

TRACKING BOND RELEASE AT A LARGE WYOMING COAL MINING OPERATION¹

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Abstract: All coal mines must provide a reclamation performance bond sufficient to cover the cost of reclaiming the mine as per the Surface Mining Control and Reclamation Act (SMCRA) of 1977. The Wyoming Coal Program has two types of bonds: an Area Bond (backfilling and grading) and an Incremental Bond. The Incremental Bond includes Phase 1 Partial Release (final grading and soil replacement), Phase 2 Partial Release (vegetation establishment commensurate with the seed mix), and Phase 3 Full Release (all requirements have been met). As of October 2010, approximately 29 690 ha have been released from bond (various phases of Area and Incremental Bond) from 35 coal mines in Wyoming that accounted for 17% of total permitted acreage and 46% of total disturbed acreage. Approximately \$238 318 400 has been paid (10.7% of total) through the bond release process compared to \$2 223 000 000 of the total bond currently held by the State for all coal mines. The average cost per ha held for Area Bond, Phase 1, Phase 2, and Phase 3 Incremental Bond was \$8 069 (\$3 267 per acre). Various phases of bond release require verification of performance standards in the field (e.g., backfilling, topsoil replacement, drainage construction, revegetation, etc.). Keeping track of all of these verifications on hundreds of parcels or reclaimed land represents a challenge for the regulatory agency, especially for large mines. As a result of these challenges, a Bond Release geodatabase was developed for the North Antelope Rochelle Mine (NARM) in Wyoming. This geodatabase was the first spatially supported database developed in Wyoming for reclamation bond release processing purposes for mined lands. The geodatabase was designed to support the tracking of areas which have achieved backfill verification and have satisfied performance standards in support of incremental bond release. Selected compliance features used to support the approval of incremental bond release during the verification process include: topsoil depth, surface stability, and wildlife habitat features. These features were monitored and entered into the geodatabase by LQD personnel during inspections using a Global Position System (GPS) enabled data collector.

Additional Key Words: GIS, Geodatabase, Reclamation

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Introduction

The Federal Surface Mining Control and Reclamation Act (SMCRA) as well as the Wyoming Environmental Quality Act require all coal mining operations to provide a reclamation performance bond sufficient to cover reclamation costs in the event that the permittee fails to complete the approved reclamation plan. The Wyoming Department of Environmental Quality (WDEQ), Land Quality Division (LQD) uses two bond types: an Area Bond and an Incremental Bond. The Area Bond covers the cost of rough backfilling and grading to prepare the area for topsoil application. The Incremental Bond covers all subsequent phases of reclamation and revegetation. The Incremental Bond covers a series of releases based on performance standards. Phase 1 Partial Release will occur when topsoil is applied, Phase 2 Partial Release when vegetation is established, and Phase 3 Full Release when all reclamation requirements have been met. Over time, as regulatory requirements have evolved, the LQD has established five categories for assigning bond release criteria for reclaimed coal mined land. The categories are based primarily on the rules that were in effect at the time an area is initially affected and/or when coal removal is completed (WDEQ, LQD, Guideline No.20, 2003). A general summary of bond release verification requirements for each category is included in references by Krzyszowska-Waitkus et al. (2000) and Schladweiler (2009).

In Wyoming, the bond release process occurs in two stages. First, bond release requirements are verified in the field. Second, after LQD receives the bond release package, the request is reviewed for compliance following Chapter 15 of Coal Rules and Regulations, WDEQ, LQD (2009). Information related to bond release verification and compliance standards is included in WDEQ, LQD Guideline No. 20, “Bond Release Procedures for Coal Mining Operations” (2003), Guideline No. 21, “Rough Backfill Verification and Area Bond for Coal Mines” (2007), and Guideline No. 22, “Verification and Compliance Standards for Phase 1 Partial Incremental Bond Release” (2007).

On October 2010, Wyoming had 35 active coal mines covering 174 718 ha. Total Wyoming coal production reached 467.6 million tons in 2008 (U.S. Energy Information Administration, 2008) which accounted for 40% of the United States coal production. One of the nation’s largest coal mines, the North Antelope Rochelle Mine (NARM) is located in Wyoming’s Powder River Basin. The large size and dynamic nature of this mine created challenges for regulatory

authorities to verify if bond release criteria had been met and collect required compliance information during monthly inspections. A system was needed to streamline field data collection and correlate it with bond release and compliance requirements. This paper presents an electronic geodatabase created by the LQD permit coordinator/inspector, and NARM personnel to track bond release verification criteria and assess compliance with regulatory requirements and permit commitments.

The system uses a Geographic Information System (GIS) database and supporting mobile Global Positioning Systems (GPS) applications. This geodatabase is the first spatially supported database developed in Wyoming for mined land reclamation bond release and inspection purposes. It was designed to support tracking areas that have achieved backfill and have satisfied the various performance standards in support of incremental bond release. The verification involves the approval of regulatory requirements for the release of bonding instruments.

Location

North Antelope Rochelle Mine is an open pit, coal mine with a 2008 coal production of 97.6 million tons. The mine combined North Antelope (open in 1982) and Rochelle (open in 1984) mines in 1999. The permit area covers 18 728 ha including 6 648 ha of disturbance. Since 1999, the permit area has increased approximately 75% from 10 702 ha, while the disturbed area increased approximately 50% from 3 458 ha.

The active coal pit covers 3 347 ha and 1 971 ha have been permanently reclaimed (Powder River Coal, LLC., 2009). The coal seam thickness varies between 18 and 24 m with an average overburden of 66 m. The three major pits are East Pit (6.5 km long), North Pit (7.6 km long), and West Pit (6.5 km long). There are three operating draglines and 11 shovels supported by numerous haul trucks and bulldozers.

Methods

LQD staff utilized an ESRI Personal Geodatabase at the ArcInfo 9.2 level, including ArcMap, ArcCatalog and ArcTools, to organize spatial data as ESRI feature classes and feature datasets. Mobile GIS functions were performed with ESRI ArcPad 7.1 mobile GIS software operating on a Trimble GeoExplorer Series GeoXM and Juno handheld GPS unit. During

monthly inspections, LQD personnel used a GPS enabled data collector to monitor selected compliance features such as topsoil depth, erosion features, wildlife habitat features, and other information necessary for incremental bond release. After collecting GPS data in the field, LQD personnel used Trimble GPS Pathfinder software and Microsoft ActiveSync to transfer it from the data collector to a computer for storage and analysis. Data sources included mine map layers submitted by the mine operator, inspection reports, and field collected GPS data. Software and hardware were supported by the Office of Surface Mining Reclamation and Enforcement (OSMRE) Technical Innovation and Professional Services (TIPS) program.

The main requirements for Area Bond, Phase 1 and 2 Partial Release and Phase 3 Full Bond Release are listed in Table 2 below. These requirements are analyzed during field inspections and recorded by GPS as well as verified by submitted documents.

Results and Discussion

The total amount of the reclamation performance bond for the 35 currently active coal surface mines in Wyoming reached \$2 223 000 000 (calculation based on Land Quality Division internal database as of October, 2010). Through October, 2010 the total amount of bond released for the total of 29 690 ha exceeded 238 million dollars (10.7% of the total bond). The average cost per ha held for Area Bond, Phase 1, Phase 2, and Phase 3 Incremental Bond was \$8 069 (\$3 267 per acre). The majority of these costs included backfilling and grading the area to the approved post-mining topography.

The NARM staff (through October, 2010) had submitted requests for Phase 1 Partial incremental bond release for a total of 1 546 ha. After approval of two bond release packages, a total of \$8 675 453 (2.7% of total) was released from the current bond of \$324 019 600.

Bond release requirements for NARM

Bond release requirements for NARM include Category 5 land only (area affected after May 3, 1978). More detailed information regarding bond release performance standards and requirements for Category 5 land is provided in Guideline Nos. 21 and 22 (WDEQ, LQD, 2007) (Table 1).

Table 1 Bond release performance standards/verifications for Category 5 land.

Bond Release Phases	Performance standards/verifications
Area Bond	<ul style="list-style-type: none"> - Backfilled and rough graded to PMT; Drainage divide matches those of the approved PMT - Rough backfill quality
Phase 1 Partial Release	<ul style="list-style-type: none"> - Backfilled and rough graded to the approved PMT - Rough backfill quality - Topsoil replacement according to the permit commitment - Stream channel reconstruction and drainage system functionality restored according to the approved reclamation plan
Phase 2 Partial Release	<ul style="list-style-type: none"> - Vegetation established for at least two growing seasons. Species composition commensurate with the approved seed mix and supports the postmining land use - Sediment control release approved - Permanent impoundments established
Phase 3 Full Release	<ul style="list-style-type: none"> - The approved postmining land use has been restored - Wildlife habitat/features restored and shrubs reestablished - Sediment ponds removed and reclaimed - Alluvial valley floors established - Mitigation wetlands - Achievement of the revegetation standards - Achievement of the shrub establishment goal and/or standards - Achievement of the tree replacement standard - Postmining groundwater supports the land use - Postmining surface water quality and quantity support the approved postmining land use and minimize impact to the hydrologic balance - Permanent impoundments suitability and stability - All approved postmining roads are functional - All temporary structures are removed

The criteria for full bond release are to obtain release from the Area Bond and all the various phases of Incremental Bond release. Incremental Bond Release also includes bond release from sediment control and reclamation or rehabilitation of sediment ponds (if ponds are to be left as permanent features for the post-mine land use). Requirements for grading, erosion stability, topsoil application, and hydrology are verified during field inspections. Overburden suitability and drainage system are reviewed in Annual Reports and compared with approved reclaimed surface maps in the permit and specific permit commitments.

Quantitative vegetation sampling followed requirements in Appendix A (Vegetation sampling methods and reclamation success standards for surface coal mining operations) of the Coal Rules and Regulations, WYDEQ, LQD, updated in 2009. Category 5 lands, (disturbed

between March 27, 1981 and August 6, 1996) are subject to a shrub density goal of 1 shrub/m² on 10% of the affected lands. Lands disturbed after August 6, 1996 have a shrub density standard of 1 shrub/m² on 20% of the affected lands.

Mining and reclamation are conducted contemporaneously. As result, the reclaimed area is a patchwork of units in varying stages of reclamation varying in size between 0.04 and 196 ha. For example, as of October 2010, there were 94 parcels rough backfill verified. This patchwork of reclamation units was one of the major reasons to establish a system for storing all needed information for bond release verification requirements and bond release compliance.

Geodatabase development

A GIS database and supporting mobile GPS application was developed specifically for the NARM. In 2003, the LQD, Powder River Coal Company, LLC (PRCC), and OSMRE, Denver began work on a pilot project and database called the “Powder River Coal Company GIS/GPS Utilization For Bond Release” for NARM and Caballo Mine which was completed in January, 2005. During the initial stages of the project, OSM-TIPS provided training to the LQD staff and industry. Later, OSM, PRCC, and LQD designed a database for electronic permit data GIS software, along with GPS mobile computing hardware and software for tracking reclamation and bond release status of mine lands. LQD staff in Cheyenne continued working on NARM database, verifying and completing the structure of the “Bond Release Geodatabase” (Calle and Krzyszowska-Waitkus, 2006), and collecting initial field verification data.

The Phase I Partial Incremental Bond Release for 781 ha was completed October 2009. Initially a combination of GPS and GIS applications utilized two geodatabases: an Inspection Geodatabase (Krzyszowska-Waitkus and Calle, 2008) and a Bond Release Geodatabase. Later, it was decided to combine the two into one geodatabase for bond verification and bond release purposes.

Geodatabase structure

The bond release and verification geodatabase uses tables and spatial data to track approved bond release packages and verify performance standards and/or specific commitments for each reclamation area in the mine. Feature classes that are related by the type of compliance function they support are organized using a feature dataset. The following feature datasets were chosen

during the construction of the geodatabase: Approved Bond Release; Compliance Inspection; Existing Topography; Hydrology; Phase 1 Verification; Phase 2 Verification; and Phase 3 Verification.

Each dataset contains specific feature classes chosen on the basis of regulatory requirements (Wyoming Environmental Quality Act, Coal Rules and Regulations, WDEQ, LQD, Guideline Nos. 21, 22), and permit commitments. All feature classes in the thematic layer were spatially defined as a point, line, or polygon. Datasets and appropriate feature classes of the geodatabase are presented in Table 2. All feature classes have an extension described by the word “Approved” and the year, e.g. Approved_2010.

Attribute fields, including domains and attribute tables, were chosen to track associated compliance information for the specific feature classes to facilitate data entry and provide consistency (Krzyszowska-Waitkus and Calle, 2008). Domains included the list (text) and range (numeric) of acceptable values for attribute fields. For example, domains for rough backfill area compliance were chosen as acceptable or not acceptable (Table 3). The domain of the compliance status in regards to backfilled area was chosen by an inspector. It was decided that it would be acceptable when an area was graded to PMT’s and when erosion features did not affect slope stability. The domain for attribute fields for the other feature classes were developed using a similar methodology.

In addition to the NARM verification and bond release geodatabase, other file folders were created to help organize incoming/requested information, transfer data, reviews, and storage of processed and approved data. The structure of additional file folders evolved through time. The following file folders were chosen to support the geodatabase: Archive Geodatabase; Document Hotlink; Bond Working Progress; GeoRef Map Scans; Imagery; Monthly Inspections ArcPad; NARM Shared GIS Files; Sent to NARM from LQD; Sent to LQD from NARM; Verification Topsoil Depth (Inspection); Verification Graded Backfilled (Inspection), and Working Export Items.

Table 2. Datasets and appropriate feature classes of the geodatabase (approved in 2010).

Data set	Feature classes
Approved_Bond_Release	Phase_1_Partial_Incremental_Approved_2010 Phase_2_Partial_Incremental_Approved Phase_3_Partial_Incremental_Approved
Compliance_Inspection	ASCM; Culverts: Erosion_Feature_Ln; Erosion_Point; Generic_line; Generic_Point; Groundwater_Monitoring; Impoundments; Other_Compliance; Photo_pit; Rough_Graded_Quality_Compliance; Stream_Channel_Reconstruction_Compliance; Surface_monitoring; Topsoil_Depth_Compliance; TSP; Wildlife_Feature
Existing_Topography	Existing_Topography
Hydrology	Ponds; Postimine_Drainage_Basin; Streams
Phase_1_Verifications	Drainage_System_Functionality_Approved_2010; LQD_Historical_Rough_Backfill_Verification Quality_Backfill_Approved_2010 Rough_Backfill_Approved_2010 Stream_Channel_Reconstruction_Approved_2010 Topsoil_Depth_Approved_2010
Phase_2_Verifications	Sediment_Control_Release_Approved_2008 Vegetation_Establishment_Approved
Phase_3_Verifications	Final_Impoundment_Renovation; Groundwater_Approved; Landuse; Mitigation_Wetlands_Approved; Pond_Removal_Approved Roads_Approved; Shrub_Establishment_Approved; Structures; Surfacewater; Tree_Replacement; Vegetation_Approved; Wildlife_Habitat_Features_Approved

Two of the file folders titled “Document Hotlink” and “Archive geodatabase” mirrored the structure of the geodatabase. All approval documents with dates and signatures as well as photos (related to the mining and reclamation progress and erosion) were stored in this Document Hotlink folder. The Archive geodatabase was used to store feature classes that were replaced with the revised and approved feature classes. The operator submits specific feature classes with the word “Requested” and they are stored in one of the supporting file folders until after reviews are completed, then they are treated as “Approved” and added to the geodatabase.

Table 3. Attribute table of rough backfill areas

Attribute field name	Data type	Domain	Comments
Polygon ID	text		Unique identifier used to reference the feature
Acreage	number		
Inspection date	date	Calendar	Records of the most recent inspection
Inspector name	text	Inspector names	Choose the inspector name
Backfill grading	text	Acceptable Not acceptable	Described if grading is acceptable to the post mine topography and if erosion is present
Compliance date	date	Calendar	Scheduled date of correction
LQD Approval date	date	Calendar	Records date of the approval
Comments	text		
Document Hotlink	text		Approval document located in the Document Hotlinks database

Geodatabase function

The geodatabase function will be illustrated in this paper by describing the process for Phase 1 partial incremental bond release of all requirements. All information needed for the verification of the Phase 1 Partial bond release requirements such as the verification of areas backfilled and graded, topsoil depth application, stream channel reconstruction and drainage system functionality (Table 1) were requested through the 2007-2008 Annual Report. This information was submitted by the operator electronically and was stored in one of the supporting file folders (with all feature classes described as requested). The LQD was requested to verify 240.8 ha that were backfilled and graded. Requested areas were compared using ArcMap and the approved PMT's with areas that were previously verified, and also with other feature classes such as Topsoil Stockpiles. It was found that one of the requested areas contained a topsoil stockpile located on a native area. As a result, 16.3 ha were removed from the request.

All requested backfill and graded areas were verified in the field during monthly inspections using ESRI ArcPad 7.1 mobile GIS software operating on handheld GPS units. Information collected during the field inspection was stored as the "Rough_Backfill_Requested" feature class under the dataset called "Phase_1_Verification". Requirements of the inspected backfilled

graded areas included the verification of the slopes, stability, and functionality described by various attribute field name and relative domains (Table 3). All requested areas, after field verifications, were approved and stored in the geodatabase (Rough_Backfill_Approved_2009).

Another requirement for the verification of Phase 1 bond release included the verification of topsoil depth application. This feature class was stored in the “Compliance_ Inspection” dataset (Table 2). Attribute fields included: topsoil depth compliance, topsoil compliance date, erosion compliance and erosion compliance date (Krzyszowska-Waitkus and Calle, 2008). When the request for approval of topsoil depth verification areas was submitted through the 2007-2008 Annual Report, the requested topsoiled polygon feature class covering 266 ha was compared with the 164 ha approved topsoiled polygons and with topsoil sites that were verified (drilled with an auger) in the field. While comparing the requested topsoiled polygons with the polygons verified in the field it was found that an additional verification of 102 ha was needed (Fig. 1). The LQD requested that the operator verify topsoil depth on the additional areas at a density of one hole for every 8-16 ha.

The remaining requirements for the requested verification of Phase 1 bond release included the field verification of stream channel reconstruction and drainage system functionality. When these field verifications were completed and approved, the previously approved feature classes, in the geodatabase, were updated.

In addition to the areas being requested for one of the various verification categories, the geodatabase is also used to track areas that had been previously verified, but have since been redisturbed by new activity. For example, if an area is approved for topsoil depth verification one year, but the next year the area has a road established through it which required the removal of the topsoil, this area would be included in the next round of verification requests but would be labeled as “Redisturbed” in the Comments field. Upon the approval of the verification package, this area would then be deleted from the geodatabase feature class for soil depth verification. With changes like this example happening every year, the geodatabase has proven invaluable in the tracking of these lands.

All feature classes requested for the verification of Phase 1 bond release requirements after “office” and “field” verification were updated and stored in the Phase 1 Verification dataset with the extension “Approved”. All approval documents with dates and a signature were scanned and

inserted into the Documents Hotlink folder. All attribute tables of every feature class include a “Document Hotlink” field that was linked to the approval documents.

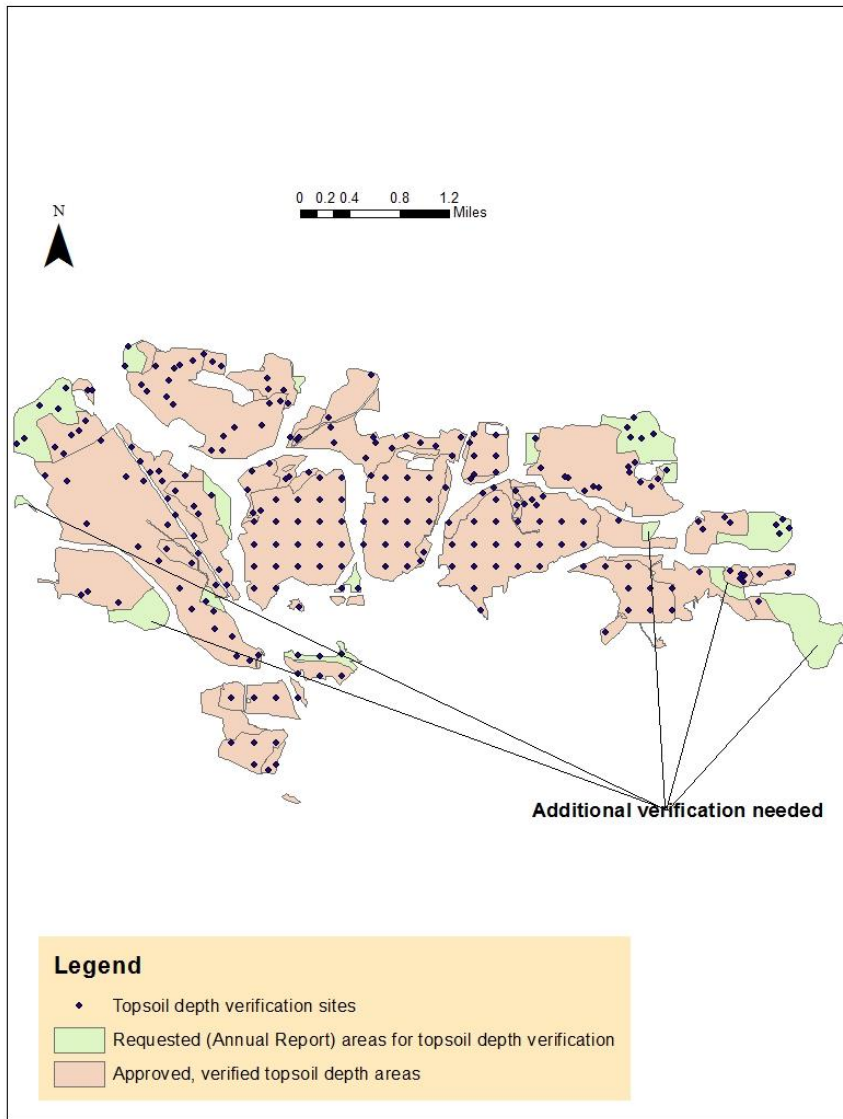


Figure 1 Comparing approved and requested areas for topsoil depth verification.

All feature classes stored in the "Compliance inspection" dataset were created as an ArcPad project in ArcMap using the ArcPad tools and exported to the Trimble GeoXM GPS unit via a desktop synchronization. All Geodatabase attribute fields and domains were supported in the ArcPad project. During a field editing session the user was prompted for all required attributes and limited to acceptable data values, in an easy-to-use data collection form that includes drop-down data entry capabilities defined by created domains. In this way complete and consistent data capture was preserved. All edits and new features were "checked" using ArcMap and

ArcPad tools through a desktop synchronization. Through this process, the geodatabase was updated to include the collected features and edits (Krzyszowska-Waitkus and Calle, 2008). When the operator submitted a Phase 1 partial bond release package, all required performance standards that were verified in the field were stored in the geodatabase with hot links to the approval letters ready to be used to approve the package in a timely manner.

A system for the exchange of information between the LQD and the operator for sending, verifying, and approving feature classes of the geodatabase has been developed. Bond verification/bond release geodatabase procedures were developed and a manual was prepared by the operator. This improved the efficiency of LQD reviews and has the potential to shorten the time for the bond release approvals.

Conclusions

GIS and GPS mobile computing technology proved to be an efficient and time-saving means of tracking all phases of the bond release process. The geodatabase simplified field data collection, organization, and tracking of bond release information. It enabled the spatial presentation of information and supported technical and scientific applications necessary for bond release decisions. The use of GPS techniques support the verification and tracking of compliance features required for various phases of bond release. The use of GPS enhanced the inspector/coordinator's ability to identify, inventory and track necessary components required for bond release verification. For NARM, the geodatabase accurately verified bond release compliance for:

- 2 502 ha of area backfilled to the post mine topography
- 2 079 ha of area topsoiled to the approved topsoil depth
- 1 350 ha of stream channel reconstruction and drainage system functionality
- 35.2 ha of sediment control release

The use of ArcMap maps and Excel attribute tables in the geodatabase streamlined preparation of the inspection report. The time needed to prepare an inspection report was reduced by approximately 2/3. Compliance information stored in the geodatabase also improved communication between the regulator, operator, and federal agencies. The geodatabase accelerated the process of compliance assessment by documenting the locations and circumstances of incidents. The WDEQ/LQD recommends the geodatabase for future bond release applications for large coal mines.

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