



ARCADIS

**Appendix A**

Chronology of Historical Reclamation  
and Decommissioning Activities



## Appendix A - Chronology of Historical Reclamation and Decommissioning Activities

Date	Activity	Reference
April 1958	Homestake Mining Company (HMC), through a variety of partnerships and joint venture associations, started operations at the uranium mill.	AKG et al 1993
1961	Groundwater contamination at HMC site first observed at the site.	EPA 2006
May 1, 1974	State of New Mexico signed agreement with NRC authorizing the New Mexico Environmental Improvement Division (NMEID) to regulate uranium milling activities in New Mexico under Atomic Energy Commission.	Organization of Agreement States. (OAS). 1994
1974 - 1975	The NMEID and the EPA conducted a study of the impacts of mining activities in the Grants Mineral Belt on area groundwater and surface water.	EPA 2006
August 1976	Agreement between NMEID and HMC on a Corrective Action Plan. Pre-dates the NMEID Discharge Plan program	AGK et al 2006
1977	Groundwater remediation activities began at the HMC site	EPA 2006
February 5, 1977	Breach of south berm of LTP resulting in release of tailings sand and slime (released contained on HMC property); release due to failed pipe coupling resulting in the crest of the south berm of the LTP washing out.	
March 1977	NMEID approved HMC's design of Collection and the Broadview Acres Injection System	AKG et al 1987
June 1977	NMEID approval for HMC to start Broadview Acres Injection System; Broadview injection started (6 new wells; monitoring of 8 wells)	HMC 1987
1977	Freshwater injection into six alluvial wells on the north side of Broadview Acres was initiated.	MFG 2006
July 1978	Active tailings collection system started (approximately 15 new wells)	HMC 1987
1978	The S and D line collection wells were started. Significant problems due to calcite precipitate were encountered in maintaining yields from wells until an inhibitor was used on the collection wells to maintain yields.	MFG 2006
1981	The NMEID approved discharge plan DP-200 for the HMC site.	EPA 2006
1981	EPA proposed that HMC site be placed on Superfund list	HMC 1982.
August 1983	A study of radon levels in residences in the area was released.	EPA 2006
September 1983	HMC site was placed on EPA's Superfund's National Priorities List (NPL) at request of the state.	Meyer, M. 2010
November 1983	EPA and HMC signed a Consent Decree that required HMC to provide an alternate water supply to homes in four subdivisions south of the site	EPA 2006
April 1985	HMC completed connections for the offsite alternate water supply to homes south of the site.	EPA 2006
June 1, 1986	The State of New Mexico returned regulatory authority for uranium mills to the NRC. With the transfer of authority to the NRC, there were concurrent regulations of ground water protection with the state.	Organization of Agreement States. (OAS). 1994

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1986	Installation of the Milan water supply for Broadview, Felice, Murray Acres and Pleasant Valley estates subdivisions.	MFG 2006
December 1, 1986	HMC submitted Tailings Stabilization and Reclamation Plan	AKG et al 1993
June 30, 1987	EPA issued an Administrative Order on Consent (AOC) to HMC to conduct an Remedial Investigation and Feasibility Study (RI/FS) for the radon operable unit (radon levels in nearby residences)	EPA 2006
October 1987 – January 1989	HMC conducted RI/FS for the radon operable unit.	EPA 2006
July 1989	RI/FS reports issued for the radon operable unit.	EPA 2006
September 15, 1989	HMC submitted Correction Action Plan for groundwater remediation for the NRC.	EPA 2006
September 27, 1989	EPA signed a Record of Decision (ROD) for the radon operable unit that determined no further action by HMC was necessary.	EPA 2006
November 1989	All activities required under 1983 Consent Decree were completed by HMC.	EPA 2006
1989	Renewal of NMED DP-200	
February 2, 1990	HMC mill operations ceased.	AKG et al 1993
May 31, 1990	HMC notified the NRC that the reclamation and decommissioning plan would be updated to address NRC comments on the initial submittal.	AKG et al 1993
June 8, 1990	HMC filed for license amendment for construction of lined evaporation pond as the initial step in final reclamation of the entire HMC site.	AKG et al 1993
July 20, 1990	NRC amended license to allow for construction of lined evaporation pond.	AKG et al 1993
November 18, 1990	HMC completed lined Evaporation Pond No. 1 that was located on the Small Tailings Pile to assist with dewatering of the Large Tailings Pile and to hold water pumped from the collection wells of the groundwater restoration plan. Evaporation Pond No. 1 started up in November.	AKG et al 1993
1990	Use of Evaporation Pond No. 1 started	MFG 2006
January 31, 1991	HMC submitted proposed tailings reclamation and mill decommissioning plan and \$20 MM parent company guarantee to the NRC.	AKG et al 1993
1992	Toe drains installed on around the Large Tailings Pile as part of tailings reclamation.	MFG 2006
December 8, 1992	HMC submitted a supplement to the Environmental Report for the mill site prepared in 1982.	AKG et al 1993
December 17, 1992	A release of diesel from a 1,500 gallons underground storage tank was discovered via saturated soils	ETEC 1992
July 23, 1993	HMC received approval from the NRC for SUA License 1471 License Amendment No. 14 (reclamation plan for LTP and STP).	NRC 1993

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Date	Activity	Reference
September 1993	Reclamation activities begun to clean up soils and decommission the mill.	EPA 2006
October 1993	HMC submitted final updated reclamation plan to NRC.	EPA 2006
December 14, 1993	Memorandum of Understanding (MOU) signed by EPA Region 6 and NRC detailing each agency's responsibilities and authority at the HMC site. NRC designated as regulatory agency for the byproduct material disposal area reclamation and closure activities.	EPA 2006
April 1, 1994	NMED advised HMC that the cleanup of diesel was deemed complete and no further action was needed.	NMED 1994
July 1994	EPA released HMC from 1983 Consent Decree.	EPA 2006
1994	Recontouring of the Large Tailings Pile was completed.	AKG 1994
November 1995	HMC Completion Report for Reclamation of Off-Pile Areas (windblown tailings) at the HMC site filed with NRC.	ERG 1995
December 10, 1995	Demolition of the mill and surface reclamation activities at the site were completed.	EPA 2006
1995	The scour trench that runs along the north and west sideslope toes of the LTP was installed.	AKG 1996
1995	Tailings dewatering of the LTP was initially tested.	MFG 2006
1995	Evaporation Pond No. 2 was installed to the west of Evaporation Pond No. 1.	Douglas 1995
January 16, 1996	HMC requested that the Large Tailings compound be removed from the annual Technical Evaluation as the final stabilized configuration had been achieved.	HMC 1996
February 29, 1996	HMC submitted a Completion Report and notified the NRC that the mill decommissioning was completed and requested amending of license to reduce monitoring requirements.	HMC 1996
July 31, 1996	NRC issued a determination that HMC's request to reduce environmental monitoring and tailings impoundment monitoring requirements were acceptable and amended the license by modifying the license conditions.	NRC 1996
January 28, 1999	NRC approved the soil cleanup and mill reclamation (mill decommissioning completion report)	EPA 2006
1999	A Reverse Osmosis unit was added to treat water and produce R.O. product water for injection into the alluvial aquifer.	HMC and Hydro-Engineering 2000
February 2000	HMC submittal to NRC and NMED of groundwater monitoring and performance review for HMC for 1999 (NRC License SUA-1471 and Discharge Plan DP-200)	Hydro-Engineering 2000
2000	The groundwater flushing program for the Large Tailings Pile began.	HMC and Hydro-Engineering 2001
March 2002	Second Reverse Osmosis (RO) Unit added to Treatment Plant to increase RO treatment capacity from 300 to 600 gallons per minute (gpm). RO product water injected into alluvial aquifer.	HMC and Hydro-Engineering 2003



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Date	Activity	Reference
May 2005	Expansion of groundwater collection and irrigation system for offsite groundwater plume remediation completed	HMC and Hydro-Engineering 2006
June 19, 2002	As part of amendment to License Amendment 34, License Condition 42 was further amended to require submittal of a land use survey with the License annual report to NRC.	NRC 2002
2002	60 Acres of irrigation were added as part of groundwater reclamation program. Fresh water injection started in Section 28. Fresh water injection into Upper Chinle well 944 was initiated. Fresh water injection into the alluvial aquifer east of Felice Acres was initiated. Fresh water injection east of Broadview Acres was initiated.	HMC and Hydro-Engineering 2003
2003	Fresh water injection line west of the Large Tailings Pile was added to the groundwater reclamation program. Fresh water injection into Section 3 was initiated.	HMC and Hydro-Engineering 2004
October 28, 2003	HMC requested that the NRC approve an extension of reclamation milestones.	
2004	24 acres of flood irrigation were added to Section 33. Injection lines added to in Section 3, east of Broadview Acres and in southern Felice Acres.	HMC and Hydro-Engineering 2005
February 6, 2004	NRC response to HMC approving Amendment 36 (extension of Reclamation Milestones).	NRC 2004
June 21, 2004	Letter from HMC to NRC as to follow-up to meeting discussions as to Chinle Aquifer Site Standards	HMC 2004a
July 21, 2004	Letter from HMC to NRC dealing with rationale/justification for Chinle Aquifer site standards.	HMC 2004b
May 2005	Expansion of groundwater collection and an additional 40 acres of irrigation added to Section 28 center pivot for groundwater plume remediation.	HMC and Hydro-Engineering 2006
August 18, 2005	NMED accepted proposed HMC site groundwater background concentrations for each aquifer unit	EPA 2006
September 2005	NMED performed sampling of residential wells at nearby subdivisions.	EPA 2006
September 27, 2005	EPA approved revised HMC site groundwater background concentrations for each aquifer unit.	EPA 2006
July 10, 2006	NRC letter to HMC approving License Amendment No. 39 (revisions to groundwater protection standards).	NRC 2006
December 12, 2006	HMC submits reclamation project groundwater corrective action program (CAP) revision to NRC.	MFG 2006
January 30, 2007	HMC issues Environmental Report for the construction of Evaporation Pond No. 3.	HMC 2007
July 31, 2008	NRC issues Environmental Assessment related to construction of Evaporation Pond No. 3.	NRC 2008a
August 7, 2008	NRC approves construction and operation of Evaporation Pond No. 3 (License Amendment No. 41).	NRC 2008b
January 21, 2009	New Mexico Environment Department announced Memorandum of Agreement with HMC to provide public water supply to several area residents still dependent on private wells.	NMED 2009a
June 2009	HMC submits comments to EPA on draft of Final Remedial System Evaluation.	

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Date	Activity	Reference
June 26, 2009	The Agency for Toxic Substances and Disease Registry (ATSDR) released final Health Consultation report for HMC mill site.	ATSDR 2009
November 10, 2009	Letter from NMED to EPA and NRC regarding evaluation of alluvial aquifer background concentrations for the Homestake Mining Company Superfund Site.	NMED 2009b
February 4, 2010	NRC request to HMC for additional information regarding Grant's Reclamation Project Groundwater Corrective Action Program (CAP).	NRC 2010g
February 15, 2010	U.S. Corps of Engineers (USACE) released a draft RSE report that recommended several major changes to the current remediation system at HMC.	ACOE 2010
February 23, 2010	HMC submittal to NRC of zeolite process technology – uranium absorption at HMC mill site.	Rimcon 2010
February 25, 2010	HMC submittal to NRC of semi-annual environmental monitoring report period – July through December 2009 (ML100970422).	HMC 2010a
February 12, 2010	HMC submittal to NMED and NRC of groundwater hydrology, restoration and monitoring at the Grants Reclamation Project for NMED DP-200.	HMC et al 2010a
February 16, 2010	HMC submittal to NMED and NRC of ground-water hydrology, restoration and monitoring at the Grants Reclamation Project for NMED Offsite DP.	HMC et al 2010b
March 5, 2010	EPA request to NRC for NRC to direct HMC to conduct sampling under EPA's guidance in support of human health risk assessment at HMC.	EPA 2010
March 15, 2010	NRC letter to HMC approving License Amendment No. 42 to License SUA-1471 (2009 annual surety update).	NRC 2010a
March 24, 2010	HMC submittal to NRC and NMED of Evaluation of 2000 – 2009 irrigation with alluvial groundwater (ML100970370).	HMC et al 2010c
March 29, 2010	HMC submittal of 2009 annual monitoring report/performance review for HMC site to NRC and NMED pursuant to NRC License SUA-1471 and NMED DP-200.	HMC et al 2010d
March 26, 2010	NRC response to EPA regarding request for radon sampling at HMC: Without evidence of HMC's remediation actions are violating any NRC requirements, the NRC does not have regulatory basis to direct HMC to conduct residential structural sampling under EPA's guidance.	NRC 2010b
March 31, 2010	HMC submittal to NRC of annual surety update for Grants Reclamation Project pursuant to NRC License SUA-1471.	HMC 2010b
May 6, 2010	NRC letter to EPA regarding comments on draft "Focused Review of Specific Remediation Issues, An Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico," License SUA-1471, Docket: 40-8903.	NRC 2010c

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Date	Activity	Reference
May 7, 2010	HMC letter to EPA regarding comments on draft "Focused Review of Specific Remediation Issues, An Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico," – February 2010.	HMC 2010c
July 25, 2010	Severe rainstorms resulted in some damage to certain areas of the LTP and LTP radon barrier and drainage pathways.	NRC 2010e
August 13, 2010	HMC submittal to NRC regarding treatment alternatives testing in the large tailings pile.	HMC 2010d
August 23, 2010	HMC submittal to NRC and NMED of semi-annual environmental monitoring report for January through June 2010.	HMC 2010e
August 26, 2010	NRC letter to HMC requesting additional information requirements for 2010 annual surety update submitted by HMC on March 31, 2010.	NRC 2010d
September 8, 2010	NRC Inspection Report 040-08903/10-001; routine announced NRC inspection of HMC site on August 11, 2010.	NRC 2010e
September 9, 2010	NRC response to HMC's request dated August 13, 2010, approving start-up of proposed treatment alternatives testing in the large tailings pile	NRC 2010f
September 23, 2010	HMC submittal to NRC regarding Repair of Radon Barrier/Rock Cover on Sideslope of HMC Large Tailings Pile	HMC 2010f
October 31, 2010	HMC correspondence to NRC regarding revision of 2010 cost estimate based on RAI letter	HMC 2010g
November 2010	Completion of construction of EP-3	Kleinfelder 2011
December 1, 2010	HMC Large Tailings Facility stormwater downdrains project (Completion Report); action to reduce potential for stormwater runoff damage issues experienced on July 25, 2010.	DBE 2010a
December 14, 2010	HMC Large Tailings Facility radon barrier repair project (Completion Report)	DBE 2010b
January 2011	HMC Evaluation of years 200 through 2010 irrigation with alluvial ground water	HMC and Hydro-Engineering 2011a
February 3, 2011	HMC filed Completion Report for the radon barrier repair work.	HMC 2011a DBE 2010b
February 3, 2011	HMC filed Completion Report for the LTP Stormwater Collection Pipe Replacement	HMC 2011b DBE 2010a
February 16, 2011	HMC's contractor submit Completion Report for EP-3	Kleinfelder 2011
February 28, 2011	NRC approved updated 2010 financial surety.	HMC 2011c
March 31, 2011	HMC submittal of 2010 annual monitoring report/performance review	HMC 2011d
March 31, 2011	HMC submittal of 2011 closure cost estimate to NRC (License amendment 43)	HMC 2011e

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<b>Date</b>	<b>Activity</b>	<b>Reference</b>
December 20, 2011	NRC approved updated 2011 financial surety (license amendment 44).	HMC 2011f
March 15, 2012	HMC submittal of updated groundwater corrective action program (CAP) for Grants Reclamation Project	HMC 2012a
March 29, 2012	HMC submittal of 2012 closure cost estimate to NRC	HMC 2012b
August 07, 2012	EPA letter to NRC advising of position on requiring Record of Decision for Operable Units 1 and 2 for the HMC site, New Mexico	EPA 2012a
August 27, 2012	HMC submittal to the NRC of the Semi-Annual Environmental Monitoring Report for January through June, 2012.	HMC 2012c
September 27, 2012	NRC advising HMC of License Amendment No. 45 (administrative amendment) to License SUA-1471 for updates to calendar dates in License Conditions 36.A(3), 36.B(1), and 36.B(2) in order to be consistent with license conditions for License Amendment No. 40 dated August 02, 2006.	NRC 2012
October 30, 2012	EPA requirements for site deletion at Homestake Mining Company superfund site, revised October 30, 2012.	EPA 2012b

## REFERENCES

- AK GeoConsult, Inc. (AKG) and Jenkins Environmental, Inc. 1993. Homestake Reclamation Plan Revision 10/93. Homestake Mining Company of California Grants Operation. Volume I, Text, Table and Figures. October.
- AKG. 1996. Letter from A.K. Kuhn, AK GeoConsultant, Inc. to F. Craft of Homestake Mining Company Regarding Evaluation of Tailing Impoundments and Evaporation Ponds, Homestake Grants Operation, Fourth Quarter, 1995.
- AK Geoconsultant, Inc. (AKG). 1994. Letter from A.K. Kuhn of AKG to Fred Craft of Homestake Mining Company Regarding Evaluation of Tailings Impoundments and Evaporation Pond, Homestake Grants Operation, Fourth Quarter, 1994. November.
- Agency for Toxic Substances and Disease Registry. (ATSDR). 2009. *Health Consultation Homestake Mining Company Mill Site Milan, Cibola County, New Mexico*. June 26, 2009.
- Douglas, M. 1995. Internal Correspondence from M. Douglas to F. Craft, Homestake Mining Company Regarding Tailings Pile Construction. July 13.
- Duran Bokich Enterprises, L.L.C. 2010a. *Homestake Mining Company Grants Project Large Tailings Facility Stormwater Downdrains Project, Cibola County, New Mexico*. Prepared for HMC. ML110400160. December 1.
- Duran Bokich Enterprises, L.L.C. 2010b *Homestake Mining Company Grants Project Large Tailings Facility Radon Barrier Repair Project, Cibola County, New Mexico*. Prepared for HMC. ML110400237. December 14.
- Emission Testing and Environmental Consultants, Inc. (ETEC). 1992. Written Notification of a release of Diesel. December 30.
- Environmental Quality Management. (EQM). 2008. [for EPA Risk Management Research Lab]. *Draft Final Remediation System Evaluation, Homestake Superfund Site, Grants, NM*. December 19, 2008.
- Environmental Restoration Group, Inc. (ERG). [for HMC]. 1995. *Completion Report for Reclamation of Off-Pile Areas at the Homestake Mining Company of California Uranium Mill, Grants Operation*. November 1995.
- Environmental Quality Management, Inc. (EGM). 2008. Remediation System Evaluation, Homestake Superfund Site, Milan, New Mexico. Draft Final Report. Prepared for U.S. EPA. December 19.
- HMC. 1982. *Superfund – Grants*. Internal document.
- HMC. 1987. *Timing of Events for Ground-Water Program*. Internal document.

- HMC. 1993. Chronology of Closure of Homestake Uranium Millsite, Grants, NM. Internal document.
- HMC. 1996. *Completion Report, Mill Decommissioning, Homestake Mining Company, Grants Uranium Mill*. ML092820142. February 29, 1996.
- HMC. 2004a. Letter from A.D. Cox to G. Janosko, Branch Chief, Chief of Fuel Cycle Facilities Branch, NRC Regarding follow-up to meeting discussions pertaining to Chinle Aquifer Site Standards. ML041770456. June 21.
- HMC. 2004b. Letter from A.D. Cox of HMC to Bill V. Von Till, Site Manager, Office of Nuclear Materials Safety and Safeguards, NRC Regarding Grants Reclamation Project Docket No. 40-8903 License No. SUA-1471, Corrections/Edits for "Background Water Quality Evaluation of the Chinle Aquifers" – October, 2003 and Associated Statistical Analyses Document. ML042080337. July 21.
- HMC. 2007. *Environmental Report for the Construction of Evaporation Pond #3 (EP3) and Associated Operations Boundary Expansion*. ML070850561. January 30, 2007.
- HMC. 2010a. *Docket No. 40-8903 License No. SUA-1471 Semi-Annual Environmental Monitoring Report Period – July through December 2009*. ML1006400171, ML100970423. February 25.
- HMC. 2010b. *License SUA-1471. Docket 40-8903 (TAC LU0134). Grants Reclamation Project – 2010 Closure Estimate*. HMC submittal to NRC. ML102230058. March 31.
- HMC. 2010c. Letter from A.D. Cox, Homestake Mining Company of California to K. Yager, Technology Innovation and Field Service Division, U.S. EPA Regarding Grants Reclamation Project – Cibola County, NM, Homestake Comments on "Focused review of Specific Remediation Issues – An Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico" – February 2010.
- HMC. 2010d. *License SUA-1471. Docket 40-8903 (TAC LU0134). Grants Reclamation Project Treatment Alternatives Testing in the Large Tailings Pile*. HMC letter to NRC requesting approval for start-up of treatment alternatives testing in Large Tailings Pile. ML102430193. August 13, 2010.
- HMC. 2010e. *Docket 40-8903 License SUA-1471 Semi-Annual Environmental Monitoring Report Period – January through June 2010*. ML102530111 and ML102530114. ML102530111. August 23, 2010.

- HMC. 2010f. Letter from A.D. Cox, Homestake Mining Company of California to J. Buckley, Project Manager, Decommissioning and Uranium Recovery Licensing Directorate, NRC Regarding Grants Reclamation Project, R M License SUA-1471 Repair of Radon Barrier/Rock Cover on Sideslope of HMC Large Tailings Pile. ML102810298. September 23, 2010. HMC. 2010g. Email from A.D. Cox, Homestake Mining Company of California to J.T. Buckley, Project Manager, Decommissioning and Uranium Recovery Licensing Directorate, NRC Regarding Revised Cost Estimate based on RAI letter. ML110110633, ML110110652. October 31, 2010.
- HMC. 2011a. Email from Al Cox, Homestake Mining Company of California, to J. Buckley, Project Manager, Decommissioning and Uranium Recovery Licensing Directorate, NRC Regarding Completion Report for Large Tailings Pile Barrier Repair Completion Report. ML110400231. February 3.
- HMC. 2011b. Email from Al Cox, Homestake Mining Company of California, to J. Buckley, Project Manager, Decommissioning and Uranium Recovery Licensing Directorate, NRC Regarding Completion Report for LTP Stormwater Collection Pipe Replacement. ML110400142. February 03.
- HMC. 2011c. Letter from Keith I. McConnell, Deputy Director. Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection to A.D. Cox, Homestake Mining Company Regarding License Amendment 43 (2010 annual surety update) to Source Material License SUA-1471. ML110380223. February 28.
- HMC. 2011d. Letter from A.D. Cox, Homestake Mining Company of California to J.T. Buckley, Project Manager, Decommissioning and Uranium Recovery Licensing Directorate Regarding Submittal of *2010 Annual Monitoring Report/Performance Review*. ML110470433, ML11102A021 – ML11102A026. March 31.
- HMC. 2011e. Letter from A.D. Cox, Homestake Mining Company to J.T. Buckley, Senior Project Manager, Decommissioning and Uranium Recovery Licensing Directorate Regarding License SUA-1471, Docket 40-8903 9TAC LU0134], Grants Reclamation Project – 2011 Closure Cost Estimate. ML111010153. March 31.
- HMC. 2011f. Letter from Bruce Watson, Acting Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection to A.D. Cox, Homestake Mining Company Regarding License Amendment No. 44 (2011 annual surety update). ML113190523. December 20. HMC. 2012a. Letter from A.D. Cox, Project Manager, Homestake Mining Company of California to John Buckley, Site Manager, U.S. NRC Transmitting Grants Reclamation Project Updated Corrective Action Plan (CAP). March 15.
- HMC. 2012b. Letter from A.D. Cox, Project Manager, Homestake Mining Company of California to John Buckley, Senior Project Manager, Fuel Cycle Facilities Branch, Division of Fuel Cycle Safety and Safeguards, Office of Nuclear Materials Safety and Safeguards, U.S. NRC, Rockville, Maryland Regarding Grants Reclamation Project – 2012 Closure Cost Estimate. ML12096A074. March 29.

HMC. 2012c. Letter from Alan D. Cox, Project Manager – Grants, Homestake Mining Company, Grants, New Mexico to John Buckley, Project Manager, Fuel Cycle Facilities Branch, Division of Fuel Cycle Safety and Safeguards, Office of Nuclear Materials Safety and Safeguards, U.S. NRC, Rockville, Maryland Regarding the Submittal of Semi-Annual Environmental Monitoring Report – January through June 2012. August 27.

Homestake Mining Company of California and Hydro-Engineering, LLC. (HMC et al). 2010a. [prepared for HMC]. *2009 Annual Monitoring Report/Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200*. March 2010.

Homestake Mining Company of California and Hydro-Engineering, LLC. (HMC et al). 2010b. [prepared for HMC]. *Ground-Water Hydrology, Restoration and Monitoring at the Grants Reclamation Project for NMED Offsite DP*. February 2010.

Homestake Mining Company of California, Hydro-Engineering, LLC, Environmental Restoration Group and Rimcon. (HMC et al). 2010c. *Evaluation of Years 2000 through 2009 Irrigation with Alluvial Ground Water*. March 2010.

Homestake Mining Company of California and Hydro-Engineering, LLC. (HMC et al). 2010d. *2009 Annual Monitoring Report/Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200*. March 2010.

HMC and Hydro-Engineering, LLC. 2011a. Evaluation of Years 2000 through 2010 Irrigation with Alluvial Ground Water. ML110470433, ML110470434, ML110470435. January.

Hydro-Engineering. 2000. [prepared for HMC]. *Ground-water Monitoring and Performance Review for Homestake's Grants Project*. February 2000.

Kleinfelder West Inc. (Kleinfelder). 2011. Letter from A. Kuhn, P.E., Kleinfelder west, Inc. to John Buckley, U.S. NRC Regarding Construction Completion Report for Evaporation Pond No. 3, Homestake Mining Company, Grants, NM. ML110610744. February 16.

Meyer, M. 2010. *U.S. Nuclear Regulatory Commission. Complexities of Decommissioning a Uranium Mill Site*. ML100560341. August 5, 2010.

MFG, Inc. (MFG). 2006. *Grants Reclamation Project Groundwater Corrective Action Program (CAP) Revision*. [prepared for HMC]. December 12, 2006.



New Mexico Environment Department. (NMED). 1994. Letter from John Cochran, Water Resource Specialist, Underground storage Tank Bureau, NMED to Fred Craft, Homestake Mining Company Regarding No Further Action Required at Homestake Mining Site, Highway 53 North, Grants, New Mexico

NMED. 2009a. Environment Department Negotiates Agreement Leading to Water Service Connections for Residents in Homestake Mill Area. January 21.

NMED. 2009b. *Evaluation of Alluvial aquifer background concentrations for Contaminants of Concern for the Homestake Mining Company Superfund Site (CERCLIS ID NMD007860935), Cibola County, New Mexico*. Letter to EPA Region VI. November 10, 2009.

Organization of Agreement States. (OAS). 1994. *Topical Discussion of the NRC/Agreement State Program*. [Webpage]. Located at: <http://nrc-stp.ornl.gov/special/topical.pdf>. Accessed on: November 22, 2010. Published by Illinois Department of Nuclear Safety. October 1994.

Rimcon, LLC. 2010. Zeolite Process Technology Uranium Adsorption at Homestake Mining Company – Grants Reclamation Project. Fe

U.S. Corps of Engineers. (ACOE). 2010. Focused Review of Specific Remediation Issues, *An Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico*. Draft report. February 2020.

U.S. Environmental Protection Agency. (EPA). 2010. *Sampling at Homestake Mining Company (HMC) site*. Letter from EPA Region VI to NRC. March 5, 2010.

EPA. 2006. *Second Five-Year Review Report for Homestake Mining Company Superfund Site Cibola County, New Mexico*. September 2006.

EPA. 2012a. Letter from Pamela Phillips, Acting Director, Superfund Division, U.S. EPA Region VI, Dallas, Texas to Larry Camper, Decommissioning and Uranium Recovery Licensing Directorate, U.S. NRC, Rockville, Maryland. August 07.

EPA. 2012b. U.S. EPA Requirements for Site Deletion at Homestake Mining Company Superfund Site. Revised October 30, 2012.

U.S. Nuclear Regulatory Commission. (NRC). 1993. Letter from Ramon D. Hall; Director, Uranium Recovery Field office, U.S. NRC Region IV, Denver Colorado to Harold Barnes, Homestake Mining Company of California, San Francisco, California Regarding approval of License SUA-1471 License Amendment 14. July 23.

- NRC. 1996. Letter from J.J. Holonich, Chief, Uranium Recovery Branch, NRC to F. Craft of Homestake Mining Company regarding Reduction in Monitoring Requirements, Amendment 24 to Source Material License SUA-1471. July 31.
- NRC. 2002. Letter from D.M. Gillen, Chief, Fuel Cycle Facilities Branch, NRC to Al Cox Regarding Homestake Mining Company, SUA-1471 – Amendment 34 – Surety and License Condition Updates (TAC L52422). ML021760400. June 19.
- NRC. 2004. Letter from Gary Janosko, Chief, Fuel Cycle Facilities Branch, NRC to A.D. Cox, Homestake Mining Company Regarding Amendment 36 – Request for Extension of Reclamation Milestones to License SUA-1471 – Docket No., 40-8903, Homestake Uranium Mill, Grants, New Mexico (TAC LU0019). ML040400140. February 6.
- NRC. 2006. Letter from G.S. Janosko, Chief, Fuel Cycle Facilities Branch, NRC to Al Cox, Homestake Mining Company Regarding Homestake Mining Company – Grants, New Mexico – License Amendment No. 39 to Materials License SUA-1471 (TAC LU0122). ML016710354, ML061940038. July 10.
- NRC. 2008a. *Environmental Assessment Related to the Issuance of a License Amendment for Construction of a Third Evaporation Pond, Homestake Mining Company of California, Grants, New Mexico Project*. ML080920594. July 31.
- NRC. 2008b. Letter from K.I. McConnell, Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate, NRC to A.D. Cox, Homestake Mining Company Regarding Grants Reclamation Project Amendment 41 to Source Materials License SUA-1471 Approving Construction of Evaporation Pond EP3 and 2007 Financial Surety. ML080920584. August 7.
- NRC. 2010a. *2009 Annual Surety Update for the Homestake Mining Company Grants Reclamation Project, Amendment No. 42 to Source Materials License SUA-1471*. Letter from NRC to HMC. ML100630104, ML100621036. March 15, 2010.
- NRC. 2010b. *Response to Request for Sampling at Homestake Mining Company Site*. NRC response to EPA Region VI. ML100710060. March 26, 2010.
- NRC. 2010c. *Comments on Draft “Focused Review of Specific Remediation Issues, an Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico,” License SUA-1471, Docket: 40-8903*. NRC response to EPA Region VI. ML101160261. May 6, 2010.
- NRC. 2010d. *2010 Surety Update for the Homestake Mining Company Grants Reclamation Project*. Letter from NRC to HMC requesting additional information. ML102220501. August 26, 2010.
- NRC. 2010e. *NRC Inspection Report 040-08903/10-001*. Report for August 11, 2010 NRC inspection of HMC mill site. ML102510742. September 8, 2010.

- NRC. 2010f. *Treatment Alternatives Testing in the Large Tailings Pile, Homestake Mining Company Grants Reclamation Project, Docket: 040-8903, License: SUA-1471.* NRC approval of HMC's proposed treatment alternatives testing in Large Tailings Pile. ML102510285. September 9, 2010.
- NRC. 2010g. Letter from J.T. Buckley, Project Manager, Decommissioning and Uranium Recovery Licensing Directorate, NRC, *Regarding Request for Additional Information Regarding the Grants Reclamation Project Groundwater Corrective Action Program (CAP) Revision, License SUA-1471, Docket No. 40-8903.* ML100320466. February 4.
- NRC. 2011. Letter from K.I. McConnell, Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate to A.D. Cox, Homestake Mining Company of California Regarding 2020 Annual Surety Update for the Homestake Mining Company Grants Reclamation Project, Amendment No. 43 to source Materials License SUA-1471. ML110380223. February 28.
- NRC. 2012. Letter from Andrew Persinko, Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U.S. NRC, Rockville, Maryland to Alan D. Cox, Project manager, Grants Reclamation Project, Homestake Mining Company, Grants, New Mexico Regarding License Amendment No. 45 to Source Material License SUA-1471. September 27.



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**Appendix B**

Summary of License SUA-1471  
Amendments

# Appendix B - Summary of License SUA-1471 Amendments

License Amendment	Approval Date	License Condition (LC) Amended	License Condition (LC) Changes
1	11/10/1986	Major license upgrade	Up the State of New Mexico returning licensing authority for uranium mills to the NRC, the NRC upgraded the license conditions as per NRC requirements.
2	10/02/1987	10, 12, 19 (revision) 32, 33, 34 (new)	<p><b>LC 10:</b> production capacity authorized at nominal throughput of 3500 tons per day and uranium water recovery from mine water updated to reflect 1986/1978 submittals from HMC.</p> <p><b>LC 12:</b> Added embankment inspection program with inspections by a registered professional engineer.</p> <p><b>LC 19:</b> Implementation of a interim stabilization program for all tailings not covered by standing water, as per recent submittals (July 15 &amp; September 10, 1987, with modifications, soil sampling and gamma survey program contaminated area cleanup requirements.</p> <p><b>LC 32:</b> Specific radiation monitoring requirements and submittal date for ALARA audit reports.</p> <p><b>LC 33:</b> Additional radiation survey requirements and specific cleanup criteria.</p> <p><b>LC 34:</b> Groundwater sampling parameters and sampling frequency.</p>
3	11/9/1988	35 (new)	New groundwater detection monitoring program to comply with 10 CFR 40, Appendix A.
4	5/18/1989	34 & 35 (revision)	Deletion of LC 34 and revisions to LC 35 for a modified groundwater monitoring program and implementation of a compliance monitoring program
5	3/19/1990	15, 31, 34, 35 (revision)	<p><b>LC 15:</b> Suspension all groundwater monitoring other than that associated with LC 35; requirement to submit a groundwater monitoring report in a specific format.</p> <p><b>LC 31:</b> HMC to propose point of compliance location for brine evaporation pond.</p> <p><b>LC 34:</b> deleted.</p> <p><b>LC 35:</b> Revisions to compliance monitoring program; groundwater monitoring requirements of LC 34 incorporated into LC 35 (LC 34 deleted); corrective action program shall be as designated in Criterion 5D, Appendix A, 10 CFR Part 40. Submit a license amendment requirement for a proposed new evaporation pond, a water balance for tailings dewatering, schedule for tailings dewatering and system to eliminate recharge from scavenger ditch. Submit a semi-annual groundwater monitoring report as per 10 DFR 40.65. Submit a performance review of the corrective action program detailing progress toward attaining groundwater protection standards.</p>

**Appendix B - Summary of License SUA-1471 Amendments**

<b>License Amendment</b>	<b>Approval Date</b>	<b>License Condition (LC) Amended</b>	<b>License Condition (LC) Changes</b>
6	4/17/1990	10, 19 (revision)	<p><b>LC 10:</b> Uranium ore processing to take place in accordance with specific programs submitted by HMC (e.g., ALARA radiation protection program and radiation monitoring requirements).</p> <p><b>LC 19:</b> Additional requirements for implementing interim stabilization program (e.g., application of chemical stabilizer, detailed quarterly inspections of effectiveness of measures implemented to control blowing of tailings by qualified personnel and annual soil sampling and gamma survey program to verify effectiveness of measures used to control blowing of tailings).</p>
7	7/13/1990	35 (revision)	Implementation of compliance monitoring program, which includes approval to construct and operate a lined evaporation pond and enhanced evaporation system as per HMC previous submittals of June 8 and 28, 1990.
8	7/20/1990	31 & 35 (revision)	<p><b>LC 31:</b> Deletion of requirement for proposed point of compliance requirement for brine evaporation pond (task completed).</p> <p><b>LC 35:</b> Modified point of compliance well locations for monitoring active tailings and inactive tailings piles as well as brine evaporation ponds as a single unit.</p>
9	10/31/1990	28 (revision)	HMC to submit an interim surety instrument acceptable to NRC in an amount of no less than \$20,000,000 in order to comply with 10 CFR Part 40 Appendix A, Criteria 9 and 10.
10	1/16/1991	35 (revision)	Addition of wells as points of compliance (M5, S5, S4); deleted portions of LC 35 pertaining to pond construction due to completion of pond construction).
11	4/01/1992	35E	Submittal of semi-annual groundwater monitoring report by February 28 of each year, replacing the previous requirement of submittals by January 31 of each year.

# Appendix B - Summary of License SUA-1471 Amendments

License Amendment	Approval Date	License Condition (LC) Amended	License Condition (LC) Changes
12	4/01/1992	4, 9, 10, 12, 28, 29 (revision)	<p>Amendments to place Grants Mill in a decommissioning status and incorporate requirements appropriate for that status:</p> <p><b>LC 4:</b> Termination date – until the NRC determines site reclamation is adequate.</p> <p><b>LC 9:</b> Authorized place of use. Applicable Amendment No. 12.</p> <p><b>LC 10:</b> Possession of residual uranium and byproduct material in the form of uranium waste tailings and other byproduct waste generated by licensee's past milling operations. Applicable Amendments 2, 6, 12.</p> <p><b>LC 12:</b> Delete requirement for minimum beach of 50 feet and minimum freeboard of 5 feet of centerline of dam crest (no longer applicable); add embankment inspection program be as specified in submittal dated 9/21/1987. Applicable Amendments of 2, 12.</p> <p><b>LC 28:</b> HMC shall maintain an NRC-approved financial surety arrangement consistent with 10 CFR 40, Criteria 9 and 10, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination if the mill and mill site, reclamation of tailings or waste disposal areas, groundwater restoration and the long-term surveillance fee.</p> <p><b>LC 29:</b> Deleted by Amendment 12.</p>
13	11/09/1992	36 (new)	<p>The amendment is administrative, incorporating reclamation milestones into the license in accordance with the Memorandum of Understanding between the EPA and the NRC. HMC shall complete site reclamation in accordance with an approved reclamation plan. The groundwater corrective action plan shall be conducted as authorized by LC 35.</p>
14	7/23/1993	12 (revision) 37 (new)	<p><b>LC 12:</b> Annual technical evaluation report of the LTP and STP shall be prepared under the direction of a register professional engineer experienced in dam design and construction. The evaluation shall include an inspection of the LTP and STP, a review and assessment of all associated monitoring data and inspection reports, and an overall judgment of the effectiveness of the inspection program. Report is to be submitted to the NRC within 1 month of completion of the report.</p> <p><b>LC 37:</b> HMC shall reclaim the LTP and STP as stated in previous HMC submittals. In addition, additional requirements were listed by the NRC as license conditions.</p>
15	8/25/1993	29	<p>Incorporation of an approved mill decommissioning plan into the license, as defined; plan requires a soil cleanup verification survey and sampling program as specified in the revised license condition.</p>

**Appendix B - Summary of License SUA-1471 Amendments**

<b>License Amendment</b>	<b>Approval Date</b>	<b>License Condition (LC) Amended</b>	<b>License Condition (LC) Changes</b>
16	9/23/1993	10 & 35 (revision)	<b>LC 10</b> and <b>LC 35</b> : License conditions amended to incorporate radiation safety and environmental monitoring programs which reflect the current status of the Grants Mill.
17	1/21/1994	19 (revision)	<b>LC 19</b> deleted by Amendment 17, which deleted requirements for implementation an evaluation of measures to minimize blowing of tailings during periods of tailings reclamation.
18	2/14/1994	38 (new)	Authorization to use of water collected as part of the groundwater corrective action program for conditioning soils to be used for interim cover or the radon barrier.
19	1/27/1995	39 (new)	HMC authorized to construct and operate a lined evaporation pond located between the existing evaporation pond (#1) and the existing brine ponds, in accordance with plans and commitments included in previous submittals and correspondence from HMC.
20	3/01/1995	29 (revision)	Approval of HMC's proposed revised soil cleanup verification and sampling plan; deletion of conditions A, B, and C that provided the previous soil cleanup program acceptable.
21	5/05/1995	11,14,20,25,27,30, 33, 35(A) and 35 (H) (revision)	Revisions to radiation monitoring program. Deletion of LC's 11, 20, 25, 27, 30, & 33. Revision to LC 14 (radiation monitoring requirements for contact with tailings pond and/or slimes). Partial revision to LC 35 (A) based on HMC submittal dated 1/09/1995. LC 35 (H) deleted – satisfied by HMC submittal dated 10/29/1993.
22	10/10/1995	36A(3), 37A(3) (revision)	<b>LC 36A(#)</b> : Revision to approve reduced radon barrier thickness for large tailings pile. <b>LC 37A(3)</b> : Revision to reflect wording change in 10 CFR 40 Appendix A, Criterion 6 = delete "above background."
23	1/30/1996	28 (revision)	New financial surety amount of \$23,688,432.
24	7/31/1996	10, 12 (revision)	Revisions to HMC's environmental and tailings pile monitoring requirements. <b>LC 10</b> : removal of requirements to perform vegetation and soil sampling. <b>LC 12</b> : The requirement for an annual Technical Evaluation Report by a register professional engineer deleted since stabilization of the LTP and STP embankments have been completed.
25	5/9/1997	36 (revision)	Approval and incorporation into the license conditions of HMC's extension of reclamation milestones.
26	5/21/1997	28	New financial surety amount of \$24,000,000.



**Appendix B - Summary of License SUA-1471 Amendments**

License Amendment	Approval Date	License Condition (LC) Amended	License Condition (LC) Changes
27	9/25/1997	13,18,21,23,31,32A,,37B & 39 (revision)	<p>LC 13: deleted (duplicate of LC 10)</p> <p>LC 18: deleted (superseded by LC 37 that references approved reclamation plan)</p> <p>LC 21: modified ("mill" replaced with "site").</p> <p>LC 23: modified (delete reference to operational/nonoperational procedures).</p> <p>LC 31: deleted (listed groundwater monitoring requirements for brine evaporation pond &amp; reclamation requirements stated in LC 35 and LC 37).</p> <p>LC 32A: deleted (mill buildings fully reclaimed).</p> <p>LC 37B: redesign of radon barrier design for small tailings pile (radon barrier thickness); housekeeping license condition changes.</p> <p>LC 39: modified (removal of requirements to notify NRC of changes to evaporation pond design and filling of pond no longer applicable since pond had been constructed and filled).</p>
28	10/3/1997	35 (revision)	Modification of groundwater corrective action plan and monitoring programs.
29	12/22/1997	9 (revision)	Deletion. Approval of HMC's request to remove the auxiliary (mine water) ion-exchange (IX) facility in McKinley County, New Mexico. IX facility has been reclaimed.
30	3/05/1998	35C (revision)	Installation of a water treatment plant using lime softening and a reverse osmosis (RO) membrane unit to treat extracted groundwater.
31	6/24/1998	14,15,35,& 39 (revision)	<p>License conditions revisions related to decontamination of equipment and personnel, reporting requirements and evaporation ponds.</p> <p>LC 14: Modification (release of equipment/packages from restricted areas in accordance with procedures attached to license).</p> <p>LC 15: Modification ( reporting of effluent and environmental monitoring in accordance with 10 CFR 40 Section 40.65)</p> <p>LC 35: Modifications (implement groundwater compliance monitoring program to assure performance of groundwater restoration program [separate requirement form LC 15]; implement corrective action program described in 9/15/1989 HMC submittal; operate Ponds #1 and # 2 and enhanced evaporation systems in each pond; submit annual performance review of corrective action program)</p> <p>LC 39: Deletion (obsolete – Pond #2 had been constructed).</p>

**Appendix B - Summary of License SUA-1471 Amendments**

License Amendment	Approval Date	License Condition (LC) Amended	License Condition (LC) Changes
32	1/28/1999	29, 37B, 37J, 37K (revision)	<p><b>LC 29:</b> deleted (mill commissioning complete and approved; borrow area locations have been documented and approved; and 90-day requirements for completion report submittal).</p> <p><b>LC 37 B:</b> modification (contaminated groundwater restoration materials and precipitated solids from evaporation ponds to be placed in small tailings pile (STP) and two evaporation ponds; STP and evaporation ponds to be recontoured and covered with radon barrier material as per HMC's final radon barrier design for the STP).</p> <p><b>LC 37J:</b> Modification (soil cleanup program associated with decommissioning of groundwater restoration facilities and STP reclamation shall be as HMC submittal of 9/15/1994 and modified by HMC submittal dated 12/13/1995).</p> <p><b>LC 37K:</b> Modification (revision of previous <b>LC 29E:</b> HMC to implement a Quality Control (QC) program for the soil cleanup verification program to include at least 10 percent of randomly selected samples to a third party lab for Ra-226 analysis and at least 30 percent of gamma spectroscopy samples to be chemically analyzed).</p>
33	9/28/2000	35 (revision)	Revised annual groundwater compliance monitoring program to assess performance of the groundwater restoration program as per LC 35 (Program separate from LC 15A).

**Appendix B - Summary of License SUA-1471 Amendments**

License Amendment	Approval Date	License Condition (LC) Amended	License Condition (LC) Changes
34	6/19/2002	12, 15, 28, 32, 35 (revision) 40, 41, 42, 43 (new)	<p><b>LC 12:</b> Revision (periodic embankment inspections be done by knowledgeable individuals; revision for annual embankment status report to be included in Annual Report [LC 42]).</p> <p><b>LC 15:</b> Revision (effluent and environmental monitoring reporting shall only include groundwater radionuclide data from point of compliance wells and background well P.)</p> <p><b>LC 28:</b> Revision (update of financial surety to \$35.2MM; revised language added to be more in alignment with the standard LC on surety requirements).</p> <p><b>LC 32:</b> revision (HMC shall follow guidance of NRC reg. guides 8.22, 8.30 and 8.31).</p> <p><b>LC 32B:</b> Addition (for any worker urine specimens exceeding 15 micrograms per liter, annual ALARA audit will indicate what corrective actions were considered or performed).</p> <p><b>LC 32C:</b> Deletion (deleted by Amendment 34).</p> <p><b>LC 35:</b> Deletion (deleting and replacing one reversal well (WK KF replaced by Well DZ).</p> <p><b>LC 40:</b> New (language identifying NRC address to receive all written notices and reports to NRC and NRC telephone number for required telephone notifications).</p> <p><b>LC 41:</b> New (language added to provide requirements and clarification on reporting spills, leaks, excursions and incidences using the approved standard LC language)</p> <p><b>LC 42:</b> New (language added to require an annual report to consolidate the required regular reporting and thus reduce the burden on the licensee, using the approved standard LC language).</p> <p><b>LC 43:</b> New (language requiring a cultural resources survey for any development activity in area(s) not previously assessment for cultural resources).</p>
35	10/29/2003	28	Updated financial surety of \$35,295,705 for 2003.
36	2/6/2004	36	Revision (approval of reclamation milestone extensions due to the implementation of the ground water corrective action program).
37	1/31/2005	28	Updated financial surety of \$33,421,971 for 2004.
38	5/13/2005	28	Updated financial surety of \$35,989,490 for 2005.
39	7/10/2006	35	Revision (revised existing groundwater protection standards (GWPSs) and establishing several GWPSs for alluvial aquifer).

**Appendix B - Summary of License SUA-1471 Amendments**

License Amendment	Approval Date	License Condition (LC) Amended	License Condition (LC) Changes
40	8/2/2006	28	Updated financial surety of \$55,481,560 for 2006.
41	8/7/2008	28, 35A & D, 43 (revision)	<p><b>LC 28:</b> Updated financial surety of \$52,394,847 for 2007.</p> <p><b>LC 35A:</b> Modification (additional monitor wells to be added for monitoring Evaporation Pond No. 3).</p> <p><b>LC 35D:</b> Modification (operation of Evaporation Pond No. 3 as well as Evaporation Pond Nos. 1 and 2; monitoring and mitigation measures for Evaporation Pond No. 3 added by reference to measures in HMC Environmental Report).</p> <p><b>LC 37B:</b> Modification (Evaporation Pond No. 3 added to requirements for all evaporation ponds).</p> <p><b>LC43:</b> Modification (additional cultural survey inventory requirements: notifications and actions to take in event cultural resource material is discovered during construction).</p>
42	3/15/2010	28	Updated 2009 financial surety of \$52,332,231 for decommissioning and reclamation costs.
43	2/28/2011	28	Updated 2010 financial surety of \$42,946,456 for decommissioning and reclamation costs.
44	12/20/2011	28	Updated 2011 financial surety of \$41,093,194 for decommissioning and reclamation costs.
45	9/27/2012	36.A(3), 36.B(1), 36.B(2)	<p><b>LC 30.A(3):</b> Complete site reclamation to control radon emissions (average flux of 20 pCi/m2/s):</p> <ul style="list-style-type: none"> <li>- Placement of final radon barrier on LTP – December 31, 2012</li> <li>- Placement of interim radon barrier on STP not cover by EP-1 prior to December 31, 2013</li> </ul> <p><b>LC 36.B(1):</b> Placement of erosion protection as part of reclamation with Criterion 6 of Appendix A of 10 CFR Part 40.</p> <ul style="list-style-type: none"> <li>- For LTP – September 30, 2013</li> <li>- For STP – December 31, 2013</li> </ul> <p><b>LC 36.B(2):</b> Projected completion of groundwater corrective actions to meet performance objectives specified in the groundwater CAP by December 31, 2011</p>



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**Appendix C**

SUA-1471 License Conditions

## MATERIALS LICENSE

Amendment No. 45

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and the applicable parts of Title 10, Code of Federal Regulations, Chapter I, Parts 19, 20, 30, 31, 32, 33, 34, 35, 36, 39, 40, 51, 70, and 71, and in reliance on statements and representations heretofore made by the licensee, a licensee is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

<b>Licensee</b>		3. License Number:	SUA-1471
1. Homestake Mining Company			
2. P.O. Box 98 Grants, New Mexico 87020		4. Expiration Date:	Until terminated
		5. Docket No.:	40-8903
6. Byproduct, Source, and/or Special Nuclear Material:	7. Chemical and/or Physical Form:	8. Maximum Amount that Licensee May Possess at Any One Time Under This License:	
Uranium	Any	Unlimited	

9. Authorized Place of Use: The licensee's uranium mill located in Cibola County, New Mexico.

[Applicable Amendments: 12, 29]

10. This license authorizes only the possession of residual uranium and byproduct material in the form of uranium waste tailings and other byproduct waste generated by the licensee's past milling operations in accordance with Tables 1 and 3 and the procedures submitted by letter dated September 2, 1993, as modified by letter dated March 7, 1996.

Anywhere the word "will" is used, it shall denote a requirement.

[Applicable Amendments: 2, 6, 12, 16, 24]

11. DELETED by Amendment No. 21.

12. Periodic embankment inspections of the large and small tailings embankment shall be conducted by knowledgeable individuals who are familiar with the site and the embankment design. An annual embankment status report shall be included in the Annual Report (see LC 42).

[Applicable Amendments: 2, 12, 14, 24, 34]

13. DELETED by Amendment No. 27.

14. Release of equipment or packages from the restricted area shall be in accordance with the attachment to SUA-1471 entitled, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials," dated September 1984.

[Applicable Amendments: 21, 31]



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15. The results of all effluent and environmental monitoring required by this license shall be reported to the NRC. For purposes of reporting requirements, only groundwater radionuclide data from the point of compliance wells and backgrounds well P shall be reported.
- [Applicable Amendments: 5, 31, 34]
16. Before engaging in any activity not previously assessed by the NRC, the licensee shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not previously assessed or that is greater than that previously assessed, the licensee shall provide a written evaluation of such activities and obtain prior approval of the NRC in the form of a license amendment.
17. Prior to termination of this license, the licensee shall provide for transfer of title to byproduct material and land, including any interests therein (other than land owned by the United States or the State of New Mexico), which is used for the disposal of such byproduct material or is essential to ensure the long-term stability of such disposal site, to the United States or the State of New Mexico, at the State's option.
18. DELETED by Amendment No. 27.
19. DELETED by Amendment No. 17.
20. DELETED by Amendment No. 21.
21. The site Radiation Protection Administrator (RPA), who is responsible for conducting the site radiation safety program, shall possess the minimum qualifications as specified in Section 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As is Reasonably Achievable."
- [Applicable Amendment: 27]
22. The results of sampling, analyses, surveys and monitoring; the results of calibration of equipment, reports on audits and inspections; all meetings and training courses required by this license and any subsequent reviews, investigations, and corrective actions, shall be documented. Unless otherwise specified in the NRC regulations, all such documentation shall be maintained for a period of at least 5 years.
23. Standard procedures shall be established for all activities involving radioactive materials that are handled, processed, or stored. Procedures shall enumerate pertinent radiation safety practices to be followed. Additionally, written procedures shall be established for environmental monitoring, bioassay analyses, and instrument calibrations. An up-to-date copy of each written procedure shall be kept in the area to which it applies.



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24. The licensee shall be required to use a Radiation Work Permit (RWP) for all work or nonroutine maintenance jobs where the potential for significant exposure to radioactive material exists and for which no standard written procedure already exists. The RWP shall be approved by the RPA or his designee, qualified by way of specialized radiation protection training, and shall at least describe the following:
- A. The scope of work to be performed.
  - B. Any precautions necessary to reduce exposure to uranium and its daughters.
  - C. The supplemental radiological monitoring and sampling necessary prior to, during, and following completion of the work.
25. DELETED by Amendment No. 21.
26. Mill tailings, other than small samples for purposes such as research or analysis, shall not be transferred from the site without specific prior approval of the NRC in the form of a license amendment. The licensee shall maintain a permanent record of all transfers made under the provisions of this condition.
27. DELETED by Amendment No. 21.
28. The licensee shall maintain an NRC-approved financial surety arrangement consistent with 10 CFR 40, Appendix A, Criteria 9 and 10, adequate to cover the estimated costs, if accomplished by a third party, for decommissioning and decontamination of the mill and mill site, reclamation of tailings or waste disposal areas, ground-water restoration, and the long-term surveillance fee. Within 3 months of NRC approval of a revised reclamation plan and its cost estimate, the licensee shall submit for NRC review and approval a proposed revision to the financial surety arrangement if estimated costs for the newly approved plan exceed the amount covered in the existing financial surety. The revised surety arrangement shall then be in effect within 30 days of written NRC approval of the surety documents.

Annual updates to the surety amount required by 10 CFR Part 40, Appendix A, Criteria 9, shall be submitted to the NRC at least 3 months prior to the anniversary date, which is designated as June 30 of each year. Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of costs and the basis for the cost estimate, adjustments for inflation, maintenance of a minimum 15 percent contingency, and reflecting any changes in engineering plans or any other conditions affecting estimated costs for site closure. Appendix C of NUREG-1620, Rev. 1, outlines the minimum considerations used by the NRC in the review of site closure cost estimates.

The licensee's currently approved surety, a Parent Company Guarantee issued by Barrick Gold Corporation, shall be continuously maintained in an amount no less than \$ 41,093,194 for the purpose of complying with 10 CFR 40, Criteria 9 and 10, until a replacement is authorized by the NRC. The use of a parent company guarantee necessitates an evaluation of the corporate parent as part of the annual surety



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update. In addition to the cost information required above, the annual submittal must include updated documentation of the (1) letter from the chief financial officer of the parent company; (2) auditor's special report confirmation of chief financial officer's letter; (3) schedule reconciling amounts in chief financial officer's letter to amounts in financial statements; and (4) parent company guarantee if any changes are appropriate.

[Applicable Amendments: 9, 12, 23, 24, 26, 34, 35, 37, 38, 40, 41, 42, 43, 44]

29. DELETED by Amendment No. 32.

30. DELETED by Amendment No. 21.

31. DELETED by Amendment No. 27.

32. The licensee shall follow the guidance set forth in U.S. Nuclear Regulatory Commission, Regulatory Guides 8.22, "Bioassay at Uranium Recovery Facilities," 8.30, "Health Physics Surveys in Uranium Recovery Facilities," and 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposure at Uranium Recovery Facilities will be As Low As is Reasonably Achievable (ALARA)," or NRC-approved equivalent.

A. DELETED by Amendment 27.

B. Any time uranium in a worker's urine specimen exceeds 15 micrograms per liter (ug/l), the annual ALARA audit will indicate what corrective actions were considered or performed.

C. DELETED by Amendment 34.

[Applicable Amendments: 2, 34]

33. DELETED by Amendment No. 21.

34. DELETED by Amendment No. 4.

35. The licensee shall implement a groundwater compliance monitoring program to assess the performance of the groundwater restoration program. This program is separate from the requirements in License Condition 15. The Licensee shall:

A. Implement the groundwater monitoring shown in Table 2 (8-99) submitted September 29, 1999, except that under "Reversal Wells," delete Well KF and replace with Well DZ, and except that well CW2 will remain in the sampling program monitoring annually for G list of parameters, and Cr is to be deleted from the D and F lists of parameters.



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Well DD and one additional monitoring well to the middle of the southeast side of EP3 (to be named later) is to be added to the Table list and will be monitored semi-annually for the B and F list of parameters. The additional well is to be installed and monitored quarterly for at least two quarters prior to EP3 becoming operational to determine background water quality for the well.

- B. The following ground water protection standards are established for each designated aquifer/zone as described in Ground-Water Hydrology for Support of Background Concentration at the Grants Reclamation Site (Hydro-Engineering, December 2001) and Background Water Quality Evaluation of the Chinle Aquifers (Homestake Mining Company and Hydro-Engineering, October 2003):

Constituents	Alluvial Aquifer	Chinle Mixing Zone	Upper Chinle Non-Mixing Zone	Middle Chinle Non-Mixing Zone	Lower Chinle Non-Mixing Zone
Selenium (mg/L)	0.32	0.14	0.06	0.07	0.32
Uranium (mg/L)	0.16	0.18	0.09	0.07	0.03
Molybdenum (mg/L)	0.1	0.1	0.1	0.1	0.1
Sulfate (mg/L)	1500	1750	914	857	2000
Chloride (mg/L)	250	250	412	250	634
TDS (mg/L)	2734	3140	2010	1560	4140
Nitrate (mg/L)	12	15	*	*	*
Vanadium (mg/L)	0.02	0.01	0.01	*	*
Thorium-230 (pCi/L)	0.3	*	*	*	*
Ra-226 + Ra-228	5	*	*	*	*

\* - ground-water protection standards not necessary for the constituents in the indicated zones

The constituents listed above for the alluvial aquifer must not exceed the specified concentration limit at compliance monitoring wells (former point of compliance wells) D1, X, and S4. At present, no compliance monitoring wells have been designated for the Chinle Mixing Zone or the Upper, Middle or Lower Chinle Non-Mixing Zones for the purpose of implementing the ground water protection standards listed above for these zones. The licensee shall propose compliance monitoring wells for the Chinle Mixing Zone and the Upper, Middle and Lower Chinle Non-Mixing Zones in a revised Corrective Action Plan to be submitted to the NRC no later than December 31, 2006. NRC will evaluate the proposed compliance monitoring wells and, if acceptable, will incorporate them into the license as compliance locations for the ground water protection standards listed above. NRC will notify the licensee and request new proposed compliance monitoring well locations from the licensee, if any of the well locations are determined to be unacceptable.



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- C. Implement the corrective action program described in the September 15, 1989 submittal, as modified by the reverse osmosis system described in the January 15, 1998 submittal with the objective of returning the concentrations of molybdenum, selenium, thorium-230, uranium, and vanadium to the site standards as listed in LC 35B. In addition, the reverse osmosis system will include the addition of Sample Point 2 downstream of the Mixing Tank. Composite samples from Sample Point 2 will be taken monthly and analyzed for U and Mo.
- D. Operate evaporation ponds, EP1, EP2 and EP3, and enhanced evaporation systems located in each pond as described in the June 8 and 28, 1990; July 26, August 16, August 19, September 2 and 15, 1994; October 25, 2006, February 7, 2007, July 18, 2007, and March 17, 2008, submittals. Monitoring and mitigation measures for EP3 contained in the HMC Environmental Report dated January 30, 2007, are incorporated into this LC by reference.
- E. Submit by March 31 of each year, a performance review of the corrective action program that details the progress towards attaining groundwater protection standards.

[Applicable Amendments: 3, 4, 5, 7, 8, 10, 11, 16, 21, 28, 30, 31, 33, 34, 39, 41]

36. The licensee shall complete site reclamation in accordance with an approved reclamation plan. The ground-water corrective action plan shall be conducted as authorized by License Condition No. 35. All activities shall be completed in accordance with the following schedules.
- A. To ensure timely compliance with target completion dates established in the Memorandum of Understanding with the Environmental Protection Agency (56 FR 55432, October 25, 1991), the licensee shall complete reclamation to control radon emissions as expeditiously as practicable, considering technological feasibility, in accordance with the following schedule:
- (1) Windblown tailings retrieval and placement on the pile:  
  
For the Large Impoundment - December 31, 1996.  
  
For the Small Impoundment - May 31, 1997.
  - (2) Placement of the interim cover to decrease the potential for tailings dispersal and erosion:  
  
For the Large Impoundment - December 31, 1996.  
  
For the Small Impoundment - May 31, 1997.
  - (3) Placement of final radon barrier designed and constructed to limit radon emissions to an average flux of no more than 20 pCi/m<sup>2</sup>/s.



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For the Large Impoundment which has no evaporation ponds – December 31, 2012.

For the Small Impoundment, tailings pile surface areas are essentially covered by evaporation ponds constructed as part of the ground-water corrective action program. Prior to December 31, 2013, the areas not covered by the evaporation ponds shall have interim cover in place. Final radon barrier placement over the entire pile shall be completed within 2 years of completion of ground-water corrective actions.

[Applicable Amendments: 25, 36, 41, 45]

- B. Reclamation, to ensure required longevity of the covered tailings and ground-water protection, shall be completed as expeditiously as is reasonably achievable, in accordance with the following target dates for completion:

- (1) Placement of erosion protection as part of reclamation to comply with Criterion 6 of Appendix A of 10 CFR Part 40:

For the Large Impoundment – September 30, 2013.

For the Small Impoundment – December 31, 2013.

[Applicable Amendments: 25, 36, 41, 45]

- (2) Projected completion of ground-water corrective actions to meet performance objectives specified in the ground-water corrective action plan – December 31, 2011.

- C. Any license amendment request to revise the completion dates specified in Section A must demonstrate that compliance was not technologically feasible (including inclement weather, litigation which compels delay to reclamation, or other factors beyond the control of the licensee).
- D. Any license amendment request to change the target dates in Section B above, must address added risk to the public health and safety and the environment, with due consideration to the economic costs involved and other factors justifying the request such as delays caused by inclement weather, regulatory delays, litigation, and other factors beyond the control of the licensee.
- E. As detailed in the licensee's October 28, 2003 submittal, the licensee is to verify compliance with the radon flux standard of 20 pCi/m<sup>2</sup>s by performing a radon flux survey for the large and small tailings piles on an annual basis during the milestone extension period specified above. An annual report detailing results of this survey shall be submitted with the annual groundwater CAP report as specified in condition 35E no later than March 31 each year.

[Applicable Amendments: 13, 22, 36]



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37. The licensee shall reclaim the large and small tailings impoundments as stated in its October 29, 1993, submittal, including the following requirements.

- A. The radon barrier for the large tailings pile shall be in accordance with material types, thicknesses and placement criteria described in Homestake Mining Company's *Final Radon Barrier Design for the Large Tailings Pile*, submitted June 16, 1995.

[Applicable Amendment: 22]

- B. The final reclamation of the area that includes the small tailings pile and the three evaporation ponds will include the disposal of the contaminated groundwater restoration materials and precipitated solids from the evaporation pond. The small tailings pile and evaporation ponds will be reconstructed and covered with radon barrier material. The placement of the barrier on the small tailings pile shall be done in accordance with the material types, thicknesses, and placement criteria described in Homestake Mining Company's *Final Radon Barrier Design for the Small Tailings Pile*, transmitted to the NRC in August 1996.

[Applicable Amendments: 27, 32, 41]

- C. The licensee shall submit a construction quality control program for NRC review and approval prior to placing any portion of the radon barrier that will ensure that the specification which limits the activity of the radon barrier material to 5 pCi/g above background, is not exceeded.
- D. The construction quality assurance and control program shall be as defined in the Staff Technical Position On Testing and Inspection (NRC, 1989). The acceptable correlation between ASTM D 2922 and ASTM D 1556 shall be as defined in the licensee's April 30, 1992, submittal.
- E. OMITTED in Amendment No. 14.
- F. The radon barrier shall not be placed on the top surface of the large tailings impoundment until the settlement has been demonstrated to be at least 90 percent of expected settlement, and the results of this determination have been reviewed and accepted by the NRC. The radon barrier may be placed on the large impoundment side slopes following final grading of the impoundment. Care shall be taken to preclude the possibility of ponding. Before the erosion protection is placed, it shall be verified that the radon barrier material meets the specifications.
- G. The adequacy of the erosion protection proposed for the side slopes of both the large and small impoundments shall be reevaluated considering any increases in impoundment heights due to the revised radon attenuation cover design.
- H. DELETED by Amendment No. 21.



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I. A completion report shall be provided within 6 months of the completion of construction. This report, including as-built drawings, shall verify that reclamation of the site has been performed according to the approved plan. The report shall also include summaries of results of the quality assurance and control testing to demonstrate that approved specifications were met.

J. The soil cleanup program associated with the decommissioning of the groundwater restoration facilities and small tailings pile reclamation shall be done as specified in the submittal of September 15, 1994, and as modified by the submittal of December 13, 1995.

[Applicable Amendment: 32]

K. The licensee shall implement a quality control (QC) program for the soil cleanup verification program to include sending at least 10 percent of the samples (randomly selected) to a vendor laboratory for Ra-226 analysis. If the vendor laboratory uses gamma spectroscopy, at least 30 percent of these QC samples shall also be chemically analyzed.

[Applicable Amendments: 14, 32]

38. The licensee is authorized to use water collected as part of the site ground-water corrective action program for conditioning soils during placement of the interim cover or the radon barrier on the tailings impoundments. The licensee shall also analyze samples of the collection water being used for this purpose for radium-226 and 228 content semiannually. If sample results exceed 30 pCi/l combined radium, the licensee shall perform an evaluation of the potential impacts of using this water on the required design of the radon barrier and submit the evaluation for NRC review within 30 days of receipt of sample results.

[Applicable Amendment: 18]

39. DELETED by Amendment No. 31.

40. All written notices and reports to NRC required under this license shall be addressed: Attn: Document Control Desk, c/o Deputy Director, Decommissioning and Uranium Recovery Licensing Directorate (Mailstop T8-F5), Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, U. S. Nuclear Regulatory Commission, 11545 Rockville Pike, Two White Flint North, Rockville, MD 20852-2738.

Required telephone notification shall be made to the NRC Operations Center at (301) 816-5100, unless otherwise specified in license conditions.

[Applicable Amendment: 34, 41]



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## 41. Spills, Leaks, Excursions, and Incident/Event Reporting

Until license termination, the licensee shall maintain documentation on unplanned release of source or 11e.(2) byproduct materials and process chemicals. Documented information shall include, but not be limited to: date, volume, total activity of each radionuclide released, radiological survey results, soil sample results (if taken), corrective actions, results of post remediation surveys (if taken), and a map showing the spill location and the impacted area. The licensee shall have procedures which will evaluate the consequences of the spill or incident/event against 10 CFR 20, Subpart "M," and 10 CFR 40.60 reporting criteria. If the criteria are met, then report to the NRC Operations Center as required.

If the licensee is required to report any spills, leaks, or excursions of source, 11e.(2) byproduct material and process chemicals that may have an impact on the environment, or any other incidents/events to State or Federal Agencies, a report shall be made to the NRC Region IV Nuclear Materials Licensing Branch Chief and NRC Headquarters Project Manager (PM) by telephone or electronic mail (e-mail) within 48 hours of the event. This notification shall be followed, within thirty (30) days of the notification, by submittal of a written report to NRC Region IV and NRC Headquarters, detailing the conditions leading to the spill or incident/event, corrective actions taken, and results achieved.

[Applicable Amendment: 34]

42. An annual report will be submitted to the NRC that includes the ALARA audit report, land use survey, monitoring data, corrective action program report, and the effluent and environmental monitoring reports.

[Applicable Amendment: 34]

43. Before engaging in any developmental activity not previously assessed by the NRC, the licensee shall administer a cultural resource inventory. All disturbances associated with the proposed development will be completed in compliance with the National Historic Preservation Act (as amended) and its implementing regulations (36 CFR 800), and the Archaeological Resources Protection Act (as amended) and its implementing regulations (43 CFR 7).

In order to ensure that no unapproved disturbance of cultural resources occurs, any work resulting in the discovery of previously unknown cultural artifacts shall cease. The artifacts shall be inventoried and evaluated in accordance with 36 CFR Part 800, and no disturbance of the area shall occur until the licensee has received authorization from the NRC to proceed.



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In the event that bones or prehistoric or historic archaeological materials are uncovered during construction or earth-disturbing activities, cease work immediately and protect the remains from further disturbance. If bones are found, immediately notify local law enforcement and the Office of the Medical Investigator pursuant to 18-6-11.2C (Cultural Properties Act NMSA 1978).

In accordance with 18-6-11.2C and/or 36 CFR 800.13(b) (Protection of Historic Properties), notify the State Historic Preservation Officer (SHPO) or the State Archaeologist, immediately.

In either case, the Agency and the SHPO, in consultation with an archaeologist who holds state unmarked human burial excavation and survey permits, will determine the necessary steps to evaluate significance, document, protect or remove the material or remains, in compliance with law. Call the SHPO or State Archaeologist at (505) 827-6320.

[Applicable Amendment: 34, 41]

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Dated: 09/27/2012

/RA/

Andrew Persinko, Deputy Director  
Decommissioning and Uranium Recovery  
Licensing Directorate  
Division of Waste Management  
and Environmental Protection  
Office of Federal and State Materials  
and Environmental Management Programs







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**Appendix D**

Memorandum of Understanding  
between Region 6, US EPA and  
Region IV, US NRC for Remedial  
Action at the Homestake Mining  
Company Uranium Mill in Cibola  
County, NM



## **APPENDIX D**

### **MEMORANDUM OF UNDERSTANDING BETWEEN REGION 6 OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY AND REGION IV OF THE U.S. NUCLEAR REGULATORY COMMISSION FOR REMEDIAL ACTION AT THE HOMESTAKE MINING COMPANY URANIUM MILL IN CIBOLA COUNTY, NM**

**SUMMARY:** On December 14, 1993, the NRC and the EPA signed an MOU delineating agency responsibilities in regulating activities at the Homestake Mining Company's Grants Uranium Mill. The NRC has regulated activities at the site since June 1, 1986, under a source and byproduct material license issued in accordance with title 10 of the Code of Federal Regulations, part 40. Prior to June 1, 1986, activities at the site were regulated under a license issued by the State of New Mexico in accordance with its status as an NRC agreement state. During the period of State regulatory authority, the Homestake site was placed on the EPA's Superfund National Priorities List at the request of the State.

#### **I. Purpose**

This document establishes the roles, responsibilities, and relationships between Region 6 of the U.S. Environmental Protection Agency (EPA) and Region IV of the U.S. Nuclear Regulatory Commission (NRC), hereinafter collectively referred to as the "Parties," regarding remedial action at the Homestake Mining Company (HMC) uranium mill in Cibola County, New Mexico. The Parties have overlapping authority in connection with this site and, consistent with the purposes of the March 16, 1992, interagency Memorandum of Understanding between EPA and NRC entitled "Guiding Principles for EPA/NRC Cooperation and Decision Making," this Memorandum of Understanding (MOU) will help assure that remedial actions occur in a timely and effective manner.

#### **II. Basis for Agreement**

NRC will assume the role of lead regulatory agency for the byproduct material disposal area reclamation and closure activities and EPA will monitor all such activities and provide review comments directly to NRC. The objective of EPA's review and comment will be to assure that activities to be conducted under NRC's regulatory authority will allow attainment of applicable or relevant and appropriate requirements under the Comprehensive Environmental Response Compensation and Liability Act of 1980, as amended ("CERCLA"). 42 U.S.C. 9601 et seq., outside of the byproduct material disposal site. NRC will require the Licensee to implement an approved disposal site reclamation plan which meets the requirements of 10 CFR part 40, Appendix A, as amended at 52 FR 43553 through 43568 (November 1987), "Uranium Mill Tailings Regulations; Ground Water Protection and other Issues," which conforms with EPA 40 CFR part 192, subpart D. EPA and NRC agree that the requirements of 10 CFR part 40, Appendix A, are the Federal environmental and public health requirements applicable or relevant and appropriate to the disposal site. EPA and NRC believe that conformance with 10 CFR part 40, Appendix A, will generally assure conformance with CERCLA requirements. However, each party will be responsible for assuring compliance with its specific regulatory requirements as discussed in this section. The parties believe that the U.S. Department of Energy or another responsible State or Federal authority will assume responsibility for long-term care of the byproduct material disposal site following remediation of the site.

#### **III. Background**

The State of New Mexico was responsible as an "Agreement State" for licensing and regulating uranium mills within the State until June 1, 1986, at which time, NRC reassumed this authority at the request of the Governor of New Mexico. Prior to this change, EPA had placed the HMC site on the National Priority List (NPL) of sites for response action under CERCLA. EPA's policy is to list only those uranium mills meeting criteria for placement on the NPL which are located in Agreement States, i.e., States which have entered into agreements with NRC pursuant to section 274 of the Atomic Energy Act of 1954, as amended, to regulate certain nuclear activities in a manner compatible with NRC's program. Mills in States where NRC has direct licensing authority have not been placed on

the list. Although New Mexico is no longer an Agreement State insofar as uranium recovery operations are concerned and NRC has reassumed primary jurisdiction, the site was properly placed on the NPL and the physical conditions resulting in that placement are still present. After completion of the closure of the disposal area and other remedial measures undertaken in full compliance with 10 CFR part 40, Appendix A (the applicable Federal standards for disposal site reclamation), EPA, pursuant to 40 CFR parts 425(e) and 515(c)(3) and in consultation with the State of New Mexico, shall determine whether all required response actions with respect to the site have been implemented. Following such a determination, the site may be considered for deletion for the NPL.

#### **IV. Agreement**

In order to achieve satisfactory cleanup of the HMC site, NRC and EPA agree to do the following:

1. The Parties shall cooperate with each other in the oversight of reclamation and remedial activity at the HMC site.
2. EPA will review the amendments to the site reclamation plan ("the plan") and will provide comments to NRC. NRC will review and, if necessary, require revisions to the plan to assure conformance to 10 CFR part 40, Appendix A, as amended, prior to approving the plan via license amendments. NRC will provide EPA with copies of all license amendments which affect the site closure plan prior to issuance for comment. If no comments are received within 30 calendar days, NRC will issue the amendment.
3. If EPA determines that remedial actions are deficient or unsatisfactory, then EPA shall provide notice to NRC of the deficiency. NRC shall assume the lead role for notification to HMC, except for such notification as EPA might statutorily be required to provide in certain events. The notification shall specify a time period within which regulatory compliance is expected to be achieved. Should compliance not be achieved in this time period, EPA will assume the lead for taking or seeking any enforcement action within its area of regulatory responsibility and NRC will assume the lead for any enforcement actions necessary within its area of regulatory responsibility. Both Parties reserve all rights under this MOU to take whatever actions are determined to be necessary, including the conduct of remedial actions within and outside the disposal area, in order to fulfill their regulatory requirements. In any event, no actions affecting site remediation will be taken by either Party without prior consultation with the other Party.
4. Both Parties shall appoint a facility coordinator who shall be responsible for oversight of the implementation of this MOU and the activities required herein. The facility coordinators shall be appointed by each Party within seven (7) days of the effective date of this MOU. Each Party has the right to appoint a new facility coordinator at any time. Such a change shall be accomplished by notifying the other Party, in writing, at least five (5) days prior to the appointment, of the name, telephone number, and mailing address of said facility coordinator.
5. The Parties will meet periodically at the request of either Party and at least semiannually insofar as it is necessary to accomplish the objectives of this MOU. The facility coordinators should communicate with each other on a routine basis by telephone.
6. The Parties will provide technical advice and any necessary regulatory consultation to one another upon request.
7. The Parties will generally provide each other with copies of all official correspondence and documents related to remedial actions at the site. The Parties will also normally provide copies of other information upon request. In the event that one of the Parties does not wish to furnish certain specific information, documents, or correspondence to the other, then said material shall be identified to the other Party along with the reasons for withholding it.
8. Whenever notice or information is required to be forwarded by one party to another under the terms of this MOU, it shall be given by and directed to the individuals at the addresses specified as follows:

EPA: Director, Hazardous Waste Management Division (6H), U.S. EPA,  
Region 6, 1445 Ross Avenue, suite 1200, Dallas, Texas 75202-2733.  
NRC: Director, Uranium Recovery Field Office, Region IV, U.S.  
Nuclear Regulatory Commission, P.O. Box 25325, Denver, Colorado  
80225.

9. Routine communications may be exchanged verbally, in person, or by telephone between the Parties to facilitate the orderly conduct of work contemplated by this MOU.
10. EPA enforcement documentation provided under this MOU will be kept as exempt material by EPA and NRC, to the extent legally possible, according to the policies and procedures under 40 CFR part 2 and 10 CFR part 2.790, respectively.
11. The Parties shall notify each other of any pending visits to the HMC property which relate to the site closure plan. To the extent that they are otherwise authorized to do so, either Party and their consultants may, at their option, accompany the other Party on such visits.

## **V. Agency Responsibilities**

### **A. NRC Responsibilities**

1. NRC will ensure that the owners/operators of the HMC uranium mill implement an approved reclamation plan that meets all relevant NRC requirements, including 10 CFR part 40, Appendix A, as amended. The reclamation plan will require HMC to assure long-term stability of the tailings, reduce gamma radiation to background levels, and diminish radon exhalation to appropriate regulatory standards. If any part of such plan is not complied with by HMC, NRC will take whatever actions it deems appropriate to ensure compliance.
2. NRC will ensure that the owners/operators of the HMC uranium mill implement a compliance monitoring program for hazardous constituents that meet all relevant NRC requirements, including 10 CFR part 40, Appendix A, for the establishment of ground water protection standards and points of compliance. NRC will verify implementation by HMC of any required compliance monitoring and/or ground water corrective action at the HMC uranium mill site resulting from the establishment of ground water protection standards as soon as such is reviewed and accepted by NRC. If any ground water requirements are not complied with by HMC, NRC will take appropriate action to ensure compliance.
3. NRC will direct HMC to provide both Parties with copies of major work product submittals as they become available. Such work products will include a reclamation plan and any other plans and specifications for assessment, remediation, and monitoring, including all analytical data.
4. NRC agrees to provide EPA with progress reports on HMC's remediation, semiannually.
5. NRC will assist in the development of information to support EPA's deletion of the site from the NPL upon completion of the remedial action, if appropriate.

### **B. EPA Responsibilities**

1. EPA will provide formalized review, consultation, and comment throughout the entire project.
2. EPA will review and provide comments on the various components of the reclamation plan, groundwater monitoring, and corrective action submittals, and other related documentation, within timeframes as agreed to between NRC and EPA. In the event that EPA determines that the implementation of the site reclamation plan, closure activities, and/or groundwater corrective action has not resulted in, or may not result in, cleanup conditions that meet applicable or relevant and appropriate requirements under CERCLA, then EPA may take whatever action it deems appropriate.

## **VI. Dispute Resolution**

In the event of a dispute between EPA and NRC concerning site activities, the persons designated by each Agency as facility coordinators, or in their absence, alternate contact points will attempt to promptly resolve such disputes. If disputes cannot be resolved at this level, the problem will be referred to the supervisors of these persons for further consultation. The supervisory referral and resolution process will continue, if necessary to resolve the dispute, to the level of the Regional Administrators of NRC and EPA. Both Parties shall continue to maintain their respective rights or responsibilities under this MOU during the dispute resolution process.

## **VII. Execution and Termination**

This agreement shall take effect upon execution by EPA and the NRC. It shall remain in effect for the duration of the program addressed herein unless terminated by mutual agreement by the two Agencies; or this MOU may be terminated unilaterally if any of the conditions set forth below are present:

1. The planning or conduct of reclamation plan, closure activities, and/or groundwater cleanup actions fail to meet standards set forth in the Basis for Agreement (Section II) of this MOU.
2. The site is deleted from the NPL.
3. The site is turned over to the Department of Energy or other responsible State or Federal authority for long-term care.
4. Regulatory, statutory, or other events occur which make this MOU unnecessary, illegal, or otherwise inappropriate.

## **VIII. Modification**

The Parties may modify this MOU from time to time in order to simplify and/or define the procedures contained herein. Each Party shall keep the other informed of any relevant proposed modifications to its basic statutory or regulatory authority, forms, procedures, or priorities. This MOU shall be revised, as necessary, by the adoption of such modifications. The MOU should be reviewed on an annual basis by both the Director, Uranium Recovery Field Office, Region IV, NRC, and the Director, Hazardous Waste Management Division, Region 6, EPA, or their designated representatives.

## **IX. Reservation of Rights**

The Parties reserve any and all rights or authority that they may have, including but not limited to legal, equitable, or administrative rights. This specifically includes EPA's and NRC's authority to conduct, direct, oversee, and/or require environmental response in connection with the site, as well as the authority to enter the site and require the production of information, within each of their own areas of responsibility.

## **X. Severability**

The nullification of any one or more sections or provisions of a section of this MOU, either by Agreement of the Parties or by Administrative or Judicial Action, shall not affect the other sections/provisions of this MOU.



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**Appendix E**

RESRAD Modeling



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Dose Conversion Factor (and Related) Parameter Summary

Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1( 1)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1( 2)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1( 3)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1( 4)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1( 5)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1( 6)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1( 7)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1( 8)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1( 9)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1( 10)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1( 11)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2( 1)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2( 2)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3( 1)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3( 2)
D-34	Food transfer factors:			
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF( 1,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF( 1,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF( 1,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF( 2,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF( 2,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF( 2,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC( 1,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC( 1,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC( 2,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC( 2,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETEG table in Ground Pathway of Detailed Report.

\*Base Case means Default.Lib w/o Associate Nuclide contributions.



Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICKO
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T( 2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T( 3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T( 4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T( 5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T( 6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T( 7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T( 8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T( 9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	5.000E+00	0.000E+00	---	S1(2)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1( 2)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVERO
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	2.700E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.700E-01	2.000E-01	---	RI
R013	Irrigation mode	ditch	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC( 2)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU( 2,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS( 2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.538E-02	ALEACH( 2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK( 2)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC( 1)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU( 1,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS( 1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.078E-02	ALEACH( 1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK( 1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE( 1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE( 2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE( 3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE( 4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE( 5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE( 6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE( 7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE( 8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE( 9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA( 1)
R017	Ring 2	not used	2.732E-01	---	FRACA( 2)
R017	Ring 3	not used	0.000E+00	---	FRACA( 3)
R017	Ring 4	not used	0.000E+00	---	FRACA( 4)
R017	Ring 5	not used	0.000E+00	---	FRACA( 5)
R017	Ring 6	not used	0.000E+00	---	FRACA( 6)
R017	Ring 7	not used	0.000E+00	---	FRACA( 7)
R017	Ring 8	not used	0.000E+00	---	FRACA( 8)
R017	Ring 9	not used	0.000E+00	---	FRACA( 9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFIS
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWIS
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

1RESRAD, Version 6.5      T½ Limit = 180 days      01/14/2013 12:20 Page 8  
 Summary : HMC Benchmark Dose Radium-226 (residential)  
 File : X:\PROJECT\_DATA\HMC\REVISION OF RECLAMATIONN PLAN\HMCBMDR.RAD

Contaminated Zone Dimensions

Area: 10000.00 square meters  
 Thickness: 0.15 meters  
 Cover Depth: 0.00 meters

Initial Soil Concentrations, pCi/g

Ra-226 5.000E+00

0  
 Total Dose TDOSE(t), mrem/yr  
 Basic Radiation Dose Limit = 2.500E+01 mrem/yr  
 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	3.192E+01	3.155E+01	3.077E+01	2.798E+01	2.022E+01	4.130E+00	0.000E+00	0.000E+00
M(t):	1.277E+00	1.262E+00	1.231E+00	1.119E+00	8.089E-01	1.652E-01	0.000E+00	0.000E+00

0Maximum TDOSE(t): 3.192E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)  
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years  
Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.737E+01	0.8573	2.832E-03	0.0001	0.000E+00	0.0000	3.886E+00	0.1217	2.069E-01	0.0065	2.658E-01	0.0083	1.939E-01	0.0061
Total	2.737E+01	0.8573	2.832E-03	0.0001	0.000E+00	0.0000	3.886E+00	0.1217	2.069E-01	0.0065	2.658E-01	0.0083	1.939E-01	0.0061

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)  
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years  
Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.192E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.192E+01	1.0000

0\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.688E+01	0.8521	2.986E-03	0.0001	0.000E+00	0.0000	3.957E+00	0.1254	2.192E-01	0.0069	2.687E-01	0.0085	2.187E-01	0.0069
Total	2.688E+01	0.8521	2.986E-03	0.0001	0.000E+00	0.0000	3.957E+00	0.1254	2.192E-01	0.0069	2.687E-01	0.0085	2.187E-01	0.0069

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.155E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.155E+01	1.0000

0\*Sum of all water independent and dependent pathways.



Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)  
 As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years  
 Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.593E+01	0.8426	3.254E-03	0.0001	0.000E+00	0.0000	4.067E+00	0.1321	2.398E-01	0.0078	2.728E-01	0.0089	2.627E-01	0.0085
Total	2.593E+01	0.8426	3.254E-03	0.0001	0.000E+00	0.0000	4.067E+00	0.1321	2.398E-01	0.0078	2.728E-01	0.0089	2.627E-01	0.0085

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)  
 As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years  
 Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.077E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.077E+01	1.0000

0\*Sum of all water independent and dependent pathways.

IRESRAD, Version 6.5      T½ Limit = 180 days      01/14/2013 12:20 Page 12  
 Summary : HMC Benchmark Dose Radium-226 (residential)  
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	2.283E+01	0.8159	3.835E-03	0.0001	0.000E+00	0.0000	4.222E+00	0.1509	2.850E-01	0.0102	2.751E-01	0.0098	3.664E-01	0.0131
Total	2.283E+01	0.8159	3.835E-03	0.0001	0.000E+00	0.0000	4.222E+00	0.1509	2.850E-01	0.0102	2.751E-01	0.0098	3.664E-01	0.0131

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.798E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.798E+01	1.0000

0\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.571E+01	0.7768	3.740E-03	0.0002	0.000E+00	0.0000	3.594E+00	0.1777	2.801E-01	0.0139	2.256E-01	0.0112	4.093E-01	0.0202
Total	1.571E+01	0.7768	3.740E-03	0.0002	0.000E+00	0.0000	3.594E+00	0.1777	2.801E-01	0.0139	2.256E-01	0.0112	4.093E-01	0.0202

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.022E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.022E+01	1.0000

0\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	3.295E+00	0.7977	7.380E-04	0.0002	0.000E+00	0.0000	6.531E-01	0.1581	5.556E-02	0.0135	3.996E-02	0.0097	8.635E-02	0.0209
Total	3.295E+00	0.7977	7.380E-04	0.0002	0.000E+00	0.0000	6.531E-01	0.1581	5.556E-02	0.0135	3.996E-02	0.0097	8.635E-02	0.0209

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.130E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.130E+00	1.0000

0\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0\*Sum of all water independent and dependent pathways.

Summary : HMC Benchmark Dose Radium-226 (residential)

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

\*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways										
Parent and Progeny Principal Radionuclide Contributions Indicated										
0 Parent	Product	Parent and Progeny Thread	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g)							
(i)	(j)	Fraction	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226+D	Ra-226+D	1.000E+00	6.359E+00	6.242E+00	6.013E+00	5.271E+00	3.581E+00	7.187E-01	0.000E+00	0.000E+00
Ra-226+D	Pb-210+D	1.000E+00	2.515E-02	6.712E-02	1.413E-01	3.254E-01	4.632E-01	1.074E-01	0.000E+00	0.000E+00
Ra-226+D	ΣDSR(j)		6.385E+00	6.309E+00	6.155E+00	5.597E+00	4.044E+00	8.261E-01	0.000E+00	0.000E+00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g								
Basic Radiation Dose Limit = 2.500E+01 mrem/yr								
0 Nuclide	t =	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02
(i)								1.000E+03
Ra-226		3.916E+00	3.962E+00	4.062E+00	4.467E+00	6.181E+00	3.026E+01	*9.885E+11
								*9.885E+11

\*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)						
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g						
at tmin = time of minimum single radionuclide soil guideline						
and at tmax = time of maximum total dose = 0.000E+00 years						
0 Nuclide	Initial	tmin	DSR(i,tmin)	G(i,tmin)	DSR(i,tmax)	G(i,tmax)
(i)	(pCi/g)	(years)		(pCi/g)		(pCi/g)
Ra-226	5.000E+00	0.000E+00	6.385E+00	3.916E+00	6.385E+00	3.916E+00



Individual Nuclide Dose Summed Over All Pathways											
Parent Nuclide and Branch Fraction Indicated											
ONuclide	Parent	THF(i)	DOSE(j,t), mrem/yr								
(j)	(i)		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00		3.180E+01	3.121E+01	3.007E+01	2.636E+01	1.791E+01	3.593E+00	0.000E+00	0.000E+00
OPb-210	Ra-226	1.000E+00		1.258E-01	3.356E-01	7.065E-01	1.627E+00	2.316E+00	5.371E-01	0.000E+00	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration											
Parent Nuclide and Branch Fraction Indicated											
ONuclide	Parent	THF(i)	S(j,t), pCi/g								
(j)	(i)		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00		5.000E+00	4.922E+00	4.768E+00	4.269E+00	3.111E+00	1.028E+00	4.347E-02	6.755E-07
OPb-210	Ra-226	1.000E+00		0.000E+00	1.510E-01	4.277E-01	1.168E+00	2.013E+00	1.136E+00	5.186E-02	8.062E-07

THF(i) is the thread fraction of the parent nuclide.

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Dose Conversion Factor (and Related) Parameter Summary  
 Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-227 (Source: FGR 12)	4.951E-04	4.951E-04	DCF1 ( 1)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1 ( 2)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1 ( 3)
A-1	Bi-211 (Source: FGR 12)	2.559E-01	2.559E-01	DCF1 ( 4)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1 ( 5)
A-1	Fr-223 (Source: FGR 12)	1.980E-01	1.980E-01	DCF1 ( 6)
A-1	Pa-231 (Source: FGR 12)	1.906E-01	1.906E-01	DCF1 ( 7)
A-1	Pa-234 (Source: FGR 12)	1.155E+01	1.155E+01	DCF1 ( 8)
A-1	Pa-234m (Source: FGR 12)	8.967E-02	8.967E-02	DCF1 ( 9)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1 (10)
A-1	Pb-211 (Source: FGR 12)	3.064E-01	3.064E-01	DCF1 (11)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1 (12)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1 (13)
A-1	Po-211 (Source: FGR 12)	4.764E-02	4.764E-02	DCF1 (14)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1 (15)
A-1	Po-215 (Source: FGR 12)	1.016E-03	1.016E-03	DCF1 (16)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1 (17)
A-1	Ra-223 (Source: FGR 12)	6.034E-01	6.034E-01	DCF1 (18)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1 (19)
A-1	Rn-219 (Source: FGR 12)	3.083E-01	3.083E-01	DCF1 (20)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1 (21)
A-1	Th-227 (Source: FGR 12)	5.212E-01	5.212E-01	DCF1 (22)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1 (23)
A-1	Th-231 (Source: FGR 12)	3.643E-02	3.643E-02	DCF1 (24)
A-1	Th-234 (Source: FGR 12)	2.410E-02	2.410E-02	DCF1 (25)
A-1	Tl-207 (Source: FGR 12)	1.980E-02	1.980E-02	DCF1 (26)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1 (27)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1 (28)
A-1	U-235 (Source: FGR 12)	7.211E-01	7.211E-01	DCF1 (29)
A-1	U-238 (Source: FGR 12)	1.031E-04	1.031E-04	DCF1 (30)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.724E+00	6.700E+00	DCF2 ( 1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2 ( 2)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2 ( 3)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2 ( 4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2 ( 5)
B-1	U-234	1.320E-01	1.320E-01	DCF2 ( 6)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2 ( 7)
B-1	U-238	1.180E-01	1.180E-01	DCF2 ( 8)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2 ( 9)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.410E-02	DCF3 ( 1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3 ( 2)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3 ( 3)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3 ( 4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3 ( 5)
D-1	U-234	2.830E-04	2.830E-04	DCF3 ( 6)

Dose Conversion Factor (and Related) Parameter Summary (continued)  
 Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-1	U-235+D	2.673E-04	2.660E-04	DCF3( 7)
D-1	U-238	2.550E-04	2.550E-04	DCF3( 8)
D-1	U-238+D	2.687E-04	2.550E-04	DCF3( 9)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF( 1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF( 1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF( 1,3)
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF( 2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF( 2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF( 2,3)
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF( 3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF( 3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF( 3,3)
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF( 4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF( 4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF( 4,3)
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF( 5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF( 5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF( 5,3)
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF( 6,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF( 6,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF( 6,3)
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF( 7,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF( 7,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF( 7,3)
D-34	U-238 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF( 8,1)
D-34	U-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF( 8,2)
D-34	U-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF( 8,3)
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF( 9,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF( 9,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF( 9,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC( 1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC( 1,2)
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC( 2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC( 2,2)
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC( 3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC( 3,2)

Dose Conversion Factor (and Related) Parameter Summary (continued)  
 Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC( 4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC( 4,2)
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC( 5,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC( 5,2)
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC( 6,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC( 6,2)
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC( 7,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC( 7,2)
D-5	U-238 , fish	1.000E+01	1.000E+01	BIOFAC( 8,1)
D-5	U-238 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC( 8,2)
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC( 9,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC( 9,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.

\*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T ( 2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T ( 3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T ( 4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T ( 5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T ( 6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T ( 7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T ( 8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T ( 9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): U-234	4.890E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	2.200E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	4.890E+01	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1( 6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1( 7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1( 8)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	2.700E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.700E-01	2.000E-01	---	RI
R013	Irrigation mode	ditch	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H (1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ (1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ (1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ (1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ (1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ (1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ (1)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC ( 6)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU ( 6,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS ( 6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.151E-02	ALEACH ( 6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC ( 7)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU ( 7,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS ( 7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.151E-02	ALEACH ( 7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC ( 8)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU ( 8,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS ( 8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.151E-02	ALEACH ( 8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 8)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC ( 1)
R016	Unsat. zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU ( 1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS ( 1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.346E-02	ALEACH ( 1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC ( 2)
R016	Unsat. zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU ( 2,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS ( 2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.151E-02	ALEACH ( 2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 2)

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by IRESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC ( 3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU ( 3,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS ( 3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.078E-02	ALEACH ( 3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 3)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC ( 4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU ( 4,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS ( 4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.538E-02	ALEACH ( 4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 4)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC ( 5)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU ( 5,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS ( 5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.800E-05	ALEACH ( 5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK ( 5)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE ( 1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE ( 2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE ( 3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE ( 4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE ( 5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE ( 6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE ( 7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE ( 8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE ( 9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE (10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE (11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE (12)



Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA ( 1)
R017	Ring 2	not used	2.732E-01	---	FRACA ( 2)
R017	Ring 3	not used	0.000E+00	---	FRACA ( 3)
R017	Ring 4	not used	0.000E+00	---	FRACA ( 4)
R017	Ring 5	not used	0.000E+00	---	FRACA ( 5)
R017	Ring 6	not used	0.000E+00	---	FRACA ( 6)
R017	Ring 7	not used	0.000E+00	---	FRACA ( 7)
R017	Ring 8	not used	0.000E+00	---	FRACA ( 8)
R017	Ring 9	not used	0.000E+00	---	FRACA ( 9)
R017	Ring 10	not used	0.000E+00	---	FRACA (10)
R017	Ring 11	not used	0.000E+00	---	FRACA (11)
R017	Ring 12	not used	0.000E+00	---	FRACA (12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET (1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET (2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET (3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET (4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET (5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET (6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV (1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV (2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV (3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE (1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE (2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE (3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

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 Summary : HMC Benchmark Dose Radium-226 (residential)  
 File : C:\RESRAD\_FAMILY\RESRAD\6.5\USERFILES\HMCBMDRU.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	U-234	4.890E+01
Thickness:	0.15 meters	U-235	2.200E+00
Cover Depth:	0.00 meters	U-238	4.890E+01

0

Total Dose TDOSE(t), mrem/yr  
 Basic Radiation Dose Limit = 2.500E+01 mrem/yr  
 Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

---

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	7.860E+00	7.666E+00	7.292E+00	6.117E+00	3.669E+00	4.873E-01	1.854E-06	7.147E+00
M(t):	3.144E-01	3.066E-01	2.917E-01	2.447E-01	1.468E-01	1.949E-02	7.415E-08	2.859E-01

OMaximum TDOSE(t): 7.860E+00 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	1.127E-02	0.0014	4.073E-01	0.0518	0.000E+00	0.0000	4.965E-01	0.0632	7.737E-02	0.0098	1.971E-01	0.0251	3.735E-01	0.0475
U-235	9.252E-01	0.1177	1.708E-02	0.0022	0.000E+00	0.0000	2.114E-02	0.0027	3.309E-03	0.0004	8.376E-03	0.0011	1.588E-02	0.0020
U-238	3.855E+00	0.4904	3.642E-01	0.0463	0.000E+00	0.0000	4.714E-01	0.0600	7.347E-02	0.0093	1.871E-01	0.0238	3.547E-01	0.0451
Total	4.791E+00	0.6096	7.886E-01	0.1003	0.000E+00	0.0000	9.891E-01	0.1258	1.542E-01	0.0196	3.926E-01	0.0499	7.441E-01	0.0947

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.563E+00	0.1989
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.910E-01	0.1261
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.306E+00	0.6750
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.860E+00	1.0000

\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	1.103E-02	0.0014	3.960E-01	0.0517	0.000E+00	0.0000	4.828E-01	0.0630	7.524E-02	0.0098	1.916E-01	0.0250	3.632E-01	0.0474
U-235	9.048E-01	0.1180	1.661E-02	0.0022	0.000E+00	0.0000	2.062E-02	0.0027	3.263E-03	0.0004	8.143E-03	0.0011	1.545E-02	0.0020
U-238	3.767E+00	0.4914	3.541E-01	0.0462	0.000E+00	0.0000	4.584E-01	0.0598	7.144E-02	0.0093	1.819E-01	0.0237	3.448E-01	0.0450
Total	4.683E+00	0.6108	7.667E-01	0.1000	0.000E+00	0.0000	9.618E-01	0.1255	1.499E-01	0.0196	3.817E-01	0.0498	7.234E-01	0.0944

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.520E+00	0.1982
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.689E-01	0.1264
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.178E+00	0.6754
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.666E+00	1.0000

\*Sum of all water independent and dependent pathways.



Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

		Water Independent Pathways (Inhalation excludes radon)													
0		Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
0	Radio-														
	Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
	U-234	1.057E-02	0.0014	3.742E-01	0.0513	0.000E+00	0.0000	4.562E-01	0.0626	7.110E-02	0.0098	1.811E-01	0.0248	3.432E-01	0.0471
	U-235	8.653E-01	0.1187	1.570E-02	0.0022	0.000E+00	0.0000	1.962E-02	0.0027	3.171E-03	0.0004	7.696E-03	0.0011	1.463E-02	0.0020
	U-238	3.597E+00	0.4932	3.346E-01	0.0459	0.000E+00	0.0000	4.332E-01	0.0594	6.751E-02	0.0093	1.719E-01	0.0236	3.258E-01	0.0447
	Total	4.473E+00	0.6133	7.245E-01	0.0994	0.000E+00	0.0000	9.090E-01	0.1246	1.418E-01	0.0194	3.607E-01	0.0495	6.837E-01	0.0938

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

		Water Dependent Pathways													
Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*		
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.436E+00	0.1970	
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.261E-01	0.1270	
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.930E+00	0.6760	
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.292E+00	1.0000	

0\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	9.127E-03	0.0015	3.066E-01	0.0501	0.000E+00	0.0000	3.737E-01	0.0611	5.824E-02	0.0095	1.483E-01	0.0242	2.811E-01	0.0460
U-235	7.397E-01	0.1209	1.290E-02	0.0021	0.000E+00	0.0000	1.647E-02	0.0027	2.846E-03	0.0005	6.304E-03	0.0010	1.207E-02	0.0020
U-238	3.057E+00	0.4998	2.741E-01	0.0448	0.000E+00	0.0000	3.548E-01	0.0580	5.530E-02	0.0090	1.408E-01	0.0230	2.669E-01	0.0436
Total	3.806E+00	0.6223	5.935E-01	0.0970	0.000E+00	0.0000	7.450E-01	0.1218	1.164E-01	0.0190	2.954E-01	0.0483	5.601E-01	0.0916

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.177E+00	0.1924
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.903E-01	0.1292
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.149E+00	0.6784
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.117E+00	1.0000

0\*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Water Independent Pathways (Inhalation excludes radon)														
Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	6.176E-03	0.0017	1.709E-01	0.0466	0.000E+00	0.0000	2.083E-01	0.0568	3.246E-02	0.0088	8.262E-02	0.0225	1.567E-01	0.0427
U-235	4.692E-01	0.1279	7.277E-03	0.0020	0.000E+00	0.0000	9.840E-03	0.0027	1.982E-03	0.0005	3.514E-03	0.0010	6.892E-03	0.0019
U-238	1.905E+00	0.5192	1.527E-01	0.0416	0.000E+00	0.0000	1.977E-01	0.0539	3.081E-02	0.0084	7.846E-02	0.0214	1.487E-01	0.0405
Total	2.381E+00	0.6488	3.309E-01	0.0902	0.000E+00	0.0000	4.158E-01	0.1133	6.525E-02	0.0178	1.646E-01	0.0449	3.123E-01	0.0851

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

AS mrem/yr and Fraction of Total Dose Received from Each Pathway														
Water Dependent Pathways														
	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.571E-01	0.1791
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.987E-01	0.1359
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.514E+00	0.6850
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.669E+00	1.0000

0\*Sum of all water independent and dependent pathways.

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 Summary : HMC Benchmark Dose Radium-226 (residential)  
 File : C:\RESRAD\_FAMILY\RESRAD\6.5\USERFILES\HMCBMDRU.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	2.113E-03	0.0043	1.581E-02	0.0324	0.000E+00	0.0000	1.932E-02	0.0396	2.999E-03	0.0062	7.599E-03	0.0156	1.449E-02	0.0297
U-235	7.638E-02	0.1567	7.045E-04	0.0014	0.000E+00	0.0000	1.127E-03	0.0023	3.099E-04	0.0006	3.235E-04	0.0007	6.934E-04	0.0014
U-238	2.896E-01	0.5942	1.403E-02	0.0288	0.000E+00	0.0000	1.818E-02	0.0373	2.834E-03	0.0058	7.211E-03	0.0148	1.367E-02	0.0280
Total	3.681E-01	0.7552	3.055E-02	0.0627	0.000E+00	0.0000	3.862E-02	0.0792	6.142E-03	0.0126	1.513E-02	0.0311	2.885E-02	0.0592

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.233E-02	0.1279
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.954E-02	0.1632
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.455E-01	0.7089
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.873E-01	1.0000

\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)

As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	1.679E-06	0.9055	0.000E+00	0.0000	0.000E+00	0.0000	1.738E-07	0.0937	4.414E-10	0.0002	8.863E-10	0.0005	1.854E-06	1.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.679E-06	0.9055	0.000E+00	0.0000	0.000E+00	0.0000	1.738E-07	0.0937	4.414E-10	0.0002	8.863E-10	0.0005	1.854E-06	1.0000

0\*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)  
 As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years  
 Water Independent Pathways (Inhalation excludes radon)

Radio- Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)  
 As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years  
 Water Dependent Pathways

Radio- Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
U-234	2.961E+00	0.4142	0.000E+00	0.0000	0.000E+00	0.0000	3.075E-01	0.0430	1.353E-02	0.0019	4.718E-02	0.0066	3.329E+00	0.4657
U-235	5.805E-01	0.0812	0.000E+00	0.0000	0.000E+00	0.0000	6.029E-02	0.0084	7.666E-03	0.0011	2.205E-03	0.0003	6.507E-01	0.0910
U-238	2.818E+00	0.3942	0.000E+00	0.0000	0.000E+00	0.0000	2.926E-01	0.0409	1.281E-02	0.0018	4.493E-02	0.0063	3.168E+00	0.4432
Total	6.359E+00	0.8897	0.000E+00	0.0000	0.000E+00	0.0000	6.603E-01	0.0924	3.401E-02	0.0048	9.432E-02	0.0132	7.147E+00	1.0000

0\*Sum of all water independent and dependent pathways.



Dose/Source Ratios Summed Over All Pathways											
Parent and Progeny Principal Radionuclide Contributions Indicated											
0	Parent (i)	Product (j)	Parent Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g)							
				0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
	U-234	U-234	1.000E+00	3.196E-02	3.108E-02	2.937E-02	2.407E-02	1.342E-02	1.245E-03	0.000E+00	6.783E-02
	U-234	Th-230	1.000E+00	2.068E-07	6.031E-07	1.354E-06	3.588E-06	7.325E-06	5.674E-06	0.000E+00	1.978E-07
	U-234	Ra-226+D	1.000E+00	4.065E-09	2.831E-08	1.458E-07	1.175E-06	7.266E-06	2.214E-05	0.000E+00	5.612E-05
	U-234	Pb-210+D	1.000E+00	9.235E-12	1.203E-10	1.240E-09	2.612E-08	3.693E-07	1.661E-06	0.000E+00	1.823E-04
	U-234	ΣDSR(j)		3.196E-02	3.108E-02	2.937E-02	2.407E-02	1.344E-02	1.275E-03	0.000E+00	6.807E-02
OU-235+D	U-235+D	U-235+D	1.000E+00	4.504E-01	4.403E-01	4.208E-01	3.587E-01	2.257E-01	3.578E-02	0.000E+00	6.427E-02
	U-235+D	Pa-231	1.000E+00	2.963E-05	9.024E-05	2.021E-04	5.009E-04	8.161E-04	2.539E-04	0.000E+00	5.559E-02
	U-235+D	Ac-227+D	1.000E+00	3.088E-07	1.937E-06	9.031E-06	5.762E-05	2.021E-04	1.227E-04	8.426E-07	1.759E-01
	U-235+D	ΣDSR(j)		4.504E-01	4.404E-01	4.210E-01	3.592E-01	2.267E-01	3.615E-02	8.426E-07	2.958E-01
OU-238	U-238	U-238	5.400E-05	1.544E-06	1.501E-06	1.419E-06	1.162E-06	6.478E-07	5.975E-08	0.000E+00	3.310E-06
OU-238+D	U-238+D	U-238+D	9.999E-01	1.085E-01	1.059E-01	1.008E-01	8.485E-02	5.140E-02	7.065E-03	0.000E+00	6.459E-02
	U-238+D	U-234	9.999E-01	4.510E-08	1.319E-07	2.912E-07	7.162E-07	1.161E-06	3.548E-07	0.000E+00	1.927E-04
	U-238+D	Th-230	9.999E-01	1.973E-13	1.331E-12	6.695E-12	5.148E-11	2.824E-10	5.378E-10	0.000E+00	5.080E-10
	U-238+D	Ra-226+D	9.999E-01	2.860E-15	4.268E-14	4.840E-13	1.139E-11	1.950E-10	1.634E-09	0.000E+00	1.134E-07
	U-238+D	Pb-210+D	9.999E-01	5.449E-18	1.456E-16	3.196E-15	1.955E-13	7.871E-12	1.068E-10	0.000E+00	3.628E-07
	U-238+D	ΣDSR(j)		1.085E-01	1.059E-01	1.008E-01	8.485E-02	5.140E-02	7.065E-03	0.000E+00	6.478E-02

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g  
 Basic Radiation Dose Limit = 2.500E+01 mrem/yr

0	ONuclide (i)	t = 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
	U-234	7.821E+02	8.044E+02	8.511E+02	1.039E+03	1.860E+03	1.961E+04	*6.247E+09	3.673E+02
	U-235	5.550E+01	5.677E+01	5.939E+01	6.959E+01	1.103E+02	6.915E+02	*2.161E+06	8.453E+01
	U-238	2.304E+02	2.361E+02	2.480E+02	2.946E+02	4.864E+02	3.539E+03	*3.361E+05	3.859E+02

\*At specific activity limit

0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)  
 and Single Radionuclide Soil Guidelines G(i,t) in pCi/g  
 at tmin = time of minimum single radionuclide soil guideline  
 and at tmax = time of maximum total dose = 0.000E+00 years

0	ONuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
	U-234	4.890E+01	1.000E+03	6.807E-02	3.673E+02	3.196E-02	7.821E+02
	U-235	2.200E+00	0.000E+00	4.504E-01	5.550E+01	4.504E-01	5.550E+01
	U-238	4.890E+01	0.000E+00	1.085E-01	2.304E+02	1.085E-01	2.304E+02

Individual Nuclide Dose Summed Over All Pathways										
Parent Nuclide and Branch Fraction Indicated										
ONuclide	Parent	THF(i)	DOSE(j,t), mrem/yr							
(j)	(i)		t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	1.563E+00	1.520E+00	1.436E+00	1.177E+00	6.564E-01	6.089E-02	0.000E+00	3.317E+00
U-234	U-238	9.999E-01	2.205E-06	6.452E-06	1.424E-05	3.502E-05	5.675E-05	1.735E-05	0.000E+00	9.421E-03
U-234	ΣDOSE(j)		1.563E+00	1.520E+00	1.436E+00	1.177E+00	6.565E-01	6.090E-02	0.000E+00	3.327E+00
OTh-230	U-234	1.000E+00	1.011E-05	2.949E-05	6.619E-05	1.754E-04	3.582E-04	2.775E-04	0.000E+00	9.675E-06
Th-230	U-238	9.999E-01	9.649E-12	6.508E-11	3.274E-10	2.517E-09	1.381E-08	2.630E-08	0.000E+00	2.484E-08
Th-230	ΣDOSE(j)		1.011E-05	2.949E-05	6.619E-05	1.754E-04	3.582E-04	2.775E-04	0.000E+00	9.699E-06
ORa-226	U-234	1.000E+00	1.988E-07	1.384E-06	7.130E-06	5.745E-05	3.553E-04	1.083E-03	0.000E+00	2.744E-03
Ra-226	U-238	9.999E-01	1.399E-13	2.087E-12	2.367E-11	5.569E-10	9.534E-09	7.991E-08	0.000E+00	5.545E-06
Ra-226	ΣDOSE(j)		1.988E-07	1.384E-06	7.130E-06	5.745E-05	3.553E-04	1.083E-03	0.000E+00	2.750E-03
OPb-210	U-234	1.000E+00	4.516E-10	5.885E-09	6.063E-08	1.277E-06	1.806E-05	8.122E-05	0.000E+00	8.914E-03
Pb-210	U-238	9.999E-01	2.665E-16	7.118E-15	1.563E-13	9.559E-12	3.849E-10	5.224E-09	0.000E+00	1.774E-05
Pb-210	ΣDOSE(j)		4.516E-10	5.885E-09	6.063E-08	1.277E-06	1.806E-05	8.122E-05	0.000E+00	8.932E-03
OU-235	U-235	1.000E+00	9.909E-01	9.687E-01	9.257E-01	7.891E-01	4.965E-01	7.871E-02	0.000E+00	1.414E-01
OPa-231	U-235	1.000E+00	6.519E-05	1.985E-04	4.445E-04	1.102E-03	1.796E-03	5.587E-04	0.000E+00	1.223E-01
OAc-227	U-235	1.000E+00	6.793E-07	4.261E-06	1.987E-05	1.268E-04	4.447E-04	2.699E-04	1.854E-06	3.870E-01
OU-238	U-238	5.400E-05	7.551E-05	7.341E-05	6.938E-05	5.683E-05	3.168E-05	2.922E-06	0.000E+00	1.619E-04
U-238	U-238	9.999E-01	5.306E+00	5.177E+00	4.930E+00	4.149E+00	2.513E+00	3.455E-01	0.000E+00	3.158E+00
U-238	ΣDOSE(j)		5.306E+00	5.177E+00	4.930E+00	4.149E+00	2.514E+00	3.455E-01	0.000E+00	3.159E+00

THF(i) is the thread fraction of the parent nuclide.

1RESRAD, Version 6.5 T½ Limit = 180 days 01/15/2013 11:11 Page 22  
 Summary : HMC Benchmark Dose Radium-226 (residential)  
 File : C:\RESRAD\_FAMILY\RESRAD\6.5\USERFILES\HMCBMDRU.RAD

Individual Nuclide Soil Concentration Parent Nuclide and Branch Fraction Indicated										
ONuclide	Parent	THF(i)	S(j,t), pCi/g							
(j)	(i)		t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
U-234	U-234	1.000E+00	4.890E+01	4.786E+01	4.584E+01	3.943E+01	2.564E+01	5.687E+00	7.693E-02	2.214E-08
U-234	U-238	9.999E-01	0.000E+00	1.357E-04	3.899E-04	1.118E-03	2.181E-03	1.612E-03	6.545E-05	6.286E-11
U-234	ΣS(j):		4.890E+01	4.786E+01	4.584E+01	3.943E+01	2.565E+01	5.689E+00	7.699E-02	2.221E-08
Th-230	U-234	1.000E+00	0.000E+00	4.355E-04	1.279E-03	3.960E-03	9.726E-03	1.805E-02	2.029E-02	1.994E-02
Th-230	U-238	9.999E-01	0.000E+00	6.150E-10	5.379E-09	5.412E-08	3.694E-07	1.706E-06	2.649E-06	2.631E-06
Th-230	ΣS(j):		0.000E+00	4.355E-04	1.279E-03	3.960E-03	9.726E-03	1.805E-02	2.029E-02	1.994E-02
ORa-226	U-234	1.000E+00	0.000E+00	9.417E-08	8.268E-07	8.427E-06	5.962E-05	3.058E-04	5.415E-04	5.471E-04
Ra-226	U-238	9.999E-01	0.000E+00	8.878E-14	2.328E-12	7.783E-11	1.576E-09	2.249E-08	6.801E-08	7.218E-08
Ra-226	ΣS(j):		0.000E+00	9.417E-08	8.268E-07	8.427E-06	5.962E-05	3.059E-04	5.416E-04	5.471E-04
OPb-210	U-234	1.000E+00	0.000E+00	9.686E-10	2.514E-08	8.122E-07	1.502E-05	1.690E-04	3.960E-04	4.065E-04
Pb-210	U-238	9.999E-01	0.000E+00	6.862E-16	5.339E-14	5.732E-12	3.140E-10	1.082E-08	4.873E-08	5.363E-08
Pb-210	ΣS(j):		0.000E+00	9.686E-10	2.514E-08	8.122E-07	1.502E-05	1.690E-04	3.960E-04	4.065E-04
OU-235	U-235	1.000E+00	2.200E+00	2.153E+00	2.063E+00	1.774E+00	1.154E+00	2.559E-01	3.464E-03	9.990E-10
OPa-231	U-235	1.000E+00	0.000E+00	4.556E-05	1.309E-04	3.753E-04	7.322E-04	5.410E-04	2.192E-05	2.092E-11
OAc-227	U-235	1.000E+00	0.000E+00	7.100E-07	5.871E-06	4.884E-05	2.027E-04	2.278E-04	1.037E-05	1.028E-11
OU-238	U-238	5.400E-05	2.641E-03	2.584E-03	2.476E-03	2.129E-03	1.385E-03	3.072E-04	4.158E-06	1.199E-12
U-238	U-238	9.999E-01	4.890E+01	4.786E+01	4.584E+01	3.943E+01	2.564E+01	5.689E+00	7.699E-02	2.220E-08
U-238	ΣS(j):		4.890E+01	4.786E+01	4.584E+01	3.943E+01	2.565E+01	5.689E+00	7.699E-02	2.221E-08

THF(i) is the thread fraction of the parent nuclide.  
 ORESALC.EXE execution time = 2.19 seconds



ARCADIS

**Appendix F**

Specifications for Reclamation  
Activities 1993 - 1995

## **Appendix F**

### **Specifications for Reclamation Activities 1993 – 1995**

#### **B Series Technical Specifications**

Appendix B of the 1993 HMC reclamation plan contained eight technical specifications which identified the work that was to be completed as per the applicable specification. These specifications were used for the demolition and reclamation work that was conducted primarily from 1993 – 1995.

#### **Technical Specification 4,150 Series**

These specifications were based on the B Series specifications, placing the content of these later specifications into a bid/construct format to be used for the actual contracting work. Copies of the specifications for the main decommissioning and reclamation activities at the Grants site to-date are included in this appendix. Referenced drawings in the specifications are not included in this appendix, but are available at the Grants site.

Once groundwater restoration activities advance to the completion stage, and surface support facilities are no longer required, current technical specifications in this Appendix will be reviewed and updated as needed to meet site conditions and regulatory requirements at that time. As necessary, new specifications will be developed for any identified tasks that would not be applicable for inclusion in the updated technical specifications.

**NOTE:** Referenced drawings in the Specifications are not included in this document. These drawings are maintained at the Grants site.

**Technical Specification "B" Series  
(1993 HMC Reclamation Plan)**

**No.    Title**

B5      Settlement Monitoring

The following specifications were replaced by more detailed Technical Specification 4,500 Series that were provided to Contractors as part of their contractual requirements.

B1      Mill Demolition  
B2      Mill Area Cover Placement  
B3      Tailing Impoundment Recontouring  
B4      Tailing Impoundment Soil Cover  
B6      Erosion Protection – Rock Materials and Placement  
B7      Diversion Levee  
B8      Site Grading



**TECHNCIAL SPECIFICATION # B5**

**SPECIFICATION  
FOR  
SETTLEMENT MONITORING**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

Revision 1

January 1, 1991

Prepared by:  
AK GEOCONSULT, INC.

## SETTLEMENT MONITORING

### A. RESPONSIBILITIES

Work under this specification to be performed by Homestake.

Quality control testing/inspection by Homestake.

### B. PERFORMANCE STANDARDS

1. Not fewer than 50 settlement monitoring points shall be established on the top surface of the large impoundment at locations shown on Figure 6 of the Reclamation Plan.
2. The monitoring points shall be constructed with materials and dimensions shown on Figure 8 of the Reclamation Plan. Other materials may be substituted if they have equivalent properties, as approved by Homestake.
3. The steel baseplate of each monitoring point shall be placed between two and four feet below the final recontoured tailings surface. The plates may be installed and the construction of the monitoring points completed either immediately after the final recontoured tailing surface has been established or when recontouring fill placement has reached the elevations designated for each steel plate. If constructed according to the latter approach, the tailing fill placed above and around the monitoring point riser and guard pipe shall be hand compacted using hand tampers or hand-guided mechanical compactors. All materials excavated for settlement point construction shall be placed in their original depths and stratigraphic order and compacted to original placement density.
4. The initial construction of each monitoring point shall include:
  - a. welding of a threaded coupling to the steel plate;
  - b. connection of one or more riser sections with appropriate couplings between sections;
  - c. Installation of a protective PVC guard pipe over the riser pipe, with grease placed in the annulus between the PVC pipe and the riser;
  - d. placement of the monitor point at its designated location and elevation; and
  - e. backfill of soil above and around the monitor point plate and riser, with the bottom of the PVC guard pipe raised to not more than 18 inches above the elevation of the steel plate.
5. Immediately following installation of each monitor point, it shall be surveyed to determine x, y and z coordinates to a precision of 0.1, 0.1 and 0.1 feet, respectively, and an accuracy of 0.05 feet or better. At least three control points shall be used for these and subsequent surveys. The control points shall be permanently located and protected at positions on the ground surface that will be unaffected by construction on the impoundment surfaces.
6. Subsequent readings shall be made to determine the elevation of each point. The initial subsequent reading shall be made within two weeks of installation and successive readings after that shall be made biweekly to monthly for six months or to the end of primary consolidation, whichever comes first, as determined by engineering analysis of settlement data. Elevation surveys of each point shall be made at least quarterly until analysis of time-rate of settlement indicates that future settlement will not significantly affect the impoundment cover. The settlement analysis will be performed by the responsible engineer.

7. The engineering analysis of settlement data shall consist of the recording and plotting of the changes in elevation vs. time for each settlement point and the plotting, comparison, and projection of cumulative elevation changes (settlements) of all settlement monitoring points.

#### **C. TESTING AND INSPECTION**

1. Homestake's Resident Manager or his designated representative shall inspect each point after it is assembled and when it is installed prior to backfilling or fill placement around the monitoring point.
2. Each point shall be visually inspected at least weekly during construction activity on the Impoundment top surface to determine if any point has been damaged or displaced by construction activity.

#### **D. DOCUMENTATION AND REPORTING**

1. The initial x, y and z coordinates of each monitor point shall be surveyed and recorded on both a computer data base and written table. Subsequent changes in elevation shall be monitored on the schedule described in Section B above and added to the computer and written records.
2. Settlements shall be evaluated quarterly by HMC or its engineer and shall be reported at least annually to the NRC.

#### **E. NONCOMPLIANCES, CORRECTIVE ACTIONS, AND STOP-WORK ORDERS**

1. Nonconformances will be identified or verified by the Homestake task manager (TM) designated by the Resident Manager (RM), who will direct the contractor to stop work or take specific corrective action. The TM or RM will consult with the appropriate technical consultant as needed to identify the importance of the nonconformance and the necessary corrective action.
2. The designated corrective action will be implemented by the contractor before additional related work is permitted. The TM will verify the corrective action by appropriate measurements, tests, or other permanent documentation.
3. Stop-work orders may be issued by the TM for any nonconformance that, in the TM's judgment, may jeopardize subsequent work that depends for its quality on the nonconforming work.

#### **F. RECORDS**

1. A daily project journal will be maintained by each TM. It will document the work accomplished, contract quantities for measurement and payment, nonconformances, corrective actions, stop-work orders, and conditions affecting the work. The daily journal will become part of the permanent reclamation and contract records.
2. The RM will maintain a permanent record file of all testing, measurements, and other records of the work performed under the specification.

# **Technical Specification 4,500 Series** **1992 – 1995**

<u>No.</u>	<u>Title</u>	
4152-S1	Recontouring of the Large Tailing Impoundment	June 24, 1992
4152-S2	Toe Drainage System of the Large Tailing Impoundment	June 6, 1992
4152-S3	Excavation and Disposal of Contaminated Soil	January 11, 1994
4152-S3A	Excavation and Disposal of Contaminated Soil for Public Roadways	January 29, 1994
4152-S4	Construction of Radon Barrier and Interim Soil Covers on the Tailing Impoundments	January 10, 1994
4152-S4A	First Phase Cover Construction on the Large Tailing Impoundment	January 27, 1994
4152-S4B	Construction of Radon Barrier on the Large Tailing Impoundment	June 9, 1995 (revised)
4152-S4C	Construction of Interim Soil Cover on the Small Tailing Impoundment	January 29, 1994
4152-S5	Construction of Soil Cover over Mill Area and Disposal Pits	September 198, 1995 (revised)
4152-S6	Construction of Rock Covers and Other Erosion Protection on the Large Tailing Impoundment	February 1, 1994
4152-S7	Site Regrading and Revegetation	January 2, 1994
4152-S8	Construction of Diversion Levee	April 9, 1994
4153-S1	Demolition of Uranium Mill Facilities	February 8, 1993

**SPECIFICATION  
FOR  
RECONTOURING OF THE LARGE TAILING IMPOUNDMENT**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S1**

**Revision 0**

**January 1, 1993**

**Prepared by:  
AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will recontour (reshape) the large tailing impoundment at its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. The large impoundment (see Drawing 4152-1), hereinafter referred to as the "Pile", contains 20-22 million tons of uranium mill tailings, covers approximately 170 acres, and is 85-100 feet high. The Pile is roughly rectangular in shape. The top is divided into two cells, an east pond area of approximately 55 acres and a west pond area of approximately 40 acres. The pond areas are surrounded by embankments of sand tailings that are about 20-40 feet higher than the lowest points in the enclosed pond basins. The existing outslopes of the Pile have gradients of approximately 2.5H:1V to 3.5H:1V. The work to be performed includes redistribution of tailings and tailing-contaminated soil, by soil excavation and fill methods, to reshape the Pile to the forms and gradients depicted in Drawings 4152-2 through 4152-5.

The Pile was operated as the tailing disposal facility for the Grants mill from 1958 to 1990. Since early 1990 no additional tailings have been placed on the Pile. During most of the Pile operation period the Pile was built out using the centerline construction method, starting from an earthfill dike. The tailings were slurried and pumped from the mill to the top of the Pile, where they were split by a cyclone separator into a coarse stream and a fine stream. The coarse stream consisted of mostly fine sand with 4-40% minus #200 sieve fraction (USCS soil classification of SP to SM). It was poured along the embankment crest and outslopes to build the containment dike for the fine split, which was discharged across the beach toward the center of the pond, and the ponded decant liquid. The resulting sedimentation caused progressively finer particles to be deposited from the top of the beach to the center of the ponds, resulting in lateral transition from SP and SM materials near the embankment crest to ML/MH and CL/CH Fines ("Slimes") in the ponds. This relative position of coarser to finer materials appears to be generally consistent in both pond areas. However, the distribution of these materials varies both laterally and vertically so that in some locations layers or lenses of finer materials (Slimes) exist where coarser materials might be expected. The total depth of Slimes could exceed 65 feet.

Both pond basins of the Pile contained standing water as of 6/4/92. Some water is expected to be liberated from the tailings in response to disturbances and loads induced by the earthwork. Water from the ponds and the underlying saturated tailings moves through the Pile and exits as seepage from both the Pile bottom and the outslope toes of the Pile. The toe seepage will be intercepted by a toe drainage system, illustrated on Drawing 4152-7, installed before the lower outslopes are recontoured.

### **1.2 Technical Definitions**

**Compactors, heavy:** Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

**Compactors, light:** Vibrating or tamping compactors weighing less than 5000 lbs. and controlled by a walk-behind operator.

**Contaminated soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) containment.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials including mill tailings.

**Earthwork control grid:** Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

**Fines:** Mineral particles (soil or tailings) passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

**Foreign material:** Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

**Job site:** The location of the large tailing Pile as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

**Native soil, natural soil:** Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

**Pile:** The large tailing impoundment.

**Planarity:** The degree to which a surface approaches a flat (but not necessarily horizontal) surface.

**Sand:** Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

**Slimes:** Tailings containing more than 50% silt and clay sizes (minus #200 sieve) classified as CL, CH, ML, or MH soil. Moisture content is variable but typically at saturation levels.

**Small tailing impoundment, small tailing Pile:** The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

**Soil classification:** Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines.

SM - silty sand; 12-50% silt fines, >50% sand.

SC - clayey sand; 12-50% clay fines, >50% sand.

SP-SM - sand with 5-12% silty fines.

ML - more than 50% Fines that classify as silt, according to reference b, and liquid limit less than 50.

MH - same as ML except liquid limit 50 or more.

CL - more than 50% Fines that classify as clay, according to reference b, and liquid limit less than 50%.

CH - same as CL except liquid limit 50 or more.

**Tailings:** Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).



### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-1b (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.

### 1.4 List of Construction Drawings

The following drawings are incorporated into this specification by reference:

4152-0	Title and Index Sheet
4152-1	Site Map, Large Tailing Impoundment
4152-2	Recontour Plan, Large Tailing Impoundment
4152-3	Cross Sections 1 - 17, Large Tailing Impoundment
4152-4	Cross Sections A - G, Large Tailing Impoundment
4152-5	Cross Sections at Corners, Large Tailing Impoundment
4152-6	Settlement Point Details, Large Tailing Impoundment
4152-7	Plan of the Toe Drainage System, Large Tailing Impoundment (included for information only - installation by others)
4152-8	Details of the Toe Drainage System, Large Tailing Impoundment

### 1.5 Included Work

The activities required for recontouring (reshaping) the Pile will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Removal of foreign material and plugging of structures on Pile: Plugging of subsurface portions of decant towers, demolition of decant tower superstructures and walkways, and removal of existing settlement monitor points. The Contractor shall take whatever measures are necessary to avoid damaging or disturbing existing piezometers at locations shown on Drawing 4752-1.
- Excavation: Excavation of tailings and tailing- contaminated soil where existing impoundment or fill surfaces are above design grades or where excavation exposes Slimes or saturated Fines below design grade. Areas of excavation include the Pile crests and upper portions of outslopes, the divider dike between the two ponds, and berms of contaminated soil around the perimeter of the Pile outslope toe as identified on Drawing 4152-2.
- Fill: Placement and compaction where specified below, of excavated tailings and contaminated soil in locations where existing surfaces are below design grades or existing materials must be replaced. Fill areas include the pond basins and lower portions of the Pile outslopes.
- Mill demolition debris burial: Earthwork necessary for covering (burial) of the mill demolition debris placed (by others) in the south and east outslopes of the Pile.
- Line and grade control: Surveys as needed to achieve specified lines and grades, using control points as shown on drawings 4152-1 and 4152-2.
- Pond area dewatering: Removal of water liberated from tailings during the course of earthwork activities.
- Settlement point installation: Installation of at least 50 settlement monitoring points, fabricated by HMC, at locations shown on Drawing 4152-2.

- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust.

#### **1.6 Related Work Performed by Others**

- Asbestos burial: Burial of asbestos materials removed from the mill facilities.
- Mill demolition: Demolition of mill buildings and equipment, burial of some debris in place (in the mill area) and transport and placement of some debris in the south and east outcrops of the Pile.
- Earthwork quality control: Sampling and testing to verify material properties and specified field density and moisture content of compacted tailings, where applicable.
- Outslope toe seepage drainage system installation: Installation of a seepage drainage system in the Pile outslope toe as shown on Drawings 4152-7 and 4152-8.
- Settlement-point surveying (both initial and ongoing).

#### **1.7 Responsibilities**

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the Work Site, will make available construction water at locations on the mill property and will approve and make payment for Work performed under this specification. The Owner will perform surveys to verify finished lines and grades and excavation and fill quantities and to document settlements.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will implement quality control measures for the Owner that will include field density and moisture testing, classification of materials, and other properties as needed and direct Owner's survey and aerial photography as provided in section 2.3 of the Special Conditions.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the Job Site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

### **PART 2 - EXECUTION**

The Contractor shall perform the following work:

#### **2.1 Removal of Foreign Materials and Plugging of Structures on Pile**

Power poles, fencing, wire, scrap iron, old pipe, rubber tires, 18 old settlement monuments, timber, abandoned monitor well casings designated by the Owner and other foreign material shall be removed from the Pile and disposed of in locations designated or approved by Owner prior to commencing excavation of tailings.

Remove the 18 existing settlement monitor points from locations shown on Drawing 4152-1. Each point consists of a steel-pipe riser with cap and a base plate. The depths of the base plates are unknown. Most points extend a few feet above the existing Pile surface and are clearly visible. However, points #A1, A3, E1 and F1 are covered and not presently visible. All settlement monitor points shall be removed to the depths necessary to eliminate their obstruction of other work required by this

specification. All debris from such removal shall be placed in the slime areas of the Pile for subsequent burial in accordance with section 2.31.

The three (3) decant towers, the walkways leading to them, and the 18 existing settlement monitor points shall be removed or plugged as described below to clear the Pile surface of obstructions to recontouring. The locations of these structures are shown on Drawing 4152-1.

Demolish the uppermost 10 feet of the three (3) decant towers and all of the elevated walkways leading to these towers. Place the demolition debris of the decant tower superstructures in the areas of Slimes in the centers of the ponds of the Pile, for subsequent burial by fill placed in accordance with section 2.31, or in the tower plugs as allowed in the following paragraph.

Place granular-soil plugs in the three (3) decant towers from the bottom (estimated to be elevation 6580 +/- 5 feet) to 10 feet below existing tops of towers. The lowest 10 feet and the uppermost 10 feet of the plugs shall be minus 3/8 inch gravelly sand (SP to SW soil). The space between uppermost and lowest 10 feet sections shall be filled with plus 3/8 inch granular soil (GP to GW soil) and may also contain concrete debris from the demolition of the top 10 feet of the decant towers. Granular soil for the plugs may be obtained from a location on Owner's property approximately two miles east of the Pile. Plug materials may be placed by free-fall.

## **2.2 Excavation**

### **2.2.1 Excavation of Tailings**

Excavate tailings to reduce Pile surfaces that stand above design grades to the *design* grades shown on Drawings 4152-2, -3, -4, and -5. In general, tailings to be excavated are sands (SP to SM); however, some Slimes might be encountered, especially in portions of the pond beaches closest to the pond basins. Only excavated tailing sands (as opposed to Slimes) shall be moved to fill locations in the outslope; any excavated Slimes shall be moved to fill locations within the pond areas. Any tailing materials judged by the Engineer to be unacceptable for fill shall be placed in designated areas of the pond basins of the Pile.

The volume of tailing excavation is expected to exceed the volume of fill required to recontour the Pile. If so directed by Owner, excess excavated tailings shall be placed in areas of the ponds to be designated at the time that an excess volume of excavated tailings becomes evident to the Contractor. If Owner determines that additional excavation is needed (excavation of tailings below the design surfaces) to satisfy fill requirements or to compensate for settlement in the pond areas of the Pile, Owner will direct the Contractor where to excavate and will provide the coordinates and grades of the final excavation surface.

Final recontoured surfaces created by excavation shall be compacted to not less than 90% maximum dry density per ASTM D-698. The compacted surface shall be rolled to create a surface free of ruts or ridges. The flat topslope and outslope surfaces shall not deviate from a planar surface by more than 1.0 feet amplitude over any 100 feet distance.

Final excavation-surface elevations may vary from those shown on the contract drawings, depending on compaction and actual fill volumes required. However, the final gradients of all excavation surfaces shall be within 10% of those shown on the construction drawings and on the outslope shall not exceed 0.20 (20% or 5H:1V).

### **2.2.2 Excavation of Contaminated Soil**

Excavate contaminated soil previously placed to create berms and roadways around the base of the Pile. Locations of the roadways and berms are shown as excavation areas beyond the final recontoured

outslopes in Drawings 4152-3, -4, and -5. The Owner shall determine when excavation has been sufficient to completely remove the contaminated soil.

### **2.3 Fill**

The Contractor shall place excavated tailings and contaminated soil as fill in locations of the Pile outslopes and pond basins shown on the drawings and as directed by Owner. Final fill surfaces on the outslopes shall not exceed a gradient of 0.20 and shall be within 10% of the gradients shown on the construction drawings. Although final fill-surface elevations may vary and will depend on settlements and actual fill volumes, final fill-surface gradients on the Pile top shall be within 10% of those shown on the construction drawings. The final surface shall be rolled to create a surface free of ruts or ridges. The flat topslope and outslope surfaces shall not deviate from a planar surface by more than 1.0 feet amplitude over any 100 feet distance.

The Contractor shall conduct its fill operations throughout this Contract in such manner that the possibility of disruption of fill lifts by the movement of underlying Slimes is prevented.

#### **2.3.1 Stabilization Lift**

The pond areas of the Pile contain saturated Slimes that must be covered with dry sand tailings to develop a competent working and bearing surface for subsequent fill placement. Before placing successive fill lifts over each pond basin, the Contractor shall place a stabilization lift of dry sand tailings over the entire pond basin to the thicknesses and densities necessary to support its heavy equipment and to prevent breach of the fill by underlying wet tailings or water. Special care shall be exercised by the Contractor in placing tailing sand over the Slimes to minimize risk to workers and equipment from liquefaction, bearing failure, lateral displacement or other phenomena arising from the very low strength, high moisture content, and plastic behavior of the Slimes. The Contractor shall take precautions and measures necessary to prevent the upward or lateral movement of Slimes that would break through or otherwise disrupt the stabilization lift. The Contractor shall use practices and equipment that minimize disturbance of the Slimes and the resultant hazards. Practices that do not include due regard for these hazards may cause endangerment to operators and equipment including sudden settlement into soft, unstable tailings.

The Contractor may use scrap materials, presently stacked in the area directly south of the Pile, to expedite placement of the stabilization lift. This scrap may be placed in the Slimes ahead of fill placement. No scrap shall be allowed within the stabilization-lift fill.

#### **2.3.2 Lifts Not Requiring Specific Compaction**

Tailing sand placed above the stabilization lift and before the uppermost 4.0 feet of fill shall be placed by methods selected by the Contractor. No minimum compacted dry density is specified for these lifts; however, the Contractor shall achieve the density necessary to provide a firm base for equipment movement required for placement of the succeeding lift.

#### **2.3.3 Lifts Placed within 4.0 Feet of Final Grade**

All fill placed within 4.0 feet of design grade, as shown on the construction drawings, shall contain only contaminated soils excavated in accordance with section 2.22 and sand tailings (classified as SP, SP-SM, SM, or SC) excavated from the large Pile. Slime materials (tailing classified as CL, CH, ML or MH soils) excavated from the large Pile shall be excluded from the upper 4.0 feet of fill. Owner shall determine the suitability of materials placed according to this section.

The fill in this upper 4.0 feet shall be placed in lifts of not more than eight inches loose thickness. Each lift in the upper 4.0 feet of fill shall be moisture-conditioned as needed, mixed, and compacted to achieve in-place dry density of at least 90% of maximum dry density as determined by ASTM D-698.

No fill shall be placed on any surface that is saturated, frozen, or holding free water. No fill shall be placed that contains ice or frozen tailings or is visibly saturated (yields free water upon exposure or disturbance). After any precipitation that causes ponding of water on the fill surface, the water shall be drained and the surface shall be allowed to dry, then scarified and recompacted before the next lift is placed.

Throughout fill construction the fill surface shall be maintained to facilitate runoff and prevent ponding of precipitation or liberated water except at locations specifically intended for water collection. All such collection locations shall be approved by Owner. Within the pond area (inside the perimeter defined by the inside edge of the original Pile dike crest) ponded water shall be removed by pumping to dust suppression sprays, used as construction water on the Pile, or piped to the brine ponds south of the Pile if approved by Owner.

Owner, the Engineer, or its authorized testing service will perform field tests to determine in-place densities and moisture contents of the top 4.0 feet of fill to ensure that no Slimes have been placed in this upper 4.0 feet.

In-place density tests, initially one for each 1000 cubic yards of fill placed within 4.0 feet of the final fill surface, will be conducted by Owner or its Engineer. Density testing of both excavation and fill areas will be referenced to a test grid covering the entire Pile. The test grid size will be based on the frequency of testing finally required by the US Nuclear Regulatory Commission and will be some integer multiple of 100 (e.g., 200 x 200 feet). Test locations will be recorded on the earthwork control grid. If a test indicates less than the required density, the entire lift within that test grid space shall be recompacted and retested until it achieves the minimum required density.

## **2.4 Settlement Point Installation**

The Contractor shall install settlement monitoring points at locations shown on Drawing 4152-2, as a minimum. The points will consist of a steel plate with welded 1.0 or 2.0 inch diameter steel-pipe riser, a 2.0 to 4.0 inch PVC or steel guard pipe with grease-filled annulus, protective threaded cap, and (at Owner's option) a 6.0 to 9.0 inch steel outer guard pipe painted international orange. The outer guard pipe, if used, shall be set not more than 2.0 feet below and shall extend at least 4.0 feet above the working surface and shall be removed and reset as earthwork progresses. The components of the point installation, less the outer guard, are shown on Drawing 4152-6. All fabrication will be performed by Owner.

The Contractor shall install the points as soon as sufficient fill has been placed over the pond areas to provide a competent working surface, as determined by Owner. The steel plate shall be set below the working level of the fill at a depth of not less than 2.0 feet on a surface that is smooth and horizontal. The riser shall be checked for verticality using a carpenter's level. The riser shall extend not less than 1.0 feet above the fill surface at the completion of installation. After the steel plate with riser is installed, the riser-guard shall be placed over the riser and filled with grease. The riser-guard shall not be connected to the riser or steel plate but shall be placed so that its lower end is not more than 18.0 inches above the plate and the riser is centered in the riser-guard.

As fill is placed around each settlement point, the external guard shall be temporarily removed and the riser and riser guard shall be extended by adding segments of both using threaded couplings and sections of lengths necessary to maintain accessibility of the points for frequent surveys. If directed by

Owner, the external guard shall be in place at all times except for riser-extension work. At no time shall the top end of the riser be more than 1.0 feet below the fill surface.

The preservation and surveying of the settlement points is crucial to the evaluation and documentation of large Pile reclamation. The Contractor shall take all necessary precautions to ensure that the points are not damaged. Damage to any point, including disturbance of position, shall be sufficient cause for Owner to stop work and require immediate replacement of, or repairs to, damaged points at the Contractor's cost and without compensation to the Contractor for suspension of other work for this reason.

The Contractor shall also cooperate with Owner in surveys of these points. Owner's surveyor will perform surveys to establish the initial coordinates of each point at the time of installation. Subsequently, that surveyor will also perform surveys at intervals of two weeks to one month to determine elevation changes (settlements). The Contractor will be informed at least two days in advance of the time of these surveys. The Contractor shall plan its work, including the location and movement of equipment, to allow access to all survey control points and settlement points at the times of these surveys, and shall avoid causing any obstruction to the survey.

## **2.5 Fill Around Demolition Debris**

The Contractor shall place contaminated soil or tailing sand fill, as directed by the Owner, around mill debris placed in the east and south out slopes of the Pile. This fill shall be placed when lifts or sections of debris placement have been completed by the demolition contractor.

## **2.6 Pond Area Dewatering and Dust Control**

The Contractor shall operate and maintain Owner's existing dust-control water spray system on the Pile, drawing water from the standing water of the east or west pond areas and, as needed, from other sources designated by Owner including the evaporation pond. Contractor may modify and relocate components of the system to avoid interference with its other work, but shall ensure that Pile surfaces are kept sufficiently moisten to prevent fugitive dust. The Contractor shall provide and operate other equipment as necessary to transport and distribute water to augment the spray system to maintain control of fugitive dust.

Water in the pond areas that cannot be pumped into the spray system shall be diverted to and drained through the decant towers.

As directed by Owner, the Contractor shall take those measures deemed necessary by Owner to ensure dust control. Such measures may include chemical dust suppressants or erosion control mats.

## **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### **3.2 Line and Grade Control**

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this Specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawing 4152-2. The recontoured-surface elevations shown on that drawing are intended for initial guidance; actual elevations may vary depending on actual volumes of excavation and fill, compressibility and settlement of Slimes, and modifications that might result from regulatory-agency requirements. In any case, gradients of the final recontoured surface will be the basis for determining the acceptance of the recontoured Pile configuration. Gradients shall be surveyed as often as necessary to control excavation and fill placement. All final gradients and elevations shall be recorded on a base drawing that includes the site coordinate system, the earthwork control grid, and the original Pile topographic contours. This base drawing will be provided in hard copy or Autocad Version 11.0 plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary but, at a minimum, at the top-of-slope and bottom-of-slope points shown on Drawing 4152-2. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### **3.3 Field and Laboratory Testing of Fill**

Testing of fill materials and in-place density and moisture will be performed by a qualified materials testing service contracted by Owner. Field density on compacted fill will be performed at an initial frequency of one test per 1000 cubic yards placed in the upper 4.0 feet of fill and on the final excavated surface on a 200 foot square grid using the Sand Cone method, ASTM D 1556. The maximum compaction density standard will be based on the Standard Proctor density test per ASTM D-698 performed at an initial frequency of one one-point test per 5000 cubic yards and one three-point test per 15000 cubic yards of fill placed.

Each field density test will be plotted on the earthwork control grid and recorded on test data sheets that become part of the permanent record of the project. The Contractor will be notified immediately when any test result fails to meet the minimum acceptable value in Part 2 of this specification.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of excavation and fill, area of final grading). A copy shall be submitted to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of excavation and fill (illustrated by distinctive colors or patterns) accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours).



- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

#### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey.
- As-built drawings of completed work.

#### **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

#### **PART 6 - SCHEDULE**

Complete the Included Work by 365 days from Notice to Proceed.

**SPECIFICATION  
FOR  
TOE DRAINAGE SYSTEM OF THE LARGE TAILING IMPOUNDMENT**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S2**

**Revision 0**

**June 6, 1992**

**Prepared by:  
AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will recontour (reshape) and place a radon-barrier soil cover over the large tailing impoundment at its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. The large impoundment (see Drawing 4152-1), hereinafter referred to as the "pile", contains 20-22 million tons of uranium mill tailings, covers approximately 170 acres, and is 85-100 feet high. The pile is roughly rectangular in shape. The top is divided into two cells, an east pond area of approximately 55 acres and a west pond area of approximately 40 acres. The pond areas are surrounded by embankments of sand tailings that are about 20-40 feet higher than the lowest points in the enclosed pond basins. The existing out slopes of the pile have gradients of approximately 2.5H:1V to 3.5H:1V.

Recontouring the pile will require redistribution of tailings and tailing-contaminated soil, by soil excavation and fill methods, to flatten the out slopes to 5H:1V. To accomplish this, sand tailings and contaminated soil must be placed in the toe areas. Most of the toe areas are presently saturated by seepage that originates in the ponds on the pile tops and travels downward and outward, exiting the toe areas in the lowest few feet of the out slopes through sand tailings that consists of mostly fine sand with 4-40% minus #200 sieve fraction (USCS soil classification of SP to SM). The toe seepage will be intercepted by a toe drainage system, illustrated on Drawings 4152-7 and 4152-8, installed before the lower out slopes are recontoured.

### **1.2 Included Work**

The work to be performed under this specification covers the installation of the toe drain system and the materials needed for the drain pipe of that system. The activities required for installing the toe drain system will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work consists of:

- Providing all drain pipe, couplings, fittings, end caps and other materials required to complete the installation of the drain pipe.
- Installation of the seepage collection sumps, including placement and compaction of backfill.
- Installation of the drain pipe and connection of the pipe to the collection sumps.

### **1.3 Related Work Performed by Others**

Activities to be performed by others include:

- Design, fabrication, and delivery of the seepage collection sumps.
- Earthwork to prepare access to drain installation areas and working benches for drain installation.
- Excavation required for the installation of seepage collection sumps.
- Surveys and staking of the locations, lines, and grades of seepage collection sumps and drainage pipes.

### **1.4 Responsibilities**

- a). Homestake Mining Company (HMC): HMC, the "Owner", will evaluate bids and award all contracts for the Included Work (Section 1.02) and Related Work (Section 1.03), will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will provide equipment (including fuel, maintenance and operators) needed to support the contractor in the installation of the drainage system, including the collection sumps.

- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work.
- c) Contractor (to be determined) shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work except as noted above and in Section 1.03. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local regulations and for the safety of its job site and of all personnel and equipment which it employs on the job site.

## **1.5 List of Drawings**

The following drawings are incorporated into this specification by reference:

- 4152-1 Pre-reclamation Plan, Large Tailing Impoundment
- 4152-7 Toe Drainage System, Large Tailing Impoundment
- 4152-8 Toe Drainage System Details, Large Tailing Impoundment

## **PART 2 - EXECUTION**

The Contractor shall furnish materials and perform work as follows:

### **2.1 Furnish Drainage Pipe Materials**

The Contractor shall procure and deliver to the site all materials associated with the drainage pipe, including the factory-applied synthetic filter wrap and all fittings and couplings required to complete the installation. The materials shall include, but not be limited to the following:

- Drainage pipe - 6" O.D. perforated high-density

polyethylene flexible corrugated pipe, Heavy Duty Hancor pipe with factory-applied Big "O" highway-grade polyester knitted geotextile sock with effective D15 of 0.08 mm, D50 of 0.20 mm, and D85 of 0.29 mm. In place of the materials available from this manufacturer, the Contractor may submit a proposal for equivalent materials for the Owner's review and approval.

- Other pipe materials - All end caps and connections (couplings and fittings including elbows for connection to sumps) required to complete the pipe installation

### **2.2 Installation of Collection Sumps**

Install four seepage water collection sumps furnished by the Owner at the locations and at the depths indicated on Drawings 4152-7 and 4152-8. Excavation required for installing these sumps will be performed by the Owner or its Subcontractor. The Contractor shall place and compact select backfill, provided at the sump locations by Owner, under the sumps and drain pipes to the thicknesses and lateral extents shown on Drawing 4152-8. The backfill shall be gravelly sand (minus 3/8 inch, SP to SW) and shall be compacted by hand-guided mechanical compactor to not less than 95% of maximum dry density per ASTM D-698.

Dewatering will be necessary to achieve excavation for and installation of at least three of the sumps (N-1, W-1, and E-1). Saturated sand and some wet clay layers were encountered in test pits at these locations at a depth of about 7.0 feet ground. Although no saturated soils were encountered in the test pit at the S-1 location to 11.0 feet, the excavation for this sump may also require dewatering before excavation to total depth and sump installation. The Contractor shall provide, install, operate and remove all necessary dewatering equipment. Installation of the collection sumps shall include all fittings and other connections required to join the collection sumps to the downstream end of each drainage pipe.

### **2.3 Installation of Drainage Pipe**

Install the drainage pipe along the alignments and at the elevations and gradients shown on Drawing 4152-7. The Contractor shall take such measures as it deems necessary to ensure that the gradient of the installed drainage pipe is within 0.0005 of the gradient and the alignment is within 2.0 feet of those shown on Drawing 4152-7 for each segment of the drainage system and that no reverse gradients (negative slopes) occur at any location along the length of the drain.

The alignment and design gradient of the south drain line will cause the pipe to pass 1.0 feet above an existing concrete pipe (west decant discharge pipe) at point SA-4. The Contractor shall take precautions to prevent its work from contacting the decant discharge pipe.

## **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, a Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### **3.2 Line and Grade Control**

The Contractor shall use whatever measures are necessary to achieve the lines and grades of the drainage pipe described in Part 2.0 of this specification and in Drawing 4152-7. The Owner or its Subcontractor will establish the ground control necessary for the Contractor's reference and use in performing its line and grade control. This ground control will include staking of a) the alignment and grade at intervals of 200 feet or less at locations 12.5 feet parallel to and offset from the center line of the drainage pipe and b) the axes and bottom depths of the four collection sumps.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., length of pipe installed). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

#### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and variances from the specifications observed by Owner.
- Changes to this specification and the drawings.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- As-built drawings of completed work.

#### **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and surveyor), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner or shall receive Owner written approval for a variance. All work and materials required for such corrective actions shall be at the expense of the Contractor.

#### **PART 6 - SCHEDULE**

Complete the Included Work within 40 calendar days according to the following schedule:

Notice to Proceed	Day 0
Complete mobilization, installation of collection sumps	Day 15
Complete drain installation	Day 40

Weather conditions that prevent work on a specific task for an entire work day shall be accommodated by a day-for-day extension in the schedule of that and other directly affected tasks.

**SPECIFICATION  
FOR  
EXCAVATION AND DISPOSAL OF CONTAMINATED SOIL**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S3**

**Revision 0**

**January 11, 1994**

**Prepared by:  
AK GeoConsult, Inc.**

## **PART 1 – GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will remove and dispose of soils contaminated by windblown tailings and other byproduct materials on and around its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. For the purposes of this specification, contaminated soil is any soil that contains more than 10.5 pCi/g of radium (Ra-226). Most of this radium contamination came from the large impoundment (see Drawing 4152-1), hereinafter referred to as the "Pile". The approximate locations and boundaries of the contaminated-soil areas and approximate depths of contaminated soils are shown on Drawing 4152-10. The areas and depths of contamination shown on this drawing are based on field sampling and laboratory testing for radium concentrations performed in accordance with procedures approved by the US Nuclear Regulatory Commission (NRC). However, such methods do not permit exact delineations of the extent of contaminated soil. Actual limits of contamination and, therefore, actual areal extent, depths and volumes of contaminated soil can be determined only during and immediately after excavation of contaminated soil. HMC will collect and test soil samples and determine when excavation of contaminated soil is complete.

The contaminated soil consists of naturally-occurring alluvial sands, clays, silts and combinations of these soils that also contain radium-bearing uranium milling byproduct. The byproduct contamination of these soils resulted from relatively small amounts of windblown alkali dust and tailing sand eroded over an extended period of time from the tailing impoundments and an accidental release of tailing solution from the large impoundment. Because of the small amount of byproduct in the total volume of soil, the contaminated soil retains the physical properties of the natural soil.

### **1.2 Technical Definitions**

Compactors, heavy: Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

Compactors, light: Vibrating or tamping compactors weighing less than 5000 lbs. and controlled by a walk-behind operator.

Contaminated soil: Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) contamination, or a total of 10.5 pCi/g of Ra-226 including background.

Earthwork: Excavation, haulage, placement, and compaction of earthen materials including mill tailings.

Earthwork control grid: Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

Fines: Mineral particles (soil or tailings) passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

Foreign material: Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

Job site: The location of the large tailing Pile as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.



Native soil, natural soil: Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

Pile: The large tailing impoundment.

Sand: Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

Small tailing impoundment, small tailing Pile: The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines.

SM - silty sand; 12-50% silt fines, >50% sand.

SC - clayey sand; 12-50% clay fines, >50% sand.

SP-SM - sand with 5-12% silty fines.

ML - more than 50% Fines that classify as silt, according to reference c), and liquid limit less than 50.

MH - same as ML except liquid limit 50 or more.

CL - more than 50% Fines that classify as clay, according to reference c), and liquid limit less than 50.

CH - same as CL except liquid limit 50 or more.

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.

### 1.4 List of Construction Drawings

The following drawings are incorporated into this specification by reference:

- |          |   |
|----------|---|
| 4152-0   | Title and Index Sheet                                       |
| 4152-1   | Pre-reclamation Plan, Large Tailing Impoundment             |
| 4152-10  | Plan of Contaminated Soil Requiring Excavation and Disposal |
| 4152-10A | Location Plan of Utilities Along Public Roadways            |

### 1.5 Included Work

The earthwork activities required for excavation and disposal of contaminated soil will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Removal of vegetation from contaminated areas prior to excavation.
- Excavation of contaminated soil from areas shown on Drawings 4152-10 and -10A, with the exception of the areas along State Route 605 between the right-of-way fences and the road as well as the road surface itself, and as otherwise designated by HMC. This does not include the berms and roadways around the base of the large impoundment that are included in Specification 4152-S1, Section 2.22.
- Disposal of contaminated soil on the large or small tailing impoundments, as directed or approved by HMC, by placement in lifts, and compaction where specified below, where existing surfaces are below design grades or existing materials must be replaced. Fill areas may include the pond basins and Pile out slopes.
- Line and grade control: Surveys as needed to achieve specified lines and grades, using control points as shown on drawings 4152-1 and 4152-2.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust.

### 1.6 Related Work Performed by Others

- Mill demolition and mill-area cover: Demolition of mill buildings and equipment, burial of debris in place (in the mill area), and placement of clean soil cover over the mill area.
- Earthwork quality control: Sampling and testing to verify material properties and specified field density and moisture content of compacted tailings, where applicable.
- Radiological sampling and testing: Sampling and testing to determine the radium content of the soil.

### 1.7 Responsibilities

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform sampling and testing of radium content in the soil, select or approve disposal locations, and verify or approve excavation and fill quantities.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will implement or review quality control measures for the Owner that will include field testing of compacted soil, engineering classification of materials, and other properties.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## **PART 2 - EXECUTION**

The Contractor shall perform the following work:

### **2.1 Removal of Vegetation from Contaminated Areas**

All emergent vegetation (those parts of vegetation above ground surface) shall be removed to one or more locations within the limits of contaminated soil and burned. Roots and other parts of vegetation below ground do not require removal and separation from the contaminated soil.

As an alternative to removing and burning emergent vegetation, the Contractor may mix this vegetation with contaminated soil and place it as fill in the large tailing impoundment that does not require compaction (Specification 4152-S1, section 2.32). No emergent vegetation may be placed in the fill requiring compaction as described in Specification 4152-S1, Section 2.33.

### **2.2 Excavation of Contaminated Soil**

Contaminated soil shall be removed by excavation from all designated areas, including those shown on Drawings 4152-10 and -10A and otherwise identified by Owner, and hauled to the tailing impoundments for disposal as fill as described in Section 2.3 below. However, no contaminated soil shall be excavated from the right-of-way of State Route 605 (areas between the fences of the east and west sides of the highway) during the phase of work covered by this specification.

During excavation and hauling of contaminated soil, the Contractor shall control the travel routes of earthmoving equipment to avoid areas of uncontaminated soil or areas where contaminated soil has already been removed. Travel routes to disposal locations shall be selected to minimize haul distances and number of routes used.

The Contractor shall control the generation and movement of dust caused by excavation or wind, using application of water in locations and amounts that will prevent the spread of contaminated soil to uncontaminated areas.

### **2.3 Disposal of Contaminated Soil**

Contaminated soil shall be disposed of in the tailing impoundments. The contaminated soil shall be placed as uncompacted fill or compacted fill in accordance with Specification 4152-S1 Sections 2.32 and 2.33, in the large impoundment until the final recontoured surface of that impoundment has been established by the Contractor and approved by Owner. If any contaminated soil remains to be disposed, it shall be placed as uncompacted fill on the surface of the small impoundment south of the evaporation pond at locations and thicknesses as directed by Owner.

## **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor

shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### **3.2 Verification of Contaminated Soil Removal**

The Owner will determine the actual lateral extent and depth of excavation necessary to remove contaminated soil. This determination will be made by collection and testing of soil samples in areas where excavation of contaminated soils has reached depths previously estimated by the Owner to be sufficient to reach regulatory standards for Ra-226 levels. Each test for Ra-226 concentration requires 15 days; therefore, the Contractor shall plan its excavation to allow for this time lag between excavation and verification.

Any excavated area that does not achieve the required Ra-226 reduction (residual levels not greater than 10.5 pCi/g) shall be excavated to successively greater depths, as determined by the Owner, until the limiting Ra-226 concentration of the exposed soil is verified by the Owner.

### **3.3 Surveys for Documentation and Volume Determination**

The Contractor shall perform land surveying to document the areas and depths of contaminated soil removal and the volumes of soil removed. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawing 4152-2. A drawing and tabulation of survey data shall be provided in hard copy or Autocad Version 11.0 plot file on 3.5-inch diskette. At its discretion, Owner may have this survey confirmed by a third-party surveyor.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., areas and volumes of excavation). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of excavation and fill (illustrated by distinctive colors or patterns) accomplished each day.
- Survey records as described in Section 3.3.
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field sampling and laboratory tests performed by Owner or its testing service.
- Photographic and video tape records of the Included Work.

- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the confirmation survey.
- As-built drawings of completed work.

#### **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

#### **PART 6 - SCHEDULE**

Complete the Included Work by 90 days from Notice to Proceed.

**SPECIFICATION**  
**FOR**  
**EXCAVATION AND DISPOSAL OF CONTAMINATED SOIL**  
**FROM PUBLIC ROADWAYS**

**HOMESTAKE MINING COMPANY OF CALIFORNIA**  
**GRANTS OPERATION**  
**NEW MEXICO**

**NO. 4152-S3A**

**Revision 0**

**January 29, 1994**

**Prepared by:**  
**AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will remove and dispose of soils contaminated by windblown tailings and other byproduct materials from public roadways (State Route 603 and Cibola County Road 63) adjacent to its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. For the purposes of this specification, contaminated soil is any soil that contains more than 10.5 pCi/g of radium (Ra-226). Most of this radium contamination came from the large impoundment, hereinafter referred to as the "Pile". The approximate locations and boundaries of the contaminated-soil areas and thickness of contamination (depth from ground surface to bottom of contaminated zone) are shown on Drawing 4152-10A.

The areas and depths of contamination shown on this drawing are based on field sampling and laboratory testing for radium concentrations performed in accordance with procedures approved by the US Nuclear Regulatory Commission (NRC). However, such methods do not permit exact delineation of the extent of contaminated soil. Actual limits of contamination and, therefore, actual areal extent, depths and volumes of contaminated soil can be determined only during and immediately after excavation of contaminated soil. HMC will collect and test soil samples and determine when excavation of contaminated soil is complete.

The contaminated soil consists of naturally-occurring alluvial sands, clays, silts and combinations of these soils, and possibly road base course, that also contain radium-bearing uranium milling byproduct. The byproduct contamination of these soils resulted from relatively small amounts of windblown alkali dust and tailing sand eroded over an extended period of time from the tailing impoundments. Because of the small amount of byproduct in the total volume of soil, the contaminated soil retains the physical properties of the natural soil.

Removal of contaminated soil from the roadways will require close supervision and careful control of equipment and workers to prevent damage to utilities above and below ground. These include overhead electric power lines and buried gas pipelines (both large diameter, high pressure cross-country transmission and smaller diameter local distribution lines) and buried telephone lines. Precautions must be taken to protect against the hazards posed by contact with these utilities as well as hazards related to vehicular traffic on the roads.

The work required by this specification includes excavation and disposal of contaminated soil, protection of utilities in the work area, and replacement of excavated soils with clean soil as required to satisfy requirements of highway departments and utility companies.

### **1.2 Technical Definitions**

**Compactors, heavy:** Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

**Compactors, light:** Vibrating or tamping compactors weighing less than 5000 lbs. and controlled by a walk-behind operator.

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) contamination, or a total of 10.5 pCi/g of Ra-226 including background.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials including mill tailings.

Earthwork control grid: Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

Fines: Mineral particles (soil or tailings) passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

Foreign material: Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

Job site: The locations of the public roadways as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

Native soil, natural soil: Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

Roadway, public roadway: The travel surfaces, shoulders, borrow ditches and other areas within the right-of-way fences bounding State Route 605 and County Road 63.

Sand: Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

Small tailing impoundment, small pile: The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% fines that classify as silt, according to reference c), and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% fines that classify as clay, according to reference c), and liquid limit less than 50.

CH - same as CL except liquid limit 50 or more

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards.
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards.



- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.
- d) Cibola County Public Works Director letter of 1/5/94 to Homestake Mining Company, with two attachments.
- e) Continental Divide Electric Cooperative, Inc. letter of 1/10/94 to Homestake Mining Company.
- f) Gas Company of New Mexico letter of 1/5/94 to Homestake Mining Company.
- g) Transwestern Pipeline Company letter of 1/5/94 to Homestake Mining Company, with two attachments.
- h) US West Communications letter of \*\*\*\* to Homestake Mining Company.
- i) New Mexico Highway and Transportation Department letter of January 20, 1994 to Homestake Mining Company.

#### **1.4 List of Construction Drawings**

The following drawings are incorporated into this specification by reference:

- 4152-0 Title and Index Sheet
- 4152-10 Plan of Contaminated Soil Requiring Excavation and Disposal (for information only)
- 4152-10A Location Plan of Utilities Along Public Roadways
- 4152-12 Configuration of Small Tailing Impoundment Before Interim Cover Placement
- 4152-15 Plan of Interim Cover Placement on Small Tailing Impoundment

#### **1.5 Included Work**

The earthwork activities required for excavation and disposal of contaminated soil will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Excavation of contaminated soil from areas shown on Drawing 4152-10A along State Route 605 and County Road 63 between the right-of-way fences and the road as well as the county road surface itself where required, and as otherwise designated by HMC.
- Disposal of contaminated soil on the small tailing impoundment, as directed or approved by HMC, by placement in lifts, and compaction where specified below, where existing surfaces are below design grade. Fill areas include only that portion of the small pile south of the existing evaporation pond.
- Restoration of excavated areas: Excavation, hauling placement and compaction as necessary to restore excavated areas to original lines and grades or to the standards required by the affected utility or government department, whichever is more stringent.
- Line and grade control: Surveys as needed to achieve specified lines and grades, using control points shown on the listed contract drawings or otherwise provided by the Owner.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust.
- Traffic control and safety devices: Furnishing, maintaining, and placement of barricades, signals, and signs as well as flagmen as needed for traffic safety.

## **1.6 Related Work Performed by Others**

- Earthwork quality control: Sampling and testing to verify material properties and specified field density and moisture content of compacted tailings, where applicable.
- Radiological sampling and testing: Sampling and testing to determine the radium content of the soil.

## **1.7 Responsibilities**

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform sampling and testing of radium content in the soil, select or approve disposal locations, and verify or approve excavation and fill quantities. The Owner will also implement and enforce the health and safety radiological procedures required for this work.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will implement or review quality control measures for the Owner that will include field testing of compacted soil, engineering classification of materials, and other properties.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## **PART 2 - EXECUTION**

The Contractor shall perform the following work:

### **2.1 Excavation of Contaminated Soil**

Contaminated soil shall be removed by excavation from all designated areas, including those shown on Drawing 4152-10A and otherwise identified by Owner, and hauled to the large or small tailing impoundment for disposal as fill as described in Section 2.3 below. Separate removal and disposal of vegetation is not required.

During excavation and hauling of contaminated soil and included vegetation, the Contractor shall control the travel routes of earthmoving equipment to avoid areas of uncontaminated soil or areas where contaminated soil has already been removed. Travel routes to disposal locations shall be selected to minimize haul distances and number of routes used.

The Contractor shall control the generation and movement of dust caused by excavation or wind, using application of water in locations and amounts that will prevent the spread of contaminated soil to uncontaminated areas.

The Contractor shall conform to the specific requirements for excavation contained in references d) through i) of Section 1.3 of this specification.

## **2.2 Disposal of Contaminated Soil**

Contaminated soil shall be disposed of by placement in lifts not greater than 12 inches uncompacted thickness in the north and east outslopes of the large tailing impoundment and the south end of the small tailing impoundment, south of the evaporation pond (Drawing 4152-12). The contaminated soil may be placed as uncompacted fill in the triangle-shaped exposed tailing area at the south end of the small pile, except that no contaminated soil shall be placed within 10 feet horizontally of the outslope surface contours of the interim cover shown on Drawing 4152-15.

## **2.3 Restoration of Excavated Areas**

The Contractor shall excavate, haul, place and compact clean soil as necessary to restore excavated areas to original lines and grades or to the current standards required by the New Mexico Highway Department, the Cibola County Public Works Director, or the utility companies. The most stringent standard for materials, compaction, line and grade contained in references d) through i) shall determine what is required at each excavated area. Clean soil to restore excavated areas shall be obtained from borrow pits on Owner's property located within one mile east of the state road.

The Contractor shall conform to the specific requirements for fill placement, restoration of surfaces, revegetation, fence replacement and other relevant requirements contained in references d) through i) of Section 1.3 of this specification.

## **2.4 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

## **2.5 Traffic Control and Safety**

The Contractor shall provide, operate or place, and maintain those devices required by references d) through i) to protect its own workers and the public from hazards related to its work within the public road right-of-way. The Contractor shall provide flagmen or other personnel as required by the references, fully trained in their duties, to control traffic and access to or passage through the work areas within the public road rights-of-way.

# **PART 3 - QUALITY CONTROL**

## **3.1 Owner Verification of Contaminated Soil Removal**

The Owner will determine the actual lateral extent and depth of excavation necessary to remove contaminated soil. This determination will be made by collection and testing of soil samples in areas where excavation of contaminated soils has reached depths previously estimated by the Owner to be sufficient to reach regulatory standards for Ra-226 levels. Each test for Ra-226 concentration requires 15 days.

Any excavated area that does not achieve the required Ra-226 reduction (residual levels not greater than 10.5 pCi/g) shall be excavated to successively greater depths, as determined by the Owner, until the limiting Ra-226 concentration of the exposed soil is verified by the Owner.

### **3.2 Contractor Quality Control**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

#### **3.2.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification as well as copies of references d) through i) and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

#### **3.2.2 Surveys for Documentation and Volume Determination**

The Contractor shall perform land surveying to document the areas and depths of contaminated soil removal and the volumes of soil removed. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawing 4152-10A. A drawing and tabulation of survey data shall be provided in hard copy or Autocad Version 11.0 plot file on 3.5-inch diskette. At its discretion, Owner may have this survey confirmed by a third-party surveyor.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., areas and volumes of excavation). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of excavation and fill (illustrated by distinctive colors or patterns) accomplished each day.
- Survey records as described in Section 3.3.
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field sampling and laboratory tests performed by Owner or its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.

- Survey notes and calculations of the confirmation survey
- As-built drawings of completed work

#### **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

#### **PART 6 - SCHEDULE**

Complete the Included Work by 90 days from Notice to Proceed.

**SPECIFICATION**  
**FOR**  
**CONSTRUCTION OF RADON BARRIER AND INTERIM SOIL COVERS ON**  
**THE TAILING IMPOUNDMENTS**

**HOMESTAKE MINING COMPANY OF CALIFORNIA**  
**GRANTS OPERATION**  
**NEW MEXICO**

**NO. 4152-S4**

**Revision 0**

**January 10, 1994**

**Prepared by:**  
**AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will place interim soil covers and initial radon barrier soil covers on the tailing impoundments at its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. The large impoundment (see Drawing 4152-11), hereinafter referred to as the "Pile", contains 20-22 million tons of uranium mill tailings, covers approximately 170 acres, and is 85-100 feet high. The Pile is roughly rectangular in shape. The top was divided into two cells, an east pond area of approximately 55 acres and a west pond area of approximately 40 acres. These ponds, the enclosing dikes and the surrounding embankment out slopes have been reshaped by excavation of tailings and placement of tailings and contaminated soil from the adjacent areas as fill to produce the configuration shown on Drawing 4152-11.

The small impoundment ("small pile") contains 1.22 million tons of tailings enclosed by a pentagonal dike constructed of native soil (Drawing 4152-12). Most of the surface of this pile, about 29 acres, is covered by a lined evaporation pond. The remaining part of the small pile, about 24 acres, is not covered by liner or native soil.

The work to be performed consists of covering some tailing surfaces with an interim cover of uncontaminated native soil and other surfaces with a radon barrier cover of clayey sand or clay soil, all of which will be excavated from selected borrow locations on HMC property adjacent to the piles (Drawing 4152-13). One foot of interim soil cover will be placed on the top surface of the large pile and on exposed tailing surfaces of the small pile, as shown on Drawings 4152-14 and 4152-15. Three feet of radon barrier cover will be placed on the out slope surfaces of the large pile, as shown on Drawing 4152-14. All cover placement on the large pile will be on surfaces previously prepared and compacted to at least 90% of maximum Standard Proctor density. Except for the surfaces of the south dike of the evaporation pond, no preparation or compaction of the exposed tailing surfaces of the small pile has been performed, and some preparation and compaction of these surfaces might be required to create a stable working base for interim cover placement on the small pile.

### **1.2 Technical Definitions**

Compactors, heavy: Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

Compactors, light: Vibrating or tamping compactors weighing less than 5000 lbs. and controlled by a walk-behind operator.

Contaminated Soil: Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) contamination.

Earthwork: Excavation, haulage, placement, and compaction of earthen materials including mill tailings.

Earthwork control grid: Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

Fines: Mineral particles (soil or tailings) passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

**Foreign material:** Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

**Interim Cover:** Uncontaminated soil placed over tailing surfaces to prevent erosion of tailings until the radon barrier cover can be placed.

**Job site:** The location of the tailing piles as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

**Native soil, natural soil:** Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

**Pile:** The large tailing impoundment.

**Planarity:** The degree to which a surface approaches a flat (but not necessarily horizontal) surface.

**Radon Barrier:** Soil cover placed over tailing surfaces to limit radon flux; composed of clayey sand or clay soils.

**Sand:** Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

**Slimes:** Tailings containing more than 50% silt and clay sizes (minus #200 sieve) classified as CL, CH, ML, or MH soil. Moisture content is variable but typically at saturation levels.

**Small tailing impoundment, small tailing pile:** The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

**Soil classification:** Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% Fines that classify as silt, according to reference c), and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% Fines that classify as clay, according to reference c), and liquid limit less than 50.

CH - same as CL except liquid limit 50 or more

**Tailings:** Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).



### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.

### 1.4 List of Construction Drawings

The following drawings are incorporated into this specification by reference:

- |          |   |
|----------|---|
| 4152-0   | Title and Index Sheet   |
| 4152-11  | Configuration of Large Tailing Impoundment After Recontouring                             |
| 4152-12  | Configuration of Small Tailing Impoundment Before Interim Cover Placement                 |
| 4152-13  | Borrow Areas for Cover Soils  |
| 4152-14A | Plan of Interim Cover and Soil Cover for Outslope Protection on Large Tailing Impoundment |
| 4152-14B | Plan of Radon Barrier Cover on Outslope of Large Tailing Impoundment                      |
| 4152-15A | Plan of Interim Cover Placement on Small Tailing Impoundment                              |

### 1.5 Included Work

The activities required for interim cover and radon barrier cover construction will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Preparation of Borrow Areas: Removal and disposal of vegetation, trash and other foreign material from the selected borrow areas; excavation of exploratory trenches as directed by the Owner.
- Excavation, hauling, placement, and compaction of interim cover soil
- Excavation, hauling, placement, and compaction of radon barrier cover soil
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.

### 1.6 Related Work Performed by Others

- Earthwork quality control: Sampling and testing to verify borrow material properties and specified field density, moisture content, and lift thicknesses of compacted soils.
- Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination.
- Settlement-point surveying (ongoing from earlier phases of the reclamation work, to record settlements of top surface of large pile).

## 1.7 Responsibilities

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to select and verify borrow soil properties, to verify finished lines and grades and excavation and fill quantities, and to document settlements.
- b) AK GeoConsult, Inc.(AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures for the Owner that will include field density and moisture testing, field classification and selection of borrow materials, and other properties as needed.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## PART 2 - EXECUTION

The Contractor shall perform the following work:

### 2.1 Borrow Area Preparation

The Contractor shall prepare borrow areas designated by the Owner prior to any excavation of borrow soil for cover construction. This preparation shall include:

- Clearing and grubbing of vegetation.
- Removal of vegetation, trash, and other foreign material to an on-site location approved by the Owner. Vegetation may be burned in lieu of removal for disposal.
- Preservation and protection of wells, water lines, and power lines needed for water supply or for the Owner's ground water restoration.
- Preservation and protection of power lines, telephone lines and other utilities along rights-of-way within borrow areas.

### 2.2 Excavation and Hauling of Borrow Soil

The Contractor shall excavate borrow soils at locations and to depths selected or approved by the Owner. All borrow soils used to construct the impoundment soil covers shall be excavated from approved borrow locations shown on Drawing 4152-13 or in other locations approved by Owner or its Engineer. In general, borrow soils will be excavated from the uppermost 5.0 feet of soil. Borrow soils for interim cover use will be typically be sand soils with USCS classifications of SP, SM or SP-SM with 100% passing 3.0 inch. Borrow soils for radon barrier will be clayey sand (SC) or a mixture of SC and clay (CL,CH) containing not less than 25% fines (-#200 sieve) by weight and 100% passing 3/4 inch. Borrow soil suitable for radon barrier may be used for interim cover, but soils classified as SP, SM, or SP-SM shall not be used for radon barrier.

No borrow material shall be used in the soil cover that has contaminated material (concentrations of byproduct-derived Ra-226 in excess of 5.0 pCi/g). With a background radium concentration of 5.5 pCi/g, the maximum total radium content of borrow soil will be not more than 10.5 pCi/g unless excess concentrations have been demonstrated by soil tests to be naturally-occurring radium.

Excavated soil shall be hauled along travel routes selected, prepared and maintained by the Contractor. The east-west county road north of the large pile shall not be used as a haulage route and shall be protected from damage or obstruction caused by the Contractor's equipment or activity. If this road must be crossed by earth-hauling equipment, a flagman shall be posted at each crossing point to control traffic during earth-hauling operations. During and after earth-hauling operations, the Contractor shall perform those repairs necessary to preserve the road surface and to return it to a condition at least equal to the condition that existed before the Contractor's work under this specification began. To ascertain satisfaction of this requirement, the Contractor shall document the condition of the road surface prior to its work and shall seek concurrence in this condition and the adequacy of any subsequent repairs from the county road department.

### **2.3 Placement and Compaction of Interim Cover**

The top surface of the large impoundment (that portion of the impoundment not including outslopes) will be covered with one foot of uncontaminated soil as an interim cover to protect against erosion of the recontoured tailings surface during that time between the completion of recontouring and the time when the radon barrier cover can be placed. The interim cover on the small pile shall be placed on all exposed tailing surfaces including the south dike of the evaporation pond and the open area of the pile surface south of the evaporation pond but not including the crests and outslopes of the initial containment embankment.

The interim cover soil of both impoundments shall be placed in six-inch lifts compacted to not less than 95% Standard Proctor density at a moisture content of -2% to +2% optimum.

No fill material shall be placed under adverse weather conditions, including freezing temperatures or during or immediately after heavy precipitation events. HMC shall determine when these adverse conditions exist. Before placement of the initial fill lift, and after any rain event that resulted in puddling of water or after any fill placement activity interruption in excess of two days, the impoundment surface shall be scarified prior to subsequent placement of any fill.

Final recontoured surface elevations of the top surface of the large pile may vary from those shown on Drawing 4152-11, depending on consolidation-induced settlements. Consequently, the final shape and contours of the interim cover on the top of the large pile shown on Drawing 4152-14 are representational only, and attainment of the elevations and gradients shown on Drawing 415214 is not required under this specification.

### **2.4 Placement and Compaction of Radon Barrier Cover**

Radon barrier cover shall be placed to an initial depth of 3.0 feet over the outslopes of the large pile. Radon barrier cover shall be placed as soon as possible after the surface of the large pile has been recontoured, except that no radon barrier will be placed on the top surface of the large impoundment until 90% of primary-consolidation settlement has been achieved, as determined from settlement point measurements and analyses.

The radon barrier cover of the large impoundment shall consist of clayey sand (SC) or a mixture of SC and clay (CL, CH) containing not less than 25% fines (-#200 sieve) by weight and 100% passing 3/4 inch. The cover soil shall be placed in six-inch lifts compacted to not less than 95% Standard Proctor density at a moisture content of -2% to +2% optimum.

No radon barrier material shall be placed under adverse weather conditions, including freezing temperatures or during or immediately after heavy precipitation events. HMC shall determine when these adverse conditions exist. Before placement of the initial fill lift, and after any rain event that resulted in puddling of water or after any fill placement activity interruption in excess of two days, the impoundment surface shall be scarified prior to subsequent placement of any fill.

The final surface of the radon barrier shall be rolled to create a surface free of ruts or ridges. The outslope shall not exceed 0.20 (20% or 5H:1V) and the outslope surfaces shall not deviate from a planar surface by more than 1.0 feet amplitude over any 100 feet distance. Along any curved portion of a topslope or outslope the final surface shall have vertical undulations not greater than 1.0 feet amplitude over a distance of 100 feet measured perpendicular to the design contours.

## **2.5 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

## **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### **3.2 Line and Grade Control**

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawings 4152-11 and -12. Gradients shall be surveyed as often as necessary to control fill placement. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### **3.3 Field and Laboratory Testing of Fill**

Testing of fill materials and in-place density and moisture will be performed by a qualified materials testing service contracted by Owner. The following tests will be performed:

- a) Particle-sie analysis - One test by ASTM Method D-422 for each 1000 c.y. and not less than one each day of borrow excavation of both interim and radon barrier soils.
- b) Atterberg Limits - Minimum of one test per day of radon barrier or interim cover placement.
- c) In-plane density and moisture of compacted fill - One test per 500 cubic yards or a minimum of two per day of fill placement activity, using the Sand Cone method, ASTM D 1556.
- d) Moisture-density standard - Standard Proctor density test using ASTM D-698, or ASTM Method D-2049 for cohesionless soils, and ASTM Methods D-2216 and D-4643 for moisture content will

be performed at an initial frequency of one one-point test per 2500 cubic yards and one three-point test per 5000 cubic yards of fill placed.

Each field density test will be plotted on the earthwork control grid and recorded on test data sheets that become part of the permanent record of the project. The Contractor will be notified immediately when any test result fails to meet the minimum acceptable value in Part 2 of this specification

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of excavation and fill, area of final grading). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities.
- Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of excavation and fill (illustrated by distinctive colors or patterns) accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours).
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey
- As-built drawings of completed work

## **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding

with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

**PART 6 - SCHEDULE**

Complete the Included Work by \_\_\_\_\_ days from Notice to Proceed.

**SPECIFICATION  
FOR  
FIRST PHASE  
COVER CONSTRUCTION  
ON THE LARGE TAILING IMPOUNDMENT**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S4A**

**Revision 0**

**January 27, 1994**

**Prepared by:  
AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will place interim soil cover and soil cover for outslope protection on the large tailing impoundment at its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. The large impoundment (see Drawing 4152-11), hereinafter referred to as the "Pile", contains 20-22 million tons of uranium mill tailings, covers approximately 170 acres, and is 85-100 feet high. The Pile is roughly rectangular in shape. The top was divided into two cells, an east pond area of approximately 55 acres and a west pond area of approximately 40 acres. These ponds, the enclosing dikes and the surrounding embankment outsoles have been reshaped by excavation of tailings and placement of tailings and contaminated soil from the adjacent areas as fill to produce the configuration shown on Drawing 4152-11.

The first phase of cover construction will consist of covering the surface of the top of the Pile with an interim cover of uncontaminated native silty or sandy soil and approximately half of the outslope surface with a cover of uncontaminated clayey sand or clay soil, all of which will be excavated from selected borrow locations on HMC property adjacent to the piles (Drawing 4152-13). All borrow areas will be prepared by clearing and grubbing before excavation of the cover soils. One (1.0) foot of interim soil cover will be placed on the top surface of the large pile, as shown on Drawing 4152-14A. A 0.5 foot layer of clayey soil cover will be placed on the west and south outslope surfaces of the large pile, as shown on Drawing 4152-14A. All cover placement on the large pile will be on surfaces previously prepared and compacted to at least 90% of maximum Standard Proctor density.

### **1.2 Technical Definitions**

**Clayey soil:** Soil that satisfies the requirements for radon barrier borrow material, consisting of soils with classifications of SC, CL, or CH or a combination of these, and having not less than 25% by weight passing the # 200 sieve.

**Compactors, heavy:** Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

**Compactors, light:** Vibrating or tamping compactors weighing less than 5000 lbs. and controlled by a walk-behind operator.

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) contamination.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials including mill tailings.

**Earthwork control grid:** Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

**Fines:** Mineral particles (soil or tailings) passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

**Foreign material:** Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.



Interim cover: Soil cover placed over tailing surfaces to prevent erosion until radon barrier cover can be placed

Job site: The location of the large tailing pile as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

Native soil, natural soil: Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

Outslope: Tailing impoundment outer slope with gradients between 0.10 and 0.20.

Pile: The large tailing impoundment.

Planarity: The degree to which a surface approaches a flat (but not necessarily horizontal) surface.

Radon barrier: Soil cover placed over tailings to limit radon flux; composed of clayey sand or clay soil.

Sand: Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% fines that classify as silt, according to reference c), and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% Fines that classify as clay, according to reference c), and liquid limit less than 50.

CH - same as CL except liquid limit 50 or more

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.

#### **1.4 List of Construction Drawings**

The following drawings are incorporated into this specification by reference:

- 4152-0 Title and Index Sheet
- 4152-11 Configuration of Large Tailing Impoundment After Recontouring
- 4152-13 Borrow Areas for Cover Soils
- 4152-14A Plan of Interim Cover and Soil Cover for Outslope Protection on Large Tailing Impoundment

#### **1.5 Included Work**

The activities required for the first phase of cover construction will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Preparation of Borrow Areas: Removal and disposal of vegetation, trash and other foreign material from the selected borrow areas; excavation of exploratory trenches as directed by the Owner.
- Excavation, hauling, placement, and compaction of interim cover soil on the top surface of the Pile.
- Excavation, hauling, placement, and compaction of clayey soil cover on the west and south outslope surfaces of the Pile.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.

#### **1.6 Related Work Performed by Others**

- Earthwork quality control: Sampling and testing to verify borrow material properties and specified field density, moisture content, and lift thicknesses of compacted soils.
- Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination.
- Settlement-point surveying (ongoing from earlier phases of the reclamation work, to record settlements of top surface of large pile)

#### **1.7 Responsibilities**

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to select and verify borrow soil properties, to verify finished lines and grades and excavation and fill quantities, and to document settlements.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures for the Owner that will include field density and moisture testing, field classification and selection of borrow materials, and other properties as needed.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present

on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## **PART 2 - EXECUTION**

The Contractor shall perform the following work:

### **2.1 Borrow Area Preparation**

The Contractor shall prepare borrow areas designated by the Owner prior to any excavation of borrow soil for cover construction. This preparation shall include:

- a) Clearing and grubbing of vegetation
- b) Removal of vegetation, trash, and other foreign material to an on-site location approved by the Owner. Vegetation may be burned after clearing and grubbing in lieu of disposal.
- c) Preservation and protection of wells, water lines, and power lines needed for water supply or for the Owner's ground water restoration.
- d) Preservation and protection of power lines, telephone lines and other utilities along rights-of-way within borrow areas.

### **2.2 Excavation and Hauling of Borrow Soil**

The Contractor shall excavate borrow soils at locations and to depths selected or approved by the Owner. All borrow soils used to construct the impoundment soil covers shall be excavated from approved borrow locations shown on Drawing 4152-13 or in other locations approved by Owner or its Engineer. In general, borrow soils will be excavated from the uppermost 5.0 feet of soil. Borrow soils for interim cover use will typically be sand soils with USCS classifications of SP, SM, or SP-SM with 100% passing 3.0 inch. Borrow soils for soil cover for outslope protection shall be clayey sand (SC), clay (CL, CH), or a mixture of these soils, containing not less than 25% fines (-#200 sieve) by weight and 100% passing 3/4 inch. Borrow soil suitable for clayey soil cover may be used for interim cover, but soils classified as SP, SM, or SP-SM shall not be used for outslope soil cover.

No borrow material shall be used in the soil cover that has contaminated material (concentrations of byproduct-derived Ra-226 in excess of 5.0 pCi/g). With a background radium concentration of 5.5 pCi/g, the maximum total radium content of borrow soil must be not more than 10.5 pCi/g unless excess concentrations have been demonstrated by soil tests to be naturally-occurring radium.

Excavated soil shall be hauled along travel routes selected, prepared and maintained by the Contractor. The east-west county road north of the large pile shall not be used as a haulage route and shall be protected from damage or obstruction caused by the Contractor's equipment or activity. If this road must be crossed by earth-hauling equipment, a flagman shall be posted at each crossing point to control traffic during earth-hauling operations. During and after earth-hauling operations, the Contractor shall perform those repairs necessary to preserve the road surface and to return it to a condition at least equal to the condition that existed before the Contractor's work under this specification began. To ascertain satisfaction of this requirement, the Contractor shall document the condition of the road surface prior to its work and shall seek concurrence in this condition and the adequacy of any subsequent repairs from the county public works department.

### **2.3 Placement and Compaction of Interim Cover**

The top surface of the large impoundment (that portion of the impoundment not including outslopes) will be covered with one foot of uncontaminated soil as an interim cover to protect against erosion of the

recontoured tailings surface during that time between the completion of recontouring and the time when the radon barrier can be placed.

The interim cover soil of the large impoundment shall be placed in six-inch lifts compacted to not less than 95% Standard Proctor density at a moisture content of -2% to +2% optimum.

No fill material shall be placed under adverse weather conditions, including freezing temperatures or during or immediately after heavy precipitation events unless approved by Owner. Owner shall determine when these adverse conditions exist. Before placement of the initial fill lift, and after any rain event that resulted in puddling of water or after any fill placement activity interruption in excess of two days, the impoundment surface shall be scarified prior to subsequent placement of any fill.

Final recontoured surface elevations of the top surface of the large pile may vary from those shown on Drawing 4152-11, depending on consolidation-induced settlements. Consequently, the final shape and contours of the interim cover on the top of the large pile shown on Drawing 4152-14A are representational only, and attainment of the elevations and gradients shown on Drawing 4152-14A is not required under this specification.

#### **2.4 Placement and Compaction of Soil Cover for Outslope Protection**

For this phase of cover construction, clayey soil cover shall be placed to a depth of 0.5 feet over the west and south outslopes of the large pile, as delineated on Drawing 4152-14A. Clayey soil cover shall be placed as soon as possible after those outslope surfaces of the large pile have been recontoured.

The outslope soil cover shall consist of clayey sand (SC), clay (CL, CH) or a mixture of these soils, containing not less than 25% fines (-#200 sieve) by weight and 100% passing 3/4 inch. The cover soil shall be placed in six-inch lifts compacted to not less than 95% Standard Proctor density at a moisture content of -2% to +2% optimum.

No clayey soil material shall be placed under adverse weather conditions, including freezing temperatures or during or immediately after heavy precipitation events unless approved by Owner. Owner shall determine when these adverse conditions exist. Before placement of the initial fill lift, and after any rain event that resulted in puddling of water or after any fill placement activity interruption in excess of two days, the impoundment surface shall be scarified prior to subsequent placement of any fill. The final surface of the clayey soil shall be rolled to create a surface free of ruts or ridges.

The outslope shall not exceed 0.20 (20% or 5H:1V) and the outslope surfaces shall not deviate from a planar surface by more than 1.0 feet amplitude over any 100 feet distance. Along any curved portion of an outslope the final surface shall have vertical undulations not greater than 1.0 feet amplitude over a distance of 100 feet measured perpendicular to the design contours.

#### **2.5 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

### **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

#### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

#### **3.2 Line and Grade Control**

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawings 4152-11 and 4152-14A. Gradients shall be surveyed as often as necessary to control fill placement. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

#### **3.3 Field and Laboratory Testing of Fill**

Testing of fill materials and in-place density and moisture will be performed by a qualified materials testing service contracted by Owner. The following tests will be performed:

- a) Particle-size analysis - One test by ASTM Method D-422 for each 1000 c.y. and not less than one each day of borrow excavation of both interim and clayey soils.
- b) Atterberg Limits - Minimum of one test per day of clayey soil or interim cover placement.
- c) In-place density and moisture of compacted fill - One test per 500 cubic yards or a minimum of two per day of fill placement activity, using the Sand Cone method, ASTM D 1556.
- d) Moisture-density standard - Standard Proctor density test using ASTM D-698, or ASTM Method D-2049 for cohesionless soils, and ASTM Methods D-2216 and D-4643 for moisture content will be performed at an initial frequency of one one-point test per 2500 cubic yards and one three-point test per 5000 cubic yards of fill placed.

Each field density test will be plotted on the earthwork control grid and recorded on test data sheets that become part of the permanent record of the project. The Contractor will be notified immediately when any test result fails to meet the minimum acceptable value in Part 2 of this specification.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of excavation and fill, area of final grading). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of excavation and fill (illustrated by distinctive colors or patterns) accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours).
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey.
- As-built drawings of completed work.

## **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

## **PART 6 - SCHEDULE**

Complete the Included Work by 90 days from Notice to Proceed.

**SPECIFICATION  
FOR  
CONSTRUCTION OF RADON BARRIER  
ON THE LARGE TAILING IMPOUNDMENT**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S4B**

**Revision 0**

**January 27, 1994**

**Prepared by:  
AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will place soil to form a radon barrier cover on the large tailing impoundment at its Grants, New Mexico operation as the second phase of cover construction in its reclamation plan for the uranium mill and tailing impoundments on that site. The first phase was placement of interim cover and clayey soil cover on portions of the large impoundment (Specification 4152-S4A). The large impoundment (see Drawing 4152-11), hereinafter referred to as the "Pile", contains 20-22 million tons of uranium mill tailings, covers approximately 170 acres, and is 85-100 feet high. The Pile is roughly rectangular in shape. The top was divided into two cells, an east pond area of approximately 55 acres and a west pond area of approximately 40 acres. These ponds, the enclosing dikes and the surrounding embankment out slopes have been reshaped by excavation of tailings and placement of tailings and contaminated soil from the adjacent areas as fill to produce the configuration shown on Drawing 4152-11.

Radon barrier will be constructed in two stages. The first stage of construction will consist of radon barrier placement on the out slopes. After a period of time, presently unknown but probably not less than one year from the date of this specification, the radon barrier will be placed on the top surface of the Pile. During earlier earthwork activities in the reclamation sequence, up to 4.0 feet of uncontaminated clayey sand or clay soil was placed on the west, north and south out slopes of the Pile, and a 1.0 foot interim cover of uncontaminated soil was placed on the top surface of the Pile, as protection against erosion of the tailings (Drawing 4152-14A). Radon barrier soils will be placed over these previously placed soils and directly over contaminated soils placed on the east out slopes of the Pile. All cover placement on the large pile will be on surfaces previously prepared and compacted to at least 90% of maximum Standard Proctor density, or 95% of maximum Standard Proctor density in the case of surfaces of previously placed interim cover or radon barrier.

All soil for radon barrier construction after the date of this revision will be excavated from the "North Borrow Area" delineated by the following points:

- Borrow areas must be prepared by clearing and grubbing before excavation of the cover soils.

### **1.2 Technical Definitions**

**Clayey soil:** Soil that satisfies the requirements for radon barrier borrow material, consisting of soils with classifications of SC, CL, or CH or a combination of these, and having not less than 25% by weight passing the # 200 sieve.

**Compactors, heavy:** Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

**Compactors, light:** Vibrating or tamping compactors weighing less than 5000 lbs. and controlled by a walk-behind operator.

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) contamination.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials including mill tailings.



Earthwork control grid: Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

Fines: Mineral particles (soil or tailings) passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

Foreign material: Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

Interim cover: Soil cover placed over tailing surfaces to prevent erosion until radon barrier cover can be placed

Job site: The location of the large tailing pile as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

Native soil, natural soil: Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

Outslope: Tailing impoundment outer slope with gradients between 0.10 and 0.20.

Pile: The large tailing impoundment.

Planarity: The degree to which a surface approaches a flat (but not necessarily horizontal) surface.

Radon barrier: Soil cover placed over tailings to limit radon flux; composed of clayey sand or clay soil.

Sand: Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% fines that classify as silt, according to reference c), and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% Fines that classify as clay, according to reference c), and liquid limit less than 50.

CH - same as CL except liquid limit 50 or more

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.
- d) d)Specification 4152-S4A, "First Phase Cover Construction on the Large Tailing Impoundment", Rev. 0, January 27, 1994

### 1.4 List of Construction Drawings

The following drawings are incorporated into this specification by reference:

- |          |   |
|----------|---|
| 4152-0   | Title and Index Sheet   |
| 4152-11  | Configuration of Large Tailing Impoundment After Recontouring                             |
| 4152-13  | Borrow Areas for Cover Soils  |
| 4152-14A | Plan of Interim Cover and Soil Cover for Outslope Protection on Large Tailing Impoundment |
| 4152-14B | Plan of Radon Barrier on Large Tailing Impoundment  |

### 1.5 Included Work

The activities required for radon barrier construction will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Preparation of Borrow Areas: Removal and disposal of vegetation, trash and other foreign material from the selected borrow areas; excavation of exploratory trenches as directed by the Owner.
- Excavation, hauling, placement, and compaction of clayey sand or clay soil on the outslope surfaces of the Pile.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.

### 1.6 Related Work Performed by Others

- Earthwork quality control: Sampling and testing to verify borrow material properties and specified field density, moisture content, and lift thicknesses of compacted soils.
- Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination.
- Settlement-point surveying (ongoing from earlier phases of the reclamation work, to record settlements of top surface of large pile)
- Piezometer installation: Drilling and installation of piezometers in the outslopes and top of the Pile.

## 1.7 Responsibilities

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to select and verify borrow soil properties, to verify finished lines and grades and excavation and fill quantities, and to document settlements.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures for the Owner that will include field density and moisture testing, field classification and selection of borrow materials, and other properties as needed.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## PART 2 - EXECUTION

The Contractor shall perform the following work:

### 2.1 Borrow Area Preparation

The Contractor shall prepare borrow areas designated by the Owner prior to any excavation of borrow soil for radon barrier construction. This preparation shall include:

- a) Clearing and grubbing of vegetation.
- b) Removal of vegetation, trash, and other foreign material to an on-site location approved by the Owner. Vegetation may be burned after clearing and grubbing in lieu of disposal.
- c) Preservation and protection of wells, water lines, and power lines needed for water supply or for the Owner's ground water restoration.
- d) Preservation and protection of power lines, telephone lines and other utilities along rights-of-way within borrow areas.

### 2.2 Excavation and Hauling of Borrow Soil

The Contractor shall excavate borrow soils at locations and to depths within the North Borrow Area selected or approved by the Owner.

The North Borrow Area may be expanded, if authorized by the Owner, to obtain quantities of radon barrier material beyond those available within 5-7 feet of ground surface.

In general, borrow soils will be excavated from the uppermost 5.0 feet of soil. Borrow soils for radon barrier placed after the date of this revision shall have the following average properties:

USCS Classification

CL or CH

Maximum Standard Proctor (ASTM D-698) Dry Density not less than 99.2 pcf

Optimum Moisture Content not less than 19.1%

No borrow material shall be used in the soil cover that has contaminated material (concentrations of byproduct-derived Ra-226 in excess of 5.0 pCi/g). With a background radium concentration of 5.5 pCi/g, the maximum total radium content of borrow soil must be not more than 10.5 pCi/g unless excess concentrations have been demonstrated by soil tests to be naturally-occurring radium.

Excavated soil shall be hauled along travel routes selected, prepared and maintained by the Contractor. The east-west county road north of the large pile shall not be used as a haulage route and shall be protected from damage or obstruction caused by the Contractor's equipment or activity. If this road must be crossed by earth-hauling equipment, a flagman shall be posted at each crossing point to control traffic during earth-hauling operations. During and after earth-hauling operations, the Contractor shall perform those repairs necessary to preserve the road surface and to return it to a condition at least equal to the condition that existed before the Contractor's work under this specification began. To ascertain satisfaction of this requirement, the Contractor shall document the condition of the road surface prior to its work and shall seek concurrence in this condition and the adequacy of any subsequent repairs from the county public works department.

### **2.3 Placement and Compaction of Radon Barrier**

Radon barrier consisting of soils from the North Borrow Area and designated by the Owner shall be placed as follows:

Top surface of pile:

First 2.0 feet - Lifts not to exceed 1.0 feet loose thickness compacted to not less than 100% maximum dry density with moisture content within 2% of optimum per ATSM D-698.

Above first 2.0 feet - Lifts not to exceed 1.0 feet loose thickness compacted to not less than 95% maximum dry density with moisture content within 2% of optimum per ATSM D-698.

Outslope surfaces of pile:

East outslope, placed over contaminated soil lifts - Lifts not to exceed 1.0 feet loose thickness compacted to not less than 100% maximum dry density with moisture content within 2% of optimum per ATSM D-698. Required minimum compacted thickness of additional cover is 0.5 feet.

Outslope aprons on south, west and north sides of pile:

1.5 feet of compacted thickness - Lifts not to exceed 1.0 feet loose thickness compacted to not less than 95% maximum dry density with moisture content within 2% of optimum per ATSM D-698.

No radon barrier material shall be placed under adverse weather conditions, including freezing temperatures or during or immediately after heavy precipitation events unless approved by Owner. Owner shall determine when these adverse conditions exist. Before placement of the initial fill lift, and after any rain event that resulted in puddling of water or after any fill placement activity interruption in excess of two days, the impoundment surface shall be scarified prior to subsequent placement of any fill. The final surface of the radon barrier shall be rolled to create a surface free of ruts or ridges.

The outslope radon barrier surface shall not exceed 0.20 (20% or 5H:1V) and the outslope surfaces shall not deviate from a planar surface by more than 1.0 feet amplitude over any 100 feet distance, except that along any curved portion of an outslope the final surface shall have vertical undulations not greater than 1.0 feet amplitude over a distance of 100 feet measured perpendicular to the design contours.

## **2.4 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

## **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### **3.2 Line and Grade Control**

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawings 4152-11 and 4152-14B. Gradients shall be surveyed as often as necessary to control fill placement. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### **3.3 Field and Laboratory Testing of Fill**

Testing of fill materials and in-place density and moisture will be performed by a qualified materials testing service contracted by Owner. The following tests will be performed:

- a. Particle-size analysis - One test by ASTM Method D-422 for each 1000 c.y. and not less than one each day of borrow excavation of radon barrier soils.
- b. Atterberg Limits - Minimum of one test per day of radon barrier placement.
- c. In-place density and moisture of compacted fill - One test per 500 cubic yards or a minimum of two per day of fill placement activity, using the Sand Cone method, ASTM D 1556.
- d. Moisture-density standard - Standard Proctor density test using ASTM D-698, and ASTM Methods D-2216 and D-4643 for moisture content will be performed at an initial frequency of one one-point test per 2500 cubic yards and one three-point test per 5000 cubic yards of fill placed.

Each field density test will be plotted on the earthwork control grid and recorded on test data sheets that become part of the permanent record of the project. The Contractor will be notified immediately when any test result fails to meet the minimum acceptable value in Part 2 of this specification.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of excavation and fill, area of final grading). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of excavation and fill (illustrated by distinctive colors or patterns) accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours).
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey.
- As-built drawings of completed work.

## **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

## **PART 6 - SCHEDULE**

Complete the first stage of radon barrier by 270 days from Notice to Proceed. Complete the second stage of radon barrier by 245 days from Notice to Proceed.

**SPECIFICATION**  
**FOR**  
**CONSTRUCTION OF INTERIM SOIL COVER ON**  
**THE SMALL TAILING IMPOUNDMENT**

**HOMESTAKE MINING COMPANY OF CALIFORNIA**  
**GRANTS OPERATION**  
**NEW MEXICO**

**NO. 4152-S4C**

**Revision 0**

**January 29, 1994**

**Prepared by:**  
**AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will place interim soil cover on a portion of the small tailing impoundment at its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. The small impoundment ("small pile") contains 1.22 million tons of tailings contained within a pentagon-shaped perimeter dike system constructed of natural soil (Drawing 4152-12). Most of the surface of this pile, about 29 acres, is covered by a lined evaporation pond. The remaining part of the small pile, about 24 acres, has tailings or contaminated soil exposed at the surface and not covered by liner or native soil.

The west, north, and east dikes of the original small pile are now incorporated into the dikes containing the evaporation pond. The remaining dikes, forming the southwest and southeast sides of the pentagon, together with the south dike of the evaporation pond define the area to be covered with the interim cover. This triangular shaped area (Drawing 4152-12) will be used for disposal of contaminated soil. The exact volume of contaminated soil to be placed in the small pile cannot be determined until the Owner has completed excavation of contaminated soil. However, the configuration of the small pile, with expected maximum capacity for contaminated soil plus one foot of interim cover placed, is shown on Drawing 4152-15.

The work to be performed consists of covering the exposed tailing or contaminated surfaces of the small pile with an interim cover of uncontaminated native soil that will be excavated from selected borrow locations on HMC property near the small pile (Drawing 4152-13). One foot of interim soil cover will be placed on exposed tailing or contaminated soil surfaces of the small pile, as shown on Drawing 4152-15. Except for the surface of the south dike of the evaporation pond, no preparation or compaction of the exposed tailing or contaminated soil surfaces of the small pile has been performed, and some preparation and compaction of these surfaces might be required to create a stable working base for interim cover placement on the small pile.

### **1.2 Technical Definitions**

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) contamination.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials including mill tailings.

**Earthwork control grid:** Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

**Fines:** Mineral particles (soil or tailings) passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

**Foreign material:** Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

**Interim Cover:** Uncontaminated soil placed over tailing surfaces to prevent erosion of tailings until the radon barrier cover can be placed.

**Job site:** The location of the small tailing pile as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.



Native soil, natural soil: Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

Slimes: Tailings containing more than 50% silt and clay sizes (minus #200 sieve) classified as CL, CH, ML, or MH soil. Moisture content is variable but typically at saturation levels.

Small tailing impoundment, small pile: The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% fines that classify as silt, according to reference c), and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% fines that classify as clay, according to reference c), and liquid limit less than 50.

CH - same as CL except liquid limit 50 or more

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.

### 1.4 List of Construction Drawings

The following drawings are incorporated into this specification by reference:

- |         |   |
|---------|---|
| 4152-0  | Title and Index Sheet   |
| 4152-12 | Configuration of Small Tailing Impoundment Before Interim Cover Placement |
| 4152-13 | Borrow Areas for Cover Soils  |
| 4152-15 | Plan of Interim Cover Placement on Small Tailing Impoundment              |

### **1.5 Included Work**

The activities required for interim cover construction will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Preparation of Borrow Areas: Removal and disposal of vegetation, trash and other foreign material from the selected borrow areas; excavation of exploratory trenches as directed by the Owner.
- Excavation, hauling, placement, and compaction of interim cover soil on the south end of the small pile.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.

### **1.6 Related Work Performed by Others**

- Earthwork quality control: Sampling and testing to verify borrow material properties and specified field density, moisture content, and lift thicknesses of compacted soils.
- Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination.

### **1.7 Responsibilities**

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to select and verify borrow soil properties, to verify finished lines and grades and excavation and fill quantities.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures for the Owner that will include field density and moisture testing, field classification and selection of borrow materials, and other properties as needed.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## **PART 2 - EXECUTION**

The Contractor shall perform the following work:

### **2.1 Borrow Area Preparation**

The Contractor shall prepare borrow areas designated by the Owner prior to any excavation of borrow soil for cover construction. This preparation shall include:

- a) Clearing and grubbing of vegetation
- b) Removal of vegetation, trash, and other foreign material to an on-site location approved by the Owner. Vegetation may be burned after clearing and grubbing in lieu of disposal.

- c) Preservation and protection of wells, water lines, and power lines needed for water supply or for the Owner's ground water restoration and operation of the evaporation pond on the small pile.
- d) Preservation and protection of power lines, telephone lines and other utilities along rights-of-way within borrow areas.

## **2.2 Grading of Existing Dike Outsoles**

The Contractor shall grade the existing outsoles of the southwest and southeast dikes to form a slope gradient not greater than 5H:1V, or 0.20. The soil originally used to construct these dikes was native soil. However, now some of this soil may be contaminated by tailings. Therefore, the Contractor shall establish the required gradient by excavation of outslope soils, using methods that will place soils that are excavated from the outsoles to locations within the triangular area and not less than 10 feet inside the final outslope surface. To accomplish this, the 0.20 gradient shall be established from a hinge line at the toe of the existing slope. The Contractor shall not move any dike soils from higher to lower positions on the outsoles. Any portion of the existing outslope flatter than 5H:1V will not require grading under this specification.

## **2.3 Excavation and Hauling of Borrow Soil**

The Contractor shall excavate borrow soils at locations and to depths selected or approved by the Owner. All borrow soils used to construct the impoundment soil covers shall be excavated from approved borrow locations shown on Drawing 4152-13 or in other locations approved by Owner or its Engineer. In general, borrow soils will be excavated from the uppermost 5.0 feet of soil. Borrow soils for interim cover use will be typically be sand soils with USCS classifications of SP, SM, or SP-SM with 100% passing 3.0 inch. Interim cover may also be clayey sand (SC) or a mixture of SC and clay (CL, CH). Borrow soil identified and reserved by the Owner as suitable for radon barrier may be used for interim cover only if approved by the Owner.

No borrow material shall be used in the interim cover that has contaminated material (concentrations of byproduct-derived Ra-226 in excess of 5.0 pCi/g). With a background radium concentration of 5.5 pCi/g, the maximum total radium content of borrow soil will be not more than 10.5 pCi/g unless excess concentrations have been demonstrated by soil tests to be naturally-occurring radium.

Excavated soil shall be hauled along travel routes selected, prepared and maintained by the Contractor. The east-west county road north of the large pile shall not be used as a haulage route and shall be protected from damage or obstruction caused by the Contractor's equipment or activity. If this road must be crossed by earth-hauling equipment, a flagman shall be posted at each crossing point to control traffic during earth-hauling operations. During and after earth-hauling operations, the Contractor shall perform those repairs necessary to preserve the road surface and to return it to a condition at least equal to the condition that existed before the Contractor's work under this specification began. To ascertain satisfaction of this requirement, the Contractor shall document the condition of the road surface prior to its work and shall seek concurrence in this condition and the adequacy of any subsequent repairs from the county public works department.

## **2.4 Placement and Compaction of Interim Cover**

The exposed top surface of the small pile (that portion of the impoundment not covered by the evaporation pond or the west, north, and east dikes of that pond) and the outsoles of the southwest and southeast dikes of the small pile down to the top of the 5H:1V outslope created in accordance with section 2.2 of this specification (estimated to average about elevation 6580) shall be covered with one foot of uncontaminated soil as an interim cover. The interim cover shall be placed only after all contaminated soil has been excavated from the site and vicinity and placed in the tailing piles. The Owner

will determine when the interim cover may be placed, based on related work performed under Specifications 4152-S3 and -S3A.

The interim cover soil shall be placed in six-inch lifts compacted to not less than 95% Standard Proctor density at a moisture content of -2% to +2% optimum.

No fill material shall be placed under adverse weather conditions, including freezing temperatures or during or immediately after heavy precipitation events. HMC shall determine when these adverse conditions exist. Before placement of the initial fill lift, and after any rain event that resulted in puddling of water or after any fill placement activity interruption in excess of two days, the impoundment surface shall be scarified prior to subsequent placement of any fill.

Final elevations of the top surface of contaminated soil or tailings on the small pile will depend on actual contaminated soil volumes placed and consolidation-induced settlements. Consequently, the final shape and contours of the interim cover on the top of the small pile shown on Drawing 4152-15 are representational only, and attainment of the elevations and gradients shown on Drawing 4152-15 is not required under this specification. However, the Contractor shall finish the interim cover to create a surface free of depressions and with an overall southward gradient not greater than 0.02.

## **2.5 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

## **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### **3.2 Line and Grade Control**

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawing 4152-12. Gradients shall be surveyed as often as necessary to control fill placement. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### **3.3 Field and Laboratory Testing of Fill**

Testing of fill materials and in-place density and moisture will be performed by a qualified materials testing service contracted by Owner. The following tests will be performed:

- Particle-size analysis - One test by ASTM Method D-422 for each 1000 c.y. and not less than one each day of borrow excavation of interim cover soils.
- Atterberg Limits - Minimum of one test per day of interim cover placement.
- In-plane density and moisture of compacted fill - One test per 500 cubic yards or a minimum of two per day of fill placement activity, using the Sand Cone method, ASTM D 1556.
- Moisture-density standard - Standard Proctor density test using ASTM D-698, or ASTM Method D-2049 for cohesionless soils, and ASTM Methods D-2216 and D-4643 for moisture content will be performed at an initial frequency of one one-point test per 2500 cubic yards and one three-point test per 5000 cubic yards of fill placed.

Each field density test will be plotted on the earthwork control grid and recorded on test data sheets that become part of the permanent record of the project. The Contractor will be notified immediately when any test result fails to meet the minimum acceptable value in Part 2 of this specification.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of excavation and fill, area of final grading). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of excavation and fill (illustrated by distinctive colors or patterns) accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours)
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey As-built drawings of completed work.

## **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

## **PART 6 - SCHEDULE**

Complete the Included Work by 30 days from Notice to Proceed.

**SPECIFICATION  
FOR  
CONSTRUCTION OF SOIL COVER OVER MILL AREA AND DISPOSAL PITS**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S5**

**Revision 0**

**December 31, 1993**

**Revision 1**

**September 18, 1995**

**Prepared by:**

**AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) has demolished most of the structures and utilities of its uranium mill at its Grants, New Mexico operation as part of its reclamation plan for the site. The plan of the mill site before demolition and the structures removed during demolition are shown on Drawing 4153-2A. Some structures have been left intact to support site operations through subsequent reclamation activities. The debris from demolition has been buried in disposal pits excavated within or near the mill area. Components with more than 10% non-compressible internal void space were filled with sand-cement slurry grout or placed in a subgrade pit that was filled with sand-cement slurry grout. Some foundations have also been left in place at or below existing grade.

The work to be performed consists of covering all mill-area and disposal pit surfaces, as shown on Drawing 4152-16, with not less than 2.0 feet of compacted clean soil obtained from a designated location on HMC property. The soil to be used for this cover is coarse-grained alluvium consisting of sand and gravel with some cobbles and fines and has a USCS soil classification of SP, SW, GP, GW or some combination of these. This soil forms a terrace between two shallow drainage courses and extends from New Mexico Route 605 (east side of the mill site) eastward for at least one mile (Drawing 4152-13). The terrace soils vary over this distance from a few hundred to over 1000 feet wide and up to 20 feet thick. The surface of the mill area cover must be graded to promote positive, controlled drainage of runoff toward the west and southwest, as shown on Drawing 4152-16.

### **1.2 Technical Definitions**

**Compactors, heavy:** Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) containment.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials.

**Earthwork control grid:** Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

**Fines:** Mineral particles passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

**Foreign material:** Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

**Job site:** The mill area as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

**Native soil, natural soil:** Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

**Pile:** The large tailing impoundment.

**Sand:** Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).



Small tailing impoundment, small tailing pile: The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications within the mill area and borrow areas are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% Fines that classify as silt, according to reference b, and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% Fines that classify as clay, according to reference b, and liquid limit less than 50%.

CH - same as CL except liquid limit 50 or more

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.

### 1.4 List of Construction Drawings

The following drawings are incorporated into this specification by reference:

- |         |   |
|---------|---|
| 4152-0  | Title and Index Sheet                     |
| 4152-13 | Borrow Areas for Cover Soils              |
| 4152-16 | Plan of Mill-Area and Disposal Pits Cover |

For information only:

- |         |                               |
|---------|-------------------------------|
| 4153-2A | Mill Area Demolition - Plan A |
|---------|-------------------------------|

### 1.5 Included Work

The activities required for construction of the cover over the mill area and disposal pits will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Preparation of Borrow Areas: Removal and disposal of vegetation, trash and other foreign material from the selected borrow areas; excavation of exploratory trenches as directed by the Owner.
- Earthwork: Excavation, hauling, placement, and compaction of cover soil.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.
- Protection and replacement of fences and utilities: Protection of fences and utilities from damage, and replacement of fences and utilities that are disturbed.

### 1.6 Related Work Performed by Others

- Mill Demolition: Demolition and burial of mill structures and equipment and burial of scrap materials.
- Earthwork quality control: Sampling and testing to verify borrow material properties and specified field density, moisture content, and lift thicknesses of compacted soils.
- Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination.

### 1.7 Responsibilities

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to select and verify borrow soil properties, to verify finished lines and grades and excavation and fill quantities, and to document settlements.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures for the Owner that will include field density and moisture testing, field classification and selection of borrow materials, and other properties as needed.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## **PART 2 - EXECUTION**

The Contractor shall perform the following work:

### **2.1 Borrow Area Preparation**

The Contractor shall prepare borrow areas designated by the Owner prior to any excavation of borrow soil for cover construction. This preparation shall include:

- a) Clearing and grubbing of vegetation
- b) Removal of vegetation, trash, and other foreign material to an on-site location approved by the Owner. Vegetation may be burned in lieu of removal for disposal.
- c) Preservation and protection of wells, water lines, and power lines needed for HMC's site operations, water supply or for the Owner's ground water restoration.
- d) Preservation and protection of power lines, telephone lines, pipelines and other utilities along rights-of-way within borrow areas.

Fences may be removed for access to borrow areas provided that if any license-boundary (security) fence is breached, a guard shall be posted at each such location during working hours and all such openings shall be closed during non-working hours.

### **2.2 Excavation and Hauling of Borrow Soil**

The Contractor shall excavate borrow soils at locations and to depths selected or approved by the Owner. All borrow soils used to construct the soil covers shall be excavated from approved borrow locations shown on Drawing 4152-13 or in other locations approved by Owner or its Engineer. All fill material used to cover the mill area and disposal pits shall be gravelly sand or sand soil (USCS Classification SP, SC, SM, SW, GW, GP, or SP-SM) that contains not more than 10.5 pCi/g of Ra-226. Borrow areas for this material are designated on Drawing 4152-13.

No borrow material shall be used in the soil cover that has contaminated material (concentrations of byproduct-derived Ra-226 in excess of 5.0 pCi/g). With a background radium concentration of 5.5 pCi/g, the maximum total radium content of borrow soil will be not more than 10.5 pCi/g unless excess concentrations have been demonstrated by soil tests to be naturally-occurring radium.

Excavated soil shall be hauled along travel routes selected, prepared and maintained by the Contractor. The east-west county road north of the large pile and New Mexico Route 605 shall not be used as haulage routes by scrapers and shall be protected from damage or obstruction caused by the Contractor's equipment or activity. If either road must be crossed by earth-hauling equipment, a flagman shall be posted at each crossing point to control traffic during earth-hauling operations. During and after earth-hauling operations, the Contractor shall perform those repairs necessary to preserve the road surfaces and to return them to a condition at least equal to the condition that existed before the Contractor's work under this specification began. To ascertain satisfaction of this requirement, the Contractor shall document the condition of the road surface prior to its work and shall seek concurrence in this condition and the adequacy of any subsequent repairs from the county and state road departments.

### **2.3 Placement and Compaction of the Cover**

Soil excavated and hauled in accordance with Section 2.2 above shall be placed and compacted in lifts over all mill area and disposal pit surfaces, illustrated on Drawing 4152-16, and on other additional surfaces identified by the Owner. Cover shall be placed to a total thickness following final compaction of not less than 2.0 feet within the limits shown on Drawing 4152-16, and beyond those limits to lateral

extents and thicknesses necessary to establish a finished surface that merges smoothly with adjacent ground surfaces.

Initial soil lifts shall be placed directly on exposed surfaces of the mill area ground, dismantled mill components, foundations, and disposal pits. Any initial lift placed directly in contact with this debris shall be saturated with clean water and shall continue to be wetted as necessary to force the fill material into residual void spaces below and within the mill debris. Additional fill shall be placed in voids using this wetting process until all such voids are filled and no more voids are created by this wetting procedure. No subsequent fill, placed with standard earthwork methods, shall be placed in these locations until the Owner has inspected and approved each location for additional fill placement.

Initial and successive lifts shall be placed not to exceed 12 inches uncompacted thickness. Compaction of all lifts, except those initial lifts wetted to fill subsurface voids, shall be achieved by the movement of heavy equipment (scrapers, dozers, etc.).

The final surface of all cover areas shall be prepared by compaction and final grading to produce the configuration shown on Drawing 4152-16. The final surface shall be compacted to not less than 90% maximum dry density per ASTM D-698 or at least 80% relative density per ASTM D-2049, whichever is appropriate for the fill material being used.

Rock shall be added to the top lift of the mill cover as specified in Amendment No. 1 to this specification.

#### **2.4 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

#### **2.5 Protection and Replacement of Fences and Utilities**

The Contractor shall take whatever measures are necessary to protect fences and utilities from damage related to its work under this specification. If necessary for the performance of the work, the Contractor may temporarily remove or relocate fences or utilities at its own expense and as approved by the Owner. Any fence or utility temporarily removed or relocated for this purpose shall be restored to its original location and to not less than its condition prior to removal or relocation.

If any fence that is part of the licensed-area boundary is breached or removed for the Contractor's work, the Contractor shall provide a guard at each such location and at all times until the fence is restored. The guard shall perform its duties in accordance with the Owner's instructions.

### **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

#### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### 3.2 Line and Grade Control

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawing 4152-16. Gradients shall be surveyed as often as necessary to control fill placement. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 (or most current version) plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### 3.3 Field and Laboratory Testing of Fill

Testing of fill materials and in-place density will be performed by a qualified materials testing service contracted by Owner. The following tests will be performed:

- a) Moisture-Density relationship testing: One test (ASTMD698 or ASTMD-2049) per 10000 cubic yards of material placed in the topmost 2.0 feet of cover.
- b) In-place density: One test (ASTMD-1556 or ASTMD-2922) per 5000 cubic yards of cover soil placed.
- c) Grain size/Soil classification (ASTMD-422): One per 5000 cubic yards.

Each field density test will be plotted on the earthwork control grid and recorded on test data sheets that become part of the permanent record of the project. The Contractor will be notified immediately when any test result fails to meet the minimum acceptable value in Part 2 of this specification.

## PART 4 - DOCUMENTATION

### 4.1 Documentation by Contractor

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of excavation and fill, area of final grading). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of borrow excavation and fill placement (illustrated by distinctive colors or patterns) accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours)
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

#### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey
- As-built drawings of completed work.

#### **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

#### **PART 6 - SCHEDULE**

Complete the Included Work by \_\_\_\_\_ days from Notice to Proceed.

**AMENDMENT NO. 1  
TO  
SPECIFICATION 4152.S5  
Revised 11/15/95**

The following is added to the end of Section 2.3 of the subject specification, on page 6:

Crushed rock (basalt), obtained from the same source as the rock used for erosion protection of the tailing impoundment surfaces, shall be mixed into the uppermost lift of the mill cover. The rock shall have a maximum size of 3.0 inches and a  $d_{50}$  of not less than 0.5 inches. This rock shall be placed in a single lift of not less than 2.0 inches over all mill cover surfaces, then mixed into the soil to a depth of not more than two times the rock lift thickness, unless otherwise approved or directed by the Owner. The mixing method shall be selected by the Contractor and shall achieve sufficient mixing to produce gradations of the resulting rock-soil mixes that have  $d_n$  values of not less than:

- a) 0.75 inches for rock-soil mix prepared using rock with  $d_{50}$  of not less than 1.0 inches ("large mix"), and
- b) 0.35 inches for rock-soil mix prepared using rock with  $d_{50}$  of not less than 0.5 inches ("small mix"),

Large mix shall be used in all locations that:

- a) lie between N1,542,200 and N1,542,600 and have surface gradients steeper than 0.03
- b) lie north of N1,542,700 and west of E493,500 and also have surface gradients steeper than 0.03
- c) are drainage courses for runoff from both the mill area and tailing impoundment or the mill area and diversion levee.

Large mix may be used in other locations approved or directed by the Owner. In all other mill cover locations the small mix shall be used.

After the rock-soil lift has been mixed enough to meet the gradation requirements above, the lift shall be compacted as required in Section 2.3 of this specification with the exception that the rock-soil lift (which will be subsequently disced, mulched and seeded) will not be required to meet the compaction standard of 90% ASTM D-698 dry density that applies to the underlying soil-only lifts.

**SPECIFICATION**  
**FOR**  
**CONSTRUCTION OF ROCK COVERS AND OTHER EROSION PROTECTION**  
**ON THE LARGE TAILING IMPOUNDMENT**

HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO

NO. 4152-S6

Revision 0

February 1, 1994

Prepared by:  
AK GeoConsult, Inc.



## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will place rock covers, riprap, and a scour protection trench on the large tailing impoundment at its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. The large impoundment, hereinafter referred to as the "Pile", contains 20-22 million tons of uranium mill tailings, covers approximately 170 acres, and is 85-100 feet high. The Pile is roughly rectangular in shape. The top was divided into two cells, an east pond area of approximately 55 acres and a west pond area of approximately 40 acres. These ponds, the enclosing dikes and the surrounding embankment outslopes have been reshaped by excavation of tailings and placement of tailings and contaminated soil from the adjacent areas as fill to produce the configuration shown on Drawing 4152-11. The Pile will be covered with a soil cover (radon barrier) that will be at least 4.0 feet thick, consisting of clayey sand and clay soils compacted to not less than 95% of maximum Standard Proctor density. The radon barrier will be protected from erosion by rock covers on the top and outslope surfaces, riprap on a portions of the lower antelopes, and a toe apron or a below-grade scour protection trench around a portion of the antelope toe.

The rock covers consist of two different covers:

- a. Top cover - A layer of rock covering all portions of the Pile top, a surface with gradients less than 0.10. This cover will be not less than 0.5 feet thick and will consist of rock with a  $d_{50}$  not less than 1.16 inches.
- b. Outslope cover - A two-part cover consisting of a lower 0.5 foot thick bedding layer of  $d_{15}$  not larger than #10 sieve and  $d_{50}$ , not larger than #4 sieve and an upper 0.8 foot thick layer of rock with a  $d_{50}$  not less than 4.7 inches.

Other erosion protection to be constructed includes:

- a. Outslope toe apron - A 10-foot wide extension of the upper layer of the outslope rock cover along the south and east outslope toes of the Pile.
- b. Riprap - A riprap layer extending from the design flood crest elevations on the lower part of the north and west outslopes downward to the scour protection trench.
- c. Scour protection trench - A below-grade rock blanket extending along a 0.58 maximum grade from the outslope toe to a depth of not less than 7.7 feet below adjacent natural ground level.

The rock to be used for the rock covers and other erosion protection is basalt. This rock is quarried, crushed, screened to size, and stockpiled at the quarry site located about 1.5 miles west of the west end of the Pile.

The work to be performed consists of loading and hauling the rock from the stockpiles at the quarry site; placing the rock on the radon barrier surfaces and toe apron surfaces; finish-grading the rock cover surfaces; and excavating, placing rock in, and backfilling the erosion protection trenches. The locations of the rock covers and other erosion protection measures are shown on Drawing 4152-17.

### **1.2 Technical Definitions**

$d_{50}$  : The size, in mean diameter, of the rock material of which 50% by weight is finer.

Earthwork control grid: Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

Fines: Mineral particles passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

Foreign material: Any solid material that is not basalt. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

Job site: The location of the large tailing Pile as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

Native soil, natural soil: Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

Pile: The large tailing impoundment.

Planarity: The degree to which a surface approaches a flat (but not necessarily horizontal) surface.

Sand: Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### **1.3 List of Construction Drawings**

The following drawings are incorporated into this specification by reference:

- |          |   |
|----------|---|
| 4152-0   | Title and Index Sheet   |
| 4152-11  | Configuration of large Tailing Impoundment After Recontouring                                 |
| 4152-14A | Plan of Interim Cover and Soil Cover for Outslope protection on the large Tailing Impoundment |
| 4152-14B | Plan of Radon Barrier on Large Tailing Impoundment  |
| 4152-17  | Plan of Rock Cover and Other Erosion Protection, Large Tailing Impoundment                    |

### **1.4 Included Work**

The activities required for rock cover and other erosion protection construction will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- a. Preparation of haulage routes: Stripping and disposal of vegetation along haulage route; excavation, haulage and placement of soil or rock needed to construct travel surfaces; and installation of fences and gates needed for restriction of access to haulage routes.
- b. Rock placement: Loading, hauling and placement of rock for rock cover layers, riprap and toe aprons.
- c. Scour protection trenches: Excavation and backfilling of soil; loading, hauling and placement of rock for construction of scour protection trenches.
- d. Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.

### **1.5 Related Work Performed by Others**

- a. Rock production: Quarrying, crushing, screening and stockpiling of rock
- b. Earthwork quality control: Sampling and testing to verify rock properties at the quarry site and gradations and thicknesses of placed rock

- c. Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination

## 1.6 Responsibilities

- a. Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to verify rock properties, to measure gradations and thicknesses of placed rock, and to verify finished lines and grades and placed-rock quantities.
- b. AK GeoConsult. Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures.
- c. Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for limiting size segregation of rock materials during hauling and placement controlling thicknesses of rock layers, and achieving specified lines and grades of rock layers and finished rock cover surfaces.

## PART 2 - EXECUTION

The Contractor shall perform the following work:

### 2.1 Haul Route Preparation and Maintenance

The Contractor shall select, prepare and maintain one or more haul roads from the rock stockpiles at the rock quarry to the Pile. The east-west county road shall not be used for hauling rock. The Contractor shall select the route alignment(s) and obtain approval from the Owner before preparing the route(s) for hauling of rock. Preparation shall include:

- a. Clearing of vegetation and removal to an on-site disposal location approved by the Owner. Vegetation may be burned in lieu of removal for disposal.
- b. Preservation and protection of wells, water lines, and power lines needed for water supply or for the Owner's ground water restoration.
- c. Preservation and protection of power lines, telephone lines and other utilities along rights-of-way crossed by the haul route(s).
- d. Hauling and placement of soil or rock to construct the haul road surfaces. The Contractor may use any rock or soil it deems appropriate for this purpose. If the source of the rock or soil to be used is located on the Owner's property, the Contractor shall identify the location, types and volumes of material needed, submit a plan for regrading and revegetation of the borrow location, and obtain the Owner's approval before using that source.
- e. Maintaining the haul road(s), including dust control, for the entire period of use.
- f. Regrading and revegetation of both the haul-road construction material borrow site and the haul road(s) in accordance with a plan prepared by the Contractor and approved by the Owner.

Fences may be temporarily removed where they cross the haul route(s) provided that if any license-boundary (security) fence is breached, a guard shall be posted at each such location during working hours and all such openings shall be closed during non-working hours.

## **2.2 Loading, Hauling and Placement of Rock**

The Contractor shall load and haul rock from the stockpile at the quarry site, designated by the Owner, to placement locations on the Pile.

All rock used for rock covers and erosion protection shall be basalt developed by a third party at a quarry on the Owner's property in the N 1/2, NE 1/4, Section 28, T 12 N, R 10 W located approximately 1.5 miles west of the large tailing impoundment.

### **2.2.1. Rock covers**

Rock covers shall be 90%-125% of the following thicknesses:

large impoundment top	0.5 feet
large impoundment bedding	0.5 feet
large impoundment outslope	0.8 feet

A bedding layer will be placed on all outslope surfaces before placement of rock cover or riprap on those surfaces.

Rock for covers and riprap shall be landed, hauled and placed by methods that maintain the gradation ranges in the stockpiled rock and prevent segregation of sizes during transport and placement.

The rock shall be placed and spread to create a uniform surface on the rock cover that is free of visible high or low spots. The planarity of the surface will be acceptable if irregularities of the surface do not exceed +/- 1.0 feet vertical difference from the design gradient surface over 100 feet and +/- 0.5 feet vertical difference within any 10-foot segment of a 100-foot survey line. On the rounded corners of the Pile this irregularity criterion shall apply along radial lines down the slope, perpendicular to the elevation contours.

### **2.2.2 Riprap**

The erosion protection (riprap) cover shall be placed in lieu of the outslope cover on the lower portions of the north and west outslopes, as shown on Drawing 4152-17. Riprap shall consist of the same rock used for the outslope rock cover. A bedding layer of 0.5 feet shall be placed before the riprap is placed. The thickness of the riprap shall be not less than 1.0 feet and shall extend to the bottom of the north and west outslopes (i.e. the downslope end of the 0.20 gradient outslope) from the following elevations on the Pile:

Southwest corner	6572.5
Northwest corner	6585.5
Northeast corner	6592.8

The upslope extent of the riprap shall be determined by straight lines connecting these elevations.

### **2.2.3 Below-grade Scour Protection**

The below-grade scour protection for the north and west sides of the reclaimed Pile shall contain rock with the same sizes and gradations as that used for the outslope rock cover. The configuration of this scour protection is shown on Drawing 4152-17.

The scour protection shall be constructed by first excavating a trench to at least 7.7 feet below the outslope toe elevation, as shown on Drawing 4152-17. After the excavation of this trench, which shall

have an inside slope not greater than 30 degrees (maximum gradient of 0.58), the trench shall be backfilled initially by dumping rock on this inside slope to form a rockfill on which the top width is at least 5.0 feet and the bottom width is at least 2.0 feet. The construction of the scour protection shall be completed by backfilling the remaining open space of the trench with soil that was initially excavated from this trench. No specific compaction of this soil is required; however, the soil will be placed by and compacted by dozer.

#### **2.2.4 Toe Apron**

Along the south and east outslope toes of the large impoundment, where no below-grade scour protection is required, the rock cover will be extended 10 feet beyond the toe of the outslope, as shown on Drawing 4152-17. This toe apron will consist of the same rock sizes and gradations as the outslope rock cover and will be constructed so that the surface of the toe apron slopes away from the toe and the outer edge of the top surface is at the same elevation as the adjacent ground surface.

#### **2.3 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

### **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

#### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

#### **3.2 Line and Grade and Planarity Control**

The Contractor shall perform land surveying to determine that the specified lines and grades and planarity have been achieved in accordance with the limits established in this specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawing 4152-17. Gradients shall be surveyed as often as necessary to control rock placement.

If any part of the rock layer surface appears by visual examination of the Owner to exceed the planarity limits, that part shall be surveyed to quantify the magnitude of irregularities. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 (or current version) plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### **3.3 Field and Laboratory Testing of Rock and Rock Placement**

Testing of rock for the necessary properties and gradations will be performed on rock in the stockpiles at the quarry by a qualified materials testing service contracted by Owner. The contractor shall have no responsibility for the rock until it removes rock from the stockpiles. The testing service will perform measurements and tests to determine size gradations and layer thicknesses of the placed rock according to the following frequencies:

- a. Visual inspection of rock delivered to the site and rock placement will be performed at least once daily.
- b. Visual inspection of rock cover surfaces will be performed at least once in each control grid cell (100 feet x 100 feet) to evaluate surface uniformity and planarity. If the visual inspection results in uncertainty or dispute about adequacy of planarity at any location, the location shall be surveyed by rod and level, or other method of at least equal accuracy, to determine if allowable limits of surface irregularity are exceeded along 100-foot long horizontal and slope-gradient lines of a 20-foot square grid covering the location in question. The allowable limits are  $\pm 1.0$  feet vertical difference from the design gradient surface over 100 feet and  $\pm 0.5$  feet vertical difference within any 10-foot segment of a 100-foot survey line. This requirement does not negate or substitute for rock thickness testing required below.
- c. One size and gradation test using a portable screen stack shall be performed for every 5000 cy of rock or bedding placed on the Pile.
- d. Rock and bedding layer thicknesses shall be measured at least once per 2000 cy placed.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of rock placed, area of final grading). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of bedding or rock material placed accomplished each day.
- Survey notes for line and grade and planarity control (verbally report results immediately, and submit copy to Owner within 24 hours)
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by owner and its testing service.

- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey
- As-built drawings of completed work

#### **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor Shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

#### **PART 6 - SCHEDULE**

Complete the Included Work by 180 days from Notice to Proceed.

**SPECIFICATION  
FOR  
SITE REGRADING AND REVEGETATION**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S7**

**Revision 0**

**January 2, 1994**

**Prepared by:  
AK GeoConsult, Inc.**



## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will regrade and revegetate the areas of the mills, soil borrow pits, and contaminated soil cleanup at its Grants, New Mexico operation as part of its reclamation plan for the uranium mill and tailing impoundments on that site. The area to be regraded and revegetated is expected to be not less than 700 acres and not more than 3000 acres. The exact area will be determined after contaminated soils have been removed, soil borrow excavation is completed, and other significant land disturbance related to reclamation can be quantified.

Soils on and near the site are classified agronomically as the Aparejo-Venadito complex, with Penistaja Fine Sandy Loam in the vicinity of the mill areas. However, the latter soil may be buried below the mill area cover.

The work to be performed consists of:

- a. Regrading the site to minimize surface irregularities and provide for positive drainage of runoff from and across the site.
- b. Revegetation of regraded and other disturbed areas other than the tailing impoundments

Drawing 4152-18, to be prepared at a later date, will show the areas to be regraded and revegetated, the approximate final contours to be achieved by regrading, and the relationship of this work to other features in the area of the job site.

### **1.2 Technical Definitions**

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) containment.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials.

**Earthwork control grid:** Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

**Job site:** The location of the mill, tailing piles, and borrow areas as well as all access routes, equipment laydown locations and storage areas on Owner property used in the Included Work.

**Native soil, natural soil:** Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.

**Pile:** The large tailing impoundment

**Sand:** Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

**Small tailing impoundment, small tailing pile:** The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% Fines that classify as silt, according to reference b, and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% Fines that classify as clay, according to reference b, and liquid limit less than 50%.

CH - same as CL except liquid limit 50 or more

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### **1.3 List of Construction Drawings**

The following drawings are incorporated into this specification by reference:

- |         |   |
|---------|---|
| 4152-0  | Title and Index Sheet   |
| 4152-13 | Borrow Areas for Cover Soils  |
| 4152-16 | Plan of Mill-Area and Disposal Pits Cover   |
| 4152-18 | Plan for Site Regrading and Revegetation - First Phase (to be prepared at a later date) |

### **1.4 Included Work**

The activities required for site regrading and revegetation will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Regrading of areas where ground surface has been disturbed
- Revegetation of disturbed areas and other areas as directed by the Owner.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.

### **1.5 Related Work Performed by Others**

- Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination.

### **1.6 Responsibilities**

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to verify finished lines and grades and regraded and revegetated areas, and to determine adequacy of revegetation.

- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures for the Owner.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of regrading and for ensuring the accuracy of soil preparation, seed mixes, application rates and other measures required to achieve successful revegetation.

## **PART 2 - EXECUTION**

The Contractor shall perform the following work:

### **2.1     Regrading**

The Contractor shall regrade the site areas designated by the Owner to the final lines and grades specified by the Owner.

With the exception of the tailing impoundments, each portion of the mill site that is disturbed by reclamation activities, including the borrow areas, shall be graded after all other construction activities have been completed and before starting revegetation activities on each portion of the affected site.

Final site grading shall be performed to establish those gradients that will assure positive drainage of surface water runoff in directions away from tailing impoundments and the reclaimed mill area. To the extent possible the final regraded contours will reestablish or maintain the directions and gradients of ground surfaces that existed prior to the development of the Homestake Grants mill site.

The line and grade control for final grading will be established after the completion of other reclamation work and before each portion of the site is regraded. The final lines and grades will be determined after the completion of those activities that directly affect ground surfaces, such as contaminated soil cleanup, excavation of borrow areas, and burial of demolished mill components.

Fences may be removed for access to regrading areas provided that if any license-boundary (security) fence is breached, a guard shall be posted at each such location during working hours and all such openings shall be closed during non-working hours.

### **2.2     Revegetation**

The Contractor shall revegetate regraded and other disturbed ground surfaces at locations selected or approved by the Owner.

#### **2.2.1   Soil Preparation**

The Contractor shall prepare the areas to be revegetated by ripping or scarifying, harrowing and disking the ground as needed for addition of soil amendments (if any) and for drill seeding. Soil amendments are not required but may be used to increase the probability of first-season growth success. All soil preparation activities shall be performed along directions perpendicular to the surface slope or, on surfaces with less than 0.01 slope gradient, along north-south directions. Soil preparation shall precede seeding by not more than one month.

### 2.2.2 Seeding

The Contractor shall apply the following seed mixture and seeding rates in all revegetation areas:

			SEEDING RATE (DRILL SEEDING)	
SCIENTIFIC NAME	COMMON NAME	GROWTH HABIT <sup>(1)</sup>	LBS PURELIVE SEED/ACRE	NUMBER OF SEEDS PER FT <sup>2</sup>
Grasses				
Agropyron smithii	Western wheatgrass	NS	4.0	10.1
Bouteloua gracilis	Blue grama	NB	2.0	37.9
Sporobolus cryptandrus	Sand dropseed	NB	0.5	60.8
Oryzopsis hymenoides	Indian ricegrass	NB	3.0	9.7
Sporobolus airoides	Alkali sacaton	NB	0.5	20.2
Shrubs				
	Four-wing saltbush	--	0.5	0.6

<sup>(1)</sup> NB – Native bunchgrasses

NS – Native Sod

All seeding shall be performed during the June-September period, unless otherwise approved by the Owner, using drill methods and following the same directions as the soil preparation activities.

### 2.2.3 Mulching

Mulch shall be applied to all seeded areas immediately after seeding. The mulch shall be straw or hay, applied at the rate of 2000 pounds per acre, and anchored with a straw crimper. After mulching, a commercial fertilizer shall be applied at the rate recommended by the manufacturer and approved by the Owner.

### 2.3 Dust Control

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

## PART 3 - QUALITY CONTROL

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

### 3.1 Supervision

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### 3.2 Line and Grade Control

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this specification. Ground control for surveys shall

be based on established benchmarks and other control points on the mill property and Pile as shown on Drawing 4152-18.

Gradients shall be surveyed as often as necessary to control regrading. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 (or most current version) plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### **3.3 Verification of Revegetation**

The Contractor shall prepare written records of seed, mulch, and fertilizer purchases and applications. The Contractor shall also provide evidence, at four consecutive three-month intervals after seeding, of vegetative growth and percent of ground covered by vegetation at not less than one 20 ft x 20 ft area per 50 revegetated acres. This evidence shall include field measures performed in accordance with current US Soil Conservation Service (SCS) practice as well as photos of each 20 ft x 20 ft area.

If the vegetation growth and ground cover density after one year from initial seeding is not equal to the averages in that year for the adjacent areas, as determined by the SCS, the Contractor shall perform additional seeding and mulching as needed and shall repeat these verification and additional seeding/mulching measures until this standard for acceptance has been achieved.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., areas regraded, areas seeded). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location and areal extent of regrading and revegetation accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours)
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.
- Documentation of revegetation success as described in Section 3.3 above.

#### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field measurements performed by Owner.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey.
- As-built drawings of completed work.

#### **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

#### **PART 6 - SCHEDULE**

Complete the Included Work by \_\_\_\_\_ days from Notice to Proceed.

**SPECIFICATION  
FOR  
DIVERSION LEVEE**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4152-S8**

**Revision 0**

**April 9, 1994**

**Prepared by:  
AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) is performing reclamation of its uranium mill and tailing impoundments at its Grants, New Mexico operation. As part of the measures to protect the cover placed over the area of the mill (now demolished) and to protect the large impoundment against erosion, an earthfill levee will be constructed between the mill area and the large impoundment (see Drawing 4152-16). This levee will be capable of diverting flood waters of the Lobo Canyon watershed that follow a poorly defined channel running east to west across the north part of the site.

The levee will extend from the east outslope of the large impoundment to the northeast corner of the mill area. The levee will be approximately 1500 feet long; the actual length will be determined by the configuration and location of the east outslope of the large impoundment and by the final reclaimed surface of the mill site in the vicinity of the administration building. The alignment will assure that the levee centerline lies between the Lobo Canyon floodplain and the covered mill area. The diversion levee is shown in plan and cross section on Drawing 4152-19.

The work to be performed consists of excavating, hauling, placing and compacting soils to construct the diversion levee; and loading, hauling, and placing rock cover on surfaces of the levee. The soil to be used for this construction consists of alluvial sediments located on the mill site and east of the mill site across Route 605. The rock, consisting of basaltic lava, will be quarried, crushed, screened and stacked by a third party at the quarry site located 2-2.5 miles west of the job site.

### **1.2 Technical Definitions**

**Compactors, heavy:** Self-propelled or towed compaction machinery including rubber-tired rollers, tamping foot (sheep's foot) rollers, and smooth drum vibrating compactors weighing in excess of 5000 lbs. and controlled by a mounted operator.

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) containment.

**Clean Soil:** Any soil other than contaminated soil

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials.

**Earthwork control grid:** Orthogonal system of uniformly spaced lines (integer multiples of 100 feet), based on the coordinate system and survey control points already established on the site, used to record locations, thicknesses, lateral extents, and types of earthwork performed each day.

**Fines:** Mineral particles passing the #200 U.S. Standard sieve; i.e. smaller than 0.075 mm grain size.

**Foreign material:** Any solid material that is neither natural soil nor tailings. Includes wood, iron and steel, plastic, rubber, glass, ceramic and concrete.

**Job site:** The diversion levee area as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

**Mill site:** The area contained within the NRC license boundary.

**Native soil, natural soil:** Naturally-occurring alluvial or residual soils existing below and at ground surface around the job site; consisting of gravel, sand, silt and clay materials.



Pile: The large tailing impoundment

Sand: Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

Soil classification: Soil descriptions based on grain size distribution and plasticity in accordance with the Unified Soil Classification System (USCS).

Expected soil classifications within the mill area and borrow areas are:

SP - poorly-graded sand with less than 5% fines

SM - silty sand; 12-50% silt fines, >50% sand

SC - clayey sand; 12-50% clay fines, >50% sand

SP-SM - sand with 5-12% silty fines

ML - more than 50% fines that classify as silt, according to reference b, and liquid limit less than 50

MH - same as ML except liquid limit 50 or more

CL - more than 50% fines that classify as clay, according to reference b, and liquid limit less than 50%.

CH - same as CL except liquid limit 50 or more

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

### 1.3 References

- a) ASTM D 698-78 "Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 4.4-lb (2.49-kg) Rammer and 12-in. (305mm) Drop", Vol 04.08, 1988 Annual Book of ASTM Standards
- b) ASTM D 1556-82 "Standard Test Method for Density of Soil in Place by the Sand-Cone Method", Vol 04.08, 1988 Annual Book of ASTM Standards
- c) Casagrande, A., 1948, "Classification and Identification of Soils," Transactions of the American Society of Civil Engineers, Vol. 113, P. 901.

### 1.4 List of Construction Drawings

The following drawings are incorporated into this specification by reference:

- |         |  |
|---------|--|
| 4152-0  | Title and Index Sheet  |
| 4152-13 | Borrow Areas for Cover Soils   |
| 4152-16 | Plan of Mill-Area and Disposal Pits Cover                                |
| 4152-19 | Diversion Levee Plan and Cross Sections (to be prepared at a later date) |

For information only:

- |         |                               |
|---------|-------------------------------|
| 4153-2A | Mill Area Demolition - Plan A |
|---------|-------------------------------|

### 1.5 Included Work

The activities required for construction of the diversion levee will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Preparation of Borrow Areas: Removal and disposal of vegetation, trash and other foreign material from the selected borrow areas; excavation of exploratory trenches as directed by the Owner.
- Earthwork: Excavation, hauling, placement, and compaction of soil to construct the diversion levee.
- Rock Cover: Loading, hauling, and placing rock over the top and side slopes of the levee.
- Dust control: Operation of water pumping, distribution and spray systems to suppress fugitive wind-blown dust in all work areas.
- Protection and replacement of fences and utilities: Protection of fences and utilities from damage, and replacement of fences and utilities that are disturbed.

### 1.6 Related Work Performed by Others

- Mill Demolition: Demolition and burial of mill structures and equipment and burial of scrap materials
- Earthwork quality control: Sampling and testing to verify borrow soil and rock material properties and specified field density, moisture content, and lift thicknesses of compacted soils.
- Quality control surveying: Surveying for verifying line and grade and for pay-quantity determination.

### 1.7 Responsibilities

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction water at locations on the mill property and will approve and make payment for work performed under this specification. The Owner will perform surveys to select and verify borrow soil and rock properties, to verify finished lines and grades and excavation and fill quantities.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will specify and review quality control measures for the Owner that will include field density and moisture testing, field classification and selection of borrow materials, and other properties as needed.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site. Contractor shall be responsible for controlling lines and grades of excavation, fill, and finished surfaces.

## **PART 2 - EXECUTION**

The Contractor shall perform the following work:

### **2.1 Preparation of Borrow and Pill Areas**

The Contractor shall prepare borrow areas designated by the Owner and the ground surface that will be covered by the levee prior to any excavation of borrow soil for levee construction. This preparation shall include:

- a) Clearing and grubbing of vegetation
- b) Removal of vegetation, trash, and other foreign material to a location approved by the Owner. Vegetation may be burned after clearing and grubbing in lieu of removal for disposal.
- c) Preservation and protection of wells, water lines, and power lines needed for HMC's site operations, water supply or for the Owner's ground water restoration.
- d) Preservation and protection of power lines, telephone lines, pipelines and other utilities along rights-of-way within the fill and borrow areas or crossed to reach borrow areas.

Fences may be removed for access to borrow areas provided that if any license-boundary (security) fence is breached, a guard shall be posted at each such location during working hours and all such openings shall be closed during non-working hours.

### **2.2 Excavation and Hauling of Borrow Soil**

The Contractor shall excavate borrow soils at locations and to depths selected or approved by the Owner. All borrow soils used to construct the levee shall be excavated from approved borrow locations shown on Drawing 4152-13 or in other locations approved by Owner or its Engineer. Fill material used to construct the levee shall be native alluvial soil. Borrow areas for this material are designated on Drawing 4152-13.

No borrow material shall be used in the levee that has contaminated material (concentrations of byproduct-derived Ra-226 in excess of 5.0 pCi/g). With a background radium concentration of 5.5 pCi/g, the maximum total radium content of borrow soil will be not more than 10.5 pCi/g unless excess concentrations have been demonstrated by soil tests to be naturally-occurring radium.

Excavated soil shall be hauled along travel routes selected, prepared and maintained by the Contractor. The east-west county road north of the large pile and New Mexico Route 605 shall not be used as haulage routes by scrapers and shall be protected from damage or obstruction caused by the Contractor's equipment or activity. On any road that must be crossed by earth-hauling equipment, a flagman shall be posted at each crossing point to control traffic during earth-hauling operations. During and after earth-hauling operations, the Contractor shall perform those repairs necessary to preserve the road surfaces and to return them to a condition at least equal to the condition that existed before the Contractor's work under this specification began. To ascertain satisfaction of this requirement, the Contractor shall document the condition of the road surface prior to its work and shall seek concurrence in this condition and the adequacy of any subsequent repairs from the county and state road departments.

### **2.3 Placement and Compaction of Fill**

Soil excavated and hauled in accordance with Section 2.2 above shall be placed and compacted in lifts to the lines and grades shown on Drawing 4152-19. The levee shall have a crest constructed at the uniform elevation of 6595 and a width of 10 feet. The outslopes shall be constructed at a gradient of 10H:1V.

The levee shall be constructed using the clean native soils placed in lifts not to exceed 12 inches uncompacted thickness. No particles larger than 2/3 of the uncompacted lift thickness shall be included in the fill. Each lift shall be compacted to not less than 80% relative density or 90% maximum dry density per ASTM D-698. The appropriate compaction testing method will be based on the classification of the soils used for fill.

#### **2.4 Rock Cover**

The Contractor shall load and haul rock from the stockpile at the quarry site, designated by the Owner, to placement locations on the levee.

All rock used for rock covers and erosion protection shall be basalt developed by a third party at a quarry on the Owner's property in the N 1/2, NE 1/4, Section 28, T 12 N, R 10 W located approximately 2-2.5 miles west of the levee location. The rock shall have a  $d_{50}$  of not less than 1.0 inch and meet the same durability, size and gradation specifications as the rock required for the top of the large impoundment (see Specification 4152-S6).

The rock shall be hauled and placed by methods that maintain the gradation ranges in the stockpiled rock and prevent segregation of sizes during transport and placement.

The rock shall be placed and spread over the top (crest) and side slopes of the levee to create a layer that is 90%-125% of the design thickness of 0.5 feet, with a uniform surface that is free of visible high or low spots.

#### **2.5 Dust Control**

The Contractor shall employ those measures necessary to minimize dust from its operations. Unless otherwise approved by the Owner, acceptable measures are limited to spraying or other method of applying water to ground surfaces.

#### **2.6 Protection and Replacement of Fences and Utilities**

The Contractor shall take whatever measures are necessary to protect fences and utilities from damage related to its work under this specification. If necessary for the performance of the work, the Contractor may temporarily remove or relocate fences or utilities at its own expense and as approved by the Owner. Any fence or utility temporarily removed or relocated for this purpose shall be restored to its original location and to not less than its condition prior to removal or relocation.

If any fence that is part of the licensed-area boundary is breached or removed for the Contractor's work, the Contractor shall provide a guard at each such location and at all times until the fence is restored. The guard shall perform its duties in accordance with the Owner's instructions.

### **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of this specification. These measures shall include, as a minimum, the following:

#### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of this specification and the drawings relevant to the work. The supervisor

shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of this specification.

### **3.2 Line and Grade Control**

The Contractor shall perform land surveying to determine that the specified lines and grades have been achieved in accordance with the limits established in this specification. Ground control for surveys shall be based on established benchmarks and other control points on the mill property and Pile as shown on Drawings 4152-16 and 4152-19. Gradients shall be surveyed as often as necessary to control fill placement. All final gradients and elevations shall be recorded on base drawings that include the site coordinate system, the earthwork control grid, and the topographic contours of the surfaces prior to fill placement. Base drawings will be provided in hard copy or Autocad Version 11.0 (or most current version) plot file on 3.5-inch diskette.

When the Contractor reports to Owner that all Included Work has been completed, Owner will perform an acceptance survey to determine if line and grade requirements have been satisfied. Owner will survey the elevations and gradients at such locations as may be necessary. At its discretion, Owner may choose to have this survey done by aerial photogrammetry.

### **3.3 Field and Laboratory Testing of Fill**

Testing of borrow soil and rock will be performed by a qualified materials testing service contracted by Owner. The following tests will be performed:

#### **3.3.1 Soil tests**

- a) Moisture-Density relationship tests or relative density tests: One per 5,000 cy by ASTM D-698 or ASTM D-2049, as appropriate for the borrow material
- b) In-place density: One test (ASTMD-1556 or ASTMD-2922) per 2000 cy placed.
- c) Grain size/Soil classification (ASTMD-422): One per 2000 cubic yards.

Each field density test will be plotted on the earthwork control grid and recorded on test data sheets that become part of the permanent record of the project. The Contractor will be notified immediately when any test result fails to meet the minimum acceptable value in Part 2 of this specification.

#### **3.3.2 Rock Tests**

- a) Rock quality testing (sulfate soundness, specific gravity, and absorption): One test on the first 500 cy produced, one test per 10,000 cy produced thereafter, and one test on the last 500 cy produced for each gradation.
- b) Rock size and gradation: One test per 5000 yards at the screening plant using the appropriate screen stack and one size and gradation test using a portable screen stack for every 5000 cy of rock placed on the impoundment.
- c) Rock layer thickness: One measurement per 2000 cy placed.

Rock test requirements a) and b) may be satisfied by the testing performed under Specification 4152-S6.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal will also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., volume of excavation and fill, area of final grading). Submit a copy to Owner by the start of the next working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Earthwork Control Plot, using the earthwork control grid at a scale of not less than 1 inch = 200 feet, showing the location, areal extent, and thickness of borrow excavation and fill placement (illustrated by distinctive colors or patterns) accomplished each day.
- Survey notes for line and grade control (verbally report results immediately, and submit copy to Owner within 24 hours)
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and observed variances from the specification.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations of the acceptance survey
- As-built drawings of completed work

## **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with specifications and drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

## **PART 6 - SCHEDULE**

Complete the Included Work by 60 days from Notice to Proceed.

**SPECIFICATION  
FOR  
DEMOLITION OF URANIUM MILL FACILITIES**

**HOMESTAKE MINING COMPANY OF CALIFORNIA  
GRANTS OPERATION  
NEW MEXICO**

**NO. 4153-S1**

**Revision 0**

**February 8, 1993**

**Prepared by:  
AK GeoConsult, Inc.**

## **PART 1 - GENERAL**

### **1.1 Project Description**

Homestake Mining Company of California (HMC) will demolish the uranium mill facilities located at its Grants, New Mexico operation (see Drawing #4153-0) as part of its total reclamation plan for that site. The site contains two mills. The uranium milling operations at the site began in 1958 and ended in February, 1990. The smaller of the two mills on the site operated from April, 1958 until January, 1962. The larger mill operated from 1958 until February, 1990. Both mills were alkaline leach-caustic precipitation processing units for concentration of uranium oxide from sandstone and limestone ores. The combined capacity of the two mills was nominally 3400 tpd. The locations and general descriptions of mill facilities are shown on Drawings #4153-1 and 4153-2.

The demolition of HMC's Grants Operation mill facilities will be performed by a mill demolition contractor working directly under contract to, and under the supervision of, HMC. The mill demolition contractor (Contractor) shall be directly responsible to HMC's resident manager, who may designate a representative from his staff to perform direct supervision of the Contractor's work. The Contractor shall perform its duties in accordance with the requirements of this Specifications. The mill demolition work will include dismantling and disposal on site of all designated mill facility components. Disposal on site may include burial in place, burial in designated excavated pits on site, or placement for subsequent burial at designated locations on the large tailing impoundment on site. Some mill components or equipment might be salvaged if approved by HMC for release for unrestricted use.

### **1.2 Technical Definitions**

**Burial:** Covering demolition debris by placing dry tailings or soil over the debris using earthmoving methods.

**Clean area:** An area designated by HMC in which surface soils have not more than 5 pCi/g Ra-226 and that may be used for temporary storage, staging and loading of salvaged equipment and material released for off-site (unrestricted) use.

**Contaminated Soil:** Soil containing more than 5pCi/g of Ra-226 resulting from milling byproduct (tailings) containment.

**Earthwork:** Excavation, haulage, placement, and compaction of earthen materials including mill tailings.

**Job site:** The location of the large tailing Pile as well as all access routes, borrow areas, equipment laydown locations and storage areas on Owner property used in the Included Work.

**License boundary:** The perimeter of the area, delineated on Drawing 4153-1, under license by the US Nuclear Regulatory Commission, to which access is controlled and from which no materials or equipment may be removed without first being surveyed for radioactive contamination.

**Pile:** The large tailing impoundment

**Radiological survey:** Measurement of alpha and/or gamma radiation contamination levels using hand-held instruments

**Sand:** Mineral particles with grain sizes between #200 and #4 sieve (0.075 mm to about 5 mm).

**Site management facilities:** Existing mill site facilities that will remain in place and used for site management until reclamation activities are completed.



Small tailing impoundment, small tailing pile: The pentagonal-shaped earthfill structure located south of the large tailing impoundment or Pile. The evaporation pond is located within this impoundment.

Slurry grout: Mixture of water, sand and cement or fly ash that is placed as a liquid to fill space in and around mill debris and that will harden to create an incompressible, non-shrinking solid.

Tailings: Solid byproduct of uranium ore milling, consisting of particles of primarily silicate minerals and containing radioactive elements (mostly Uranium and radium). Particle sizes range from clay (less than 0.002 mm) to medium sand (less than #40 sieve).

Voids, void space: Macroscopic size (readily visible without magnification) air-filled openings within solid materials.

### **1.3 List of Construction Drawings**

The following drawings are incorporated into these Specifications by reference:

4153-0	Title and Index Sheet
4153-1	Site Plan
4153-2	Mill Area Plan

### **1.4 Included Work**

The activities required for demolishing the mills will be performed by the Contractor using its own or subcontracted labor and equipment. The Included Work, described in detail in Part 2, consists of:

- Dismantling and removal of all above-ground structures, equipment, and other components of the mill facility as designated by HMC.
- Disposal or salvage of all dismantled mill components. Disposal may include in-place laydown for subsequent burial, placement in below-grade disposal pits for subsequent burial, or placement in or on the large tailing impoundment for subsequent burial by others. Some mill components, if adequately decontaminated, may be salvaged and released from the site for unrestricted use.
- Encapsulation of mill components placed in below-grade disposal pits for burial using slurry grout.

### **1.5 Related Work Performed by Others**

- De-energization of electrical systems and disconnection of gas and water lines in facilities designated for demolition.
- Asbestos removal and burial: Removal of asbestos materials from the mill facilities and burial in outslope of the Pile. (work in progress).
- Placement of soil cover over mill area.
- Removal of site management facilities.
- Disposal of facilities and scrap material outside of mill area.
- Tailing impoundment earthwork.

## 1.6 Responsibilities

- a) Homestake Mining Company of California (HMC): HMC, the "Owner", will provide controlled access to the work site, will make available construction and cleanup water at locations on the mill property, will perform all supervision and quality control of the Contractor's work, and will approve and make payment for work performed under these Specifications.
- b) AK GeoConsult, Inc. (AKG): AKG, the "Engineer," will review or inspect and advise the Owner on the acceptance of the Included Work. The Engineer will assist the Owner on quality control measures and evaluations of Contractor's work.
- c) Contractor shall provide all equipment, materials, labor and supplies and perform all work necessary to accomplish the Included Work. Contractor shall be responsible for the knowledge of and compliance with all applicable federal, state, and local laws and regulations and for the safety of its job site and of all personnel and equipment which it employs and all others who are present on the job site.

## PART 2 - EXECUTION

Work to be performed involves facilities and areas shown on Drawings #4153-1 and 4135-2. Numbers in parentheses below refer to facility numbers on Construction Drawing #4153-2. The Contractor shall perform the following:

### 2.1 Dismantle and Remove Designated Mill Facilities

The Contractor shall dismantle and remove to ground surface all structural components and equipment, and backfill any voids below ground surface, of the following mill facilities:

- Ore receiving section including ore receiving scale (1) and ore storage pads (2, 2A).
- Crushing and sampling section including the grizzly (3), crusher (4), rotary dryer (5), belt transfer building (5A), reciprocating samplers (6), and enclosing and connecting structures.
- Fine ore storage bins (7, 7A).
- Ore grinding section including ball mills (8), thickener tanks (9), ore roaster (8A) and enclosing and connecting structures.
- Uranium leaching section including the pressure leaching autoclaves (10), mixing tanks (10A), atmospheric leaching pachuca tanks (11), filters (12), vacuum pumps (12A), solution storage tank (13), tailing slurry pipeline (14), tailing pond ion exchange tanks and equipment (15), ion exchange precipitation unit, and enclosing structures.
- Precipitation section including pregnant solution tank (16), precipitation tanks (17, 18), and precipitate thickener tanks (19) and the enclosing structures.
- Vanadium removal section including the roasting furnace (20).
- Packing, storage and shipping section including the yellowcake drying furnace (21), the yellowcake packaging facilities (22, 22A), and the yellowcake drum storage and loadout facility (23).
- Miscellaneous structures including:
  - Warehouses (27, 27B)
  - Sampling plant (29)
  - Electric shop (30)
  - Carpenter shop (32) May be used as site office by Contractor
  - Power house (34)

- Oil and water coolers
- Compressor house (36)
- Electrical storage building (37)
- Water tanks (38, 38A)
- Training building (39)
- Storage units (40)
- Cooling tower (41)
- Boilers (42)
- Three 20,000 gal. vertical diesel storage tanks,  
one 12,000 gal. horizontal diesel storage tank (46A)

The administration building (24), garage/instrument shop /environmental lab complex (25/31/35), shop (26), oil warehouse (27A), laboratory (28), change house (33), guard house (33A), south water tank (38A), water well (43) and truck maintenance buildings (46) shall be left in place and fully operational as site management facilities.

All structures designated for demolition shall be dismantled into pieces that are suitable in both size and shape for disposal in locations approved by HMC. All above-ground structural supports, including columns, pedestals, walls and piers, shall be removed to ground level or point of attachment to the supporting foundation, whichever is lower. Below-grade facilities shall be left in place and completely backfilled with debris and slurry grout or with soil.

Mill components shall be demolished as follows:

- Dismantle, crush or cut all metal roofing, siding, and flat structural material and place on ground surfaces in and adjacent to the dismantled structure. Distribute material to minimize residual void space and eliminate protrusions above or depressions below the surface of the debris material.
- Dismantle metal tanks and distribute and flatten the dismantled pieces to allow in-place burial without excessive void space. Tanks that cannot be dismantled shall be moved to disposal pits.
- Cut pipe into lengths that permit easy handling and placement for burial at existing ground surface or in pits. Crush pipe with heavy equipment or fill the space inside pipe with slurry grout.

## **2.2 Dispose of Demolition Debris**

All debris resulting from the activities under Section 2.1 above shall be disposed of at designated on-site locations. No debris shall be removed from the site without HMC approval. HMC will perform radiological surveys on all materials designated for salvage to determine that they are sufficiently cleaned of radioactive contamination to meet the requirements for release for unrestricted use. Any debris selected for salvage that does not meet release standards shall be decontaminated and surveyed for residual radioactivity until HMC determines that the material satisfies standards for release from the site.

All debris that has been selected for salvage and approved for release by HMC shall be temporarily stored in a "clean area" (see Drawing 4153-2) designated by HMC and prepared and maintained by the Contractor. Any material that has been radiologically surveyed and found to be suitable for release from the site shall not be exposed to sources of contamination or contaminated materials and shall be kept in the clean area until it is removed from the site.

Nonsalvaged materials shall be disposed of in locations determined or approved by HMC. Flat, incompressible materials with no internal void space may be disposed of by placing such materials flat on the ground surface at or adjacent to their original locations; i.e. they may be disposed of in place. Such

materials shall be inspected and approved for in-place disposal prior to their placement by the Contractor. These materials may include metal or fiberglass siding, plate glass, and similar materials with very small thicknesses compared to their lengths and widths. Materials that are non-compressible and have irregular shapes or substantial internal void spaces shall be placed in below-grade pits within the mill area or in pits or excavated vaults in the large tailing impoundment. These pits shall be subsequently backfilled with slurry grout, as described in Section 2.3.

Machinery, pipe, tanks, and any other equipment that cannot reasonably be dismantled and buried in place shall be removed to below-grade disposal pits or the large tailing impoundment for burial. Such components that contain more than 10% void space shall be filled with slurry grout prior to burial in the tailing impoundment. Wood, fiberglass, and other compressible or organic material shall be pulverized using a shredder. The pulverized material shall be distributed uniformly over the mill area prior to placement of cover soil.

After mill components have been dismantled and placed at ground surface for subsequent burial, void spaces that remain under and within such components shall be filled by soil, by slurry grout, or other approved method that eliminates void space.

### **2.3 Fill Disposal Pits**

After demolition debris has been placed in each disposal pit to a depth not greater than 5.0 feet, the remaining void space within and around the debris shall be filled with slurry grout to the top of the debris placed in the pit. The grout shall be allowed to set sufficiently to attain enough strength to support additional debris placed subsequently in the pit. Any space left between the top of the debris/ grout surface and the surrounding ground surface shall be backfilled with soil and compacted enough to support heavy construction equipment.

## **PART 3 - QUALITY CONTROL**

The Contractor shall take all measures necessary to achieve all requirements of Part 2 of these Specifications. These measures shall include, as a minimum, the following:

### **3.1 Supervision**

During all times that the Contractor's equipment or personnel are performing Included Work on the job site, the Contractor supervisor shall be present to direct the work. The supervisor shall have experience, satisfactory to Owner, in the type of work being executed. The supervisor shall have on-hand at all times a copy of the current revision of these Specifications and the Construction Drawings relevant to the work. The supervisor shall have the authority to make decisions for the Contractor in all matters related to parts 2 and 3 of these Specifications.

### **3.2 Slurry Grout Mix Control**

The Contractor shall develop a slurry grout mix that satisfies the performance requirements of these Specifications. At least 30 days before initial slurry grout placement, the Contractor shall submit for approval by HMC a solidified cylinder sample of the proposed mix accompanied by documentation showing the composition and size gradations, sources and ratios of the grout components. Once accepted by HMC, the slurry grout mix shall contain not less than the minimum units of approved cementitious components (i.e., cement or fly ash), expressed as the ratio of cementitious material to non-cementitious solid (e.g., sand). The amount of water used per units of solids shall be proposed by the Contractor for each method of grout delivery and placement proposed, and if more than one method is proposed a solidified cylinder sample of the proposed mix for each method shall be submitted for HMC approval at least 30 days before the first use of each method. The Contractor shall submit at least one cylinder sample of its slurry grout for each 1000 cubic yards of mix placed.

## **PART 4 - DOCUMENTATION**

### **4.1 Documentation by Contractor**

The Contractor shall record and report, in a format acceptable to Owner, the following information:

- Daily journal containing list of equipment used, hours worked, reimbursable materials consumed or used, and labor hours by wage category. The journal shall also record Included Work tasks started, completed, and in progress and the units of work accomplished (e.g., structures or equipment demolished or removed, volume of slurry grout placed). Work planned for the next day shall be outlined including the number of workers, work locations and activities at each location. Submit a copy of each day's journal to Owner by the end of each working day.
- Daily Work Summary listing all pay items and quantities. Submit by the start of the next working day.
- Debris Disposal Plan, at a scale not less than 1 inch = 100 feet, showing the location, areal extent, and depth of disposal pits and the origin and type of debris placed in each pit. This plan shall be updated daily and submitted to HMC at the conclusion of the work.
- Written notifications to Owner of unexpected conditions, conditions that prevent conformance with specifications, disputes over acceptance of Contractor's work. Verbally notify Owner immediately upon discovery or identification, submit in writing within 24 hours.

### **4.2 Documentation by Owner**

Owner will create and maintain the following documentation that relates to the Included Work:

- Field inspection notes of Contractor's performance, work accomplished, and variances from the Specifications.
- Records of all field and laboratory tests performed by Owner and its testing service.
- Photographic and video tape records of the Included Work.
- Chronological record of notifications to the Contractor of variances from specifications, unacceptable work performance, discrepancies in payment quantities claimed by the Contractor, and all related resolutions thereto.
- Survey notes and calculations.
- As-built drawings of completed work

## **PART 5 - ACCEPTANCE**

Owner shall have sole discretion to accept in part or in full, or to reject in part or in full, the Contractor's work. Acceptance or rejection will be based on Owner's visual inspections (including those of its Engineer and testing service), quality control data required under Part 3, and documentation required under Part 4.

Upon identification of unacceptable work, Owner will notify the Contractor of the deficiency. The notification will include the location, extent, and description of the unacceptable work. Before proceeding with additional work at that location the Contractor shall correct the deficiency by bringing the work into compliance with Specifications and Construction Drawings to the satisfaction of Owner. All work and materials required for such corrective actions shall be at the expense of the Contractor.

## **PART 6 - SCHEDULE**

Complete the Included Work by 335 days from Notice to Proceed.