July 29, 2022

Mr. Rick Shean
Chief, Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505

Ms. Leigh Barr
New Mexico Energy, Minerals & Natural Resources Department
Oil Conservation Division, Environmental Bureau
LeighP.Barr@state.nm.us

Re: Response to Comments in the June 6, 2022 Approval with Modifications, Status Report III—Groundwater and PSH Recovery System Enhancements Reinjection Pilot Test, March 2022
HollyFrontier Navajo Refining LLC – Artesia Refinery
EPA ID NO. NMD048918817
HWB-NRC-22-001

Dear Mr. Shean:

HollyFrontier Navajo Refining LLC (HFNR) is submitting this letter in response to the New Mexico Environment Department (NMED) letter dated June 6, 2022, regarding the March 2022 Status Report III—Groundwater and PSH Recovery System Enhancements Reinjection Pilot Test (Status Report). Below are HFNR's response to each of NMED's June 6, 2022 comments (shown in italics).

Response to NMED Comments

Comment 1

In the Aquifer Test section, page 2 of 9, paragraph 1, the Permittee states "[p]ressure transducers were placed in the injection wells, monitoring wells, and recovery wells in each pilot test area to measure the groundwater level prior to commencement and throughout the aquifer tests. Depths to water measurements were confirmed periodically with manual measurements using an oil-water interface probe." Although the Permittee states that water level measurements were confirmed at the beginning and throughout the pump test, the information was not provided in the Report. Tables 1 {Summary of Hydraulic Properties, RW-23 Pumping Test) and 2 {Summary of

Hydraulic Properties, RW-24 Pumping Test) summarize the hydraulic properties from the testing activities but there is no well information in these tables. In addition, the well distances from the recovery wells are also presented in tables but those data are found in the text of the Report. Provide a table that summarizes the well log information (i.e., well depth, screen interval, top of casing), the initial and final groundwater levels for each test, the initial and final depth to product, initial and final product thickness, and the duration of the test for each well. It would also be helpful to include information about any issues related to equipment and pumps and if the test had to be stopped prior to completion and why. Include this table with the response letter.

Response 1

Table 3 (attached) summarizes the well log information for each well monitored during the step-tests, constant rate tests, or injection tests, the initial and final depth to water and depth to product measurements manually recorded, as applicable, and the duration of the tests for each well.

Comment 2

In the Southern Pilot Test Area, Constant-Rate Pumping Test section, page 3 of 9, paragraphs 3 and 4, the Permittee states, "[h]ydraulic properties derived from the [the time/drawdown data] analyses are summarized in Table 1 [and r]esults of this [drawdown observed in the observation wells versus distance from recovery well RW-23] analysis are presented on Figure 3 and indicate a mean effective transmissivity and storativity of 567 ft^2/day and 5.7 x 10^{-4}, respectively." According to Table 1 (Summary of Hydraulic Properties RW-23 Pumping Test), the geomean transmissivity and storativity are recorded as 101.2 ft^2/day and 2.32 x 10^{-3}, respectively. The estimation of the aquifer properties appears to widely vary depending on selected analytical methods. Discuss the significance of the differences between the analytical methods for determining the aquifer properties and evaluate which calculated aquifer properties are more suitable to use for the pilot operations. In addition, provide a more detailed discussion (e.g., calculations, assumptions) about the aquifer properties obtained from each analytical method in the response letter.

Response 2

As indicated in the Status Report and in Table 1, three methods were used to estimate the transmissivity and storativity at various wells in the Southern Pilot Test Area depending on conditions unique to each well (e.g., well bore storage and delayed drainage – Moench and Neuman) and in the absence of such conditions, a method (Cooper-Jacob Straight Line) which could be fit to the data. The following table summarizes the differences in the assumptions that apply to each method:

Assumption	Cooper-Jacob	Neuman	Moench
The aquifer is infinite in areal extent	X	X	X
Aquifer is homogenous and has a uniform thickness	X	X	X
Aquifer is Isotropic	X	(1)	(1)
Pumping well fully penetrates the aquifer	X	NA	NA
Flow is unsteady	X	X	X
Water is released instantaneously from storage with decline in hydraulic head	X	(2)	(2)
Diameter of pumping well is small such that well bore storage can be neglected	X	X	(3)
Distance to pumped well is small and time is large	X	NA	NA
No delayed gravity response in aquifer	X	(2)	(2)
Flow is uniform and horizontal through vertical axis of well	X	NA	NA
Displacement small relative to initial saturated thickness	X	NA	NA
Initial hydraulic gradient is small	X	X	X

Notes:

(1) - Method accounts for anisotropy.
(2) - Method accounts for delayed gravity response.
(3) - Accounts for well bore storage if present.
Assumptions for Cooper-Jacob apply to both drawdown vs. time and drawdown vs distance analysis.
NA – Not Applicable

It is important to note that all pumping test solutions are subject to certain simplifying assumptions and as such, analytical methods used for pumping test analysis only provide estimates of hydraulic properties and spatial variation in transmissivity and storativity is expected, even when using the same method.

Two assumptions solely applicable to the Cooper-Jacob Method are isotropic conditions in the aquifer and the assumption that time is large. As a cone of depression continues to expand at a particular well location (drawdown has not reached pseudo-steady state), drawdown may be affected by several factors such as skin effects, well losses and aquifer heterogeneities encountered by the cone of depression (Harp and Vesselinov, 2013. *Accounting for the Influence of Aquifer Heterogeneity on Spatial Propagation of Pumping Drawdown*. Journal of Water Resources and Hydraulic Engineering. Volume 2, Issue 3, September 2013). Analysis of such data using the Cooper-Jacob Method can underestimate transmissivity.

A review of the Cooper-Jacob analysis of drawdown versus time for wells PMW-1 through PMW-3, RW-19, and IW-1 suggests that drawdown likely did not begin to approach pseudo-steady state conditions until the end of the test. For this reason, transmissivities for the Cooper-

Jacob analysis of drawdown versus time from these wells are likely low and should be viewed as a lower end bound. In contrast, the Cooper-Jacob analysis of drawdown versus distance used drawdowns from the end of the pumping test where drawdown more closely approximated pseudo-steady state conditions and can be considered to provide reasonable upper and lower bounding estimates of transmissivity and storativity, respectively.

The Newman and Moench Methods account for anisotropic conditions present in the aquifer as well as well bore storage in delayed gravity drainage observed in wells analyzed with these methods (RW-23, PMW-4 and PMW-5 in the Southern Pilot Test Area and RW-24, PMW-9 and PMW-10 in the Northern Pilot Test Area). The Newman and Moench Methods provided a good fit to the data and yielded comparable results for aquifer properties. For this reason, results from the Newman and Moench Methods are more representative of the aquifer in the vicinity of the pumped well.

Comment 3

In the Southern Pilot Test Area, Injection Test section, page 3 of 9, paragraph 6, the Permittee states, "[t]he injection test at 4 gpm was completed with a well seal, but the results indicated that the water rose in IW-1 to the top of the casing and leaked from the well cap." The pressurized injection was attempted over two days of the testing period according to Attachment 2 (Time Sequence Logs - Southern Pilot Test Area Injection Test). There is potential for the forced fluid injection to create fractures that may cause the injected fluid to bypass target zones of the aquifer matrix and prevent uniform distribution of fluids. The fractures caused by forced injection are irreversible and the activities from future injections may cause the injected fluids to flow through the same fractures. NMED recommends utilizing a reduced injection flowrate to distribute fluids more uniformly within the aquifer matrix. The maximum injection flowrate should not exceed the sustainable pumping rate unless the extraction of the groundwater can facilitate a higher injection flowrate. Include this provision in the next phase of the pilot test operations. No response is necessary.

Response 3

HFNR understands that the maximum injection flowrate should not exceed the sustainable pumping rate and will include this provision in the pilot test operations.

Comment 4

In the Southern Pilot Test Area, Injection Test section, page 4 of 9, paragraph 4, the Permittee states, "PMW-1 and RW-19 are nearest to IW-1 at approximately 44 feet downgradient and 56 feet upgradient, respectively. The observed connectivity is a positive indicator to support the subsequent steps planned for the pilot test to evaluate the distribution and effectiveness of larger

volumes and longer duration operations of extraction and amended injection." Based on the boring logs from the Permittee's October 28, 2021 Status Report II, the screened interval of well IW-1 was installed above the water table. Therefore, NMED is concerned that the screened intervals of the injection wells that are positioned above the water table may generate positively biased results for the shallow groundwater zone because the injection fluids may be distributed in a larger lateral extent at the water table interface. In order to evaluate and determine if a uniform distribution of injection fluid occurred throughout the screened interval during the pilot test, the Permittee must implement the groundwater monitoring program detailed in Comment 2 of the NMED's December 27, 2021 Letter. This provision must be included with the activities described in the next phase of the pilot test as described after the section titled, Incorporation of NMED Comments, and reported in the Phase IV Letter Report. In addition, it would have been helpful to include cross-section figures for both test areas to further support the Permittee's statement about the "observed connectivity." Include cross-section figures for both test areas in the final report.

Response 4

In response to Comment 2 of NMED's December 27, 2021 letter, HFNR indicated that packers can be installed to limit injection fluid movement above the water table during the actual operation of the pilot test reinjection system. Considering the expected operation rates (2 gallons per minute [gpm] or less) and hydrogeologic response observed at peripheral wells at these rates during the aquifer testing, HFNR expects that injection fluids will not be under pressure during application and the saturated hydraulic conductivity will likely be greater than capillary conductivity in the coarse-grained zone.

The electronic acceptor/tracer monitoring program suggested in Comment 2 of the NMED's December 27, 2021 letter, including samples from the water table and bottom of the pilot test monitoring wells, will be implemented as described below.

- Two samples will be collected from pilot study monitoring wells PMW-1 through PMW-11: one sample from the top of the water table and one sample from a depth near the bottom of the well screen.
- Each sample will be submitted for laboratory analysis of sulfate, bromide, and total Kjeldahl nitrogen (TKN).
- The vertical sampling frequency will be once during system start up, and again after approximately three months of continuous pilot test operation (i.e., when system reaches steady-state conditions).

Provided that the monitoring described above indicates adequate vertical distribution of the injection fluids and amendment at startup and after the system has reached steady state conditions, HFNR does not believe that vertical water column monitoring is necessary for the entire duration of the pilot test. As described in Section 5.4 of the approved *Revised Groundwater and Phase-Separated Hydrocarbon Recovery System Enhancements: Reinjection Pilot Test Work Plan* with replacement pages dated May 2020 (Work Plan), these parameters will be monitored at a frequency appropriate for determining injection system effectiveness.

Cross-sections of each pilot test area will be provided in the Final Report.

Comment 5

In the Northern Pilot Test Area, Stepped-Rate Drawdown Test section, page 5 of 9, paragraph 3, the Permittee states, "[a]t the beginning of the test, 0.78 feet of phase-separated hydrocarbon (PSH) was measured in the well [RW-24]. At the end of the test, the thickness of PSH had increased to 1.34 feet and the PSH-water interface appeared to be at the bottom of the screen as evidenced by PSH periodically observed in the discharge." Biostimulation technologies are not effective for the abatement of PSH. Although the pilot test data may be useful to develop design parameters for other in-situ remediation and/or containment technologies (e.g., PSH recovery), NMED continues to recommend removing PSH prior to the use of any enhanced biodegradation technologies. No response required.

Response 5

No response provided.

Comment 6

In the Northern Pilot Test Area, Stepped-Rate Drawdown Test section, page 5 of 9, paragraph 3, the Permittee states, "[t]o limit entrainment of PSH in the collected water which was to be used at IW-2 for the injection testing, the last step was terminated after 100 minutes of pumping." It is important that the extracted water containing PSH not be injected back in the system. Explain what measures will be taken to prevent this from occurring in the response letter. Furthermore, NMED recommends treating the extracted water so that PSH can be removed prior to being injected.

Response 6

HFNR recognizes the importance of not re-injecting extracted water that contains PSH. As described in the approved Work Plan, each recovery well will be fitted with a pneumatic product recovery pump and a separate submersible groundwater recovery pump (Section 5.2.2 and Appendix B). Section 5.2.6 and Figure 3 of the Work Plan describe the treatment of extracted

water and PSH removal with an oil-water separator. An oil-water separator is included in the pilot system design. As also described in Section 5.2.6, potential PSH in recovery wells will be measured weekly and continuously removed with a skimmer pump. PSH thickness and recovered volume will be documented and apparent improvements to PSH recovery will be noted.

Comment 7

In the Northern Pilot Test Area, Constant Rate Pump Test section, page 6 of 9, paragraph 1, the Permittee states that "[t]he constant-rate pumping test for RW-24 was initiated on December 16, 2021 at approximately 2 [gallons per minute (gpm)]. At 410 minutes (6.8 hours) into the test, the PSH-water interface had fallen to the bottom of the well screen, a sheen began to be observed in the discharge, and the pump was shut down. The discharge was isolated from the fluids used for the injection tests." Address the following in the response letter:

a. *Explain why the pump test at RW-24 was not run again at a lower pumping rate so that data could be collected over 24 hours. Furthermore, explain why 2 gpm was selected for the pumping rate if product was present at 1.34 feet during the step test at the rate of 2.24 gpm after running the test for 100 minutes. Additional step tests at lower pumping rates should have been run prior to completing the step test at 2.24 gpm to determine if product would be observed during those runs.*

b. *Explain if only a sheen was observed in the discharge or if product was also present in the discharge. State the amount of discharge that was separated from the fluids used for the injection tests and how it was disposed.*

Response 7

a. As stated in Section 5.2.3.1 of the approved Work Plan, the purpose of the pumping test was to characterize the hydrogeologic properties of the Shallow Saturated Zone. Based upon a review of data collected immediately following the constant-rate pumping test at RW-24, drawdown data had sufficiently stabilized in wells RW-24, PMW-9, PMW-10, and PWW-8 to characterize hydrogeologic properties of the Shallow Saturated Zone in the Northern Pilot Test Area. Therefore, the objective of the pumping test was deemed to have been met and performing another pumping test at RW-24 at a lower pumping rate was determined by the project team to be unwarranted. Furthermore, the approved Work Plan acknowledged that the constant rate test might need to be terminated early if unanticipated drawdown occurred and a constant rate was unable to be maintained for the planned test duration. The approved Work Plan also stated the pilot test wells were designed for the completion of the reinjection pilot test and are not optimal for pump testing.

As stated in the Status Report, PSH was initially present at a thickness of 0.78 feet prior to initiating the first pumping step at a discharge rate of 0.73 gpm and the thickness of PSH increased over the two additional steps performed at discharge rates of 1.47 gpm and 2.24 gpm, respectively. At the discharge rate of 1.47 gpm, drawdown appeared to approach quasi steady-state conditions with the depth to water 2.8 feet above the base of the bottom of the screen at the end of the pumping step test. Based upon extrapolation of the data, the fluid level after pumping for 24 hours was projected to be approximately 1.5 feet above the bottom of the screen. At the higher pumping rate of 2.24 gpm, PSH began to be recovered after 100 minutes of pumping indicating that the sustainable pumping rate over a 24-hour period without recovering PSH was greater than 1.5 gpm but less than 2.24 gpm. Based upon these data and the projected drawdown of 1.5 feet above the bottom of the well screen at 1.47 gpm, 2 gpm was determined to be a reasonable estimate of pumping rate for the constant rate test.

While additional steps may have refined the pumping rate for the constant rate test, PSH would likely still have been extracted at a lower pumping rate and early termination of the constant rate test in RW-24 would have been required considering the limited duration of each step inherent in stepped-rate tests and the desire to maximize drawdown during the constant rate pumping test. Regardless, the objective of the pumping test outlined in the Work Plan was deemed to have been met as noted above.

b. During the step-test and constant rate test at RW-24, recovered groundwater was first contained in a 1,000-gallon tank and then overflow was placed in the 4,000-gallon tank. No sheen was observed in the 1,000-gallon tank. Only a sheen was observed in the 4,000-gallon tank. No PSH was observed in the discharge and no measurable PSH was present in either tank. During the injection test at IW-2, approximately 360 gallons of recovered water was first pumped from the 1,000-gallon tank with the Geotech SS Geosub 2 pump into the injection well. Then approximately 340 gallons were pumped from the 4,000-gallon tank with the Grundfos Redi-Flo3 pump into the injection well. The Grundfos pump intake was placed in the 4,000-gallon tank sufficiently below the top of the fluid level to ensure no sheen was pumped into IW-2. Recovered water remaining in both tanks was removed by a vacuum truck and placed in a holding tank pending release into the refinery wastewater treatment system upstream of the oil/water separator.

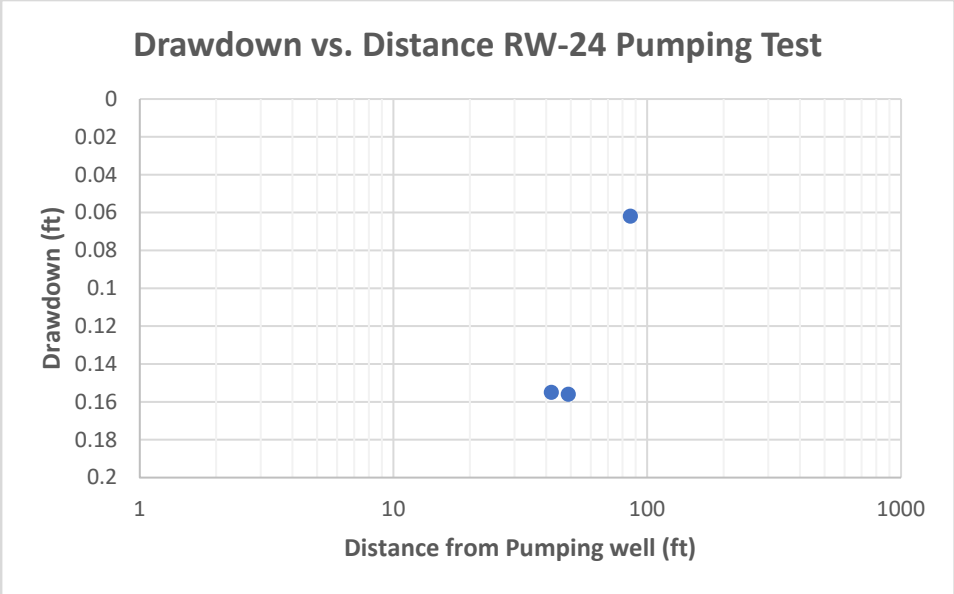
Comment 8

In the Northern Pilot Test Area, Constant Rate Pump Test section, page 6 of 9, paragraph 1, the Permittee states,"[d]rawdown and recovery data for RW-24 and the three wells that exhibited a response to pumping were analyzed using AQTESOLV. Data from the observation wells was

analyzed using the Neuman Solution because groundwater was unconfined and exhibited characteristics of delayed drainage. RW-24 was analyzed using the Moench Solution, which accounts for well bore storage effects present in the well." Although recovery well RW-24 was analyzed using the Moench Solution, the Permittee did not provide a figure similar to Figure 3 (Drawdown vs. Distance RW-23 Pumping Test) that provided additional information for determining transmissivity and storativity. Provide a figure with the same information as Figure 3 in the response letter.

Response 8

HFNR previously assessed the drawdown-distance relationship for the data collected during the RW-24 constant rate test for inclusion in the Status Report. Distance-drawdown plots for estimating transmissivity are constructed using simultaneous drawdown measurements obtained from a minimum of three observation wells spaced at sufficient distances from the pumped well such that the drawdowns form a pseudo-straight line. Data from the pumped well is not used in the analysis as drawdown in a pumped well is affected by head losses and may yield erroneous or misleading results. Although drawdown was measured in three wells, two of the wells (PMW-9 and PMW-10) are located approximately equidistant from the pumped well as shown on the plot below and exhibited nearly identical drawdowns. On this basis, PMW-9 and PMW-10 effectively function as a single point on a distance-drawdown plot and a meaningful trend could not be established. For this reason and to avoid misleading results, distance-drawdown analysis was not performed using the data for the RW-24 pumping test.



Comment 9

Figures 2 (Stepped Rate Test RW-23) and 6 (Stepped Rate Drawdown Test RW-24) summarize the data for the step rate drawdown tests; however, these figures do not provide any information about the initial water levels recorded prior to beginning the test. It would be helpful to provide the water level elevation and the screen length. Revise the figures to include this information with the response letter.

Response 9

Screen length and the initial water level elevation have been added to Figures 2 and Figure 6. The revised figures are numbered Figure 2A and Figure 6A and are attached.

Comment 10

Figure 3 (Drawdown vs. Distance RW-23 Pumping Test) is a graph that represents the analysis of drawdown in the observation wells versus distance from recovery well RW-23 to assess the mean effective transmissivity over the Southern Pilot Test Area. Results from this analysis indicate a mean effective transmissivity and storativity of 567 square feet per day (ft^2/day) and 5.7 $x10^{-4}$, respectively. The transmissivity and storativity were calculated using the equations presented on Figure 3. Explain why the transmissivity value of 4,243 gallons per day (gpd) was used to calculate the storativity, 0.00057, instead of using the converted transmissivity value of 567 ft2/day. In addition, explain why a full day was used to calculate the storativity when the test was stopped at 20.5 hours because the pump shutdown unexpectedly. Provide the explanation in the response letter.

Response 10

The forms of the equations presented on Figure 3, both for transmissivity and storativity, derive and use transmissivity with the units of gallons per day per foot (gpd/ft) (Driscoll, F.G, 1986. Groundwater and Wells, 2nd Edition. Johnson Division, St. Paul, MN. P. 2 36-237). The transmissivity of 4,243 gpd/ft is equivalent to 567 square feet per day (ft^2/day). The revised figure (attached) shows 567 ft^2/day in parentheses for clarification and the "=" sign was removed.

HFNR acknowledges the discrepancy in the time used to calculate storativity. A rounded time of 1 day was used in the calculation versus the actual time of 0.854 days (20.5 hours). A revised Figure 3A using the actual time is attached and shows a slightly lower storativity (0.00048).

If you should have any questions or comments regarding this status report, please feel free to contact me at (575) 746-5487 or Jason Leik at (214) 970-8902.

Sincerely,

Kawika Tupou
Environmental Manager
HollyFrontier Navajo Refining LLC

Attachments (4)

cc: NMED: D. Cobrain, L. Tsinnajinnie, M. Suzuki
HFC: J. Leik
TRC: J. Speer, C. Pearson, B. Oslund, S. Hoover, C. Smith

Table 3 - Well Information and Manual Water Level Gauging Data

Groundwater and PSH Recovery System Enhancements, Reinjection Pilot Test
HollyFrontier Navajo Refining LLC, Artesia Refinery, Artesia, New Mexico

Area	Well ID	Step, Constant Rate, or Injection Test [1]	Land Surface Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Top of Screen Elevation (ft amsl)	Screen Interval (ft bgs)	Well Depth (ft btoc)	Date Measured	Time Measured	Depth to PSH (ft btoc)	Depth to Water (ft btoc)	Corrected GW Elevation [2] (ft amsl)	PSH Thickness (ft)	Duration of Test (HH:MM) [3]	Comments[4]
Southern Wells	IW-1	Step	3,366.24	3,365.32	3,346.86	29.38-19.38	28.46	12/07/21	12:05	22.45	22.77	3,342.81	0.32	--	Initial measurement. Pump test at RW-23.
		Step						12/07/21	14:17	22.41	22.72	3,342.85	0.31	0:47	Last measurement recorded.
		Step						12/08/21	7:40	22.48	22.81	3,342.77	0.33	--	Initial measurement. Pump test at RW-23.
		Step						12/08/21	13:37	22.48	22.78	3,342.78	0.30	5:37	Last measurement recorded.
		Step						12/09/21	~ 10:10	22.48	22.49	3,342.84	0.01	--	Initial measurement.
		Constant Rate						12/10/21	~ 7:40	22.44	22.78	3,342.81	0.34	--	Initial measurement. Pump test at RW-23.
		Constant Rate						12/11/21	2:50	22.69	23.07	3,342.55	0.38	18:05	Last measurement recorded.
		Injection						12/13/21	8:55	22.50	22.88	3,342.74	0.38	--	Initial measurement.
		Injection						12/13/21	12:05	NM	NM	NM	NM	--	Start injection test with Geotech SS Geosub 2 pump.
		Injection						12/13/21	15:35	6.07	6.12	3,359.24	0.05	3:30	End injection test with Geotech SS Geosub 2 pump because reached maximum flow rate for pump.
		Injection						12/13/21	16:47	NM	NM	NM	NM	--	Start injection test with Grundfos Redi-Flo3 pump and sealed well cap (no water level measurements recorded).
		Injection						12/13/21	18:08	NM	NM	NM	NM	1:21	End injection test with Grundfos Redi-Flo3 pump.
		Injection						12/14/21	8:20	NM	NM	NM	NM	--	Start injection test with Grundfos Redi-Flo3 pump and sealed well cap (no water level measurements recorded).
		Injection						12/14/21	9:41	NM	NM	NM	NM	1:21	End injection test with Grundfos Redi-Flo3 pump when groundwater started leaking from well (cap unable to prevent water from leaking).
		Injection						12/14/21	11:40	21.78	21.79	3,343.54	0.01	--	Initial measurement.
		Injection						12/14/21	11:45	NM	NM	NM	NM	--	Start injection test with Grundfos Redi-Flo3 pump.
		Injection						12/14/21	13:05	--	2.72	3,366.27	--	1:20	Last measurement recorded.
		Injection						12/14/21	13:15	NM	NM	NM	NM	1:30	End injection test with Grundfos Redi-Flo3 pump.
	PMW-1	Step	3366.19	3368.99	3345.61	30.58-20.58	33.38	12/07/21	11:58	--	26.68	3,342.31	--	--	Initial measurement. Pump test at RW-23.
		Step						12/07/21	14:13	--	26.68	3,342.31	--	0:43	Last measurement recorded.
		Step						12/08/21	~ 7:43	--	26.72	3,342.27	--	--	Initial measurement. Pump test at RW-23.
		Step						12/08/21	13:34	--	26.69	3,342.30	--	5:34	Last measurement recorded.
		Step						12/09/21	10:09	--	26.68	3,342.31	--	--	Initial measurement. Pump test at RW-23. No additional measurement recorded.
		Constant Rate						12/10/21	7:38	--	26.69	3,342.30	--	--	Initial measurement. Pump test at RW-23.
		Constant Rate						12/11/21	2:51	26.92	26.93	3,342.07	0.01	18:06	Last measurement recorded.
		Injection						12/13/21	9:50	--	26.77	3,342.22	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/13/21	12:38	--	26.69	3,342.30	--	0:33	Last measurement recorded.
		Injection						12/14/21	7:43	--	26.76	3,342.23	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/14/21	9:43	--	26.52	3,342.47	--	1:23	Last measurement recorded (measurement recorded two minutes after first portion of test ended)
		Injection						12/14/21	12:01	--	26.60	3,342.39	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/14/21	13:11	--	26.44	3,342.55	--	1:26	Last measurement recorded.
	PMW-2	Step	3,365.98	3,368.92	3,345.40	30.58-20.58	33.52	12/07/21	11:52	--	27.00	3,341.99	--	--	Initial measurement. Pump test at RW-23.
		Step						12/07/21	14:07	--	26.99	3,342.00	--	0:37	Last measurement recorded.
		Step						12/08/21	~ 7:46	--	27.02	3,341.97	--	--	Initial measurement. Pump test at RW-23.
		Step						12/08/21	13:30	--	27.04	3,341.95	--	5:30	Last measurement recorded.
		Step						12/09/21	10:07	--	27.03	3,341.96	--	--	Initial measurement. Pump test at RW-23. No additional measurement recorded.
		Constant Rate						12/10/21	7:32	--	27.00	3,341.99	--	--	Initial measurement. Pump test at RW-23.
		Constant Rate						12/11/21	2:54	27.26	27.27	3,341.66	0.01	18:09	Last measurement recorded.
		Injection						12/13/21	9:54	--	27.10	3,341.89	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/13/21	12:41	--	27.04	3,341.95	--	0:36	Last measurement recorded.
		Injection						12/14/21	7:49	--	27.91	3,341.08	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/14/21	8:42	--	27.06	3,341.93	--	0:22	Last measurement recorded.
		Injection						12/14/21	12:04	--	26.96	3,342.03	--	0:19	Last measurement recorded. Injection test at IW-1. No initial measurement recorded.

Table 3 - Well Information and Manual Water Level Gauging Data

Groundwater and PSH Recovery System Enhancements, Reinjection Pilot Test

HollyFrontier Navajo Refining LLC, Artesia Refinery, Artesia, New Mexico

Area	Well ID	Step, Constant Rate, or Injection Test [1]	Land Surface Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Top of Screen Elevation (ft amsl)	Screen Interval (ft bgs)	Well Depth (ft btoc)	Date Measured	Time Measured	Depth to PSH (ft btoc)	Depth to Water (ft btoc)	Corrected GW Elevation [2] (ft amsl)	PSH Thickness (ft)	Duration of Test (HH:MM) [3]	Comments[4]
Southern Wells	PMW-3	Step	3,365.79	3,368.46	3,345.21	30.58-20.58	33.25	12/07/21	11:48	--	26.99	3,342.00	--	--	Initial measurement. Pump test at RW-23.
		Step						12/07/21	14:06	--	26.96	3,342.03	--	0:36	Last measurement recorded.
		Step						12/08/21	~7:48	--	27.03	3,341.96	--	--	Initial measurement. Pump test at RW-23.
		Step						12/08/21	13:26	--	27.09	3,341.90	--	5:26	Last measurement recorded.
		Step						12/09/21	10:05	--	26.97	3,342.02	--	--	Initial measurement. Pump test at RW-23. No additional measurement recorded.
		Constant Rate						12/10/21	7:30	--	26.98	3,342.01	--	--	Initial measurement. Pump test at RW-23.
		Constant Rate						12/11/21	2:59	--	27.29	3,341.70	--	18:14	Last measurement recorded.
		Injection						12/13/21	10:03	--	27.07	3,341.92	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/13/21	12:53	--	27.00	3,341.99	--	0:48	Last measurement recorded.
		Injection						12/14/21	7:52	--	27.05	3,341.94	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/14/21	8:46	--	27.03	3,341.96	--	0:26	Last measurement recorded.
		Injection						12/14/21	12:07	--	26.95	3,342.04	--	0:22	Last measurement recorded. Injection test at IW-1. No initial measurement recorded.
	PMW-4	Step	3,365.23	3,368.06	3,345.23	30.0-20.0	32.83	12/07/21	11:45	--	26.99	3,342.00	--	--	Initial measurement. Pump test at RW-23.
		Step						12/07/21	14:02	--	26.98	3,342.01	--	0:32	Last measurement recorded.
		Step						12/08/21	~ 7:52	--	27.04	3,341.95	--	--	Initial measurement. Pump test at RW-23.
		Step						12/08/21	13:21	--	27.20	3,341.79	--	5:21	Last measurement recorded.
		Step						12/09/21	10:03	--	27.01	3,341.98	--	--	Initial measurement. Pump test at RW-23.
		Step						12/09/21	13:07	--	27.19	3,341.80	--	2:37	Last measurement recorded.
		Constant Rate						12/10/21	7:23	--	26.96	3,342.03	--	--	Initial measurement. Pump test at RW-23.
		Constant Rate						12/11/21	3:02	--	27.41	3,341.58	--	18:17	Last measurement recorded.
		Injection						12/13/21	10:07	--	27.05	3,341.94	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/13/21	13:07	--	27.01	3,341.98	--	1:02	Last measurement recorded.
		Injection						12/14/21	7:54	--	27.30	3,341.69	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/14/21	8:48	--	27.04	3,341.95	--	0:28	Last measurement recorded.
		Injection						12/14/21	12:09	--	26.97	3,342.02	--	0:24	Last measurement recorded. Injection test at IW-1. No initial measurement recorded.
	PMW-5	Step	3,365.20	3,368.27	3,345.20	30.0-20.0	33.07	12/07/21	11:41	--	27.75	3,341.24	--	--	Initial measurement. Pump test at RW-23.
		Step						12/07/21	14:00	--	27.77	3,341.22	--	0:30	Last measurement recorded.
		Step						12/08/21	7:55	--	27.77	3,341.22	--	--	Initial measurement. Pump test at RW-23.
		Step						12/08/21	13:31	--	27.99	3,341.00	--	5:31	Last measurement recorded.
		Step						12/09/21	10:00	--	27.76	3,341.23	--	--	Initial measurement. Pump test at RW-23.
		Step						12/09/21	13:00	--	27.96	3,341.03	--	2:30	Last measurement recorded.
		Constant Rate						12/10/21	7:21	--	27.78	3,341.21	--	--	Initial measurement. Pump test at RW-23.
		Constant Rate						12/11/21	3:05	--	28.16	3,340.83	--	18:20	Last measurement recorded.
		Injection						12/13/21	10:05	--	27.84	3,341.15	--	--	Initial measurement. Injection test at IW-1. No additional measurement recorded.
		Injection						12/14/21	7:58	--	27.82	3,341.17	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/14/21	8:55	--	27.82	3,341.17	--	0:35	Last measurement recorded.
		Injection						12/14/21	12:15	--	27.77	3,341.22	--	0:30	Last measurement recorded. Injection test at IW-1. No initial measurement recorded.
	RW-19	Step	3,367.09	NM	NM	35.0-15.0	57.17	12/09/21	~ 10:00	25.69	27.53	--	1.84	--	Initial measurement. Pump test at RW-23. No additional measurement recorded.
		Constant Rate						12/10/21	7:44	25.65	27.52	--	1.87	--	Initial measurement. Pump test at RW-23. No additional measurement recorded.
		Injection						12/13/21	9:59	25.75	27.63	--	1.88	--	Initial measurement. Injection test at IW-1. No additional measurement recorded.
		Injection						12/14/21	~ 8:02	25.73	27.61	--	1.88	--	Initial measurement. Injection test at IW-1. No additional measurement recorded.
		Injection						12/14/21	10:06	25.55	27.40	--	1.85	1:46	Last measurement recorded.

Table 3 - Well Information and Manual Water Level Gauging Data

Groundwater and PSH Recovery System Enhancements, Reinjection Pilot Test

HollyFrontier Navajo Refining LLC, Artesia Refinery, Artesia, New Mexico

Area	Well ID	Step, Constant Rate, or Injection Test [1]	Land Surface Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Top of Screen Elevation (ft amsl)	Screen Interval (ft bgs)	Well Depth (ft btoc)	Date Measured	Time Measured	Depth to PSH (ft btoc)	Depth to Water (ft btoc)	Corrected GW Elevation [2] (ft amsl)	PSH Thickness (ft)	Duration of Test (HH:MM) [3]	Comments[4]
Northern Wells	RW-23	Step	3,365.17	3,367.38	3,345.17	35.21-20.21	37.21	12/07/21	12:10	--	26.60	3,342.39	--	--	Initial measurement.
		Step						12/07/21	13:30	NM	NM	NM	NM	--	Start step test with Geotech SS Geosub 2 pump.
		Step						12/07/21	15:58	--	27.81	3,341.18	--	2:28	Last measurement recorded.
		Step						12/07/21	16:21	NM	NM	NM	NM	2:51	End step test.
		Step						12/08/21	7:50	--	26.68	3,342.31	--	--	Initial measurement.
		Step						12/08/21	8:00	NM	NM	NM	NM	--	Start step test with Geotech SS Geosub 2 pump.
		Step						12/08/21	14:04	--	31.40	3,337.59	--	6:04	Last measurement recorded.
		Step						12/08/21	14:05	NM	NM	NM	NM	6:05	End step test.
		Step						12/09/21	10:22	--	26.61	3,342.38	--	--	Initial measurement.
		Step						12/09/21	10:30	NM	NM	NM	NM	--	Start step test with Geotech SS Geosub 2 pump.
		Step						12/09/21	11:12	--	31.90	3,337.09	--	0:42	End step test. Last measurement recorded.
		Step						12/09/21	11:44	--	26.65	3,342.34	--	--	Initial measurement.
		Step						12/09/21	11:45	NM	NM	NM	NM	--	Start step test with Geotech SS Geosub 2 pump.
		Step						12/09/21	14:14	--	31.95	3,337.04	--	2:29	Last measurement recorded.
		Step						12/09/21	14:33	NM	NM	NM	NM	2:48	End step test.
		Constant Rate						12/10/21	8:35	--	26.60	3,342.39	--	--	Initial measurement.
		Constant Rate						12/10/21	8:45	--	26.60	3,342.39	--	--	Start constant rate test with Geotech SS Geosub 2 pump.
		Constant Rate						12/11/21	5:45	--	1.19	3,367.80	--	21:00	Observed pump unexpectedly shut down. Subsequent data unsuitable for evaluating hydraulic properties.
		Injection						12/13/21	10:09	--	26.70	3,342.29	--	--	Initial measurement. Injection test at IW-1. No additional measurement recorded.
		Injection						12/14/21	7:56	--	26.69	3,342.30	--	--	Initial measurement. Injection test at IW-1.
		Injection						12/14/21	8:51	--	26.68	3,342.31	--	0:31	Last measurement recorded.
		Injection						12/14/21	12:13	--	26.62	3,342.37	--	0:28	Last measurement recorded. Injection test at IW-1. No initial measurement recorded.
	IW-2	Step	3,360.86	3,359.94	3,340.48	30.38-20.38	29.46	12/15/21	8:54	21.53	21.96	3,338.32	0.43	--	Initial measurement. Pump test at RW-24.
		Step	3,358.62	3,360.83	Unknown			12/15/21	13:44	21.49	21.89	3,338.37	0.40	4:44	Last measurement recorded.
		Constant Rate						12/16/21	7:06	21.54	22.00	3,338.31	0.46	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	11:42	21.52	21.98	3,338.33	0.46	3:27	Last measurement recorded.
		Injection						12/17/21	10:40	20.96	21.39	3,338.33	0.43	--	Initial measurement.
		Injection						12/17/21	10:45	NM	NM	NM	NM	--	Turned on pump but promptly turned off due to error with the pump control box.
		Injection						12/17/21	10:50	NM	NM	NM	NM	--	Start injection test with Geotech SS Geosub 2 pump.
		Injection						12/17/21	11:45	--	19.22	3,338.33	--	0:55	End injection test.
		Injection						12/17/21	12:45	21.44	21.70	3,338.33	0.26	--	Initial measurement.
		Injection						12/17/21	12:50	NM	NM	NM	NM	--	Start injection test with Geotech SS Geosub 2 pump.
		Injection						12/17/21	15:02	NM	NM	NM	NM	2:12	Switched to Grundfos Redi-Flo3 pump because maximum flow rate was reached with the Geotech SS Geosub 2 pump.
		Injection						12/17/21	16:00	--	12.50	3,338.33	--	3:10	Last measurement recorded.
		Injection						12/17/21	16:08	NM	NM	NM	NM	3:18	End injection test.
	MW-131	Step	3354.30	3357.12	3334.30	50.0-20.0	52.82	12/15/21	8:50	25.41	26.47	3,331.50	1.06	--	Initial measurement. Pump test at RW-24.
		Step						12/15/21	13:21	25.41	26.49	3,331.49	1.08	4:21	Last measurement recorded.
		Constant Rate						12/16/21	7:12	25.45	26.55	3,331.45	1.10	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	12:21	25.44	26.53	3,331.46	1.09	4:06	Last measurement recorded.
		Injection						12/17/21	8:41	25.43	26.53	3,331.47	1.10	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	15:31	25.39	26.43	3,331.52	1.04	2:41	Last measurement recorded.
	PMW-6	Step	3361.22	3364.14	3341.22	30.0-20.0	32.92	12/15/21	7:45	--	25.42	3,343.57	--	--	Initial measurement. Pump test at RW-24.
		Step						12/15/21	13:49	--	25.41	3,343.58	--	4:49	Last measurement recorded.
		Constant Rate						12/16/21	7:03	--	25.51	3,343.48	--	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	11:38	--	25.48	3,343.51	--	3:23	Last measurement recorded.
		Injection						12/17/21	8:47	--	25.49	3,343.50	--	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	15:29	--	25.41	3,343.58	--	2:39	Last measurement recorded.
	PMW-7	Step	3,360.76	3,363.64	3,340.76	30.0-20.0	32.88	12/15/21	8:52	--	25.38	3,343.61	--	--	Initial measurement. Pump test at RW-24.
		Step						12/15/21	13:40	--	25.39	3,343.60	--	4:40	Last measurement recorded.
		Constant Rate						12/16/21	7:09	--	25.44	3,343.55	--	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	12:24	--	25.41	3,343.58	--	4:09	Last measurement recorded.
		Injection						12/17/21	8:43	--	25.41	3,343.58	--	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	15:25	--	25.29	3,343.70	--	2:35	Last measurement recorded.

Table 3 - Well Information and Manual Water Level Gauging Data

Groundwater and PSH Recovery System Enhancements, Reinjection Pilot Test
HollyFrontier Navajo Refining LLC, Artesia Refinery, Artesia, New Mexico

Area	Well ID	Step, Constant Rate, or Injection Test [1]	Land Surface Elevation (ft amsl)	Top of Casing Elevation (ft amsl)	Top of Screen Elevation (ft amsl)	Screen Interval (ft bgs)	Well Depth (ft btoc)	Date Measured	Time Measured	Depth to PSH (ft btoc)	Depth to Water (ft btoc)	Corrected GW Elevation [2] (ft amsl)	PSH Thickness (ft)	Duration of Test (HH:MM) [3]	Comments[4]
Northern Wells	PMW-8	Step	3,360.37	3,363.35	3,340.37	30.0-20.0	32.98	12/15/21	8:49	25.43	25.64	3,337.88	0.21	--	Initial measurement. Pump test at RW-24.
		Step						12/15/21	12:58	25.44	25.66	3,337.87	0.22	3:58	Last measurement recorded.
		Constant Rate						12/16/21	7:18	25.49	25.70	3,337.82	0.21	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	12:12	25.48	25.72	3,337.82	0.24	3:57	Last measurement recorded.
		Injection						12/17/21	8:38	--	25.47	3,343.52	--	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	15:33	25.44	25.66	3,337.87	0.22	2:43	Last measurement recorded.
	PMW-9	Step	3,360.25	3,363.14	3,340.25	30.0-20.0	32.89	12/15/21	8:48	--	-- [5]	--	--	--	Initial measurement. Pump test at RW-24.
		Step						12/15/21	13:08	25.31	26.49	3,337.59	1.18	4:08	Last measurement recorded.
		Constant Rate						12/16/21	7:20	25.27	26.42	3,337.64	1.15	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	13:50	25.36	26.55	3,337.54	1.19	5:35	Last measurement recorded.
		Injection						12/17/21	8:35	25.26	26.40	3,337.65	1.14	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	15:36	25.23	26.36	3,337.68	1.13	2:46	Last measurement recorded.
	PMW-10	Step	3,360.08	3,362.90	3,340.08	30.0-20.0	32.82	12/15/21	8:07	--	25.59	3,343.40	--	--	Initial measurement. Pump test at RW-24.
		Step						12/15/21	13:01	--	25.73	3,343.26	--	4:01	Last measurement recorded.
		Constant Rate						12/16/21	7:23	--	25.68	3,343.31	--	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	14:05	--	25.78	3,343.21	--	5:50	Last measurement recorded.
		Injection						12/17/21	8:27	--	25.67	3,343.32	--	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	15:43	--	25.64	3,343.35	--	2:53	Last measurement recorded.
	PMW-11	Step	3,359.05	3,361.94	3,339.05	30.0-20.0	32.89	12/15/21	8:11	24.97	26.19	3,336.73	1.22	--	Initial measurement. Pump test at RW-24.
		Step						12/15/21	13:54	24.94	26.19	3,336.75	1.25	4:54	Last measurement recorded.
		Constant Rate						12/16/21	7:25	25.06	26.29	3,336.63	1.23	--	Initial measurement. Pump test at RW-24.
		Constant Rate						12/16/21	14:08	25.01	26.24	3,336.68	1.23	5:53	Last measurement recorded.
		Injection						12/17/21	8:20	25.04	26.29	3,336.65	1.25	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	17:49	25.02	26.28	3,336.67	1.26	4:59	Last measurement recorded.
	RW-24	Step	3,360.30	3,362.38	3,340.30	35.0-20.0	37.08	12/15/21	8:55	24.72	25.50	3,337.50	0.78	--	Initial measurement.
		Step						12/15/21	9:00	NM	NM	NM	NM	--	Start step test with Geotech SS Geosub 2 pump.
		Step						12/15/21	14:15	29.88	31.92	3,332.09	2.04	5:15	Last measurement recorded.
		Step						12/15/21	14:17	NM	NM	NM	NM	5:17	End step test.
		Constant Rate						12/16/21	8:10	24.75	25.79	3,337.42	1.04	--	Initial measurement.
		Constant Rate						12/16/21	8:15	NM	NM	NM	NM	--	Start constant rate test with Geotech SS Geosub 2 pump.
		Constant Rate						12/16/21	15:03	29.16	32.07	3,332.64	2.91	6:48	Last measurement recorded.
		Constant Rate						12/16/21	15:05	NM	NM	NM	NM	6:50	End constant rate test.
		Injection						12/17/21	8:33	24.68	26.10	3,337.42	1.42	--	Initial measurement. Injection test at IW-2.
		Injection						12/17/21	15:54	24.64	26.06	3,337.46	1.42	3:04	Last measurement recorded.

Notes:

[1] Observation wells for the injection/step/constant rate tests at the southern wells: PMW-1 through PMW-5, RW-19, IW-1 during the step/constant rates tests, and/or RW-23 during the injection tests; Observation wells for the injection/step/constant rate tests at the northern wells: PMW-6 through PMW-11, MW-131, IW-2 during step/constant rate tests, and/or RW-24 during injection tests.

[2] Water elevations corrected for PSH, if present, using a specific gravity of 0.8.

[3] At observation wells, "Duration of Test" calculated by the time elapsed between the start of the test at the injection/Pump test well and the last measurement recorded at the observation well.

[4] Initial measurement recorded before test began. Last measurement recorded is the closest field data available to the final (end of test) measurement.

[5] Depth to water recorded in field at PMW-9 on 12/15/2021 at 08:48 (25.23 ft btoc) is likely a field error and should not be used.

ft = feet
~ = approximate time measured
-- = not applicable
amsl = above mean sea level
bgs = below ground surface
btoc = below top of casing
GW = groundwater
PSH = Phase Separated Hydrocarbon
NM = Not Measured
HH:MM = Hour:Minutes

Figure 2A
Stepped Rate Test RW-23
1 gpm, 2 gpm, 2.48 gpm and 2.75 gpm Steps

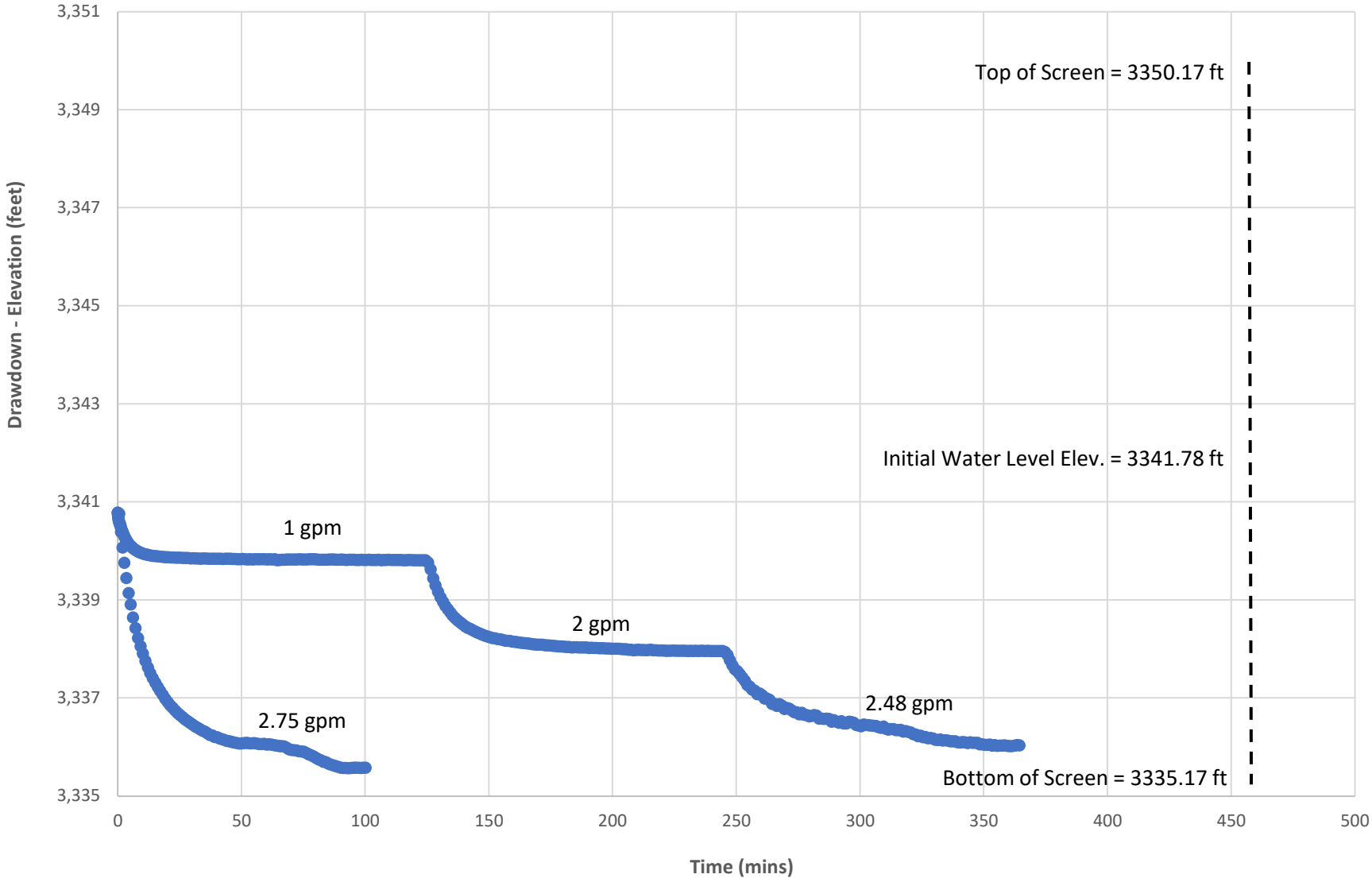


Figure 3A
Drawdown vs. Distance RW-23 Pumping Test

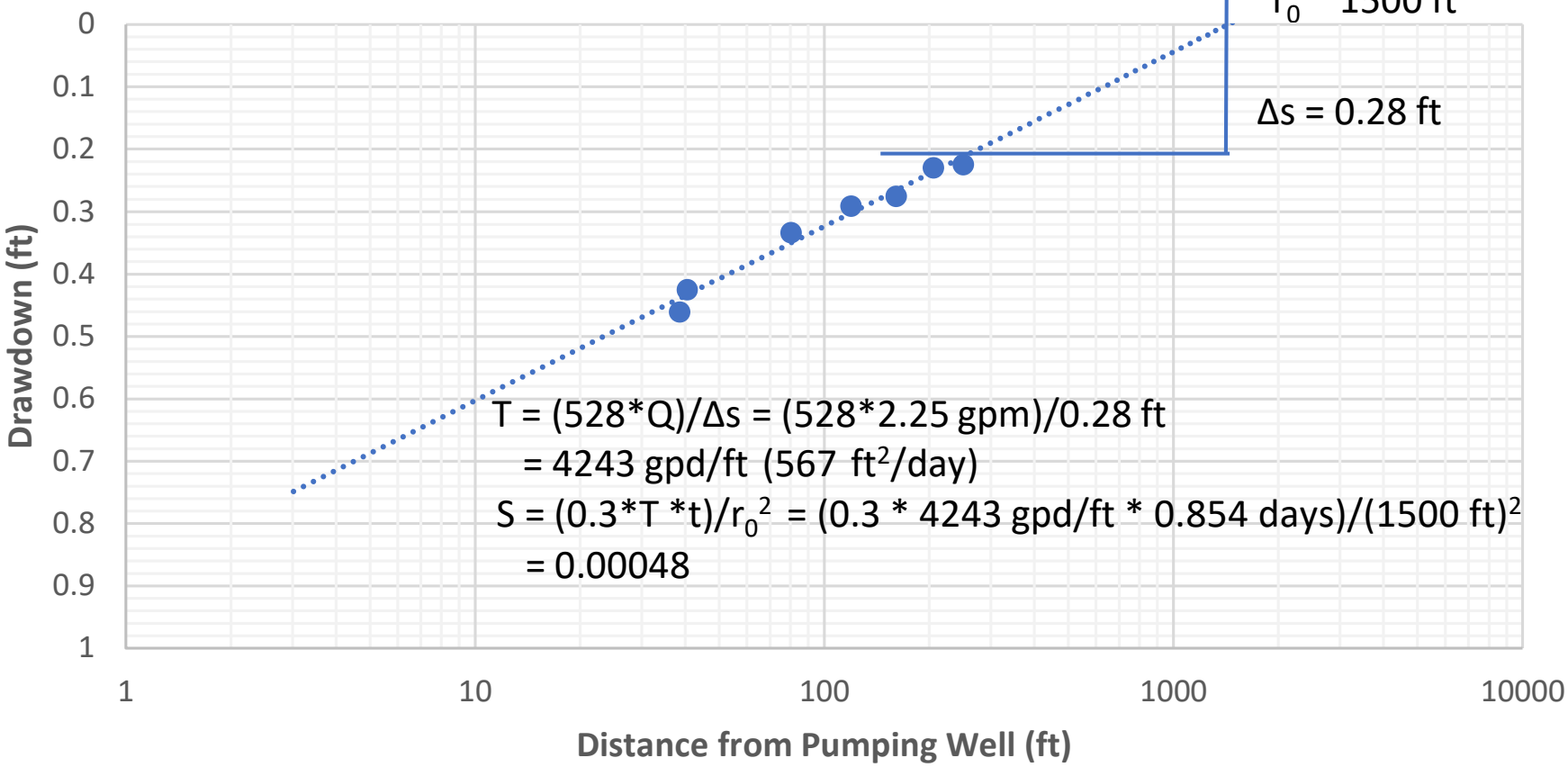
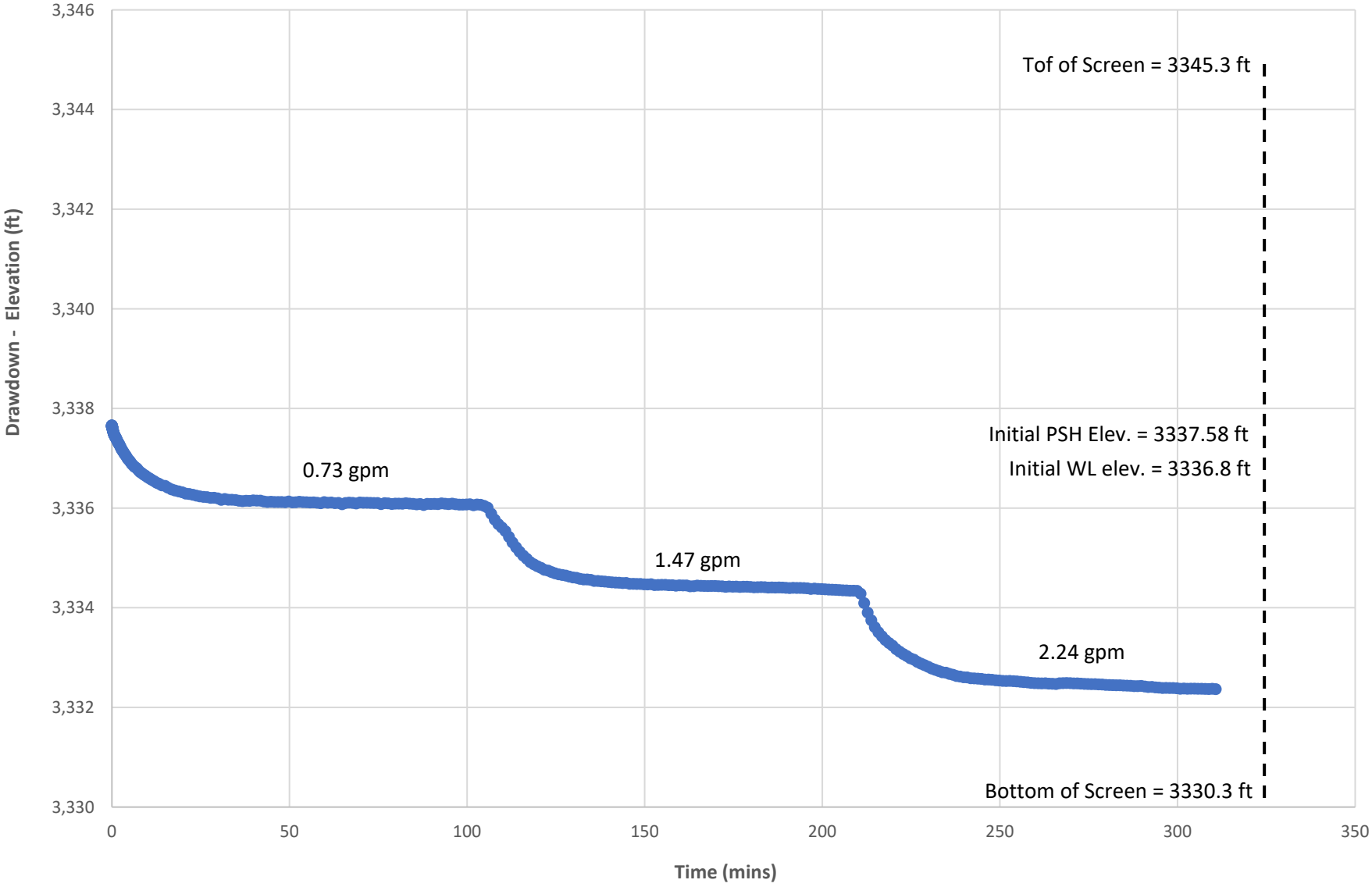


Figure 6A
Stepped Rate Drawdown Test RW-24
0.73 gpm, 1.47 gpm, and 2.24 gpm



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State of New Mexico
Energy, Minerals and Natural Resources
Oil Conservation Division
1220 S. St Francis Dr.
Santa Fe, NM 87505

CONDITIONS

Action 129820

CONDITIONS

Operator: HF Sinclair Navajo Refining LLC ATTN: GENERAL COUNSEL Dallas, TX 75201	OGRID: 15694
	Action Number: 129820
	Action Type: [UF-GWA] Ground Water Abatement (GROUND WATER ABATEMENT)

CONDITIONS

Created By	Condition	Condition Date
michael.buchanan	Commentary and responses received for the record.	1/10/2024
michael.buchanan	Response to Comments in the June 6, 2022 Approval with Modifications, Status Report III— Groundwater and PSH Recovery System Enhancements Reinjection Pilot Test, March 2022 Received for the record.	1/10/2024