STATE OF NEW MEXICO
BEFORE THE WATER QUALITY CONTROL COMMISSION

In the Matter of:	)	
	)	
PROPOSED AMENDMENT TO 20.6.2 NMAC (Copper Rule)	)	**No. WQCC 12-01(R)**

EXHIBIT SHELLEY – 6

U.S. Department of Labor
Mine Safety and Health Administration

ENGINEERING AND DESIGN MANUAL

COAL REFUSE DISPOSAL FACILITIES

Second Edition
May 2009

NOTE: Instructions for using this DVD version of the Manual are provided on the next page

MSHA
Mine Safety and Health Administration

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amount of runoff, the design storm criteria for the impoundment may need to be applied to the ditch design in order to protect the embankment from erosion during a severe flood.

5.6.2 Open-Channel Spillway Performance Considerations

Many impoundments are designed such that the reservoir storage capacity and decant system discharge capacity provide for design storm runoff management, but sometimes a separate open-channel spillway is also required. These should be designed with a capacity that will allow routing of the design storm flow through the impoundment while maintaining adequate freeboard. Open-channel spillways are less commonly employed at refuse disposal embankments because of staged development. The following should be considered in the design of open-channel spillways:

- Hydraulic capacity (head versus discharge capacity) and minimum freeboard for the approach channel, control section, and discharge channel or conduit so that sufficient capacity is available for releases up to the design peak outflow. Measures to control floating debris or hillside trees that could cause obstructions may be required at the approach channel.
- Channel geometry, including considerations for transition sections (e.g., contraction section), changes in alignment (e.g., super-elevation at bends), and grade (e.g., sufficient capacity for hydraulic jumps).
- Stable channel conditions, considering excavation slopes as well as potential for erosion due to water flow associated with velocity/tractive force/duration on the channel lining. Channel linings require suitable foundation and drainage systems and should be designed for tractive and uplift forces.
- Energy dissipation structures at the spillway outlet.

If large-diameter conduits are used in conjunction with open channels or in place of an open channel, material selection, inlet design, alignment and grade, backfill, seepage control, and outlet design issues are similar to those for decant systems.

5.7 SURFACE DRAINAGE CONTROLS

Surface drainage controls at coal refuse disposal embankments typically consist of drainage ditches and channels, bench and haul road gutters, and culverts that collect and convey runoff to downstream structures.

5.7.1 Permanent Drainage Controls

Permanent drainage controls are structures that will be in service during operation of the disposal facility and following reclamation and abandonment of the facility. These structures should be designed for the 100-year-recurrence-interval storm. Typically, the 100-year, 24-hour-duration storm is used for design, consistent with state regulatory criteria.

The design of permanent drainage controls should be based upon the following considerations:

- Hydraulic capacity considering the peak discharge rate from the design storm for the contributing drainage area.
- Channel geometry, including accommodation for transition sections and changes in alignment (e.g., super-elevation at bends) and grade (e.g., additional capacity for hydraulic jumps in subcritical flow sections).
- Stable channel conditions, considering flow velocity/tractive force/uplift/duration for the channel lining, if the channel is not excavated in competent rock.
- Energy dissipation structures at channel outfalls.

5.7.2 Temporary Drainage Controls

Temporary drainage channels function periodically during operation, but are not part of the long-term surface water controls related to reclamation and abandonment. These may include temporary ditches for diversion or runoff collection within the disposal facility, bench and haul road gutters (before topsoil placement and reclamation), and most culverts. Temporary ditches and culverts may be designed with a hydraulic capacity lower than for permanent drainage controls, because of shorter service life and other criteria. For instance, state regulations or recommendations for some drainage structures may specify a 10- or 25-year-recurrence-interval storm. Temporary ditches may be designed without linings provided that: (1) their service life is relatively short and potential erosion damage can be readily repaired and (2) lack of linings will not cause adverse impacts to the safety of the disposal facility or compromise downstream sedimentation controls.

5.8 INSTRUMENTATION AND PERFORMANCE MONITORING

Instrumentation is typically a component of coal refuse disposal plans and is recommended for all high or significant-hazard-potential sites. Instrumentation records should be reviewed as they are accumulated. The data are best evaluated by maintaining a continuous plot of the readings versus time. The data should be reviewed as part of annual inspections and certifications and should be maintained for the life of the facility. The data review provides a basis for: (1) assessment of facility performance relative to design intentions, (2) detection of trends and problems that may develop, and (3) operational plan modification or facility expansion. Design plans should indicate maximum acceptable levels for instrument readings or percentage changes that trigger further investigation or actions. Facility performance will typically be enhanced by monitoring the parameters discussed in the following paragraphs with appropriate instrumentation:

5.8.1 Seepage

Seepage from the impoundment should be monitored for flow rate and changes in appearance (discoloration or appearance of fine particulates and precipitates). This monitoring should include seepage through the embankment, through internal drainage structures, and through underground mines that receive seepage from the impoundment. Weirs should be installed, preferably with a staff gauge in the weir approach pool, so that flow rates can be easily and accurately measured. To evaluate changes in seepage rates, it is important to know the impoundment pool level and to have data pertaining to rainfall and groundwater levels, so that possible correlations can be evaluated.

5.8.2 Piezometric Levels

Saturation levels and water pressures within an impounding embankment or embankment foundation, as well as within any earthen barriers, should be monitored and recorded to determine whether hydrostatic pressures are within design limits and whether changes or trends are reasonable. Selection of the type of piezometer and installation location is based on site-specific requirements and the potential for rapid or sudden changes in pore water pressure (as may occur upstream of construction areas). Open standpipe piezometers provide direct measurement of groundwater levels, while vibrating-wire and pneumatic piezometers allow for monitoring of phreatic conditions in fine-grained deposits where rapid changes in pore pressure may be important. A table indicating maximum allowable readings for piezometers should be included with the design report.

5.8.3 Pool Levels

Records for the pool level in the impoundment should be maintained for freeboard monitoring and for determining correlations between piezometric levels and seepage quantities. Pool level can be monitored by installation and reading of staff gauges. When water in nearby mine workings has the potential to affect an impoundment or may indicate the performance of a barrier, the mine pool level should be monitored.

5.8.4 Rainfall Data

A rain gauge installed near the disposal site can provide site-specific precipitation data for correlations with piezometric levels and seepage quantities, and these data may be essential in situations where there is breakthrough potential and where discharges from a mine are related to seepage from an impoundment. Rainfall data should be routinely collected and recorded so that changes in seepage, mine discharge, or water level data can be correlated to rainfall infiltration/runoff.

5.8.5 Deformation or Movement

Where significant embankment settlement can occur or there is a potential for subsidence in the vicinity of an impoundment, movements should be monitored and recorded. Monitoring of the slopes and crest of an impounding embankment should be conducted at regular intervals during both operating and dormant phases for evaluating performance and for demonstrating conformance with flood routing assumptions. When subsidence is a concern, both horizontal and vertical movements should be measured. Movements should also be monitored if evidence of slope displacement is detected. In situations where deformation is occurring, the rate of movement, and especially any acceleration of the rate, provides valuable information for assessing its significance. Methods for monitoring surface deformation include survey monuments and extensometers. Movements below the ground surface can be monitored with inclinometers and extensometers. These types of instruments are discussed in more detail in Chapter 13.

5.9 RECLAMATION, ABANDONMENT AND POST-MINING LAND USE

A coal refuse disposal plan should address reclamation, abandonment and post-mining land use requirements.

General provisions for and plans related to abandonment of a coal refuse embankment are part of the final operational stage of the disposal facility and should address elimination of the impoundment, unless the impoundment is a component of planned post-mining land use. Reclamation should incorporate the following provisions:

- Stockpiles of soil and topsoil for reclamation should be located near the facility on stable ground and within sedimentation controls.
- Reclamation materials should meet the growth medium and nutrient requirements of the vegetation plan. Topsoil amendments and alternatives may be necessary.
- To protect against erosion and sedimentation and potentially negative environmental impacts, surface drainage and infiltration should be controlled.

Elimination of impoundments should address the following:

- Regrading of the impounding embankment and backfilling of the impoundment should be performed in a manner such that proper surface drainage is established and the fine coal refuse is stabilized. Final backfill elevations should facilitate drainage and accommodate settlement of the fine refuse that will occur over time.
- During the final periods of disposal and progressive elimination of the impoundment capacity, the outlet works such as the decant structure or spillway should remain operational until impoundment regrading is complete.
- Decant systems should generally be sealed by grouting.

Post-mining land use will affect the reclamation plan, particularly if existing structures such as the impoundment or ponds are to be retained.

important to the development and operation of a disposal facility and should generally be designed for the 100-year storm. Design criteria for these structures may also be governed by state or local regulations. Table 9.6 provides a summary of typical design criteria for minor hydraulic structures at locations that are not part of the coal refuse disposal facility. These structures typically include storm sewers, culverts, drainage ditches and gutters.

9.6 DETERMINATION OF RUNOFF QUANTITIES

The most important aspects of hydrologic analyses related to refuse disposal facility performance during and after storm rainfalls are the determination of the peak runoff rate and the total runoff volume at the point of interest. Four methods for determining these parameters that are available to the designer are presented in Table 9.7. The first three methods presented in the table are discussed in this section following a general discussion of basic hydrology parameters.

9.6.1 Basic Hydrology Parameters

There are three basic factors that must be considered when predicting runoff rates and quantities. These are: (1) precipitation (intensity and duration), (2) watershed (size and time of concentration), and (3) soil types and land use conditions. These factors are further explained in the following subsections.

9.6.1.1 Precipitation Intensity-Duration and Distribution

Storms are defined by their precipitation intensity-duration relationships. Storms can range from high-intensity, short-duration thunderstorms to low-intensity, long-duration rainfalls lasting several days. The intensity-duration relationship that should be used for hydrologic analyses and channel design is that which produces the maximum peak runoff rate. This is particularly true for the small watersheds common to coal refuse facilities where the time of concentration (time required for rainfall to travel from the most hydrologically distant point in the watershed to the point of interest) is

TABLE 9.6 TYPICAL DESIGN CRITERIA FOR MINOR HYDRAULIC STRUCTURES(1)

Structure Type and Condition	Design Criteria
Storm Sewers	10-year rainfall
Diversion Systems	
Temporary (1-year life or less and watershed > 5 acres)	
Construction areas, roads, pipelines	2-year rainfall
Permanent	
Sediment Retention Structures (watershed <100 acres and height < 15 feet):	10-year rainfall
Emergency spillway capacity	25-year, 24-hour rainfall
Principal spillway capacity	10-year, 24-hour rainfall
Culverts:	
Access Roads and Drainage Swales	10-year, 24-hour rainfall
Local and Urban Roads	25-year, 24-hour rainfall
Highways and Streams	100-year, 24-hour rainfall
Drainage Ditches and Gutters	10-year rainfall

Note: 1. These criteria do not apply to minor structures on coal refuse disposal facilities. Permanent perimeter ditches and bench gutters on coal refuse disposal facilities should be designed for the 100-year storm.