

Chapter 1

Introduction, Findings, and Options

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Introduction, Findings, and Options

INTRODUCTION

Surface mining is the oldest method of mining coal, from the days of pick and shovel and horse-drawn plows and scrapers, to today's huge operations, each covering thousands of acres and producing as much as 15 million tons per year. With the development of technologies for efficiently mining large amounts of coal by surface methods, however, came concern about the environmental impacts of surface mining. While stream pollution and unstable mountainsides have long been a source of concern in Appalachia, the effects of surface mining in the Western United States did not receive a great deal of attention until the early 1970s. At that time, when the Western industry was beginning to expand greatly, a National Academy of Sciences (NAS) study cast doubt on the ability to develop reclamation technologies and methods suited to the West's vastly different climate, topography, geology, soils, hydrology, and ecology (2).

As far back as the late 1930s, a few States had enacted legislation requiring some form of reclamation of surface mined lands, yet serious abuses continued in many areas. In the early 1970s, the Federal Government's commitment to the development and utilization of coal as a vital part of our national energy future, coupled with the NAS study and the growth of the environmental movement, led to congressional interest in uniform national standards for surface mine reclamation. The 93rd and 94th Congresses passed legislation containing such standards, but both met a Presidential veto (4). In 1977, the Surface Mining Control and Reclamation Act (SMCRA, Public Law 95-87) was approved by Congress and signed by President Carter.

SMCRA established minimum national environmental performance standards for surface mining and reclamation. These standards require, among other things, restoration of disturbed land to original or better conditions and to the approximate original contour, and minimization of disturbances to the existing hydrological balance.

The standards are implemented through a permit program, and enforced through inspections and the requirement that mine operators post a performance bond. In its permit application, a coal company must submit a detailed mining and reclamation plan that provides a detailed baseline characterization of all premining aspects of the physical and biological environment, predicts the impacts of mining and reclamation on that environment, demonstrates the ability to meet the performance standards during and after mining, and sets forth a detailed proposal for postmining land use and management.

While SMCRA established a nationwide program for regulating surface coal mining and reclamation, it also recognized that because of the diversity in terrain, climate, biological, chemical, and physical conditions in coal resource areas, the primary governmental responsibility for regulating surface mining should rest with the States. Therefore, provision was made for State regulatory programs consistent with SMCRA, with Federal oversight.

With the advent of SMCRA, the Federal and State regulatory authorities, coal operators, and public interest groups shifted their attention to the ability of mining and reclamation technologies to meet the performance standards, to the reliability of analytical techniques for predicting the impacts of mining and reclamation, and to the adequacy of data to support permitting and leasing decisions.

Moreover, because approximately 70 percent of Western surface mines incorporate Federal coal, the public concern and debate in the 1970s that focused on the Federal coal leasing program became inextricably linked with the concerns about the environmental impacts of surface mining. Thus SMCRA requires that Federal lands be reviewed to determine their acceptability for all or certain types of mining, and provides specific unsuitability criteria that define categories of land

that must be protected from, or during mining. These provisions supplemented those of the Federal Coal Leasing Amendments Act (FCLAA, Public Law 94-377) and the Federal Land Policy and Management Act (FLPMA, Public Law 94-579), which require the preparation of a comprehensive land use plan before coal lease sales.

In mid-1983, economic and environmental concerns about the implementation of the Federal coal leasing program led Congress to suspend leasing until completion of reports on the economic aspects of leasing by a newly appointed Commission to Review Fair Market Value for Federal Coal Leasing, and by the Office of Technology Assessment (OTA) on the program's ability to ensure the development of coal leases in a manner compatible with current environmental laws and regulations, including SMCRA and the land use planning provisions of FCLAA and FLPMA (3).

The OTA report, *Environmental Protection in the Federal Coal Leasing Program*, found that the basic framework of the program—the legislative mandates and the use of increasingly stringent analyses from land use planning to mine permitting—is workable and capable of ensuring environmental protection upon development of leased tracts (1). The report concluded, however, that the 1982 changes in the program regulations reduced the effectiveness of the statutory requirements and increased the risk of adverse environmental impacts from the development of some leased tracts.

[In particular, OTA found that the increase in the number of tracts to be evaluated for leasing, combined with the rotation and attrition of field personnel, taxed the Bureau of Land Management's (BLM) planning and assessment capability beyond the point where BLM could adequately assess the suitability of the tracts proposed to be offered for lease. OTA also found that, in many cases, BLM's presale data and analyses were inadequate to support a decision on whether recently leased tracts and those proposed for future leases could be developed in an environmentally compatible manner. Consequently, decisions about acceptability of tracts for mining had been deferred beyond lease planning, when they are

supposed to be made, to the Secretarial decision or mine permitting stage. Decision deferrals also led to overuse of lease stipulations (conditions placed on a lease) to address gaps in the data and analyses and the resulting uncertainties about impact mitigation requirements. These stipulations would then have to be addressed during permitting. While OTA recognized the importance of ensuring environmental protection during permitting, mining, and reclamation, it was unable to evaluate those aspects of the Federal coal management program within the confines of that earlier assessment.

As a result, the House Committee on Interior and Insular Affairs asked OTA to do a follow-on assessment to assist the committee in its authorization and oversight responsibilities for the implementation of SMCRA. Recognizing "the increasingly important role of mining and reclamation methods in ensuring environmental protection during and after mine development," the Committee asked OTA to assess "the ability of current mining and reclamation technologies and methodologies, and of Federal programs and policies, to meet the statutory mandates." In addition, the Committee requested "guidance about methods for evaluating the success of reclamation practices, including an analysis of the levels and kinds of uncertainty." Due to the Committee's dual oversight responsibilities for Federal lands and for the reclamation program, they restricted the scope of the request to Federal surface mined lands in the Western United States.

In response to this request, OTA designed this assessment to examine six aspects of the implementation of SMCRA in the West:

1. the state of development of technologies and methodologies to reclaim Western surface mined lands;
2. the encouragement given to research and to the development and use of innovative and emerging permitting and reclamation techniques;
3. the reliability of methods, or analytical techniques, for predicting and evaluating the success of reclamation practices, including an analysis of the levels and kinds of uncertainty;

4. the adequacy of baseline and monitoring data on mined land reclamation in the Western United States, and how those data are being used to support 1 through 3, above;
5. the effectiveness of lease stipulations and permit conditions as means of imposing technological or methodological requirements for environmental protection and resolving uncertainties in mining and reclamation situations; and
6. technical and policy options for resolving uncertainties about, and for improving the prospects for, successful reclamation on Western Federal lands, including research and development needs.

It should be noted that this study does not attempt to assess the short- or long-term success of reclamation under SMCRA in the Western United States. While significant reclamation experience has been gained in the 8 years since approval of SMCRA, no Western lands will be eligible for bond release until 1989 at the very earliest. Any such assessment would therefore be premature. Rather, this assessment is limited to analyzing the criteria that may be used to judge the success of reclamation, evaluating the reliability of techniques for predicting the success of reclamation, and defining the remaining uncertainties that need to be resolved before judgments can be made about the long-term success of Western surface mine reclamation.

In response to the Interior Committee's restriction of the scope of the study to Western Federal lands, OTA focused on the four Western leasing regions where there is significant development of Federal coal resources by surface mining methods: the Fort Union, Powder River, Green River-Hams Fork, and San Juan River Coal regions (see fig. 1-1). Although there are substantial amounts of Federal coal in the Uinta-Southwestern Utah Coal Region, all of it is being mined by underground methods. Similarly, while there are a number of surface mines in Oklahoma and Texas that encompass interesting reclamation situations, there is little Federal coal in those areas. Also, mines in Washington and Alaska were excluded because of their limited extent. Surface mine reclamation on Tribal lands was not evaluated due to the ongoing development of a per-

manent legislative and regulatory program for those lands.

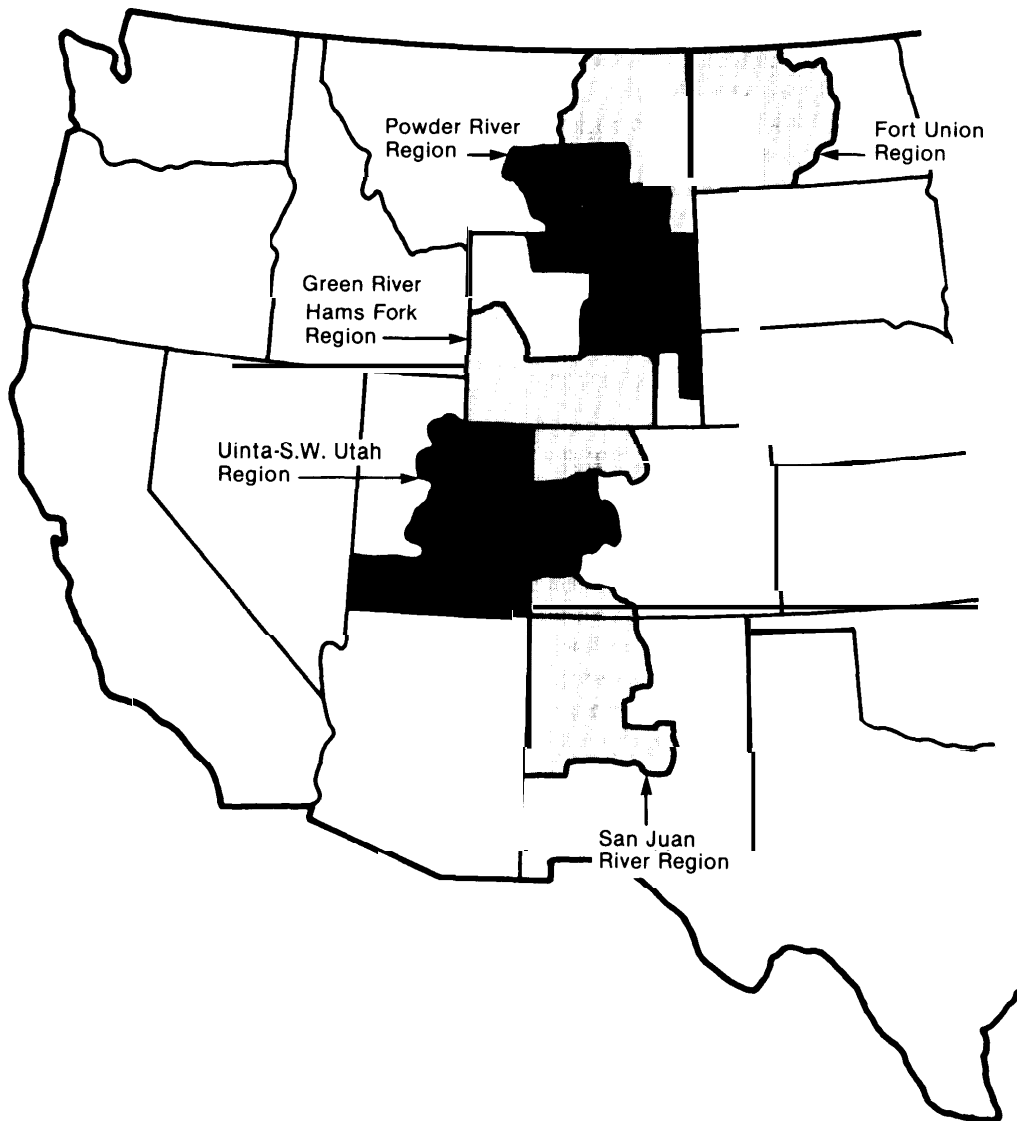
Finally, OTA limited its analysis to those issues related to the physical and biological environment that are specifically addressed by SMCRA: surface and groundwater hydrology, soils and overburden, revegetation, and wildlife. While OTA recognizes that issues related to air quality and to social and economic impacts and surface owner consent may be of equal or even greater concern in some areas, these issues are sufficiently complex that it would not have been possible to address them adequately in this assessment. Although the physical and biological disciplines usually are discussed separately in this report, it is important to keep in mind that surface mine reclamation involves the reconstruction of the surface and subsurface components of a total ecosystem, and all of the aspects of that system are interrelated.

To assist in the formulation of OTA'S response to the letter of request, background papers were prepared that evaluate items 1 through 5, above, for the four disciplines (hydrology, soils, vegetation, and wildlife). These reports are appended as volume 2 to this assessment. In addition, the study was assisted by an advisory panel composed of experts on Western surface mine reclamation drawn from the coal industry, environmental organizations, State and local governments, ranchers, academics, and independent research organizations. Interested Federal agencies participated in advisory panel meetings as *ex officio* members. The panel gave OTA guidance on its study plan and on technical and policy options, and reviewed and commented on drafts of the background papers and this report. While the panel provided advice and comment throughout the course of the assessment, the members do not necessarily approve, disapprove, or endorse the findings of this report, which are the sole responsibility of OTA.

Volume 1 of the report is organized as follows:

- chapter 2 presents OTA'S technical findings on the major issues identified in this assessment;
- chapter 3 describes the context for Western surface mine reclamation, including the four

Figure I-I.— Five Western Coal Regions



SOURCE: Office of Technology Assessment.

- coal regions, and the methods used in Western surface mining and reclamation;
- chapter 4 outlines the legislative and regulatory context for Western reclamation, including SMCRA and relevant portions of the leasing program, and identifies the Federal and State agencies that implement them;
- chapter 5 discusses the data requirements and collection methods for surface mine planning and permitting and assesses the availability and adequacy of baseline and monitoring data;
- chapter 6 evaluates the analytical techniques used to predict the impacts of mining and to design reclamation strategies;
- chapter 7 reviews the criteria and methods that have been developed to evaluate the success of reclamation;
- chapter 8 examines a variety of specific technical issues related to the long-term success of Western surface mine reclamation; and
- chapter 9 discusses ongoing research and innovation in reclamation, outlines research needs, and identifies the constraints on re-

search and options for removing those constraints.

The following section briefly reviews OTA'S findings and lists technical and policy options that Congress might consider in its oversight of SMCRA and the regulatory programs. The options, the congressional and Federal agency actions they may entail, and their potential costs and bene-

fits are summarized in table 1-1 and discussed in greater detail in chapters 2 through 9. Some of these options would be relatively easy to implement, while others would be more difficult or controversial. Potential problems with their implementation are noted in the discussion in the main body of the report.

FINDINGS AND POLICY OPTIONS

Surface coal mining in the Western United States is a relatively new activity compared to Eastern mining, and its operational and regulatory characteristics are different from those in the East. Most Western mines have been developed since the early 1970s, and, unlike Eastern mines, many operate on public lands with Federal coal. The technical uncertainties related to the expansion of surface coal mining in the West, arising from the West's vastly different—and highly variable—climate, topography, geology, soils, hydrology, and ecology, were studied prior to enactment of SMCRA, and the legislative requirements for mining and reclamation permits, performance standards, and bonds recognized certain risks associated with those uncertainties.

Knowledge gained about Western mining and reclamation situations in the intervening years has resolved many of the technical issues, and **the prognosis for the long-term success of reclamation in the West has brightened considerably. Some technical uncertainties still exist about several aspects of reclamation, particularly about methods for delineating overburden material that may be detrimental to revegetation and water quality, and about the success of hydrologic restoration. These uncertainties were recognized at the time SMCRA was debated and approved. The coal industry and the regulatory authorities have learned a lot more about these problems in the intervening years, and, while much work remains to be done, in OTA'S view the risks these uncertainties may pose to the long-term success of Western reclamation have been reduced significantly.** Further resolution of these uncertainties and other outstanding technical issues would increase the probability of suc-

cess as well as the quality of Western reclamation, make permitting and designing Western surface mines easier, and reduce the costs of regulation and reclamation.

Resolving Uncertainties

The remaining uncertainties about the reclamation of surface mined lands in the West arise primarily from inadequate or unverified analytical techniques for accurately predicting the impacts of mining and planning reclamation. In particular, the geology of some Western coal regions is so variable and/or complex that the occurrence of overburden material detrimental to postmining water quality or revegetation is very difficult to predict. Similarly, the slow recharge rate of some Western aquifers makes it difficult to judge the effectiveness of current plans for restoration of the hydrologic balance until years after final bond release. Accurate quantitative methods for predicting and evaluating impacts to wildlife also are lacking.

Current regulatory requirements may not provide sufficient latitude to industry in choosing predictive and other analytical techniques that may compensate for these uncertainties. Rather, reclamation designs based on worst-case impact assessments must be used, which increases the cost of mining and reclamation.

Options for resolving these and other technical uncertainties include:

1. Increase and improve the analysis of monitoring data from ongoing mining and reclamation in order to improve the accuracy of

Table 1-1.—Summary of Policy Options

| Option | Possible ranges of congressional action | Federal agency actions | Potential costs and benefits |
|--|--|---|---|
| Resolving uncertainties: | | | |
| 1. Analyze monitoring data to improve analytical techniques | None for voluntary industry analysis Directive in appropriations for OSM analysis or revision of regulations to require industry or RA analysis Amendment of SMCRA needed to mandate RA analysis plus oversight and budget authorization | Formal rulemaking to specify types of analyses required | High for industry, oversight for RAs High for RAs or OSM, rulemaking and oversight for OSM Rulemaking and oversight for OSM high for RAs or industry |
| 2. Define goals of analysis to focus on resolving uncertainty | Directive in appropriations Oversight and authorization Hearings | Rulemaking to define goals | Rulemaking and oversight; improved cost-efficiency |
| 3. Research and development on analytical techniques and physical and biological systems | Directive in appropriations Oversight and authorization Hearings | Budget reallocation Continuing supervision or implementation | Government or industry allocation of research funds Agency oversight Supervision of analysis |
| 4. Provide regulatory latitude on selection of analytical techniques | Directive in appropriations Oversight and authorization | Analysis of available techniques Formal or informal rulemaking Oversight of State programs | Rulemaking/oversight for OSM More flexibility and lower costs for industry, but also potentially greater risk of reclamation problems |
| Data adequacy and management: | | | |
| 5. Standardize data collection methodologies and data formats in regulations | Directive in appropriations Oversight and authorization Amend SMCRA to mandate standardization | Analysis of available methodologies Formal or informal rulemaking Oversight of State programs | Supervision of analysis Rulemaking/oversight for OSM Less flexibility but also possibly lower costs for industry |
| 6. Develop a scoping process for baseline and monitoring data collection | Directive in appropriations Oversight and authorization Amend SMCRA to mandate process Hearings | Formal or informal rulemaking Oversight of State programs | Rulemaking/oversight for OSM Lower costs and increased efficiency for industry and agency data collection and analysis |
| 7. Develop integrated databases from permitting and other information | Directive in appropriations Oversight and authorization Mandate development in legislation Hearings | Budget reallocation Supervision or implementation of database development Continued supervision or maintenance of databases | Initial cost very high Continued commitment to database management Long-term reduction in data collection costs for all affected Federal and State agencies and permit applicants |
| 8. Continue to develop multidisciplinary approach to data collection/analysis | Oversight and authorization | Commitment to the continual integration of all available information to continually refine understanding of reclamation | Potential long-term savings for agencies and industry |
| 9. Develop valid methods for generating and interpreting overburden chemical data | Directive in appropriations Oversight and authorization | Formal or informal rulemaking Coordination of industry efforts Oversight of State programs | Rulemaking/oversight for OSM |
| Evaluating reclamation success: | | | |
| 10. Evaluate phase II and III bond release criteria | Directive in appropriations Oversight and authorization Hearings Amend SMCRA to mandate criteria for specific disciplines | Analysis of existing and possible criteria Formal rulemaking Oversight of State programs | Supervision of analysis Rulemaking/oversight for OSM Greater certainty for industry and agencies |
| 11. Establish procedure for periodic reexamination of bond release criteria | Directive in appropriations Oversight and authorization Hearings Amend SMCRA to mandate procedure for specific disciplines | Analysis of possible procedures Formal rulemaking Implementation in Federal program Oversight of State programs | Supervision of analysis Continued implementation Rulemaking/oversight |

Table I-I.—Summary of Policy Options—Continued

| Option | Possible ranges of congressional action | Federal agency actions | Potential costs and benefits |
|--|--|---|---|
| Post-bond release liability: | | | |
| 12. Research the identification and handling of deleterious overburden | Directive in appropriations Oversight and authorization | Budget reallocation Supervision or conduct of research Eventual Incorporation of research results in regulatory programs None | Initial cost high but potential long-term benefits great for agencies and/or industry Greater certainty for all parties |
| 13. Examine need for congressional policy on post-bond release reclamation failure | Hearings | | |
| Technical Issues: | | | |
| 14. Develop valid test for ABP in Western overburden and incorporate in regulatory programs | Directive in appropriations Oversight | Supervision of research Formal or informal rulemaking | Research cost moderate Potential long-term benefits great |
| 15. Collect data on sedimentation and control methods | Hearings Directive in appropriations Oversight and authorization Hearings | Supervise data collection Formal rulemaking Oversight of State programs Formal or informal rulemaking Oversight of State programs | Data collection costs high Potential long-term benefits great Rulemaking/oversight Lower reclamation costs Improved prospects for revegetation success |
| 16. Promote optimization of the soil resource | Hearings Oversight and authorization | | Rulemaking/oversight Lower reclamation costs Improved prospects for revegetation success and landscape diversity Fewer postmining land use conflicts Initial costs slightly higher but potential long-term benefits great |
| 17. Reexamine woody plant density standards | Hearings Directive in appropriations Oversight and authorization | Formal or informal rulemaking Oversight of State programs | Rulemaking/oversight Lower reclamation costs Improved prospects for revegetation success and landscape diversity Fewer postmining land use conflicts Initial costs slightly higher but potential long-term benefits great |
| 18. Ensure OSM and BLM coordination on postmining land use characterization and implementation | Oversight and authorization | Commitment to coordination on part of both agencies | |
| 19. Enforce requirements for quantitative characterization of pre- and post-mining land uses | Oversight | Increase BLM scrutiny of permit applications Stricter OSM enforcement of SMCRA Oversight of State programs Supervise research Analysis of results Formal or informal rulemaking Adoption of integrated approach to reclamation planning | Slightly higher permit review costs Greater certainty in reclamation requirements Potential for long-term benefits in ecosystem function and viability |
| 20. Research the costs and benefits of landscape diversity | Directive In appropriations Oversight and authorization | | |
| Innovation and research: | | | |
| 21. Clarify regulatory policy on experimental practices vs. alternate reclamation techniques | Directive in appropriations Oversight and authorization Hearings | Formal or informal rulemaking Change in OSM approach to both Oversight of State programs Formal rulemaking | Rulemaking/oversight Lower reclamation costs Greater regulatory efficiency Lower review costs Greater efficiency in permitting Increased use of experimental practice option Less strict review Initial adjustment likely to be difficult Major benefits for public confidence in regulation Strict definition of mandate and review schedules could ease adjustment process |
| 22. Establish strict schedules for approval of experimental practices | Directive in appropriations Oversight and authorization Amend SMCRA to mandate schedules | | |
| 23. Establish local advisory committees to review applications for alternate techniques | Directive in appropriations Oversight and authorization Hearings Legislation mandating committees | Implementation of legislation or rulemaking Appointment of committees Oversight of committees | |

Table I.1.-Summary of Policy Options—Continued

| Option | Possible ranges of congressional action | Federal agency actions | Potential costs and benefits |
|--|---|--|---|
| 24. Increase appropriations for and/or develop new avenues for funding research | Reallocation of revenue Oversight and authorization Hearings | Improve management of research revenues | Lower administrative costs Higher research costs |
| 25. Establish cooperative Western reclamation research organization | Oversight and authorization | Assist in determination of research priorities | Voluntary industry funding |
| 26. Establish mechanism for disseminating research results | Directive in appropriations Oversight and authorization Legislation mandating establishment | Manage publication and distribution Oversight of State publication and distribution | Potentially high, depending on subscription price |
| Regulatory authority personnel: | | | |
| 27. Provide greater career incentives for technical personnel | Directive in appropriations Hearings | Changes in management and personnel policies Oversight of State programs | Greater regulatory efficiency |
| 28. Reduce frequency of personnel transfers and rotations | Directive in appropriations | Changes in management and personnel policies | Greater regulatory efficiency |
| 29. Ensure adequacy of State program funding for technical personnel | Oversight | Oversight of State programs | Greater regulatory efficiency Potentially higher State program costs |
| 30. Evaluate Federal and State roles in permit review | Directive in appropriations Oversight and authorization Hearings | Changes in management and personnel policies | Greater regulatory efficiency Lower permit review costs |
| 31. Establish computerized databases on leasing and permitting decisions | Directive in appropriations Oversight and authorization | Develop database format Set up and maintain database | Relatively low initial and maintenance costs |
| Lease Stipulations: | | | |
| 32. Evaluate the need for and role of lease stipulations | Directive in appropriations Oversight and authorization Hearings | BLM/OSM coordination on analysis | Supervision of analysis Increased efficiency in leasing and permit review |
| 33. Require BLM to establish uniform permit review procedure and require coordination in development and documentation of compliance review for lease stipulations | Directive in appropriations Oversight and authorization | BLM (or USFS) coordination with OSM in developing lease stipulations Establish BLM procedure for documenting review of compliance with stipulations | Relatively low initial and maintenance costs Increased efficiency in leasing and permit review |

"RA" means Regulatory Authority.

SOURCE: Office of Technology Assessment.

predictive and design techniques (see also the separate discussion of data, below).

2. Clearly define, in the Federal and State regulatory programs, the goals of pre- and post-mining analyses of the potential and actual impacts of mining and reclamation in order to ensure that such analyses focus on remaining areas of uncertainty and are integrated with reclamation goals in order to increase the efficiency of reclamation planning and permitting (also see option 6).
3. Devote additional Federal, State, and industry research and development resources to improving the quantitative techniques for predicting the impacts of mining and designing successful reclamation, and to improving our understanding of the physical and biological systems to be reestablished (see separate discussion of research, below, for more specific means of achieving this).
4. Examine the Federal and State regulatory programs to determine whether they provide sufficient latitude in the selection of analytical techniques for predicting the impacts of mining and designing reclamation appropriate to site-specific reclamation conditions in the Western United States, and incorporate such latitude where it currently is insufficient.

Data Adequacy and Management

Although the quantity and quality of data on Western reclamation have increased dramatically since the passage of SMCRA, data-related problems still limit the accuracy and efficiency of reclamation planning and evaluation. First, the large quantity of data being collected has raised serious data management problems for both mine operators and regulatory authorities. In some disciplines, especially hydrology, the quantity of monitoring data is so large that regulatory authority personnel and resources rarely are available to review it. The lack of a standardized or computer-accessible format for baseline and monitoring data also makes it difficult and/or very expensive for regulatory authorities to review the data, complicates the integration of data into regional analyses (particularly cumulative

hydrologic impact assessments), and constrains the efficient use of available data by other groups.

Moreover, **despite recent improvements, collection of reliable data still is difficult for some parameters, either because standardized data collection methodologies are lacking, or laboratory techniques for generating data need to be refined, or there are natural obstacles to collecting the data.** The lack of reliable methods for interpreting the results of laboratory techniques that generate chemical data about overburden pose potential risks to postmining water quality and revegetation. Repairs are very difficult and costly if unanticipated overburden problems are found during reclamation monitoring and evaluation. Standardized methods for collecting data on flow and water quality in ephemeral streams and on wildlife habitat quality also are lacking, increasing the difficulty of industry planning and regulatory review of reclamation in these areas. The lack of monitoring data on spoils recharge from pump tests contributes to the uncertainty about the long-term success of hydrologic restoration.

Options for improving data collection and management include:

5. Incorporate guidelines for standardized data collection methodologies and formats for data presentation in the regulatory programs in order to increase the efficiency and accuracy of industry planning for reclamation, facilitate regulatory authority review of that planning, and facilitate the use of baseline and monitoring data in regional analyses.
6. Develop a scoping process similar to that used for environmental impact statements to optimize the quantity and format of baseline and monitoring data in order to eliminate unnecessary data collection and to facilitate data review and analysis by operators and regulatory authorities.
7. Develop integrated databases from permit applications and other sources to facilitate regional impact assessments and to ensure that baseline and monitoring data are accessible to other organizations to which such data could be useful.

8. Continue to develop a multidisciplinary approach to data collection and analysis that integrates actual on-the-ground conditions with reclamation planning and evaluation for all of the disciplines addressed.
9. Encourage coordinated research efforts to develop-valid methods for generating and interpreting overburden chemical data.

Evaluating Reclamation Success

Criteria for bond release on reclaimed areas have not yet been formulated beyond the first phase of release (backfilling the pit) in the five Western States studied. Furthermore, most existing evaluation methods and standards have serious limitations, especially those for evaluating postmining hydrology and revegetation—the two areas emphasized in the SMCRA performance and design standards. Most past experience in judging the success of reclamation has concentrated on revegetation success, yet no method has been developed that adequately accounts for both temporal variations in environmental conditions and the spatial diversity in vegetation that occurs over large areas. The tens to thousands of years that may be required to resaturate spoil aquifers, and the infrequent peak flow events in Western drainages mean that evaluations of reclamation success in these areas must be made with incomplete knowledge and predictive techniques. Despite these limitations, “successful” revegetation and hydrologic restoration are used as the primary indicators of success for the other disciplines—soils, overburden, and wildlife.

Establishing criteria for the second and third phases of bond release on a statewide or regional basis may be difficult because of the wide variability among Western mining and reclamation situations. In addition, knowledge about reclamation in the West is increasing rapidly, and bond release criteria should be reviewed periodically or be sufficiently flexible to incorporate research and monitoring results. Yet, if regulators do develop Phase II and III bond release criteria, they may find their flexibility to establish detailed criteria limited by previously approved reclamation plans that establish de-

facto criteria on a case-by-case basis. A decision about the appropriate type and level of criteria best suited to Western mining conditions requires further study.

Options for increasing the certainty in the success evaluation process include:

10. Evaluate the relative expediency of state-wide versus areal versus mine-specific criteria for all disciplines for the second and third phases of bond release, and establish such criteria based on the results of that evaluation.
11. Establish a procedure for periodic reexamination of bond release criteria that incorporates advances in reclamation technology based on research results and monitoring data but considers the effects of any change in criteria on existing permits.

Post-Bond Release Liability

Evaluation of the first phase of bond release (backfilling) may be inadequate in some areas to ensure that deleterious spoil material has not inadvertently been placed in the water table or in the root zone. While vegetation monitoring ultimately could reveal the presence of deleterious spoil in the root zone, subsequent reconstruction of the affected areas would be very expensive. Furthermore, the long-term results of placement of such spoils in groundwater may not become evident until the spoil has resaturated. This may not occur for decades or even centuries—long after final bond release—creating both technological and legal uncertainties about how such water quality problems would be corrected. While OTA was unable to quantify the potential for or scope of impacts from this problem, we believe it to be sufficiently serious that it should be given high priority in reclamation research and planning. Until judicial decisions on the issue become available, it is unclear who will be liable for reclamation problems that arise after final bond release has been obtained.

Options for clarifying post-bond release liability include:

12. Support and expand research on ways to identify and handle deleterious overburden

prior to and during mining in order to minimize the possibility of such material becoming an environmental hazard by being placed in the water table or root zone.

13. Examine the need for a congressional policy for accommodating post-bond release reclamation failures in lieu of judicial decisions on a case-by-case basis.

Technical Issues

Technical issues highlighted in this assessment encompass the technologies, data, and analytical methods related to the acid-base potential of Western overburden, the impacts of sediment control methods, the effects of soil handling on revegetation, the ability to meet uniform high woody plant revegetation standards, the characterization and implementation of postmining land uses, and the potential value of restoring landscape diversity.

Acid Potential in Western Mine Spoils

There are conditions under which acid formation will occur in Western postmining spoils, primarily in portions of the powder River Basin and in New Mexico. If acid-forming materials are placed in the postmining root zone, they can be detrimental to revegetation. **But, available techniques for estimating the acid-base potential of overburden, and thus the possible magnitude of its adverse impacts, have produced unreliable results in the West. As a result, some operators have failed to identify materials that need special handling, while others have been required to special handle some materials unnecessarily.** Research currently being funded by Western mine operators is making progress in solving this problem.

Sediment Control

Sedimentation ponds—the current design standard for controlling the sedimentation in streams that is caused by soil and overburden disturbance in mining and reclamation—are expensive to build and maintain and increase the amount of land that must be disturbed in mining. Their storage and release of water also can have adverse impacts on downstream surface

water quantity and quality. **Alternate means of maintaining sediment production at or below the level produced from undisturbed Western terrain are considered proven technology in agriculture, highway construction, and other land-disturbing activities.** To support a proposal that the design standards for sediment control be revised, operators need to demonstrate that alternate means of control are as effective as sedimentation ponds in Western surface mining. Such a demonstration will require empirical data on sediment yields and on natural sediment concentrations in streams, plus monitoring data from areas where alternate controls are in use.

Soil Handling and Revegetation

In the Western coal regions, where natural soils in many areas are thin and marginally productive, optimization of the soil resource is essential to the success of revegetation. **Cumulative Western mining experience suggests that hauling topsoil directly to a reclamation site, rather than stockpiling it, preserves the biologically active component of the soil and thus improves the establishment of planted and volunteer species, and can produce superior lifeform and species diversity within a relatively short time.** Research in deep soils and the limited monitoring data available suggest that combining direct hauling with two lifts (separate handling of surface and subsoils) may produce the best results in reestablishing rangeland diversity. However, **State programs that require salvage of all suitable soil materials and redressing in uniform thickness may not promote optimization of the soil resource in all mining and reclamation situations, and may add unnecessarily to reclamation costs.**

Revegetation of Woody Plants

Because woody plants—trees, shrubs, and subshrubs—are ecologically important in the West, the revegetation performance and success standards are tied in part to the reestablishment of native woody plant species of the same type and density that existed on the site before mining. This raises several concerns, especially in areas where the premining density may be artificially high due to overgrazing or other factors (primarily Wyo-

ming, Colorado, and New Mexico). First, **even with the most advanced shrub establishment technology, there is little field evidence that high densities can be reestablished over an entire reclamation site during the 10-year liability period, with sagebrush being among the most difficult to reestablish.**

Second, **while groupings of shrubs in moderate to high densities improve habitat quality for a variety of animal species, high uniform woody plant densities detract from the quality of the land for livestock grazing.** As a result, ranchers have undertaken large-scale programs to thin or kill sagebrush and other woody species, frequently under the auspices of BLM's rangeland management program. **Lower woody plant densities, if accomplished as groupings based on premining habitat mapping, could mitigate this conflict between revegetation requirements and postmining range management, yet still provide wildlife habitat as valuable as high uniform premining densities.**

Postmining Land Use

The conflict between shrub density standards and range management, as well as other reclamation-land use conflicts, can in part be traced to lack of specificity in designation of the postmining land use during permitting. **Despite legislative and regulatory requirements for the quantitative characterization of the pre- and postmining land capability and productivity, the land use characterizations in most permit applications reviewed for this assessment are at best perfunctory.** A number of the applications contained land use discussions with little more information than the statement "The premining land use is grazing and the postmining land use will be grazing." In some cases, this lack of specificity can be attributed to inadequate baseline data in the permit application; in others it is the fault of the Federal surface management agency, which is required to determine, or at least consent to, the postmining land use.

Landscape Diversity

Requiring full restoration of "landscape diversity"—the mosaic nature of Western land-

scapes resulting from localized differences in the physical environment, plant communities, wildlife populations, and land uses—would go beyond the premises of SMCRA and might be too inflexible for adaptation to changing technology and to climatic and other uncontrollable variables. Yet some attention to the various components of landscape diversity is needed to ensure long-term ecosystem function. Surface features typically eliminated in mining include rimrock and escarpments, ridges, bad land topography, and "microsites" (small premining surface features important to hydrology or wildlife habitat).

Some landforms (e.g., hogback ridges and badlands) are impossible to reestablish, and others may be too costly or difficult for all but the most elaborate reclamation plans. Many others can, however, be mimicked in the postmining topography (e.g., a section of unreduced highwall creates an artificial cliff that simulates rimrock). Regulatory authorities have required the restoration of landscape diversity at specific mines on a case-by-case basis, primarily for vegetative communities such as ponderosa pine woodlands, woody draws, and wetlands. On the other hand, regulatory requirements for uniform topsoil depth and full highwall reduction tend to homogenize postmining site conditions, and may discourage diversity in some mining and reclamation situations.

Attention to landscape diversity would require a reclamation plan with integrated analyses of the relations among the postmining topography, surface and groundwater hydrology, revegetation communities, land use, and the geomorphology of the contiguous areas. **Long-term research efforts are needed to demonstrate whether the potential benefits of such an approach for ecosystem function and viability would outweigh the costs.**

Options for resolving these technical issues include:

14. Continue industry and regulatory authority efforts to develop a valid, reliable test for acid-base potential in Western mine spoils, and then incorporate the results in

- State guidelines for analytical techniques and overburden suitability.
15. Increase data collection efforts on the relative effectiveness of sediment control ponds versus alternate controls to determine whether the design standard for sediment control could be implemented more flexibly on a case-by-case basis.
 16. Implement the regulations on soil salvage and redressing thickness more flexibly to promote optimization of the soil resource and improve revegetation success.
 17. Reexamine woody plant density standards to determine whether lower overall densities accomplished in high-density groupings would resolve the postmining conflicts between wildlife habitat and range management.
 18. Ensure coordination between OSM'S reclamation programs and BLM's range management programs in the specification and management of postmining land uses.
 19. Enforce the requirements for the detailed quantitative characterization of pre- and postmining land uses, productivity, and capabilities more strictly to provide greater guidance to operators in reclamation planning and to land use management agencies in permit application and reclamation review (see also option 33).
 20. Institute a research program to examine the costs and benefits of a landscape diversity approach to reclamation.

Innovation and Research

Cutbacks in funding have significantly reduced reclamation research. Also, there are few vehicles for dissemination of research results, leading to delays in the adoption and regulatory approval of improved reclamation techniques. In addition, OSM'S inflexible application of some design and performance standards for reclamation, and strict interpretation of the experimental practice provision of SMCRA can stifle innovation in reclamation. Although greater regulatory flexibility might increase the probability of challenges to permitting decisions, it also

could increase the long-term quality and reduce the costs of reclamation, particularly in the areas of replacement of uniform topsoil depth, technological design standards for sediment control, and high uniform shrub density standards.

Options for increasing innovation and research include:

21. Develop a Federal regulatory policy that distinguishes between formal experimental practices and site-specific variances or alternative reclamation techniques in Western mining and reclamation situations, and provide greater regulatory flexibility in approving the latter when the operator demonstrates they will be at least as effective in meeting reclamation standards as traditional methods or technologies.
22. Establish strict schedules for regulatory authority approval of experimental practices to ensure that they can be implemented effectively within the context of the mining and reclamation schedule.
23. Establish local advisory committees to review permit applications that propose site-specific variances or alternative reclamation techniques to ensure that local concerns about their potential impacts are considered fully and to facilitate their approval by the regulatory authority.
24. Increase appropriations for reclamation research and/or develop new avenues for funding research within existing Federal (and State) revenues (e.g., from existing permit fees, royalties and bonus payments on coal leases, the abandoned mine reclamation fund, severance taxes).
25. Establish a cooperative Western reclamation research organization with industry and government funding to encourage research on resolving uncertainties, and promote innovation and information exchange.
26. Establish a mechanism for disseminating the results of research projects and analyses of monitoring data, such as regular publication of a newsletter or journal by the OSM Western Technical Center (or the State regulatory authorities).

Regulatory Authority Personnel

Personnel cutbacks, rotations, and turnover in Federal and State regulatory and land use management agencies impair retention of an institutional memory about lease tracts and reclamation plans, contribute to regulatory inconsistency and inefficiency, increase the cost of permit and reclamation review, and impair OSM'S ability to provide technical assistance to State regulatory authorities. Two continuing problems are: 1) the wide disparity among salaries for State employees (at the low end of the scale), Federal agencies, and industry (at the high end); and 2) the tendency in government agencies to promote competent technical personnel to management positions. Both of these encourage technical specialists to begin their careers in the State regulatory authorities but to leave for government management or industry positions as soon as they have gained some experience.

Options for preserving technical expertise in Federal (and State) agencies and improving the quality and consistency of leasing and permitting decisions include:

27. provide greater career incentives for experienced technical personnel to remain in Federal (and State) government service, and to remain in technical positions, through such means as expanding the grade levels available to technical and field personnel, or placing more emphasis on technical expertise in career advancement.
28. Reduce the frequency of personnel transfers and rotations, and of reorganizations in Federal agencies.
29. Pay greater attention, in Federal oversight of State programs, to the adequacy of State funding for ensuring sufficient technical expertise, and the adequacy of Federal technical assistance to the States (e.g., through personnel details).
30. Reevaluate the respective roles of State and Federal regulatory authorities in technical review of permit applications, in order to eliminate duplication and improve the efficiency of permit review, and to promote State primacy.
31. Establish computerized databases on Federal coal leasing decisions and on mining and reclamation permit decisions to aid new personnel in becoming familiar with past actions and their rationale.

The Fate of Lease Stipulations During Permitting

Determining the fate of lease stipulations during permitting is difficult because **BLM does not have an established uniform permit review process, and neither BLM nor OSM makes a written finding that lease stipulations have been complied with in approving a reclamation plan and permit. The absence of a formal process and any documentation of its completion is compounded by the rapid turnover and rotation of BLM personnel in district and resource area offices, leading to a lack of institutional memory on the treatment of lease stipulations during permit review.** Based on OTA interviews with BLM personnel, it is clear that the primary emphasis in their permit review process is on full and efficient recovery of the Federal coal resources, and environmental review is secondary. Further, the environmental review focuses on compatibility with the approved postmining land use and with the resource area land use management plan, not on compliance with lease stipulations.

In examining the BLM lease stipulations themselves, OTA found that they are too vague and general to provide meaningful guidance to lessees or permitting agencies on long-term Federal land use objectives or to fulfill their intended purpose of alerting these groups to potential reclaimability problems on Federal lease tracts. The vagueness of lease stipulations also contributes to the potential for increased environmental risk in the leasing process due to inadequate preleasing data and analysis, as reported in OTA'S 1984 assessment of *Environmental Protection in the Federal Coal Leasing Program*, especially in light of the fact that there is little or no probability that a negative finding of reclaimability will be made on a tract once it has been leased.

Options for clarifying the need for and improving the effectiveness of lease stipulations are:

32. Require the Bureau of Land Management to evaluate the need for and role of lease stipulations in light of the detailed analysis during permitting of all potential environmental impacts of mining and reclamation, and in light of OTA'S 1984 findings on the value of lease stipulations.
33. Require BLM to establish a uniform permit application review procedure that includes documentation of their review of permit applications for compliance with lease stipulations, and require coordination among all agencies involved in leasing and permitting on the development of such stipulations to ensure they provide meaningful guidance on potential reclamation problems.

CHAPTER 1 REFERENCES

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