# Chapter 4

# PROJECT PLANNING

Planning for a coal refuse disposal facility should be integrated with overall mine development and operation plans. Procedures for the planning and design of safe, environmentally acceptable and economical refuse disposal facilities are stressed throughout this and subsequent chapters of this Manual. This chapter presents important planning and design sequences and procedures that can be employed to optimize refuse disposal operations. Topics covered include:

- Unique aspects of refuse disposal
- Operations and site-related considerations
- Sustainable mining practices
- Economic considerations
- Environmental and regulatory considerations
- Planning sequence
- Design sequence

Understanding these topics is essential to the design and construction of a refuse disposal facility that imposes minimal restraints on the production of coal, assures the safety of miners and the surrounding public, and protects the environment. A refuse facility that meets these goals ultimately optimizes control of the overall cost of mining operation.

## 4.1 UNIQUE ASPECTS OF REFUSE DISPOSAL

The disposal of coal refuse materials from preparation to transport and placement imposes problems that are similar in many ways to more routine types of civil or mining construction projects. However, some aspects of refuse disposal may provide opportunities for optimization as follows:

- Dissimilar refuse materials are continually generated. These include: (1) coarse refuse in solid form, (2) fine refuse in slurry or dewatered sludge form, and (3) for some sites, combined coarse and fine refuse. The characteristics and quantities of coal refuse may change over time due to changes in geology, production, mining methods, and coal preparation. Anticipating these changes in advance provides an opportunity to develop a cost-effective disposal plan.

- Refuse materials can be disposed in a manner that allows for post-mining land use that can enhance the future value of the property.
- Coarse refuse, at times supplemented with amounts of borrowed soil and rock materials, may be used to develop the structural capability to retain less carefully placed or slurried refuse. In some instances, amendments such as industrial by-products containing lime to address acid generation within the refuse are necessary and these amendments can make up a significant percentage of the material placed.
- Co-disposal of coal combustion waste (fly ash and bottom ash) with coal refuse may be an effective contracting strategy or necessity for the mine, and this waste can be used as an amendment to benefit the refuse disposal facility. Combustion waste can be a significant percentage of the material placed and, like amendments, can alter embankment material properties.
- A disposal facility may be adapted to serve other operating requirements, such as the recovery of clarified water for return to the preparation plant.
- Short- or long-term water impoundments may be created behind properly constructed refuse embankments.
- Some structural or hydraulic features must be adaptable to modification as the facility grows in size and shape over its service life.
- Transport methods and equipment may change as the facility grows horizontally and vertically.
- Technological advancements, market demands and regulation changes may occur within the service life of the facility.
- Final portions of coarse refuse from normal operations, rather than borrow material, may be used to make the completed facility structurally safe and environmentally acceptable for abandonment.
- Portions of refuse, properly mixed with appropriate amendments, may be used to facilitate planting on a completed portion of the facility when reclamation soils are scarce.

A major factor in many of the above items is the abundance of refuse material available for construction, at little or no added cost. Proper planning must be employed to take advantage of the favorable characteristics of refuse and to minimize the need for using more costly borrow soil and rock and specially purchased construction materials.

## 4.2 OPERATIONS AND SITE-RELATED FACTORS

Each mine has characteristics that uniquely affect overall coal production and processing operations. Proper planning on a site-by-site basis will assure that processing and refuse disposal procedures that best suit the mining operation are established. It is possible, however, to develop a list of considerations for the planning of practically all refuse disposal facilities, corresponding to elements of federal and state permitting requirements. The length of this list and its subject breadth illustrates the importance of meaningful coordination between management, operating personnel and the design/permitting team. These factors can be grouped into two categories, as follows:

**Factors Primarily Related to Disposal**

- Capacity, number and location of potential disposal areas at the site.
- General topographical, soils, geologic, seismological, hydrologic and cultural char-


< PREVIOUS VIEW

acteristics of the site. Cultural characteristics may include buildings, infrastructure (such as roadways, pipelines, power lines, etc.), and cemeteries.

- Environmental and ecological conditions at the site, including surface water, groundwater, wetlands, wildlife and plant species.
- Mining (past, current, or potential future), oil and gas development, and other natural resources at the site. Analyzing the potential impacts from active or abandoned underground mines that may underlie a refuse site is of utmost importance. Previous site development and refuse disposal activities should be identified.
- Capital requirements for initiating disposal at each disposal area.
- Operating and maintenance costs at each disposal area.
- The relationship between the capacity of each disposal area and its distance from the preparation plant.
- Proximity of population centers and residences.
- Current property boundaries and land availability.
- Land-use practices within and in adjacent areas and post-mining land-use considerations.
- Contingencies for unexpected conditions (i.e., changes in mine life resulting in changes to the final embankment configuration and abandonment provisions).

**Factors Primarily Related to Overall Operations**

- Public relations.
- Source of coal and type of mining.
- Extent of preparation of coarse and fine refuse.
- Production rates of coarse and fine refuse and their reliability.
- Changes in geologic conditions as the mine advances.
- Anticipated life of the mine.
- Geochemical characteristics of coarse and fine refuse.
- Water requirements for the preparation process.
- Modifications needed to meet future market demands and regulation requirements.
- Available and preferred materials handling equipment.
- Flexibility in location of preparation plant.
- Required infrastructure (roads, portals, slopes, shafts, conveyor beltlines, railroads, etc.) during the life of the mine.
- Additional materials generated at the mine by other operations or by nearby construction projects (site developments, power plants, etc.) that might provide economic value and be beneficial when combined with the disposed refuse.
- Water treatment facilities required for operation or environmental control.
- Corporate policy on capital expenditures versus operating costs.

Data relative to each of the above factors can be obtained through preliminary investigations and discussions with appropriate mine personnel. This information can then be used to formulate specific studies leading to refinement of the project plan, performance of site-selection studies, and initial design. As discussed in Sections 4.6 and 4.7, the designer must coordinate closely with the operating staff during the early project stages and must incorporate environmental, permitting and regulatory requirements into the facility planning.

## 4.3 SUSTAINABLE MINING PRACTICES

Sustainable mining practices have evolved into management of natural resource development in a manner compatible with the environment and the needs of the community in which mining plays a significant role. By practicing sustainable development, mining companies can improve their access to land and markets, as well as enhance their reputations and value, and thus promote the coal industry. Yearly (2003) cites the following three tenets for sustainable mining:

- Integrated approaches to decision making on a full, life-cycle basis that satisfy obligations to shareholders and that are balanced and supported by sound science and social, environmental and economic analysis within a framework of good governance.
- Consideration of the needs of current and future generations.
- Establishment of meaningful relationships with key constituencies based on mutual trust and a desire for mutually beneficial outcomes, including those inevitable situations that require informed trade-offs.

Inherent in sustainable development is: (1) the commitment to implement effective planning and design practices and (2) the need for research and development leading to improved methods for harnessing natural resources with minimal impacts on the environment. Government regulation creates the framework for protecting the environment from impacts, although it is the mining professionals who are responsible for establishing the plans and designs that accomplish the mining operations in a sustainable manner. This may require the involvement of a diverse professional community. Sustainable mining goals established for engineers and leaders in the mining industry and detailed in the Milos Statement from the International Conference on Sustainable Development Indicators in the Mineral Industries held in Milos, Greece are discussed in Karmis (2003).

Project planning for coal refuse disposal should be integrated with overall development and operations planning for mining activities. In the following paragraphs, economic, environmental and regulatory considerations are addressed, along with planning and design sequence.

## 4.4 ECONOMIC CONSIDERATIONS

To achieve the desired optimum solution, economic factors must be considered during all phases of disposal facility planning, design and implementation. Major economic decisions are required for: (1) selecting the disposal facility site, (2) selecting the materials handling systems, and (3) for planning the entire sequence of disposal operations from initiation through abandonment. The expenditures required are usually classified as:

- Capital costs
- Operation and maintenance costs
- Reclamation (abandonment) costs
- Potential long-term liability costs

The determination of these costs is part of the planning process and influences the design, permitting and site operations. Periodic updates of estimated costs should be part of the planning and design process. Disposal facility planning and design should be keyed to the financial requirements of the mine, so that cash projections cover the costs associated with operating and maintaining the disposal facility. Carefully planned investment during initial phases of site development and selection of disposal facility configurations can have a major beneficial effect on subsequent operating and reclamation (abandonment) costs.

Table 4.1 presents a general breakdown of various cost components associated with planning, design, and implementation of a coal refuse disposal facility. These components are provided as a general guideline for developing costs. Specific site conditions and operational requirements may introduce other elements not reflected in the table.

### TABLE 4.1 COAL REFUSE DISPOSAL FACILITY COST COMPONENTS

**I. Capital Cost**

Property Acquisition

Permitting and Planning

Engineering and Design

Site Development

- Access Roads
- Wetlands and Stream Mitigation
- Site Preparation
- Perimeter and Diversion Ditches
- Liner and Underdrain System Decant Installation
- Mine/Entry Stabilization or Protection
- Refuse Transport and Handling System
- Erosion and Sedimentation Control
- Amendment Transport and Handling System
- Starter Embankment
- Internal Drainage System
- Decant Installation
- Spillway Construction

**II. Operating Cost**

Equipment Operations

- Refuse Transport (haulage & pumping systems)
- Refuse Placement and Compaction

Facility Construction

- Site Preparation for Facility Expansion
- Perimeter and Diversion Ditch Extension
- Mine/Entry Stabilization or Protection
- Liner and Underdrain System Extension
- Amendment Materials
- Haul/Access Roads and Surfacing
- Internal Drains Installed in Stages
- Decant Pipe Extension and Capping
- Spillway Extension
- Survey Control

Maintenance

- Erosion and Sediment Control
- Haul/Access Roads and Surfacing
- Liner and Ditch Repairs

Regulatory Compliance and Reporting

- Site Inspections and Testing
- Monthly, Quarterly, and Annual Reporting

**III. Reclamation Costs**

Engineering/Permitting Oversight

Facility Construction

- Impoundment Backfilling and Stabilization
- Site Grading
- Cap/Soil and Topsoil Placement
- Revegetation

**IV. Potential Long-Term Liability Costs**

Acid Mine Drainage Treatment

Mine Discharge

Erosion and Sedimentation Control

Revegetation

## 4.5 ENVIRONMENTAL AND REGULATORY CONSIDERATIONS

Environmental and regulatory considerations should be incorporated into the planning process, and can be defined steps performed as part of, or in advance of, the permitting of the coal refuse disposal facility with state and federal agencies. These considerations are addressed jointly, because frequently the method for addressing environmental issues may be directed by regulatory guidance or law. Primary federal statutes and regulations include the Federal Mine Safety and Health Act (1977) and the Surface Mining and Reclamation Act of 1977 (SMCRA), as well as more widely applicable statutes and regulations such as the Clean Air Act and Clean Water Act. SMCRA established the Office of Surface Mining (OSM) with authority to implement a national program to regulate surface effects resulting from coal mining. State regulatory programs and agencies may take on this responsibility, if approved by the OSM, which will remain in an oversight role. For the states that take on this responsibility, most of the regulatory requirements of their programs are similar to the OSM regulations found in 30 CFR Chapter VII. In response to local concerns and conditions, some state programs have requirements that are more extensive than the federal rules. Additionally, some state agencies responsible for other programs, such as dam safety, impose requirements for coal refuse disposal facilities. Designers should contact state regulatory agencies to obtain current information on their regulatory programs and requirements.

Environmental issues at some sites can require significant time and effort to address, affecting the entire regulatory approval process. This section discusses environmental and regulatory considerations in the planning process, and the engineering and design of specific containment structures at disposal facility sites are discussed in subsequent chapters of this Manual. However, the state and federal permitting process, including environmental impact studies and mitigation requirements, is left for other publications. Because state regulatory input shapes many of the decisions associated with planning and design of a refuse disposal facility, contact with these agencies and review of their publications is essential.

Some specific environmental and regulatory factors that influence the planning and design of coal refuse disposal facilities include the following:

- Site selection process and permitting submittals prior to facility design. Some states require a rigorous process for site selection as part of permitting new coal refuse disposal facilities or the expansion of existing facilities.
- Facility configuration (slopes, benches, crest width, etc.). Federal and state regulations include specific requirements for some facility parameters, either as part of mining, coal refuse disposal, or dam permitting guidance.
- Erosion and sedimentation and stormwater control structures. State regulations and some local (municipal) entities provide specific guidance for meeting erosion and sedimentation control and stormwater requirements.
- Liners for containment of refuse materials. Some state regulations provide guidance for liners for refuse disposal facilities.
- Amendments for neutralization of refuse materials. State regulations provide guidance for acid neutralization of refuse materials.
- Wetlands and stream encroachments. Federal and state regulations provide guidance for addressing wetlands and stream encroachments, including mitigation requirements where necessary.
- Prime farmlands. State regulations provide guidance for addressing the presence of prime farmlands near proposed refuse facilities and include mitigation measures where necessary.

## 4.6 PLANNING SEQUENCE

Table 4.2 shows a typical sequence of events involved in the planning, design, operation and abandonment of coal refuse disposal facilities. Site-specific factors and the specific objectives of persons collectively involved in the process may preclude direct application of the indicated sequence. However, proceeding generally in the manner shown should aid in the design, permitting and construction of a coal refuse disposal facility. Particular notation is made of the following items:

- Continuing interaction between operations/mine personnel and the designer is shown. The important relationship between coal production and refuse disposal dictates this cooperation, if mine operation and facility construction are to proceed optimally.
- Interaction between the designers and the regulatory agencies relative to site selection and design elements is shown. This interaction will allow identification of special regional or site-specific concerns, methods to address concerns, and will generally facilitate the permitting process.
- Engineering should be an integral part of disposal operations, as well as construction monitoring and inspections, particularly on complex, long-term projects. Involvement of the designer, or engineering personnel thoroughly familiar with the design requirements, allows review of performance information relative to design parameters and identification of needed adjustments.
- The next to the last step (XI) in Table 4.2 is periodic review of mine operations and the disposal facility development. Regardless of the accuracy of initial planning, the typically long active period of use of a disposal facility makes it likely that unanticipated changes to the original design will occur. Periodic review of the effects of these changes must be performed so that continued safe, economical and environmentally acceptable refuse disposal can be achieved.

## 4.7 DESIGN SEQUENCE

The design sequence presented in Table 4.3 details the technical aspects of the total planning-implementation process for disposal facility development in a safe and environmentally acceptable manner. The primary design emphasis occurs during the third to seventh steps of the planning sequence in Table 4.2. The elements of coal refuse disposal facility design and their general interrelationship are presented in Chapter 5. Subsequent chapters of this Manual present detailed technical information and procedures related to completion of facility design.

Table 4.3 presents a typical sequence of design steps and provides a checklist of the most important items requiring consideration for a typical refuse disposal project. Reference is made in the table to sections of the Manual where additional detailed discussion is presented.

The items in Table 4.3 may not be totally applicable in all instances. In the case of small facilities, a very detailed study may not be appropriate, and portions of the investigation and analyses can possibly be eliminated by simply using conservative design assumptions. On the other hand, conditions may be present at other sites that require studies beyond those identified in Table 4.3. The existence of such special conditions can only be determined by an experienced designer through careful study of site conditions.

Item VIII in Table 4.3 summarizes the deliverable products of the design sequence, including the design report and preparation of facility plans and specifications. General guidance on the content of these documents is presented in Chapter 11; however, site-specific issues may require elements not identified in the table.

TABLE 4.2 PLANNING STEPS FOR COAL REFUSE DISPOSAL FACILITY DESIGN

| | Planning Steps | Participants | Regulatory Involvement |
|---|---|---|---|
| I | Gather and Evaluate Mine Development and Disposal Information | Management<br>Operations<br>Engineering | No |
| II | Perform Initial Siting Studies, Develop Disposal Concepts and Conduct Alternatives Analyses for Potential Sites | Operations<br>Engineering | Yes |
| III | Perform Detailed Investigations and Prepare Preliminary Design | Engineering | No |
| IV | Modify to Best Suit Operations and Evaluate Development Costs | Operations<br>Engineering | No |
| V | Confirm Preliminary Design Assumptions and Regulatory Criteria | Management<br>Operations<br>Engineering | Yes |
| VI | Finalize Plans, Specifications and Permit Documents; Refine Development Costs | Engineering | No |
| VII | Final Approval | Management<br>Operations<br>Engineering | Yes |
| VIII | Implement Site Development | Operations<br>Engineering | Yes |
| IX | Conduct Disposal Operations | Operations<br>Engineering | No |
| X | Construction Monitoring, Maintenance | Operations<br>Engineering | No |
| XI | Periodic Inspections and Review of Operations | Management<br>Operations<br>Engineering | Yes |
| XII | Abandonment and Reclamation | Operations<br>Engineering | Yes |

Preparation of a design report is suggested for all facilities, regardless of the required extent of investigation and analyses. This report: (1) provides the opportunity for all parties (designer, operator and regulatory groups) to understand design assumptions and limitations, (2) provides the opportunity for the designer to clearly state validating design assumptions during the construction or operations phases, and (3) helps to avoid confusion or misunderstanding between the designer, operator and regulatory groups.

Clear and accurate plans and specifications are essential for operations personnel to properly construct and develop a disposal facility and for the operator's quality control representatives to verify that all details are completed correctly. Accurate plans and specifications minimize the potential for misunderstandings that could cause schedule delays during the review period and during construction. General guidance for the content of refuse facility plans and specifications is presented in Chapter 11 of this Manual; however, there may be site-specific elements that are not addressed in Chapter 11.

TABLE 4.3 TYPICAL DESIGN SEQUENCE[1]

| Subject | Manual Section |
|---|---|
| **I. Site Contour Survey Data** | |
| A. USGS Topographic Maps | 6.4.1.1 |
| Hazard potential | |
| Watershed area | |
| B. Aerial Photography | 6.4.1.4 |
| Embankment and pond area: five-foot minimum contour interval (two-foot interval is preferable) | |
| Spillway and outlet works: five-foot minimum contour interval (two-foot interval is preferable) | |
| **II. Review of Available Publications and Data** | |
| A. Soils and Geology | Chapter 6 |
| Government agencies: | |
| • United States Geological Survey (USGS) | |
| • Natural Resource Conservation Service (NRCS, formerly SCS) | |
| • State geologic survey(s) | |
| Other Sources: | |
| • Universities | |
| • Studies from nearby sites | |
| • Coal mine exploration borings | |
| • Aerial photographs | |
| B. Hydrology Data | Chapter 9 |
| Government agencies: | |
| • National Weather Service | |
| • USGS gaging station data | |
| • NRCS runoff data | |
| C. Mining Status | Chapter 8 |
| Coal operator's records | |
| Government agencies: | |
| • Office of Surface Mining, U.S. Department of the Interior | |
| • State agencies | |
| D. Seismicity | 7.7 |
| U.S. Geological Survey (USGS) | |
| Published records of recorded earthquake epicenters | |
| **III. Site Reconnaissance** | |
| A. Area Upstream and/or Upgradient and Downgradient from the Facility | 6.4.2, 14.4.2 |
| B. Reconnaissance of Natural Features | 6.4.2 |
| Topography and morphology | |
| Soil conditions, rock outcrops, sinkholes | |
| Vegetation cover | |
| Drainage patterns, springs and streams | |
| Erosion | |
| Stability (sliding and sloughing) | |
| Wetlands | |
| C. Reconnaissance of Man-Made Features | 6.4.2 |
| Roads and railroads | |

TABLE 4.3 TYPICAL DESIGN SEQUENCE
(Continued)

| Subject | Manual Section |
|---|---|
| Buildings and other structures | |
| Bridges | |
| Stream modifications and channels | |
| Mine entrances and features (shafts, boreholes, highwalls, auger holes, spoil/refuse, AMD discharges, mine subsidence features, etc.) | 8.3 |
| Other infrastructure (gas wells, pipelines, power lines, etc.) | |
| Water treatment facilities | |
| **IV. Site and Facility Configuration Selection** | |
| A. General Considerations | Chapters 3, 5 |
| B. Geotechnical Considerations | Chapters 6, 7, 8 |
| C. Drainage Considerations | Chapter 9 |
| D. Environmental Considerations | Chapter 10 |
| E. Equipment and Construction Considerations | Chapter 11 |
| **V. Field Investigations** | |
| A. New Facilities | |
| <u>Borings</u> – Locations, depths and types of sampling should be selected by an experienced designer. | 6.4.3 |
| <u>Geophysical surveys</u> – Supplemental to borings for exploration and testing. | 6.4.4, 8.3.2 |
| <u>Piezometers</u> – Normally piezometers are required only in selected borings for monitoring water levels in abutments, etc. or to determine if water conditions will create construction difficulties. | 6.4, 13.4.2 |
| <u>Test pits</u> – Test pits can be used to economically gain additional data in area planned for facilities and adjacent areas where borrow material may be obtained. | 6.4.3.3 |
| <u>Water samples</u> – Normally from surface water streams, major springs, and ground water wells. | 10.3 |
| <u>Field mapping</u> – Notation should be made of major spring locations, rock outcrop zones, mine openings, evidence of subsidence, existing landslides and any other conditions that might affect construction of refuse facility structures. | 6.4.2, 8.2 |
| B. Existing Facilities | |
| <u>Borings</u> – Locations, depths and types of sampling should be selected by a qualified engineer. | 6.4.3 |
| <u>Geophysical surveys</u> – Supplemental to borings for exploration and testing. | 6.4.4, 8.3.2 |
| <u>Piezometers</u> – Since phreatic conditions in an existing facility cannot be accurately estimated, piezometers should be installed in borings critical to stability analyses. | 6.4, 13.4.2 |
| <u>Test pits</u> – Test pits can be used for the same purpose as for new facilities, plus to evaluate the nature of weathering with depth, to obtain large samples of existing embankment materials, and to conduct in-situ density tests. | 6.4.3.3 |
| <u>Water samples</u> – From stream above and below facility, from the impoundment (if any) and from all major downstream seeps or springs. Also, from groundwater wells. | 10.3 |
| <u>Field mapping</u> – Same as for new facilities, plus observation should be made to locate any seepage zones on downstream face and to note any evidence of cracking or movement on any portion of the existing facility. | 6.4.2, 8.2 |
| <u>Flow measuring weirs</u> – Weirs or calibrated pipes should be installed to monitor the flow from any major seepage zone noted on the downstream face of the facility. | 13.4.3 |
| <u>Survey monitoring</u> – If any evidence of movement of the existing facility is noted in a critical zone, survey monuments can be installed to determine if the movement is active and the rate of movement. | 13.4.1 |

TABLE 4.3 TYPICAL DESIGN SEQUENCE
(Continued)

| Subject | Manual Section |
|---|---|
| **VI. Laboratory Investigations** | |
| A. Soils/Rock and Refuse Materials | 6.5 |
| General and index properties: | |
| • Water contents of all samples | |
| • Grain-size analysis of representative samples | |
| • Liquid and plastic limits of fine-grained materials | |
| • Specific gravity of refuse materials | |
| Materials behavior: | |
| • In-situ properties | |
| On Shelby tube samples or prepared samples for approximating in-situ conditions | |
| Strength tests with representative pore-pressure conditions | |
| Consolidation of fine-grained materials | |
| Hydraulic conductivity tests | |
| • Materials to be used for construction | |
| Compaction tests | |
| Strength tests with representative pore-pressure conditions | |
| Consolidation of fine-grained materials | |
| Hydraulic conductivity tests | |
| Special tests for refuse materials: | |
| Ash content and ignition tests | |
| B. Water Quality Testing | Chapter 10 |
| The water quality testing program will be a function of the potential source of water, environmental conditions, and specific facility design features (may require determination of pH, temperature, specific conductance, suspended and dissolved solids, sulfates and metals). | |
| **VII. Analyses and Design** | |
| A. General Considerations | |
| Hazard classification | Chapter 3 |
| Site development and startup | Chapters 4, 5 |
| Erosion and sedimentation control | Chapters 5, 6, 9 |
| Staging | Chapters 5, 6 |
| Reclamation and abandonment | Chapters 5, 6, 10 |
| B. Geotechnical | |
| Parameters – Establish material properties from field/laboratory data and/or other sources. For new facilities the properties of refuse may have to be estimated based on coal seam and preparation procedures because the material may not be available. | 6.4, 6,5 |
| Geometry – Establish basic embankment cross section configuration for each stage, including methods for controlling seepage. | Chapters 5, 6 |
| Static stability – Estimate pore pressure conditions for critical stages or conditions. Modify geometry if required to achieve satisfactory static stability conditions. | 6.6.4, 6.6.5 |
| Dynamic stability – Perform seismic hazard assessment, liquefaction, stability, and deformation analysis, as required, considering hazard classification of embankment and seismic risk zone of site. Modify geometry if required to achieve satisfactory dynamic stability. | Chapter 7 |
| Settlement – Evaluate if settlement of soft layers could cause loss of freeboard, embankment cracking or damage to drainage facilities. | 6.6.3 |

TABLE 4.3 TYPICAL DESIGN SEQUENCE
(Continued)

| Subject | Manual Section |
| --- | --- |
| Subsidence – Evaluate if underground mining could affect stability. | Chapter 8 |
| Buried pipe design – Analyze pipe stresses and strain, select materials, and design installation and backfill requirements for conduits and decant pipes. | 6.6.6 |
| Special considerations: | |
| • Determine special foundation preparation requirements, including treatment of existing mine spoil or refuse. | Chapters 6, 8 |
| • Design special material requirements such as starter embankments, drainage materials, filters and soil cover or intermediate layers, if any. | Chapter 11 |
| • Establish special construction requirements for diversion ditches, spillway cuts, structure and pipe foundations, etc. | 11.7 |
| • Specify borrow areas for required soils and rock materials. | 6.2.3.4 |
| • Specify construction procedures to satisfy design assumptions. | 11.1 |
| C. Hydrology and Hydraulics | Chapter 9 |
| Determination of design storms | 9.5 |
| • Establish requirements for critical stages such as facility startup or abandonment. | |
| • Establish basic storage-decant-spillway scheme | |
| Sedimentation Control | 9.4.4 |
| • Establish sedimentation pond requirements. | |
| Decant and spillway systems | |
| • Perform hydrology analyses for storm served only by storage and decant | 9.6 |
| • Design decant system | 9.7.4 |
| • Perform hydrology analyses for maximum design storm | |
| • Design spillway structures (or cuts) for various stages | 9.7 |
| • Design erosion protection system and/or stilling mechanisms. | |
| Diversion Systems | Chapters 9, 10 |
| • Design size of diversion ditches for various stages, including abandonment. | |
| D. Special Considerations | |
| Environmental protection – Evaluate potential acid generation and seepage quality, and determine containment or neutralization requirements. | Chapter 10 |
| Corrosion – Evaluate probable seepage quality and related limitations on construction materials. | 6.5.2.5, 6.6.6.1, 11.7 |
| Vegetation – Determine requirements for vegetation of completed surface, including the need for soil cover or surface preparation and treatment. | Chapter 10 |
| Monitoring – Design monitoring and inspection program commensurate with the total design. | Chapter 12 |
| **VIII. Preparation of Design Documents** | |
| A. Designer's Report Contents | Chapter 11 |
| Introduction | |
| History (for existing sites) | |
| Discussion of site conditions and previous mining/site development/refuse disposal | |
| Field investigations | |
| Laboratory testing | |
| Geotechnical analyses | |
| Hydrology and hydraulics analyses | |
| Special considerations | |
| Facility staging | |

TABLE 4.3 TYPICAL DESIGN SEQUENCE
(Continued)

| Subject | | Manual Section |
|---|---|---|
| | Recommended design | |
| | Abandonment requirements | |
| | Monitoring and inspection | |
| B. | Plans | Chapter 11 |
| | Location map | |
| | Location plan on USGS quadrangle base | |
| | Plan of borings and field investigation | |
| | Boring and test pit logs | |
| | Laboratory data | |
| | Hydrology data | |
| | Results of stability analyses | |
| | Plans of facility at critical stages | |
| | Plan and cross sections of hydraulic structures | |
| | Details of hydraulic structure components | |
| | Capacity curves for control sections of hydraulic structures | |
| | Details of monitoring installations | |
| C. | Specifications | Chapter 11 |
| | Site preparation | |
| | Foundation preparation | |
| | Embankment construction and internal drainage facilities | |
| | Surface drainage facilities | |
| | Decant system | |
| | Emergency spillway construction | |
| | Instrumentation | |
| | Reclamation and abandonment | |
| D. | Calculation Brief (should include input files for computer runs) | Chapter 11 |
| | Coal refuse production rates (by weight and volume) | |
| | Starter embankment and staging | |
| | Hydrology and hydraulics analyses (sedimentation control, design storm routing, drainage channel design, dam breach analysis) | |
| | Stability analyses (including seismic hazard assessment and stability analysis) | |
| | Settlement analyses | |
| | Seepage analyses and internal drain design | |
| | Surface drainage channel lining design | |
| | Buried pipe analyses | |
| | Environmental analyses | |
| E. | Operation and Maintenance Plan | Chapter 11 |

Note: 1. The design procedure should be modified appropriately to suit the size, arrangement and specific characteristics of the facility being designed.