

UMTRA MANAGEMENT APPROACH

Honoring Commitments

George Rael -- Environmental Restoration Division Director, U.S. Department of Energy,
Albuquerque, NM

Larry Pinkel -- Project Manager, Jacobs Engineering Group Inc., Albuquerque, NM

Edward Artiglia -- Program Manager, Roy F. Weston, Inc., Albuquerque, NM

Kenneth Johnson -- Project Manager, Jacobs Engineering Group Inc., Albuquerque, NM

Duane Zeurcher -- Cost Schedule Engineer, Jacobs Engineering Group Inc., Albuquerque, NM

Steven Cox -- Project Manager, Jacobs Engineering Group Inc., Albuquerque, NM

Rodney Harrison -- Procurement Manager, Morrison Knudsen Corporation, Albuquerque, NM

Loretta Fahy -- Environmental Protection Specialist, U.S. Department of Energy, Germantown,
MD

Dave Mathes -- Assistant Manager, Office of Southwestern Area Programs, U.S. Department of
Energy, Germantown, MD

ABSTRACT

At the end of fiscal year 1998, the U.S. Department of Energy's Uranium Mill Tailings Remedial Action Surface Project completed construction of the last two uranium mill tailings disposal cells at Maybell and Naturita, Colorado. Over the past 20 years, the Project has remediated a total of 22 former uranium ore processing sites and has engineered and constructed 19 disposal cells containing approximately 43.8 million cubic yards of stabilized contaminated material.

This paper will discuss management challenges faced by the Project Team and some of the approaches used to successfully accomplish Project objectives. These approaches include: the Project's management organization; working relationship with the regulator; and the Project's commitment and approach to local, Tribal, state, and federal stakeholders. The paper will also discuss important aspects of the integrated project management system, and approaches used to deal with significant cost drivers to the Project. Also presented are aspects of the Project's highly successful health and safety program.

INTRODUCTION

The Department of Energy's (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project marked a significant milestone on November 8, 1998 - the 20th anniversary of the Project's enabling legislation, the Uranium Mill Tailings Radiation Control Act of 1978.(1) With completion of disposal cell construction at Maybell and Naturita, Colorado, Congress, through the DOE, has met its commitment to the citizens of the United States to remediate and stabilize uranium mill tailings at designated former mill sites.

During the past two decades, the UMTRA Project has encountered many technical, budgetary, and stakeholder relations challenges. Hundreds of talented people in numerous government organizations and contractor firms have worked together to achieve the success that is evident today. An important part of the UMTRA legacy is the management approaches used to proactively deal with these challenges and which ultimately resulted in an "end state" that met the expectations of the Project's stakeholders.

The Project took a retrospective look at what worked and what didn't at a Lessons Learned Workshop held in Albuquerque in May of 1997.(2) Attendees included some of the key figures involved in the early formation of the Project and others with 10 or more years of UMTRA experience. Key management approaches identified at the Lessons Learned workshop that worked well for UMTRA are highlighted in this paper. Specific areas that will be addressed include:

- Project organization.
- Working relationship with the regulator, the Nuclear Regulatory Commission.
- Stakeholder interactions.
- Integrated project management system.
- Cost drivers and cost containment.
- Health and safety.

PROJECT BACKGROUND

DOE's UMTRA Surface Project is one of the world's largest materials management projects undertaken to reduce or eliminate risk to the general public from exposure to potentially hazardous and radioactive materials. With an estimated cost at completion of nearly \$1.5 billion, DOE has encapsulated and isolated nearly one-fourth of all the uranium mill tailings generated in the United States (approximately 43.8 million cubic yards).

Beginning in the early 1940's, uranium exploration, mining, and milling were conducted to support the Manhattan Project and later, to develop America's nuclear arsenal and nuclear power industry. Uranium mill tailings are the sandy waste produced by the uranium ore milling process. Because only one to five pounds of usable uranium are extracted from each ton of ore, tremendous quantities of waste were produced during more than 40 years of milling operations in the United States.

Until the early 1970s, there was little recognition of the hazards presented by these tailings. Federal regulation of the industry was minimal. As a consequence, mill tailings piles were left at sites, mostly in the West, in an unstabilized and unprotected condition. Some of these tailings were removed and used in the construction of foundations and walls of private and public buildings. The hazard of the tailings and public exposure increased substantially because of the concentrated emission of radon gas. The tailings piles also contained heavy metal elements that were a source of ground water contamination.

In response to public concerns, Congress passed Public Law 95-604, the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, (42 USC 7901 et seq.)(1) to deal with the potential health hazards associated with the mill tailings. Under Title I of the Act, Congress gave DOE responsibility for remediating the tailings at abandoned processing sites to be designated by the Secretary of Energy. Initially, 24 sites were designated; however in 1995, the state government of North Dakota requested de-listing of the two sites located there. Under Title II of the Act, uranium processing sites still in operation after 1978 remained the responsibility of their private owners. The UMTRA Title I sites (Figure 1) are located in 10 states: Arizona, Colorado, Idaho,

New Mexico, North Dakota, Oregon, Pennsylvania, Texas, Utah, and Wyoming. Four of the sites are located on Tribal lands.

UMTRCA established a framework for executing the remediation and assigned specific responsibilities to various agencies. The U.S. Environmental Protection Agency (EPA) was to establish the standards to be used for the remedial actions. The U.S. Nuclear Regulatory Commission (NRC) was directed to provide consultation and concurrence on the type of remedial action that would be performed in accordance with the EPA standards. DOE was responsible for remediation of the designated former uranium processing sites as well as the properties in the vicinity of the sites where wind and water erosion deposited tailings or where people removed them from the site for use in construction or landscaping. Nearly 14,000 potential "vicinity properties" were identified and evaluated. 5,436 of these properties were determined to be "includable" under UMTRCA and were remediated. DOE was also directed to comply with the National Environmental Policy Act (NEPA) and perform detailed studies of the environmental impacts that the remedial action would have at each of the sites before the remedial action began.

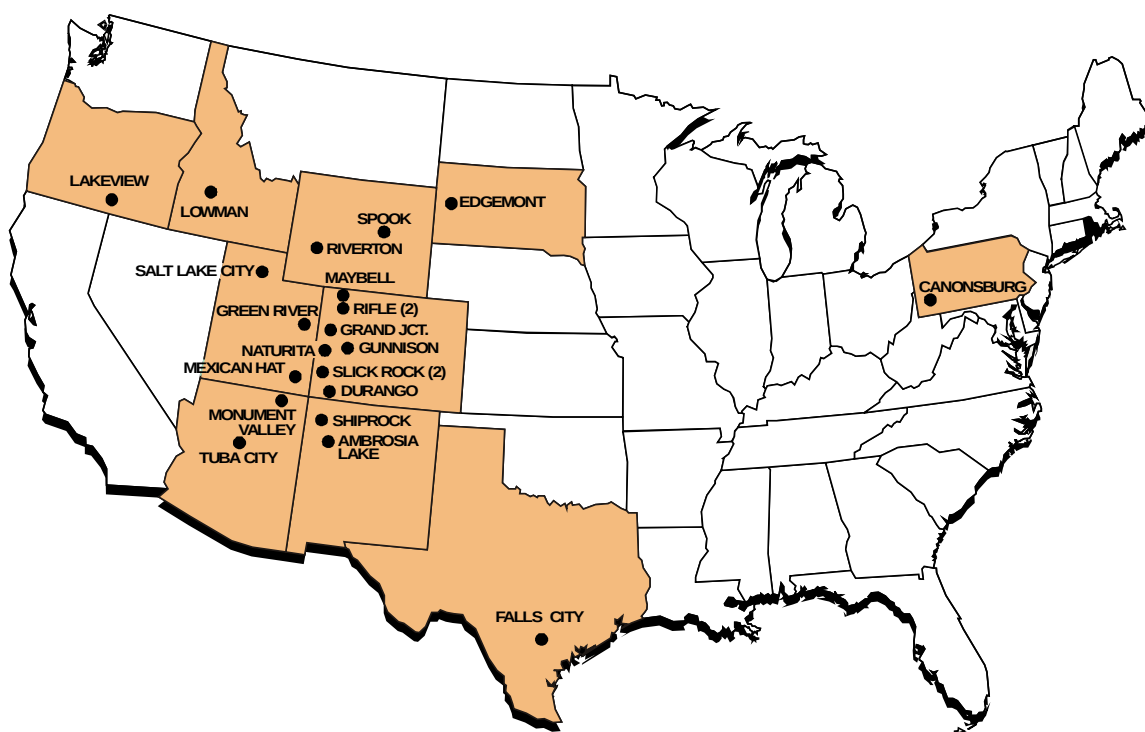


Figure 1. Location of UMTRA Title I Sites

UMTRCA authorized the DOE to enter into cooperative agreements with the affected states and Indian tribes to perform remedial actions at each designated processing site. The agreements established the process for involving these stakeholders in the decision-making process and also provided a tool for reimbursement of costs incurred in executing their responsibilities under the agreements. As part of each agreement, the federal government would fund 90 percent of the

remedial action and the state would fund the remaining 10 percent. For remediation of processing sites located on Tribal lands, the federal government would fund 100 percent of the cost.

The EPA's UMTRA standards were initially published (40 CFR Part 192) on March 7, 1983, which started a seven-year clock for completing the remediation of the designated sites.(3) However, the ground water portion of the EPA standards was challenged in court and remanded back to the EPA for revision. A proposed revision of the ground water standards was issued in 1987, but the standards weren't finalized until 1995. Due in part to the uncertainty surrounding what the final ground water standards would look like, the DOE decided in the late 1980's to separate the ground water remediation into a separate project. In this way, the more urgent need to encapsulate the tailings piles could be pursued to a conclusion with less impact from the delay in the standards. In 1996, DOE's Albuquerque (AL) Operations Office transferred responsibility for the UMTRA Ground Water Project to its Grand Junction Office (GJO). The Surface Project has been continually managed by AL from Albuquerque.

UMTRCA was amended in 1983 (Public Law 97-415, Sec. 21, January 4, 1983 96 Stat. 2079) to add Edgemont, South Dakota, for vicinity properties only. Congress passed the UMTRA Amendments Act of 1988 (Public Law 100-616, November 5, 1988, 102 Stat. 3192) extending DOE's surface remediation authority to September 30, 1994, and removing any time limitation on ground water restoration authority. The last change to UMTRCA (Public Law 104-259) extended the Secretary's remediation authority until September 30, 1998.(1)

The purpose of remedial action at each site was to minimize or eliminate potential hazards to human health and the environment resulting from exposure to tailings and other residual radioactive materials (RRM) at the former processing sites and at contaminated vicinity properties. The Surface Project scope included the characterization of contamination at each processing site and the design and construction of an engineered disposal cell to isolate the RRM from the environment for a period of at least 1,000 years, but no less than 200 years. Where possible, tailings piles were encapsulated in place. However, the EPA ground water standards and other concerns ultimately drove the need to relocate about half of the tailings piles to alternate locations. Following remediation, processing sites were restored and made available for useful purposes.

PROJECT ORGANIZATION

Project Formation

Significant changes in the federal government's organization structure for direction of nuclear energy programs took place in the latter half of the 1970s. These changes brought new and improved management concepts from the military establishment that were applied to the UMTRA Project when it was conceived in 1979. It should also be emphasized that even with a favorable organizational and management environment, it takes commitment, communications, and dedicated employees to bring project success.

With the passage of UMTRCA in 1978, one of the first concerns at DOE Headquarters (HQ) was how best to manage an effort that promised to be a major undertaking. One of the first steps taken was to prepare and approve a management plan. A key element of this plan was to establish a Project Office located at the Albuquerque Operations Office. The program manager

would represent the Project's interest in Washington, and contractors would be hired to support the federal staff with planning, design, and construction. This was a significant departure from the old Atomic Energy Commission days when construction projects were managed by Headquarters with field organizations essentially carrying out instructions from Washington.

One of the key features of the agreement between DOE AL and DOE HQ was that while the Project Office would be a part of the DOE AL organization, the Project initially retained a degree of independence. For example, the UMTRA Project was funded as a line item in the DOE budget through FY 1995. As such, annual appropriations were dedicated to UMTRA activities. As AL's environmental management program matured, the UMTRA Project gained efficiencies and synergism through integration with other environmental restoration activities.

Another step taken immediately after the Project was established was development of a project work breakdown structure (PWBS). Using a technique borrowed from the Department of Defense project management structure, the work was organized into logical divisions of effort that integrated budgeting, project cost and schedule control, and contractor scopes of work. The work structure also provided the DOE Project Manager with a tool for assigning and managing project office staff responsibilities.

Project Team Organization

The DOE Project Office staff consisted of about 20 people at the height of Project activity. Skills represented by the group included project management, engineering, health physics, environmental, hydrology, finance, safety, and project controls. Matrix support was provided by DOE AL in specialized areas such as legal and real estate. A key ingredient to the success of this organization was the designation of site managers. These technically qualified and experienced managers were empowered to integrate the overall effort and be the champion for their sites. As such, the site managers served as contracting officers, representatives for the Technical Action Contractor (TAC) and Remedial Assistance Contractor (RAC) contracts. They also were the primary point of contact with stakeholders for their sites.

The decision to use two separate prime contractors, the TAC and RAC, can be traced back to 1979 when the DOE AL identified an acquisition strategy as part of the resource analysis it provided headquarters before setting up the UMTRA Project Office (Figure 2). The TAC was responsible for site characterization, the NEPA process, conceptual site design, final design reviews, remedial action plan coordination; health and safety programs, quality assurance, public information and participation, and integrated cost and schedule control. The RAC's responsibilities included detailed engineering for remedial action; remedial action construction and inspection; and on-site health, safety, radiation, and environmental monitoring.

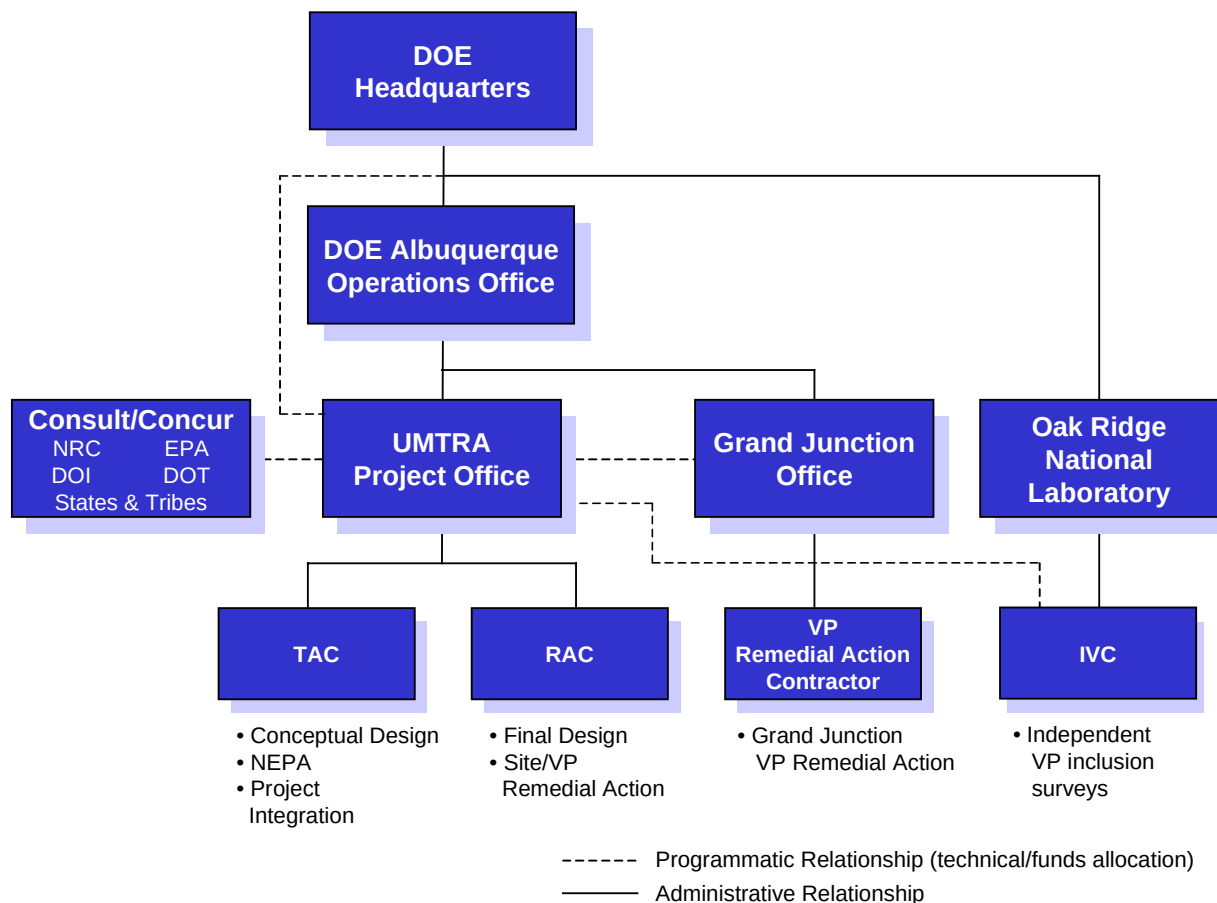


Figure 2. UMTRA Project Organization

Generally speaking, the use of two prime contractors was very successful and contributed to the overall success of the Project. The advantages of this approach included:

- A built-in system of checks and balances, particularly in the areas of design, cost, and schedule. For example, both the RAC and TAC developed independent construction cost estimates and had to work out the difference if it exceeded 10 percent. Also, the TAC developed conceptual designs, the RAC turned the concept into construction designs, and then the two contractors jointly reviewed the final product
- Contractors displayed a natural competitiveness which provided incentives and challenges to come up with cost savings, stimulated new ideas, and helped to avoid complacency on the part of both contractors.

Although outweighed by its advantages, certain disadvantages of the two-contractor approach were noted. These included:

- Some loss of efficiency due to the intensive reviews required during “hand-offs” between contractors.
- Extra effort had to be taken to ensure that contracts were specific regarding scope of work, that roles and responsibilities were clearly defined, and that schedules remained

coordinated. In addition, DOE was forced to become the facilitator when contractors had competing ideas on how to resolve issues.

Responsibility for vicinity property remediation at the Grand Junction site was delegated to AL's GJO. This was a logical decision due to the large number of vicinity properties located there and the experience of the GJO and its local contractors in dealing with the complex issues involved with this most significant part of the UMTRA Project. Oak Ridge National Laboratory, through its Grand Junction office, was utilized as the Independent Verification Contractor (IVC), to ensure independence in the determination of vicinity properties to be included in the UMTRA Project.

WORKING RELATIONSHIP WITH THE NRC

The DOE and the NRC entered into a memorandum of understanding (MOU) in July of 1985 to define an orderly process for executing the agencies' respective statutory obligations under UMTRCA. The document was revised in November of 1990 to make improvements based on the first five years of Project experience. The specific intent of the MOU was to minimize or eliminate duplication of effort, to facilitate and expedite reviews and concurrence, and to promote accomplishment of the objectives of Title I of the UMTRCA within the statutory mandated schedule and within constraints imposed by Congressional appropriation.

In the MOU, the agencies clarified their roles and responsibilities in accordance with UMTRCA. A key element of the MOU was the creation of two programmatic guidance documents, a Technical Approach Document and a Standard Review Document. These documents established early agreement regarding the content and format of site-specific concurrence documents, acceptable design approaches and techniques to demonstrate compliance with the EPA standards, and the sequencing and time frames for NRC reviews. These "agreements on how to agree" proved invaluable over the years to maintain schedule and to avoid issues related to techniques or approaches used in site-specific documents.

Maintaining good communication on technical and management issues of a programmatic nature has been a key factor in the DOE/NRC relationship. Quarterly management meetings were held between the DOE and NRC Project managers to review the progress of the Project and to discuss and resolve programmatic differences. Semi-monthly conference calls were held between the DOE and NRC Team leaders to review the status on specific documents, such as the Remedial Action Plan or the Completion Report for each site. The results from these telephone calls helped each Team Leader to prioritize the work efforts of their respective staffs. A log was maintained of the schedule commitments made during each call that was shared by both agencies.

STAKEHOLDER INTERACTION

UMTRCA mandated that the public be kept informed about Project plans and activities, and encouraged public participation in Project decision-making. This requirement was years ahead of its time, and represented one of the earliest examples of formal DOE public participation. As a result, some of the public involvement practices that have become commonplace within the DOE in recent years were being performed on the UMTRA Project almost 20 years ago.

Choices about how remedial actions are conducted affect many segments of the public, and each of these segments is a stakeholder in the Project. Remedial action choices on UMTRA had

actual or perceived impacts on individual property rights and values, peace and quiet of neighborhoods, traffic volume and safety, future land use, and usability of water. In addition, the acceptability of a given level of risk reduction was a public value issue.

For these reasons, UMTRA Project officials solicited and responded to public input on Project decisions, both on policy and on the technical choices between options. In this way, it minimized adverse impacts on stakeholders and resolved stakeholder concerns to the extent technically and fiscally possible. This was done through direct dealings with UMTRA Citizen Advisory Boards at active sites; one-on-one meetings with local, county, and state officials; and through regular public meetings prior to and during remediation. Each state, under its cooperative agreement, had a responsibility to act as a proponent for local communities. In this capacity, the states organized the local boards, participated in the meetings, and otherwise assisted the DOE to meet the requirements of UMTRCA.

During project meetings in local communities, members of the public were given the opportunity to learn about the UMTRA mission and the local project, weigh the pros and cons of various alternatives proposed, and consider the advantages and disadvantages of the proposed plan in order to compare the acceptability of its risks and costs (both monetary and social) with that of other alternatives. While DOE's technical experts explained what could be done, the public was given the opportunity to provide input on what should be done.

Such public input contributed to numerous changes in the way DOE remediated surface contamination at and near UMTRA sites. At Grand Junction, Colorado, public concern about the movement of tailings using haul trucks on city streets resulted in DOE altering their haul plan by developing a train-truck transport system to move the material to a disposal cell 17 miles south of the city. And at Naturita, Colorado, public concern resulted in a change of the disposal site from Dry Flats, a hill just south of town, to a commercially-owned site at Uravan, Colorado.

An innovative and effective means to interact with the Project's many stakeholders was the annual "States and Tribes" meeting. DOE sponsored these meetings in the vicinity of an active UMTRA site each year to update states, tribes, and local agencies on the status of the Project. They also provided a unique forum for these representatives to share their experiences, concerns, and ideas with each other, as well as with DOE. Other communications tools used over the course of the UMTRA Project include the following:

- An extensive mailing list containing over 4,500 names was maintained to ensure interested stakeholders received applicable news releases, meeting notifications, progress reports, and other general information.
- Two toll-free telephone numbers were maintained for anyone to call and ask questions of the Project Office. Every effort was made to respond to each call within 24 hours.
- Public reading rooms were set up in each UMTRA community where local citizens could read documents and reports pertaining to the site selection, design, and construction of the disposal cell in their area.
- UMTRCA required that an annual status report be prepared by DOE and submitted to Congress. This report was shared with state and Tribal UMTRA representatives for their information and to assist them in keeping their governmental organizations informed.

Each state, tribe, and cooperating federal agency also had the opportunity to provide input, which was included in the reports.

- An annual video was also prepared during the later stages of the Project to document remedial actions being taken at the sites during the previous year. These videos were also widely distributed as a means to educate and inform various stakeholder groups on the Project's purpose and progress.

Not only were local citizens involved with the processing site remediation and the construction of the disposal cells, but many were also involved personally with the vicinity property program. In the community of Grand Junction alone, there were more than 4,400 property owners and lessees that had a vested interest in how the Project would affect their properties. In many cases, the contamination in structures was so extensive that families would have to relocate, or businesses be shut down and relocated to a new site or set up in trailers at the existing site. These situations led to negotiations to reimburse costs and to work out details for how the properties would be rebuilt.

DOE GJO, in cooperation with the Colorado Department of Public Health and Environment, responded to the needs of the Grand Junction community by establishing an Owner Relations Department that worked with property owners on a full-time basis. This department was the primary contact with the owner. The department obtained access to properties by securing owners' signatures, obtained signatures on remedial action agreements, and found suitable facilities for relocating owners. This department coordinated program activities with state and local agencies and facilitated the resolution of owners' concerns with designers, construction engineers, and subcontractors.

COST/SCHEDULE PLANNING AND CONTROL

Overview

As a designated Major System Acquisition, the UMTRA Project was required to meet the planning, control, and reporting requirements specified in DOE Orders 4700.1 and 2250.1.(4,5) In response, the Project Office implemented an Integrated Project Management System (IPMS) to support the following functions:

- Planning and organizing Project work among the various project participants.
- Preparing and supporting federal budget submittals.
- Tracking cost/schedule performance.
- Preparing internal and external cost, schedule, and status reports.
- Maintaining the Project's technical, cost, and schedule baselines.

The Project Office required the four major contractors (RAC, TAC, Grand Junction RAC, and IVC) to maintain their own management control systems consistent with the Project's IPMS requirements. Each of these systems was thoroughly documented and subject to formal reviews by DOE. The major contractors also maintained individual Management Plans subject to Project Office approval. These plans provided the detail on how each contractor would manage the work assigned to them. Additional information included milestone plans, deliverable lists, budgeted cost of work scheduled plans, cost plans, and employee staffing levels.

There were over 100 small contracts, interagency agreements, and cooperative agreements with states and tribes over the life of the Project. These Project participants were not required to meet the stringent requirements of the major contractors, but their budgets, schedules, and costs did have to be included into the IPMS to create the Project baseline, develop the Project's budget requests, track costs, and monitor performance. The following sections discuss how the IPMS was used by the Project Office in the areas of planning and scheduling, budget preparation, performance measurement and reporting, and change control.

Planning and Scheduling

UMTRA Project work scope was established by UMTRCA, the EPA standards, NEPA requirements and stakeholder input. The project work breakdown structure (PWBS) developed during project formation was passed down to each major contractor as they came on board. Work was then authorized to them within specific PWBS elements. Each contractor created a contract work breakdown structure (CWBS) by expanding the authorized PWBS elements to lower levels of detail, as needed, to completely define and manage the assigned work. DOE also developed an organization breakdown structure (OBS) to permit the assignment of multiple contractors to common WBS elements and to maintain traceability of all project data back to the contractor systems. Using the OBS and approved CWBSs, work was authorized to ensure that the assigned contractor scopes of work and their estimated costs were integrated with one another and met the project's authorized funding, scope, and schedule commitments.

To bring consistency to the development of the project master schedule which included all sites, a generic site logic was developed that accounted for all the necessary steps for completion of a site (characterization through licensing), but allowed enough flexibility to accommodate each site's unique conditions. The activities, sequencing, and durations for each activity were developed from contractor estimates, experience on prior work, and MOUs or other agreements specifying the schedule related responsibilities of project participants. Management milestones were added to highlight contractor interface points, submission of documents for outside agency reviews, and performance milestones defined by DOE HQ.

Monthly schedule meetings were held to review schedule accomplishments, discuss the status of upcoming activities, and develop "work-arounds" to mitigate any identified schedule impacts. Attendees included Project Office and contractor site managers and others who were empowered to make scheduling decisions for their organization. In this way, a coordinated master schedule update was published each month that was consistent with lower level contractor schedules at critical interface points.

Budget Preparation

DOE utilized the IPMS to support the Project's Field Budget Submittal to DOE HQ. Coordinated budget guidance was issued to the major contractors for use in preparing their individual budgets. This guidance was based on the current status of project activities, anticipated funding levels provided by HQ, and any changes to priorities or remediation approaches directed by the Project Office. The budget submission was created from a roll-up of major contractor's budget input, estimates of all other project participants' costs, and application of escalation and contingency. Formal budget reviews were held by the Project Office to ensure completeness, integration, and adequate supporting detail. The IPMS also provided a yearly

forecast of each state's cost share from the approved budget for each site. This information was provided to state representatives for use in their legislative funding process.

One of the key attributes of UMTRA's budget development process was a continuing emphasis on risk identification, assessment, and follow-up. The risk analysis included possible scope changes based on contractor risk identification, stakeholder input, and site management analysis. The Project Office held risk analysis meetings twice per year to develop, update, and review risks to project schedules and cost. Each risk item had a defined scope with a cost estimate, an evaluation of when it would occur, and a probability of occurrence developed by the contractors and reviewed by the Project Office. By compiling all of this risk information, the Project's budget contingency requirements were well defined and documented.

Performance Measurement

The IPMS combined monthly performance data from all contractors, agencies, states and tribes. Earned value information was provided by the major contractors that permitted the recognition of cost variances (differences in cost of work performed versus budgeted) and schedule variances (dollar value of work ahead or behind schedule). This large volume of information to collect and integrate led to the use of an exception management system. Thresholds were established for contractors at various levels of the CWBS. This streamlined the job of the Project Office to identify the "critical few" issues that required their attention.

Contractor reports were submitted in paper form, as well as a specified electronic format, so they could be summarized for internal DOE use. Further summarization of the data and addition of higher level variance explanations was accomplished to prepare the project's external reports such as the Project Manager's Progress Report and the Progress Tracking System (PTS). Project performance was also reported to Congress and the public through the Annual Report.

Change Control

A Change Control Board (CCB) was created that reviewed contractor proposed baseline changes and made recommendations to the UMTRA Project Manager. The uniqueness of this board was the empowerment given to the prime contractors and Project Office personnel. The Project Office specified baseline control thresholds at various levels of the PWBS and CWBSs. Below these thresholds, contractors were authorized to internally process baseline changes using their management reserve budget, provided no impact to funding would result. These changes were documented and reported to the Project Office as "notifications." Above the thresholds or if funding would be impacted, change requests had to be submitted to the board for review. The UMTRA Project Manager had final approval/disapproval authority within prescribed headquarters thresholds.

The composition of the CCB included the DOE Project Manager or Deputy Project Manager, the Project Financial Officer, and the prime contractor Project Managers. The Contracting Officers were consulted if contractual questions arose. This representation ensured all aspects of each request were considered, including the potential effect on other contractors. Over the years, this procedure was fine tuned and became more successful by improving the communication channels between the Contractors, site managers and contracting officers. Obtaining DOE site management and other contractor "buy-in" at the start of the request cycle by the contractors proved the most beneficial.

COST DRIVERS AND COST CONTAINMENT

Cost Drivers

In February 1982, one year before the EPA's UMTRA standards were to be published, the total project cost estimate was \$849 million. Key assumptions in this estimate were:

- EPA standards would be published in January 1983.
- The Project completion date would be December 1989 (seven years after publication of the standards).
- 24 sites would be remediated.
- One tailings pile would be relocated to an off-site disposal area.
- Total tailings volume would be 19.3 million cubic yards.
- 4,875 vicinity properties would be remediated.

Based on the execution budget for FY 1998, the last year of remedial activities at the last two sites, the estimated total project cost was \$1,486 million. This value includes actual costs through FY 1997 plus the budget for remaining activities, including remaining contingency. At project completion, key work scope parameters include:

- EPA ground water standards were finalized in January 1995; however DOE used the proposed final standards issued in 1987 for site designs from that point forward.
- Tailings remediation was completed by the end of FY 1998. Licensing of the last two sites is planned for spring of 1999.
- 22 sites were remediated. The state of North Dakota requested that the Belfield and Bowman sites be de-listed as designated UMTRA processing sites; however site characterization, NEPA, and detailed design activities had all been completed by the time the state made their request.
- Total tailings volume was 43.8 million cubic yards.
- 12 tailings piles were relocated to off-site disposal areas.
- 5,436 vicinity property were remediated out of nearly 14,000 properties surveyed. 137 vicinity properties at Edgemont, South Dakota, had been added to the program and a separate disposal cell was constructed to contain a large vicinity property at Burrell, Pennsylvania.

Publication of the EPA's proposed final ground water standards in 1987 not only delayed the Project, but was also a major cost driver. To avoid further delay, DOE decided to use the proposed final standards as the basis for disposal cell designs from that time forward. The standards were finalized in 1995 without significant additional changes affecting cell designs.

To comply with EPA's proposed new standards, surface remediation strategies had to prevent uranium and other contaminants in the tailings from entering and contaminating the ground water underlying the site. The standards required a compliance demonstration on the basis of

numerical limits. Thus, at six sites, DOE either 1) removed the tailings to an off-site location rather than disposing of them on-site as planned, or 2) changed the location of a planned disposal cell. For example, for the site at Naturita, Colorado, a decision was made to relocate the contaminated materials to an off-site area because of their close proximity to the ground water. The estimated additional cost to identify, characterize, and design for a new disposal site; then haul the tailings there by truck was over \$12 million.

At five other sites, DOE had to redesign the disposal cell and/or the cell's cover to comply with the new standards. At the Grand Junction, Colorado, site for example, the location of the site had to be changed, extensive additional characterization was required, and the cell had to be completely redesigned. The resulting cost increase was about \$48 million.

Remediation costs increased because of the discovery of additional tailings at the sites. The 1982 cost estimate was based on the assumption that about 19.3 million cubic yards of tailings would need to be stabilized at the sites. The final total is about 43.8 million cubic yards. Higher quantities of sub-pile material were excavated than were estimated in the early days of the Project as excavation control protocols were developed to deal with various residual radioactive materials including Thorium. Higher quantities of wind blown and water borne materials were also identified during construction at some sites. In some cases, additional quantities drove disposal cell design changes that increased the size or configuration of the disposal cell with an associated increase to the cost. Estimates of tailings quantities became much more accurate in later years through experience on the first few sites

Vicinity properties also contributed to increased costs. The total number of vicinity properties increased by about 10 percent from the 1982 estimate; however, a more significant effect was the higher volume of tailings found at some properties. For example, in Grand Junction, Colorado, where the majority of vicinity properties were found, the total amount of tailings found at these vicinity properties increased from an estimated 747,000 cubic yards to almost 2 million cubic yards.

State and local entities' concerns affected the remediation strategies selected and the attendant costs. Responding to strong stakeholder concerns about leaving tailings in place, DOE changed from on-site disposal to more costly off-site disposal at several locations, including Grand Junction, Colorado; Gunnison, Colorado; Salt Lake City, Utah; and Riverton, Wyoming. In addition, at the Grand Junction site, local concern about safety led to the use of a train-and-truck method of transporting contaminated materials, rather than a cheaper truck-only method. Local officials wanted a transport system that avoided routing extensive truck traffic through heavily populated areas. The train-and-truck method required the construction of railroad transfer facilities and the manufacture of specially equipped containers. The additional unanticipated \$28 million of costs for these changes required the interruption of work at the Mexican Hat and Monument Valley sites and postponement of planned work at the Ambrosia Lake site at an estimated cost of about \$6.6 million.

The UMTRA Project had to comply with changes to DOE's environment, safety, and health requirements and federal transportation requirements. As an example, it was determined that the Project had to comply with the Department of Transportation's regulations governing the transport of hazardous waste. Complying with the regulations added approximately \$11 million to the remediation cost at the Grand Junction, Colorado, site, to provide for additional

inspections, hiring a full-time transportation compliance officer, providing additional training for truck drivers on handling hazardous material, and purchasing additional insurance.

Cost Containment

In 1995, the UMTRA Project was presented with the National Performance Review's "Hammer Award" by Vice President Al Gore. The award was in recognition of the Project's Cost Reduction/Productivity Improvement Program (CR/PIP) which had been in operation since 1988. Through the CR/PIP, UMTRA project personnel had identified over \$61 million of cost savings and cost avoidance.

The UMTRA Project has always maintained solid management and technical approaches that continuously focused on cost efficiency. However, the DOE Project Office felt that more could be done. In 1988, UMTRA staff reviewed several existing programs, including one at DOE GJO, and then developed a pro-active, employee centered cost savings program that would contribute to the Project's environmental restoration mission by providing the means to achieve and recognize continuous improvements and cost savings. Key elements of the program and the results obtained follow:

- The program empowered all UMTRA employees to enhance productivity or quality, and reduce costs. Individual employees, or employee teams, could propose their ideas and project management would consider them in a timely manner. If an idea made sense, it would be implemented.
- Contractors developed their own goals for total savings and employee participation percentage each fiscal year. These goals established a degree of "friendly competition" among the contractors to continuously improve their performance and in turn, motivated employees to participate.
- There were no cash awards. Any employee who participated in the program was invited to a bi-annual "free lunch" where they received a certificate and personal thanks from the DOE Project Manager and other senior DOE officials.
- Diverse groups representing DOE, other federal agencies, state/Tribal representatives, and contractors were encouraged to collaborate on cost saving ideas. "Credit" for these results were shared among the participants.
- The CR/PIP helped to consolidate, focus, and document all cost savings activities. For example, savings from value engineering were documented in the CR/PIP and those participants received recognition for their contribution to cost reduction.
- The CR/PIP cost savings identification process was integrated with the change control and budget processes. Approved cost reduction proposals, above a certain threshold, were automatically reviewed by the CCB for potential baseline change action. In this way, the savings recognized in the CR/PIP would be properly reflected in the baseline and future project budgets.

At the end of fiscal year 1998, the UMTRA CR/PIP had realized more than \$75 million in cost savings or avoidance. Over 1,500 employee suggestions have been received from: DOE (HQ, AL, and GJO); the TAC (Jacobs Engineering and teaming partners, Roy F. Weston, AGRA Earth and Environmental, and Geraghty & Miller); the RAC (MK-Ferguson and teaming partner Rust

Federal Services); the Grand Junction RAC (Rust Geotech and MacTec); Oak Ridge National Laboratory (Grand Junction); and the Colorado Department of Public Health and Environment. This program illustrates that teamwork can produce benefits that save taxpayers money and improve the quality of the work and services provided.

In 1988, the U.S. Office of Management and Budget (OMB) issued a requirement to all federal departments and agencies to adopt and use value engineering as appropriate to identify and reduce nonessential procurement and program cuts. In 1989, DOE responded to the OMB circular and issued DOE Order 4040.1, outlining the purpose and scope of value engineering. The UMTRA Project embraced value engineering as an important tool to meet the EPA standards and other site requirements at the lowest cost.

The UMTRA Value Engineering (VE) program was established to compare the way remedial action was planned with other, potentially less costly, alternatives for meeting project objectives. Each session was led by a certified value engineer and followed the traditional VE process of information gathering, speculation, analysis, development, and presentation. Technical staff from outside the project were typically invited to participate to ensure a degree of independence from the “as-is” design. Each VE session was thoroughly documented. Two additional phases, implementation and follow-up, were completed after the VE session was completed.

The UMTRA VE program resulted in total savings of over \$30 million. Sites were typically evaluated twice, once at the conceptual design phase and again at about the 60 percent stage. As an example, the cover design for the Maybell, Colorado, site was the focus of a value engineering review. In order to meet EPA ground water standards, a very low hydraulic conductivity of the infiltration barrier was needed. A geosynthetic barrier, called Claymax, which consisted of a layer of bentonite clay between two geotextiles, was selected to meet this need. During the value engineering session, project personnel proposed mixing bentonite with the natural soils rather than using Claymax. Laboratory testing confirmed that the mixed materials would perform as needed and would save approximately \$1 million.

In addition to its use in reviewing site designs, the value engineering process was also successfully used to analyze programmatic issues. VE was used to refine and streamline the commingled waste investigation process to ensure that it met all radiological and hazardous material regulatory requirements in a cost-effective manner. VE was also used as a framework to facilitate planning for post-UMTRA control of uranium mill tailings located in the state of Colorado as executed by the Long Term Surveillance and Maintenance Program.

Value Engineering activities were directly related to CR/PIP, the CCB, and Project cost estimation. Copies of approved VE changes and VE validation reports were integrated into the CR/PIP system. Some VE changes warranted budget or schedule baseline changes through the CCB. VE reports were distributed to various cost estimators, planners, and designers so that future cost estimates would reflect the planned and implemented changes.

Value engineering has proven to be a valuable tool for the UMTRA Project. It produced results that could be seen in the field, and more importantly on the bottom-line.

HEALTH AND SAFETY

DOE had a commitment to establish and maintain a very visible health and safety program for all workers on the Project (DOE Orders 5400.1 and 5480.1B).(6,7) Achieving complete participation and acceptance by all federal and contract personnel required the health and safety program to have top management support and be visible to each individual working at the sites. This program was important at the grass roots level since the primary source of truck drivers and heavy equipment operators would come from people living in the communities located near the processing site being remediated.

During disposal cell construction in the 1980s, the RAC supported the field safety program with safety and health representatives dispatched from their Albuquerque project office. When the number of sites under construction increased, starting in 1990 and completing in 1998, the decision was made to assign permanent safety and health representatives to the RAC's construction management team to coordinate activities at each site. This level of commitment dramatically reduces the number of reportable incidences.

As part of the commitment to protecting human health and the environment, the RAC also provided their field managers with on-site teams of radiological control personnel to monitor personnel exposure in and around the contaminated processing site.

Unfortunately, the Project did have one fatality. A worker died when crushed by a rock grinder at the Grand Junction disposal cell in May, 1992. Following a thorough investigation, DOE added or increased the involvement of the safety and health program at all levels, especially with the field construction phase. In addition to stepping up various audit activities, the Project Office initiated the Safety Advancement Field Effort (SAFE). The SAFE team was composed of three highly qualified construction safety and truck transportation experts who performed informal assessments at each construction site in "circuit rider" fashion. Issues and recommendations were discussed directly with field personnel. No formal "audit reports" were written so all parties could be completely open and take full advantage of the SAFE team's experience. Corrections were made in the field and concerns that were noted were shared with the other construction supervisors and safety representatives at the other sites.

Site verification of safety and health implementation was performed at several levels. The field construction management provided by the RAC inspected subcontractor operations daily. The RAC Albuquerque Operations also conducted routine inspections in addition to providing safety training and lessons learned discussions with all of the RAC health and safety officers. The DOE UMTRA Project Office, with support from the TAC and RAC safety and health personnel, conducted frequent independent oversight audits of site operations.

The interests and concerns of local communities were also considered in the health and safety program. For example, a concern was raised by a citizen in the Naturita community regarding the town's emergency response capability. UMTRA Project representatives reviewed the capability of the local emergency medical response to maintain their support to this rural community and to cover the increased activities of the UMTRA remedial action. The result of the review was a grant from the federal government, through the state of Colorado, to the Naturita community to increase their response capability during the active phase of the Project.

The Project's overall record in the area of health and safety has been outstanding. In the past 12 years, the Project's recordable injury rate has risen above the DOE Construction Rate only once. Even then it was well below the Bureau of Labor Statistics (BLS) reported rate for heavy construction. As shown in Figure 3, the Project's OSHA recordable injury rate for the past five years has been roughly half of the DOE construction rate and one-fourth of the BLS rate.

The Project has also fared very well in terms of transportation safety. UMTRA haul trucks have logged over 22.2 million miles of highway and off-road driving. The truck accident rate per million miles driven has remained below the Department of Transportation rate for the past 12 years.

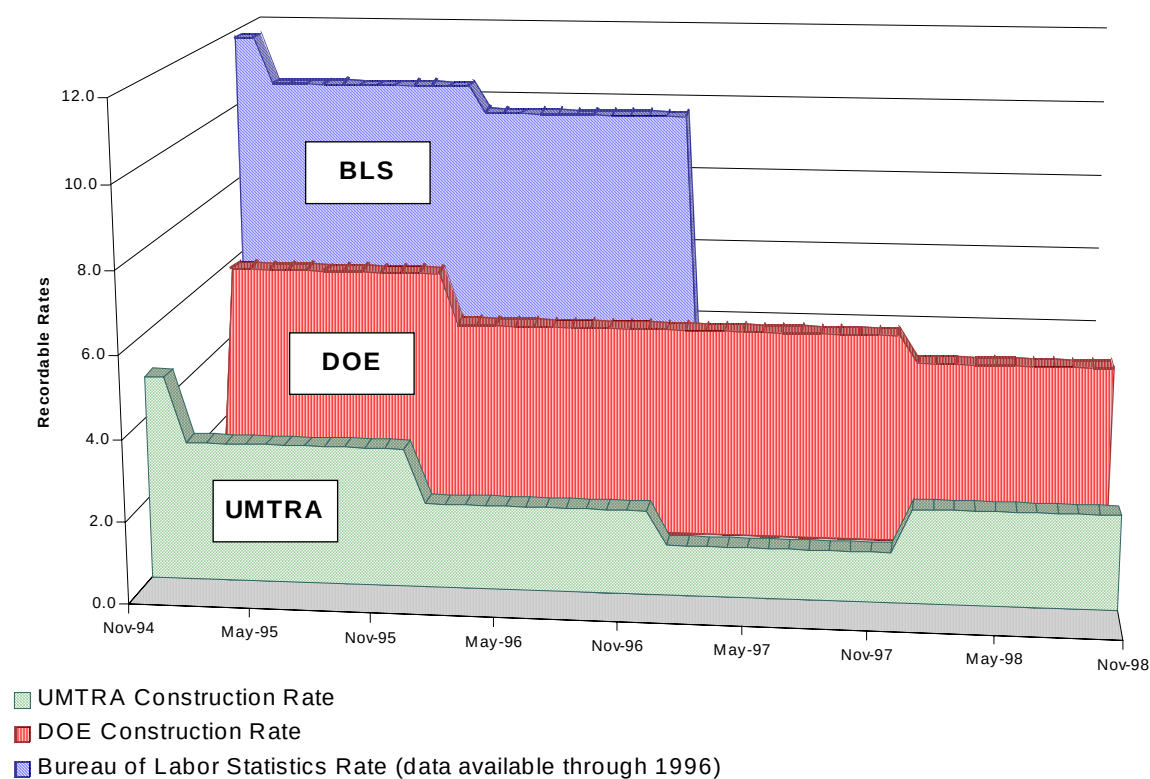


Figure 3. Comparison of UMTRA/DOE/BLS Recordable Injury Rates

SUMMARY

With the completion of disposal cell construction at Maybell and Naturita, Colorado, the DOE had fulfilled its commitment to Congress and the American people to stabilize radioactive and contaminated materials at 22 former uranium processing sites. The Project has lived through its share of technical problems, stakeholder issues, budget constraints, and changes to the regulatory standards for remediation of the processing sites. The management approaches described in this paper were a significant factor in the Project's ultimate success.

Over the course of 20 years, the UMTRA Project actively solicited public and stakeholder input and when appropriate, DOE adjusted the Project's direction. The numerous public meetings, press releases, conferences, interviews, and the like, required long hours from various DOE, contractor, federal agency, state, and Tribal staff, but paid dividends as the UMTRA sites were successfully closed in partnership with each state, tribe, and community.

Commitments to the public and local, state, and Tribal governments for surface remediation have been met. Now the paperwork has to be completed on the final two sites in order to have the remedial action certified by the NRC. Then the sites will be included under the NRC's general license. The DOE GJO will continue to monitor the disposal sites under the Long Term Surveillance and Maintenance Program and pursue the remaining ground water requirements of the EPA standards.

Listed below are a few final statistics and accomplishments for the UMTRA Surface Project:

- 22 sites completed.
- 5,436 vicinity properties remediated.
- 43.8 million cubic yards of material stabilized.
- 22.2 million truck miles driven without a transportation-related fatality.
- Injury rate 85 percent below national construction rate.
- Federal funding \$1.38 billion; state funding of \$100 million.
- National Performance Review Hammer Award recipient for Cost Reduction/Productivity Improvement.

ACKNOWLEDGMENTS

Much of the information provided was gleaned from the UMTRA Lessons Learned Workshop. Specifically, we want to acknowledge Richard Campbell, Steven Hamp, Fred Morgan, and John Elmer whose contributions to the workshop were especially useful. We also appreciate Sandy Portlock for providing word-processing support and Britain Harvey for providing the graphics support.

REFERENCES

1. Uranium Mill Tailings Radiation Control Act of 1978 (as Amended),” Public Law 95-604 (92 Stat. 3021), (42 USC §7901 et seq), November 8, 1978.
2. DOE (Department of Energy), 1997 UMTRA Lessons Learned Workshop (Compact disc) May, 1997.
3. 40 CFR Part 192, Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, U.S. Environmental Protection Agency.
4. DOE Order 4700.1, Change 1, 1992. Project Management System, June 1992, U.S. Department of Energy, Office of Project and Facilities Management, Project Management Division.

5. DOE Order 2250.1B, Cost and Schedule Control Systems Criteria for Contract Performance Measurement, October 25, 1985. U.S. Department of Energy, Office of Project and Facilities Management, Project Management Division.
6. DOE Order 5400.1, General Environmental Protection Program, June 29, 1990, U.S. Department of Energy, Environmental Protection Division, Office of Environment, Safety and Health, Washington, D.C.
7. DOE Order 5480.1B, *Environment, Safety and Health (ES&H) Program for DOE Operations*, September 1986, U.S. Department of Energy, Safety Programs Division, Washington, D.C.