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Subject: RE: Gasco: DNAPL Mobility Meeting follow-up

Hi Wes,
As a follow up to our May 30, 2023 meeting to discuss the results of the DNAPL mobility evaluation, I am sending this email to summarize the conclusions and action items from the meeting to ensure we are all on the same page with regards to the use of the data in estimating the extent and volume of potentially mobile and residual DNAPL at the Gasco OU. Below is a summary of the conclusions and action items:

- DEQ will allow excluding the use of 1000G test data from the quantitative analysis but will require the use of an additional line of evidence, DNAPL movement at 100G, from the step tests. Adding this line of evidence changes one sample (DG-Core4-C1) from residual to potentially mobile at an initial DNAPL saturation value of 22.6%. DEQ is therefore interpreting 22.6% saturation as the cutoff between residual and potentially mobile DNAPL.

- DEQ agreed with our proposal to perform a sensitivity analysis regarding the distribution and volume of potentially mobile and immobile (residual) DNAPL. The sensitivity analysis would be bounded using DEQ's estimate (22.6%) and our estimate (35%) of the DNAPL saturation that represents the transition point from potentially mobile to residual DNAPL. For each value, we will go through the process of depicting the

distribution of potentially mobile and immobile DNAPL and calculating the volume of potentially mobile and residual DNAPL.

- The TarGOST %RE threshold value to estimate above or below 35% DNAPL saturation will be 80% RE. The TarGOST %RE threshold value to estimate above or below 22.6% DNAPL saturation will be 52%.

- All the TarGOST waveform groups will be treated equivalently for the purpose of applying TarGOST % RE data to identify potentially mobile or residual DNAPL. We will use these new data to perform 3-D depictions of the depths of potentially mobile and residual DNAPL at the TarGOST boring locations. We will also use the TarGOST data and other lines of evidence (DNAPL entry into wells, boring log descriptions, DNAPL mobility test results, etc.) to revise the MGP residuals maps.

Please let us know if DEQ agrees with these conclusions. We are developing an outline of the MGP residuals mapping process and DNAPL volume calculation process for review during our next technical meeting(s) and would appreciate confirmation regarding the above conclusions so that we can finalize the details for the next steps (DNAPL delineation and volume calculations).

Thanks,
Matt

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Subject: RE: Gasco: DNAPL Mobility Meeting follow-up

Matt,

Thank you for sharing the meeting slides from the April 4th and 20th DNAPL mobility meetings along with the DNAPL data gaps mobility assessment tables and DNAPL Mobility Summary table spreadsheets. We have prepared this email to provide information that we would like to discuss during our upcoming meeting on May 30th. We would like to focus on the following topics:

1. Path forward for estimating the DNAPL saturation representative of the transition between residual and potentially mobile.

2. Correlation of DNAPL mobility using the TarGOST reference emitter responses (%RE) and use of other empirical lines of evidence

To support these discussions, I have attached "DEQ EDITED" versions of the spreadsheets you shared along with some figures that show TarGOST responses relative to wells where DNAPL entry is occurring. Edited information in the spreadsheets is identified using dark red and bold font and have also embedded notes, where appropriate. Our primary edit to the data analysis is to revise the DNAPL mobility line of evidence criteria #1 from "DNAPL expressed from sample with 10G centrifuge force" to "DNAPL expressed from sample with 10G **and/or 100G** centrifuge force." We have also marked the "tarry" samples that you identified during our April 20th meeting in the spreadsheets.

For background, our approval of the DNAPL Data Gaps Investigation Work Plan was based on the understanding that DNAPL mobility in the Fill WBZ was complete for the purposes of the Feasibility Study (FS). Our objective was to collect additional DNAPL mobility information in the Alluvium WBZs to characterize DNAPL mobility in those WBZ. We observe that 17 of the 42 DNAPL mobility tests conducted in 2022 were from samples collected from the Fill WBZ. None of the DNAPL mobility plugs collected from Alluvium WBZ beneath the Gasco Site (excluding the Siltronic GSA) exceeded 13.55% saturation, thus providing limited information for understanding DNAPL mobility for DNAPL in the Alluvium at the Gasco Site, where (according to the Interim FS) there is approximately 1MM gallons of DNAPL. At this point in time, there is not enough DNAPL mobility data collected from the Alluvium WBZ beneath the Gasco Site to reliably estimate DNAPL saturation that represents the transition from residual to potentially mobile, and empirical evidence of potentially mobile DNAPL exists for this area. Given the available information, DEQ understands that, for the purposes of the FS, DNAPL mobility results from centrifuge testing will need to be combined across the Fill WBZ and Alluvium WBZ, and across all of the Gasco GSAs.

As we mentioned during our previous meetings, DEQ did not previously agree to exclude the single-step 1,000G DNAPL mobility test results from 2009. The request to exclude these data deviates from the approved DNAPL mobility approach presented in Appendix H of the Interim FS and was not proposed when DEQ approved the DNAPL Data Gaps Investigation Work Plan. While we agree that centrifuge testing conducted at 1,000G of centrifugal force is conservative, we believe that the lines of evidence proposed by Anchor QEA and identified in the Interim FS Appendix H appropriately counterbalance the conservatism of the 1,000G tests for the purpose of estimating the transition between residual and potentially mobile DNAPL, particularly at the FS-stage. Further, we believe that relying only on DNAPL mobility test results conducted at 10G for 1 hour introduces too much uncertainty and could lead to potentially overestimating the DNAPL saturation that represents the transition from residual to potentially mobile. However, we are willing to allow NW Natural to incorporate the 2009 single-step 1,000G test results into the Gasco OU FS for informational or contextual purposes, and rely on the 10G/100G results, as presented in the attached DEQ-edited spreadsheets, as the basis for estimating the transition between residual and potentially mobile DNAPL in the Gasco OU FS. By incorporating the 100G results from the step tests, as presented in the DEQ-edited spreadsheets, DEQ believes that the potential uncertainty in the DNAPL mobility results would be reduced to an acceptable %RE level. As you will see in the DEQ-edited spreadsheets, incorporating DNAPL expression from the 100G portion of the step test, the transition between residual and potentially mobile can be interpreted at a DNAPL saturation of 22.6%. DEQ has identified 8 non-tarry samples as 'transition zone residual,' 4 with DNAPL saturations less than 22.6%, and 4 with DNAPL saturations greater than 22.6%. These 'transition zone residual' samples are classified as residual based on the applications of the lines of evidence but were only assessed using a centrifugal force of 10G for 1 hour. The 'transition zone residual' samples are bound by P16A-C1 (classified as residual based on 1,000G test) and DG-CORE 6-B2 (classified as mobile at 10G and includes step-test results). In conclusion, NW Natural may either 1) include the 2009 1,000G DNAPL mobility tests as presented and approved in the Interim FS Appendix H, which would lead to an interpretation that the transition between residual and potentially mobile occurs at a DNAPL saturation of 20%, or 2) include the 2009 1,000G DNAPL tests for informational and contextual purposes and incorporate the 100G step test results consistent with DEQ's edited spreadsheets, which would lead to an interpretation that the transition between residual and potentially mobile occurs at a DNAPL saturation of 22.6%. DEQ does not agree that a DNAPL saturation of 35% represents a reliable estimate of the transition between residual and potentially mobile DNAPL. We expect additional DNAPL mobility testing may be necessary during remedial design to further refine our collective understanding of DNAPL mobility, depending on the selected remedial alternative.

For the second topic, we would like to discuss options for corelating the DNAPL saturation indicative of potential mobility with TarGOST %RE values and incorporate other empirical evidence (i.e., DNAPL entry into wells) into developing these relationships. In reviewing the April 4th meeting slides, we believe that the orange wave-form data show relatively good correlation between DNAPL saturation and TarGOST average %RE, but that the blue-green and yellow waveforms on their own do not (although we observe that the yellow waveform data may agree with the orange waveform data). Assuming the yellow waveform data agree with the orange waveform data, we would like to discuss whether blue-green waveform data warrant their own correlation and/or whether some of the blue-green waveform data may be representative of tarry materials, as opposed to oil, and should be excluded from the plot. Alternatively, the anomalous result that

produced a TarGOST %RE could be excluded and a separate correlation could be developed for green and blue waveforms respectively. DEQ acknowledges that there are limited green or blue waveform results, and developing correlations based on so few samples introduces uncertainty. Ultimately, we are concerned that DNAPL mobility should be interpreted for much lower TarGOST %RE for blue waveform data. In other words, the TarGOST %RE that represents potential mobility for orange waveform data would significantly underrepresent mobility of blue waveform data. We have also attached figures that overlay well screen (including filter pack) intervals onto nearby TarGOST boring logs. We would like to discuss how this information can be used to demonstrate that the relationships between DNAPL saturation and TarGOST %RE will reliably predict DNAPL mobility. To minimize estimates of potentially mobile and residual DNAPL mass/volume in the FS, it may be more appropriate to develop a range of criteria or lines of evidence that would be used to identify potential mobile DNAPL.

Thank you,

Wes

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Subject: RE: Gasco: DNAPL Mobility Meeting follow-up

Hi Wes,
Following up on the action items from our April 20th call to discuss the Gasco DNAPL mobility analysis, here are the two excel files that we reviewed during our call as well as a copy of the presentation slides.

The DNAPL data gaps mobility assessment tables include the results of the centrifuge testing, DNAPL transmissivity calculations, and the ASTM Weight of Evidence results for determining DNAPL mobility classifications. I have included the 2009 data that were from samples analyzed at 1000G, the 2018 data that were from samples analyzed using the multi-step approach, and the 2022 data that were from samples analyzed at 10G. The samples are ordered, left to right, from lowest to highest initial DNAPL saturation. Also, included on the last tab, is the sensitivity analysis for the 10G data.

The DNAPL Mobility Summary table summarizes all of the mobility results and also includes other relevant data, such as the GSA and WBZ that the sample was collected from, soil classification, and an estimated hydraulic conductivity value (using HydroGeoSieve) for the samples where grain size analysis was completed. The columns are filterable via the drop-down arrows located in row 2. By default, the rows are sorted from lowest to highest initial DNAPL saturation. Chart 1, the DNAPL mobility classification graph, will update automatically when you filter the data in the table.

Once you and your team have had a chance to review the data tables and slides, we can schedule a time to continue our discussion regarding the DNAPL mobility evaluation.

If you have any questions, don't hesitate to reach out.

Thanks,
Matt

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Thanks. Enjoy the weekend.

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Hi Wes –

During our call on April 4th, you mentioned that DNAPL movement occurred at DG-Core-22 in some samples with low DNAPL saturation values. Following the meeting, we checked the data and identified that the DNAPL saturation values for DG-Core-22 shown in Table 2 of the Upland FS DNAPL Data Gaps Investigation Data Package did not match the lab report included in Attachment E. Attached is the revised Table 2 with the cells highlighted that changed values from the previous version. We QA/QC-ed the entire table for consistency and all the other numbers matched the lab reports. However, we rounded the pore fluid saturation values to one decimal place in the revised summary table to match the data in the PDF version of the laboratory report. The discrepancies in the original summary table did not affect the DNAPL mobility evaluation results presented during the April 4 meeting. Apologies for any confusion.

John J. Renda, RG

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