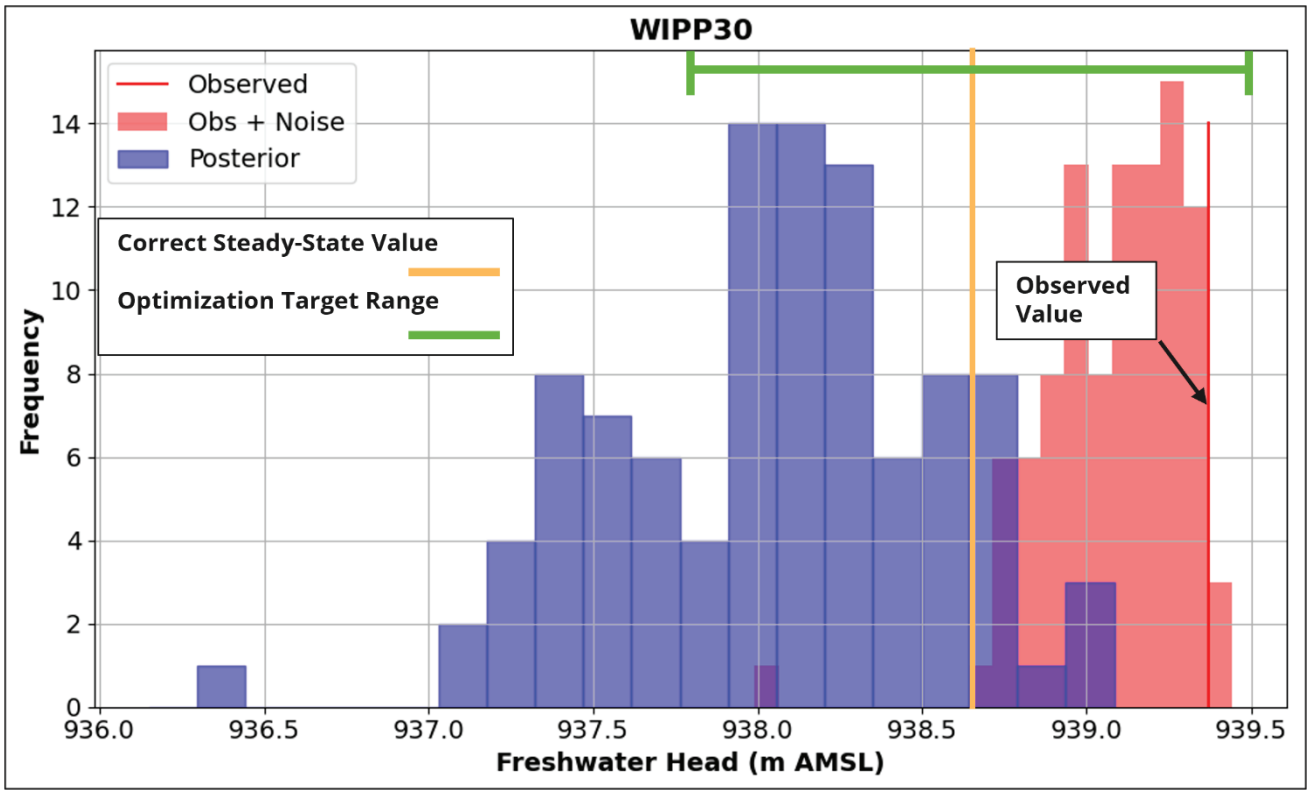

Figure 3: The correct (maroon) and utilized (red line) observed steady-state values used to generate observation targets (red histogram) within a correct range of values (green bracket). Posterior values which describe the resulting heads at WIPP-30 post calibration (blue histogram) surround the correct observation target.

Considering that the incorrect observation values were not explicitly used as calibration targets and the posterior results surround the correct observation values, these input errors likely have a minimal impact on the calibrated T-fields. With respect to performance assessment (PA) calculations, the difference in the WIPP-25 and WIPP-30 well heads are expected to have minimal impact on the PA results. The calibrated T-fields accommodate heads across a much broader global range than the intended WIPP-25/WIPP-30 head ranges, ensuring that uncertainty is accounted for despite the narrower input range. Additionally, potential releases through the Culebra are significantly lower than those from other release mechanisms, and a minor change in the T-fields will not alter this conclusion.

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References:

Bowman, D., R. Kushnereit, M. Pedrazas, P. Johnson, N. Deeds, and J. Pinkard. 2023. Analysis Report Documenting the Data, Generation, and Calibration of T-fields for CRA-2024. Carlsbad, NM: Sandia National Laboratories. ERMS 579507.

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