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JAN 2007
NMED Hazardous Waste Bureau

Date: January 30, 2007
Refer to: EP2007-0059

Mr. James Bearzi
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

SUBJECT: SUBMITTAL OF THE ADDENDUM TO THE WORK PLAN FOR SANDIA CANYON AND CANADA DEL BUEY

Dear Mr. Bearzi:

Please find attached the Addendum to the Work Plan for Sandia Canyon and Canada del Buey (LA-UR-99-3610). This addendum is being submitted pursuant to a requirement of the Notice of Approval for the Interim Measures Investigation Report for Chromium Contamination in Groundwater dated December 27, 2006. The addendum addresses the requirements of the NMED's approval letter and provides detail of implementation and the rationale for each activity in the context of the ongoing investigation, especially as it relates to chromium and other contaminants that could impact groundwater.

The NMED's approval letter requires that the results of this next phase of work be reported to the NMED by September 14, 2007. In a meeting between LANL and NMED on January 8, 2007, it was agreed to that the following reports would be delivered by that date:

- Phase 1 Sandia Canyon Sediment Investigation Report
- Fate and Transport Report
- R-35 Status Report

Submittal of these deliverables by September 14, 2007 will provide a substantial portion of the investigation data for the Sandia Canyon investigation and will allow for the Sandia Canyon Investigation Report to be prioritized and moved up in the Consent Order schedule to December 15, 2008.

If you have questions, please call Danny Katzman at (505) 667-6333 (katzman@lanl.gov) or Mat Johansen (505) 665-5046 or mjohansen@doeal.gov.

Sincerely,

Andrew Phelps, Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,

David Gregory, Federal Project Director
Department of Energy
Los Alamos Site Office

AP/DG/DK/tml

Enclosure: Addendum to the Work Plan for Sandia Canyon and Canada del Buey (LA-UR-99-3610)

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Addendum to the Work Plan for Sandia Canyon and Cañada del Buey

Scope (New, modified, or ongoing activity)	Work Description	Rationale
Archival Work (ongoing)	A review of solid waste management units and areas of concern in Los Alamos, Sandia, and Mortandad canyons was conducted to identify the potential source(s) of chromium (including the mass associated with each source) as part of the "Interim Measures Investigation Report for Chromium Contamination in Groundwater" (LANL 2006, 094431). Additional review will further constrain the mass of chromium and volume of effluent released to these canyons. This review will also improve estimates of other contaminants released to Sandia Canyon, such as zinc, phosphate, molybdenum, and arsenic.	Knowledge of groundwater flow paths and operations at Los Alamos National Laboratory (LANL, the Laboratory) support a focus on Los Alamos, Sandia, and Mortandad canyons as the likely sources of chromium in the regional aquifer in and around R-11 and R-28. The likely sources are related to usage of chromate-containing compounds to inhibit corrosion in cooling-tower systems that discharged to each of the three watersheds. Lesser sources include electroplating and photo processing facilities. Information about sources and release histories will be incorporated into models evaluating fate and transport of chromium and other mobile constituents. Delineation of transport rates and flow paths within Sandia Canyon will be improved by tracking contaminants that were released concurrent with and following chromium releases. Model simulations will incorporate bounding estimates of released contaminant masses to quantify the level of resolution in mass estimates required to evaluate potential remedial options.
Sediment Investigation (modified)	The Laboratory proposes to modify the scope of the Sandia Canyon sediment investigation described in the work plan (LANL 1999, 064617) by (1) modifying the locations of Phase 1 investigation reaches, and (2) modifying Phase 1 numbers of sample and analytical suites, adding supplemental analyses to evaluate chromium geochemistry. In detail, these two actions involve the following: (1) The Laboratory proposes to add an additional upcanyon reach closer to the primary contaminant source ("S-3 West"), and to eliminate two downcanyon reaches (S-4 Central and S-5 West) from the initial sampling phase. (2) The Laboratory proposes five changes to the Phase 1 sediment analyses, as presented in the work plan. First, add chromium(VI), molybdenum, isotopic thorium, perchlorate, polycyclic aromatic hydrocarbons, and volatile organic compounds to the analytical suite in all full-suite samples. Second, restrict analyses in S-3 West to chromium and other metals, chromium(VI), molybdenum, and polychlorinated biphenyls as key contaminants. Analyses in the	The modification of the list of priority reaches specified in Table 7.1.2-1 of the work plan (LANL 1999, 064617, p. 7-9) will better focus work on evaluating the nature of chromium contamination. The new reach, S-3 West, will be roughly midway between reaches S-2 and S-3, in a portion of the canyon relatively close to the primary contaminant source that is expected to be important for understanding the chromium inventory in the Sandia watershed. The two reaches eliminated from this first phase of investigation, S-4 Central and S-5 West, are in an area of expected relatively low chromium contamination, based on sample data from reaches S-3 and S-5 Central collected in 2000. In addition, any contamination in S-4 Central and S-5 West will be adequately bounded by data from the nearby reaches, S-4 West, S-4 East, and S-5 Central. S-4 Central and S-5 West could be further investigated in later phases if such work is required. The modifications to the analyte suites and sample numbers will provide better Phase 1 characterization than presented in the work plan, including: potential identification of a larger number of chemicals of potential concern; a better estimate of the inventory of total chromium, chromium(VI), and other analytes in sediment in the Sandia watershed; an improved evaluation of the geochemical stability of chromium; and an

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	remaining Phase 1 reaches would include the full suite specified in the work plan. Third, collect approximately 40 samples in the wetland (reach S-2) for chromium and other metals to define the total chromium inventory better. Chromium(VI) analyses would also be obtained from these samples. Fourth, obtain additional analyses on approximately 20 samples to help evaluate the geochemical stability of chromium species. In addition to total chromium, chromium(VI), and other metals, analyses would include iron(II), manganese(IV), phosphorus, total nitrogen, sulfate, sulfur, and total organic and inorganic carbon. Five, analyze approximately eight samples of cattails in reach S-2 for metals to evaluate potential biologic uptake.	evaluation of the uptake of chromium and other metals into plants in the Sandia wetland.
Water Balance Investigation (new)	This activity will constrain the location and amount of surface water and alluvial groundwater loss in the narrow bedrock-dominated portion of Sandia Canyon between surface-water gaging stations E123 and E123.5. The infiltration investigation conducted as part of the Interim Measures Work Plan for Chromium Contamination in Groundwater (LANL 2006, 091987) will be expanded by installing one or two new temporary stream gages, as allowed by topography. Together with discharge data from outfalls and flow data from existing stream gages, the new stream gages will allow division of upper Sandia Canyon into three or four stream segments, providing better delineation of the areas of surface-water loss. Streambed infiltration losses will be determined by comparing surface-water flow between gages.	Areas of surface-water and alluvial-groundwater loss probably coincide with those parts of the canyon floor that contributed recharge to deeper perched zones and to the regional aquifer during and after the period of chromium release from the Technical Area 3 (TA-03) power plant. A water balance investigation reported in the Interim Measures Investigation Report for Chromium Contamination in Groundwater (LANL 2006, 094431) showed that approximately 35% of the current TA-03 effluent volume to upper Sandia Canyon is lost along the approximately 3.5 km (2.2 mi) reach of canyon between the Sandia wetland and temporary gage E123.5. Further refinement of the water loss estimates along this portion of Sandia Canyon will identify vadose-zone pathways and potential entry points for historical chromium contamination into the regional aquifer. These data will be applied in models of groundwater flow and chromium transport. These data will also help constrain the nature and extent of chromium and other contaminants.
Surface Water and Groundwater Sampling (modified)	Analytical suites for ongoing sampling conducted in Sandia Canyon, as described in the Interim Facility Groundwater Monitoring Plan (IFGMP), will be modified by adding stable isotopes of chromium (δ^{53}Cr) at the proposed locations. An initial sampling round will be conducted to determine if isotopic variations in δ^{53}Cr occur along surface water and groundwater flow paths within the Sandia and Mortandad watersheds. Samples from some of these locations may be at or below the lower concentration limit necessary for accurate and precise chromium isotope	Water-quality (geochemical) data obtained from one or more sampling rounds provide information about the occurrence and distribution of contaminants in surface and groundwater in the Sandia and Mortandad watersheds. Chemical and isotopic data will fingerprint potential contaminant sources and improve geochemical and hydrologic-transport numerical models that quantify processes controlling fate and transport of chromium and other contaminants of relevance (arsenic, molybdenum, and zinc). Ultimately, these data support the evaluation of potential remedial options.

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	measurement, and/or the presence of high levels of organic matter may interfere with chromate extraction and analysis (Tom Johnson, University of Illinois at Urbana-Champaign, personal communication). Based on results from the first round of sampling, some of these locations may be eliminated from future rounds of sampling if they are not suitable for analysis by this technique. In addition, variations in $\delta^{53}Cr$ for the initial round of data will be evaluated to determine if isotopic fractionation due to the reduction of chromium(VI) to chromium(III) occurs along the surface water and groundwater flow paths. If evidence for isotopic fractionation is present, sampling will be conducted for three more quarters in the Sandia watershed and as approved in the next IFGMP for Mortandad Canyon. Stable chromium isotopes are proposed for addition to the current monitoring suites at the following locations: <u>Sandia Canyon</u> Surface Water – E121, E122, adjacent to SCA-1, E123, at new temporary gage station, and at E123.5 Alluvial Groundwater – SCA-1, SCA-3, SCA-5 Intermediate Groundwater – SCI-1, R-12 (screens 1 and 2) Regional Groundwater – R-11, R-10, R-10a, and R-35(a and b) when online <u>Mortandad Canyon</u> Surface Water – E1FW, E1E, E200 Alluvial Groundwater – MCO-0.6, MCO-2, MCO-4.5, MCO-5, MCO-7.5 Intermediate Groundwater – MCOBT-4.4, MCOI-5, MCOI-6 Regional Groundwater – R-1, R-15, R-13, R-28, R-33, R-14, R-34	Analysis of $\delta^{53}Cr$ should enhance the geochemical conceptual model for chromium, including quantitative evaluation of chemical-biochemical reduction of chromium(VI) to chromium(III), followed by adsorption of chromium(III) onto ferric (oxy)hydroxide and/or precipitation of insoluble $Cr(OH)_3$. Analytical results for $\delta^{53}Cr$ are anticipated to provide quantitative information on the fate and transport and natural attenuation of chromium in surface water and groundwater environments at the Laboratory.
Fate and Transport Modeling (new)	This activity includes the development of a site-scale groundwater-flow and contaminant-transport model that incorporates historic chromium sources in Sandia, Mortandad, and Los Alamos watersheds, and existing water-supply wells in the vicinity (PM-3	Numerical models are useful tools for integrating available knowledge about the fate and transport of chromium. Combining a quantitative treatment of all uncertainties with calibration and weighting of results based on their agreement with chromium measurements provides a

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	and O-4). The model will include the vadose zone and the regional aquifer and be based on all available hydrogeological data and supporting information, including the distribution of chemicals such as molybdenum and phosphate that replaced the use of chromium. The model will include detailed documentation of key input parameters and conceptual models and address uncertainties in the model results. The Laboratory will engage NMED in incorporation of aspects of the conceptual model and plausible ranges and distributions for model input parameters. At a minimum, conceptual models to be considered will include those recently suggested, such as: 1) the fault system that crosses the wetland as a fast pathway for chromium transport; 2) a vadose zone pathway that includes down-dip lateral spreading of perched intermediate groundwater above perching horizons; and 3) spatial and temporal changes to infiltration in Sandia Canyon due to past erosion of canyon-bottom alluvium. Model results will be compared to available monitoring data as well as to estimates of the total mass of chromium in the system. If necessary, simulation results will be weighted based on agreement between simulated and measured concentrations. The model results will include but not be limited to maps showing the expected concentration of chromium, the probability that chromium concentrations exceed maximum contaminant levels, and chromium concentrations associated with confidence limits agreed upon by LANL and NMED.	defensible approach to providing quantitative answers to key questions such as: 1) What is the nature and extent of chromium? 2) What is the uncertainty in the nature and extent of chromium? 3) Is the current monitoring-well network capable of intercepting all potential chromium pathways? 4) What is the long-term fate of chromium in the vadose zone and regional aquifer? 5) What is the most effective and efficient remedial option for chromium? 6) What additional characterization is necessary to reduce model uncertainty sufficient to allow the selection of a remedial option?
R-28 Testing (new)	R-28 will be pumped for at least 30 hr at a constant rate of approximately 5 gallons per minute while water levels, chemical constituents, and other indicator parameters are measured. In addition, water levels will be monitored continuously in R-35(a and b), R-11, R-13, R-15, and R-8A during the test. The 30-hr test duration should produce water that is currently located outside the "zone of influence" of the potential residual drilling fluids. LANL will work with NMED prior to the test to define a set of potential test responses, in terms of water levels, contaminant concentrations, and indicator parameters. These potential	This test will evaluate the effects of possible residual drilling fluid contamination on measured chromium concentrations, provide insight into the nature of the chromium plume, and provide information on aquifer parameters to be used in conceptual and numerical models of chromium fate and transport.

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	responses will be based on conceptual models of flow and transport such as one model assuming that the chromium concentrations are affected by drilling fluids and another model assuming they are not affected by drilling fluids. These hypothetical responses will seek to identify unique responses of each conceptual model and assure test design and sampling protocols that can observe these unique responses. Water samples will be collected at R-28 prior to pumping and during pumping at the following frequency: every hour during zero to 12 hr; every 4 hr from 12 to 24 hr; and at 30 hr, at the end of pumping. Field parameters including oxidation-reduction potential, temperature, pH, turbidity, specific conductance, and dissolved oxygen will be measured during pumping and sampling. For all samples collected, filtered waters will be analyzed for metals and anions (including perchlorate), and nonfiltered waters will be analyzed for metals, total organic carbon, acetone, and 2-proponal (isopropyl alcohol). In addition, at the 4- and 6-hr intervals, filtered water samples will be analyzed for stable isotopes of nitrogen, and nonfiltered waters will be analyzed for low-level tritium (using electrolytic enrichment at the University of Miami) and stable isotopes of oxygen and hydrogen. To evaluate chromium reduction by potential residual drilling fluids, stable isotopes of chromium will be analyzed in samples collected at 0, 2, 4, 8, 12, 18, 24, and 30 hr.	
PM-3 Zonal Sampling (new)	The Los Alamos County Utilities Department informed the Laboratory that access to PM-3 will not be granted until at least the fall of 2007.	Zonal sampling may provide insights into depth-dependant variations in the quality of water entering the well screen at PM-3. LANL proposes that the need for zonal sampling at PM-3 be assessed after results for the R-35 and numerical modeling activities are evaluated.
Vadose Zone Boreholes (new)	NMED requested that one to two vadose-zone characterization coreholes be installed approximately a mile upstream of SCC-1, if accessible. Field visits indicate that there are no accessible sites close enough to the stream channel in this portion of the canyon for the installation of coreholes.	Proposed fate and transport modeling studies can evaluate different infiltration scenarios for this part of the canyon. In addition, geochemical data provided by sediment and water samples collected from the Sandia wetland, surface water, alluvial groundwater, intermediate groundwater, and regional groundwater will support evaluation of chromium migration pathways. The need for additional deep corehole investigations will be evaluated in the context of numerical modeling results.