NOMINATION FOR THE 2000 ABANDONED MINE LAND RECLAMATION AWARDS

CARRIZO 1 AML RECLAMATION PROJECT

Submitted By:
THE NAVAJO AMLR PROGRAM

CARRIZO 1 AMLR PROJECT

Location: The radioactive abandoned uranium mine sites under this project are located in the beautiful Carrizo Mountain/Red Valley areas in the Teec Nos Pos, Beclabito, Sweetwater, and Oak Springs Chapters in Apache County, AZ, and San Juan County, NM, close to the four Corners area. Most site locations being on steep mesa tops or edges, rugged terrain and extremely deteriorated haul roads, totaling 10 miles in length, made the access to the sites very challenging.

Nominating Team: Following are the members of the nominating team:

Madeline Roanhorse, Director, Navajo AMLR/UMTRA Department
S. Deb Misra, P.E., Professional Engineer
Ernest Diswood, Manager, Shiprock AML Field Office
Lynn Benally, Reclamation Specialist II

Project Start Date: June 7, 1999. **Completion Date:** December 13, 1999.

Construction Cost: $892,872.75 to reclaim over 245 mine portals, vertical shafts, rimstrips, and subsidence areas; over 3,200 feet of dangerous highwalls; over 57,000 cubic yards of radioactive mine waste spread over 35 acres of land; and 7 acres of haul roads**.**

Organization Responsible for Reclamation: The Navajo Abandoned Mine Lands Reclamation Program (Program): P.O. Box 1875, Window Rock, AZ 86515. Tel. No.: (520) 871-6982; Fax No.: (520) 871-7190; E-mail: aml_dmisra@dine.navajo.org. Planning, Design, and construction inspection were done in-house. Besides the nominating team members, other participants in this project were Messrs. Melvin Yazzie, Leon Spencer, Delbert Bekis, Darriel Yazzie, Larry Jackson, Carl Holiday, and Ms. Davida Daukei. Contractor was Silver State Construction Company, Inc.

Accomplishments: The project utilized award-winning maintenance-free designs, implemented cost-effective radiological clean-up standard developed in-house, and experimented with a newly-developed mine closure method using thick, reinforced polyurethane foam plugs - safeguarded against ultra-violet rays. It was a large and complex project which amidst severe physical challenges reclaimed 20 hazardous abandoned uranium mine sites inflicted by over 250 abandoned mine features. The Program proudly considers this millennium-end project which exceeded the objectives of Surface Mining Control and Reclamation Act worthy for an award.

Uranium mining started in the Carrizo Mountains in the 1940s to satisfy America s quest for nuclear superiority by supplying some of the best fuels for the Manhattan Project. Unregulated mining left a legacy of radioactive scars on the body of Mother Earth and inflicted the lives of the Dineh (Navajo people) by disrupting their harmony with Nature. After long years, as a result of this top-quality, practically-invisible reclamation project, those scars are finally removed and the land with its radioactivity returned to pre-mining background level is available for regular use.

Nomination Prepared: March, 2000.

Narrative Description of Project Work

Brief History/Background of the Source of the AML Problem:

Bright-colored outcrops of uranium-vanadium ores were discovered in the mesas of the Carrizo mountain/Monument Valley areas in 1942 by a Navajo person, Mr. Luke Yazzie. Since then many mining companies including the Vanadian Corporation of America (VCA) conducted mining on the mineral leases obtained from the Navajo Tribe in early 1940s. Mining was conducted using underground room-and-pillar and open stopes as well as surface rimstrips and openpit methods. Mining hit its boom during the 1950s but as the demand for vanadium and uranium dropped in the 1960s, the mines and mills were shut down. Local Navajos worked hard with less pay and were exposed to harmful radiation without any knowledge.

Due to lack of federal regulations, the unregulated mining left a multitude of physical hazards such as: deep and dangerous adits, inclines, vertical shafts, highwalls, benches, openpits, radioactive mine wastepiles, protore, polluted and radioactive water in openpits, drill-hole with undetonated explosives, and environmental degradations caused by gamma radiation, windblown radionuclides, and leachates from wastepiles carrying heavy and radioactive metals. These hazards posed extreme dangers to the local Navajos and their livestock. Without knowledge of health risks, they used radioactive rocks to build homes, were exposed to gamma radiation while grazing their livestock; and used mine openings to shelter their animals during winter. Livestock drank the radioactive water. The mesa-top radioactive abandoned uranium sites are in the middle of grazing areas, close to residences and road-side businesses. Prevalent land use is open grazing, hiking, and hunting.

Description of the Reclamation Work and Problems/Solutions:

Reclamation work at the 130-acres Carrizo 1 AMLR Project eliminated all the Priority 1, 2, and 3 types of safety hazards and environmental degradations associated with the AML sites by eliminating or safeguarding over 245 abandoned mine features described earlier. Reclaimed areas were covered with 18-24 inch thick layer of non-radioactive topsoil or cover-soil to reduce residual radiation emission. Drainage patterns were established by constructing diversion berms and armored channels. Access roads were eliminated by ripping and blocking off. Though the project seemed to be simple, it presented the several difficulties and concerns which had to be overcome by careful but cost-effective design.

The old haul roads, totaling 9.5 miles in length, were steep, totally deteriorated, and unpassable. Most of the AML sites were located on tall and steep a mesa with radioactive mine waste dumped on the slopes. The radioactive mine waste was very rocky with sizes from 4-inch to 6 feet in maximum dimension. This put heavy earthmoving equipment in severe operating and hauling conditions. Large boulders overhung the cliff edges. Some wastepiles were very steep and the terrain underneath were unknown which made volume estimate difficult. Proper equipment selection made the project successful. Soon the work became very much like actual mining work and compliance with various safety and environmental laws and regulations became necessary.

Dangerous highwalls, unstable mine opening, tall wastepiles, and high level of radiation and radon gas emission were some of the major problems. High winds, gusting up to 35-50 miles/hour, caused dust storms and dispersion of windblown radionuclides. Effective site-specific safety program was developed and coordinated with the contractor to achieve accident-free construction work. Mine closure methods utilized excavation/backfilling for openpits, some of the portals and vertical shafts, highwalls, rimstrips, and subsided areas; reinforced cement concrete bulkheads and polyurethane foam plugs for selected mine portals; and reinforced concrete caps for some vertical shafts.

To safeguard the construction workers from the hazards and harmful radioactive environment, the Program developed its own Health and Safety Manual as well as its own radiological clean-up standard. Radiological surveying, radiological characterization of mine waste, verification of radiological clean-up of reclaimed areas, personnel dose monitoring, etc. soon became a tremendous task. The radiological clean-up guidelines for the reclaimed surface were established as follows: residual Ra-226 concentration in the first six inches of the reclaimed soil was not to exceed 25 pCi/g; in addition, the residual gamma emission from the reclaimed surfaces was not to exceed 50 microR/hr. The average background Ra-226 concentration in the first 6 inches of soil in the vicinity of the project areas is about 5.2

picoCuries per gram. The background gamma emission levels at I meter above the ground surface is about 15.5 microRoentgen per hour. In actuality, the radioactivity of the reclaimed surfaces was at the background level.

The Program provided training to the construction workers in radiation safety, use of personnel protective equipment, radiation protection, general work-safety, and personal hygiene (use of coverall, decontamination procedure, etc.). Thermoluminescent dosimeter (TLD) badges were used by all workers for radiation monitoring purposes. Working hours of personnel in areas that exceeded 100 pCi/g of Ra-226 concentrations in the soil were limited to 4-5 hours/day. The following monitoring and control functions were carried out on a daily basis: access control to confine radionuclides inside the project areas and decontaminate personnel; personal radiation dose monitoring by periodic frisking; radiological verification of clean-up of the reclaimed areas; air-quality monitoring for dust particulates and radionuclides; and equipment frisking for periodic decontamination. During dust storms, prevalent during March-July, the work was temporarily suspended. All equipment cabs had airtight enclosures with air-conditioning or air cooling systems to protect workers from harmful contaminants. Workers used approved air filters or respirators to prevent inhalation of dust. No eating, drinking, smoking, and chewing were allowed within the project boundaries to minimize radionuclide intake into the body. Personnel entry inside mine openings was strictly prohibited. Back-filling by heavy equipment by pushing or dumping over highwalls exceeding 10 vertical feet were not allowed in order to avoid dust generation. Haul roads were kept damp to reduce the dust levels using water trucks with double spraying rotating-type fire hoses mounted inside the driver's cab. This minimized dust generation, suppressed dust, and minimized airborne radionuclides at earthwork excavation and dumping points. Due to strict adherence to the safety standards, the project was accident-free. Personnel exposure to radiation during the duration of the project was below detection range, as evidenced by the TLD badge and urine sample analysis results.

High wind and forceful surface runoff are the two major erosive forces in the area. The mine waste blocked the natural drainage pattern. Though the project was located in an arid climate where rainfall is about 5-6 inches per year, the area is prone to heavy summer thunder storms which causes severe erosion problem and leaching of radionuclides and heavy metals from mine wastepiles. To prevent or minimize erosion, gentle slopes were provided on the reclaimed surfaces. The reclaimed surfaces were terraced and left rough by scarifying or furrowing. This technique facilitated erosion control and caught some rain water to promote growth of native vegetation. Drainage system was completely revamped with armored channels and drainage diversion berms using compacted rocky earth material.

There was a shortage of topsoil to cover the reclaimed areas to reduce emission of residual gamma radiation. To minimize the use of topsoil, an innovative backfilling concept/ sequence was designed. Using this approach, the mine wastepiles were classified into three categories depending on the level of radioactivity present in the material. Class A consisted of the clean material with its radioactivity not exceeding that of the background. Class B consisted of material whose radioactivity exceeded the background value by no more than 25 pCi/g. Class C consisted of the rejected low grade ore or overburden material left after mining with radioactivity exceeding the background value by more than 25 pCi/g. The idea was to place a buffer zone of sufficient thickness at the bottom of the openpit to isolate the buried layers of radioactive material from any potential groundwater contact. The Class C layers were sandwiched between layers of Class A and/or Class B. The top layer was always Class A. To eliminate or reduce the residual radiation emission from the reclaimed ground surfaces, the layers were compacted with at least five passes of the heavy earthmoving equipment. In some of the wastepiles, all the three classes of materials were mixed up. So it was decided to reclaim the openpits following the backfill sequence and then determine which areas were still "hot". Occasional hot spots were then covered with Class A soil.

The project was located in scenic mountains and Red Valley areas. Thus, emphasis was given to blend the reclaimed areas with the surrounding landscape both in terms of form and color.

The Navajo people are very sensitive to their cultural resources and many biological species. In fact, the Navajo Nation has its own species list in addition to the list of the US Fish and Wildlife Service. So, the stipulations provided in the archaeological and biological study reports to avoid or mitigate impacts by the reclamation work to these natural resources were directly incorporated in the technical specifications to avoid any confusion during construction work. The overall process for environmental assessment and regulatory compliance with the National Environmental Policy Act (NEPA) requiring multi-agency coordination was time consuming but the experience gained utilizing programmatic and regional approaches will help the Program in streamlining the NEPA compliance process.

Efficiency and Innovation of Design and On-Site Effectiveness:

The success of a project is measured by the effectiveness of its actual on-site construction work. This project has achieved that effectiveness. Proper equipment selection for excavation, hauling, grading, and backfilling operations was vital to the success and high level of productivity of the project. For every task, optimization techniques was used. Building of short haul roads and access ramps minimized the haul distance to within 500 feet and made wastepiles deposited on very steep slopes accessible for excavation. At a very reasonable cost and beating the deadline, the reclamation work successfully eliminated all the physical hazards and environmental problems. The reclaimed land is now open to its normal use.

For several of mesa-top or mesa-side, hard-to-access mine portals with access roads in severely deteriorated conditions, the usual methods of mine closure such as by backfilling or concrete bulkheads were not practicable. Knowing that several state AML programs have successfully used polyurethane foam (PUF) plugs for vertical shaft closures, the Navajo AML Program experimented with this emerging method to determine its adaptability for ***horizontal and inclined mine entries*** under the Carrizo 1 AMLR projects situated near the Four Corners area. Small-scale simple in-house experiments were conducted with the help of PUF experts and existing data were researched on the PUF material to determine its suitability. Six feet thick PUF plugs reinforced with No. 9 chain-link fencing wires were found to be adequate to seal the mine adits. The outside of the plugs were covered with at least 2-3 feet thick earth backfill for protection from degradation by ultraviolet rays. Ready-to-use, bagged PUF materials were transported close to the AML sites by small pick-up trucks and then manually carried to the work place or sometimes lowered down to the sites from the mesa ledges by ropes. Adits of various dimensions with various types of difficult locations were selected to determine the suitability of this method. The project demonstrated that equipment-less mine closure using bagged PUF, pre-measured for a perfect mix, is a fool-proof and faster (takes only 3-4 hours for an average-size portal) method very suitable for remote applications since the PUF materials can be back-packed to the sites. PUF is completely resistant to acid drainage and weather, it fills the mine voids completely and adheres to rocks stabilizing weakened ground, is safe to use, and does not pollute the environment. It attains a density of 2.3-2.6 lb/cu. ft. With a compressive strength of 22-33 psi in matter of minutes. A paper with details of the PUF closure design considerations, cost, applicability in various situations, and other valuable data for adit closures will be presented in the upcoming Annual Meeting of the National Association of Abandoned Mine Land Programs.

The Program's radiological clean-up standard worked very well and was easy to implement. Final clean-up was comparable to the background radiation level. The radiation safety plan was effectively implemented, enforced, and liked by every worker. Many outcrops of uranium ore were encountered within or adjacent to the project areas. It was decided to cover these outcrops with topsoil/cover soil to reduce the radiation level. Drainage improvement designs were successfully implemented according to the technical specifications. As envisioned, due to the construction of terraces, furrows, and check dams, most of the surface runoff was absorbed in the project area which is helpful for plant growth. The surface runoff is no longer radioactive.

Departmental guidelines were established which gained OSM's support and had since been very effective. Due to the shortage of topsoil in the area to cover up the reclaimed areas, an innovative openpit backfilling concept and sequence (described earlier) was designed which minimized the use of topsoil. *To* eliminate or reduce the residual radiation emission from the reclaimed ground surfaces, the layers of mine waste within the disposal or burial pits were compacted with at least 5 passes of the heavy earthmoving equipment. To minimize erosion of the reclaimed surfaces by rainstorm/thunderstorm (which is usually the case during the monsoon season), gentle slopes were provided and the surfaces were left rough by scarifying or farrowing. This technique facilitated erosion control by trapping surface runoff or slowing it down and thus promoting vegetative growth.

The bid documents had carefully chosen clear language to avoid any conflict or confusion during construction work. The pre-bid meeting and site tour were mandatory for the bidders. The project was a lump-sum type project. Payment for earthwork was based on one-time volume only in bank cubic yards for the material in the wastepiles with no allowance for additional payment being made for dumping it in the openpit or for double handling. The quantities of work were declared to be estimates only within reasonable limits of error (plus or minus 15%). No work measurements were necessary. There were no disputes over any work quantity. To assure the quality of work, provisions were included in the contract documents for a two-year workmanship warranty, payment and performance bonds, and liquidated damages for not completing the work in time. Use of Value Engineering and Partnering techniques during all phases of work enhanced productivity and safety. This also eliminated any Change Order and conflict with the contractor. There were many technical, cultural, and environmental constraints in this project. To assure that the reclamation work is culturally and environmentally sound, various stipulations were made part of the technical specifications. This was a very efficient approach. In some areas, flexibility was provided within the technical specifications so that field changes could be made during construction phase to suit existing conditions. Land surveying, engineering data collection, and characterization of wastepiles were completed using automated state-of-the-arts instruments such as GPS Total Station. Mapping and drafting were performed using AutoCAD Release 14 and SurvCADD software.

Benefits to Community:

Many of the sites were in close proximity to local residences and road-side businesses. Overwhelming evidences of site visitations were present to the dangerous and radioactive mine sites. After completion of the reclamation work, the project truly met the spirit of the SMCRA by removing all the dangerous AML features as well as the sources of water pollution, soil erosion, sedimentation, and radiation emission. Reclaimed lands are now aesthetically pleasing and open to the community for livestock grazing. The reclaimed land is once again consistent with the surrounding land forms and the scenic vistas.

The contractor's Navajo work force received decent wages which helped to ease the high unemployment situation in the community. The Program staff gained valuable reclamation experience which can be used in future project. Since the people from the community were involved right from the project planning phase, the relationship between the Program and the community improved. This will have a far fetching beneficial effect toward the success of later projects in the Monument Valley area some of which will be public facilities /utilities projects.

Finally, Navajo people view themselves, their world, and environment as an interconnected whole system involving religion, concepts of health, and the harmony with nature. The disruption in any part of the system, be it their lives or the land, therefore, causes an imbalance or disharmony. The AML sites are like scars on the body of Mother Earth and the reclamation process heals those scars. Therefore, the reclamation work brought pride and a serene feeling among the inspired workers and the community.

Conclusion:

The project, wholly funded by AML fund successfully eliminated all the physical hazards and environmental problems. Three projects were combined to form this large and extensive project for cost-effectiveness. Complex in nature, it required application of multi-disciplinary engineering principles and cost-effective and innovative solutions. The actual construction work performed by the contractors exceeded the requirements of the technical specifications. The project enhanced the land use and returned it close to its original natural setting. The project is an example of an award-worthy and exemplary reclamation which fulfilled the goals of the SMCRA.

Photo Captions

Photo No. 1: Shows placement of radiologically clean backfill against portals sealed by concrete bulkheads or polyurethane plugs; against rimstrips; and against highwalls. Radioactive wastepiles are graded to reduce slopes and covered with clean backfill to reduce radioactive emission to approximate background level.

Photo No. 2: Shows closure of a mesa-side uranium portal with reinforced concrete bulkhead. Initially the portal was backfilled with radioactive mine waste, as much as possible. The associated highwall and the outside of the portal will be backfilled to 2 H ; 1 V slope.

Photo No. 3: Shows transporting of polyurethane foam material to a difficult mesa-side uranium portal using rope. The foam is in cardboard boxes containing double compartment foam components.

Photo No. 4: Shows closure of one hard-to-access uranium portal located on a steep mesa slope by polyurethane foam plug. The plug is min. 6 ft. thick with its outside covered with 2-3 ft. of backfill

Photo No. 5: Shows a hard-to-access mesa-side uranium portal with unstable roof.

Photo No. 6: Shows a mesa-top dangerous, unstable, and radioactive vertical shaft (some of the shafts are deep and hidden by vegetation)