Presented at the 2001 National Association of Abandoned Mine Lands Annual Conference, August 19-22, 2001, Athens, Ohio

Review of the Multiple Accounts Analysis Alternatives Evaluation Process Completed for the Reclamation of the Zortman and Landusky Mine Sites.

Shaw, S.C.*, Robertson, A.MacG, (* corresponding author)
Robertson GeoConsultants Inc., Suite 640, 580 Hornby Street
Vancouver, BC Canada V6C 3B6

Maehl, W.C.
Spectrum Engineering Inc., 1413 4th Avenue North,
Billings MT, 59101

Kuipers, J.
Center for Science in Public Participation, P.O. Box 462,
Boulder, MT 59632

Haight, S.
United States Bureau of Land Management, P.O. Box 1160,
Lewistown, MT 59457

ABSTRACT

An extensive mine reclamation project is currently on-going at the Zortman and Landusky gold mines in the Little Rocky Mountains of north-central Montana. Both sites are known for playing an industry-leading role in the development of valley heap leach systems and have been in the news for 'state-of-the-art', regulator-driven reclamation efforts. It is an essential requirement in the mining industry today that all stakeholders, including the proponent, regulatory agencies and community representatives as well as potential opponents, participate in decision making. This has been the case at Zortman and Landusky where the US Bureau of Land Management (BLM) and the MT Department of Environmental Quality (DEQ) assembled a multi-stakeholder, multi-disciplinary reclamation team tasked with designing and evaluating a range of reclamation alternatives for both sites. This, by necessity, involved a collective understanding of the positive and negative impacts of the different alternatives, taking into account that the range of impacts affect numerous stakeholders to varying degrees. As we are likely to see more often in the future, the financial assurance provided in the bonds for reclamation at Zortman and Landusky fell short. Therefore, a balance had to be found between the economics of reclamation and the technical, environmental and socio-economic issues at the sites. A process called the Multiple Accounts Analysis (MAA) was selected to evaluate the various alternatives for reclamation. The process provided a clear, transparent and defensible framework that has enabled relative ranking of various alternatives, as well as the prioritization of interim remediation measures aimed at optimizing the degree of remediation attainable with the limited financial resources available. This paper describes the MAA process and the rationale developed to prioritize the remediation measures and evaluate the various reclamation alternatives.

INTRODUCTION

The Zortman and Landusky gold mines are located in the Little Rocky Mountains of North-central Montana, approximately 155 miles north of Billings. Mining by underground methods in the area can be traced back to the 1880's. Modern, large scale open pit mining and heap leach operations were implemented nearly 100 years after the first gold panners settled in the area (i.e. between 1979 and 1996). Mining ceased at both sites in 1996 when the mining company became insolvent. As a result, reclamation of the mines fell under the direction of the Montana Department of Environmental Quality (MT DEQ) and the U.S. Bureau of Land Management (BLM) using the funds from the mining company established reclamation bond. A reclamation plan, initially proposed as one of a number of alternatives in a 1996 Environmental Impact Statement (EIS) (US DOI and MT DEQ, 1996) was stipulated in a Record of Decision (ROD) (MT DEQ and US DOI, 1998). Since the publication of the ROD, it was determined that there were insufficient funds in the Reclamation Bond to complete the reclamation plan as stipulated. It was also ascertained that more detailed consideration of additional reclamation measures and the impacts of those measures was required. As a result, the regulators assembled a multi-stakeholder, multi-disciplinary reclamation team tasked with re-designing and re-evaluating a range of reclamation alternatives for both sites. The reclamation team, or working group, was comprised of members of the MT DEQ, the BLM, the US EPA, the Fort Belknap Indian Community and their technical consultants and the agency appointed engineering firm Spectrum Engineering Inc. and their subconsultants including Robertson GeoConsultants who lead the MAA process.

In order to effectively evaluate the different alternatives and reclamation measures possible at these sites a framework for evaluation was needed. It was critical that this framework be clear, inclusive of all stakeholder issues and defensible. The Multiple Accounts Analysis (MAA) was selected as the framework for alternatives evaluation for this project. The MAA provided a forum in which stakeholders could express their concerns and communicate and defend their assessments of the positive and negative impacts of a specific alternative and subsequently compare that, or any, alternative against others.

OBJECTIVES OF THE MAA

The general objective of the MAA is to provide the means by which evaluators can select the most suitable, or advantageous, alternative from a list of alternatives by weighing the relative benefits and costs of each. The disadvantages can be expressed as 'costs' or 'losses', for consistency the authors have used the word 'costs' in this paper to represent negative impacts. This involves three basic steps:

1. Identify the impacts (benefits and costs) to be included in the evaluation;
2. Quantify the impacts (benefits and costs);
3. Assess the combined or accumulated impacts for each alternative, and compare these with other alternatives to develop a preference list (ranking, scaling and weighting) of the alternatives.

In mining, the diversity of impacts that must be considered makes integrated (combined and cumulative impacts) assessment difficult. How does one compare the 'apples and oranges' in one fruit basket with the 'plums and bananas' in another to decide which is the preferable. To a large extent any comparison is subjective and depends on the flavor preference (value basis) of the analyst. It is not possible, and probably not desirable, to remove this subjectivity as each analyst seeks to have his/her value basis applied in the analysis. It is therefore an advantage if the evaluation methodology (analysis) is systemized and transparent, allowing the various analysts to clearly indicate their value basis and results. If the results of analyses from two analysts are similar, despite differences in value basis, then there is likely to be consensus on the alternative selected. If results are materially different, then the root cause of the difference can be identified and discussions and/or additional studies focused on the material, value basis, issues to determine if a consensus resolution can be reached.

Specifically, the objective of the MAA for the Zortman and Landusky sites was to re-evaluate the ROD stipulated reclamation plan by:

- Identifying any information gaps in the knowledge base deemed critical to selecting a reclamation alternative (and complete the necessary studies to obtain that information);
- Identifying alternatives to the ROD stipulated reclamation plan;
- Identifying measures within the various alternatives that were common (and develop a list of 'interim' reclamation measures);
- Establish a ranked preference list of possible reclamation alternatives based on the relative benefits and costs of each;
- Provide the decision-makers with a concise, informative tool with which to select a reclamation alternative acceptable to all stakeholders.

DEVELOPMENT OF RECLAMATION ALTERNATIVES

One of the first things identified by the working group was the need for an updated site characterization, and in particular the re-assessment of the potential for current and long term acid rock drainage (ARD) and for the identification of material on-site that is suitable for use as construction or cover material. The results of this site characterization were described in Shaw (2000) and Shaw et al. (2000). It was determined that the existing and potential future for ARD from the pit walls, waste rock and spent ore heap leach pads was significant on both sites. During these investigations it also became evident that source control (or control of acid generation) could not effectively eliminate the generation and migration of ARD. Therefore every reclamation alternative considered included measures for long term water collection and treatment.

The characterization studies also identified available material sources on site for construction and cover purposes. These included the historic tailings, topsoil stockpiles and dolomite stockpiles. In general these were fairly coarse grained, permeable materials not suitable for the construction of infiltration barrier layers. Detailed cover modeling, using the on-site climate data and physical characteristics of these materials, was completed in order to compare the relative benefits of covers with different thicknesses and material properties as well as the differences in infiltration between water barrier and water balance covers. The details of that cover modeling are reported in a paper in these proceedings (see Wels et al, these proceedings). Water balance (or water storage) covers were generally found to be most cost effective.

Based on these results and other site characteristics such as topography, erosion potential, aesthetics etc., various reclamation alternatives were devised. The alternatives were developed around the following 'primary' objectives.

For Zortman:

Alternative Z1 – was the same as the ROD stipulated alternative 3.

Alternative Z2 – focused on optimizing the water collection and treatment within the bond limitations in order to minimize the long term operating and maintenance requirements of the water treatment plant.

Alternative Z3 – focused on optimizing source control within the bond limitations by minimizing the infiltration into various facilities on site with low permeability covers.

Alternative Z4 – provided additional pit backfilling utilizing pad/dump facilities and application of high infiltration reduction efficiency (high cost) covers over the backfill.

Alternative Z5 – included total pit backfill to pre-mining topography with extensive pad/dump removal and application of high infiltration reduction efficiency covers over backfill.

Alternative Z6 – focused on optimizing source control and aesthetics by application of high infiltration reduction efficiency covers and land form and revegetation optimization.

For Landusky:

Alternative L1 – was the same as the ROD stipulated alternative 3.

Alternative L2 – focused on optimizing earthwork within the bond limitations in order to maximize surface run-off and source control within economic means.

Alternative L3 – focused on optimizing free draining conditions out of the pit complex so as to minimize long term ponding within the pit complex.

Alternative L4 – focused on removing material in the drainage channel and providing free drainage conditions from the pit complex.

Alternative L5 – provided additional pit backfill to cover sulfidic highwalls utilizing mined material that is currently situated in the drainage channel.

Alternative L6 – included total pit backfill to pre-mining topography with extensive pad/dump removal and application of high infiltration reduction efficiency covers over the backfill.

Based on the primary objectives for each alternative, various reclamation measures were included in each alternative. The primary differences between alternatives on Zortman were related to the location of the water treatment plant, the types and thickness of reclamation covers and the amount of pit backfill. The primary differences between alternatives on Landusky were related to the types and thickness of reclamation covers, the amount of pit backfill and the direction and maintainability of surface drainage. Detailed descriptions of each alternative can be found in the Supplemental Environmental Impact Statement (SEIS) (US DOI and MT DEQ, 2001).

MAA DEVELOPMENT

The development of the MAA, as well as the evaluation of alternatives included in the MAA, was an iterative process. The first draft of the MAA for Zortman was completed in November, 1999 and the final draft completed for the SEIS in March, 2001. Nearly a year and a half of studies, discussions, alternative evaluations and refinements were completed in order to optimize the various alternatives and achieve consensus within the working group of the relative advantages and disadvantages of each alternative. The process by which the MAA was developed for Zortman and Landusky is described below and the results are provided in a following section. Details describing the development and mechanics of an MAA evaluation can also be found in Robertson and Shaw (1998, 1999).

Framework of the MAA

The MAA was structured such that four broad categories of issues, referred to as 'accounts' were defined. These were a technical account, project economic account, environmental account and a socio-economic account. All the stakeholder issues (called 'sub-accounts') were grouped under one of these main accounts and listed on the MAA 'ledger'. Sub-accounts were defined as any material impact (benefit or cost) associated with any of the alternatives being evaluated. Within each sub-account, indicator values of that particular issue were defined in order to give a clear, understandable description of the impacts. An 'indicator value' is a measure or descriptor that provides the reader with some concept or 'picture' of the degree of impact, allowing the reader to measure or compare impacts between alternatives. Some sub-accounts had more than one indicator while others were represented by just one.

Some indicators were straightforward and quantitative (e.g. costs), however many indicators, particularly environmental and socioeconomic indicators, were difficult to accurately describe or quantify without an enormous amount of investigation and analysis. For example, within the environmental account, the sub-account 'surface water quality protection' was identified. The predictive values for long term water quality 'protection' are difficult to quantify, therefore the indicator and measure, of the surface water protection value by necessity was qualitative. Based on the current level of understanding of issues such as the likely water quality in a specific drainage and the reliability of the collection systems etc., a qualitative 'protection value' was assigned to each drainage on each mine for each alternative. A descriptive value of 'high', 'somewhat high', 'intermediate', 'somewhat low' or 'low' was given to each of the alternatives depending on the reclamation measures included in each alternative. For instance, installation of high infiltration reduction efficiency (higher cost) covers in one alternative would provide greater protection to water quality than installation of lower infiltration reduction efficiency (lower cost) covers in another alternative.

As a result of uncertainties such as long term water quality predictions, much of the assessment was necessarily based on judgment rather than deterministic analysis. The judgment was however based on some modeling and analyses and the experience of experts in the topic. The anticipation and assessment of the performance of engineered structures, natural processes at work and environmental impacts require a sound understanding of the current technologies as well as considerable experience on a wide variety of similar projects in order to recognize and identify potential impacts, issues and risks. Therefore, having participants who were experienced with similar projects and/or dedicated to understanding and learning the realistic benefits and limitations of certain measures was critical to the success of these evaluations.

A great deal of understanding and information transfer was accomplished during the task of filling out the MAA ledgers. It was during this stage that the determination of alternatives that were critically flawed occurred (did not meet threshold values such as water quality standards or cost limitations). As a result, the alternatives were periodically modified so as to preclude any critical flaws. Once the ledgers were completed, the numerical evaluations began. This involved ranking, scaling and weighting the indicator values in each of the sub-accounts. This numerical normalization allowed the working group to compare the indicators equally, amongst themselves and between different sub-accounts.

Ranking, Scaling and Weighting of the MAA

Each of the alternatives being assessed was first **ranked,** in order from best to worst, with respect to the indicators for each sub-account. Ranking is a simple ordered list and makes no attempt to distinguish how great the difference in impact is between alternatives on the list. In practice, there may be very little or very large differences in the impact from the best to the worst.

Since the separation of the best alternative from the worst may be either very slight or very significant, a **scaled** value (S) was then assigned to each alternative for each of the indicators using a nine point scale (Figure 1). The authors found a nine point scale was readily understandable and provided a range and discretion suited to these evaluations. The 'best' alternative in the ranking was always given a value of 9. If the 'worst' alternative was considered to be half as good as the best, it was given a value of 5 and the other alternatives were distributed between these values. An example is the indicator 'percent of area revegetated'. While the 'best' alternative included ~88% aerial coverage, the 'worst' alternative had ~45% of the area revegetated. The scalar values that were then applied were those shown in Figure 2.

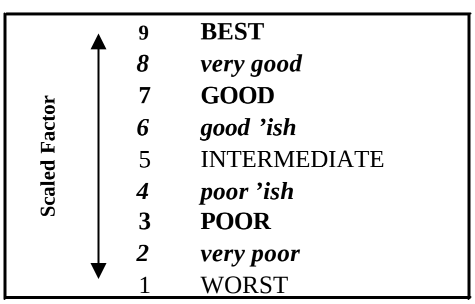

Figure 1. Subdivisions of Scaling System

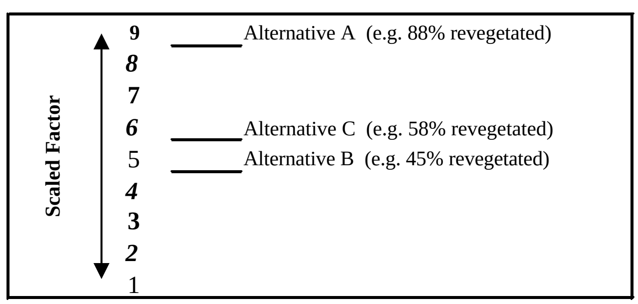

Figure 2. Example of scaling and positioning of "ranked" options.

To enable each member of the working group the opportunity to introduce their value bias between individual indicators, a **weighting** factor (W) was applied to each indicator. A weight of '5' indicated a 'high value' or important indicator. The process of assigning weights to the various indicators on the ledger served to educate all parties involved on two levels. First, it served to clearly identify those issues that were most critical to the different stakeholders. For instance, while aesthetics might be of utmost importance to one stakeholder, capital cost might be most important to another. The second level of understanding achieved in this process was that each evaluator had the opportunity to defend his/her weightings and more often than not a compromise between extremes was reached as the complexities of the mine sites were stripped down, issue by issue, and the issues were assessed relative to one another.

The cumulative 'score' of one alternative compared to another in any one sub-account was obtained by adding together the products of the scalar value and weight for each indicator in a sub-account and normalizing by dividing by the sum of the weights for all indicators of that sub-account (equation 1). The higher the score, the more favorable the alternative in any one category.

$$\text{Sub-Account Score} = \frac{\text{sum of Scalar Values x Weights (for each indicator in the sub-account)}}{\text{sum of Weights for indicators in the sub-account}} \qquad (1)$$

The process of adding together the sub-account scores to obtain the account scores for the four main accounts and the overall MAA score followed the same procedure of weighting and normalization.

MAA OUTCOME AND RECLAMATION PROGRESS

The spreadsheets created for the Zortman and Landusky MAAs are too large to include in a paper, therefore the results provided below are summaries of much larger evaluations. A separate MAA was completed for each mine site, although the issues used to evaluate the different alternatives were similar. The general issues are provided in Table 1 below.

Indicators for each of the sub-accounts were selected in the same manner as the example shown above for the 'Re-establishment of Biological/Vegetative Potential'. Descriptive values or measurements of each indicator for each alternative was then provided (i.e. the 'ledger' was completed). From the ledger, the numerical evaluation was completed. Table 2 provides an example of the ranking, scaling and weighting process for one sub-account.

In this example, alternative 2 was scored highest with respect to this sub-account, followed by alternative 3 then alternative 1. A score for each sub-account was calculated, and similarly a score for each account was calculated. The summary of the final scores for the Zortman and Landusky alternatives are provided in Tables 3 and 4 respectively.

TABLE 1. SUMMARY OF MAA ACCOUNTS AND SUB-ACCOUNTS.

ACCOUNTS	SUB ACCOUNTS (issues)
TECHNICAL	Spent Ore Heap Leach Pads
	Leach Pad Dikes
	Waste Rock Dumps
	Open Pits
	Historic Underground Workings
	Historic Tailings
	Storm Water Control Ditches
	Collection & Seepage Capture/Pumpback Systems
	WTP/LAD Treatment & Release
	Alternative Water Treatment Technologies
	Reclamation Covers
PROJECT ECONOMICS	Short Term Reclamation & LAD Costs
	Long Term Monitoring/Maintenance Costs
	% of Reclamatioin Attainable within the Bond
	Long Term Water Collection/Treatment & Monitoring Cost
ENVIRONMENT	Surface Water Quality Protection
	Surface Water Quantity Protection
	Groundwater Quality Protection
	WTP Inflow Water Quantity and Quality
	LAD Water Quantity
	LAD Water Quality
	Re-establishment of Biological/Vegetative Potential
SOCIO-ECONOMICS	Aesthetics
	Hunting & Recreation
	Tourism
	Health & Safety
	Traditional/Cultural
	Community Infrastructure
	Completion Period
	Mineral Development Potential
	Future Burden on Society
	Employment Opportunities

INDICATORS	ALT 1	ALT 2	ALT 3	…
Density of revegetated areas	poor	intermediate	good	…
Ecosystem diversity/sustainability	intermediate	high	low	…
Percent of area with regrowth	45	58	88	…
Compatability with wildlife habitat	low	high	low	…

NOTE:
WTP = Water Treatment Plant
LAD = Land Application Disposal

TABLE 2. EXAMPLE OF RANKING, SCALING AND WEIGHTING A SUB-ACCOUNT

ACCOUNTS	SUB-ACCOUNTS	INDICATORS	INDICATOR WEIGHTS	ALT 1	ALT 2	ALT 3	…
	⋮						
ENVIRONMENT	Re-establishment of Biological/Vegetative Potential	Density of revegetated areas	**3**	1	5	9	…
		Ecosystem diversity/sustainability	**5**	5	9	1	…
		Percent of area with regrowth	**3**	5	6	9	…
		Compatability with wildlife habitat	**4**	1	9	1	…
	SUB-ACCOUNT SCORE			**3.13**	**7.42**	**4.03**	
	⋮	⋮	⋮	⋮	⋮	⋮	⋮
ACCOUNT SCORE							

SCALAR VALUES

TABLE 3. SUMMARY OF THE TECHNICAL WORKING GROUP EVALUATION FOR THE ZORTMAN RECLAMATION.

ACCOUNTS		EXISTING CONDITIONS as of Jan 1999	CONDITIONS FOLLOWING INTERIM RECLAMATION as of Feb 2001	ALTERNATIVE Z1 (Final EIS ALT.3, ROD)	ALTERNATIVE Z2 (Optimize Water Treatment within Bond)	ALTERNATIVE Z3 (Optimize Source Control within Bond)	ALTERNATIVE Z4 (Additional Pit Backfilling)	ALTERANTIVE Z5 (Total Backfill to Pre-Mine Topography)	ALTERNATIVE Z6 (Optimize Source Control and Aesthetics)
TECHNICAL	ACCOUNT SCORE	4.95	5.85	7.45	6.65	6.49	8.14	8.83	7.11
PROJECT ECONOMICS	ACCOUNT SCORE	7.42	7.16	5.73	8.61	8.23	4.47	4.42	7.45
ENVIRON-MENT	ACCOUNT SCORE	5.68	5.87	8.10	6.76	7.17	8.18	8.22	8.38
SOCIO-ECONOMICS	ACCOUNT SCORE	4.66	4.85	5.98	6.13	6.06	7.01	7.48	7.05
MULTIPLE ACCOUNT SCORE		5.61	5.85	6.93	6.94	6.95	7.12	7.39	7.58
SCORE RELATIVE TO EXISTING CONDITIONS		0.00	0.24	1.32	1.33	1.34	1.51	1.78	1.97

TABLE 4. SUMMARY OF TECHNICAL WORKING GROUP CONSENSUS ANALYSIS FOR LANDUSKY

ACCOUNTS		EXISTING CONDITIONS as of Jan 1999	CONDITIONS FOLLOWING INTERIM RECLAMATION as of Feb 2001	ALTERNATIVE L1 (Final EIS ALT.3, ROD)	ALTERNATIVE L2 (Optimize Earthwork Within Bond)	ALTERNATIVE L3 (Free Draining MT Gulch)	ALTERNATIVE L4 (Remove & Backfill 85/86 Pad but No Notch)	ALTERNATIVE L5 (Backfill Pit Holes & Sulfide Highwalls)	ALTERNATIVE L6 (Total Backfill to Pre-mine Topography)
TECHNICAL	ACCOUNT SCORE	6.27	7.03	7.86	7.51	7.67	7.92	8.28	7.79
PROJECT ECONOMICS	ACCOUNT SCORE	7.58	7.95	7.31	8.31	8.00	7.13	6.29	4.67
ENVIRON-MENT	ACCOUNT SCORE	5.75	6.37	7.51	7.18	7.35	7.82	7.79	7.89
SOCIO-ECONOMICS	ACCOUNT SCORE	4.47	4.78	5.81	5.77	5.77	6.22	6.84	7.32
MULTIPLE ACCOUNT SCORE		5.88	6.39	7.09	7.10	7.12	7.28	7.33	7.07
SCORE RELATIVE TO EXISTING CONDITIONS		0.00	0.52	1.21	1.22	1.24	1.40	1.46	1.20

Tables 3 and 4 represent the MAA scores when costs were not considered a limitation (i.e. costs are included in the evaluation). However the difference in reclamation costs between alternatives was large. For Zortman, the alternatives ranged in cost from 9.8 million dollars (the existing bond amount) to 45.4 million dollars. For Landusky the range was even greater, the least costly alternative was estimated to be 19.2 million dollars (the existing bond amount) and the most expensive alternative was estimated to be 156.1 million dollars. In order to assess the relative MAA score on a cost basis (a type of cost-benefit analysis) a sensitivity analysis was completed whereby the weights for those sub-accounts related to financial issues were set at '0'. The resulting scores were then plotted against the total cost for each alternative. The resulting plot provides a relationship of MAA score per dollar value. Figures 3 and 4 below are such plots for Zortman and Landusky respectively.

The dot labeled 'Ideal Alternative Placement' in both figures is plotted at the location where the highest possible score (a '9') and the existing reclamation bond amount for each site intersect. On a score per dollar basis then, the alternative that plots closest to the ideal would be the most preferred alternative, i.e. the alternative that provides the greatest environmental protection while not being cost prohibitive.

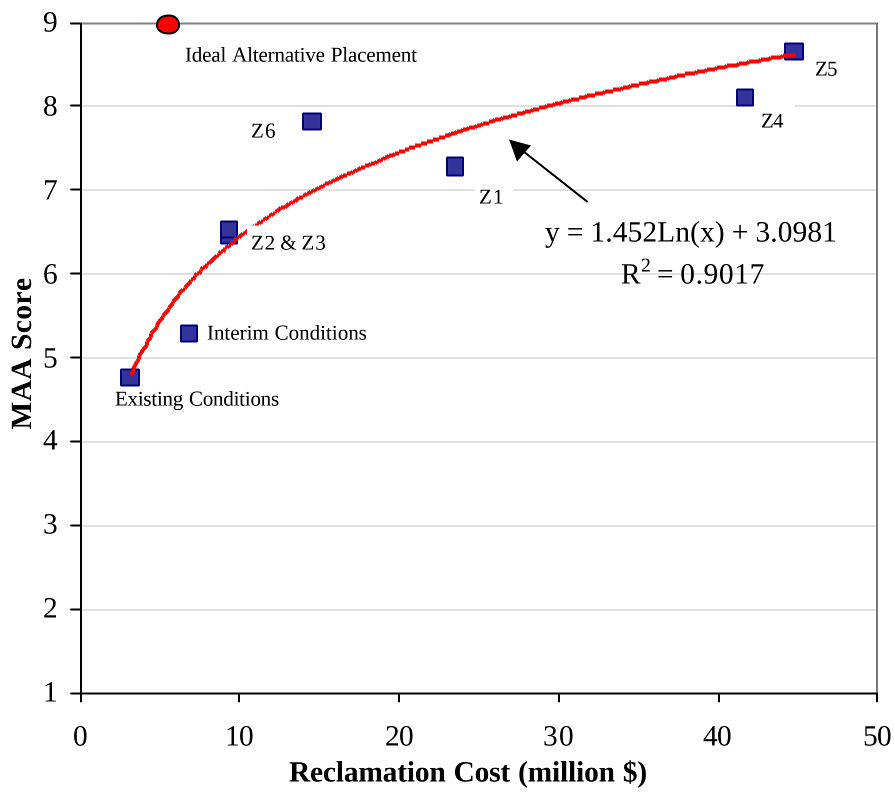

Figure 3. MAA Score versus Reclamation Cost for the Zortman Reclamation Alternatives

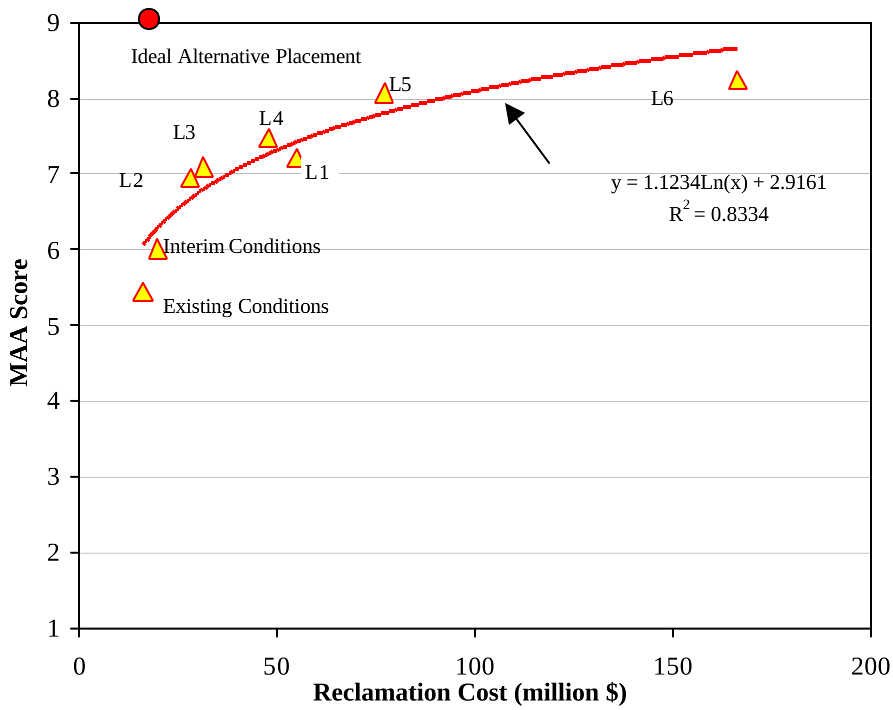

Figure 4. MAA Score versus Reclamation Cost for the Landusky Reclamation Alternatives.

Note that for both evaluations, the curve fit flattens out significantly as the costs increase. This suggests that the greatest benefits are seen in the first ~15 million dollars spent for Zortman and ~25 million dollars spent for Landusky. A significant proportion of the achievable positive impact can therefore be expected by measures that can be completed within the bond limitations. Currently avenues are being examined for funding beyond the bonded amount which will add to the overall benefits of reclamation at both sites. The performance of the MAA has enabled agreement to be reached allowing interim reclamation measures to proceed for those measures that were consistent between alternatives. These are expected to have a large positive impact on both sites. The ability to expedite the development of consensus and agreement on the interim measures has resulted in large savings in site maintenance costs and expediting the implementation of site reclamation.

UTILIZATION OF THE MAA

The MAA process described briefly in this paper, from the technical perspective, served many purposes at the Zortman and Landusky mine sites, including:

(1) Identified information gaps and data needs from which studies were developed.
(2) Provided a framework in which all stakeholders could identify and discuss issues of importance to them.
(3) Clearly identified measures common to all alternatives and allowed for continuous interim reclamation throughout the evaluation process.
(4) Provided an objective and simplified basis on which sensitive issues could be discussed.

(5) Provided a defensible and transparent tool with which decision makers could evaluate the positive and negative impacts of available alternatives.
(6) Formed a framework for writing the SEIS.

The ultimate utilization of any alternative evaluation however is highly dependent on the acceptability of the method to all the stakeholders and evaluators involved. The perspective from three of the evaluators for the Zortman and Landusky alternatives analysis have been included in this paper to provide their points of view.

From the Project Management Perspective

The Zortman/Landusky mine reclamation project carried with it a tremendous amount of negative baggage from the past. The Indian Tribes had always opposed the mine from the beginning and came into the MAA process not trusting the DEQ and BLM who had allowed the mine to begin and expand over the years. The EPA's role was one of total support of the Tribe and making sure the "process" was followed. DEQ and BLM had tasked the Spectrum Engineering team of experts with reclaiming the mine immediately. In the initial start-up meeting, it was made clear that one very large bid package should be developed within two to three months and the entire mine site be reclaimed within 12 months. The DEQ felt that the primary goal was to stay within the forfeited bond amount while BLM was primarily concerned with following all of the requirements of the final EIS and Record of Decision (ROD).

From an engineering and management standpoint, it was physically and financially impossible to satisfy each of the four major players. The first few meetings, before the initiation of the MAA process, were somewhat antagonistic and fairly unproductive. It became obvious that the goal of placing the work into a bid package would not happen, due to lack of agreement on what that might entail. The MAA process quickly allowed the engineering team to evaluate all of the alternatives for each mine site disturbance and combine them into logical groupings to satisfy each of the stakeholders. Once each of the stakeholders became convinced that their concerns would be met via the MAA evaluation, the goal became one of defining the common reclamation work elements shared by all alternatives. This common work was then advanced and approved as interim reclamation and work began. It took less than six months of monthly meetings before reclamation had begun with much of that time consumed in educating the stakeholders in what the MAA process and various reclamation measures would or could achieve.

The success or failure of the MAA evaluation process is very much dependent on the participants involved. If the stakeholders are not willing to openly participate and allow science and common sense to come into play, then the process will ultimately fail due to preconceived conclusions. For the Zortman/Landusky project, the MAA process proved to be hugely successful. The engineering team watched the four major stakeholders start the process as though they were on the ends of a four-way tug rope with the MAA process being the knot in the middle holding them together. Everyone had agreed to not let go of the rope. After some initial tugs in various directions, everyone eventually gravitated towards the center. The collective proved to be greater than the sum of the parts and the reclamation conclusions provided solutions better than the initial proposed solutions at greatly reduced costs. The MAA process *provided all of the background information for the supplemental EIS, while allowing much of the mine to be reclaimed prior to completion of the EIS. This was definitely a success.*

From the Regulatory Perspective

As one of the regulatory agencies responsible for overseeing reclamation at the Zortman and Landusky mines, BLM needed to achieve several major objectives. The first was to implement an administrative order from the Interior Board of Land Appeals (IBLA) requiring BLM to consult with the Fort Belknap tribal government on reclamation of the mines. The second objective was to determine how to reclaim the mines with the anticipated shortfall in funding from the reclamation bonds. And the third objective was to continue with reclamation work while consulting with Fort Belknap and preparing any additional analysis required under the National Environmental Policy Act (NEPA). The DEQ, and to some extent EPA, shared the same objectives, though were not subject to the IBLA order. The MAA process was presented as a way for BLM and the other regulatory agencies to meet these objectives after several sessions of more traditional discussions among the parties failed to produce much result.

The technical working group involved in the MAA process became the primary mechanism for consultation between BLM and the Fort Belknap government. While "consultation" culminates in discussions between the agency head (BLM State Director) and the Fort Belknap Indian Community Council, without the results of the technical working group there would have been little basis for such discussions. The technical, social, and financial issues surrounding the mine reclamation were so complex that a considerable amount of advance staff discussion under some sort of process was virtually mandatory in order to present management with the salient points for meaningful government to government consultation. At the start of the process, the MAA discussions were recognized by BLM as a systematic approach to American Indian consultation which may be unique in its ability to build a consensus on the impacts of a particular action while preserving each parties' ability to disagree with the ultimate decision. If we could get that far, our expectations would be met. In reality our expectations were exceeded as it became evident that with consensus on the impacts (costs and benefits) it was possible to achieve consensus on the preferred reclamation alternatives.

The second regulatory concern was how to reclaim the mines with a reclamation bond that was short by tens of millions of dollars. The agencies had to face the reality that the reclamation plans approved in the 1998 ROD were not affordable (nor in some respects desirable); yet there was still a mandate to meet minimum state and federal reclamation requirements. The MAA process revealed the important reclamation components where the agencies could get the most "bang for the buck" in reclamation performance. This allowed for prioritizing of the reclamation work, which served to drive the development of alternatives. Alternatives were structured so that reclamation components of high priority (high benefit) were funded first while components with less benefit per dollar were only included in the higher cost alternatives after satisfying priority concerns. In other words, if there were only x amount of dollars the MAA showed how it should be spent to achieve the most benefit at a variety of funding levels. The result was that the MAA provided the agency with a budgeting tool that can be used to show the funding authority exactly what environmental benefit can be achieved with each funding *increment. This type of cost-benefit analysis is especially important when funding in excess of the bond amounts will be provided by the taxpayers, and public officials must justify the expense.*

The regulatory agencies' third objective, to keep reclamation efforts active, was addressed as the MAA process progressed. While it was understood that the MAA and NEPA processes would take some time to complete, no one wanted to delay needed reclamation during the interim, but at the same time the agencies could not prejudice the selection of a final alternative by taking irretrievable action. During alternatives development it became apparent that many of the critical reclamation elements were common to all alternatives. This quickly led the parties to agree to implement these common elements under the heading of interim reclamation. The benefits of interim reclamation included a reduction in overall costs by preserving the purchasing power of the bonds and the immediate covering of spent ore heaps and waste rock in order to reduce accumulation of undesirable leachate.

One of the greatest benefits of the MAA process for BLM was its ability to jump-start the NEPA process. In many respects the MAA has all the elements of a well structured NEPA analysis. Development of the accounts ledger is very similar to NEPA scoping and issue identification. Once it was decided that the level of NEPA analysis would be a Supplemental EIS (SEIS), the MAA alternatives were useable as the alternatives SEIS. The MAA scoring process provided the basis for the interdisciplinary impact assessment in the SEIS. And the detailed stakeholder involvement at the technical level provided public involvement with greater substance than would have been achieved with public meetings or through advisory groups. The results of the MAA therefore served as the core for preparation of the SEIS on mine reclamation. In addition, the results of the MAA provided a quantitative impact assessment often lacking in EISs. This quantitative scoring provided superior decision making tools for agency management. One example of the MAA-generated decision making tools are the graphs shown in figures 3 and 4, where overall reclamation performance and cost can be compared among the reclamation alternatives.

Another major benefit of the Zortman-Landusky MAA process is that it made the EIS process much less contentious. Because the key stakeholders were able to achieve consensus during preparation of the MAA on the alternatives that should be considered and their respective impacts and benefits, there was little area left for dispute during the EIS process. Since the SEIS is based upon the MAA results, there is a foundation for public consensus on the SEIS impact assessment as well. If the MAA process had not been conducted, the SEIS would have been of poorer quality and its findings more contentious.

From a regulatory perspective the MAA process was effective for BLM, and the other agencies, in identifying priority reclamation needs, in facilitating consultation with the Fort Belknap government, and in assisting with preparation of the NEPA analysis. Keys to success of the process include the mutual recognition that the mines had to be reclaimed and the willingness of all parties to work together. These factors are critical if the MAA process is to be applied to other actions such as resource management planning or various land use authorizations in which stakeholder groups are asked to participate. All stakeholders have to agree at some level with the fundamental purpose of the project, in this case that the mines needed to be reclaimed, and all the stakeholders have to be willing to work together. Unfortunately this type of *consensus building is regarded with suspicion where the basic purpose of the project cannot be agreed upon, and the MAA process may be frustrated. In these cases, even absent public stakeholder involvement, the MAA process may provide a useful approach to conducting in-house interdisciplinary team analyses.*

From the Public Participation Perspective

As technical advisors to the Fort Belknap Environment Department and Fort Belknap Indian Council, representing the Gros Ventre and Assiniboine Tribes, it is also our responsibility to pay attention to cultural issues, lending new meaning to the term "political scientist." The Tribes have long-standing issues with land ownership and mining in the Little Rocky Mountains dating back to the 1890's, when the lands in the area of the Zortman and Landusky gold mines was ceded to the U.S. government under extenuating circumstances. The enormity of cultural and traditional issues associated with the modern day open pit heap leach mines, along with a history of distrust of state and federal governmental agencies, preceded the mining company's bankruptcy and operation of the site by the Montana DEQ and US BLM. In addition, the Tribes and EPA together with the State of Montana had won a landmark lawsuit in 1995 requiring $30 million in environmental expenditures by the company prior to its bankruptcy, and had recently filed additional lawsuits seeking to address long-standing trust responsibility, water protection and reclamation issues.

Initial attempts to engage in meaningful dialogue, much less substantive discussion of scientific and technical issues, were frustrated by a lack of process to guide the efforts of the various parties, who seemed willing, if unable, to engage in a constructive manner. The introduction of the MAA process, together with other key factors, presented an outstanding opportunity for the various participants to focus their issues in a constructive framework that made differentiation of the issues evident, was driven by scientific/technical analysis, and allowed for substantive participation by all stakeholders. As a construct to facilitate public participation the MAA process affords a well thought out framework within which to engage concerns and issues commonly or uniquely raised by public interests. Its applicability to other similar situations, both commonplace and simple or one-of-a kind and complex, is largely dependent upon the willingness of the various participants to engage meaningfully and completely in the process, and necessitates that the commitment, expenditure and expertise be addressed up front. Given the opportunity, the MAA process can be successfully used, as it has been at Zortman and Landusky, to bring a higher level of understanding and consensus as to cost and benefit of various reclamation alternatives, and lead to a better acceptance of the ultimate outcome of the reclamation and long-term water management tasks that will result from those efforts.

The other key factors that led to the success of the MAA process at the Zortman and Landusky mines reclamation project include the following:

- *Expertise and Make-Up of Working Group – A high level of professional skill and experience, representing diverse areas of expertise, but in all cases knowledgeable in reclamation, was assembled together in the working group. Specific areas of competent expertise that were critical to the effort included acid rock drainage assessment and prediction, surface and groundwater hydrology, water management and treatment, cover* *design, revegetation and overall practical reclamation experience. A healthy balance towards optimism and pessimism was also present among the technical participants in the group, and the existence of an informal partnerships to ensure that issues were given the necessary consideration was also beneficial to the group. The result was to give the Tribes and other public interests greater confidence in the results and recommendations that were derived from the process.*

- *Level of Involvement – The MAA process and other means afforded exceptional accessibility to participation by the Tribes in highly technical endeavors. Funds to retain competent technical consultants and in-house tribal staff were critical to the effort, as was their unfettered availability to attend all meetings, review documents and participate in other critical aspects of the process. This also allowed the advisors and in-house tribal staff to effectively communicate on issues and progress at regular tribal council meetings and to allow the council to be responsive and involved in the activities of the working group and make constructive recommendations and decisions. Numerous additional site tours and meetings were held between the Fort Belknap Tribal Council and senior representatives from the various agencies that allowed the MAA group to elevate unresolved process and administrative issues that otherwise hamstrung the working group.*

- *Willingness to Include All Alternatives – The MAA process included consideration of all alternatives, including one of full restoration supported by the Fort Belknap Tribal Council. The willingness to include this alternative, which the agencies had previously automatically deemed to be unrealistic, along with the promise by the agencies to consider alternatives that could exceed the existing bond amount in their final recommendation, provided for objectivity that had previously been missing from earlier considerations. The result is a consensus "preferred alternative" that all the participants, the DEQ, BLM, EPA and Fort Belknap, have agreed to support with the Tribes leading the congressional efforts to obtain the necessary funds to accomplish reclamation and long-term water treatment in the most overall beneficial and responsible manner agreed upon (currently about $30 million is being sought after to complete reclamation and provide a long-term water treatment and site management trust fund).*

These factors were unique to the Zortman and Landusky project, but to some degree should similarly be addressed in any MAA process. The MAA process, combined with the right circumstances and allowances for each given situation, has demonstrated its effectiveness at facilitating public participation in a manner that would be advantageous to any similar environmental analysis being conducted either internally by industry or as part of a NEPA type public involvement process.

REFERENCES

Montana Department of Environmental Quality and U.S. Department of the Interior Bureau of Land Management, 1998. *Record of Decision, Zortman and Landusky Mines Reclamation Plan Modifications and Mine Life Extensions*. Report prepared June, 1998.

Robertson, A. MacG. and Shaw, S.C. (1998). Alternatives Analysis for Mine Development and Reclamation. Proceedings of the 22nd Annual BC Mine Reclamation Symposium, Penticton, BC. Canada, (September 14-17, 1998)pp. 51-62.

Robertson, A.MacG., Shaw, S.C., (1999). Multiple Accounts Analysis for Tailings Site Selection. In: Sudbury '99 conference proceedings, Mining and the Environment II, vol. 3, pp. 883-891.

Shaw, Shannon C. (2000). Geochemical Characterization and Water Quality Predictions for the Zortman/Landusky Reclamation Project. In Proceedings of the Eighth Annual Mine Design, Operations & Closure Conference 2000, Polson, Montana April 16-20

Shaw, S.C., Robertson, A. MacG. and Maehl, W.C. (2000). Material Characterization and Prioritization of Remediation Measures at the Zortman/Landusky Mine Sites. In Proceedings of the 2000 Billings Land Reclamation Symposium, Billings, Montana, March 20-24, 2000, pp 346-358.

Wels, C., Loudon, S.C. and Newman, G. (2001). Modeling of Alternative Cover Scenarios for Mine Rock Piles at the Zortman and Landusky Mine Sites, these proceedings.

U.S. Department of the Interior Bureau of Land Management and the State of Montana Department of Environmental Quality, Hard Rock Bureau, 1996. *Final Environmental Impact Statement, Zortman and Landusky Mines Reclamation Plan Modifications and Mine Life Extensions*. Report prepared March, 1996.

U.S. Department of the Interior Bureau of Land Management and the State of Montana Department of Environmental Quality, Hard Rock Bureau, 2001. *Supplemental Environmental Impact Statement, Zortman and Landusky Mines Reclamation Plan Modifications*. Report prepared April, 2001.