

HOLISTIC RECLAMATION OF COPPER TAILINGS IN THE SOUTHWEST

Stuart A. Bengson, Agronomist
ASARCO Incorporated, Sahuarita, AZ

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Abstract. Introducing a new concept for successful ecosystem reclamation/restoration of mine wastes and disturbances. "Holistic reclamation" involves a complete approach to reclamation and goes beyond simplistic landscaping. After more than a decade of copper tailings reclamation/revegetation in the southwest the author has observed some of the features of "holistic reclamation" functioning. Plants, soils, living organisms, all function together in a symbiotic "holism". All ecosystems evolved and function as a direct part of the "holistic" environment. By observing the effects of "top-soiling" and other revegetation techniques on sterile copper tailings minuscule inter-relationships and elementary evolutionary processes can be seen. Particularly noticeable has been the beneficial affects of animal impacts on reclaimed areas. Grazing animals can stimulate plant growth and vigor, help to control slope erosion, and provide for seedbed preparation and seed dispersal. Wildlife add further diversity to the entire ecosystem. Reclamation of mine wastes can help to unlock some of the basic secrets of ecology-primitive genesis. By understanding these processes and functions perhaps we can develop new and better mine reclamation techniques. The ultimate goal of mine waste reclamation should be the establishment of functional and productive ecosystems in accordance with projected or desired land-use plans. Anything less would be merely cosmetic landscaping and may not be self-sustaining nor particularly productive or functional.

Key words: ecosystems restoration, holistic reclamation, copper tailings, animal impacts

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The term "Holistic Mined Land Reclamation" (HMR) is coined from the term "Holistic Resource Management" or HRM, which was developed by Allan Savory. Erroneously HRM is most often mis-quoted, maligned, and mis-represented as the "Savory grazing system". Although "grazing can be an essential component of HRM, it goes far beyond a simplistic "grazing system". The truth is, in fact, HRM is a TOTAL management system. Holistic Resource Management involves the entire ecosystem. An ecosystem is a dynamic functioning entirety, not unlike the human body. The ecosystem has to be managed as a "whole", it cannot be dissected into separate components and still function. Holistic Resource Management is "holism" functioning as it is meant to.

"Holism" is a term, or philosophy if you prefer, that was introduced by Jan Smuts several decades ago. It involves looking at things in their

entirety. In the "whole", all individual parts lose their prior identity, and the "whole" becomes greater than the sum of the parts. Unfortunately as science evolved it was trained to separate the "whole" into individual specialized components. This made it easy for science to study and understand the functioning of each component, but not how all the components function together. "Integrated" science only puts teams of specialized segregated scientists together and still fails to fully comprehend the functioning whole.

Holistic Resource Management (HRM) is a concept that Allan Savory has been developing for the past 25-30 years, and it is still developing. It is an on-going learning process, studying the functions as a "whole" and cannot be separated using only the most desired portions. It's like trying to cut steaks off the cow and still have the cow

function and give milk. The main premise of HRM is that the ecosystem evolved as a function of the "whole". HRM is based on understanding this "whole"-how each separate part (science) of the ecosystem works WITH the other parts. The HRM Model is a "guide" to help orient the thinking process.

The Holistic Mined-Land Reclamation Model (See Graph 1) is copied from the HRM Model. A few words and terms have been changed to emphasize reclamation. This is a "goal oriented" model. In this case the "goal" is a productive, post-mining, land-use description. By going through the model, using the various "guidelines" to select and dictate use of the "tools", "ecosystem blocks" are developed that result in the desired "land-use description". The key to successful use of this model is understanding the basics of the "ecosystem blocks", how the "tools" can be used, and developing new "guidelines" in conjunction with using the existing "guidelines" as needed. Each site, each ecosystem, is unique and will react differently to the various treatments, techniques and other inputs. In this model the concepts and techniques, etc. are applied and then the site is monitored. Changes are made to meet new demands. As the developing ecosystem changes/evolves the management or tools, etc. must change to meet the new demands.

The "ecosystem blocks" are the very foundation which supports a viable and productive land-use description. "Succession", of course, refers to the evolutionary processes. Evolution is a never ending process. While "climax" ecosystems are often referred to I believe that they are merely stable plateaus or "landings" in the progressive "steps" of the time continuum. Plants of one or more species will dominate a site due to adaptation to specific site conditions or environment, as the site environment changes so does the plant community. An ecosystem develops and evolves as a function of all the components--plants, soil, organisms, etc. and all the interacting aspects of the environment. Many plants, especially grasses, evolved in a "grazed" environment or ecosystem. Understanding some of these basic principles of evolution or succession will help to develop a sound "holistic" approach to mined-land reclamation.

The "Water Cycle" and "Mineral Cycle" are based on the hydrologic and mineral balances. The continual recycling of water and minerals through the ecosystem. Plants, organisms take up water and nutrients; use them in metabolic processes; store some and excrete some; and continually recycle the materials.

The "Energy Flow" refers to the flow of solar energy throughout the entire ecosystem. From plants converting solar energy to food/carbohydrate energy, to grazing animals or other organisms converting the plants energy to protein, to wastes, etc. up and down the chain. Successively energy is used up consumed, it is not recycled as water and nutrients. There is a constant daily resupply of energy from the sun. Grazing animals may be the most efficient way to "harvest" the sun's energy and convert it to an energy form beneficial to man.

The "Tools" and "Guidelines" are merely the

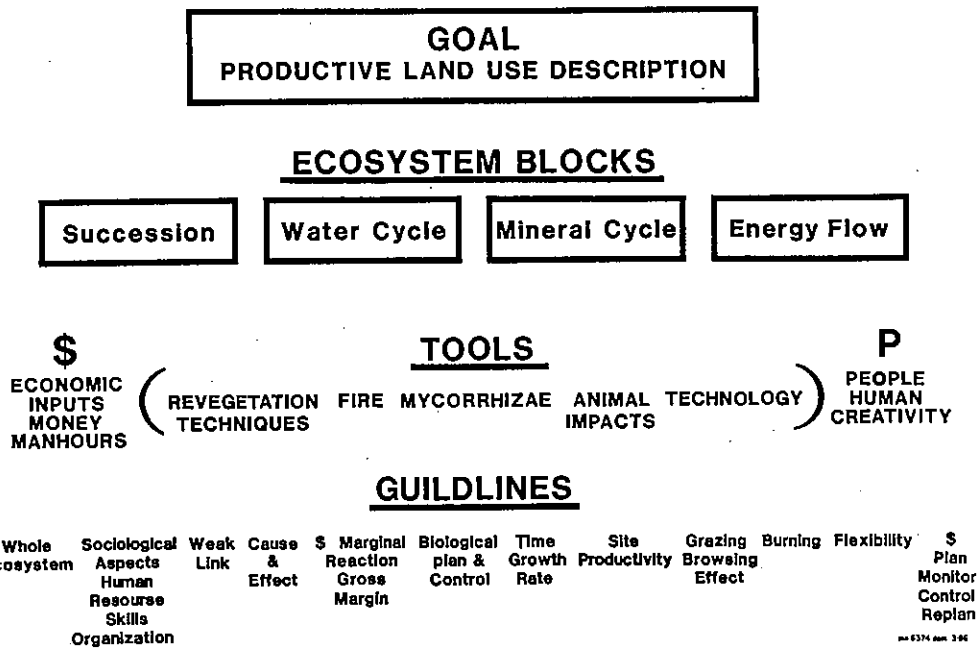
methodologies and aspects to be considered to develop and build the "Ecosystem Blocks", to reach the desired productive land-use description. There are the economic inputs - money and man-hours - functioning with human creativity influencing the various "ecological tools" used to develop the desired ecosystem. There are existing revegetation/reclamation techniques such as top-soiling, seeding, etc. Fire can be a very beneficial tool in achieving a desired ecosystem. Mycorrhizae and other organisms can play a key role in the establishment of desired ecosystems. Animal impacts, of course, can play a vital role. In "brittle" environments - those more classically referred to as "arid"--ecosystems stagnate at low productivity levels, or rapidly deteriorate, if not grazed properly. Often, too little grazing depresses plant vigor and growth. Animal impacts also include soil surface disturbance to "prepare the seed bed" and dissemination of seed and recycling of nutrients through animal wastes. The key to animal impacts is not necessarily numbers of animals, but time. One donkey going down a slope once a day, 365 days a year, will create a beaten path where erosion and other adverse conditions will cause ecosystem deterioration. However, 365 donkeys going down the same slope just once a year will create conditions conducive to enhancement of the ecosystem. Technology simply refers to the development of new-improved techniques to use as tools (i.e. computers, bio-engineering, etc.). All of these are used within guidelines which determine their practicality and effectiveness. The "Weak Link" refers to an evaluation to determine the possible waste of energy or money. The "Biological Plan & Control" is a planning procedure to reach the productive land-use described as the goal. Each "Tool" is evaluated and monitored continually using the various "Guidelines". If a "Tool" fails to meet all the criteria to reach the desired goal it is modified or discontinued. Each site is variable and as the ecosystems evolve conditions will change. This Holistic Mined-Land Reclamation Model can be applied, but then must be monitored to study the reactions and adapted as needed for the specific site conditions.

Holistic Mined-Land Reclamation (HMR) is a concept for successful ecosystem restoration. It is a new way to approach the old problem of how to reclaim mine wastes to a productive land-use description. Because of our natural tendency to categorize everything into neat little separate sciences we have failed to see the whole functioning entity. As reclamation scientists we separated the whole functioning ecosystem into top-soil, plant species, spoil amendments, seeding techniques, etc., without looking at the ecosystem as a "whole". The resulting mine reclamation has been, for the most part, simplistic land-scaping.

It is hard to comprehend the "whole" or "holistic" sense of the ecosystem. We are all trained professionals in our own specialized categories of science (i.e. foresters, soil or range scientists, agronomists, etc.). Even working together in "integrated teams" on a reclamation project we tend to dissect the functioning ecosystem into special, individual categories we know and understand best and feel comfortable in. It may not have been until man finally reached space and was able to look back at the earth that the real

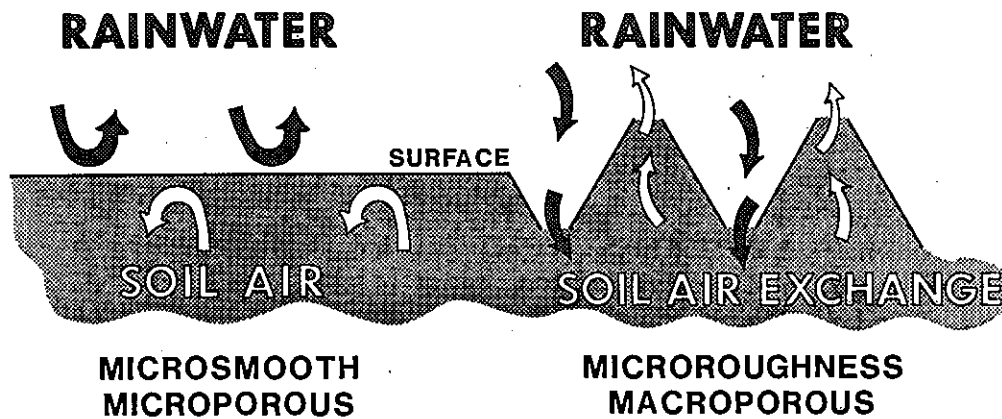
GRAPH 1.

HOLISTIC MINED LAND RECLAMATION MODEL



GRAPH 2.

AIR / EARTH INTERFACE



meaning of "wholeness" became apparent.

Mined-land reclamation can offer some very unique opportunities to unlock some of the basic secrets of ecology evolution, or genesis. By studying how plants, soils, organisms, etc. all evolve and develop as a "whole" functioning ecosystem on sterile mine wastes, we can learn how some of the symbiotic relationships operate. The inter-actions of the many parts as a "whole" creates the functioning ecosystem.

In southern Arizona I have been observing the effects of various reclamation techniques applied to copper tailings and overburden wastes for well over 12 years. The establishment and evolution of functional productive ecosystems on these barren sterile, inhospitable mine wastes was appreciably speeded up by the use of such techniques as: top-soiling, supplemental irrigation, species selection, and other revegetation techniques. By observing successes and failures it became apparent that more was involved than topsoil and seed. Nothing was overtly visible, but miniscule inter-relationships and elementary evolutionary processes could be observed. Better germination and plant establishment was achieved using "fresh" topsoil or soil materials gathered from various sources. Time of planting certain species and irrigation timing became important considerations. Amongst the most visible aspects of "holistic" reclamation was the impacts of grazing animals. At first livestock were a detriment to successful establishment of vegetation. Then after initial establishment had been achieved the vegetation started to decline. Livestock had been totally excluded and the plants were losing vigor. By allowing grazing the plant vigor was stimulated, seed and organic matter was disseminated, and

surface disturbances enhanced regeneration and erosion control. Most grass species evolved in a grazed ecosystem, without grazing they quickly stagnated and declined. The grazing, if properly managed, removes old growth allowing room for new vigorous growth. Grazing also stimulates seed development. Animal impacts on the surface became quite noticeable in the dissemination of organic wastes. The wastes contained seed (both of the species used in revegetation and native seed from the surrounding area) and micro-organisms. The action of hooves helped to break up hard crusted surfaces and created small pockets or basins to trap rainfall (See Graph 2.). The grazing of steep slopes tended to be on the contour thereby creating small benches to reduce runoff and erosion. As these ecosystems evolved and developed wildlife also moved in to help build the diversity and stability of the ecosystems. Today these sites are producing self-sustaining, viable, productive ecosystems.

The job is not complete though. There are still evolutionary changes occurring and many inter-relationships that are still unknown or not well understood. Continued monitoring and study of new and varied techniques is required to gain more knowledge about the functioning of a "holistic" ecosystem. By developing a more "holistic" approach we can develop new and better mine reclamation techniques. The ultimate goal of "holistic mined-land reclamation" should be to establish fully functional-productive ecosystems in accordance with projected or desired land-use plans. Anything less would be merely cosmetic landscaping that may not be self-sustaining nor particularly productive or functional.