PHC RECLAMATION, INC.

Complete Engineering, Design and Construction Management Services for Reclamation, Revegetation and Restoration of Minelands and other Disturbed Sites

Snake River Reclamation Project
People's Choice Award Winner: Best National Reclamation Project
United States Department of the Interior, Office of Surface Mining

Traditional Reclamation Services
Wetland, Upland, Reforestation and Revegetation Services
Hazardous Mine Site Mitigation and Closure
Stabilization of Mine Site Historic Structures
PHC Reclamation, Inc. was founded in 1995 and our personnel have extensive experience in reclamation and engineering projects. Team professionals have provided full turnkey services including project management, consulting, technical and biological services, site investigation, engineering and design and construction management services for clients throughout the United States. Several of the projects have received national and state recognition and national awards.

Our size allows our key personnel to take a direct role on projects ensuring consistent, responsive and professional service to our clients at competitive costs. PHC-REC key personnel work directly with customers to help design and implement solutions for difficult land restoration projects, including large scale mineland reclamation, reclamation of sites disturbed by construction and other activities, habitat restoration, reforestation and revegetation of degraded sites.

Services

Engineering and Design
PHC-REC provides engineering and design services for reclamation lands disturbed by mining, construction and other activities. These services include inventory, investigation, engineering, design, specifications, costing, scheduling and construction management oversight. Our qualified and registered staff can assist you on all of your engineering project needs.

Reforestation and Revegetation
PHC-REC is the recognized leader in the use of biologically based solutions using mycorrhizal fungi and bacteria for the establishment of trees, shrubs, forbs, grasses and flowers on disturbed lands. Our team of professionals has dedicated much of their careers over the past twenty years in the revegetation and reclamation of disturbed lands. PHC-REC specializes in grass and shrub revegetation of severely disturbed sites using our exclusive VAM fungal spore pellets to accelerate the establishment of vegetation in the toughest of soils and climates. PHC-REC also specializes in reforestation of poor and distressed soils using mycorrhizal fungi inoculated tree seedlings.

Technical Support

PHC-REC Scientists and Technical Experts work directly with clients to help design and implement solutions for difficult land restoration projects. Our Team offers:

- Preparation of Environmental Impact Statements (EIS)
- National Environmental Protection Act (NEPA) requirements
- Preparation of Environmental Assessments (EA)
- Engineering Cost Analysis (ECA)
- Construction Management and QA/QC

PHC-REC has offices strategically located in several states providing immediate service to our clients in the mining, environmental, forest and other industries. Our professionals can assist clients with their entire project from start to finish or provide solutions to any part of their program.

Mycorrhizae: Nature’s Stress Manager

Mine overburden and mine/mill waste material form highly stressed rooting environments. Conventionally planted seeds and seedlings often have high mortality rates and slow growth rates on these stressed sites. Why? The stressed soils of these sites contain few (if any) natural populations of mycorrhizal fungi. These fungi form a symbiotic relationship with their plant hosts to help the plants withstand the stresses of their environment. More than 99% of the Earth’s land plants benefit from colonization of fine roots by mycorrhizal fungi.

The bottom line: Optimum plant life is not possible without mycorrhizae.

Mycorrhizal fungal technology allows PHC-REC to perform land reclamation in unique ways. We combine our superior mycorrhizal fungi/plant relationship with other natural soil system solutions such as microbial sciences, biosolids and water management technologies. These tools are selected and customized for specific site conditions. As a result, the newly introduced plants are healthier with larger, stronger and more viable root systems. Quick vegetation establishment produces increased plant survival, decreased soil erosion and reduced long-term maintenance. The net result is lower initial revegetation costs and significantly lower long-term maintenance costs.

PHC-REC’s sister company, Plant Health Care, Inc. pioneered the biological processes needed to produce inoculants of ectomycorrhizal fungi for pines and hardwoods, as well as inoculants of endomycorrhizal fungi (VAM) for species of native grasses, forbs, and flowers. Plant Health Care, Inc. also perfected the protocols for mycorrhizal fungal inoculant application in bareroot and container nurseries and on mine sites.
Vesicular-arbuscular mycorrhizal (VAM) fungi establish beneficial symbiotic relationships with the fine roots of many trees, shrubs, flowers, grasses and agronomic crops. Through this partnership, VAM make water absorption by the plant more efficient and improve absorption of essential mineral elements. As a result, VAM plants exhibit significantly higher survival rates and accelerated lush growth, especially in stressed environments.

PHC-REC employs a proprietary “cocktail” blend of four species of VAM fungi in each pellet to inoculate the soil. The incorporation of multiple strains of VAM fungi represents a significant advance in the efficacy of the mycorrhizal technology. The multiple strains ensure a match between the plant host and the VAM fungi which provides the most benefit to the plant host.

PHC-REC's exclusive pelletized VAM fungal inoculants also resist dislocation by wind to better ensure plant establishment.

**PHC-REC's innovative Pitter technology**

Also unique to PHC-REC is the use of a Reclamation Pitter. The Pitter was developed specifically for reclamation of steep slopes, rocky terrain and other harsh working environments. Unlike conventional seed applicators, the Pitter combines four functions in a single pass: shallow ripping of the seed bed, application of the pelletized inoculants, construction of the pits, and broadcasting of the seed. The pits are constructed rather than imprinted, with each row offset from the adjoining row. Approximately 10,000 pits are constructed per acre. The individual pits act as small reservoirs and seed beds to aid seed germination and vegetation establishment. The pits also mitigate soil erosion from water runoff and wind.

Pitting is extremely cost-efficient. Cost per acre of PHC-REC's Pitter technology is significantly less than that of other seeding methods used in combination of mulching and hydromulching.

**MycorTree® Seedlings**

Seedlings transplanted into mine overburden and mine and mill waste materials are immediately exposed to a highly stressed rooting environment. Many seedlings die and others routinely grow slowly.

Research and development worldwide has proven the practical value of inoculating nursery-produced tree and shrub seedlings with superior species of beneficial mycorrhizal fungi. Their survival and growth rates on adverse sites are far superior to nursery-run stock due to improved water and nutrient absorption and improved tolerance to drought, high temperatures and other stresses. MycorTree®s, available solely through PHC-REC, combine state-of-the-art biotechnology with the latest advances in seedling cultural production practices. The result is a variety of robust, “survival enhanced” seedlings that establish quickly and exhibit superior growth and quality performance across a range of soil compositions, pH, fertility and drainage conditions.

For its clients, PHC-REC locates an appropriate container nursery near the reclamation site. Company experts supervise the production of MycorTree®s that are custom-designed for the specific vegetation establishment program. Native plant species and local seed sources are used. PHC-REC then employs at least two species of ectomycorrhizal fungi on tree seedlings and four species of endomycorrhizal (VAM) fungi on other plant species. Multi-fungal species assure diversity of mycorrhizal types that provide multiple benefits on the plant roots. All MycorTree®s undergo a verification process prior to outplanting to ensure the presence of the specific mycorrhizae. Full-scale MycorTree®s seedling programs, from the planting of seed through the planting of seedlings at the site, are routine for PHC-REC clients. Outplanting tests using a range of MycorTree®s species regularly demonstrate volume increases of more than 300% on severe sites. Even in optimum forest and nursery soils, MycorTree®s show improved growth of as much as 50%.

**Regular Trees:**

Loblolly pine planted on an Ohio coal mine site without mycorrhizal fungi

**MycorTrees:**

Loblolly pine inoculated with mycorrhizal fungi on an Ohio coal mine site
PROBLEM:
- Strip-mined areas, gob piles and industrial mineral waste sites were barren and eroded with mixture of bench slopes and out slopes of 2:1 or steeper.
- Soils were highly acidic (pH 2.9 to 3.4) without adequate stabilizing vegetation.
- Erosion caused off-site sedimentation of drainage.

SPECIAL CLIENT CONCERNS:
- Low-cost, low-maintenance reclamation method needed.
- Most areas not eligible for traditional reclamation techniques under federal abandoned mineland guidelines.
Project Profiles

Ohio Coal Mine Reclamation
Athens, Gallia and Meigs Counties, Ohio

OBJECTIVE:
To effectively revegetate and reforest seriously degraded lands for the lowest cost and least maintenance possible.

PHC-REC NATURAL SYSTEMS SOLUTIONS:
PHC-REC experts selected an ectomycorrhizal fungus, *Pisolithus tinctorius* (Pt), for use in the revegetation project. This unique fungus is ecologically adapted to adverse and hostile soils. Tree seedling species that matched the site were inoculated with the Pt in a nursery prior to planting.

RESULTS:
- Since 1981, the program has planted 5 million seedlings having Pt ectomycorrhizae with at least an 85% survival rate on nearly 3,000 acres of abandoned strip-mines in southern Ohio.
- About 200 acres each year are now successfully reclaimed using the mycorrhizal fungal technology. Although these sites contain highly stressed and low fertility soils (available phosphorus less than 1 ppm), overall tree growth continues to be exceptional even without fertilization or lime.
- Virginia pine trees after six years were nearly 10 ft. tall with 90% survival.

Snake River Gravel Pit Reclamation
Teton County, Wyoming

Located within the John D. Rockefeller, Jr. Memorial Parkway and approximately two miles south of the Yellowstone National Park south entrance.

PROBLEM:
PHC-REC was contracted by the State of Wyoming to evaluate and eliminate the public safety hazards and environmental degradation associated with sixty-five acres of lands previously disturbed by gravel mining activities within the Snake River floodplain.

SPECIAL CLIENT CONCERNS:
In addition to being located within the Yellowstone Grizzly Bear Recovery Area, the project site was home to seven different mammal, bird or reptile species that are either listed on or are being considered under the Threatened and Endangered Species Act. This included the whooping crane, bald eagle, grizzly bear, the Ute ladies'-tresses, the gray wolf, mountain plover and the western boreal toad.

OBJECTIVE:
To reclaim the site and restore wetlands necessary to improve habitat values while complying with National Park Service (NPS) policies, the Clean Water Act in accordance with the U.S. Army Corps of Engineers, the Environmental Protection Agency and the Wyoming Department of Environmental Quality standards and directives.

PHC-REC NATURAL SYSTEMS SOLUTIONS:
Under the direction of a cooperative effort between PHC-REC, NPS and AML personnel, earthwork activities were conducted by a grading contractor. Approximately 350,000 cubic yards of mine reject material and topsoil was reshaped to re-establish sedge meadows, willow flats, stream channels, oxbow ponds and upland features. An agronomic contractor collected 5 different species of wetland plants and willow cuttings with live buds, all native to the Snake River floodplain, and stored, germinated and grew the wetland seedlings in an off-site plant nursery. A total of 602,000 herbaceous plants and 35,000 willow cuttings were planted within the project site limits.

RESULTS:
After a decade since mining activities ceased, the damage to the wetland and riparian ecosystem has been reclaimed in accordance with NPS management policies and legislative mandates.

For excellence in engineering design and construction management Services, PHC-REC was the recipient of the coveted 2004 People’s Choice Award for best national reclamation project presented by the United States Department of the Interior, Office of Surface Mining.
More than 20,000 acres of land disrupted by 100-plus years of mining and related activities; includes mine waste dumps, borrow areas, and mill tailings.

Extensive erosion, sedimentation of drainages, dust hazards, and little or no satisfactory vegetation. Waste dump slopes of 1.5:1 or steeper with highly acidic conditions, numerous borrow areas with gravelly conditions, and several large areas of mill tailings.

No topsoil in areas of disturbance and only small inadequate amounts of topsoil available locally. Subsoils ranged from poor quality to unsuitable.

Low precipitation, drought conditions common, freezing winter temperatures, high altitude.

Environmental concerns of the company, the public and the EPA.

Lack of suitable growth medium resource (no topsoil, poor subsoils).

Cost.
Project Profiles

Bingham Canyon Copper Mine Reclamation
Salt Lake County, Utah

OBJECTIVE:
- Mine Waste Dumps: Mitigate production of acidic water, stabilize dumps and reduce erosion, establish vegetation and return dumps to wildlife habitat use
- Borrow Areas: Eliminate dust hazards, mitigate erosion, return to beneficial use
- Tailings Areas: Eliminate dust hazards, mitigate erosion, establish wildlife habitat area

PHC-REC NATURAL SYSTEMS SOLUTIONS:
- PHC-REC selected site-suitable plant species based on test plot results.
- Site-specific mycorrhizal fungi were identified and used in conjunction with other mycorrhizal fungi to provide optimal benefits to tree and shrub seedlings. Grasses, forbs and shrubs started from seed on site.
- Biosolids were used as a soil amendment to improve the physical, chemical and plant nutrient characteristics of the low quality “soils”.
- Unique reclamation equipment for VAM fungal inoculation, seeding and erosion mitigation was developed by the PHC-REC team.
- VAM fungal spores in pelletized form were created by PHC, Inc. scientists for easy and controlled field inoculation.
- A custom, nursery-grown tree and shrub seedling program was established and protocols developed for the inoculation of trees and shrubs with specific mycorrhizal fungi.

RESULTS:
More than 6,000 acres of disturbed lands have been reclaimed to date, and the client's objectives have been met. Regulatory compliance has been achieved for local, state and federal agencies. Thousands of custom seedlings have been planted in the reclaimed areas. Survival and growth rates of inoculated trees and shrubs are significantly higher than non-inoculated plants. The client has received three environmental awards for reclamation. Reclamation of additional disturbed lands continues.

The Kirwin Stabilization Project
Park County, Wyoming

OBJECTIVE:
PHC Reclamation, Inc. was contracted by the Wyoming Department of Environmental Quality, Abandoned Mine Lands Division (AML) to initiate work related to AML Project 17F-7, the Kirwin Stabilization Project. The project involves the stabilization and preservation of numerous buildings, including two mineshaft houses and the Superintendent’s House located in the historic ghost town of Kirwin. The Tumlum Mine shaft house was constructed approximately 110 years ago and is one of the most unique structures in the Kirwin Mining District. The historic Wolf Mine shaft house was developed fifty years later in the 1940s. Having these preserved shaft houses from different eras makes Kirwin an ideal site to interpret the evolution of mining.

PHC-REC SOLUTIONS:
In cooperation with the AML, Shoshone National Forest (SNF) with the USDA Forest Service, State Historic Preservation Office (SHPO) and private citizen volunteers, stabilization work on the Superintendent's House was completed in August 2003. The work performed by PHC-REC in association with the Tumlum Shaft stabilization included conducting a historic literature research, review of AML's preferred stabilization recommendations and alternatives, subcontracting of all shaft head frame stabilization work, and subcontractor management.

PHC-REC completed eligibility research and determination, costing, and preparation of contract documents, specifications and plans for the stabilization of the Mine Superintendent's House. Preparation of the plans and specifications required close and continued coordination with the SNF, USDA Forest Service, SHPO, and AML. Specifications were prepared based on the Secretary of the Interior's Standards and Guidelines for the rehabilitation, restoration, preservation and reconstruction of historic structures. The final design details specified how to stabilize the structure including adding material to support the existing foundation, removing and replacing sill and top logs, stabilizing dormers, replacing deteriorated ceiling joists, resheathing the roof, preserving historic building members and establishment of surface drainage away from the structure.

RESULTS:
PHC-REC prepared specifications and plans for stabilization of the Tumlum Cabin and the Wolf Shaft House. This work involved re-roofing the Tumlum cabin and jacking the Wolf Shaft House over 15 inches on the southwest corner.
PROBLEM:
- Hazards associated with highwalls, open or partially collapsed portals, exploration trenches and pits, vertical openings, adits, subsidence features, unstable spoil and gob piles, dilapidated buildings and equipment, geomorphic instability, on-site and off-site erosion and degradation and hazardous materials.
- Hazardous subsidence hole induced by surface water drainage located above an abandoned coal mine entry.
- Abandoned exploration trench with highwalls and a washed-out portion of the Gebo Road induced by underground mine related subsidence.
- Hazard mitigation of 6 underground coal mine features, including adits, portals and a series of exploration trenches with dangerous highwalls.

SPECIAL CLIENT CONCERNS:
- Evaluate and eliminate the public safety hazards associated with abandoned underground and surface coal mine sites while preserving the historic values of the Bighorn Basin’s coal mining history.
The Gebo Coal Mines Project

Hot Springs County, Wyoming

OBJECTIVE:
Inventory, investigate and prepare reclamation designs to mitigate the hazards associated with a subsidence hole induced by surface water drainage above an abandoned coal mine entry, an abandoned exploration cut and a washed-out portion of county road.

Ensure that the historic significance of the area is preserved and documented. The site hazard assessment and on-site fieldwork is located within the Gebo-Crosby coal-mining district near the historic ghost town of Gebo, Wyoming. The National Register of Historic Places Report identifies the historic context and includes a narrative of the coal mining performed in the Bighorn Basin from 1890 to 1950.

PHC-REC NATURAL SYSTEMS SOLUTIONS:
A riprap bulkhead was constructed within the exposed subsidence hole and then backfilled with borrow material from the spoils located adjacent to the abandoned mine cut. The site was graded to allow surface water drainage to flow to the west of the closure area and not directly above it. Topsoil originating from the site was then placed over all disturbed areas, including the access route.

The washed-out road was the major focus of construction. Approximately 3,360 cubic yards of riprap was installed for the 4 drop structures and 31,525 cubic yards of soil was excavated and placed for channel realignment tasks. The entire disturbed area was topsoiled with soils originating from the site and adjacent areas.

New fence was placed along the county road where construction activities were conducted in the former “wash-out” area. Approximately 21.5 acres were disturbed during this project and the entire disturbance area was revegetated. Agronomic activities included ripping, disking, pitting and seeding.

RESULTS:
PHC-REC completed Investigation Tasks, Eligibility, Consents & Clearances, Construction Bidding, Engineering Design (Plans & Specifications), Project Coordination, Construction Management, and Monitoring.

The public safety hazards associated with abandoned underground and surface coal mine sites were completely eliminated while preserving the historic values of the Bighorn Basin’s coal mining history.
The Bentonite Reclamation Project
Crook and Weston Counties, Wyoming

PROBLEM:
- Public safety hazards and environmental degradation associated with 28 abandoned bentonite mine sites.
- Hazardous safety conditions included unstable highwalls and slopes, bentonitic muck and open pits.
- These sites posed numerous environmental degradation problems such as poor water quality, sodic and acidic soils, off-site sediment deposition and gully erosion.

SPECIAL CLIENT CONCERNS:
- Preserving habitat, cultural resource and threatened and endangered species concerns

OBJECTIVE:
- PHC-REC inventoried, investigated and addressed eligibility concerns, consents and clearances, soil and bentonitic muck assessments, surface hydrology analysis, geomorphic evaluations and wetland delineations and verification.
- Designs and plan drawings were developed to address the above mentioned issues as well as cultural resource and threatened and endangered species concerns.
- Construction was performed in 6 separate phases or groups in order to address a number of factors, including available access, geographic location, size, land ownership, Corp of Engineer permitting requirements and expected costs for each group.

PHC-REC NATURAL SYSTEMS SOLUTIONS:
- Earthwork activities were conducted and included excavation and grading, spoil removal and burial, shaping of existing ponds or wetlands and construction of stable drainage channels.
- Agronomic tasks were conducted and involved chemical amendment, application and incorporation, agricultural ripping and disking, pitting and seeding.
- Erosion control blanket was installed in a number of constructed and existing drainage ways.
- Approximately 6.1 acres of wet meadows and marshes were enhanced or developed, over 12.6 acres of pond shoreline was expanded and/or enhanced and approximately 8,500 feet (1.0 miles) of drainage was constructed or re-aligned within or to existing channels.

RESULTS:
Investigated: Eligibility, Consents, Clearances, Construction Bidding, Engineering Design (Plans & Specifications), Project Coordination, Construction Management, Monitoring.
Completely eliminated the public safety hazards associated with abandoned underground and surface bentonite mine sites while restoring fields, wet meadows and marshes.
A prairie fire ignited graded coal slack piles that were associated with completed AML reclamation projects, the most recent being the Monarch Coal Mine Subsidence.

Prevent vehicle travel across the burning coal slack located within the county road.

Prevent migration of the burning coal slack into the reclaimed portal located south of the county road.

Properly encapsulate, isolate or extinguish all burning coal slacks.

To eliminate one or a combination of the 3 essential components of a mine fire: oxygen, fuel source and heat.

Investigated; Construction Management; Monitoring.

Within the three days that PHC-REC personnel were on-site, burning coal slack and/or ash was properly encapsulated or contained per the construction methodology instructed by the AML. A cut-off trench was constructed across County Road 106 to prevent vehicle travel across the burning coal slack located within the road. Another cut-off trench was constructed to prevent migration of the burning coal slack into the reclaimed portal located south of the county road.

The construction methodologies used were encapsulation of the burning coal slack by excavating a pit, pushing the material into the pit and covering the material with adjacent soils. Excavating “cut-off” trenches around random coal slack burn areas to prohibit further migration of the burning coal slack and restricting its fuel source within the trenched area. Combining the encapsulation and trench methods and mixing the burning coal slack with adjacent soil materials (free of combustible materials).

The Sheridan Mine Fire Project

Sheridan County, Wyoming

PROBLEM:
- A prairie fire ignited graded coal slack piles that were associated with completed AML reclamation projects, the most recent being the Monarch Coal Mine Subsidence.

SPECIAL CLIENT CONCERNS:
- Prevent vehicle travel across the burning coal slack located within the county road.
- Prevent migration of the burning coal slack into the reclaimed portal located south of the county road.

OBJECTIVE:
- Properly encapsulate, isolate or extinguish all burning coal slacks.
- To eliminate one or a combination of the 3 essential components of a mine fire: oxygen, fuel source and heat.

RESULTS:
- Investigated; Construction Management; Monitoring.
- Within the three days that PHC-REC personnel were on-site, burning coal slack and/or ash was properly encapsulated or contained per the construction methodology instructed by the AML. A cut-off trench was constructed across County Road 106 to prevent vehicle travel across the burning coal slack located within the road. Another cut-off trench was constructed to prevent migration of the burning coal slack into the reclaimed portal located south of the county road.
- The construction methodologies used were encapsulation of the burning coal slack by excavating a pit, pushing the material into the pit and covering the material with adjacent soils. Excavating “cut-off” trenches around random coal slack burn areas to prohibit further migration of the burning coal slack and restricting its fuel source within the trenched area. Combining the encapsulation and trench methods and mixing the burning coal slack with adjacent soil materials (free of combustible materials).

The Kemmerer Coal Mine Fire Project

PROBLEM:
- Due to the very high surface temperatures and instability of the ground above the mine fire, no equipment was allowed to perform grading work along or over the surface cracks and vents.

SPECIAL CLIENT CONCERNS:
- The Town of Kemmerer’s Fire Chief had requested that a fire line be constructed along the perimeter of the cracks and vents to help contain possible surface fires and facilitate fire-fighting equipment.

OBJECTIVE:
- PHC-REC investigated and reported hazards related to surface cracks and vents that originated from an underground coal mine fire along Oyster Ridge located just east of the town of Kemmerer, WY.
- Construction of a fire line, perimeter fence and removal of all combustible fuels along the surface.

RESULTS:
- Investigated: Consents & Clearances, Construction Bidding, Engineering Design (Plans & Specifications), Project Coordination, Construction Management, Monitoring.
- Construction of a fire line, perimeter fence and removal of all combustible fuels along the surface was completed.
- PHC-REC performed emergency hazard mitigation work associated with the Kemmerer Mine Fire.
The Shirley Basin Uranium Project
Carbon County, Wyoming

PROBLEM:
- Key members of the PHC-REC team were involved with the largest reclamation project ever undertaken by the Wyoming AML program. The project included the inventory, evaluation, design and reclamation of over 1800 disturbed acres including 72 million cubic yards of uranium mine waste stabilization, 42 thousand feet of highwall reduction, and nearly 3 miles of Little Medicine Bow River relocation.
- Responsibilities included design, preparation of construction plans and specifications, and on-site management of all reclamation activities.

SPECIAL CLIENT CONCERNS:

Groundwater
To aid in the prediction of ground water quality impacts from pit backfill, an extensive column leach study was undertaken. To help verify predictions made by the Column Leach Study, four ground water monitoring wells were completed within backfill placed in the Walker/Jenkins Pit. Two wells were completed in the Main Wind River Aquifer and two wells were completed in the Lower Wind River Aquifer.

Revegetation of Spoils/Erosion Control
Numerous problems were identified with these soils and included the following:
- Extremely low pH (as low as 2.2).
- High selenium concentrations (as high as 4.12 ppm).
- Saline soils with high electrical conductivity (as high as 9.0).
- Acid-forming soils (acid-base account less than -5.0).
- Low soil fertility.

Radiometric Cleanup and Verification
During reclamation, three general types of radiometric monitoring and cleanup verification needed to be performed. These included:
- Cleanup of known large quantities of material with high radiometric readings
- Field radiometric monitoring and cleanup during more routine reclamation activities; i.e. highwall reduction, river and drainage construction.
- Monitoring and cleanup verification of all final reclaimed surfaces within the AML Project13 limits.

OBJECTIVE:
- A great amount of work was undertaken as part of AML Project i3.
  The listing below gives a synopsis of the completed major objectives:
  - 31,200 feet (5.9 miles) of highwall reduction and stabilization.
  - 16,500 feet (3.1 miles) of river channel relocation Little Medicine Bow River.
  - 44,500 feet (8.4 miles) of ephemeral drainage channel construction.
  - 46,300 cubic yards of riprap (rock) drainage protection.
  - 33,000,000 cubic yards of total earth movement.
  - County bridge replacement.
  - 196,540 feet (37 miles) of Erosion Control Drainage construction.
  - 1,650 acres of reclaimed disturbance.

PHC SOLUTIONS:
Some of the major elements considered during design include the following:
- Stabilization of highwalls by either weighting the toes or reducing the slopes
- Sorting and safe burial of radioactive wastes
- Sorting and containment of selenium and other unsuitable wastes under a minimum of two feet of cover.
- Erosion resistant and geomorphically stable grading construction drawings.
- Relocation of the Little Medicine Bow River to a relatively non-erosive slope and stabilizing channel where needed with riprap.
- Reconstruction and stabilization of the ephemeral drainage patterns for all reclaimed areas.

RESULTS:
The project area included approximately 7.25 square miles or approximately 4,640 acres. The major tasks completed during the investigation phase include the following:
- The 7 existing spoil stockpiles were drilled with 238 holes and included a combined depth of 19,750 vertical feet.
- A total of 3,950 composite samples were obtained for each five-foot interval drilled.
- 607 samples were analyzed for major constituents utilizing standard DEQ test methods, EP toxicity and other methods.
- Impoundment and ground water samples were analyzed and evaluated.
- Geotechnical stability of highwalls was evaluated.
- River mechanics for the Little Medicine Bow River was analyzed and a study of underground and surface water hydrology was accomplished including a column leach study to determine potential ground water impacts from placement of overburden material within the impoundments.
- Reconnaissance level vegetation, wildlife and soil investigations were conducted.
- A cultural resources inventory and study was conducted.
- A baseline radiological study was performed.
- A radiological health risk study was performed to determine appropriate radiation cleanup levels to target. This study established different limits for different future land use patterns.
The historic Silver Reef Mining District contains multiple outcroppings of silver in sandstone and is the only known example of silver in sandstone ever found in North America. The sandstone proved to be loaded with silver, copper and uranium. A boom began in earnest in 1875 around Silver Reef and lasted until dropping silver prices caused a collapse of the area around 1890.

Hazards associated with the historic mining district needed to be evaluated and addressed.

**OBJECTIVE:**
The purpose of the project was to inventory, investigate and prepare hazard mitigation designs for over 500 shafts, adits, portals, subsidence holes, dilapidated buildings and other mine-related features associated with the historic Silver Reef Mining District in southern Utah.

**PHC SOLUTIONS:**
- Site investigation and evaluation, consents and clearances, site eligibility research, mine permit research, mineral claim research, limited surveying, mapping, hazard assessment, conceptual design and construction specification preparation and costing.
- Additional work performed included development of a systematic inventory methodology and identification convention for each mine feature and establishment of permanent marking of each mine feature with rock bolts and washers or rebar and aluminum caps containing site identification numbers.

**RESULTS:**
This Project received a Certificate of Achievement from the U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement Division.

The Copper Mountain Mines Project
**Fremont County, Wyoming**

**PROBLEM:**
Mineral exploration and extraction of gold, copper, silver, tungsten, feldspar, beryl and low-grade uranium resources was conducted throughout the Copper Mountain region from the early 1880’s to the mid-1970’s. Significant public safety hazards needed to be mitigated due to the diverse types of minerals mined or prospected, the mining techniques and the extent of disturbance.

**OBJECTIVE:**
The purpose of the project was to evaluate and eliminate the public safety hazards associated with abandoned underground and surface mine sites located in the historic Copper Mountain Mining District. PHC-REC field personnel identified the existing and potential safety and environmental hazards pertaining to open or partially collapsed portals, prospect pits, exploration trenches, adit workings, subsidence features and highwalls, unstable spoil piles and dilapidated structures then developed and executed a reclamation plan.

**PHC SOLUTIONS:**
- Over 500 mine features were inventoried with approximately 120 of those features representing an immediate hazard or potential injury concern to the public and wildlife. In addition, acidic mine drainage, mine spoils in ephemeral and intermittent drainages, impacted wetlands, soil deposition and gully erosion problems were identified at numerous mine site areas.
- Reclamation designs were developed to mitigate the public hazards. The designs were influenced by many factors including the type of hazard, access, cultural resource and Threatened and Endangered Species concerns, and special interests from the BLM, Fremont County, private surface and mineral owners and claimants.
- Acidic mine drainage, mine spoils in ephemeral and intermittent drainages, impacted wetlands, soil deposition and gully erosion problems were addressed per federal and state environmental cleanup and mitigation standards with design concepts involving channel re-alignments, spoil encapsulation, placement of erosion and sediment control features.

**RESULTS:**
The project area encompassed 52 Sections across 3 Township and Ranges. Over 505 mine features were inventoried and evaluated. Work performed included site investigation and evaluation, consents and clearances, eligibility research, mine permit and exploration notice research, mineral claim research, previous reclamation assessment, surveying and mapping, hazard documentation, conceptual designs and costing. A database was established with GIS interface to house all investigation and inventory work performed.
Project Profiles
The Seahorn Ramsey Mines Project
Carbon County, Wyoming

PROBLEM:
- The State of Wyoming needed to mitigate the public and wildlife safety hazard associated with an abandoned underground coal mine sites northwest of Saratoga, Wyoming.
- Wildlife considerations included scheduling construction activities outside of known bald and golden eagle nesting periods and the construction of a bat culvert.

OBJECTIVE:
The purpose of the project was to evaluate and eliminate the public safety hazards associated with two abandoned underground coal mine sites located northwest of Saratoga, Wyoming, while preserving the historical significance of the individual sites, structures and adjacent man camps.

PHC SOLUTIONS:
- PHC-REC identified existing and potential safety and environmental concerns pertaining to open portals, exposed adit workings, vertical openings, subsidence features and geomorphic instability.
- Responsibilities included site investigation and evaluation, consents and clearances, site eligibility research, mine permit research, mineral claim research, limited surveying, mapping, hazard assessment, conceptual design and construction specification preparation, costing, construction bidding and construction management.

RESULTS:
All hazards associated with the twenty five abandoned coal mines were successfully mitigated and construction activities were completed by October 2002. A bat culvert bulkhead was constructed in one of the open mine adits located adjacent to the North Platte River. Cultural resource studies conducted for the project found that four of the coal mines were eligible for nomination to the National Register of Historic Places.

PHC Reclamation, Inc. (PHC-REC) is an experienced mining, environmental and reclamation consulting firm providing cost-effective, biologically based solutions for land reclamation and restoration projects. PHC-REC is the leader in the use of mycorrhizal fungi and bacteria for the establishment of trees, shrubs, forbs and grasses on lands distressed by mining activities.
Team professionals have dedicated much of their work over the past 20 years to the investigation, inventory, engineering, design, construction management and revegetation of reclamation projects.
PHC-REC has assembled personnel with extensive experience in reclamation projects. Team professionals have provided management, consulting, technical and biological services, investigation, engineering, and design and construction management services for client’s reclamation projects throughout the United States.
PHC-REC Team:

Chris Walla, P.E.
President, PHC Reclamation, Inc.

Reclamation Services

With more than 25 years in mining, reclamation and construction management services, Mr. Walla’s experience with project management, permitting, engineering, design and regulatory compliance is an integral element of PHC-REC’s cost-saving and successful engineering program. He has performed management, consulting, investigation, design and construction management services for environmental reclamation projects throughout the United States worth over 150 million dollars. Three of these projects received national awards for achievement from the U.S. Department of the Interior, Office of Surface Mining, Reclamation and Enforcement Division and one project received the Wyoming Engineering Society President’s Project of the Year Award. Mr. Walla has extensive knowledge and experience in the areas of earthwork grading plans and specifications, wetland and pond design, costing, contract administration and management, permitting, and National Environmental Policy Act (NEPA) and in the Clean Water Act (CWA) requirements. He has managed the development of environmental assessments, wetland delineation reports, geotechnical engineering analysis, and Storm Water Pollution Prevention Plans. Mr. Walla has written and prepared over 200 different sets of contract documents and specifications for restoration and mine land reclamation projects.

Joe Alexis, P.E.
Project Mining/Metallurgical Engineer

Reclamation Services

Mr. Alexis has ten years experience in environmental remediation of mine lands and government installations that produced hazardous chemical materials and nuclear waste. Joe also has and an additional twenty years of involvement in coal and mineral processing, including separation techniques and equipment related to froth flotation, magnetic separation, electrostatic separation and gravity concentration. Mr. Alexis oversaw the construction and operation of coal and mineral pilot plants in the countries of South Africa, Canada, Madagascar and the U.S. Also in that time he designed, assisted in the construction and oversaw operations of a dredging and coal preparation facility for the recovery of fine coal from abandoned slurry ponds located in the Central U.S.

Daniel Adams, P.G.
Senior Project Manager

Reclamation Services

Mr. Adams has designed, coordinated and managed environmental and mine reclamation projects over the past 15 years. With more than 25 years in mining, exploration, reclamation, and project management, Mr. Adams has extensive experience and practical knowledge in geology, permitting, environmental compliance, hydrology, budgeting, planning, construction management, and revegetation. As Site Manager, Mr. Adams was responsible for all reclamation and closure planning for the $12 million Basin Creek Mine project. Responsibilities included conceptual engineering and hydrological designs, cost estimation, bid solicitation and contractual agreements, and construction oversight. Mr. Adams has experience in all phases of mining projects including exploration, sustainable development, production, reclamation and closure.

Ron Gossard
Project Environmental Engineer

Reclamation Services

Mr. Gossard has performed site investigation, site assessment, consents and clearances, permitting, design, environmental sampling/monitoring, regulatory compliance inspections and construction management tasks for active coal and non-coal mine operations, abandoned mine land reclamation projects and petroleum hydrocarbon remedial investigation and cleanup projects. Ron’s extensive field experience involving abandoned mine field investigations and hazard assessment as well as his construction management oversight abilities, provides an added diversification to the PHC-REC team.

Dr. Donald H. Marx

Mycorrhizae and Soils

Dr. Marx is a world renown authority on mycorrhizal fungi and their practical application. He is the 1991 recipient of the prestigious Marcus Wallenberg Prize awarded by the King of Sweden (considered the Nobel Prize of Forestry) for his international work on mycorrhizae for improved tree establishment on degraded land with the USDA Forest Service. For the past 40 years, Dr. Marx has pioneered the practical use of mycorrhizal fungi on native trees, forbs and grasses to solve problems in the reclamation/profitation of mined land and other degraded sites. He has conducted field research in cooperation with several state AML programs, federal agencies and private mining companies to revegetate adverse sites, such as mine lands, pollution-damaged sites like Copper Basin, Tennessee, borrow pits and other severely eroded sites. Dr. Marx’s scientific and practical experience on the natural approach to reclamation programs is now available to PHC-REC clients.

Dr. C. Edward Cordell

Reclamation and Forestation Services

Dr. Cordell has extensive experience in applying the mycorrhizal fungal technology to custom container and bareroot native tree and shrub seedling production for mineland reclamation and forestation projects throughout the U.S. and abroad. He has initiated and completed several major reclamation and forestation projects for federal and state agencies and for private companies. Dr. Cordell has received many awards for his contributions to mineland reclamation projects. Following more than 30 years as a tree nursery and field forestation specialist with the USDA Forest Service, Dr. Cordell incorporates this vast experience into PHC-REC’s unique biological approach to more effective/ economical reclamation/reforestation programs.
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