E-1.0 OBJECTIVES AND SCOPE

This appendix establishes a "watch list" that identifies perched-intermediate and regional groundwater monitoring wells (hereafter referred to as the deep monitoring wells) for which the representativeness of water-quality data for certain constituents is questionable and describes the approaches used for tracking the performance of deep monitoring wells. These deep monitoring wells are sampled at Los Alamos National Laboratory (LANL or the Laboratory) under the Interim Facility-Wide Groundwater Monitoring Plan (the Interim Plan). Table E-1.0-1 lists the preliminary watch list of deep monitoring wells for the monitoring year (MY) Interim Plan, and describes the reason for this condition.

This appendix is organized as follows:

- Section E-1.0 summarizes the objectives of groundwater monitoring in deep wells.
- Section E-2.0 identifies deep monitoring wells that are purged less than 3 casing volumes (CVs).
- Section E-3.0 defines a protocol for assigning deep monitoring wells to watch lists with appropriate follow-up actions when questions arise concerning the reliability and representativeness of water-quality data from those wells.
- Section E-4.0 outlines an approach for conducting reliability assessments of deep monitoring wells to determine their capability for producing representative water-quality samples and to identify any potential effects of well installation, rehabilitation, or sampling protocol on data quality.

One well is also included on the watch list because of possible construction issues. In addition to wells described in Table E-1.0-1, the representativeness of new water-quality samples from other wells is continually reviewed for possible addition to the watch list. The results from newly drilled wells and recently converted Westbay wells are part of this evaluation.

Inclusion of a well on the watch list is intended to be used as a general indicator of data quality and should not be construed as a definitive identification of data usability. The watch list is also dynamic insofar as it will be updated as conditions evolve. Changes will occur when additional water-quality data justify the removal or addition of wells from the list.

E-2.0 DEEP WELLS WITH LIMITED PURGE VOLUMES

Water that remains in a monitoring well for a period of time may not be representative of formation water because of physical, chemical, or biological changes that may occur as the water remains in contact with the well casing, dedicated sampling equipment, and the air space in the upper casing. This stagnant water may not represent formation water at the time of sampling. To ensure samples collected from a monitoring well are representative of formation water, stagnant water in the casing is generally removed (i.e., purged) from the sampling zone within the well before it is sampled. As prescribed in Standard Operating Procedure (SOP) ERP-DIV-SOP-20032, Groundwater Sampling, the Laboratory's standard practice is to purge perched-intermediate and regional wells a minimum of 3 CVs plus the volume of the drop pipe and to continue purging until water-quality parameters stabilize. Once the parameters stabilize, it is assumed all stagnant water has been removed from the well and fresh formation water is available for sampling.

However, purging 3 CVs is not always possible or feasible, particularly in low-producing monitoring wells that purge dry at low pumping rates. SOP-ERP-DIV-SOP-20032 allows deviation from the 3-CV purge requirement for such conditions. However, data users may want to be aware of deep monitoring wells at which the 3-CV purge requirement generally cannot be met to consider potential impacts for data

reliability. Table E-1.0-1 lists deep well screens that cannot meet the 3-CV purge requirement and describes the reason for this condition.

E-3.0 WATCH LIST ASSIGNMENTS

This section discusses additional watch list criteria for deep monitoring wells in this Interim Plan for which the representativeness of water-quality data is questionable.

Data examined for the assessment includes field parameters monitored during purging before sample collection, field parameters associated with samples at the time of collection, major-ion concentrations, trace-metal concentrations, and detections of organic constituents. The assessments are based on site-specific geochemical criteria. The assessment may result in recommendations concerning the well's configuration, sampling protocols (such as purging volumes), extension or limitation of the analytical suites to be collected from the well screen, or caveats about data usability.

The specific objective of a reliability assessment is to determine the current reliability of a well (including its sampling system) as it relates to the water-quality data objectives of the specific monitoring network to which it is assigned. In general, reliability assessments may be conducted for a subset of the wells assigned to the watch list described in the preceding section or for deep wells within the context of a specific monitoring network.

The watch list presented in Table E-1.0-1 includes deep well screens for which field parameters monitored during purging consistently fail to meet stability criteria as well as deep well screens which show anomalous chemistry data, suggesting groundwater in the screened interval may not be fully equilibrated following construction or rehabilitation. Table E-1.0-1 also provides the rationale for each listed well screen and lists recommended follow-up actions.

E-4.0 RELIABILITY ASSESSMENT PROTOCOL

The specific objective of a reliability assessment is to determine the current reliability of a well (including its sampling system) as it relates to the water-quality data objectives of the specific monitoring network to which it is assigned. In general, reliability assessments may be conducted for a subset of the wells assigned to the watch lists described in the preceding section or for deep wells within the context of a specific monitoring network.

Data examined for the assessment includes field parameters monitored during purging before sample collection, field parameters associated with samples at the time of collection, major-ion concentrations, trace-metal concentrations, and detections of organic constituents. The assessments are based on site-specific geochemical criteria and generally focus on data obtained for the four most recent sampling events. The assessment may result in recommendations concerning the well's configuration, sampling protocols (such as purging volumes), extension or limitation of the analytical suites to be collected from the well screen, or caveats about data usability.

Field parameters. Time-series data for field parameters monitored during purging before sample collection are examined for attainment of stable values by the end of purging. Stabilization criteria are prescribed in ER~~SOP-EP-DIV-~~SOP-20032, Groundwater Sampling, and are derived from the stabilization criteria recommended by the U.S. Environmental Protection Agency (EPA) (Yeskis and Zavala 2002, 204429) and from the Compliance Order on Consent. The most sensitive indicator parameters are dissolved oxygen (DO) and turbidity. Other parameters such as water temperature, specific conductance, pH, and oxidation-reduction potential (ORP) are also monitored but are considered less sensitive indicators of formation water.

Table E-1.0-1 (continued)

Location	Monitoring Group	Watch List Rationale	Description of Condition	Action
Wells with Westbay No-Purge Sampling Systems (continued)				
Water-Quality				
R-43 S2	Chromium Investigation	Field parameters monitored during previous extended purging events showed some indication that DO levels were continuing to increase although stability criteria were met earlier in the purge.	Variability in DO levels may be associated with mixing of groundwater with varying geochemical signature originating from different strata accessed during purging.	Per field sampling SOP, collect samples after stabilization of field parameters during a 3- to 6-CV purge. This recommended action is based on evaluation of data collected during the extended purge conducted at R-43 S2 on August 8, 2015.
R-61 S1	Chromium Investigation	Phosphate levels associated with chemicals used during rehabilitation of the well screen conducted in fall 2012 are elevated above background. Residual drilling lubricants associated with drilling may be present around the borehole near the well screen.	NMED indicated data from R-61 cannot be used to make regulatory decisions (NMED 2015, 600154) and requested that R-61 be replaced. The Laboratory submitted the drilling work plan for R-61r on February 2, 2015 (LANL 2015, 600175).	Continue monitoring R-61 S1 for water levels only.
R-61 S2	Chromium Investigation	High iron and manganese; reducing conditions in vicinity of well screen. Phosphate levels continue to remain elevated above background. Residual lubricants associated with drilling may be present around the borehole near the well screen.	NMED indicated data from R-61 cannot be used to make regulatory decisions (NMED 2015, 600154) and requested that R-61 be replaced. The Laboratory submitted the drilling work plan for R-61r on February 2, 2015 (LANL 2015, 600175).	Continue monitoring R-61 S2 for water levels only.

Table E-1.0-1 (continued)

Location	Monitoring Group	Watch List Rationale	Description of Condition	Action
Wells with Westbay No-Purge Sampling Systems (continued)				
R-62	Chromium Investigation	Field parameters monitored during extended purging events showed some indication that DO levels were continuing to increase although stability criteria were met earlier in the purge. Additionally, the chromium concentrations vary with purge volume.	Historical data from sampling conducted under different purge volumes show variations in chromium concentrations. One conceptual model for the variations in chromium concentration assumes aquifer heterogeneity as the cause. Data collected during pump/extended purge tests conducted at R-62 in May 2014 and February 2016 suggest extended purging at R-62 may increasingly draw water from strata within the screened/filter pack interval that has higher concentrations of chromium than the zone accessed using the standard 3- to 6-CV purge protocol.	An 8-h extended purge will be performed during the second quarter (January–March) of MY2017 to monitor transients of chromium (and related constituents [e.g., nitrate]) within the chromium plume area.
R-67	Chromium Investigation	R-67 is a new groundwater monitoring well that was completed on September 21, 2015.	~~No specific condition. R-67 is included in this watch list because it is a new well.~~ Water-quality data show elevated iron and manganese concentrations, suggesting reducing conditions are present.	~~Purge and sample R-67 per the Interim Plan.~~Collect Interim Plan samples at 3 to 6 CV per the ER-SOP-20032, Groundwater Sampling, followed by a 15 CV~~casing volume~~ extended purge to assess well performance. During the extended purge, collect screening samples at 3, 6, 9, 12, and 15 CVs and analyze for anions, cations, alkalinity, and pH. Additionally, collect microfiltration (0.02-micron filter) samples for cation analysis on a case-by-case basis.

Table E-1.0-1 (continued)

Location	Monitoring Group	Watch List Rationale	Description of Condition	Action
Wells with Westbay No-Purge Sampling Systems (continued)				
CdV-R-37-2 S2	TA-16 260	High iron and manganese; reducing conditions in vicinity of well screen.	~~Initial low DO concentrations during purging, along with relatively high iron and manganese, suggest reducing conditions near well screen. NMED requested that the Laboratory prepare a work plan to rehabilitate or restore CdV-R-37-2 but approved postponement of this work plan in its letter of June 12, 2014 (NMED 2014, 524957).~~Water-quality and field parameter data indicate CdV-R-37-2 S2 does not produce representative samples, even with extended purging.	~~Extend purging protocol to 36 CVs to improve representativeness of samples. Continue sampling CdV-R-37-2 S2 semiannually.~~ Reduce sampling frequency to annual and collect Interim Plan samples at 3 to 6 CV per ER-SOP-20032, Groundwater Sampling. Limit sample analysis to low-level tritium and high explosives. Code all samples collected from CdV-R-37-2 S2 as "W."
R-58	TA-16 260	R-58 is a new groundwater monitoring well that was completed on November 5, 2015.	~~No specific condition. R-58 is included in this watch list because it is a new well.~~ Water-quality data show elevated iron and manganese concentrations, suggesting reducing conditions are present.	~~Purge and sample R-58 per the Interim Plan~~Collect Interim Plan samples at 3 to 6 CV per ER-SOP-20032, Groundwater Sampling, followed by a 15 CV~~casing-volume~~ extended purge to assess well performance. During the extended purge, collect screening samples at 3, 6, 9, 12, and 15 CV and analyze for anions, cations, alkalinity, and pH. Additionally, collect microfiltration (0.02-micron filter) samples for cation analysis on a case-by-case basis.
R-40 Si (formerly R-40i)	TA-54	Screen showed drilling foam and reducing conditions in the past, with high iron and manganese	Recent data suggest improving trends, with increasing DO and decreasing iron and manganese concentrations.	Sample for low-level tritium, general inorganics, and metals only.
R-40 S1	TA-54	High iron and manganese	Residual drilling effects are evident; the yield is extremely low.	Sample for VOCs and low-level tritium. Collect sample at 1 CV plus drop-pipe volume because of extremely low recovery rate.

Table E-1.0-1 (continued)

Location	Monitoring Group	Watch List Rationale	Description of Condition	Action
Wells with Westbay No-Purge Sampling Systems (continued)				
R-54 S1	TA-54	High iron and manganese; reducing conditions in vicinity of well screen.	Field parameters vary from regional aquifer background values until considerable purging has been conducted. Initial low DO concentrations during purging, along with relatively high iron and manganese, suggest reducing conditions near well screen.	Sample for low-level tritium only.
R-55i	TA-54	High iron and manganese	Iron and manganese concentrations are elevated relative to background. Sulfate, nitrate, chloride, and magnesium are also elevated. DO values are low but are improving with extended purging.	Sample for low-level tritium only.
R-12 S1	General Surveillance	Screen shows reducing conditions, as indicated by low DO and ORP.	Well screen shows low DO and ORP during purging.	Sample for low-level tritium only.
R-12 S2	General Surveillance	Sample data suggest the possibility of reducing conditions.	Manganese concentrations are elevated; dissolved chromium concentrations are low, and DO is low.	Continue sampling R-12 S2 annually (rather than biennially) with the intent of reducing the potential for stagnation around the well screen between sampling events. Per field sampling SOP, collect samples after stabilization of field parameters during a 3- to 6-CV purge. This recommended action is based on evaluation of data collected during the extended purge conducted at R-12 S2 on July 22, 2015.
R-16 S4	General Surveillance	Screen shows reducing conditions, as indicated by potentially low, but stable, DO, even after extended purging.	Concentrations of phosphate above background persist in samples from R-16 S4.	Per field sampling SOP, collect samples after stabilization of field parameters during a 3- to 6-CV purge. This recommended action is based on evaluation of data collected during the extended purge conducted at R-16 S4 on July 28, 2015.