Attachment 16

2016-12-20 Region 9 Response to Comments

Florence Copper Production Test Facility (PTF)
Class III In-Situ Production of Copper Permit No. R9UIC-AZ3-FY11-1
[PTF Permit]
Response To Comments

Description of PTF Draft Permit Changes

Pursuant to Title 40 Code of Federal Regulations (40 CFR) § 124.17(a)(1), EPA's final permit decision includes changes to certain provisions of the Florence Copper draft PTF permit, as specified below in items 1-26. In addition to the descriptions of changes, EPA provides the reasons for the changes in this final permit decision.

1) EPA changed a paragraph in Part I, Authorization to Construct and Inject describing the duration of the permit authorization to clarify that the duration of the permit is not limited to seven (7) years, which includes the approximate two (2)-year PTF operational life and five (5)-year post-closure monitoring period, but will include preoperational time for construction and testing and may include post-closure monitoring beyond five (5) years, if deemed necessary by EPA.

2) EPA changed the issuance and effective date language of Part I of the draft permit because the timeframe for issuance of the final permit is different when public comments request a change to the draft permit, per 40 CFR 124.15(b). Because comments were received, the final permit now will become effective at a later specified date unless review is requested under 40 CFR § 124.19. In addition, the authorized person signing for EPA Region IX has changed from Jane Diamond, the prior Water Division Director, to the Acting Regional Administrator Alexis Strauss.

3) EPA added the phrase "well construction and testing and" at Part II.B.2 to clarify that no migration into or between Underground Sources of Drinking Water (USDWs) also applies during well construction and testing before the operating life of the PTF.

4) EPA added a sentence to Part II.C.4 to clarify where any conflict or inconsistency exists between Appendix B and the permit conditions, the permit conditions shall supersede the procedure or detail in Appendix B. This change addresses the public comments identifying potential inconsistency between the language in the permit conditions and Appendix B.

5) EPA added a requirement at Part II.C.6.d for Conductivity sensors to be installed with a spacing of 20 feet between sensors through the Lower Basin Fill Unit (LBFU)/oxide interface in the annulus of the observation wells. This requirement will allow detection of any potential vertical movement into the exclusion zone of the oxide and the LBFU to correct any excursion outside the injection and recovery zone. EPA added this requirement in response to concerns expressed in public comments of potential vertical movement into the LBFU.

6) EPA added tracer testing to Part II.C.8 with aquifer pump tests prior to injection operations for determination of preferential flow paths in the PTF injection formation. A commenter recommended including tracer tests because it was useful for the BHP Pilot Test. Results from this formation testing will be used to update the groundwater flow model for the PTF if significantly different from the modeling conducted for the application. For clarification, EPA also included a requirement that the formation testing procedures must be submitted to EPA for review and approval in accordance with Part II.A.2. The injection formation testing is a required field demonstration to be submitted prior to testing for EPA review and approval in accordance with the procedures at Part II.A.2 in the permit.

7) EPA inserted several clarifying edits in Part II.D in the permit for corrective actions. In the first sentence of Part II.D.1, EPA added reference to the conditions in D.2 and 3 for wells and coreholes subject to corrective action. In addition, EPA added clarifications in Part II.D.3 specifying the type of cement that FCI must either demonstrate is already present in the casing annulus or else place as further corrective action.

8) EPA added a sentence in Part II.E.1 to clarify where any conflict or inconsistency exists between the Operations Plan in Appendix E and the permit conditions, the permit conditions shall supersede the language in the Plan. This change addresses the public comments identifying potential inconsistency between the language in the permit conditions and Appendices.

9) EPA added clarification at Part II.E.1.b to describe that the inward gradient of at least one foot can be adjusted as specified in the contingency requirements at Part II.H.1.b, subject to EPA approval. This clarification addresses operational flexibility already in the permit and public comments to consider well inefficiencies.

10) EPA changed the condition at Part II.E.1.c to require that bulk electrical conductivity (EC) measurement in the observation wells should not significantly exceed baseline values and statistical noise levels, as determined by EPA approved procedures, to confirm hydraulic control. This change was in response to public comments questioning the effectiveness of EC monitoring to confirm hydraulic control since EC will always decrease away from the mine due to dilution. Comparing measurements to background and statistical noise levels at the perimeter of the well field will ensure effective EC monitoring to confirm hydraulic control.

11) EPA corrected the condition at Part II.E.6.e to replace “sodium carbonate” with “sodium bicarbonate.”

12) EPA changed the reference to the state authorized POC wells in Part II.F.1 to recognize that the POC wells established by ADEQ have not been finalized. The final permit language states that POC wells established by ADEQ for the PTF well field, pursuant to a final Aquifer Protection Permit (APP), will also serve as water quality monitoring wells

for the federal UIC permit. This change addresses public comments about the status of these wells.

13) EPA added a sentence to Part II.F.2.c to clarify where any conflict or inconsistency exists between Exhibit P-1 and the permit conditions, the permit conditions shall supersede the language in the Exhibit. This change addresses the public comments identifying potential inconsistency between the language in the permit conditions and appendices.

14) EPA added pH (lab), adjusted alpha, and uranium isotope parameters to Table 2, referenced in Part II.F.2.b. These water quality parameters were already included in other parameters. EPA also changed the footnotes for Table 2 to clarify the determination of the formation-related radioactive chemicals. One footnote notes that Adjusted Alpha, Radium 226 and Radium 228, and Uranium isotopes are only analyzed if Gross Alpha Particle Activity exceeds the parameter's AL or AQL. Another footnote defines Adjusted Gross Alpha to include Radium 226 but exclude Radon 222 and total Uranium.

15) EPA added language in Parts II.F.2.a and b to reference Tables P-3 and P-4 in Appendix K for complete details of Level 1 and 2 parameter monitoring. EPA also added some clarification in Part II.F.4 to reference Tables P-3 and P-4 for water quality monitoring well schedules.

16) EPA changed the hydraulic control monitoring well requirement in Part II.F.5 to require that FCI monitor bulk electrical conductivity in the observation wells on a daily basis at the screens and on a weekly basis at the LBFU/oxide interface, consistent with changes described above and in Part II.F.6.b. Bulk EC measurement is the combined electrical conductivity value of the geologic formation and the pore fluids. EPA added an additional section on conductivity monitoring in Part II.F.6.b to specify the procedures that FCI must conduct, prior to injection, to establish background electrical conductivity levels at observation wells and to identify a statistically significant increase above noise levels in bulk conductivity values at the observation wells that would signal a loss of hydraulic control and a possible excursion requiring contingency actions. The permit condition also requires the proposed procedures to be submitted to EPA for written approval for the baseline data, action levels, and procedures to ensure that the best geophysical monitoring practices are used. EPA added these requirements to address public comments and improve the effectiveness of conductivity monitoring at the perimeter of the well field.

17) EPA changed the frequency for recording injection pressure in Part II.F.10 from continuous and daily to recording daily only. This change addressed a public comment and clarified the intent consistent with the language at Part II.E.4.a for injection pressure to be monitored continuously and recorded on a daily basis. EPA also edited a parameter in Part II.F.10 from total cumulative injection volume to total cumulative produced fluids volume.

18) EPA changed the reporting of results section at Parts II.G.2.c, e, and j to clarify and be consistent with other electrical conductivity monitoring changes in the permit, as described above. EPA changed paragraph b of Part II.G.2 from flows to volumes in response to a public comment and to more accurately describe the parameter. EPA also amended paragraph b to include the daily percent recovery to injection volume and identify any 24-hour periods that the volume recovered was less than the minimum percent of volume injected and any contingency actions taken. EPA added paragraph d to require that electrical conductivity measurements and resistivity profiling results are reported.

19) EPA changed the reporting paragraph at Part II.G.4 to clarify that all formation testing and geophysical well logging shall be submitted to EPA and subject to review and approval by EPA before commencement of PTF operations.

20) EPA changed the contingency plan at Part II.H.b to be consistent with electrical conductivity monitoring changes in the permit where loss of hydraulic control is defined by a statistically significant increase in bulk conductivity values above noise levels in observation wells over a 48-hour period.

21) EPA added two sentences to Part II.I to clarify that the Permittee shall comply with the conditions at I.1 and I.2, except where any conflict or inconsistency exists between the Plans and permit conditions, the permit conditions shall supersede the language in the Plan. This change addresses the public comments identifying potential inconsistency between the language in the permit conditions and the plans in Appendix F.

22) EPA edited Part II.I.1.c by deleting “or below” for clarity to define the sulfate concentration indicator. EPA also added to the closure requirements at Part II.I.1.c clarification that an updated schedule shall be submitted for EPA approval.

23) EPA added to Part II.I.2 to allow post-closure monitoring in accordance with Part II.F.4 to be extended beyond five years, if EPA deems it necessary to ensure adequate protection of USDWs. EPA added this provision to post-closure monitoring to address public comments that the five-year post-closure monitoring may not be adequate if unexpected migration of contaminants is detected.

24) EPA added to Part II.K that the duration of this Class III permit shall include well construction, corrective actions, and demonstrations required prior to injection under permit conditions in Part II, Sections C, D and E.2. EPA changed this language to address a public comment and clarify the intent of the duration of the permit. Also, for consistency with the post-closure monitoring changes, EPA added that the duration of this Class III Permit shall include any post-closure monitoring required beyond five (5) years.

25) EPA updated Part II.L.1.a to include that the Permittee shall post an approved financial instrument such as a surety bond or other financial assurance in the amount of $4,457,000 to

guarantee aquifer restoration, ground water monitoring, and plugging and abandonment activities for closure and post-closure of all wells and facilities specifically regulated by the UIC Permit. EPA updated this information in response to concerns from public comments to guarantee that EPA will have the necessary resources to properly close and abandon the PTF site, in the event the permittee is not capable of doing so.

26) EPA replaced the final unsigned Memorandum of Agreement (MOA) on Historical Preservation in Appendix G of the draft permit with the final signed copy of the MOA for the PTF permit because it is the final effective copy between signatories and invited signatories.

Summary of Significant Public Comments and EPA Response to Comments

Pursuant to 40 CFR § 124.17(a)(2), below in items 1-79, EPA briefly describes and responds to all significant comments raised during the public comment period and during the public hearing held on January 22, 2015. For clarity, EPA organizes the comments and responses below under several topical headings.

BHP Pilot Test

1) **Comment:** A commenter questions whether EPA Region 9 conducted a thorough and reasoned evaluation of FCI's application because EPA did not review the BHP Pilot Test data. The commenter notes that FCI repeatedly cited the BHP Pilot Test in its permit application, and because the FCI PTF is similar to the previously conducted BHP Pilot Test, EPA should have considered any problems observed during the BHP pilot in writing the Underground Injection Control (UIC) permit.

   EPA Response: EPA reviewed the data provided in the hydraulic control demonstration report submitted by Broken Hill Proprietary (BHP) in April 1998, as required by the UIC permit issued in 1997. EPA also reviewed the required quarterly reports submitted by BHP and by subsequent owner/operators of the BHP pilot test site from 1998 to the present as they were submitted. In addition, during the public comment period for the current permit action, FCI provided electronic versions of additional reports and related information to EPA. The additional submittals were not a requirement of the original UIC permit issued to BHP in 1997, but EPA reviewed the information for relevance to the current permit for the FCI Production Test Facility (PTF). EPA evaluated information relevant to the PTF project for possible modification of permit conditions before issuing the final permit decision.

   Much of the information in the additional reports relates to operational and economic feasibility of the BHP in-situ copper recovery (ISCR) project, rather than to environmental concerns and UIC permit requirements, and is therefore less relevant to compliance with the UIC permit for the PTF. Moreover, based on our review of all BHP Pilot Test information and data provided by FCI, we found no basis to deny the UIC permit for the PTF. None of the data or reports showed evidence that hydraulic control was lost without regaining control during the short 105-day duration of hydraulic control demonstration, or during the rinsing and monitoring operations that followed until 2004 when aquifer restoration was achieved and EPA approval was given to cease the rinsing operations. While EPA's review of the BHP Pilot Test data determined that hydraulic control was temporarily lost in two brief occurrences during the hydraulic control test, it was detected and regained within 24 hours in both occurrences through operational modifications, as required by the permit. The prompt and successful restoration of hydraulic control in those instances demonstrates the ability to restore hydraulic control during PTF operations with similar but more stringent monitoring requirements.

   The PTF size, well field, and operation are similar to the BHP Pilot Test, but the purpose of the two operations differ in significant respects. The purpose of the BHP test was for the permittee to demonstrate for a period of at least 90 days that hydraulic control could be maintained during ISCR operations, using four pairs of observation and perimeter recovery

wells to monitor water levels and electrical conductivity in those wells. The purpose of the PTF is to not only demonstrate the capability to maintain hydraulic control, but also to monitor ISCR operations for a period of 14 months, followed by aquifer restoration and closure operations for nine months and post-closure monitoring for five more years. The BHP Pilot Test was an incomplete demonstration due to its shortened duration. EPA issuance of a permit for the PTF project will provide a longer duration test of the ISCR operation, aquifer restoration, and successful closure of the project

In addition, the UIC permit for the PTF is significantly different from the BHP permit in that it requires five supplemental monitoring wells to be placed at the perimeter of the PTF well field to detect potential lateral excursions of ISCR fluids. The permit also requires two monitoring wells placed above the orebody (one in the Lower Basin Fill Unit (LBFU) and one in the Upper Basin Fill Unit (UBFU)), slightly downgradient of the well field, to detect potential vertical excursions from the oxide bedrock unit orebody. In contrast, no monitoring wells were installed near the BHP well field for the earlier BHP Pilot Test. In addition, the BHP permit allowed ISCR operations to expand to full commercial scale after the testing phase. The current UIC permit only authorizes the PTF. Any proposed expansion of operations beyond the PTF would require a new UIC permit application.

2) **Comment:** A commenter asserts that EPA Region 9 did not adequately perform its due diligence with regard to the completeness of FCI's UIC permit application because important BHP test data was missing and EPA should have been aware of this missing information as a result of the judicial review and remand of the state Aquifer Protection Permit (APP) for the PTF. The commenter also claims there were a number of deficiencies in the PTF application and that EPA cannot accept as fact a permit applicant's conclusions and assertions, without reasonable investigation and analysis.

EPA Response: FCI provided the information required for a complete UIC permit application, and based on their initial submittal, EPA reviewed and requested additional information. The permit application and review process was comprehensive and spanned a time period of more than three and one-half years, beginning in 2011. EPA requested additional information several times from FCI over that 3.5-year period to clarify, modify, and supplement the UIC permit application. Specifically, information was requested to modify input data and parameters of the groundwater flow model for evaluation of the area of review (AOR) of the PTF and the regional groundwater flow over the life of the PTF ISCR operations and post-closure period. EPA conducted an in-depth review and evaluation of the application, including the supplemental information, over the 3.5-year period. EPA does not agree that FCI withheld any data that was relevant to the review of the application and preparation of the draft UIC permit. EPA also provided an opportunity for public comment on the BHP Pilot Test reports as posted on the EPA internet web page during the public comment period. As noted above, FCI provided additional information and data during the public comment period, as did other public commenters. Before issuing the final permit decision, EPA conducted additional review/analysis to assess the relevance and value of the BHP Pilot Test information. EPA's independent review of the information submitted did not reveal any deficiencies in the application or significant issues in the permit. Based on EPA's review of all relevant information, EPA found no basis to deny the UIC permit.

However, as summarized above, EPA made minor revisions to the permit terms and conditions as a result of public comments submitted. EPA's review of the PTF application, preparation of a proposed permit, consideration of public comment, modification of some terms and conditions of the proposed permit, and issuance of the final permit decision followed the appropriate requirements in 40 CFR Part 124.

3) **Comment:** A commenter claims that EPA ignored a comprehensive adjudicatory proceeding, namely a state of Arizona Administrative Law Judge's review of ADEQ's Temporary Aquifer Protection Permit for the PTF, which addressed issues identical to those relevant to the draft UIC permit.

   EPA Response: EPA disagrees that the Agency ignored the adjudicatory proceeding held by the State of Arizona prior to public noticing the draft UIC permit and issuing a final UIC permit for the PTF. A number of technical issues that were highlighted in the state's APP review process, including the groundwater flow model for evaluation of the AOR of the PTF and the regional groundwater flow over the life of the PTF ISCR operations and post-closure period, were addressed by FCI in their UIC permit application submittals. These submittals preceded EPA's issuance of the proposed UIC permit for the PTF. However, it is also important to note that ADEQ's Aquifer Protection Program is significantly different and independent from the federal UIC program. EPA's UIC permitting process resulted in proposed permit conditions that differed from those required in the Temporary APP, and EPA's regulations required a public participation process that was completed before EPA issued its final permit decision, which differed from the temporary APP process.

Migration Concerns Based on the BHP Pilot Test

4) **Comment:** A commenter claims that EPA did not consider evidence of aquifer heterogeneity at the PTF location, and the commenter cites graphics that they assert provide evidence from the BHP test illustrating the presence of a "short circuit" in the aquifer and demonstrating aquifer heterogeneity. The commenter expresses concern that short circuits and preferential flow can allow acid escapes at the margin of the pilot project.

   EPA Response: EPA is aware of the heterogeneity of the oxide bedrock orebody in terms of variable hydraulic conductivity (K). EPA believes that the Equivalent Porous Media (EPM) model utilized to inform the permit application is appropriate for the purpose of constructing a groundwater model of the orebody, with variations for consideration of fault zones that may provide preferential flow paths. EPA required FCI to modify the model to account for higher hydraulic conductivity in the plane of the major fault zone that intersects the PTF orebody. The AOR model demonstrated that excursions of ISCR fluids could occur for a distance of up to 201 feet beyond the well field assuming a loss of hydraulic control for 30 days, which EPA considers highly unlikely. Still, that distance is well within the proposed 500-foot AOR of the PTF well field, within which permit conditions require corrective action to prevent movement of fluids into or between USDWs. Moreover, a loss of hydraulic control for as long as 30 days is an extremely conservative assumption since the permit requires daily monitoring to detect loss of hydraulic control and requires corrective action to restore hydraulic control.

Even considering the heterogeneity of the oxide bedrock zone, ISCR fluids will not migrate beyond the PTF well field as long as hydraulic control is maintained. The UIC permit requirements for maintaining an inward head gradient by means of extracting at least 10% more fluid than is injected, and monitoring electrical conductivity in observation wells, should ensure that ISCR fluids are contained within the PTF well field. In the highly unlikely event that an undetected excursion of ISCR fluids laterally beyond the observation wells or vertically into the LBFU or UBFU should occur, the supplemental monitoring wells would detect the excursion. In addition, in such an instance, FCI would be required to address the excursion by cessation or reduction of injection rates and continued or increased pumping at the recovery wells. EPA believes the more likely scenario is for any excursion to be detected by daily monitoring within the well field and corrected by adjustment of pumping and injection rates at individual wells to control and maintain inward flow to the well field in accordance with the permit conditions.

EPA agrees that the graphics presented by the commenter as evidence of potential "short circuits" that could result in "acid escapes" in the BHP well field indicate heterogeneity of the BHP Pilot Test orebody and the potential for preferential flow paths. However, this heterogeneity is not indicative of a loss of hydraulic control and resultant excursions of ISCR fluids. The commenter describes the short circuit as "a preferential flow pathway for water to move in an east-west direction near the bottom of the project site." The commenter further states that "[w]hen site geology has short-circuits, acid escapes are possible even when water balance and gradients seem to demonstrate hydraulic control." In addition, the commenter asserts that the BHP Pilot Test experienced "failed containment," but presents no facts to support that assertion. Fluids were contained within the well field and the "short circuit" was successfully reversed after reconfiguration of injection and recovery wells. EPA is confident that the more stringent monitoring requirements for hydraulic control and excursions at the PTF well field will ensure detection and reversal of any ISCR excursions beyond the well field.

In response, preferential flow paths may exist, but the graphics submitted by the commenter do not demonstrate a loss of hydraulic control and escape of ISCR fluids from the BHP well field. Furthermore, in support of the EPM model with major faulting applied by FCI, the Field Test Report cited by the commenter states that "the approach of equivalent porous medium embedded [with] significant discrete features matches field data very well in such a highly fractured and heterogeneous rock, as was found by Neuman (1982)." A groundwater consultant representing another commenter also supported the EPM approach for addressing heterogeneity in the models.

5) **Comment:** A commenter claims that the primary UIC permit conditions to demonstrate hydraulic control are not sufficient, and presents examples of simulations to illustrate particle capture analysis as a preferred method that is applicable to the proposed mining technology for the ore body.

EPA Response: Although not presented as an accurate predictive or analytical tool for the ore body, it appears that particle tracking models developed by the commenter show that hydraulic control may be weakened or lost temporarily, but can be restored by adjusting pumping and injection rates in selected wells. In addition, rinsing operations will remove ISCR fluids and restore the PTF aquifer to MCLs or pre-operational background levels, if those exceed MCLs, before closure of the well field is authorized.

Aquifer restoration is designed to prevent migration of contaminants downgradient beyond the AOR and exempted area after PTF closure. Monitoring the performance of the PTF operation will provide real data to enable the assessment of hydraulic containment capabilities for ISCR operations at the proposed site.

6) **Comment:** A commenter claims that EPA ignored conclusive evidence of failed hydraulic control and that relevant BHP data shows impermissible acid escape. The commenter asserts that acid solutions migrated vertically into the LBFU during the BHP Pilot Test and expresses concern that FCI cannot control the sulfuric acid solution injected into fractured bedrock. In related comments, other commenters expressed concern that injected solution would travel in unpredictable directions or that movement of water between upper and lower basins was possible.

EPA Response: BHP Pilot Test data and reports reviewed by EPA indicate that two instances of apparent losses of hydraulic control during the hydraulic control test lasted for no more than 24 hours. These temporary losses of hydraulic control were detected and quickly restored by operational changes to the injection and extraction regime, as BHP's UIC permit required. The comment regarding injected acid solution migrating horizontally to OWB-1 and OWB-4 within the BHP well field appears to be accurate, but does not consider that sulfate levels at these observation wells were quickly restored to background levels during initial aquifer rinsing operations. The BHP Field Test Report of October 1999 (see Section 5.4.4, page 99) provides a more complete discussion of the data and an explanation of the probable cause of the temporarily high sulfate levels in those wells. EPA believes that with additional safeguards built into the modeling, testing procedures, and monitoring of the PTF under the current permit (relative to the permit requirements for the BHP Pilot Test), hydraulic control of the PTF is expected to exceed that experienced during the successfully completed BHP Pilot Test.

Vertical excursions of injected acid solution into the lower 22 feet of the LBFU that occurred during the BHP Pilot Test described by the commenter were anticipated in the groundwater model of the BHP Pilot Test. The vertical excursion prediction and information on vertical migration of leach solutions into the LBFU was contained in the BHP report dated September 12, 2001, written by John Kline. The model prediction was 25 feet and the actual migration was measured at 22 feet according to that report. However, the basis for this reported excursion and measurement into the LBFU was electrical resistance tomography (ERT) data performed by Steamtech Environmental services for BHP during the injection test. EPA notes that the ERT data were considered unreliable above the top slot of the well screen by FCI and Adrian Brown, P.E. (see expert testimony for the State of Arizona Water Quality

Appeals Board hearing). Thus, EPA believes there is uncertainty as to whether a vertical excursion actually occurred. Notwithstanding this uncertainty, the lower 200 feet of the LBFU is in the exempt portion of the aquifer, so even if an excursion did occur, it was not a violation of the permit.

During operation with continuous monitoring, EPA expects the required injection and recovery well array to allow maintenance of the inward hydraulic control and prevent migration outside of the well field. As an additional preventative measure, EPA added to the final permit for the PTF that FCI shall properly install conductivity sensors through the LBFU/oxide interface in the observations wells, which are at the perimeter of the well field. Monitoring of bulk conductivity at those sensors will provide additional protection against excursions into the LBFU and UBFU. Based on past testing at the property, the Middle Fine Grained Unit (MFGU) between the basin fill units is a confining unit further preventing vertical fluid movement. Moreover, the additional conductivity monitoring at the PTF well field should detect any excursions into the LBFU zone and trigger contingency actions to restore hydraulic control or reverse vertical migration of lixiviant as needed. Any vertical excursions into the LBFU could also be addressed, if necessary to ensure adequate protection of USDWs, by requiring higher pumping rates in the recovery wells or lower injection rates in the injection wells.

Any possible excursions into the LBFU will be contained to the PTF well field area until they are reversed during aquifer rinsing and restoration operations. That was the case at the BHP site where aquifer restoration standards were attained in 2004 and approved by EPA in July 2005. Furthermore, the BHP point-of-compliance (POC) wells open to the LBFU have not experienced any ISCR-related exceedances. For the PTF UIC permit, the M57 supplemental monitoring well in the LBFU located downgradient at the perimeter of the PTF well field will also serve to detect any potential excursions into the LBFU and trigger remedial actions if that should occur. Finally, the M61 supplemental monitoring well, to be located east of the PTF well field, and open in the lowermost interval of the LBFU at the intersection of the Sidewinder Fault with the LBFU, will serve to detect any potential excursions in the fault zone and trigger remedial actions as required by EPA.

7) **Comment:** A commenter claims that BHP was not able to contain injected acid mining solutions as intended, and that monitoring and reporting did not alert EPA to the horizontal escapes of acid mining solution experienced by BHP.

EPA Response: The interpretation of the BHP data presented by the commenter regarding horizontal escapes of acid mining solution is misleading. The elevated sulfate concentrations in two observation wells were temporary and returned to background levels after reconfiguration of key injection and recovery wells, as discussed in the draft BHP Field Test Report of October 1999, and as described in the Response to Comment 6 above. Water quality monitoring in the observation wells was not a permit requirement, but was performed by BHP voluntarily. For the PTF permit, water quality at the PTF is required to be monitored at the supplemental monitoring wells to ensure any potential excursions are detected and reversed before escaping the AOR. The water levels and electrical conductivity readings are

also required to be monitored at the observation wells for assurance of hydraulic control. If acid and sulfate levels are elevated at observation wells, EC readings will increase as an indicator of high sulfate levels, which will trigger contingency actions to prevent migration beyond the well field and require reporting to EPA.

8) **Comment:** A commenter asserts that BHP Pilot Test data provides insight regarding escape of acid and demonstrates that EPA needs to make critical changes in the UIC permit. The commenter points to the BHP Pilot Test's acid-water balance measurement as not demonstrating control of injected solution because BHP maintained the required differential between injection and recovery, yet a post-test acid balance demonstrated that at least 12% of the injected acid was not recovered.

   EPA Response: Data reviewed by EPA do not support the commenter's statement regarding "acid-water balance measurement." Sulfate recovery for the BHP test, as an indicator of "acid-water balance", was essentially complete before aquifer rinsing was completed in 2004, which is indicative of a complete acid-water balance at that point. Acid-water balance measurement during the early rinsing stage, which is when the 12% injected acid imbalance referenced by the commenter was noted, is not a valid method for demonstrating control of injected fluid. Control is maintained by withdrawing 10% more fluid than is injected and demonstrated by maintenance of an inward gradient of at least one foot between the observation and recovery wells and below action levels for bulk electrical conductivity in the observation wells. Moreover, sulfate recovery and acid-balance is expected to be demonstrated and background sulfate levels to be restored with completion of the aquifer rinsing operations.

9) **Comment:** A commenter claims that the BHP Pilot Test data showed that measurements of inward hydraulic gradients failed to account for well inefficiencies and that EPA needs to revise the PTF permit to address this issue.

   EPA Response: EPA disagrees that a change is necessary to the PTF UIC permit. Under the PTF permit conditions, the one-foot water level differential between observation and recovery wells is a minimum requirement and can be increased if data show it is not sufficient to maintain hydraulic control, based on electrical conductivity readings in observation wells. Operational flexibility built into the draft PTF permit will allow for modifications of the rate of extraction well over-pumping to account for well inefficiencies, or other factors, in order to maintain inward hydraulic gradient.

10) **Comment**: A commenter claims that the BHP Pilot Test permit did not require any monitoring of vertical migration inside of the well field, and that was a factor contributing to acid escaping.

   EPA Response: BHP Pilot Test monitoring did have some issues contributing to uncertainty of whether fluids were contained in the injection and recovery zone, which are described in Response to Comments 4 and 6. In the PTF permit, the LBFU and UBFU will be monitored downgradient at the northwest perimeter of the well field in monitoring wells M57-LBF and M56-UBF, respectively. Also, EPA added a permit condition requiring bulk electrical conductivity monitoring through the LBFU/oxide interface in the observation wells to detect

vertical migration of leach solutions and contaminants, as discussed in other Responses. As discussed in prior Responses to Comments 4 and 6 above, EPA's review of the BHP Pilot Test data and reports indicates that the test was ultimately successful at demonstrating hydraulic control and aquifer restoration.

11) **Comment:** A commenter asserts that BHP conducted tracer tests that showed strong flows due north and due west, in addition to the northwest regional flow, which demonstrates the need for two additional observation wells in the PTF permit – one due north and another due west of the injection/recovery well field.

EPA Response: EPA believes that the seven planned observation wells are sufficient and their locations are appropriate for ensuring hydraulic control of the PTF operations to prevent migration of ISCR fluids. The purpose of monitoring EC data at the observation wells is to ensure hydraulic control and detect any escape of ISCR fluids between adjacent recovery wells before migrating beyond the recovery wells. Tracer tests at the BHP site cited by the commenter are not necessarily representative of flow at the PTF site. Furthermore, two observation wells are located at the western and northern periphery of the PTF well field, and monitoring wells are situated to detect flow due west and north as well as northwest of the PTF well field.

12) **Comment:** A commenter cites data from the BHP Pilot Test regarding vertical migration of mining solutions into the LBFU and questions how EPA can allow such migration to occur at the PTF site, which they claim is the primary drinking water supply for a growing city.

EPA Response: EPA disputes that vertical migration of ISCR fluids into the lowermost portion of the LBFU during PTF operations is likely to occur. Movement of ISCR fluids into the LBFU was predicted to be 20 to 40 feet at the BHP site, and under a worst case scenario of a loss of hydraulic control for up to 30 days, modeling for the current permit indicates up to 54 feet of vertical migration into the LBFU at the PTF site. However, the lowermost 200 feet of the LBFU is not a protected "underground source of drinking water" because it is an exempted portion of the aquifer. Moreover, all ISCR constituents must be reduced to acceptable levels in compliance with permit conditions before post-injection aquifer rinsing stops and EPA authorizes closure of the PTF. The PTF permit also requires monitoring of the LBFU water quality to ensure that any ISCR constituents, if present, do not migrate downgradient beyond the AOR. These conditions will ensure protection of any underground sources of drinking water outside the PTF site. Refer to the Response to Comment 6 above for more discussion on this issue.

13) **Comment:** A commenter cites concerns about the BHP Pilot Test in 1998, including a groundwater elevation increase of almost 200 feet in recovery well BHP-5 during the start-up of the pilot test and discrepancies in hydraulic control between recovery and observation wells pair BHP-5 and OWB-4. The commenter also questioned the methodology for measuring conductivity values in the BHP observation wells compared to that used for the BHP recovery wells, and alleged that this lack of certainty in the methodology raises questions about the hydraulic control demonstration.

EPA Response: EPA acknowledges that the water level differential between the OWB-4 and BHP-5 wells in the early days of the hydraulic control demonstration in late 1997 and early 1998 was unstable as noted by the commenter. However, the water level differential between these wells was positive after 10 days of operations and remained positive with an average of approximately five (5) feet for the duration of the 90-day BHP demonstration. EPA considers these data a demonstration of BHP's ability to restore and maintain hydraulic control after an initial brief period of instability.

As previously noted, EPA was satisfied with the BHP hydraulic control demonstration in 1998, however, we are including more stringent requirements for monitoring and maintaining hydraulic control in the UIC permit for the PTF operation.

Regarding the commenter's issue concerning measurement methods for electrical conductivity in the BHP wells, EPA agrees there was some uncertainty. The depths of sampling relative to the injection zone in the paired BHP recovery wells (i.e., nearest perimeter recovery well to each observation well) was not identified, which raises a potential concern that the samples may not have been representative of water quality at the injection zone depth. The PTF permit requires installation of conductivity sensors at key intervals in the observation, recovery, and multi-level sampling wells at the PTF well field, which will ensure samples are representative of the injection zone depths. This issue was one of the bases to require more reliable electrical conductivity monitoring in the PTF permit to demonstrate hydraulic control.

The Existing Aquifer Exemption

14) **Comment:** A commenter asserts that the existing aquifer exemption should have been revoked at the same time EPA revoked the existing UIC permit issued to BHP in accordance with law and EPA policy.

EPA Response: For clarification, to date, EPA has not revoked the existing UIC permit that EPA originally issued to BHP Copper in 1997. As EPA noted in our August 5, 2010 letter to Curis Resources (now Florence Copper Inc.), responding to their request for a minor modification and transfer of the existing UIC permit, the Agency determined that the most appropriate course of action was a revocation and reissuance process for the UIC permit, per 40 CFR §§ 144.38 and 144.39. With EPA's issuance of the final UIC permit for the PTF, the existing UIC permit is concurrently revoked. Regarding the commenter's assertion that EPA should revoke the existing aquifer exemption at the same time the existing UIC permit is revoked, EPA does not agree. EPA's action on the existing and new UIC permits is separate from the existing aquifer exemption, and EPA's action to revoke and reissue the UIC permit does not affect the existing aquifer exemption, which was approved by EPA in 1997. Neither federal statutes, EPA regulations, nor Agency policy require that EPA revoke an aquifer exemption when a UIC permit is revoked.

15) **Comment:** Commenters describe several changes in circumstances that are present today in the area around the aquifer exemption in comparison to when the exemption was first granted in 1997. Examples of these changes include local zoning changes from industrial to

residential/commercial, plans for future development which include potential use of the LBFU outside the ore body for drinking water wells, and the installation of drinking water wells downgradient of the mine site. A commenter alleges that these changes provide justification for EPA's denial, revocation or rescission of the aquifer exemption and asserts that EPA has modified exemptions in other instances due to changes in facts and circumstances.

EPA Response: EPA understands that changes have occurred in the vicinity of the proposed project area and downgradient of the site. However, these circumstances do not compel EPA to make changes to the existing aquifer exemption, approved in 1997. The existing aquifer exemption, which was not challenged at the time of its approval in 1997, has been in place throughout the time when the local land use changes identified by the commenter occurred. With EPA's issuance of the PTF permit, the Agency is not obligated to reexamine the basis for the original aquifer exemption. However, out of an abundance of caution, EPA elected to review whether the portion of the existing exempted aquifer that would be impacted by the PTF operations continues to meet the aquifer exemption regulatory criteria in 40 CFR §146.4(a) and (b)(1). The PTF operations will be conducted entirely within the existing exempted area. This review was not a formal reevaluation or reconsideration of the aquifer exemption, and EPA's action to approve the PTF permit is not a re-approval of the existing aquifer exemption. The exemption was validly approved by EPA in 1997, it has remained in force since that time and the exemption remains in place today, unaltered by EPA's approval of the PTF permit.

For review of the exemption criterion in 40 CFR §146.4(a), EPA considers whether groundwater areas proposed for exemption currently serve as a source of drinking water. EPA considers "current sources" to include water that is currently withdrawn for drinking water purposes as well as water that will be withdrawn in the future by wells that are currently in use[1]. For the PTF, EPA reviewed whether the groundwater within the AOR is currently being withdrawn for drinking water and if such ground water will be withdrawn in the future by drinking water wells currently in existence. EPA confirmed that there are no drinking water wells withdrawing water from the identified portion of the aquifer today, which is consistent with the exemption status of that aquifer. In addition, EPA determined that the groundwater in the project's AOR would take at least 127 to 211 years to travel the distance to the nearest potential (inactive) drinking water well (ADWR No. 55-212512), located approximately 1.2 miles downgradient of the PTF well field. EPA based this determination on an estimated hydraulic conductivity ranging from an average of 15 feet/day to a maximum of 25 feet/day and a groundwater flow velocity of 30 to 50 feet per year in the LBFU. If tortuosity of pore spaces were considered in the calculation, the travel time would be even longer. Moreover, because ADWR No. 55-212512 has only been used for test purposes and has not been used for municipal drinking water purposes, EPA documented in our Draft Permit Statement of Basis the groundwater migration to the location of the closest

[1] See Memorandum, *Enhancing Coordination and Communication with States on Review and Approval of Aquifer Exemption Requests under SDWA*, from Peter Grevatt, Director, EPA Office of Ground Water and Drinking Water, dated July 24, 2014)

active drinking water well. As described in the Statement of Basis, the travel time from the LBFU above the PTF mine zone to the closest active drinking water well (at Merrill Ranch) would be greater than 200 years. This time period exceeds the reasonable lifetime of any active public drinking water wells.

EPA also reviewed the exemption criterion at 40 CFR §146.4(b)(1), and documented that the portion of the aquifer within the project's AOR will not be a potential future source of drinking water due to the presence of minerals that are expected to be commercially producible. Based on this review, EPA concluded that the portion of the existing exempted aquifer that would be impacted by the PTF operations continues to meet the aquifer exemption regulatory criteria.

Finally, the PTF permit contains technical provisions and aquifer restoration requirements to ensure that the downgradient non-exempt drinking water aquifer is adequately protected. Please refer to EPA's Response to Comment 20 for additional discussion of the aquifer protection in the LBFU.

16) **Comment:** A commenter asserts that EPA did not follow applicable regulation and guidance for exempting aquifers. In particular, for mining permits, the commenter claims that the exempted area is to be kept as small as possible while still allowing mineral extraction. The commenter also alleges that a recent EPA rulemaking and permitting decisions follow this approach. Finally, the commenter cites a figure used in a Region 9 EPA presentation that shows an exemption area completely within a project's AOR, and asserts that this approach is the only appropriate application of an aquifer exemption.

EPA Response: The comment that EPA did not follow applicable regulations and guidance because the aquifer exemption boundary is larger than necessary for the PTF operation represents a misunderstanding of EPA's current action. In the current action, EPA is approving the PTF mining permit for activity wholly within the boundary of the existing aquifer exemption. As noted in a prior response, EPA's current action to approve the PTF permit has no effect on the existing aquifer exemption. EPA defined the aquifer exemption boundaries in 1997, in consideration of the particular characteristics of the permitted project, the mining site, and the specific purpose of in-situ copper recovery. The 1997 exemption boundary was based on the entire extent of the ore body that contains minerals expected to be commercially producible, with an additional lateral buffer zone of 500 feet from the ore body. In establishing the existing exemption boundary, EPA adhered to applicable regulations and guidance for aquifer exemption approval.

In addition, as described in our response to Comment 15 above, EPA conducted a review to confirm that the portion of the existing exempted aquifer that would be impacted by the PTF operations continues to meet the aquifer exemption regulatory criteria.

Regarding the figure from an EPA Region 9 presentation, that figure is not a representation of all aquifer exemption scenarios. Rather, the figure was a simple example that illustrated one approach for proposed uranium ISR mining. Also, the recent rulemaking referenced in

the comment is a proposed rule specific to commercial uranium mining projects, and the permitting examples provided are for proposed uranium ISR projects. Uranium ISR mining rules and projects are not appropriate analogues for comparison to a small-scale copper recovery pilot test such as the PTF. Please refer to EPA Response to Comment 55 which describes some of the significant differences in the hydrogeologic characteristics, processes, and operations involved in ISR mining for copper versus uranium.

17) **Comment:** A commenter questions the basis for EPA's exemption of the Lower Basin Fill Unit (LBFU), which is the aquifer immediately above the copper ore body. The commenter alleges that the Agency erred in including the LBFU as an exempt aquifer, and that the exemption of the LBFU is not consistent with EPA's regulations and guidance. Reasons provided by the commenter include that there are existing plans to use the LBFU within the exempted area as a source of drinking water and that the LBFU does not contain commercially developable mineral resources that might justify an exemption. The commenter also asserts that the Upper Basin Fill Unit (UBFU) (the aquifer above the LBFU) is contaminated, and that EPA has chosen to protect the UBFU, but will not protect the exempted portion of the LBFU.

EPA Response: As previously noted, EPA is not granting an aquifer exemption with the present PTF permit action. The lateral and vertical boundaries of the exempted aquifer were approved in 1997 based on site specific hydrogeologic conditions and the subsurface contours of the ore body. The LBFU and the highly fractured ore body are directly connected hydrologically, and therefore, both formations are a part of the aquifer that EPA exempted. A commercially producible quantity of copper is present within the aquifer that is comprised of both the ore body and portions of the LBFU. Therefore, EPA properly determined, when approving the aquifer exemption in 1997, that the portion of the aquifer being exempted contained a commercially producible quantity of a mineral and met the criteria in 40 CFR § 146.4(b)(1).

As discussed in earlier responses, EPA's exemption criteria include a requirement that the proposed aquifer does not currently serve as a source of drinking water and that it cannot now and will not in the future serve as a source of drinking water. Regarding future use of the aquifer, EPA's regulatory criteria include specific conditions and circumstances which, if met, establish that the aquifer in question cannot and will not be used as a future source of drinking water. Included among the specific conditions and circumstances which establish that an aquifer will not serve as a future source is the presence in the aquifer of a commercially producible quantity of minerals or hydrocarbons. With respect to the exempted aquifer at the PTF site, this aquifer was validly exempted in 1997, in part due to the presence of a commercially producible quantity of copper. Plans referenced in the comment for potential consideration of the aquifer for future drinking water use were developed after the aquifer exemption was approved by EPA.

Finally, the commenter's concerns about protecting the UBFU, and not the LBFU, warrant clarification. Both the UBFU and the downgradient portion of the LBFU, which lies outside the exempt area, meet the definition of an USDW, as defined in 40 CFR §144.3, and are

protected under the Safe Drinking Water Act. This USDW protection has not changed since the original approval of the aquifer exemption in 1997. Moreover, in the current PTF permit action, EPA prescribes permit conditions to prevent migration of fluids from the well field out of the AOR and the exempted area, restore the aquifer to MCL or pre-injection background levels, and monitor for ongoing protection of USDWs.

18) **Comment:** A commenter raises questions and concerns about the AOR for the PTF, including its size relative to the boundary of the exempt aquifer. The commenter also claims that if EPA approves a large exemption area, then the AOR must be even larger. Finally, the commenter states that EPA should require FCI to close all of the boreholes within the exempted aquifer and area of review, address the problem of the underground mine shafts, and close numerous other wells on and near its property.

EPA Response: The AOR, also known as a zone of endangering influence, is the area surrounding injection wells in which the pressures in the injection zone may cause migration of the injection or formation fluids out of the injection zone and into a USDW, as described in 40 CFR § 146.6(a)(1)(ii). It is not necessary for the AOR to be larger in size, or even the same size, as the area of an exempt aquifer, since the AOR is determined based on factors that are not related to the size of an exempt aquifer. The size of the AOR is based on the distance of the expected pressure influence resulting from the permitted injection activity. In the PTF permit process, EPA determined the AOR, based on information in the UIC application and EPA regulation at 40 CFR § 146.6, to be the area of the PTF well field and a circumscribed width of 500 feet beyond the well field.

The calculated zone of endangering influence is at the edge of the PTF well field during periods when an inward hydraulic gradient is maintained, and extends through the lateral distance the groundwater may migrate beyond the well field from the maximum permissible excursion (i.e., loss of hydraulic control) of 48 hours, as defined in the final permit. The Permittee demonstrated in their application that the proposed AOR of 500 feet surrounding the PTF well field is conservative with respect to protecting USDWs because it is 7.5 times the actual distance that injection fluids may migrate during the maximum permissible excursion of 48 hours. In addition, this AOR also provides a safety factor of 2.5 to 4 times the actual distance that fluids may migrate under a worst-case scenario of a 30-day period of excursion.

Applicable to the AOR for the PTF permit, EPA included permit conditions, as corrective actions, requiring FCI to properly plug and abandon coreholes and other wells within the AOR prior to injection. These requirements do not include the underground mine shafts because the shafts are not within the AOR. The “corrective action requirements” (per 40 CFR § 146.7) will serve to prevent fluid movement through holes or wells in the AOR that could act as a conduit or leak into the upper USDWs, which are not exempt aquifers.

Drinking Water Concerns Near FCI Mine Site

19) **Comment:** Commenters state that the nearest well to the FCI property is Johnson Utilities' "Anthem 4" (ADWR No. 55-212512), which is located 1.2 miles directly downgradient of FCI's PTF. A commenter adds that although not currently active, Anthem 4 was installed to meet future water demands for the expected growth in the area, and that the LBFU has regional importance as a drinking water supply.

EPA Response: The well identified by the commenter (ADWR No. 55-212512) is located approximately 1.2 miles downgradient of the PTF well field and is an inactive well installed to meet future water demands, according to the commenter and the well registry on the Arizona Department of Water Resources (ADWR) internet site. During the two years that the PTF operates under hydraulic control, the ground water in the LBFU would be pulled down to the recovery wells. After that, the estimated travel time for groundwater in the LBFU from the PTF well field to this well ranges from a minimum of 127 to 211 years, based on estimated groundwater flow velocities of 30 to 50 feet per year in the LBFU. ADWR's Assured and Adequate Water Supply rules require the source water supply in the aquifer for drinking water wells to be available on a continuous basis for 100 years. Therefore, EPA assumes that the expected life of this drinking water well would be no more than 100 years and could be considerably less than 100 years in this case because the subject well has not yet been activated for municipal drinking water purposes. Moreover, the PTF permit requires FCI to rinse the aquifer once injection ceases so that water quality is returned to MCLs or pre-operational background levels if greater than MCLs, thereby further ensuring that any constituents in the PTF groundwater will not reach the identified well.

20) **Comment:** Commenters assert that additional permit conditions are needed to protect the LBFU, because the permit would allow contaminants to be discharged into the LBFU. A commenter also states that no baseline standards have been established for aquifer restoration.

EPA Response: The PTF permit conditions are fully protective of all USDWs, as defined in 40 CFR §144.3, which includes the un-exempted portion of the LBFU and the UBFU. Injected fluids will be contained within the oxide bedrock zone and approximately the lower 55 feet of the 200-vertical foot exempted portion of the LBFU, even in modeled worst-case scenarios (i.e., loss of hydraulic control for 30 days). Based on a 48-hour loss of hydraulic control, which is the maximum time that a loss of hydraulic control would occur under permit conditions, vertical excursions are expected to result in no significant migration of injected solution into the LBFU. Background concentrations for water quality parameters in the permit will be determined for PTF wells and supplemental monitoring wells before injection begins. These data will establish aquifer restoration standards for the PTF wells and water quality standards at the POC and supplemental monitoring wells. During aquifer restoration operations, the permit requires that the oxide zone and the potentially impacted portion of the LBFU be restored to original baseline water quality, or to federal MCLs if greater than baseline concentrations. Groundwater quality monitoring will ensure that aquifer restoration standards are met within the PTF well field and continue for five years or more after restoration is achieved.

21) **Comment:** A commenter refers to plans for growth that will require development of new wells in the LBFU just outside of FCI's western property border and notes that after the mine property sat idle since the early 2000s, the surrounding area was locally zoned as a master planned community. The commenter also states that because the mine is not consistent with this planned future development, nearby governmental entities, such as the Town of Florence, formally oppose FCI's proposed mine.

EPA Response: As was noted in our response to Comment 15 above, EPA understands that changes have occurred in the vicinity of the proposed project area and downgradient of the site since the late 1990s. However, local ordinances and zoning restrictions do not replace EPA's responsibility to implement the UIC program under the Safe Drinking Water Act to ensure protection of USDWs under our statutory authority. Based on the conditions in the PTF permit, EPA believes that the surrounding USDWs will be protected, as required, regardless of surface land use and ownership. See EPA's response to Comment 20 above for additional discussion regarding protection of drinking water sources.

Monitoring

22) **Comment:** A commenter recommends that EPA include pre-injection testing requirements in the permit, including a sequential well field development and testing concept to properly determine the hydrogeology of the well site. The commenter claims that only after conducting appropriate tests can FCI properly design and drill observation and multi-level wells where potential escapes of injected fluid will travel.

EPA Response: The sequential well field development and testing concept suggested by commenter is not necessary because the site has been extensively tested by FCI and by previous owners of the property. Further, permit conditions require additional testing and evaluation before ISCR operations commence. The permit requires that FCI submit a detailed well testing plan for EPA review before drilling the PTF wells and conducting the tests. Two additional observation wells, located due west and north of the well field, were recommended by the commenter. The permit provides for seven observation wells placed at strategic locations between the recovery wells at the PTF perimeter, and EPA believes these wells will be adequate to confirm hydraulic control of PTF operations and to detect and allow reversal of any possible excursions to prevent migration of ISCR fluids beyond the observation well locations.

23) **Comment:** A commenter claims that the UIC permit's hydraulic control conditions will not ensure containment of injected acid, nor will they meet the objective to trigger an alert before contaminants escape. The commenter asserts that the permit erroneously compares recovery of water rather than acid or sulfate and states that FCI's method of calculating volume differentials will mask failures of hydraulic control. The commenter also notes that the BHP UIC permit, like the current permit, required more water pumped out than was injected, but they claim that does not prove that migration of acid mining solutions is prevented. Finally, the commenter asserts that the permit's conditions to ensure hydraulic control will not be successful because of the lack of well-to-well volume comparisons, constant volume differential requirements, and more accurate flow monitoring.

EPA Response: These comments are based on an inaccurate assumption and premise that the differential volume ratio of fluids extracted versus fluids injected is the criterion for measuring hydraulic control. The inward flow gradient and electrical conductivity (EC) data are in fact the basis for measurement and evaluation of hydraulic control. Monitoring and management of extraction and injection rates are the means for maintaining the inward flow gradient and ensuring that hydraulic control is restored in the event that bulk EC readings at the observation wells exceed action levels. In addition, the permit includes a provision that the 110% extraction to injection volume ratio is subject to adjustment based on inward flow gradient and EC data. EPA understands the fluid recovered will include groundwater from outside of the well field, which is the reason for the permit's minimum 110% extraction to injection volume ratio, with potential adjustment to account for PTF operating experience and results. FCI will pair observation wells with two adjacent recovery wells, and they are required to monitor and measure inward flow gradient in all observation/recovery well pairs to ensure an inward flow gradient of at least one foot is maintained between all well pairs.

If EC data at observation wells indicate that the one-foot minimum is insufficient, the permit allows it to be adjusted accordingly (see Part II.H.1.b of the permit). Also, in the final permit, EPA clarified that the minimum inward gradient may be adjusted only with prior written approval from EPA (see Part II.E.1.b). One of the objectives of the PTF is to determine the optimum values of inward flow gradient and extraction to injection flow ratios for ISCR operations at the FCI property.

As EPA noted in the Response to Comment 8, it is misleading to conclude that because the recovery rate for sulfuric acid was only 88% in the BHP Pilot Test project, there was a failure to control acid migration. Eighty-eight percent was the reported recovery in September 1999 after rinsing for only 18 months. BHP reported sulfate recovery at 98.6% in 2001 and approximately 100% in 2004 when rinsing operations were terminated. The Brown and Caldwell report dated April 21, 2004 and prepared for Merrill Mining as a Proposed Cessation of Hydraulic Control at the BHP Pilot Test Field states that the low sulfate concentrations in 2003 sampling of the BHP wells suggest that practically all of the 2 percent sulfuric acid solution that was injected into the leach zone had been removed. The current UIC permit requires that sulfate recovery be measured and completed during the PTF restoration process to ensure water quality standards are attained before PTF closure is authorized.

24) **Comment:** A commenter claims that the permit conditions requiring excess extraction and a minimum one-foot water level difference (i.e., inward gradient) are not protective of surrounding groundwater in light of hydraulics and chances of acid escape from the process zone. The commenter also relates this concern to the BHP Pilot Test gradient data for wells BHP-9 and OWB-4. The commenter asserts that the data showed an inward hydraulic gradient, but that OWB-4 had numerous high sulfate concentrations in March and April 1998, indicating horizontal acid escapes toward that observation well even when BHP complied with the water gradient condition in its permit. Finally, the commenter suggests that well inefficiencies causing errors in the water levels that are greater than the minimum one-foot differential could lead to a false conclusion that an inward gradient is maintained in compliance with the permit condition.

EPA Response: The commenter does not acknowledge that the PTF UIC permit requires electrical conductivity monitoring in observation wells to monitor and ensure hydraulic containment of ISCR fluids, in addition to monitoring differential water levels and excess extraction to manage and control containment of ISCR fluids. As described in the above Response to Comment 6, EPA added bulk electrical conductivity monitoring and clarifications for observation well monitoring through the ore body and LBFU interface. EPA believes that continuous monitoring and daily management of injection and extraction rates at individual wells will be sufficient to maintain hydraulic control and to restore it if there is a temporary loss of hydraulic control. Excess extraction rates are expected to be sufficient to overcome the low velocity of the groundwater flow to the northwest and prevent the escape of ISCR fluids between extraction wells. In addition to this well field monitoring, the supplemental monitoring wells will be placed within the AOR perimeter and above the exempted zone in the LBFU and UBFU to ensure that any excursions are detected and reversed before escaping the AOR or into a nonexempt zone above the exclusion zone. Moreover, the natural vertical gradient between the LBFU and the bedrock zone is downward, which should increase net flow into the bedrock zone during PTF recovery and rinsing operations and sustain flow into the bedrock zone during the post-closure period. In response to the comments that BHP did not maintain hydraulic control in the spring of 1998 between the BHP-9 and OWB-4 wells, while there was a temporary loss of hydraulic control, it was restored after BHP reconfigured the wells as evidenced by a massive drop in sulfate concentrations to background levels after the reconfiguration and continued rinsing operations. Furthermore, there was no indication of a sustained loss of control during ISCR operations at the BHP test site. The elevated sulfate level in OWB-4 was likely due to injection and recovery well configurations during initial rinsing operations, rather than an actual loss of hydraulic control.

As previously noted, the UIC permit provides for consideration of an increase of the one-foot inward gradient if that proves insufficient to maintain hydraulic control based on bulk EC measurements in the observation wells and head data from POC and supplemental monitoring wells (see Part II.H.1.b). EPA modified permit language for requirements of EC monitoring and reporting to clarify that the EC standards will be based on a statistically significant increase above measured ambient and noise levels at each observation well rather than EC differentials between observation and recovery wells. Regarding the comments about well inefficiency, EPA agrees that recovery wells will not operate at 100% efficiency, however, the gradient would still be inward at less than 100% well efficiency, as depicted in the figures provided by the commenter explaining the impact of well inefficiencies. EPA recognizes that the actual groundwater gradient will be somewhat less than one-foot, as measured at observation and recovery wells, due to recovery well inefficiencies. The differential in water levels will still create an inward gradient so long as the measurements are accurate. If measurement accuracy proves insufficient to ensure the inward gradient differential, the required differential will be increased to account for the level of measurement accuracy and statistical variation in observed water levels.

25) **Comment:** A commenter suggests that a mass balance of injected versus recovered fluid volumes cannot determine whether all the injected acid has been removed and thus ensure hydraulic control is maintained. The commenter also claims that metering errors in measuring excess recovery is an issue (i.e., a 10% excess recovery is not sufficient, if there is a cumulative potential error in metering of 10%).

EPA Response: The injected solution will be diluted to approximately 0.5% sulfuric acid, not the "entirely acid" solution stated by the commenter. Therefore, a water balance is the appropriate analytical tool for this exercise. The aquifer restoration operation requirements ensure that water quality standards established by the permit must be met before rinsing is discontinued. Hydraulic control is assured if an inward gradient of one foot or more is maintained and the bulk electrical conductivity measurements in the observation wells remain below action levels. The permit requirement for a minimum of 10% over production of recovered versus injected fluids is not a measure of hydraulic control, but a means to maintain the inward gradient. It may be increased if proven insufficient or decreased if found to be excessive, subject to EPA review and approval. The 10% differential is expected to be sufficient to exceed any potential metering error, but can also be increased during PTF operations if necessary. Flowmeters are required to be calibrated to ensure a deviation in measurement accuracy of 5% or less.

26) **Comment:** A commenter recommends that FCI monitor and report groundwater conditions at the observation wells in a manner designed to detect excursions. The commenter also states that the permit requires EC monitoring, but does not provide detailed requirements regarding depth. Finally, the commenter alleges that identification of an excursion by lower EC at an observation well than at a recovery well will not accurately detect an excursion, and that the permit should instead require an alert level for EC or pH values at observation wells based on ambient conditions.

EPA Response: First, as noted in Response to Comment 6, EPA revised permit language to require additional EC sensors above the well screens in observation wells and EC action levels at the observation wells based on bulk EC conditions to detect excursions, as recommended by the commenter. Daily water level and bulk EC readings are required in the observation and recovery wells to detect a loss of hydraulic control and potential lateral excursions of ISCR fluids beyond the recovery well perimeter. EPA believes this to be sufficient to detect excursions. Contrary to the commenter's assertion that depth is not accounted for in EC monitoring, permit conditions at Part II.C.6.d require conductivity sensors strapped to the well screens in recovery, observation, and multi-level sampling wells at regular intervals to facilitate electrical resistivity profiling of the formation and will account for depth.

27) **Comment:** A commenter recommends that the permit should require observation wells due north and due west because there is a high percent chance that flow will be in that direction based on tracer test results from the BHP Pilot Test. The commenter also suggests that final locations for observation wells should be determined after aquifer testing and valid modeling.

EPA Response: EPA considered placement of observation wells due north and due west of the PTF well field, as recommended by the commenter, but has decided that the two additional observation wells are not needed. The existing required observation well locations are based on the groundwater flow modeling that EPA required to predict potential flow paths and the results presented in the permit application for the PTF operation. The current placement of observation wells is designed to detect excursions between recovery wells, an area where EPA believes excursions would be more likely. Two observation wells are located at the western periphery and two are located at the northern periphery of the PTF well field. EPA believes this monitoring scheme is sufficient for monitoring for hydraulic control in the downgradient direction of natural groundwater flow. In addition, each observation well will be paired with two recovery wells for monitoring water levels, rather than with just one recovery well as proposed by FCI. Also, supplemental monitoring wells are placed west and due north of the PTF well field as added protection against excursions in those directions.

28) **Comment:** A commenter requested that EPA require additional resistivity sensors, observation, and monitoring wells within the well field. Specifically, the commenter cited a need for resistivity sensors to be installed in the outermost borehole wall of each well and just above the exclusion zone.

EPA Response: The purpose and benefit of additional resistivity sensors requested to be installed in the outermost borehole wall of each well and just above the exclusion zone is not provided by the commenter. Annular conductivity devices (ACDs) are required to be installed in the casing/wellbore annulus of observation and multi-level sampling wells to detect vertical channels adjacent to the wellbore because cement bond logs are not applicable for evaluation of the cement seal in the annulus of wells constructed of fiberglass reinforced plastic (FRP). The injection/recovery and monitoring wells will be constructed with steel outer casing, which will allow evaluation of the cement seal in the casing/wellbore with cement bond logs. ACDs will be placed no more than 10 feet above the MFGU or more than 10 feet above the exempted zone in the LBFU if the MFGU base is more than 200 feet above the LBFU (vertical limit of the exempted zone) in the observation and multi-level sampling wells. In addition, EPA has added the permit condition for FCI to install EC sensors at 20-foot intervals through the LBFU/oxide interface in the observation wells to detect excursions of oxide fluids in the exclusion zone and the LBFU. EPA believes this change, in addition to the already proposed M56 supplemental monitoring well, will be sufficient to protect the LBFU aquifer.

29) **Comment:** A commenter states that the permit requirements will not provide adequate monitoring for vertical migration of injected fluids into the LBFU. The commenter notes that injected fluids will flow upward into the LBFU, and, therefore, EPA should include additional monitoring conditions to address potential vertical escapes, such as monitoring ports in the Westbay wells at the LBFU-Oxide Unit interface within the PTF well field and additional EC sensors at the LBFU-Oxide Unit interface on each well.

EPA Response: The permit requires monitoring for vertical and horizontal migration of ISCR fluids in the LBFU and UBFU in the proposed M56 and M55 monitoring wells, respectively. EPA considered the commenter's recommendation to install additional

monitoring wells or ports in the multi-level sampling wells to sample above and near the top of the exclusion zone. However, EPA decided that sampling the LBFU fluids in those wells could cause movement of oxide zone fluids into the LBFU due to pressure differentials induced by the sampling procedure. Annular conductivity devices will be installed in the observation and Westbay wells at key intervals to monitor for vertical channels adjacent to the well bore and mechanical integrity as a permit condition. The permit requires conductivity sensors to be strapped to the wells screens at regular intervals in the recovery, observation, and Westbay wells for resistivity profiling in the oxide zone. EPA added clarification that the sensors in the observation wells shall be used to monitor bulk conductivity on a daily and weekly basis to detect excursions. Also, EPA added to the permit a requirement for additional sensors to monitor bulk conductivity through the LBFU/oxide interface in the observation wells. As a result of these required conditions, EPA believes the monitoring requirements and conditions in the permit provide adequate monitoring for vertical migration of injection or formation fluids.

30) **Comment:** A commenter asserts that the permit's water quality monitoring requirements are not representative and meaningful indicators of whether the USDW remains protected from the PTF's injected acid. The commenter states specifically that the monitoring requirements demonstrating compliance with operational conditions (i.e., hydraulic control water level requirements) are not sufficient to satisfy regulatory requirements. They claim that EPA regulations at 40 CFR § 146.32(e) support a requirement for both water level and representative water quality monitoring above the injection zone and outside the mine field. Related to this issue, the commenter also recommends an increase in monitoring frequency from quarterly for level 1 parameters and semi-annually for level 2 parameters to semi-monthly to be in compliance with 40 CFR § 146.33(b)(4).

EPA Response: The observation wells serve the purpose cited at 40 CFR § 146.32(e) for detecting any potential excursions during ISCR and rinsing operations by monitoring of water levels on a daily basis and bulk EC readings on a daily and weekly basis, which are representative of water quality. EPA modified EC monitoring requirements in the permit to require additional EC sensors above the injection zone on the observation wells at the perimeter of the well field to ensure detection of any potential excursions before migration outside the mine field. The supplemental monitoring wells would not be expected to detect an excursion in the planned two-year duration of ISCR and rinsing operations and would be expected to appear late in the post-closure monitoring period because of the estimated travel time to the monitoring wells. A loss of hydraulic control for an extended period and an excursion during ISCR operations would be detected at the observation wells long before it could reach a monitoring well. Based on those considerations, semi-monthly monitoring would be unwarranted unless an exceedance of alert levels were to occur at the supplemental monitoring wells whereas conditions in the permit would allow EPA to require additional monitoring and/or action beyond those specified in the permit.

31) **Comment:** A commenter questions the description in Appendix K (Exhibit P-1) where the supplemental monitoring wells and the operational monitoring well MW-01 are all described as operational monitoring wells, whereas the permit language describes them as water quality

monitoring wells. The commenter also questions EPA's reference to ADEQ-mandated POC wells and alleges that they are the only compliance monitoring wells required in the draft EPA permit, with the remaining wells referenced as "operational" wells.

EPA Response: The term "operational" wells used in Exhibit P-1 in Appendix K is not descriptive of their purpose. As described in permit condition Part II.F.1, all supplemental monitoring wells, including the MW-01, are intended to serve as water quality monitoring wells to monitor water quality laterally in the oxide bedrock zone and vertically above the PTF ore body in the LBFU and UBFU, and within the AOR. To the extent there are any inconsistencies or conflicting provisions between permit terms and the Exhibits included in the Appendices, the final permit's conditions are controlling. EPA added this clarification to the permit. In addition, as noted in Response to Comments 24, EPA revised the permit language to clarify that FCI is required to measure background EC levels in the observation wells and statistically significant increase above noise levels will serve as the basis for an EC exceedance.

The commenter's statement that EPA should not reference ADEQ-mandated POC wells and the assertion that these are the only compliance monitoring wells is not accurate. First, these wells (M54-LBF and M54-O in Figure 11-1) will be mandated by the UIC permit in their approved locations, whether or not they are contained in a state-issued permit. EPA added this clarification to the permit in Part II.F.1. Moreover, the supplemental monitoring wells serve as point of compliance wells and the first line of defense against excursion of ISCR fluids in the post-closure monitoring period since they will be located much closer than the POC wells are located to the PTF well field. They are not simply "operational" wells as the commenter asserts. The location of the POC wells, established in accordance with ADEQ requirements, is beyond the AOR. These wells are additional points of compliance in the UIC permit.

32) **Comment:** A commenter questioned the effectiveness of EC monitoring conditions in the proposed UIC permit, and stated that the requirement of a lower EC reading at an observation well than a recovery well is not evidence of hydraulic control.

EPA Response: EPA agrees that a lower EC reading at an observation well than a recovery well by itself is not evidence of hydraulic control. Fluid electrical conductivity values within the well field will vary widely. To address the issue, EPA improved the final permit language to measure bulk EC readings at observation wells for the purpose of detecting any loss of hydraulic control or any excursion of injection or ISCR fluids at the perimeter of the well field. A statistically significant increase in bulk conductivity values above baseline conductivity and noise levels according to procedures subject to approval by EPA will trigger contingency actions. The permit conditions require EC sensors on the screened interval of observation wells to detect lateral excursions. EPA added installation, measurement, and reporting of EC sensors through the LBFU/oxide interface in observation wells to detect vertical migration and further assure maintenance of hydraulic control. If the bulk EC readings exceed the baseline and noise values, as confirmed by EPA approved procedures, contingency action is required.

33) **Comment:** A commenter suggests that EPA provide specific EC monitoring requirements that are critical to obtaining valid and useful data. The commenter notes that the permit's reporting requirements as laid out in Appendix E, Operations Plan (Exhibit K-2), fail to specify EC data to be reported in the required quarterly monitoring reports. The commenter recommends that the permit conditions should be modified to compare observation well EC measurements with background conditions and to mandate FCI conduct a sulfate balance if there is a problem with EC measurement. The commenter also states that the conductivity sensors required by the permit are unreliable.

EPA Response: EPA modified the final permit to require bulk EC monitoring installed at set depths to statistically compare background conditions at the appropriate depths and noise levels in the observation wells. Bulk EC monitoring is a combined geologic formation and pore fluids conductivity measurement. The permit requires the bulk EC monitoring data to be included in the quarterly reporting. As previously noted, EPA has clarified in the final permit that permit conditions supersede any inconsistent or conflicting language in any FCI exhibits included in the Appendices of the permit.

Regarding the commenter's suggestion that the permit requires FCI to conduct a sulfate balance in the event of an EC measurement problem, EPA does not agree. Sulfate will be out of balance in the PTF well field until completion of rinsing operations following ISCR operations. Thus, tracking the sulfate balance during ISCR operations, while feasible, would not be useful for monitoring hydraulic control as the commenter contends. The full sulfate recovery from rinsing and pumping is not expected to occur until completion of the aquifer restoration operations. The final permit requires FCI to conduct a sulfate balance analysis during rinsing operations to ensure aquifer restoration is attained in compliance with permit conditions.

The commenter provides no basis for the assertion that the conductivity sensors are unreliable. The conductivity sensors are reliable for use outside the polyvinyl chloride or fiberglass reinforced plastic well casing or strapped to the well screen based on established geophysical survey practices. While the commenter references a statement by FCI that a similar conductivity sensor produced invalid data during the BHP Pilot Test, however, that was referring to the sensors not providing good quality data for the formation measurements only during the BHP Pilot Test. In that instance, the sensors were used inside the casing, which could cause interference with formation measurements and uncertainty in the depth to correlate between wells and the formation.

34) **Comment:** A commenter notes inconsistency between the permit conditions and Appendix K, including repeated reference in Appendix K to the State's Aquifer Water Quality Standard (AWQS) as the basis upon which monitoring levels and limits will be set rather than MCLs, which are referenced in the permit conditions.

EPA Response: The conditions in the UIC permit for MCL-based limits prevail over descriptions provided in Exhibit P-1 in Appendix K. EPA included a statement in the permit

to clarify that permit conditions supersede any inconsistent or conflicting statements in the FCI exhibits included in the Appendices.

35) **Comment:** A commenter questions the location of POC wells and asserts that the POC wells are years or decades away for a two-year project, which is unreasonable. The commenter recommends that points of compliance should be at the interface between the regional aquifer and the oxide zone within the AOR, for example, where the supplemental monitoring wells are located or closer. The commenter states that the two closest monitoring wells will be located more than 700 feet from the well field on the other side of the aquifer, thus contamination will occur before it is even recorded.

EPA Response: The commenter's description of the compliance monitoring wells is not accurate. The permit's supplemental monitoring wells, which are within the 500-foot AOR, will serve as point of compliance wells. Exceedances of alert levels at those wells will require remedial actions to prevent any migration past this point and require mitigation of the discharge. Point of compliance wells established by ADEQ are located beyond the supplemental monitoring wells and will serve as a secondary tier of monitoring and compliance with the UIC permit. In addition, the permit conditions require FCI to install conductivity sensors on the well screens at regular intervals in the observation, recovery, and multi-level sampling wells to facilitate electrical resistivity profiling of the formation. These EC sensors at the observation wells shall be the closest monitoring at the perimeter of the well field to detect potential lateral excursions and trigger contingency actions. As discussed in Response to Comments 6 and 24, EPA also added a permit condition in the final permit to require conductivity sensors through the LBFU/oxide interface in observation wells to detect any potential vertical movement of excursions at the perimeter of the well field.

36) **Comment:** A commenter suggests EPA should require FCI to disclose its meaningful monitoring data on project performance to the public.

EPA Response: Unless submitted data is deemed to be business confidential by EPA, monitoring data will be available to the public upon request.

37) **Comment:** A commenter questions the adequacy of the permit's post-restoration monitoring requirements and states that insufficient monitoring could lead to premature conclusions of stability.

EPA Response: EPA believes that the UIC permit monitoring requirements are adequate to contain contaminants within the boundary of the AOR and the exempted aquifer in the post-restoration period. EPA can also require longer-term stability monitoring if monitoring in the post-closure period indicates incomplete restoration or a rebound occurs (i.e., increase in concentrations from restored levels) and an exceedance in contaminant concentration is detected in the supplemental monitoring wells. If that occurs, remedial actions may be required and post-closure monitoring can be extended beyond five years. EPA modified the final permit to include an increase in the five-year post-closure monitoring period as an option, if EPA deems it necessary to insure adequate protection of USDWs.

Groundwater Restoration

38) **Comment:** A commenter states that aquifer restoration must be completed before review of a commercial permit application begins. The commenter claims that the permit condition at Part II.I.1.c is unclear due to the requirement for closure operations to commence "after copper recovery operations have been completed," which they assert could be read to mean that restoration obligations are not triggered until cessation of commercial copper production. The commenter also references FCI's proposed Exhibit Q-2 adopted as Appendix F, stating that it could be interpreted to mean that groundwater restoration is not required unless permit amendments for commercial operations are denied.

EPA Response: EPA disagrees with the comments that the permit condition is unclear regarding restoration and closure requirements for the PTF. EPA believes the permit language is clear that PTF restoration is required after cessation of ISCR operations at the PTF site.

The current permit applies only to the PTF operations, restoration and closure. With issuance of the PTF permit, the original BHP permit is simultaneously revoked by EPA and any further ISCR operations would require a new permit, which would need evidence of successful PTF operations and restoration. Also, where possible conflicts or inconsistencies in language exist between the permit and the FCI language in exhibits in the Appendices, the final permit language supersedes the FCI language. EPA has added a statement to the permit to clarify that permit conditions supersede any inconsistent or conflicting statements in the FCI exhibits included in the Appendices of the permit.

39) **Comment:** A commenter claims that FCI's proposed restoration methods may not result in groundwater quality that meets MCLs or background levels. The commenter asserts that continuing high pH and sulfate concentrations from the BHP Pilot Test well field show that constituents of the acid injected in 1997-98 remain present to this day. The commenter notes that radio chemicals remained above the applicable water quality standards in 2010 at 3 BHP Pilot Test wells, and that the groundwater quality results demonstrate that BHP's restoration efforts were not successful in eliminating threats to drinking water supplies.

EPA Response: Background pH levels will be determined in the PTF wells prior to commencement of injection, and restoration standards will be established on that basis. While secondary MCLs are not enforceable, the permit requires that "the permittee shall ensure that constituents which do not have primary MCLs do not impact USDWs in a way that could adversely affect the health of persons." USDWs will be adequately protected by ensuring that water quality standards are maintained at the supplemental monitoring wells surrounding and above the PTF ore body. Acidity can be further reduced by injection of neutralizing agents such as sodium bicarbonate, which was not done at the BHP Pilot Test site. Protection of USDWs is also enhanced for the PTF well field relative to the BHP Pilot Test site since the supplemental monitoring wells are much closer to the PTF site than the 31 POC wells are to the BHP Pilot Test site.

EPA reviewed restoration results, approved cessation of rinsing operations, and authorized closure of the BHP in-situ test well field in July 2005. Monitored constituents and acidity levels reported for the 31 POC monitoring wells in the Quarterly Monitoring Reports submitted in January 2015 are all in compliance with water quality standards.

Sulfate levels in the BHP well field may have rebounded somewhat in a few wells, but were well below the 750 mg/L indicator level when sampled in 2010. Most of the 20 wells showed significant decreases or stable levels at low concentrations well below the secondary MCL of 250 mg/L. Trace metal concentrations were at extremely low or non-detect levels in 2010 and showed no evidence of significant rebound in the five sampling events that occurred between 2000 to 2010.

The three wells cited by the commenter that had reported exceedances in radium concentrations in 2010 were likely related to natural causes because excess radium levels have occurred historically at those wells and none have shown decreased pH levels or elevated sulfates as would be expected if the wells had been impacted by ISCR fluids.

40) **Comment:** A commenter states that the aquifer restoration process is poorly defined and relies too heavily on sulfate concentrations to define successful restoration. The commenter also claims that the permit does not require FCI to restore the groundwater aquifer to pre-mining conditions. They allege that the permit allows FCI to pollute the aquifer, as long as the pollutants are not regulated by a federal MCL and have not reached an existing well, and they note that pollutants without federal MCLs can degrade the aquifer and render it unsuitable for drinking or other portable uses. Finally, the commenter states that the UIC permit must have clear and enforceable standards for cleanup of the aquifer after mining because it is allowing injection into the Town of Florence's main source of drinking water.

EPA Response: First, the oxide zone and the exempted portion of the LBFU are not the Town of Florence's main source of drinking water as stated by the commenter. Drinking water wells are located in the LBFU far outside of the exempted portion of the aquifer. Second, the standard of the permit is USDW protection to ensure that any contaminants whether it is regulated or not do not impact USDWs in a way that could adversely affect the health of persons. Monitoring wells will be located well within the AOR of the PTF and far inside of the aquifer exemption boundary, to ensure that any contaminants that might remain in the PTF project area after restoration do not migrate beyond the monitoring well locations. The POC wells are a secondary line of defense in the highly unlikely event that a contaminant was to escape detection at the monitoring wells. Restoration of the aquifer to meet federal MCLs, or pre-operational background levels if greater than MCLs, is the standard for the PTF well field. The risk of any potential migration of a contaminant beyond the well field would be reduced by the natural attenuation of that contaminant as it moves into a higher pH environment downgradient of the PTF. The surrounding USDW is protected from any impact based on the safeguards of restoration in the PTF well field, monitoring wells within the AOR, POC wells located within the exemption boundary, and natural attenuation and dispersion of residual contaminants.

41) **Comment:** A commenter states that the permit requires FCI to monitor contaminant concentrations at well manifolds as an indicator of restoration progress and ultimate success, and they claim that contaminant concentrations at well manifolds are not accurate indicators of groundwater conditions in and around the PTF well field. They suggest it is more accurate to measure sulfate concentrations at each well head. The commenter also states that reports summarizing the results of the BHP Pilot Test contain repeated statements that the aquifer is extremely heterogeneous and that the EPA assumption that BHP relied on in its groundwater modeling does not work. Under these conditions, the commenter states that sampling at individual wells is the only reasonable means to verify groundwater restoration.

EPA Response: Although the permit requires well manifold monitoring initially, after sulfate is at or below the 750 mg/L level and all constituents meet primary MCLs or the pre-operational background concentrations in the manifold samples, then samples are required to be collected at each individual well, analyzed for sulfate, and meet the same sulfate concentration level (as was met in the manifold samples) for acceptable closure. The sulfate concentration level required for each well is the indicator sulfate level which is at 750 mg/L or below that met the primary MCLs or pre-operational background concentrations for the manifold sample. EPA revised the permit language at Part II. I.1.c to clarify this condition of restoration. Rinsing continues until the sulfate concentration is less than the indicator sulfate concentration in each well. After this condition is met, the permittee may discontinue rinsing for 30 days and will resample each well to verify wells remain below the indicator sulfate concentration. Therefore, permit conditions are focused on sampling each individual well to confirm groundwater restoration and indicate acceptable closure.

The commenter's arguments against the use of the EPM assumption in the flow and transport model is discussed in Response to Comments above. Also, the differences between the BHP flow and transport model and the FCI model for the PTF are significant and therefore, a comparison of predictions and results may not be appropriate. A full description of the BHP model was not provided, which makes it difficult to make direct comparisons. Also, the sources for some of these comments are drafts of BHP reports with incomplete conclusions and recommendations. FCI considered the results of the shortened and incomplete BHP ISCR operation of limited value in preparing a UIC permit application for the PTF project.

42) **Comment:** A commenter states that compliance with the sulfate indicator concentration does not guarantee restoration of the PTF well field and that although the permit requires Level 1 and Level 2 sampling at individual wells during PTF operations and after closure, the sampling schedule is too limited to accurately gauge the success of restoration.

EPA Response: Monitoring for sulfate concentrations at each PTF well, after establishing the indicator sulfate concentration at the well manifolds by measuring and ensuring contaminant concentrations are below primary MCLs or the pre-operational background levels if greater than MCLs, is a valid and acceptable measure of aquifer restoration.

The purpose of the monitoring and POC wells and the sampling schedule is not to "gauge the success of restoration" as stated by the commenter. It is to ensure that residual ISCR fluids

that are not detected and mitigated during restoration do not migrate beyond the monitoring well ring and the AOR and, thus, remain within the exempted aquifer.

Permit sampling frequency at the monitoring and POC wells is considered adequate given that the distance to the monitoring wells is such that any residual contaminants from the PTF well field should not reach the monitoring wells during the nine-month restoration period and the early post-closure monitoring period. If quarterly Level 1 sampling reveals an exceedance, the maximum distance a contaminant could travel beyond the monitoring well is 10 feet, based on the approximate 40 foot per year groundwater flow velocity. USDWs are adequately protected because the AOR boundary is hundreds of feet beyond the monitoring well ring, the aquifer exemption boundary is hundreds of feet beyond the AOR, and the exceedance would require remedial operations to reverse the excursion and eliminate the exceedance. In addition, more frequent monitoring and other actions may be required by EPA if AL or AQL exceedances were to occur and were not mitigated within an acceptable time frame (see permit Part II.H.2).

43) **Comment:** A commenter asserts that post-closure monitoring is not adequate to demonstrate the aquifer's long-term stability after mining stops. They claim that for commercial uranium ISR mines, USEPA has recommended 30 years of post-closure monitoring to demonstrate aquifer stability. They also claim that closure of a copper ISR mine is similar to closure of a hazardous waste storage facility and merits the same precautions, including a requirement for the operator to conduct post-closure monitoring for 30 years. The commenter also states that 30 years may not be necessary, but asserts that no one knows the length of time necessary to demonstrate aquifer stability after the PTF closes. They also state that adequate post-restoration rebound monitoring is not required by the permit. They reference an EPA proposed rule for uranium mining (Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, January 26, 2015) as a model for post-restoration monitoring and to demonstrate that geochemical conditions can continue to change for long periods after ISR mining has ended requiring long-term monitoring to ensure USDWs are protected.

EPA Response: Post-closure monitoring may be extended beyond five years if warranted by water quality data in the monitoring or POC wells. EPA has added language to the permit that clarifies that the monitoring requirement may be extended beyond five years if EPA deems that necessary to protect USDWs.

The commenter's reference to the January 26, 2015 EPA proposed rule for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings in support of their post-closure comments is not appropriate, as the proposed rule, which has not yet been finalized by EPA, applies to commercial uranium mines, not to a small ISR copper pilot test facility. In addition, ISR uranium mining is conducted in sedimentary rocks (sandstone primarily) while ISR Copper mining at the FCI site is in highly fractured igneous rock. ISR uranium mining typically applies an oxidation reaction to mobilize uranium oxide using sodium bicarbonate as an oxidizing agent. The PTF project will inject dilute sulfuric acid to dissolve and mobilize copper in the pregnant leach solution.

44) **Comment:** A commenter states that temporary cessation should be prohibited by the permit or, at a minimum, better regulated by more definite permit terms.

EPA Response: Temporary cessation of PTF operations would be subject to EPA approval, as stated on page 5 of Exhibit P-1 in Appendix K of the draft permit. However, the permit does not provide for temporary cessation of ISCR or rinsing operations during the planned 23-month duration ISCR and rinsing operations except as a contingency if hydraulic control is lost or excursions occur or USDWs are otherwise endangered. There is no provision for temporary abandonment of injection wells in the permit as described at 40 CFR § 144.52(a)(6) unless it should occur after restoration is completed and before PTF wells are plugged and abandoned during closure procedures.

If temporary cessation of operations were approved, FCI would continue to follow applicable requirements of the permit, such as maintaining hydraulic control and monitoring during the period when operations are permitted to temporarily cease.

45) **Comment:** A commenter states that the Operations and Closure Plans contain numerous errors and inconsistencies with the permit that must be corrected, specifically Appendix E, Exhibit K-2: PTF Operations Plan and Appendix F, Exhibit Q-2: Closure and Post-Closure Plans.

EPA Response: These errors and inconsistencies between the permit conditions and language in the FCI exhibits in the Appendices to the permit have been addressed by clarifications to the permit language, as described in previous Response to Comments. Permit conditions supersede any erroneous and/or inconsistent language in the FCI exhibits included in the Appendices.

46) **Comment:** A commenter asserts that all available evidence indicates that complete restoration of an in situ leach mine has never been successful, as shown by uranium ISR mines. The commenter claims it will be impossible for FCI to return the aquifer to meeting drinking water standards.

EPA Response: The commenter refers to restoration results at ISR uranium mines, which have had documented challenges. However, aquifer restoration success was demonstrated for ISR copper mining at the BHP Pilot Test site within six years of cessation of ISCR operations. The BHP project is much more relevant and applicable to the PTF project than the ISR uranium mining operations cited by the commenter. EPA approved closure of the BHP well field in 2005 after rinsing operations were concluded in 2004. No exceedances related to ISCR operations have been reported in quarterly monitoring of POC wells since initiation of the BHP Pilot Test in 1997.

47) **Comment:** A commenter states that the BHP Pilot Test well field continues to experience pH levels and contaminant concentrations that would not be expected had restoration been successfully achieved and maintained. They allege that the BHP test was the same size as the PTF, but restoration remains incomplete 17 years later.

EPA Response: EPA does not agree with the commenter's assertion that BHP aquifer restoration remains incomplete 17 years after completion of the pilot project. The BHP wells were last sampled in 2010, and results showed that water quality parameters were in compliance with permit conditions for restoration. Moreover, EPA accepted the demonstration of restoration in 2004 and authorized closure of the BHP well field in 2005. Although the pH levels in four BHP wells had not yet returned to background levels, pH does not have a primary MCL. Nonetheless, laboratory test results show that mixing with bicarbonate bearing groundwater will cause the pH to increase to background levels (6.0 to 8.0 pH), according to the John Kline report, dated September 12, 2001 and titled "Well Field Reclamation Test and Well Field Metallurgical Balances." The laboratory tests also indicated that injection of neutralizing agents such as sodium bicarbonate would raise the pH to background levels, which EPA has discretion to require as a contingency action. In addition, monitoring at the POC wells has continued on a quarterly basis since 1998 to the present time without any exceedance related to ISCR operations. Refer to further EPA discussion of this topic in Response to Comment 40 above.

Arsenic

48) **Comment:** A commenter recommends that EPA Region 9 evaluate the new bench test procedures utilized by FCI's consultant. They note that data generated by the bench tests were used in FCI's geochemical model, which was used to predict arsenic and other contaminant concentrations after restoration.

EPA Response: The geochemical model will be reviewed and modified by the results of PTF operation and restoration. It will also be used in forecasting performance for potential further ISCR operations beyond the PTF, which is one of the objectives of the PTF. Bench testing and computer modeling are no substitutes for the field-scale pilot test data. Rinsing operations will continue until restoration goals are reached and stabilized. Water quality will be monitored at the supplemental monitoring and POC wells to ensure that USDWs beyond the exempted zone are protected.

49) **Comment:** A commenter questions FCI's geochemical model based on expert testimony provided at a state hearing by Dr. Terence McNulty, P.E. They claim that Dr. McNulty testified that these bench tests resulted in arsenic concentrations of up to 32,000 µg/L in pregnant leach solution, with 4 of 24 samples exceeding 1,000 µg/L and the remainder below the bench test detection limit of 1 µg/L but possibly much higher than the arsenic MCL. The commenter notes that Dr. McNulty also testified that bench test concentrations of arsenic were averaging 80 µg/L in simulations of post-mining groundwater after rinsing with site water and a neutralizing agent. They claim that the geochemical model submitted with FCI's application predicts arsenic concentrations significantly lower than the results testified to by Dr. McNulty and the arsenic standard sought by FCI for the state permit.

EPA Response: Regardless of the geochemical modeling or bench test results and testimony at the state hearing, background arsenic levels will be determined at the PTF and supplemental monitoring wells and will be the standard for restoration and contingency

actions to protect USDWs if concentrations are greater than the MCL. The commenter erroneously states that the 20 of 24 bench test sample results were "below the bench test detection limit of 1 µg/L but possibly much higher than the arsenic MCL" of 10 µg/L." For clarification, the bench test detection limit was stated as 1 mg/L or 1 part per million (ppm), not 1 µg/L (microgram per liter) or 1 part per billion (ppb), by Mr. McNulty in his testimony on May 6, 2014. Also, Dr. McNulty testified that the probable average arsenic concentration in the rinse water was 50 micrograms per liter (or parts per billion), not 80 micrograms per liter (µg/L).

50) **Comment:** A commenter states that EPA Region 9 needs to determine why arsenic levels are increasing in BHP Pilot Test wells, noting that these increases began five years or more after the pilot test ended. The commenter also states that monitoring and remediation actions to address arsenic contamination after it occurs is not adequate.

EPA Response: Arsenic concentrations increased to slightly above the 10 µg/L MCL in 2007 and 2010 sampling in three of the four original BHP injection wells, after cessation of rinsing in 2004. Arsenic concentrations in the other 16 BHP wells have remained below the MCL of 10 µg/L and show no significant increases through 2010. No sampling data was required and, therefore, is available from the BHP wells since 2010 to assess whether those levels were sustained or were statistical variations. Because the background concentrations of constituents were not determined for the BHP wells, the slight increases in arsenic levels may represent a return to the ambient groundwater concentrations or statistical variations at the three injection well locations. For the PTF, FCI is required to determine background concentrations before operations begin in order to establish groundwater restoration standards. Finally, there have been no arsenic exceedances at the POC wells in quarterly sampling reports through 2014, and the proposed supplemental monitoring wells will be placed to detect any exceedance at those locations (i.e., all within the PTF AOR and the aquifer exemption boundary).

Sulfate

51) **Comment:** A commenter questions the permit's use of a sulfate concentration of 750 mg/L as an indicator that the aquifer has been restored to permit standards after PTF operations are complete, noting that this is the same concentration used in the BHP permit. The commenter also suggests that the PTF permit should set Alert Levels (ALs) that are consistent with the secondary MCL for sulfate and the permit should require sulfate monitoring for more than five years in post-closure monitoring.

EPA Response: Sulfate has remained at background levels and/or below the secondary MCL of 250 mg/L in the BHP observation wells through the last sampling event in 2010 and through 2014 in the POC wells. For the PTF, ALs for sulfate will be established in accordance with provisions in Appendix K, Exhibit P-1 of the UIC permit for constituents without a primary MCL, which EPA considers adequately protective of USDWs. EPA can extend groundwater quality monitoring at the PTF monitoring wells and POC wells beyond five years, as noted in prior Responses above. Refer to EPA Response to Comment 40 for

more detailed discussion of this issue. EPA modified the permit language to clarify that potential extension of monitoring beyond five years.

52) **Comment:** A commenter states that the permit allows sulfate contamination in the LBFU. They also note that the oxide zone is in direct hydraulic communication with the LBFU, which sits atop and downgradient of the oxide zone. The commenter claims that after restoration, sulfate concentrations of up to 750 mg/L will travel out of the exempted aquifer and into a USDW relied upon by local residents.

EPA Response: The ISCR operation will be in the oxide zone below the exempted portion of the LBFU. Low levels of sulfate contamination that may enter the lower LBFU above the oxide zone during ISCR operations will be monitored and reversed by means of hydraulic control and by aquifer rinsing operations. The PTF restoration operation is required to effectively remove sulfate and other constituents to levels consistent with permit conditions preventing an impact to USDWs. This requirement will ensure that sulfate levels are reduced to acceptable levels before closure of the PTF. Refer to Part II.I.1 of the permit.

As noted, permit conditions require that an alert level for sulfate be determined when the additional POC and supplemental monitoring wells are installed, based on background concentrations of sulfate. If an exceedance occurs at a POC or monitoring well, the contingency plan provisions require actions to evaluate the cause and mitigate the effects, if any, of the discharge responsible for the exceedance. EPA may require additional monitoring and/or action beyond those specified in the permit in accordance with the conditions at Part II.H.2.a.v, H.2.b.v and I.1.b.

Finally, if sulfate were to escape the AOR and aquifer exemption boundary or remained in the LBFU above the exclusion zone after aquifer restoration is completed, it would be well over one hundred years for the sulfate to reach the nearest potential (inactive) drinking water well located approximately 1.2 miles downgradient of the PTF well field. This is based on an estimated hydraulic conductivity ranging from an average of 15 feet/day to a maximum of 25 feet/day and a groundwater flow velocity of 30 to 50 feet per year in the LBFU, but does not consider the natural attenuation that would occur. Moreover, if tortuosity of pore spaces were considered in the calculation, the travel time would be even longer. The permit is specifically written to prevent contaminants from migrating out of the exempted aquifer and into a USDW relied upon by local residents.

Radiochemicals

53) **Comment:** A commenter references an EPA report titled Technologically Enhanced Naturally Occurring Radioactive Materials in the Southwestern Copper Belt of Arizona, EPA document 402-R-99-002, October 1999, page 31, (www.epa.gov/sites/production/files/2015-05/documents/402-r-99-002.pdf) and claims that it shows column leach test results for Pregnant Leach Solution produced high levels of radionuclides (leachable) in 1996 for the BHP Pilot Test site in Florence. The commenter states that BHP tests demonstrated the radiochemicals at this site will leach into groundwater during ISR mining, as confirmed by

column leach tests. They also assert that although the BHP column leach tests showed radiochemical concentrations could be reduced through rinsing, BHP could not return gross alpha, radium or radon concentrations to background levels, and that radiochemical analysis conducted in 2001 showed adjusted gross alpha exceeding water quality standards in seven of the 20 wells and total radium exceeding standards in six of the wells.

EPA Response: The commenter states that in 2001 the radiochemical concentrations in groundwater samples from the BHP wells exceeded water quality standards in seven of the 20 wells for adjusted gross alpha and in six of the 20 wells for total radium. Subsequent sampling in later years of aquifer restoration showed that the concentrations decreased to levels below the water quality standards or remained within the background concentration range. See EPA's Response to Comment 54 below for further discussion of background concentrations.

54) **Comment:** A commenter states that radiochemicals have consistently exceeded standards at various wells at the site since the BHP Pilot Test. They cite a report Merrill Mining provided in April 2004, after the BHP Pilot test, that noted radiochemical exceedances for June 2001 and December 2003 monitoring well samples – AWQS exceedances for adjusted alpha and for total radium. The commenter notes that Merrill claimed the results were indicative of background values, because pH and sulfate levels indicated no impact from ISR mining. However, the commenter states that no background sampling was conducted when these wells were installed, so there was no baseline level of natural conditions for comparison. They assert the conclusion is contradicted by background data in the Site Characterization Report, Table 4.5-4 (January 1996), collected from 20 wells around the mine site in 1995 before ISR operations of any kind began, indicating that background levels of radiochemicals in groundwater across the 20 wells was well below applicable federal and state levels.

The commenter also claims that CH1-R well contained total radium at a concentration of 5.5 pCi/L, in excess of the AWQS, and uranium concentration four times the federal drinking water standard in December 2003. They also cite a June 2005 report from Brown and Caldwell, which shows adjusted gross alpha and total radium concentrations were below applicable standards for wells CH1-R, CH1-B, CH2-R, and CH2-B, and they state that subsequent data for CH1-R shows total radium and uranium levels in excess of federal and state standards after 2005 samples were taken.

Finally, the commenter claims that FCI's recent water quality monitoring data in December 2011 and January 2012 from P49-O, a monitoring well perforated in the oxide bedrock zone into which BHP injected acidic solution, demonstrates significant exceedances of alert levels for sulfate, magnesium, and total dissolved solids.

EPA Response: The commenter's assertion that "background levels of radiochemicals in groundwater across 20 wells was well below the applicable federal and state levels", in reference to the Magma Copper Company, Site Characterization Report, Table 4.5-4 (January 1996), is misleading. The actual pre-operational background levels reported in Table 4.5-4 were highly variable from well to well and from month to month and showed

relatively high gross alpha activities from 8.0 to 51 pCi/L (compared to the permissible value of 3.0 pCi/L and MCL of 15 pCi/L) in three of the five oxide monitoring wells. Gross alpha activities in the LBFU and the UBFU were also highly variable and exceeded the MCL of 15 pCi/L in some wells, showing 41 pCi/l in one LBFU well and 45 pCi/L in one UBFU well. EPA believes that those data and the pH and sulfate results support the Merrill Mining conclusion that radiochemical exceedances in December 2003 monitoring well samples were indicative of background radiochemical levels at the BHP site.

The data cited by the commenter for the CH1-R well is also misleading because total radium was reported as less than 1.5 pCi/l, well below the AWQS level, and uranium had decreased to 17.9 pCi/L in the June 28, 2010 sample from that well. The small exceedances reported in the 2004 Brown and Caldwell report, and any since, for total radium in the BHP-2 and OWB-4 wells have occurred historically at those wells and are considered to be related to natural causes. This is supported by the fact that neither of these wells have shown decreased pH levels or significant elevation in sulfate concentrations as would be expected if the wells had been impacted by ISCR fluids. EPA agrees with the conclusion that the exceedances of sulfate, magnesium, and total dissolved solids reported in the P49-O monitoring well in December 2011 and January 2012 were due to causes unrelated to the BHP Pilot Test site operations (see Haley and Aldrich letter to Curis Resources (Arizona), Inc. dated March 27, 2012).

For the PTF, the permit requires FCI to determine background concentrations of radiochemicals for PTF wells and supplemental monitoring wells before injection begins to establish aquifer restoration standards for the PTF wells and water quality standards at the POC and supplemental monitoring wells.

Groundwater Issues at Uranium In-Situ Mine Operations

55) **Comment:** A commenter provided information from a 2009 United States Geological Survey (USGS) open-file report 2009-1143, Groundwater Restoration at Uranium In-Situ Recovery Mines, South Texas Coastal Plain (May 11, 2009), which examined groundwater data from 27 ISR uranium mines, composed of 77 individual well fields, in Texas. The commenter notes that final sample and restoration results were available and summarized at 13 of the 27 ISR mines, and that groundwater could not be restored to the goal of baseline conditions for all 26 chemicals analyzed at 22 of 77 well fields where final sample results were available. The commenter also notes restoration standards were revised by state regulators for at least one chemical for every well field.

EPA Response: Restoration results at ISR copper operations at the PTF site are not directly comparable to results at uranium ISR mines due to numerous factors, including differences in geological settings, geochemical reactions, and mobilizing solutions applied to recover copper versus uranium. Uranium ISR mines in the United States are typically in sedimentary deposits while copper deposits usually occur in igneous rocks as is the case at the PTF site. Moreover, groundwater restoration at the BHP Pilot Test site was demonstrated by Merrill Mining in 2004 and was approved by EPA in July 2005, seven years after restoration

operations began. No exceedances related to the BHP operations have been detected at the POC wells since that time.

FCI restoration operations at the PTF site will continue beyond the nine-month period proposed by FCI if restoration goals are not met by the end of that time. FCI will monitor groundwater quality at the supplemental monitoring and POC wells during the five-year post-closure monitoring period to protect USDWs from migration of any residual contaminants beyond the AOR and aquifer exemption boundary. In the unlikely event that an aquifer quality limit exceedance occurs, EPA may require additional monitoring and/or remedial actions beyond those specified in the permit. EPA added a permit condition for continued groundwater monitoring beyond five years, if necessary, to assess groundwater restoration stability during the post-closure monitoring period.

Groundwater Flow and Transport Model

56) **Comment:** A commenter claims that EPA did not consider evidence revealing problems with FCI's groundwater models. Further, the commenter states that EPA's acceptance of the FCI model contradicts agency guidance, which stresses the importance of basing predictive tools on observed conditions and testing them against such conditions, rather than relying solely on data obtained from hypothetical models.

EPA Response: This comment is similar to the discussion in Comment 4 above regarding the alleged failure of FCI to properly account for the heterogeneity of the ore body in the groundwater flow model. EPA considers the ground water modeling an acceptable simulation and prediction of aquifer flow conditions, and appropriate for the geologic conditions observed and hydraulic properties measured at the FCP property. EPA required FCI to model seven different scenarios with input parameter values provided by EPA based on actual hydrogeologic conditions at the site. This includes a major fault zone that intersects the oxide bedrock zone, which provides a potential preferential lateral and vertical flow path within the model. The permit requires formation testing prior to injection to evaluate subsurface characteristics within the PTF AOR, and the model parameters will be revised if the resulting test results show parameters significantly different from those used in the model.

57) **Comment:** A commenter claims that conceptual models for simulating flow and transport were not adequately developed. They state that the character of flow at the scale of the PTF has been poorly defined, and the importance of heterogeneity and anisotropy of fractures throughout the oxide bedrock zone at this scale has not been properly addressed. The commenter provides numerous additional comments challenging the groundwater modeling and its assumptions, including the claim that FCI based its modeling assumptions and calculations on an EPM model that does not reflect real-world conditions nor adequately address the risks to the LBFU. They claim that due to alleged flaws in the groundwater and transport model, the utility of the model as a tool for predicting flow is questionable, and will lead to flawed decisions regarding definition of the AOR and zone of endangering influence, placement of monitor wells, and evaluation of the ability to maintain hydraulic control.

EPA Response: EPA does not agree with the assertion that EPA has not properly addressed the importance of heterogeneity and anisotropy of fractures throughout the oxide bedrock zone in the permit. EPA believes that for the purposes of the permit application, heterogeneity has been adequately addressed. Fractures are so pervasive that the ore zone rock consists largely of rubble, as evidenced in cores. The heavily fractured nature of the oxide bedrock zone cannot be modeled on the basis of individual fractures or fracture zones. EPA is confident that the EPM assumption is appropriate for the PTF model, and accuracy of the EPM model will be tested and reviewed as an objective of the PTF project. The geophysical logs and aquifer pump and tracer testing required before ISCR operations begin will provide additional data specific to the PTF that can be used to modify key model parameters and improve the accuracy of the model predictions. Operational flexibility built into the permit will allow for hydraulic control to be maintained even if non-anticipated flow-paths develop during the test.

The hydrologic modeling is considered valid, based on EPA required modifications to the model for AOR evaluation. These modeling modifications included the evaluation of seven possible scenarios of porosities, hydraulic conductivities, preferential flow in the plane of the Sidewinder Fault Zone, and localized absence of the MFGU confining layer, which were based on information provided in the UIC permit application and studies or reports associated with the application. An assumed worst-case scenario with loss of hydraulic control for 30 days was the basis in all scenarios except for the 48-hour basis applied in the Scenario 1 base model.

The groundwater flow model also includes an assumption of directional or preferential flow paths in the plane of the major fault that intersects the PTF in a north-south strike orientation and dipping to the west. The highly variable permeability of the ore body will tend to an average value on the regional scale of the model. The different layers of the model account for differing porosities and permeabilities in those layers as well as the major fault zone. If preferential flowpaths in fluid flow occur, those can be detected and corrected through management of individual flow and/or injection rates. The performance of the PTF well field, not the regional groundwater flow model, will determine how those rates will be managed to control fluid flow within the PTF.

58) **Comment:** A commenter states that FCI did not include sufficient justification of the EPM assumption necessary to apply the model codes used for the PTF model. They recommend that EPA require a detailed evaluation of the BHP test data to show that the data available for the oxide unit support use of the EPM assumption. The commenter also states that recently developed models that rely on discrete fracture realizations based on observed fracture data have performed relatively well as predictive tools.

EPA Response: A detailed evaluation of the BHP test data to show that the data support use of the EPM assumption would not necessarily be applicable to the PTF site because the fault zone's positions and orientation are unique to each site. The testing and performance of the PTF is expected to reveal the heterogeneity and directional flow variability unique to that site. Flow of fluids into and out of the PTF well field can be managed, as it was at the BHP

site, to maintain hydraulic control. As previously noted, EPA considers a discrete fracture system model an impractical model for the PTF ore zone and that the EPM assumption is the appropriate basis for the groundwater flow and transport model.

59) **Comment:** A commenter claims that the transport model was not used to properly assess the recovery of contaminated groundwater. They recommend that EPA conduct a detailed analysis of the BHP test, particularly the geochemical changes following the acid leaching test, to estimate the time it will take to restore the groundwater quality at the PTF site.

EPA Response: EPA disagrees with the comments suggesting a need for further detailed analysis of the BHP test. The BHP test and monitoring data indicate that aquifer restoration was successful with no indication of ISCR related exceedances at the POC wells 17 years after testing. EPA does not agree that further analysis of the BHP test will provide additional useful information on the estimated time to restore groundwater at the PTF site.

60) **Comment:** A commenter states that the models have not been sufficiently calibrated for simulating contaminant flow and transport at the PTF site. They recommend that EPA require aquifer tests and tracer tests similar to those conducted at the BHP test site, and that the flow and transport model be calibrated to match the results of the tests.

EPA Response: Extensive aquifer testing was performed and the results were included in the FCI permit application. EPA reviewed those reports and believes further testing at the PTF site is warranted when the PTF wells are installed. The permit requires the permittee to perform aquifer pump tests similar to those run in the BHP project prior to injection in order to evaluate subsurface characteristics of the oxide bedrock zone, overlying basin fill units, and the confining MFGU within the AOR (see Part II.C.8 of the permit). In addition, EPA added a requirement for tracer tests to the permit as a component of the aquifer testing at Part II.C.8. The results of these aquifer tests will be compared to parameters used in the groundwater flow model, and the model parameters will be revised accordingly if they are found to be significantly different from those used in the model.

The PTF project will provide a test and evaluation of the ISCR operation and restoration results prior to any potential authorization of further ISCR operations at the site. The permit requires post-closure audits of the computer modeling during the third, fifth, and seventh years after commencement of PTF operations to reassess the predicted fate and transport of the pollutants discharged by the PTF operations. Refer to Part II.J of the permit for Post-Closure Audits.

61) **Comment:** A commenter states that a particle capture concept is not used to operate the PTF project. They claim that particle capture analysis directly and quantitatively addresses hydraulic containment. The commenter provides a number of examples of particle capture use and asserts that particle capture analysis is the best chance to implement the proposed operations safely.

EPA Response: While particle capture modeling recommended by the commenter could be a useful exercise to conduct prior to commencement of the PTF test, such modeling would not

assure hydraulic control as it represents a simulation based on uncertain inputs, not a direct measure of containment. EPA believes that direct measurement and monitoring of water levels and bulk electrical conductivity will be sufficient to maintain hydraulic control of ISCR fluids. In addition, EPA added a requirement for electrical conductivity sensors above the well screens in the observation wells to detect any possible loss of hydraulic control. The PTF operations will test the adequacy of those methods, which is one of the primary objectives of the PTF, and adjustments and alterations can be implemented during PTF operations if those methods and standards prove insufficient. One objective of the PTF is to better refine hydrologic modeling at the site prior to the consideration of any potential future ISCR operations.

The examples of particle capture simulation at the BHP well field presented by the commenter and depicted in the commenter's Figures 3 to 7 show particle track movement beyond the perimeter extraction wells, but the particle tracks are pulled back to extraction wells in each figure and none of the tracks move beyond the observation wells. Those examples appear to indicate that hydraulic control is sustainable under the conditions applied to the four simulation scenarios. In any event, rinsing operations are intended to restore the aquifer to permit requirements by the recapture of particles that may have escaped the well field during ISCR operations.

62) **Comment:** A commenter states that the model scenarios conducted in support of the UIC application explored only minor variations in a few select parameters of the model and did not address key uncertainties in input assumptions and parameters. They claim that useful data collected at the field site and analogous sites have not been implemented into the design of the model and sensitivity to variability in physical properties was not addressed.

EPA Response: EPA does not agree with these comments and assertions. Sensitivity analyses of the groundwater flow model were performed to account for uncertainty in model input parameters. As previously noted, seven different scenarios were modeled at EPA's request to evaluate the model sensitivity to changes in porosity and permeability of the oxide bedrock unit and the effect on the PTF area of review determination. Refer to EPA's previous Responses regarding the use of the EPM assumption rather than a discrete fracture network model recommended by the commenter. The uncertainty of model prediction will be reduced by the application of the PTF well testing and logging data and operation of the PTF for calibration of the model.

63) **Comment:** A commenter suggests that EPA should require a competent geochemical model, and claims that FCI's geochemical model is not adequate to predict restoration expectations.

EPA Response: One of the PTF objectives is to develop a geochemical model for possible future ISCR operations at the site. The BHP Pilot Test was too short in duration to generate sufficient data to resolve some of the issues related to geochemical modeling discussed by the commenter. The BHP Field Test Report includes recommendations for implementation of an additional ISCR test of longer duration, which is consistent with the basis for the current PTF project. The longer term PTF operation will provide a more reliable basis for predicting the geochemical performance of any future ISCR operations at the site.

64) **Comment:** A commenter suggests that EPA should require that the transport model be used to inform the estimates of the number of pore volumes that will be required to sufficiently reduce any contaminants in the aquifer.

EPA Response: The estimated number of pore volumes required to reduce the contaminants in the aquifer can be determined through the restoration process at the PTF site, and then applied to any potential future ISCR operations at the site, which is one of the critical objectives of the PTF project. The BHP copper recovery operation was too short in duration to provide a reliable estimate of pore volumes necessary at the PTF site. Also, the transport model requires calibration by application of PTF testing, well logging, and operational data to provide the most reliable predictions of pore volumes necessary to reduce any contaminants in the aquifer.

General

65) **Comment:** A number of commenters expressed general opposition to the PTF, but did not present any new information related to the UIC permit. The commenters contend generally that the proposed PTF will have a negative effect on the environment, local economy, Town of Florence, and surrounding community and that the proposed project is too risky to be close to their communities, water resources, and families.

EPA Response: EPA takes these comments and concerns of the nearby community members seriously. However, the Agency has thoroughly considered the ways in which fluids can escape from the injection activity into a USDW and concluded that the UIC permit conditions are fully compliant with the mandates of the UIC regulations to protect USDWs.

66) **Comment:** A commenter takes issue with EPA's administrative process, and the fact that the Agency did not consider public input in the preparation of a proposed permit.

EPA Response: While EPA's UIC permitting process regulations do not have a public participation process prior to the public noticing of the draft permit, EPA carefully considers the comments and feedback before making a determination on a permit action. The federal regulations for EPA permit decision-making at 40 CFR Part 124 describe the steps EPA follows in processing permit applications, preparing draft permits, issuing public notice, inviting public comment, and holding public hearings on draft permits. After EPA public notices a draft permit, there is significant opportunity for public input during the public comment period. The purpose of the public comment period is for the public to provide input on the substance of the proposed permit and the application materials before EPA makes a final decision. Within the extended public comment period that lasted four months, a public information session and hearing were held by EPA Region 9 in Florence, Arizona in January 2015 to solicit input from the public on the draft permit and proposed PTF project. EPA has provided written responses to all significant comments on the draft permit, in accordance with the requirements of Part 124. EPA's final permit decision reflects input and consideration of the comments received from the public.

67) **Comment:** A commenter expresses concern that old wells, boreholes, coreholes, and mine shafts located within the proposed test area cannot possibly be found and plugged and can serve as conduits for the leached toxic solution, heavy metals, radionuclides, etc. that can contaminate the drinking water aquifer.

EPA Response: As described in Response to Comment 4, EPA determined the AOR (also known as the zone of endangering influence) to be the PTF well field area and a circumscribing width of 500 feet beyond the well field. EPA determined this AOR based on the modeling information in the UIC application and EPA regulations at 40 CFR § 146.6.

Pursuant to the requirements at 40 CFR § 144.55, the applicant identified the location of all known wells (including any holes, mineshafts, etc) within the AOR penetrating formations affected by the increase in pressure from the injection activity. From public sources and previous owners of the property, FCI provided a detailed list of these holes and wells present within the AOR. EPA requested additional information regarding such coreholes and wells to determine the quality of past construction, cementing, plugging, and abandonment. Given the amount of historical information available, EPA is satisfied with the completeness of the list. For wells or coreholes that were improperly sealed, completed, or abandoned, EPA requires in the permit conditions at Part II.D for each to be properly cemented, plugged and abandoned to EPA's satisfaction, pursuant to corrective action requirements in 40 CFR §§ 144.55 and 146.7. Prior to any injection, FCI will need to demonstrate that these coreholes and wells in the AOR are properly plugged and abandoned to prevent fluid movement that can act as a conduit to a USDW.

68) **Comment:** A number of commenters express concern that the permit does not specify an amount of financial assurance that EPA will require of FCI to guarantee proper closure and post-closure activities. Commenters question whether FCI has the financial wherewithal to pay for abandonment and post-closure monitoring, and they recommend that EPA require an approved financial instrument (e.g., a bond) be in place before PTF operations begin.

EPA Response: To protect USDWs, EPA requires FCI to set aside sufficient financial resources, such as a performance bond, prior to well construction to operate/maintain and plug and abandon UIC and other permit-authorized wells consistent with approved closure plans, and to implement any necessary aquifer restoration. For the PTF project, EPA determined that financial assurance in the amount of $4,457,000 is required to assure that EPA will have the necessary resources to properly close and abandon the PTF site, in the event the permittee is not capable of doing so. In the final permit, EPA specifies this amount, which will cover proper aquifer restoration, ground water monitoring, and plugging and abandonment activities for closure and post-closure of all wells and facilities specifically regulated by the UIC permit. The permit requires FCI to establish this level of financial assurance prior to the construction of any UIC permit-authorized well, and maintain such financial responsibility for the duration of UIC permit-authorized well operations, closure and post-closure (see Part II.L).

69) **Comment:** A commenter claims that FCI has not demonstrated the ability to recognize and react to a loss of hydraulic control, in part because their UIC application did not show that two previous tests of the proposed technology, a Santa Cruz Joint Venture and the BHP copper ISR test, maintained control of injected fluids.

EPA Response: The Santa Cruz ISR test referenced by this commenter consisted of only a five-spot cell with one injection well in the center of a square shaped cell, four recovery wells at each corner of the cell, and three monitoring wells to the west of the cell. EPA does not have information on the operation and results of this Santa Cruz pilot test, except that it concluded in 1998, lasted 309 days, and the project was deemed not commercially viable. The commenter did not cite any specific reports or technical papers to support their assertions about this test. However, the small size of the project, lack of observation wells, and insufficient number and improper placement of monitoring wells are characteristics that are very different from the PTF project.

EPA has articulated in prior Response to Comments 4 and 6 that the BHP Pilot Test was successful in maintaining hydraulic control. While there may have been some loss of control for brief, temporary periods during the test, BHP reestablished hydraulic control through management of injection and production rates in selected wells. Water level differentials and electrical conductivity readings in the observation and recovery wells indicated that hydraulic control was maintained throughout the test period and during the rinsing operations that followed, with only brief interludes (24 hours) of potential temporary loss of control. Water levels in the BHP5/OWB well pairs were slightly less in OWB4 for up to 24 hours on two occasions in November 1997. Water level data are missing for 8 ½ days in the OWB5 in December 1997, but differentials were always positive between BHP2 and OWB-5 before and after that time period and electrical conductivity data confirmed that no loss of hydraulic control occurred during that time period. Review of the quarterly report data indicates that the few reported exceedances in POC wells were not due to ISCR operations.

70) **Comment:** A commenter questions the permit's description of the PTF schedule and requests that EPA amend the permit to clarify the schedule and ensure realistic timeframes for the activities outlined in the permit.

EPA Response: The UIC permit authorizes injection only after the PTF well field and monitoring wells are installed and pass Mechanical Integrity Tests (MIT), and the aquifer testing plan and the corrective action plan are implemented and evaluated by EPA. The two-year operational life of the PTF begins when corrective action is completed, permit requirements at Part II.C, D, and E.2 are met, and injection commences. EPA modified the permit language to clarify the schedule for the beginning of ISCR operations and the duration of the permit.

71) **Comment:** A commenter raises a concern that the permit does not require FCI to delay any further ISCR operations until all data from the pilot test is properly reported and analyzed. They note that the purpose of an experiment such as the PTF is to gather meaningful data to

allow FCI, EPA, and the public to properly analyze the implications of the ISR operation and ensure that proper safeguards are in place to protect a drinking water aquifer.

EPA Response: The current permit only authorizes the PTF, and does not provide any further authorization for potential future ISCR operations at this site. FCI is not precluded by the PTF permit from submitting a subsequent UIC permit application for further ISCR operations before the PTF operations, closure, and monitoring are terminated. However, any subsequent permit application would be evaluated by EPA in consideration of the PTF results and no further ISCR operations beyond the PTF could proceed without a new UIC permit.

72) **Comment:** A commenter expresses concern about sulfuric acid transport, storage, and handling at the site. They assert that monitoring is inadequate to detect spills, and that the acid injection process creates noxious fumes that cannot be controlled, potentially affecting neighboring homes.

EPA Response: Sulfuric acid product transportation, storage, and handling is outside the scope of the UIC permit under the authority of the Safe Drinking Water Act. It is regulated as a hazardous material under federal, State and local requirements. The required monitoring of the PTF under the UIC permit is intended to ensure protection of USDWs. Any air emissions from the PTF operation would also not be regulated under the Safe Drinking Water Act. Any air related emissions from operation of the PTF will be regulated by applicable federal, state, and local laws. In addition to the UIC permit, FCI has obtained numerous other permits (e.g., ADEQ Aquifer Protection Permit, Pinal County Air Quality Control District Air Quality Permit) that address issues that are outside the scope of our Safe Drinking Water Act UIC authority. FCI has also prepared a facility-wide Environmental Plan to address control of hazardous materials and other environmental issues to ensure all personnel working on-site follow applicable laws and regulations.

FCI's Comments on the Draft Permit

73) **Comment:** FCI states that well operation requirements are unduly restrictive for purposes of the PTF testing program to optimize mineral extraction and they recommend not less than 105% for a minimum extraction to injection percentage as a pre-authorized test option.

EPA Response: The permit allows an increase or reduction in the 110% minimum extraction to injection percentage, subject to PTF performance and EPA approval. Based on EPA's analysis of the BHP Pilot Test data, 110% may not be sufficient unless extraction and injection rates are closely monitored and adjusted on an individual well and daily basis to maintain an inward gradient of at least one foot at all well pairs. Therefore, EPA does not agree with adjusting the percentage downward prior to review of actual performance at the levels set in the permit.

74) **Comment:** FCI states that the table in Part II.F.10.a should be modified for the frequency column fourth row from "continuous and daily" to "daily."

EPA Response: According to the Injection Pressure requirement at Part II.E.4.a, the operating condition for injection pressure states that it will be monitored continuously and recorded daily. EPA modified the table in Part II.F.10a in the UIC permit for frequency to be consistent with the intended operating condition that requires monitoring continuously and recording daily.

75) **Comment:** FCI states that Part II.G.2.b. should be clarified from referencing "flows" to "volumes."

EPA Response: EPA agrees that the term "flows" is meant to be "volumes" for reporting of results and has made this change to clarify the term in the UIC permit.

76) **Comment:** FCI states that Part III.E.11.a requires a complete application for a new permit at least 180 days before the permit expires, but since the current permit is for a short-term PTF operation, a 90-day period is more appropriate.

EPA Response: EPA does not agree that a 90-day period is more appropriate for submittal of a timely application for a short term PTF operation. The PTF permit will not expire until EPA is satisfied with the results of post-closure monitoring to ensure protection of USDWs. In the unlikely event that EPA would require the permittee to continue an activity regulated by this permit past the expiration of this permit, EPA would need the six months prior to expiration of the permit to progress through the permit process and determine the actions necessary for any additional post-closure activity.

77) **Comment:** FCI states that the permit appears to reference only the POC wells identified in the temporary APP issued by ADEQ. They note that there are numerous other POC wells in existence. The commenter describes that these wells will provide additional groundwater protection and assurance that the proposed PTF will meet the no migration requirements in the UIC permit.

EPA Response: EPA recognizes that some of the POC wells required for the BHP project are not referenced in the current UIC permit. Because of the nature and duration of this PTF Pilot Test, EPA considers these historical POC wells too far from the test to be effective points to detect potential excursions from the PTF during the life of the operation or post-closure monitoring. EPA believes the proposed monitoring within the AOR in the UIC permit for the PTF is sufficient to detect any potential excursions and to ensure there is no migration of ISCR fluids into USDWs.

78) **Comment:** FCI states that the aquifer exemption is not a part of the current proceeding and EPA's justification for the existing exemption continues to be appropriate. They note that the aquifer exemption described by EPA was approved in 1997 based on a determination in accordance with 40 CFR § 146.4 that the exempted zone could not serve as a source of drinking water in the future. They assert that there is nothing in the administrative record of the UIC permit that warranted a re-evaluation of this determination. However, FCI agrees with the reasoning behind EPA's conclusions that the exempted zone does not currently

serve as a source of drinking water and cannot now, or in the future, serve as a source of drinking water.

EPA Response: EPA addresses issues related to the aquifer exemption in the prior responses of the aquifer exemption section.

79) **Comment:** FCI states that in-situ copper mining has occurred in Arizona, and although in-situ mining may not be as well-known to the general public, it has been used successfully in conjunction with conventional copper mining in Arizona for decades. The commenter also notes that in Arizona, three such operations have used the in-situ methodology to extract additional copper following conventional mining, or to extract copper from parts of the deposits adjacent to open pits or underground workings. They note that in the 1990's, a cooperative in-situ solution mining research project was undertaken between the U.S. Bureau of Mines and Santa Cruz Joint Venture, and that BHP operated a stand-alone ISCR test operation on what is now the Florence Copper property. According to FCI, none of the ISCR projects in Arizona have violated federal or state environmental permit requirements during or since their operation.

EPA Response: EPA is aware of these in-situ copper mining projects occurring in Arizona. In the prior Response to Comment 69 addressed the Santa Cruz Joint Venture and the BHP Pilot Test has been extensively discussed in these Responses to Comments.