HOMESTAKE
Grants Project

Homestake Mining Company of California

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Closure Manager

21 July 2014

ATTN: Document Control Desk
Director, Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission,
Washington, DC 20555–0001

ATTN: Mr. Jack Parrott, Sr. Project Manager
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Washington, DC 20555–0001

RE: Responses to NRC's Requests for Additional Information Pertaining to HMC's License Amendment Request to Change Radon Background Location from HMC 16 to HMC 1Off

Mr. Parrott:

Please find attached to this cover letter Homestake's responses to NRC's Requests for Additional Information (RAIs) pertaining to the subject license amendment request to change Homestake's background location for radon.

Should you have any questions, please feel free to call me directly at 505.290.3067.

Respectfully,

JRT kp

Jesse R. Toepfer
Closure Manager
HOMESTAKE MINING COMPANY OF CALIFORNIA

CC: Mr. David Mayerson – New Mexico Environment Department, Santa Fe, New Mexico
Mr. Sai Appaji – United States Environmental Protection Agency Region 6, Dallas, Texas
Mr. Bill Ferdinand, Barrick – Salt Lake City, Utah
Mr. Patrick Malone, Barrick – Salt Lake City, Utah
Mr. Jon Indall, Comeau, Maldegen, Templeman & Indall – Santa Fe, New Mexico
Mr. Mike Schierman, Environmental Restoration Group – Albuquerque, New Mexico

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1	General	NA	HMC should provide quantitative information to support its conclusion that the proposed background location is representative of background radon at the Homestake site and its site boundary. In particular, HMC should address how the contribution of the local offsite sources to radon in air concentration at the proposed background location is similar to the contribution of the same sources to the radon in air concentration at the site and site boundary. In addition, HMC should provide quantitative support to its conclusion that radon emissions in the San Mateo Creek drainage are more important than emissions in the other two drainages, relative to determining in which drainage the background location should be placed.	As discussed in Section 3.1 of the License Amendment request, the intent of the modeling was to support or verify the conceptual model for radon transport which states 1) the highest radon concentrations in air occur during calm or near-calm conditions and 2) during calm conditions radon transport is driven predominantly by topography. The model was used as a tool in the selection of additional monitoring locations where quantitative information (e.g. radon-222 concentration measurements) would be collected. This approach addresses the difficulties described in Section 4.2.4 of the Draft NRC Staff Interim Guidance "Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301" (September 2011 [NRC Radon Guidance]) in selecting appropriate locations to be representative of background for a site. Modeling the actual impact of offsite sources as suggested in the RAI would require a quantitative estimate of the source strength of the more than 300 uranium mines in and around the project area. This is neither practical nor needed to determine an appropriate location to measure background radon concentrations in air for the site. The need is to understand the mechanism of radon transport in complex terrain (the conceptual model) and to select appropriate monitoring locations based on the terrain and conceptual model to best estimate background radon concentrations. Knowing the actual radon source strength from off-site sources would not change the conceptual model or the selection of monitoring locations, it would only change the magnitude of the modeled result at a given location, which is already measured quantitatively with detectors. It should be noted that San Mateo Creek drainage includes the Northwest Drainage shown on Figure 2.3. The San Jose Drainage as described in Section 2.5 is not important to the site background radon for the reasons described therein. The two drainages potentially contributing background radon

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				concentrations to the site are San Mateo Creek to the north and Lobo Canyon to the east. The number of known uranium mines in these two drainages is: • 277 in San Mateo Creek Drainage, which includes Northwest Drainage and San Mateo Drainage, as shown on Figure 2.7 • 11 in Lobo Canyon The watershed shed areas for San Mateo Creek and Lobo Canyon are 111,400 acres and 29,658 acres respectively as shown on Figure 2-7. San Mateo Creek has the highest number of radon sources and largest watershed area when compared to Lobo Canyon which provides quantitative information that supports the conclusion that radon emissions in San Mateo Creek are more important than Lobo Canyon when evaluating background radon concentrations for the site.
2	General	NA	HMC should provide an evaluation of all the monitoring data and modeling results to address the apparent inconsistencies discussed above. HMC should provide details of its modeling results.	The basis for this RAI is contained in 6 paragraphs. HMC will address each of these paragraphs separately. The paragraphs are defined as 2a through 2f. Collectively the responses to these paragraphs are the response to this RAI.

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2a	General	NA	For the proposed location for background to be appropriate, radon in air concentrations at that location should be representative of radon in air concentrations at the site and site boundary without contributions from site releases (i.e., background at the site and site boundary). HMC has performed many measurements of environmental radon in air and with this submittal has also performed modeling of releases from the site and from hypothetical local offsite sources, intended to support the proposed background location. However, HMC has not explained how the existing monitoring data are consistent with or support location HMC-1Off are presenting background radon concentrations at the site and site boundary. In addition, in some cases existing environmental monitoring data appear to the NRC staff to be inconsistent with the proposed location representing background radon concentration at the site and site boundary.	The purpose of the study was to evaluate the representativeness of background levels of radon up-gradient and close to the site but without being influenced by the site sources of radon. Because pre-operational radon data are not available, HMC modeled radon from hypothetical offsite and onsite sources to select the most appropriate locations to evaluate the background radon concentrations. The purpose for modeling the offsite sources is described in the response to RAI-1. The purpose for modeling an onsite source was to evaluate areas where impacts from onsite sources would be minimal. HMC chose 10% of the model prediction at HMC-4 as the decision line for minimal impact from off-site sources. Based on historical quantitative data from HMC-4, 10% level would be near the detection limits for the detectors and certainly within the range of regional background radon concentration variability. Both the offsite and onsite source locations and strengths were hypothetical since HMC was not using the model as a quantitative tool but only to provide a conceptual model, from which an additional radon monitoring location(s) could be selected to evaluate actual background radon conditions near the site. Even if actual site source term data were used, the contour line representing 10% of the model prediction at HMC-4 would not change since it is a ratio or fraction of modeled values. The NRC Radon Guidance states "A background location would typically need to be close to the monitoring locations, with geology similar to the site geology, so that the background location is representative of the monitoring location. But the background location should also be far enough from the facility that the radon concentration is not significantly impacted by radon releases from the facility. If onsite meteorological data are available, the data can be used to help determine if background locations are unimpacted or minimally impacted by site operations." This is precisely what HMC has done. HMC-1Off is the location closest to the site with geology similar to site geology while not being significantly impacted by the site.

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2b	General	NA	HMC has proposed that location HMC-1Off be the background location. Track-etch detector measurements of radon in air are presented by HMC in Table 4-1 and are plotted, normalized to the concentration at location HMC-4, in Figure 4-4. Based on these measurements, the radon in air concentration at HMC-1Off is almost the same (1.49 pCi/L) as the concentration at HMC-4 (1.53pCi/L). If HMC-1Off represents the background radon concentration at HMC-4, this would mean that the site emissions of radon provide a very small impact to the concentration at HMC-4 (the difference being 0.04 pCi/L). However, in section 4.1.1 of the report, HMC describes the results of modeling radon releases from the site. HMC presents a contour line in Figure 4-1 and refers to it in the text stating: "where radon concentrations are expected to be less than 10 percent of the values at HMC-4 and HMC-5 (in the range of 0.1 pCi L-1 when compared to net measured values)." The NRC staff understands this to indicate that net measured values at HMC-4 and HMC-5 are roughly 1 pCi/L, so that the 10 percent is the 0.1 pCi/L stated by HMC. HMC makes a similar statement on page 25 of the report. The NRC staff notes that HMC did not provide results of the modeling calculations at the boundary air monitoring stations, so it is unclear exactly what the modeling results are. A net concentration of around 1 pCi/L would be inconsistent with the application of HMC- 1 as the background location, which would imply a measured net concentration at HMC- 4 of 0.04 pCi/L.	As discussed in RAI-2a, HMC chose 10% of the model result at HMC-4 as the decision line for minimal impact from off-site sources. The statement that "this is in the range of 0.1 $pCi.L^{-1}$ when compared to net measured values" is correct when HMC-16 is used for the background value and was intended to put the 10% decision line in the context of measured values. The statement should not be interpreted that HMC supports HMC-16 as the most representative location for background radon concentrations in air. The actual modeled radon concentrations at site boundary locations from the arbitrary site source strength would be meaningless but the normalized model output (data normalized to the average response from HMC-4 and HMC-5) is meaningful since the normalized data from known strength of site sources and arbitrary strength for same sources would be identical.

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2c	General	NA	It is unclear how the use of HMC-1Off would be consistent with the range of concentrations measured at the site boundary stations HMC-1 through HMC-7. If HMC-1Off represents background for the entire site, then the differences in measured radon concentrations for different site boundary locations would presumably be due to differences in impact from site releases. As an example, HMC-4 has a long-term measured concentration of 1.66 pCi/L, while HMC-3 has a concentration of 1.09 pCi/L (from the HMC values in Table 4 1). The difference is 0.57 pCi/L, which presumably is due to impacts from radon releases from the site. However, if HMC-1Off were the background location, the concentration at HMC-3 would appear to be lower than that (new) background (HMC-1Off had a concentration of 1.49 pCi/L from Table 4-1). In addition, the HMC modeling of radon releases from the site appears to indicate impacts from site releases at location HMC-3 (based on Figure 4-1, although as noted above detailed modeling results were not provided). Based on HMC's modeling, and based on proximity to the tailings piles, the NRC staff considers it reasonable that HMC-3 is impacted by radon releases from the site. Thus, the NRC staff considers a result of concentrations at HMC-3 being lower than background to be inconsistent with impacts from the site releases.	The long term average radon concentrations on the eastern boundary of the site (HMC-3 and HMC-7) are historically lower than the remaining locations on the perimeter. As discussed in the report (Section 5, page 25) this observation may be representative of the portion of the Lobo Creek drainage where radon concentrations are likely lower due to fewer number of known sources. HMC disagrees with NRCs presumption that the difference between HMC-3 and HMC-4 is due to impacts from radon releases from the site. HMC believes that air --with its lower radon concentrations-- from Lobo Canyon has a larger influence on HMC-3 and HMC-7 due to their proximity to this source, while air --with its higher radon concentrations-- from San Mateo Creek has a larger influence on HMC-4 and HMC-5. Since compliance with public dose limits is evaluated at HMC-4 and HMC-5 it is more appropriate to use background concentrations of radon representative of San Mateo Creek. The existing approach to demonstrate compliance with public dose limits is more conservative than using HMC-3 or HMC-7 since radon concentrations at HMC-4 and HMC-5 are higher comparatively. HMC disagrees with the NRCs interpretation of HMCs modeling regarding site impacts.

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2d	General	NA	The NRC staff notes that location HMC-16 is reasonably close to the Homestake site, and based on past monitoring the average radon concentration(1.05pCi/L) is relatively similar to the lowest concentrations measured at the site boundary at locations HMC-3 (1.09 pCi/L) and HMC-7 (1.17 pCi/L) as provided in Table 4-1. Based on the limited data obtained so far (about 2 years, see table 4-1), the radon concentration at HMC-1Off is 1.49 pCi/L, which appears to be significantly higher than the concentrations at HMC-3 and HMC-7. Based on HMC's modeling of radon releases from the tailings piles, it is expected that HMC-3 and HMC-7 are somewhat impacted by releases from the site. Thus, to the NRC staff, it appears inconsistent to consider HMC-1Off as representative of the site background when the concentration at HMC-1Off is higher than the concentrations at site boundary locations.	HMC-16 is reasonably close to the Homestake site but sits on a topographical high point where radon does not accumulate in near calm conditions. Based on the conceptual model, a location in the drainage bottom would be more representative of background. Please see our response regarding discussions of HMC-3 and HMC7 radon results and NRC;s interpretation of HMCs modeling results. HMC believes HMC-3 and HMC-7 are more strongly influenced by the drainage from Lobo Canyon which has fewer sources of radon sources, therefore lower concentrations in air. The airflow from Lobo Canyon would travel south of HMC-4 and HMC-5 (see figure 2.2-10 of the updated Decommissioning and Reclamation Plan included below). HMC disagrees with the statement that the amount of data for HMC-1Off is limited. While it certainly has been collected for less time than location within HMCs historical monitoring network, the 2 years of data exceed the criterion of one year baseline data recommended by NRC for new a licensee (10 CFR 40, Appendix A, Criterion 7. Given the conceptual model of radon transport (i.e. 1 the highest radon concentrations in air occur during calm or near-calm conditions and 2) during calm conditions radon transport is driven predominantly by topography). and the locations of potential offsite sources in the Lobo Canyon and San Mateo Creek drainages (Figure 2-3 of amendment request) the selection of HMC-1Off is consistent to represent background concentrations of radon at HMC-4 and HMC-5.

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2e	General	NA	The HMC measurements also appear to indicate significantly higher impacts to HMC-4 than to HMC-3 (difference of 0.57 pCi/L mentioned above). If this is correct, modeling should be generally consistent with the result. Because HMC has not provided detailed results of its modeling of the site releases, the NRC staff cannot determine if the modeling is consistent with that measured difference. In Section 5 of the report, HMC states that measured radon concentrations in the Lobo Creek drainage are lower than in the other drainages (based on location HMC-4Off). HMC further states that the portion of the Lobo Creek drainage that intersects the site is expected to move southward along the eastern perimeter. HMC states that that may explain the lower radon concentrations measured at HMC-3 and HMC-7. However, HMC has not provided technical support for that conclusion. In addition, the NRC staff notes that the measurements of radon in the Lobo Creek drainage are based on a single monitoring station (HMC-4) for a single monitoring period of 5 months from October 2011 to March 2012. That is a much shorter monitoring period than for locations HMC-1Off through HMC-3Off.	See response to 2b regarding the intent of the modeling and 2c regarding radon concentrations measured at HMC-3 and HMC-7.

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2-f	General	NA	Based on the figures in HMC's report, it appears that all of locations HMC-1, HMC-1A, and HMC-1Off are in the same part of the San Mateo Creek drainage. Average concentrations at these three locations are provided in Figure 4-4 and Table 4-1. The average concentration at HMC-1A was 1.25 pCi/L, which is lower than the averages at HMC-1Off (1.49 pCi/L) and HMC-1 (1.43 pCi/L). Location HMC-1A is in between HMC- 1Off and HMC-1. Based on HMC's modeling of radon releases from the site (Figure 4-1) and proximity of HMC-1 to the tailings piles, it appears that the concentration at HMC-1 is significantly impacted by radon releases from the site. The NRC staff considers this conclusion to be consistent with a lower concentration measured at HMC-1A, because HMC-1A is farther from the tailings piles and thus is expected to have reduced impacts from releases from the site (though this is not quantified). However, based on the locations, the NRC staff considers the lower concentration at HMC-1A to be inconsistent with HMC-1Off being representative of background at the site and site boundary.	It is inappropriate to compare measured results to model predictions since the model used arbitrary offsite sources (both location and strength) and arbitrary source strengths for on-site sources. HMC-1 is up-gradient from the tailings pile and while within the 10% contour line, and conservatively eliminated from background location consideration, it is likely not significantly impacted from the large tailings pile. The reported difference between HMC-1 and HMC-1A is likely due to the period of the reported data. Table 4-1 indicates (footnote b) that the monitoring period for the reported data is from 1994 4Q to 2012 4Q. This is true except for HMC-1A. As discussed in the 2010 Semi-Annual Environmental Monitoring Report July-December, HMC-1A was established in the second quarter of 2010 to monitor potential emissions from evaporation pond EP-3. To compare HMC-1 and HMC-1A radon concentrations it is best to use the average over the same monitoring period. The average radon concentration for HMC-1A from 2010 2Q to 2012 4Q is 1.25 pCi/L while the average for HMC-1 for the same monitoring period is 1.26 pCi/L. These averages are essentially identical. The average radon concentration at HMC-16 for this monitoring period is 0.71 pCi/L. The average radon concentration at HMC-1Off for this monitoring period is 1.28 pCi/L, similar to HMC-1 and HMC-1A. If radon from the site actually impacts locations north of the site, HMC-1 would be more susceptible to these impacts followed by HMC-1A then HMC-1Off simply due to the distance from the site. This supports the use of HMC-1Off as the best background location since it is the closest location to the site without being potentially impacted from site sources (given the conservative selection criteria) of radon and is in the same geological area.

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3	General	NA	HMC should either include the topography of the tailings piles in its modeling or provided justification for not including that topography.	HMC did not include the topography of the tailing piles in the model run of offsite sources because the movement of radon was not predicted all the way to the piles given that we were evaluating locations north and east of the site. The tailings piles were outside of the modeled area. The height of the tailings pile was considered when modeling onsite sources of radon.
4	General	NA	HMC should provide a technical justification for its statement that HMC-16 may be an inappropriate location to represent the site background.	When taken in its entirety, the report does provide a clear, defensible, and technical justification that HMC-1Off is an appropriate location to represent the site's radon background values. The technical data that supports this license amendment request rests upon sound scientific methods incorporating quantitative data and qualitative concepts, all of which is based, to the best extent practical, on the existing regulatory guidance available. The key takeaways from the report include: • The Site is located in a topographical low point within the San Mateo Creek drainage basin • HMC-16 is located in a topographical high point, and is arguably outside of the San Mateo drainage basin • Radon tends to accumulate in low lying drainage basis during periods of calm and near calm conditions • The San Mateo Creek drainage contains a large number of radon sources, up gradient from the Site • HMC-16 is not an appropriate location to represent the Site background for radon in air, neither at the Site nor at the Site boundary • HMC-1Off is an appropriate location to represent the Site background for radon in air, both at the Site and at the Site boundary

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5	General	NA	HMC should provide justification for its statement that the additional data available for HMC-1Off is a significant reason to conclude HMC-1Off is a better location for background. HMC also should provide justification for why the relatively small difference in distance for locations HMC-1Off and HMC-6Off is a significant reason to conclude HMC-1Off is a better location for background.	HMC does necessarily believe HMC-1Off is a better location than HMC-6Off. In fact, Table 5-1 and Section 5 both state that these two locations represent good candidates for a background location. Additionally, HMC does not state that the additional data available for HMC-1Off is a "significant reason" why HMC-1Off is a better location. The NRC Radon Guidance states "A background location would typically need to be close to the monitoring locations, with geology similar to the site geology, so that the background location is representative of the monitoring location. But the background location should also be far enough from the facility that the radon concentration is not significantly impacted by radon releases from the facility. HMC-1Off is closer to the site without being significantly impacted by the site. Therefore, using the NRC's own guidance,HMC-1Off is a better candidate for a background location than HMC-6Off. HMC decided to select one location to represent background and this is why HMC-1Off was selected as the best site. The additional data at HMC-1Off aided in the selection but was not the deciding factor.

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6	General	NA	(a) Justify that treating the transport of radon in air as a heavy gas is appropriate. (b) Justify why hypothetical onsite radon release quantities were adequate to describe onsite sources of radon release when site measurement data is available. (c) Provide an explanation for why other locations being considered as potential background locations (i.e., HMC-4Off, HMC-5Off, and HMC-6Off) only had the shorter term monitoring performed and why that was adequate to determine their suitability as background locations. (d) Provide support for the statement that radon concentrations trend closely to percent calm distributions.	(a) Radon is a heavy gas but was not treated as such. AERMOD models gases as neutrally buoyant. AERMOD was selected to model radon because 1) it is an EPA approved air dispersion model, 2) it considers terrain and surfaces feature affects, and 3) radioactive decay of the source term can be incorporated. (b) The purpose of modeling onsite radon releases was to determine background areas not potentially influenced by the site. HMC used a ratio of the model result at a receptor location to the average of the model result for HMC-4 and HMC-5. Background locations had to be above of the 0.1 or 10% decision line to be considered. Using this approach, the same decision line could be applied to modeled or actual releases, the 10% decision line would look the same in both cases (c) Locations HMC-1Off, HMC-2Off and HMC-3Off were sited when the study began in 2009: its focus was on San Mateo Creek. Following additional analysis, HMC in consultations with the NRC added three additional locations to capture radon concentrations in offsite drainages: Lobo Canyon (HMC-4Off), the "Northwest Drainage" (HMC-5Off) and one location further up gradient in San Mateo Creek (HMC-6Off) to see if a concentration gradient between HMC-6Off and HMC-1Off could be observed. These were merely added to supplement the knowledge of radon concentrations in the drainage areas around the site; not necessarily as locations representative of site background. (d) Please refer to Figures 2-6 "Frequency of 2009 calm data records as a function of time (hour)" and Figure 4-5 "Real-time radon concentrations in air in summer (a) and winter (b) months". Figure 4-5 shows that radon concentrations are generally highest in the early morning hours and decrease into the late afternoon after which they begin to rise again. Figure 2-6 shows that the number of records for calm conditions within a twenty four hour period is greatest in the early morning and decreases until late afternoon after which they begin to rise again. References describing environmental radon transport are provided.

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6	General		Continued from previous page	Moses, H. *et al.* 1960. The Effect of Meteorological Variables upon the Vertical and Temporal Distributions of Atmospheric Radon. Journal of Geophysical Research 65.4: 1223-1238. Merril, E.et al. 1998. Diurnal and Seasonal Variations of Radon Levels, Effects of Climatic Conditions, and Radon Exposure Assessment in a Former Uranium Metal Production Facility. Health Physics 74(5) : 569-573, May 1998 Porstendorfer J. *et al* 1994. Daily Variation of the Radon Concentration Indoors and Outdoors and the Influence of Meteorological Parameters. Health Physics 67(3):283-287, September 1994. Siaway, G. 2009. Evaluation of the Relationship Between Indoor Radon and Geology, Topography and Aeroradioactivity. Dissertation, George Mason University, 2009. Zahorowski W. *et al.* 2006. Radon as a Tracer of Atmospheric Transport Phenomena on Different Spatial and Temporal Scales. Australian Nuclear Science and Technology Organization. 15th Pacific Basin Nuclear Conference. Sydney Australia. 2006

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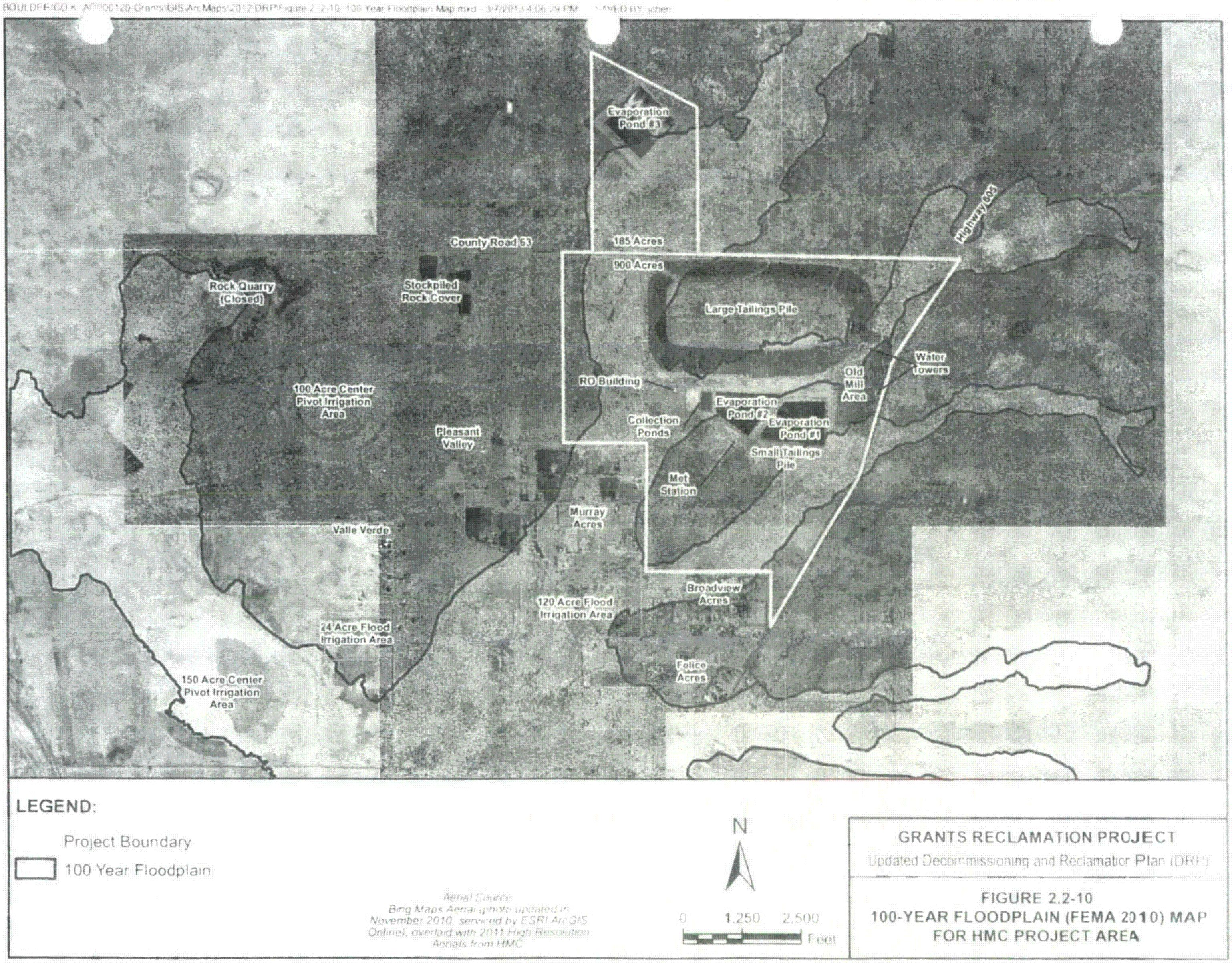
7	General	NA	Provide additional information explaining why sampling location HMC-16 is cross gradient of radon sources and why its location up gradient of the site affects its ability to be representative of background conditions at Homestake.	Figure 2-3 shows the location of HMC-16 relative to important drainages leading into the site. HMC-16 is located on a topographical high outside and west of the "Northwest Drainage" The drainage line near HMC-16 runs from the northwest, then turns east, and finally runs northeast prior to merging with the main "Northwest Drainage" line. If this location was upgradient from the site, the drainage line would run from the northwest to the southeast until it merged with the main drainage line just north of the site. For these reasons, we described HMC-16 as being cross gradient, not up gradient from the site. The conceptual model predicts lower radon concentrations at HMC-16 due to its topographic position than the locations in the (topographically lower) main drainage area. It should be duly noted that actual measurements support the prediction of the conceptual model.
8	Figure 2-3	6	Provide additional information to explain the term LLD or correct the citation in the figure.	The term LLD should be ULD. The corrected figure is provided with this response to RAIs.
9	Figure 2-3	6	Provide additional information to explain the rationale for describing the drainages from the EPA "LLD" sites as natural U versus anthropogenic sources of radioactivity.	Figure 2-3 is titled "Location of potential anthropogenic sources of radon near the Homestake site". Nowhere on this Figure is the term natural U used. The figure depicts anthropogenic sources as red dots. The word "Natural" in the legend refers to the direction of air flow in the drainage and differentiates natural from anthropogenic flows therein.


Evaporation Pond #3
185 Acres
County Road 63
900 Acres
Highway 605
Rock Quarry (Closed)
Stockpiled Rock Cover
Large Tailings Pile
Water Towers
RO Building
Old Mill Area
100 Acre Center Pivot Irrigation Area
Evaporation Pond #2
Evaporation Pond #1
Collection Ponds
Pleasant Valley
Small Tailings Pile
Met Station
Murray Acres
Valle Verde
Broadview Acres
120 Acre Flood Irrigation Area
24 Acre Flood Irrigation Area
Felice Acres
150 Acre Center Pivot Irrigation Area
LEGEND:
Project Boundary
100 Year Floodplain
N
0 1,250 2,500 Feet
GRANTS RECLAMATION PROJECT
Updated Decommissioning and Reclamation Plan (DRP)
FIGURE 2.2-10
100-YEAR FLOODPLAIN (FEMA 2010) MAP
FOR HMC PROJECT AREA