Land & Water Law Review

Volume 26 | Issue 2 Article 2

1991

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LAND AND WATER
LAW REVIEW

VOLUME XXVI 1991 NUMBER 2

URANIUM MINE AND MILL TAILINGS RECLAMATION IN WYOMING—TEN YEARS AFTER THE INDUSTRY COLLAPSED

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In the early 1980's, uranium mining in the United States all but stopped because of a sharp drop in market price. The uranium mining industry has never recovered. Wyoming was left with large open-pit uranium mines, radioactive tailings, and a financially troubled industry which found considerable sympathy for its plight among state and federal lawmakers.

This economic crash provided an unexpected test for reclamation laws passed during the prosperous energy boom years of the 1970's. How well these laws and the responsible regulators met this test is the subject of this article. The state and federal laws governing uranium mine and mill tailings reclamation are explained. The political battles over these reclamation laws are analyzed. An attempt is also made to assess the actual quality of reclamation achieved in the last ten years. The author concludes by arguing that there are lessons from the uranium case which could have a new and wider relevance if the demand for western coal ever experienced a similar decline.

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A semester's sabbatical in Washington, D.C., provided by Western Wyoming College, gave me time for writing and editing that I would not have otherwise had, and allowed me access to knowledgeable individuals and important documents.

INTRODUCTION

An Unexpected Test for State and Federal Reclamation Laws

The uranium industry posed a special test to state and federal reclamation laws passed in the 1970's. This was not the test for which these laws were designed. In the 1970's, many residents of the intermountain West worried that the region's natural environment and rural communities were about to be sacrificed in the nation's quest for energy.[1] Such concerns contributed to the enactment of new environmental legislation. These laws, passed in the 1970's, promised to rein in a robust and wealthy mineral industry, and to assure that this industry would help pay to restore the land it disturbed.[2] However, when it came time to actually apply these new laws, both the health of the industry and the major concern of western residents had changed.

By the early 1980's, fears of being overwhelmed by an energy boom had been replaced by fears of bust and economic decline.[3] It was common in this period to hear warnings that strict enforcement of environmental standards would cost precious jobs, and might even be the final blow that closed an important mine. Reclamation laws faced a new and unforeseen challenge, which caused one environmental publication to comment that "[a]s these industries decline, they become more destructive than they were in prosperity."[4]

In the energy bust of the 1980's, the uranium industry fell earlier and harder than other energy producers.[5] Western oil, natural gas, and oil shale also were hit hard, but left less of a reclamation problem. The large surface coal mines of the West fared better, thanks to high

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1. *See* Binder, *Strip Mining, the West and the Nation*, 12 LAND & WATER L. REV. 1, 11-16 (1977); Comment, *Wyoming Environmental Quality Act of 1973* (§ III. Land Quality), 9 LAND & WATER L. REV. 65, 97 (1974).

2. *See* Rosenberg, *Uranium Mining and Milling in Virginia: An Analysis of Regulatory Choice*, 4 VA. J. NAT. RESOURCES L. 81, 99-102 (1984) (on the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA)); Grammer, *The Uranium Mill Tailings Radiation Control Act of 1978 and NRC's Agreement State Program*, 13 NAT. RESOURCES LAW. 469, 500, 506, 521 (1981); *The Surface Mining Control and Reclamation Act of 1977: An Analysis*, 2 HARV. ENVTL. L. REV. 288, 292-98, 327, 328 (1977); Comment, *supra* note 1, at 65, 98, 107-09.

3. *See* REOPENING THE WESTERN FRONTIER 65-147 (E. Marston ed. 1989).

4. Marston, *Real Reclamation*, High Country News, Aug. 4, 1986, at 15.

5. However, many of the uranium companies are subsidiaries of major oil companies or other large companies. In response to congressional inquiries, the Nuclear Regulatory Commission (NRC) indicated that these parent companies would not be liable for reclamation costs unless they had executed a corporate guarantee in lieu of required sureties. *Domestic Uranium Mining Industry and the Dept. of Energy's Uranium Enrichment Program: Hearings Before the Subcomm. on Energy Research and Development of the Senate Comm. on Energy and Natural Resources*, 100th Cong., 1st Sess. 649, 653, 664, 665 (1987) [hereinafter *Uranium Mining Hearings*]. *See also* Bremberg, *Financial Responsibility Requirements and the Implementation of Environmental Policy: The Case of the Uranium Mill Tailings Radiation Control Act*, 8 UCLA J. ENVTL. L. 171, 196-98 (1989).

productivity, low sulfur coal, and long-term contracts to supply power plants.[6] The collapse of the uranium industry in the 1980's is therefore somewhat of a special case. But, given certain assumptions, western coal, too, could face a loss of markets.[7] Consequently, lessons learned from the recent attempt to achieve reclamation in the depressed uranium industry might have a new and wider relevance.

This article focuses on uranium mine and mill tailings reclamation in Wyoming.[8] Wyoming and New Mexico together accounted for about 80% of the nation's total uranium production during the 1970's boom.[9] However, reclamation problems in the two states are quite different. In Wyoming over 90% of the uranium was produced from large open-pit mines.[10] A single pit could be 500 feet deep, and disturb a surface area up to 200 acres.[11] The total acreage disturbed by a mine ranged from 300 to 3,000 acres.[12] In contrast, uranium ore in New

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6. *See, e.g.*, Jones, *Coal Update*, 8 WYO. GEO-NOTES 4, 4-17 (1985) (pub. by Geological Survey of Wyoming); *Wyoming Second Largest Coal Producer*, Casper Star-Tribune, Jan. 26, 1984, at B-1.

7. Future demand for coal could be affected by a preference for cleaner, renewable, fuels. Such alternative fuels could become more cost competitive through technical improvements; legislation which either favored such alternatives or proved more burdensome to coal; or because of some change in the supply, such as the depletion of the most easily mined coal seams. New efforts at fuel conservation and efficiency could affect the demand for coal. Coal generated power could even face new competition from nuclear power, spurred by fears of global warming. *See, e.g.*, J. McKean & J. Diemer, Future of the Inland West U.S. 4-6 (March 19, 1981) (photo. manuscript produced for U.S. Dept. of Energy, Western Regional Studies Project (a discussion of this study is found in: Simpson, *Study Says Wyoming Faces Big Bust by 2020*, Casper Star-Tribune, Aug. 16, 1981, at A-1, A-16)); Melnykovych, *Bush Official Says Coal Still in Energy Future*, Casper Star-Tribune, Feb. 23, 1991, at A-3; Lazarus, *Fusion Breakthrough Could Cloud Wyo. Future*, Casper Star-Tribune, Apr. 16, 1989, at A-1, A-12; Hegna, *Wyoming Coal Market Will Be Hurt, Study Says*, Casper Star-Tribune, Oct. 6, 1985, at A-1, A-12.

8. Only the reclamation efforts of the private uranium industry will be examined here. Two government uranium reclamation programs also operate in Wyoming. The Abandoned Mine Land (AML) program is the more important, and is administered jointly by Wyoming and the federal Office of Surface Mining. This program reclaims lands mined before companies were required to reclaim. It is financed by Wyoming's share of the federal AML tax on current coal production.

The Uranium Mill Tailings Remedial Actions (UMTRA) Project is a federal Department of Energy effort to clean up tailings sites that were either abandoned or inactive as of 1978. There are two UMTRA projects in Wyoming. The larger involves the removal of tailings from the old Susquehanna-Western uranium mill near Riverton, Wyoming. *See generally* WYO. DEP'T OF ENVTL. QUALITY, 1989 ANN. RPT. 29-32 (reviews the AML and UMTRA projects).

9. QUALITY DEVELOPMENT ASSOCIATES, INC., WYOMING'S URANIUM INDUSTRY—STATUS, IMPACTS, AND TRENDS 4-8 (Sept. 30, 1978) (Report to Wyo. Dept. of Econ. Planning and Dev.) [hereinafter QUALITY DEVELOPMENT ASSOCIATES, INC.]. Wyoming's share was about one-third of total production. *Id.*

10. *Id.* at 3-1.

11. *Id.* at 3-1, 6-2.

12. WYO. DEP'T OF ENVTL. QUALITY, LAND QUALITY DIVISION, URANIUM SUMMARY (June 26, 1984).

Unless otherwise noted, all unpublished Wyoming Department of Environmental Quality (DEQ) reports, U.S. Nuclear Regulatory Commission (NRC) reports, and correspondence from mine operators cited in this study can be found in the files and archives of the Land Quality Division, Wyo. Dept. of Envtl. Quality, 3rd Floor,

Mexico often was too deep for surface mining.[13] The underground uranium mines found there pose a less formidable reclamation task.[14] However, the problem of reclaiming radioactive mill tailings, which remain after the uranium is extracted from the ore, is common to both states. Both states are also subject to federal legislation governing uranium mill tailings reclamation.[15] Reclamation of open-pit uranium mines is governed by state law.[16]

The analysis presented will be legal, political, and environmental. The mixture of federal and state law that governs uranium mine and mill tailings reclamation will be explained. The actual implementation of these laws is also examined, as are disputes at both the state and federal level over implementation and interpretation of the law. Discussion of actual reclamation activity will draw heavily on inspection reports from the Wyoming Department of Environmental Quality (DEQ) and the Nuclear Regulatory Commission (NRC), supplemented by interviews and field observation.

The quality of uranium mine reclamation will be assessed, in addition to its legal adequacy. Where situations are similar, the standard used for judging quality will be that set by the surface coal mining industry in the West.[17] Reclamation in western surface coal mines is well documented,[18] and progress is generally viewed as quite satisfac-

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Herschler Bldg., 122 West 25th, Cheyenne, Wyoming 82002 [hereinafter DEQ/LQD files]. Copies of all reports cited are also in the author's possession.

13. Riccitiello, *Uranium Mining and Milling: A Primer*, 4 WORKBOOK 222, 224 (1979).

14. Underground mines disturb less surface area, and are developed in a way that minimizes the removal of waste rock (spoil), resulting in much smaller spoil storage piles than those at surface mines. 2 U.S. ENVTL. PROTECTION AGENCY, POTENTIAL HEALTH AND ENVIRONMENTAL HAZARDS OF URANIUM MINE WASTES: REPORT TO CONGRESS, at 1-16 (1983).

15. *See infra* text accompanying notes 117-198.

16. In December 1989, the Environmental Protection Agency (EPA) reaffirmed its decision *not* to regulate radon emissions from open-pit uranium mines, under the Clean Air Act. National Emission Standards for Hazardous Air Pollutants; Radionuclides, 54 Fed. Reg. 51,654, 51,678-79 (1989) [hereinafter 1989 NESHAPS]. *See also infra* text accompanying notes 155-159.

Radon emissions from underground uranium mines are regulated by the EPA. 40 C.F.R. § 61.20 (1990). For a discussion of the possible impact of the Clean Air Act Amendments of November 1990 on the regulation of radionuclide emissions from open-pit and underground uranium mines, *see infra* text accompanying notes 195-197.

Under the 1976 Resource Conservation and Recovery Act (RCRA) the EPA has the authority to regulate hazardous mining wastes, and has announced its intention to develop regulations for this purpose in the early 1990's. U.S. Envtl. Protection Agency, Office of Solid Waste and Emergency Response, Strawman II, Recommendations for a Regulatory Program for Mining Wastes and Materials Under Subtitle D of the Resource Conservation and Recovery Act (May 21, 1990) (photo. manuscript). *See also* Regulatory Determination, 51 Fed. Reg. 24,496 (1986).

17. Coal mines do not have to contend with the reclamation of radioactive mill tailings, so this is one case where the situation is obviously not similar. However, Department of Energy efforts to reclaim abandoned tailings sites (*see supra* note 8) might provide an interesting standard, in some future study, against which the mill tailings reclamation efforts of the industry could be judged.

18. *E.g.*, U.S. CONGRESS, OFFICE OF TECHNOLOGY ASSESSMENT, WESTERN SURFACE

tory.[19] Other, more abstract, criteria for determining quality could be used. But the accomplishments of western coal operators provide a standard that exists in the real world, and that has been achieved working in similar physical and climatic conditions. A comparison with western coal, therefore, provides a straightforward and realistic basis to discuss the quality of uranium mine reclamation in Wyoming.

An Industry Collapses

The last uranium boom ended in 1980.[20] Prices rose dramatically from under $6 per pound of uranium oxide (U_3O_8) in 1973, to $40 per pound in 1976.[21] Prices stayed in the $40 range between 1976 and 1979, which, considering inflation, represented a substantial decline in real value.[22] This decline accelerated rapidly in 1980, when the price of uranium oxide fell from $40 per pound to $25 per pound.[23] Prices held at this level in 1981, and then fell to $17 per pound in 1982.[24] After a brief rise in 1983, prices again fell below $20 per pound, where they remained through the 1980's.[25]

In 1977, Wyoming produced about 4.5 million tons of uranium ore.[26] (Uranium ore is milled to extract uranium oxide.) Projections were that Wyoming's output would reach almost 19 million tons of uranium ore in 1990.[27] In fact, production peaked at 5.5 million tons

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MINE PERMITTING AND RECLAMATION OTA-E-279 (U.S. Gov't Printing Office, June 1986) [hereinafter OFFICE OF TECHNOLOGY ASSESSMENT).

19. *Id.* at 7.

The quality of coal mine reclamation elsewhere is open to debate. Smaller operators in the Southeast and Midwest, who do not have a long-term commitment to a single large mine, have proven much more difficult to regulate. *See, e.g.*, Comment, *Recent Efforts To Stop Abuse of SMCRA: Have They Gone Far Enough?*, 20 ENVTL. L. 167 *passim* (1990).

20. For a discussion of the factors behind the uranium boom and bust of the 1970's, from cartels to Three Mile Island, see: *Domestic Uranium Mining and Milling: Hearing Before the Subcomm. on Nuclear Regulation of the Senate Comm. on Env't and Pub. Works*, 98th Cong., 1st Sess. (1983) [hereinafter *Hearing*] (hearing held in Riverton, Wyo.); A. OWEN, THE ECONOMICS OF URANIUM 44-56 (1985); J. TAYLOR & M. YOKELL, YELLOWCAKE: THE INTERNATIONAL URANIUM CARTEL (1979); Comment, *Recent Congressional Proposals for Providing Relief to the Domestic Uranium Industry: Saving Grace or Just Another Expensive Bailout?*, 10 J. ENERGY L. & POL'Y 171, 177-80 (1990) [hereinafter *Relief Proposals*]; Friedberg, *Elephants, Uranium, and the Energy Crisis*, 49 TENN. L. REV. 885 (1982).

21. Owen, *Short-Term Price Formation in the U.S. Uranium Market*, 6 ENERGY J. 37, 38-40 (1985).

Uranium ore may contain less than 0.1 percent uranium. The uranium is chemically extracted from the ore (or milled) to produce a concentrate, commonly known as "yellowcake," which contains about 80% uranium oxide. A. OWEN, *supra* note 20, at 26.

22. Owen, *supra* note 21, at 40.

23. *Id.* at 41.

24. *Id.*

25. *Id.*

26. QUALITY DEVELOPMENT ASSOCIATES, INC., *supra* note 9, at 4-10.

27. *Id.* at 8-7.

in 1978.[28] By 1982, ore production had fallen over 60%, to 2.1 million tons.[29] Production was under 2 million tons by 1984; under 1 million tons by 1985; and under 500,000 tons by 1986.[30] In 1990, the last conventional open-pit mine and mill operation, Pathfinder's Shirley Basin Mine, closed temporarily.[31] As of late 1990, the only uranium production in the State was from a single solution mine, that removes the uranium from the ore while it is still in the ground.[32]

The rapid demise of Wyoming's uranium industry is well illustrated by employment figures. Total employment by Wyoming's uranium producers went from 5,000 in March 1980, to under 2,500 by December 1981.[33] The figure was below 1,000 by the end of 1984, and by 1986 only 435 people in the State were employed in the industry.[34] In the early 1980's, eighteen Wyoming mines were operating, nine of which also included uranium mills.[35] By the mid-1980's, most of the eighteen were employing only maintenance crews, and only six mines employed more than ten people.[36]

The year 1988 was especially distressing for the uranium industry. Efforts to win protection from foreign uranium imports failed both in Congress[37] and before the Supreme Court.[38] The failed effort to protect producers from imports, in turn, led to a liquidation of uranium which had been held back in expectation of higher prices.[39] This sell-off of uranium contributed to a 29% fall in current prices in 1988

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28. *Hearing, supra* note 20, at 49.

29. Glass, *Minerals Update*, 26 WYO. GEO-NOTES 1 (1990).

30. *Id.*

31. Harris, *Uranium Update*, 26 WYO. GEO-NOTES 28, 29 (1990).

32. This mine was operated by Power Resources (London Central Energy) at the Highland mine property in Converse County. Harris, *Industrial Minerals and Uranium Update*, 28 WYO. GEO-NOTES 29, 33 (1990).

33. WYO. MINING ASS'N, WYOMING MINERAL INDUSTRY FACTS 1985 at 40 (1986).

34. *Id.*

35. *Id.* at 36.

36. *Id.* at 40.

37. S. 2097 passed the Senate in March 1988. S. 2097, S. REP. No. 214, 100th Cong., 2d Sess. (1989). This bill established limits on the amount of imported uranium that United States nuclear utilities could load into their reactors without paying a surcharge. As much imported uranium comes from Canada, this provision was undercut when implementing legislation for the United States-Canadian Free Trade Agreement was passed by Congress later in 1988. *See Domestic Uranium Industry and Enrichment Program: Hearings on H.R. 4934 and H.R. 5181 Before the Subcomm. on Energy and Power of the House Comm. on Energy and Commerce*, 100th Cong., 2d Sess. 1, 2, 144, 155, 156, 205 (1988).

In 1989, the Senate again passed legislation to assist the uranium industry (S. 83, S. REP. No. 60, 101st Cong., 1st Sess. (1989)), but this also failed in the House. *See generally Relief Proposals, supra* note 20, at 185-92.

38. In 1988, the Court found that legislation passed in 1983, to protect the domestic uranium industry, did not require that foreign imports be restricted, unless such restrictions would assure the viability of the domestic industry. Huffman v. Western Nuclear, Inc. 486 U.S. 663 (1988). *See also* Griffin & Dorin, *Huffman v. Western Nuclear, Inc.: An Examination of the Domestic Uranium Industry's Recent Defeat*, 11 U. PA. J. INT'L BUS. L. 433 (1989); *Relief Proposals, supra* note 20, at 171, 181-83.

39. White, *Uranium: Renewed Price Weakness*, ENGIN. & MINING J., Mar. 1989, at 45.

(from $16.55 per pound of uranium oxide to $11.75 per pound).[40] In 1989, prices dropped below $10 per pound.[41] Prices remained at this low level in 1990. In real dollar terms, uranium prices in 1990 were lower than at any time since the United States government had allowed a private uranium market to come into existence in the late 1960's.[42]

DEFERRED RECLAMATION

In the early and mid-1980's, it would have been oxymoronic to ask about the quality of uranium mine reclamation in Wyoming. Little or no reclamation was taking place. With few exceptions mining had stopped. Yet, the reclamation seemingly promised by law did not happen. Some doubted if the uranium industry ever would reclaim.

Requests to Defer Reclamation

Uranium mine reclamation in Wyoming is governed by the 1973 Environmental Quality Act.[43] This law appears to require that mine reclamation take place either as mining progresses or soon after mining has ceased. The Act calls for "[a] time schedule encouraging the earliest possible reclamation program consistent with the orderly and economic development of the mining property."[44] Operators are to "[r]eclaim the affected land as mining progresses in conformity with the approved reclamation plan."[45] The Act also states that "[a]fter the mining operations have ceased or within thirty (30) days after abandonment of the mining operation, the operator shall notify the administrator of such fact and commence reclamation and restoration."[46]

In the early 1980's, rules implementing this Act called for reclamation "concurrently" with mining.[47] If this were not possible, then "[r]eclamation must begin within 180 days after termination of mineral production."[48] However, these rules also provided that if reclamation could not be completed within two years, an operator could request "to leave an operation partially unreclaimed for a period of time

40. *Id.*

41. White, *Uranium: Price Plunge Continues*, ENGIN. & MINING J., Mar. 1990, at 59.

42. Harris, *Uranium Update*, 25 WYO. GEO-NOTES 28, 29 (1990). *See also* A. OWEN, *supra* note 20, at 36-44.

43. WYO. STAT. §§ 35-11-101 to -1428 (1988).

44. *Id.* § 35-11-402(a)(iii) (1988).

45. *Id.* § 35-11-415(b)(ix) (1988).

46. *Id.* § 35-11-401(e)(viii) (1988).

47. WYO. DEP'T OF ENVTL. QUALITY, LAND QUALITY DIV., RULES AND REGS. 1981 ch. IV, § 2(l)(1) (Mar. 1981).

48. *Id.* (In 1986, this specific time limit was dropped from the rules. *Compare with* WYO DEP'T OF ENVTL. QUALITY, LAND QUALITY DIV., RULES AND REGS., ch. IV (Sept. 1, 1986)).

on the basis that economic conditions may make it profitable to continue mining in the near future."[49] Requests for deferred reclamation, or "interim mine stabilization" as it came to be called, had to contain an explanation of how mining would be profitable in the future.[50] Companies also had to provide a description of how the mine would be stabilized and made safe, and explain what steps would be taken to prevent water pollution.[51]

When the bottom fell out of the uranium market, the uranium mining industry was quick to take advantage of this chance to defer reclamation. Most companies could not afford to mine, but neither did they want to reclaim.[52] Excavating millions of cubic yards of material to reach the uranium could take two years and was the most expensive part of opening a mine.[53] The industry argued that if it were forced to fill in pits before all the ore was extracted, then this would be the end of uranium mining in Wyoming:

> And certainly if any shafts are allowed to, or mines refilled with water or have to be reclaimed in total and filled up [sic], almost certainly they will never be gone back into for the low-grade ore that's there. Certainly not in our lifetime or many lifetimes. So we are very concerned that this legal position of interim stabilization become a very real part of our operation and understood by the government.[54]

The possibility that uranium companies might be allowed to stop mining without restoring the land was greeted skeptically by environmental groups. The Wyoming Outdoor Council said that recommendations to ease state regulations "amount to a subsidy to an industry that is not competing. Where is the free market we hear so much about?"[55] The Powder River Basin Resource Council urged the State "to require reclamation of uranium mines that have been in effect abandoned by the current slump in the uranium industry."[56] The Resource Council argued that reclamation of inactive mines should start because it would save water. They claimed that "Kerr-McGee's Bill Smith mine in Converse County has been inactive since 1978 but has

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49. *Id.* ch. IV, § 2(l)(2) (Mar. 1981).

50. *Id.*

51. *Id.*

52. For a discussion of reclamation requirements for non-coal mines in the State of Wyoming, see *infra* text accompanying notes 235-272.

53. Purdy, *Reclamation Ongoing at Pathfinder Mines, but Expense Worries Officials*, Casper Star-Tribune, Oct. 25, 1981, at A1, A16. *See also* QUALITY DEVELOPMENT ASSOCIATES, INC., *supra* note 9, at 3-1, 6-2.

54. *Hearing*, *supra* note 20, at 16 (statement of William H. Budd, Wyo. Mining Ass'n).

55. White, *Uranium Industry Slump Blamed on Economics*, Casper Star-Tribune, Nov. 16, 1981, at B1.

56. *Powder River Basin Council Wants Uranium Reclamation*, Rock Springs Daily Rocket-Miner, Oct. 13, 1981, at 14.

been dewatering land to the tune of 3,000 acre-feet a year."[57] While the Resource Council said it was sympathetic to the plight of uranium workers, it suggested that they could be employed repairing land that had been damaged by mining. "There are certainly a lot more jobs in reclamation than there are in waiting for the uranium market to come alive."[58]

The State Responds

The state agency responsible for ensuring reclamation is the Department of Environmental Quality (DEQ). In the early 1980's, DEQ found itself in a dilemma. Uranium was an important industry in the State. In 1973, however, the legislature had passed a tough new mine reclamation law, the Environmental Quality Act, which promised that mined land would be reclaimed to a use at least equal to its highest previous use.[59] Ideally reclamation would be concurrent with mining, but in any case it was to begin as soon as mining ceased. Yet, little uranium mine reclamation had taken place since the law was enacted, and much new land had been disturbed during the boom of the 1970's. Now, in the face of an uncertain market, uranium companies were seeking to defer reclamation until economic conditions improved.

DEQ first took a rather hard line with the industry. The Agency's policy was to deny "a reclamation deferral unless a company could show economic conditions would improve in two years."[60] Essentially, this meant a company had to have a delivery contract.[61] DEQ's hard line softened as lay-offs in the uranium industry mounted, and as uranium and its future became a subject of political debate. As early as August 1981, Governor Ed Herschler wrote the Department of Environmental Quality "suggesting DEQ rules be changed to allow more discretion because the uranium industry may remain in a slump until the year 2000."[62] The State's treatment of the uranium industry became an issue in the 1982 governor's race.[63] In 1983, the legislature amended the Environmental Quality Act to instruct DEQ that it "shall consider interim mine stabilization" in promulgating regulations.[64] In 1985, Governor Herschler vetoed a bill that would have re-

57. *Id.*
58. *Id.*
59. WYO. STAT. § 35-11-402(a)(i) (1988). *See also* WYO. DEP'T OF ENVTL. QUALITY, LAND QUALITY DIV., RULES AND REGS. ch. II, § 1 (1975).
This law was "tough" in comparison to other state mine reclamation laws which existed in the 1970's. Binder, *supra* note 1, at 36.
60. Barron, *Freudenthal Responds to Morton Uranium Criticism*, Casper Star-Tribune, Sept. 2, 1982, at B1 (Wyoming Attorney General Steven Freudenthal explaining DEQ policy in 1981).
61. Telephone interview with official in the Land Quality Div., Wyo. DEQ (Aug. 19, 1985).
62. Barron, *supra* note 60.
63. *See id.*
64. WYO. STAT. § 35-11-401(n) (1988).

stricted DEQ's ability to write new regulations on deferred reclamation.[65] In the same year, there was even an attempt to take the decision to defer reclamation out of state hands. Pathfinder Mines Corporation led a fight to amend the Environmental Quality Act. The amendment would have allowed non-coal surface mining companies to adjust mining and reclamation schedules, without state approval, as long as such changes did not threaten serious environmental damage.[66] This amendment, which had considerable support in the Wyoming Senate, was twice defeated in the House by a single vote.[67]

Even though most of these efforts to aid the industry were unsuccessful, the legislature's obvious concern did help to produce a compromise of sorts between the State and the uranium industry.[68] Companies that wanted to defer reclamation no longer had to try to show that mining would be profitable in the near future.[69] (Indeed, the future looked no brighter than it had earlier.)[70] DEQ would grant reclamation deferrals for a five year period, and additional five year extensions of the deferral were possible.[71] In turn, companies would continue to submit annual reports on the status of their mines, and DEQ would continue to inspect the mines on an annual basis or more frequently if necessary. Bonds also had to be maintained to cover the costs to the State if a company defaulted on its reclamation obligation. There were even attempts by DEQ to get companies to begin partial reclamation, working in areas of the mine that would not come into use if mining resumed.[72]

Although it was clear by the mid-1980's that the companies would not be allowed to walk away from their closed-down mines, this, nevertheless, was a period of some disillusionment for those who had believed that the 1973 Environmental Quality Act would ensure immedi-

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65. *See* WYO. OUTDOOR COUNCIL, *The Issue: Interim Mine Stabilization (HB 433A)*, LEGISLATIVE ANALYSIS 1985, at 22-25 (1985); WYO. OUTDOOR COUNCIL, LEGISLATIVE REPORT, Feb. 7, 1985, at 4.

66. MacKinnon, *Fate of Mine Reclamation Measure Still Uncertain*, Casper Star-Tribune, Feb. 23, 1985, at A4. *See also House Tentatively Approves Mine Measure*, Rock Springs Daily Rocket-Miner, Feb. 2, 1985, at 1.

67. MacKinnon, *Reclamation Bill Splits House*, Casper Star-Tribune, Feb. 2, 1985, at A1, A14; WYO. OUTDOOR COUNCIL, LEGISLATIVE ANALYSIS 1985, *supra* note 65.

68. *See Mining Officials Find Better Cooperation with DEQ*, Rock Springs Daily Rocket-Miner, June 27, 1985, at 6; *DEQ Director Calls for Cooperation*, Rock Springs Daily Rocket-Miner, June 23, 1987, at 2.

69. For example, in a telephone interview in 1985, a DEQ official stated: "Practically all uranium operators have requested and received interim stabilization . . . . Operators still have to show that there are recoverable reserves, but this is really open-ended. Some reserves are recoverable, but only when uranium reaches $80 a pound." Telephone interview, *supra* note 61.

70. *See, e.g.*, Horsely, *Wyoming Asks to Join Uranium Companies in Suit Filed Against Department of Energy*, Casper Star-Tribune, July 26, 1985, at B1; *Chernobyl Meltdown: The Nuclear Bargain*, NEWSWEEK, May 12, 1986, at 40-9.

71. A formal change in the rules was made in 1986 to allow for such five-year deferrals and renewals. LAND QUALITY DIV., *supra* note 48, ch. IV, § 2(l)(ii)(A) & (D).

72. DEQ annual inspection reports contain many examples of this. *See* DEQ/LQD files *passim*.

ate reclamation. Uranium mining had essentially stopped, yet little or no reclamation was taking place. Such a situation brought to mind arguments made in support of a federal take-over of coal mine reclamation in the 1970's. Federal regulation was necessary, some said, because state governments would lack the will to force costly reclamation requirements on an important local industry.[73] The lack of reclamation activity at Wyoming's closed down uranium mines seemed to support this point.

A Reassessment of Wyoming's Flexible Approach to Uranium Mine Reclamation

Those in the 1980's who worried about uranium mine reclamation not taking place, would in the early 1990's be more likely to praise Wyoming's flexible approach to reclamation. This is because final reclamation is well under way at most mines. Most open-pit uranium mine operations in Wyoming have indicated that they are moving towards final reclamation and closure, or at least they are reclaiming in probable preparation to close.[74] The significance of this move, of course, depends on the quality of final reclamation achieved. Still, it appears most companies which operated open-pit uranium mines in the 1970's, will in the 1990's fulfill their mine reclamation obligation under Wyoming law. Mines which also operated uranium mills must in addition cover and reclaim the radioactive tailings piles which remain after the uranium is milled. Mill tailings reclamation is regulated under federal law,[75] and the reclamation process is more lengthy

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73. *E.g.*, CONG. RESEARCH SERVICE, SEN. COMM. ON ENERGY AND NAT. RESOURCES, STATE SURFACE MINING LAWS, Pub. L. No. 95-25, 95th Congress, 1st Sess. 22, 25 (1977); *The Surface Mining Control and Reclamation Act of 1977: An Analysis*, 2 HARV. ENVTL. L. REV. 288, 295 (1977).

74. Uranium mining companies are often hesitant to discuss their plans, but according to interviews and DEQ reports the following major companies in Wyoming had reclaimed, or were actively reclaiming, uranium mines or mill tailings as of the early 1990's. Parent companies are listed in parentheses. The companies are: Bear Creek Uranium Co. (Rocky Mt. Energy/Union Pacific); Exxon; Petrotomics Co. (Texaco); Sequoyah Fuels Corp. (Kerr-McGee, recently sold to Rio Algom); Silver King Mines, Inc. (T.V.A.); Western Nuclear, Inc. (Phelps Dodge Corp.).

Umetco Minerals Corp. (Union Carbide Corp.) is actively reclaiming its mine, but is also serving as a repository for the tailings being removed by the federal UMTRA project at Riverton, Wyoming. American Nuclear Corporation has dismantled its uranium mill and begun reclaiming tailings, but has indicated that it would like to contract for disposal of uranium mine and mill by-product waste from other sites. Whipple, *Gas Hills Uranium Mill Site To Receive Radioactive Waste*, Casper Star-Tribune, Oct. 6, 1990, at A3.

75. *See infra* notes 117-221 and accompanying text. Until 1987 Wyoming had regulated the non-radioactive aspects of uranium mill tailings in cooperation with the Nuclear Regulatory Commission (NRC). The NRC allowed Wyoming to collect a single reclamation bond, if a company so desired, which covered reclamation of the mill and tailings area as well as the mine itself. In 1987, however, citing the need to avoid dual regulation, the State removed "uranium mill tailings, facilities and impoundments from the jurisdiction of the Wyoming Environmental Quality Act." Wyo. House Enrolled Act 104, 49th Legis. (1987) (amending WYO. STAT. §§ 35-11-103(e)(viii), (xvi), (xvii), & § 35-11-301(a)(iii).

as it involves drying out the tailings. But, here too, it appears that considerable progress towards final reclamation will take place in the 1990's.

This increased reclamation activity is not a direct result of pressure from the State. It has far more to do with the continued poor economic and political prospects for the United States' uranium industry.[76] Also, some companies have begun reclamation after long-term delivery contracts were purchased or after lengthy contract disputes were settled.[77]

The Wyoming Department of Environmental Quality (DEQ) can take credit, however, for conducting an effective holding operation in the midst of an economic crisis. Reclamation was deferred, but the mining companies never had reason to doubt that it would eventually be required. DEQ can also take credit for keeping open the possibility of a return to mining throughout the 1980's. In the end, most companies have decided this was not possible. Reclamation is well under way, and it is being done by the companies themselves, not the State. Only one important default on a reclamation bond has occurred, where the State had to undertake reclamation for a company that abandoned a solution uranium mine.[78] This final reclamation project is estimated to cost $2.5 million. The State held two reclamation bonds totaling $1.1 million. The smaller bond for $500,000 was never collected as the surety company followed the mining company into bankruptcy.[79] The accomplishment of having only one such default

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76. *See supra* notes 37-42 and accompanying text.

77. For example, Bear Creek Uranium Co. (Union Pacific) had its contract with the operator of San Onofre II nuclear plant in California purchased in 1985. Hegna & Harding, *Glenrock's Bear Creek Uranium to Close Later this Year*, Casper Star-Tribune, Aug. 10, 1985, at B1. Bear Creek began final reclamation soon after and will probably be one of the first companies to apply for release of reclamation bonds.

In 1987, a midwestern utility settled its contract obligations with Minerals Exploration Co. (Unocal 76). So far Minerals Exploration Co. has announced no plans to permanently close its mine and mill. *See* Collins, *Sweetwater Mining Firm Wins Zone Change*, Casper Star-Tribune, May 12, 1988, at B1.

78. Kirshner, *Uranium Mine Potential Health Threat*, Casper Star-Tribune, Dec. 12, 1985, at B1.

DEQ took steps to revoke a $42,000 reclamation bond on an underground uranium mine owned by U.S. Energy. However, an agreement was reached whereby the mine would be reclaimed by the company. (In the Matter of a U.S. Energy Corporation Forfeiture of Bond, Permit No. 480, No. 1359-84 (Wyo. Envtl. Quality Council, Aug. 3, 1984) (DEQ/LQD files).)

There have been a number of small bond forfeitures in Wyoming. *See Mine Reclamation and Bonding: Oversight Hearing Before the Subcomm. on Mining and Natural Resources of the House Comm. on Interior and Insular Affairs*, 101st Cong., 1st Sess. 277, 281 (1989) [hereinafter *Hearing on Bonding*].

79. Fortunately, the State negotiated a $1.9 million settlement with the joint venture partner of the company that abandoned the mine. WYO. DEP'T OF ENVTL. QUALITY, 1987 ANN. RPT. 22, 23 (1987); WYO. DEP'T OF ENVTL. QUALITY, 1989 ANN. RPT. 32, 33 (1989).

On the general problem of finding safe sureties to guarantee surface mine reclamation, see: U.S. GEN. ACCOUNTING OFFICE, SURFACE MINING: COST AND AVAILABILITY OF RECLAMATION BONDS (April, 1988); Bremberg, *supra* note 5, at 198-200; *Hearing on*

during an extended economic crisis would by itself seem worthy of acclaim.

A Major Exception

It is too early to conclude that Wyoming's flexible approach to uranium mine reclamation, in the 1980's, will result in completed reclamation in the 1990's. This is because a major exception exists to the general move towards final reclamation—Pathfinder Mines Corporation, a subsidiary of the French state-owned company Cogema.[80] Pathfinder's three mines are so large,[81] and its outstanding reclamation obligation so great, that a final assessment of the state policy of deferring reclamation would be premature.

Together Pathfinder's mines make up the largest uranium holding in the State.[82] Representatives of Pathfinder have indicated at various times that the company plans to resume mining when economic conditions permit, and until very recently a token mining operation was maintained.[83] In the meantime, however, Pathfinder has the most unreclaimed land,[84] and the largest volume and largest area of unreclaimed tailings in the State.[85] The bond to guarantee reclamation at the three mines is the largest uranium bond held by the State—covering total reclamation costs of over $75 million.[86] Recently, questions were raised in the press about the lack of reclamation activity at Pathfinder's mines.[87] The press also questioned the

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Bonding, *supra* note 78, *passim*.

80. Compagnie Généale des Matières Nucléaires is among the leading world companies serving the nuclear fuel cycle. *See* White, *COGEMA*, ENGIN. & MINING J., Aug. 1986, at 32, 33.

81. These are the Shirley Basin mine and mill in Shirley Basin, the Lucky Mc mine and mill in the Gas Hills, and the Big Eagle mine near Jeffery City.

82. WYO. DEP'T OF ENVTL. QUALITY, *supra* note 12.

83. *See, e.g.*, Harris, *Uranium Update*, 27 WYO. GEO-NOTES 33 (1990); Ensor, *Lucky Mc Mill To Close, Firm Says*, Casper Star-Tribune, Mar. 1, 1988, at A-1, A-16; Kirshner, *Pathfinder: Reclamation Laws Make Firm Reluctant To Buy TVA Mine Site*, Casper Star-Tribune, Dec. 15, 1985, at B-1.

84. WYO. DEP'T OF ENVTL. QUALITY, *supra* note 12. *See also* Kessler, *Pathfinder Uranium Mines Unbonded*, FRONTLINE REP., Aug./Sept. 1990, at 1, 2 (Wyo. Outdoor Council newsletter).

85. Government figures show that Pathfinder's Shirley Basin and Lucky Mc mills produced 17.8 million short tons of tailings covering 550 acres. This is a far greater quantity than any other company in Wyoming has produced. *See* U.S. ENVTL. PROTECTION AGENCY, OFFICE OF RADIATION PROGRAMS, FINAL RULE FOR RADON-222 EMISSIONS FROM LICENSED URANIUM MILL TAILINGS 4-8, 4-9 (Background Information Document, Aug. 1986) [hereinafter FINAL RULE RADON-222]; *Uranium Mining Hearings*, *supra* note 5, at 660.

86. Kessler, *supra* note 84. *See also* O'Gara, *Pathfinder Bond Unreliable: DEQ*, Casper Star-Tribune, Sept. 28, 1990, at A1, A12. This does not include the irrevocable letters of credit held by the NRC for reclamation of the mill and mill tailings at Pathfinder's Lucky Mc and Shirley Basin mines. NRC figures showed these letters of credit guaranteed an obligation of over $12 million. *Uranium Mining Hearings*, *supra* note 5, at 662. On letters of credit and other financial sureties accepted by NRC to guarantee the reclamation of mill tailings, *see* Bremberg, *supra* note 5, at 191-206.

87. O'Gara, *supra* note 86, at A12.

adequacy of Cogema's assets in the United States, said to be $8 million, which provide the guarantee for the $78 million reclamation obligation.[88]

With such an important exception to the general move to reclaim, no conclusion can be drawn about the wisdom, or successful outcome, of Wyoming's policy of deferring reclamation. Furthermore, until Pathfinder resumes full-scale mining or begins final reclamation, the State policy of allowing companies to defer reclamation, without any final time limit, is still very much in effect, and thus, open for debate.

REGULATING RADIONUCLIDE EMISSIONS

A likely criticism of allowing uranium companies to defer reclamation is that unreclaimed uranium mines, and mill tailings, pose a threat to health and the environment. Just such an argument was made by the Wyoming Outdoor Council in response to a proposal from Pathfinder Mines to ease the process for deferring reclamation: "In the draft regulations, no recognition is given to the special hazards associated with radioactive debris. Every possible effort should be made to *minimize the exposure of organic life to radiation.* There is no such thing as a 'safe' level of radiation."[89]

The Radiation Threat

The radiation danger from surface uranium mining is created when soil and rock are removed to reach uranium ore. This soil and rock shield the surface from radiation emanating from the uranium bearing formation.[90] Decay products of radon-222 pose the major cancer risk to humans.[91] Ordinarily, most radon-222 generated below the surface decays into nongaseous radionuclides before it can migrate through the space between soil particles.[92] However, with a half-life of 3.8 days, if radon-222 does escape into the atmosphere, these gaseous atoms can travel hundreds of miles before they decay.[93]

Once in the atmosphere, the decay products of radon-222 can attach to microscopic dust particles. When inhaled, these small particles may stick to the moist epithelial lining of the bronchi.[94] Before being

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88. *Id.* at A1, A12. *See also* O'Gara, *DEQ Decided Not To Press Pathfinder On Cleanup Bond*, Casper Star-Tribune, Sept. 29, 1990, at A1, A16 [hereinafter *Cleanup Bond*]; O'Gara, *Sullivan: DEQ Backed Off Pathfinder Reclamation*, Casper Star-Tribune, Oct. 12, 1990, at A1, A16.

89. Letter from A. Donn Kesselheim, Wyo. Outdoor Council, to Dave Park, Envtl. Quality Council (Mar. 3, 1986) (DEQ/LQD files).

90. FINAL RULE RADON-222, *supra* note 85, at 3-4, 3-6.

91. 1989 NESHAPS, *supra* note 16, at 51,663; S. SALESKA, NUCLEAR LEGACY II-6 to II-9 (Public Citizen, Critical Mass Energy Project, Sept. 1989).

92. FINAL RULE RADON-222, *supra* note 85, at 3-6.

93. *Id.* at 2-2.

94. *Id.* The radon-222 decay process involves seven principal decay products before the radon-222 becomes nonradioactive lead. The first four short-half-life radio-

cleared from the bronchi by mucus, they can expose several types of lung cells to alpha radiation and increase the risk of lung cancer.[95] Total energy dissipation in the lungs from the decay products is about 500 times greater than that derived from radon itself,[96] and is about twenty times more destructive than either beta or gamma radiation.[97]

Unreclaimed uranium mill tailings are another source of radon-222 emissions into the environment. About half the uranium mines in Wyoming have, or had, mills on the premises.[98] At the mill, uranium ore is crushed, blended and ground to the proper size for the leaching process which extracts uranium.[99] Mill tailings are what remain after the uranium is removed. After leaching, most of the original bulk is left as residue, and typically a ton of ore will produce almost a ton of tailings residue.[100] Tailings consist of sands and slimes (coarse and fine tailings) plus the spent solution used to leach the uranium from the ore.[101] This liquid residue is pumped to a tailings pond which when dried is referred to as a tailings pile. These ponds are quite large. About half the licensed tailings ponds in Wyoming are over 100 acres in size, the largest being 261 acres.[102]

Although most of the uranium is removed from the ore in the milling process, the tailings residue contains much of the radioactivity of the original ore.[103] This radioactivity comes from unextracted uranium, radium-226, thorium-230 and other trace metals.[104] These radionuclides are found in tailings at several hundred times the normal level in soil.[105] Non-radioactive, but potentially water polluting contaminants also are commonly found in tailings. These contaminants may include arsenic, molybdenum, lead, selenium, chloride, manga-

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active decay products of radon-222 are the most important sources of cancer risk. Members of the decay chain with relatively long half-lives are much more likely to be ingested than inhaled and generally present much smaller risk. *Id.*

95. *Id.*

96. M. EISENBUD, ENVIRONMENTAL RADIOACTIVITY 142 (3d ed. 1987).

97. S. SALESKA, *supra* note 91, at II-3. The ray or particle emitted by a radionuclide is typically an alpha particle, a beta particle, or a gamma ray. Gamma rays are the most penetrating and tend to be the most hazardous when the source of radiation is outside the body. It may require lead or concrete to stop them. Alpha particles, on the other hand, cannot even penetrate the skin. Once an alpha-emitting source is inhaled or ingested, however, it is extremely damaging for the short distance it does travel. Alpha particles are high "linear energy transfer" (high-let) radiation. This means they transfer large amounts of energy in each unit of distance they travel. *Id.* at II-1, II-3.

98. FINAL RULE RADON-222, *supra* note 85, at 4-28 to 4-36.

99. Riccitiello, *supra* note 13, at 225, 226.

100. FINAL RULE RADON-222, *supra* note 85, at 3-9.

101. *Id.* at 3-19.

102. *Id.* at 4-8, 4-9, 4-28 to 4-35.

103. S. SALESKA, *supra* note 91, at III-2.

104. FINAL RULE RADON-222, *supra* note 85, at 3-1, 3-12.

105. M. EISENBUD, *supra* note 96, at 177; Riccitiello, *supra* note 13, at 227. But Eisenbud notes: "Since the area covered by the tailings piles . . . is small compared to the areas not covered by tailings piles, the piles themselves do not make a significant contribution to the concentration of Rn in the general environment." (M. EISENBUD, *supra* note 96, at 177.)

nese, and sulfates.[106]

As noted, the major radiation danger to humans is from alpha radiation exposure to the lungs. However, there is considerable argument over how serious this danger is. The uranium industry and others, including a National Research Council panel, have argued that "[t]he health risks posed by exposure to radon from uranium mill tailings piles are trivial for the average U.S. citizen," and with a few exceptions, "range from small to modest for most persons who live close to piles . . . ."[107] Their argument is that measurements of radon-222 concentrations fall quickly to background level within a few kilometers from uncovered tailings piles, and that most licensed tailings piles are found in sparsely settled areas.[108]

The Environmental Protection Agency (EPA) estimated in 1986 that about five fatal cancers per year in the United States could be attributed to licensed tailings impoundments.[109] The uranium mining industry sees this risk as minor compared to other risks accepted by the general public. For example, motor vehicle accidents claim almost 50,000 lives per year; tripping and falling cause 470 deaths per year; and tornadoes cause 130 deaths per year.[110] EPA's response to such arguments is that although the danger from uranium mill tailings may appear trivial if viewed in annual terms, the potential total death toll could be enormous and the threat to humans almost eternal.[111] Thorium-230 is the parent of radium-226, which in turn decays to radon-222. Almost all of the thorium-230 present in the ore before mining is found in the milled tailings.[112] This long-lived nuclide has a half-life of 77,000 years. Therefore, after 77,000 years, half of the radionuclides will remain; after another 77,000 years, one-fourth will remain, and so on.[113] EPA calculated that it would take about 265,000 years for the radioactivity from existing tailings piles to be reduced to 10% of its initial value.[114] The almost permanent nature of this threat was one of

106. Riccitiello, *supra* note 13, at 227; Environmental Standards for Uranium and Thorium Mill Tailings at Licensed Commercial Processing Sites, 48 Fed. Reg. 45,926, 45,928 (1983) [hereinafter Standards Licensed Sites].

107. NATIONAL RESEARCH COUNCIL, SCIENTIFIC BASIS FOR RISK ASSESSMENT AND MANAGEMENT OF URANIUM MILL TAILINGS 2 (1986).

108. FINAL RULE RADON-222, *supra* note 85, at 3-4, 4-35 to 4-37; M. EISENBUD, *supra* note 96, at 177.

109. FINAL RULE RADON-222, *supra* note 85, at 6-9. *See also* National Emission Standards for Hazardous Air Pollutants; Regulation of Radionuclides, 54 Fed. Reg. 9612, 9642, 9644, 9647 (1989) (proposed Mar. 7, 1989) [hereinafter Proposed NESHAPS].

110. Standards Licensed Sites, *supra* note 106, at 45,934; Proposed NESHAPS, *supra* note 109, at 9621. *See also EPA Radon and Radionuclide Emission Standards: Hearing Before the Procurement and Military Nuclear Systems Subcomm. of the House Comm. on Armed Services*, 98th Cong., 1st Sess. *passim* (1983) [hereinafter *Hearing on EPA Standards*].

111. Standards Licensed Sites, *supra* note 106, at 45,934.

112. FINAL RULE RADON-222, *supra* note 85, at 3-13; M. EISENBUD, *supra* note 96, at 176.

113. S. SALESKA, *supra* note 91, at II-10.

114. FINAL RULE RADON-222, *supra* note 85, at 3-1, 3-13.

the concerns that led Congress to pass the Uranium Mill Tailings Radiation Control Act (UMTRCA) in 1978.[115] At the time, the Chairman of the NRC testified that "by counting far into the future" one could conclude that radon from uranium mill tailings represented "the dominant radiation exposure from the nuclear fuel cycle."[116]

Regulating Radionuclides: UMTRCA

Until 1989, the only specific emission limit on radon releases from uranium mining was for tailings piles after they had been reclaimed.[117] This standard, promulgated under UMTRCA, required that tailings piles be reclaimed so radon emissions would not exceed twenty picocuries per square meter per second (20 pCi/m2-s).[118] Radon emissions from unreclaimed tailings commonly range from 300 to 500 pCi/m2-s.[119] To reduce emissions to the required level (20 pCi/m2-s), the EPA estimated that each tailings pile would have to be covered with six to ten feet of earth.[120]

This emission standard for reclaimed tailings piles was issued by the Reagan Administration in October 1983, more than three years after the original deadline set by Congress.[121] When it was announced,

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115. UMTRCA, Pub. L. No. 95-604, 92 Stat. 3021-43 (codified as amended at 42 U.S.C. §§ 7901-7942 (1988) and amended provisions of the Atomic Energy Act of 1954, 42 U.S.C. §§ 2011-2282 (1988)).

116. *Uranium Mill Tailings Control: Hearings on H.R. 13382, H.R. 12938, H.R. 12535, H.R. 13049 Before the Subcomm. on Energy and the Environment of the House Comm. on Interior and Insular Affairs*, 95th Cong., 2d Sess. 75-76 (1978) (statement of Joseph M. Hendrie).

The debate over the danger of radon-222 continues. *Compare* Roscoe, Steenland, Halperin, Beaumont, & Waxweiler, *Lung Cancer Mortality Among Nonsmoking Uranium Miners Exposed to Radon Daughters*, 262 J. AM. MED. A. 629 (1989) *with* Blot, Xu, Boice, Zhao, Stone, Sun, Jing, & Fraumeni, *Indoor Radon and Lung Cancer in China*, 82 J. NAT'L CANCER INST. 1025 (1990). *See also* Bolch & Lyons, *A Multibillion-Dollar Radon Scare*, PUB. INTEREST, Spring 1990, at 61; Henshaw, Eatough, & Richardson, *Radon as a Causative Factor in Induction of Myeloid Leukaemia and Other Cancers*, 335 LANCET 1008 (1990); NATIONAL RESEARCH COUNCIL, COMMITTEE ON THE BIOLOGICAL EFFECTS OF IONIZING RADIATIONS, HEALTH RISKS OF RADON AND OTHER INTERNALLY DEPOSITED ALPHA-EMITTERS, BEIR IV (1988); NATIONAL RESEARCH COUNCIL, COMMITTEE ON THE BIOLOGICAL EFFECTS OF IONIZING RADIATIONS, HEALTH EFFECTS OF EXPOSURE TO LOW LEVELS OF IONIZING RADIATION, BEIR V (1990); Nuclear Regulatory Commission, Final Rule, Revision of 10 C.F.R. Part 20, "Standards for Protection Against Radiation" (to be printed in the Federal Register, 1991) (available from NRC Public Document Room, Wash., D.C.) [hereinafter Final Rule, Revision of 10 C.F.R. Part 20].

117. In 1989, emission limits were issued for unreclaimed, operating, tailings piles. *See infra* text accompanying notes 160-176.

118. Standard for Management of Uranium Byproduct Material, 40 C.F.R. § 192.32(b)(1)(ii) (1990).

A picocurie is a trillionth of one curie, which is the standard measure of radiation.

119. Standards Licensed Sites, *supra* note 106, at 45,931.

120. *Hearing on EPA Standards*, *supra* note 110, at 47 (statement of William Ruckelshaus, Administrator, EPA). *See also* FINAL RULE RADON-222, *supra* note 85, at 7-1 to 7-7.

121. Standards Licensed Sites, *supra* note 106, at 45,947. *See also Hearing on EPA Standards*, *supra* note 110, at 46 (statement of William Ruckelshaus, Adminis-

the standard was criticized by the uranium industry and industry supporters in Congress as too stringent.[122] Environmental groups were even more upset because the final standard allowed ten times more radon emissions from reclaimed tailings than that which had previously been used by the Nuclear Regulatory Commission (NRC).[123]

The EPA was further criticized for its failure to issue standards for operating, unreclaimed tailings piles.[124] EPA explained that a numerical limit on radon from operating tailings piles was "inappropriate."[125] The procedures necessary to achieve a numerical standard would vary in effectiveness during different phases of the milling operation, and from site to site.[126] EPA suggested that new tailings management techniques ("work practices") to control radon emissions from operating tailings piles might be considered later as part of rulemaking under the Clean Air Act.[127]

The Continuing Battle Over the Clean Air Act

Another source of federal control over radionuclide emissions had its immediate origin in the last year of the Carter Administration. On December 27, 1979, the EPA listed radionuclides as a hazardous air pollutant under section 112 of the Clean Air Act.[128] This began a battle over radionuclide emission standards which has continued into the 1990's. This long dispute has gone through two distinct phases and is now entering a third.

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trator, EPA).

122. *See, e.g., Hearing on EPA Standards, supra* note 110, at 1 *passim*; Standards Licensed Sites, *supra* note 106, at 45,934, 45,937.

123. *See, e.g.*, Shuey, *Bringing Tailings Under Control*, 10 WORKBOOK 110-12 (1985); Standards Licensed Sites, *supra* note 106, at 45,932.

Two picocuries per square meter per second also had been the limit originally proposed by the EPA in 1981 for inactive or abandoned tailing piles that were being reclaimed by the federal government. 46 Fed. Reg. 2556, 2559 (1981). This proposed limit was also changed to 20 pCi/m2-s when final standards were issued for disposal of these abandoned tailings sites. 48 Fed. Reg. 590, 598 (1983).

124. *See, e.g.*, Standards Licensed Sites, *supra* note 106, at 45,936.

Licensing regulations for uranium mills adopted by the NRC in the late 1970's mandated that all tailings impoundments limit radon-222 to as low as reasonably achievable (ALARA) levels (10 C.F.R. part 40, app. A). Total emission limits were not specified. However, in the NRC's general standards for protection against radiation, dose limits are set for individuals. For areas within the mill property, radon-222 concentrations have to be limited to 30 pCi/liter (about one-third of a working level), and in unrestricted areas outside of the mill to 3 pCi/liter (about one-thirtieth of a working level). Standards For Protection Against Radiation, 10 C.F.R. §§ 20.101-20.108, app. B (1991); *see also* FINAL RULE RADON-222, *supra* note 85, at 1-1, 1-5, 7-15.

On December 13, 1990, in a public meeting the NRC approved for publication a final rule which reduced the dose limit to the public from 3 pCi/liter to 0.1 pCi/liter. This change will be codified at 10 C.F.R. part 20, app. B, table 2. (Final Rule, Revision of 10 C.F.R. part 20, *supra* note 116.)

125. Standards Licensed Sites, *supra* note 106, at 45,936.

126. *Id.*

127. *Id.*

128. 44 Fed. Reg. 76,738 (1979). Section 112 of the Clean Air Act governs EPA regulation of hazardous air pollutants. 42 U.S.C. § 7412 (1988).

The first phase of this battle was over whether or not EPA would issue final standards regulating radionuclides.[129] When final standards eventually were issued, disagreement continued over their adequacy. This first phase lasted until the late 1980's.

The second phase of the battle began after a D.C. Circuit Court of Appeals decision found that the EPA had improperly considered cost and technological feasibility in setting radionuclide standards under the Clean Air Act.[130] As a result of this decision, EPA withdrew previous emission standards and announced that it would take a fresh look at the entire question of risk from radionuclides. This fresh look led to the promulgation of new, controversial radon emission standards for unreclaimed tailings piles, and a new deadline for reclaiming tailings ponds where the mill producing tailings had been dismantled, or where the tailings pond was full.

A third major phase of this battle over the Clean Air Act is just beginning. It started when the Clean Air Act was revised in 1990 (the Clean Air Act Amendments of November, 1990).[131] Supporters of the uranium mining industry hope that this new legislation will allow uranium mill tailings to completely escape EPA regulation. A provision of the 1990 Amendments speaks to the need to eliminate dual regulation. As uranium mill tailings are also regulated by the NRC, under UMTRCA, industry supporters believe that this provision eliminating dual regulation should apply.[132] Failing this, the uranium mining industry hopes to escape a new round of rule-making resulting from the 1990 Amendments. Here the industry is looking to a provision of the new law that would defer its immediate application where a pollutant had previously been regulated under the Clean Air Act before it was amended in 1990.

The Initial Application of the Clean Air Act to Tailings Emissions

The 1979 listing of radionuclides as a hazardous air pollutant was to be followed within 180 days by proposed emission standards for

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129. *See infra* text accompanying notes 133-147.

130. *See infra* text accompanying notes 145-176.

131. Clean Air Act Amendments of 1990, Pub. L. No. 101-549, 104 Stat. 2399. On the evolving dispute over the Clean Air Act Amendments of 1990, see *infra* text accompanying notes 177-198.

132. The question of dual regulation arises because UMTRCA is enforced by the NRC (although the standards for UMTRCA were written by the EPA). The standards implementing the Clean Air Act are both written and enforced by EPA. Thus, uranium mill tailings are regulated by both the NRC (under UMTRCA) and the EPA (under the Clean Air Act). The complaint of dual regulation would not apply to uranium mines, because they are not regulated under UMTRCA. Recently Wyoming's Senator Simpson has been especially vocal in citing "dual regulation" as a reason for removing uranium mill tailings from EPA regulatory control under the Clean Air Act. *See, e.g.*, S. REP. No. 228, 101st Cong, 2d Sess. 203-05, *reprinted in* 1990 U.S. CODE CONG. & ADMIN. NEWS 3387, 3588-90. 136 CONG. REC. S3797-99 (daily ed. April 3, 1990); 136 CONG. REC. S17248 (daily ed. Oct. 26, 1990). *See also infra* note 158.

major sources of the pollutant.[133] These major sources would include uranium mines and mill tailings, in addition to a large number of other sources such as nuclear power plants, hospitals, research facilities, and elemental phosphorus plants. It was not until 1983, after a successful suit by the Sierra Club,[134] that EPA finally issued its initial "proposed standards" for major sources of radionuclide emissions.[135] The court rejected arguments by the EPA, under Reagan, that the term "shall" was directory, not mandatory, and that regulating radionuclides was impossible because of their complexity.[136]

In 1984, after another suit by the Sierra Club, the court ordered EPA to promulgate final standards or make a finding that radionuclides are not hazardous air pollutants.[137] EPA responded by withdrawing most of the proposed standards issued in 1983, arguing that control practices already in effect were sufficient to protect the public, and that no additional regulation was necessary.[138] As EPA had neither produced final standards nor removed radionuclides from the list of hazardous air pollutants, EPA was then found in contempt of court and ordered to promulgate final standards.[139]

EPA responded to the contempt order by issuing new standards where they had been withdrawn.[140] EPA also produced the promised work practice standards for operating, unreclaimed tailings piles.[141] These work practice standards called for new designs for tailings ponds that would decrease the radon-emitting area. In the future, companies could either build a much smaller impoundment, or use a

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133. 42 U.S.C. § 7412(b)(1)(B) (1988).

134. Sierra Club v. Gorsuch, 12 ENVTL. L. REP. (ENVTL. L. INST.) 20,457, 20,459 (N.D. Cal. 1982).

135. 48 Fed. Reg. 15,076 (1983). *See also* Note, *Unfinished Business: The Regulation of Uranium Mining and Milling*, 18 U. RICH. L. REV. 615, 632 (1984).

136. Sierra Club v. Gorsuch, 12 ENVTL. L. REP. (ENVTL. L. INST.) 20,458-59 (quoted in Comment, *Radioactive Air Pollution From Uranium Mining: Regulatory Abdication in the Face of Scientific Uncertainty*, 13 ENVTL. L. 545, 570 (1983)). *See also* Graham, *The Failure of Agency-Forcing: The Regulation of Airborne Carcinogens Under Section 112 of the Clean Air Act*, 17 LAND USE & ENVTL. L. REV. 399, 412 (1986).

But see Dwyer, who argues that much of the delay was part of the conscious and justifiable strategy by EPA to resist implementing unrealistic standards, which were based on symbolic statutory language that Congress had never intended should be implemented. (Dwyer, *The Pathology of Symbolic Legislation*, 17 ECOLOGY L.Q. 233 *passim* (1990)).

137. Sierra Club v. Ruckelshaus, 15 ENVTL. L. REP. (ENVTL. L. INST.) 20,080 (N.D. Cal.), *modified* 15 ENVTL. L. REP. (ENVTL. L. INST.) 20.082 (N.D. Cal. 1984). *See also* Dwyer, *supra* note 136, at 261 n.120; 1989 NESHAPS, *supra* note 16, at 51,658.

138. 49 Fed. Reg. 43,906-07 (1984). *See also* 1989 NESHAPS, *supra* note 16, at 51,658.

139. Sierra Club v. Ruckelshaus, 15 ENVTL. L. REP. (ENVTL. L. INST.) 20,101, 20,103 (N.D. Cal. 1984). *See also* Dwyer, *supra* note 136, at 261 n.121; 1989 NESHAPS, *supra* note 16, at 51,658; 50 Fed. Reg. 5190, 5191 (1985).

140. 50 Fed. Reg. 5190 (1985) (standards for radionuclide emmissions from elemental phosphorous plants, DOE facilities, and NRC-licensees); 50 Fed. Reg. 15,386 (1985) (a work practice standard for underground uranium mines).

141. 51 Fed. Reg. 34,056 (1986).

system of continuous disposal, in which no more than ten acres of tailings were exposed at any one time.[142] Operators were given a generous transition period to begin construction of new impoundments.[143] However, no additional extensions or exceptions for use of old tailings ponds would be allowed after December 31, 2001.[144]

The Sierra Club, Environmental Defense Fund, Natural Resources Defense Council, and the American Mining Congress filed petitions challenging these new rules.[145] Finally, in late 1987 and 1988, EPA was granted motions for voluntary remands and was allowed to withdraw emission standards for all radionuclide source categories.[146] An announcement followed that EPA would take a "fresh look" at the entire question of risk from radionuclides.[147] This "fresh look" boded ill for the uranium industry, as it was motivated by a court decision on an emissions standard for vinyl chloride, which like the standards for radionuclides, had been issued under section 112 of the Clean Air Act.

New Emission Standards for Unreclaimed Tailings Piles and a New Deadline for Final Disposal

In *Natural Resources Defense Council, Inc. v. Environmental Protection Agency* (*Vinyl Chloride*) the D.C. Circuit Court of Appeals found that the EPA had improperly considered cost and technological feasibility in setting standards under section 112 of the Clean Air Act.[148] Section 112 required emission standards be set at a level which "provides an ample margin of safety to protect the public health."[149] The court found that an "acceptable" or "safe" risk level must first be determined using health criteria alone.[150] After this initial step, EPA could then consider technological and cost factors in adjusting the resulting standard to assure that it provided "an ample margin of safety."[151]

The uranium industry was obviously apprehensive about a radon limit that would initially be set using only health criteria. Some environmental groups had even argued that from a health perspective

142. *Id.* at 34,060, 34,062-63.
143. *Id.* at 34,061.
144. *Id.*
145. 1989 NESHAPS, *supra* note 16, at 51,658.
146. *Id.*
147. Proposed NESHAPS, *supra* note 109, at 9615.
148. 824 F.2d 1146, 1163, 1165 (D.C. Cir. 1987) [hereinafter *Vinyl Chloride*]. *See also* Dwyer, *supra* note 136, at 236-42, 269-71, 308-09; Comment, *"Acceptable" Risk for Hazardous Air Pollutants*, 13 HARV. ENVTL. L. REV. 535, 539 (1989); Note, *Toward Sensible Regulation of Hazardous Air Pollutants Under Section 112 of the Clean Air Act*, 63 N.Y.U.L. REV. 612, 641 (1988).
149. 42 U.S.C. § 7412(b)(1)(B) (1988).
150. *Vinyl Chloride*, 824 F.2d at 1165.
151. *Id.* at 1152, 1165. *See also* Comment, *supra* note 148, at 538-39; and *infra* note 152.

"there is no such thing as a safe level of radiation."[152] EPA's proposed rules, issued in March 1989, did little to quiet industry fears.[153] One industry representative stated that if the most stringent of these EPA proposals were adopted, the United States uranium mining and milling industry would be shut down in six months to two years, and reclamation costs would increase by over 300%.[154]

The final National Emission Standards for Hazardous Air Pollutants (NESHAPS) for radionuclides were published in December 1989.[155] With one major exception, the new rules were seen by the Wyoming uranium industry as less severe than expected.[156] A major lobbying effort by the affected industries appeared to have had results.[157] The existing standard of 20 pCi/m2-s for reclaimed tailings piles was reaffirmed.[158] EPA also decided not to regulate radon emis-

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152. *See e.g., supra* note 89 and accompanying text. The Natural Resources Defense Council argued for a zero-emission standard in *Vinyl Chloride*, 824 F.2d at 1152. After the *Vinyl Chloride* decision environmental groups contended that the decision required EPA to virtually eliminate environmentally induced cancer. Dwyer, *supra* note 136, at 274-75 n.182; *see also* Comment, *supra* note 148, at 542-45.

However, in explaining its later rulemaking, EPA emphasized that the court did not require a finding that "safe" means "risk-free." The court said that EPA itself must decide what risks are acceptable in the world in which we live. For example, the court cited driving a car or breathing city air as risk-laden activities that society does not consider unsafe. 1989 NESHAPS, *supra* note 16, at 51,684-85.

Regarding the *Vinyl Chloride* decision, Dwyer has commented aptly that "[t]he court's interpretation, however, produced more confusion than regulation. In conflating 'safe' and 'acceptable,' the court mistakenly assumed that an 'acceptable' level of risk could be determined without regard to regulatory costs or consequences and, paradoxically, equated an acceptable cost-free risk level with 'risks [that] are acceptable in the world in which we live'." Dwyer, *supra* note 136, at 308-09.

153. Proposed NESHAPS, *supra* note 109, at 9612.

154. Remarks by Robert Poyser, Pathfinder Mines Corp., prepared for 34th Annual Wyoming Mining Association Convention 3 (June 15-17, 1989) (photo. manuscript).

155. 1989 NESHAPS, *supra* note 16, at 51,654.

156. *See, e.g.*, Poyser, *The EPA's Final Rule For Regulating Radionuclides*, MINING CLAIM, Dec. 1989, at 15 (pub. by The Wyo. Mining Association) (Robert Poyser of Pathfinder Mines Corp. stated: "In general, however, it appears that the rule is more tolerable than that originally proposed in March of this year.").

157. On the lobbying effort, see Remarks by Robert Poyser, *supra* note 154, at 12-14. *See also* the many comments from the uranium industry and others, critical of the proposed NESHAPS issued in March, 1989, contained in EPA Docket A-79-11, No. X-III-D (EPA, Wash., D.C.).

But Dwyer argues that the reason *Vinyl Chloride* did not result in tougher standards was because EPA considered health-based standards unrealistic and extreme, and was willing to manipulate the "acceptable risk" concept to prevent their implementation. Dwyer, *supra* note 136, at 268, 273-82, 309.

158. 1989 NESHAPS, *supra* note 16, at 51,683, 51,702 (codified at 40 C.F.R. § 61.222 (1990)). The standard for tailings disposal (reclaimed tailings) was not changed from that issued in 1983, under UMTRCA, and enforced by the NRC. Nevertheless, EPA decided to issue a NESHAP, under the Clean Air Act. This was necessary, EPA stated, because "[t]he existing UMTRCA regulations set no time limits for the disposal of the piles." *Id.* at 51,683. For the first time, EPA also set out required monitoring methods for determining radon-222 emissions. *Id.* at 51,709-11.

Both NRC and EPA will now be regulating the standard for tailings disposal. This dual regulation has become a major complaint of the uranium industry and Wyoming's Senator Simpson. *See* letter from Senator Alan K. Simpson, to William K. Reilly, Ad-

sion from open-pit uranium mines because "many of the inactive uranium mines are in various stages of reclamation by placement of an earthen cover over the pit and the overburden. This reclamation of the mines significantly reduces radon emissions." Further, "[d]ue to the depressed state of the uranium mining industry, there is no reason to believe that new surface mines will be constructed."[159]

For the uranium industry in Wyoming, the major unpleasant and unexpected ruling[160] was the EPA decision to set a limit on radon emissions from unreclaimed, "operating" or "existing" tailings piles.[161] Previously, the idea of such a limit had been termed "inappropriate" by EPA.[162] This new standard was 20 pCi/m2-s, exactly the same limit that was applied to reclaimed tailings.[163] EPA admitted that there were only two ways such a strict standard could be met: "This rule will have the practical effect of requiring the mill operators to keep their piles wet or covered."[164] Indeed, the justification for this new standard was to assure that these piles did remain wet or covered since "the risks from mill tailings piles can increase dramatically if they are allowed to dry and remain uncovered."[165]

This decision, in turn, created a new problem for EPA. "EPA recognizes that in the case of a tailings pile which is not synthetically or clay lined . . . water placed on the tailings in an amount necessary to reduce radon levels, can result in ground water contamination."[166] Most existing uranium mill tailings ponds are unlined. They were built before the NRC first began requiring liners in the late 1970's,[167] and later were given an exemption from the requirement for a liner in the rules issued under UMTRCA.[168]

In trying to resolve one problem, radon emissions, EPA was likely creating another. EPA acknowledged that it "cannot allow a situation where the reduction of radon emissions comes at the expense of in-

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ministrator EPA, at 3 (Jan. 30, 1991) (requesting reconsideration and recision of the radionuclide NESHAPS for uranium mill tailings) (available from EPA Docket A-79-11, No. XVII-F-13, Wash., D.C.) *See also supra* note 132.

159. 1989 NESHAPS, *supra* note 16, at 51,678.

160. *See, e.g.*, Poyser, *supra* note 156, at 15.

Industry also expressed considerable disquiet with the new whole body dose standard for underground uranium mines. *Id.* (This standard is explained in 1989 NESHAPS, *supra* note 16, at 51,676-78, and codified at 40 C.F.R. § 61.22 (1990)).

161. 1989 NESHAPS, *supra* note 16, at 51,680, 51,703. An "existing impoundment" is defined as "any uranium mill tailings impoundment which is licensed to accept additional tailings and is in existence as of Dec. 15, 1989." 40 C.F.R. § 61.251(d) (1990).

162. *See supra* notes 125, 126 and accompanying text.

163. 40 C.F.R. § 61.252(a) (1990).

164. 1989 NESHAPS, *supra* note 16, at 51,680.

165. *Id.*

166. *Id.*

167. Standards Licensed Sites, *supra* note 106, at 45,931, 45,941. *See also* FINAL RULE RADON-222, *supra* note 85, ch. 4 & app. A.

168. 40 C.F.R. § 264.221(a) (1990) *cited in* 40 C.F.R. 192.32(a) (1990); *see also* Standards Licensed Sites, *supra* note 106, at 45,931, 45,941, 45,942.

creased pollution of the ground or surface water;"[169] therefore, the Agency acted. In a decision which will affect both the speed of reclamation and chances for a revival of open-pit mining and milling, EPA eliminated the exemption for liners.[170] In an important related ruling, EPA determined that tailings ponds which did not meet EPA's new legal requirements would cease to be operational,[171] and would have two years in which to reclaim.[172] This same new two-year limit to reclaim also applied if a tailings impoundment was full, or if the mill it accepts tailings from had been dismantled or otherwise decommissioned.[173] The time limit was necessary, EPA explained, because "existing UMTRCA regulations set no time limit for disposal of the piles. Some piles have remained uncovered for decades emitting radon. Although recent action has been taken to move toward disposal of these piles, some of them may still remain uncovered for years."[174]

Industry responded to these new rules with anger. The American Mining Congress called the requirement that all tailings ponds be lined "illegal," "infeasible," "arbitrary," and "capricious."[175] These new rules could prove extremely costly if companies had to replace tailings ponds. As a representative of Pathfinder Mines noted: "It appears that the new rule may require immediate shutdown until new facilities can be permitted, constructed and become operational . . . ."[176]

The Clean Air Act Amendments of November 1990

Almost as soon as these December 1989 NESHAPS were pub-

169. 1989 NESHAPS, *supra* note 16, at 51,680.

170. "[A]ll piles will be required to meet the requirements of 40 CFR 192.32(a) which protects water supplies from contamination. Under the current rules, existing piles are exempt from these provisions, this rule will end that exemption." *Id.* (codified at 40 C.F.R. § 61.252(c) (1990)).

The exemption referred to here is for liners: "Any surface impoundment . . . must have a liner for all portions of the impoundment (except for existing portions of such impoundments)." 40 C.F.R. § 264.221(a) (1990) *cited in* 40 C.F.R. 192.32(a) (1990).

171. 1989 NESHAPS, *supra* note 16, at 51,702.

"*Operational* means a uranium mill tailings pile that is licensed to accept additional tailings, and those tailings can be added without violating subpart W [rules governing operating tailings] or any other Federal, state or local rule or law." 40 C.F.R. § 61.221(b) (1990).

172. 40 C.F.R. § 61.222(b) (1990).

173. 40 C.F.R. § 61.221(b) (1990). *See also* 1989 NESHAPS, *supra* note 16, at 51,683, 51,702.

However, "[i]f the two year period is not enough time for these piles to dry out and be covered and disposed of then EPA is prepared to develop expeditious compliance schedules in consultation with affected parties . . . ." (1989 NESHAPS, *supra* note 16, at 51,683.)

174. 1989 NESHAPS, *supra* note 16, at 51,683.

175. Petition of the American Mining Congress for Reconsideration and Stay of Radionuculides NESHAPS and Comments on Reconsideration of Subpart I, Before the Environmental Protection Agency, at 27-36 (Feb. 13, 1990) [hereinafter AMC Petition] (EPA Docket A-79-11, No. XIV-D-120, Wash., D.C.).

176. Poyser, *supra* note 156, at 15.

lished, an attempt was made to overturn them. Petitions for reconsideration were filed with EPA,[177] and petitions for review with the court.[178] The industry's biggest hope, however, was Congress. At the same time that EPA announced its new rules for radionuclide emissions, Congress was beginning serious work on revising the Clean Air Act. Senator Simpson of Wyoming succeeded in getting a provision approved in the Environment and Public Works Committee that would change the definition of "air pollutant" in the Clean Air Act to exclude radionuclides emitted from NRC-licensed facilities, including uranium mill tailings.[179] Ostensibly, the purpose of this change was to eliminate dual regulation by the EPA and the NRC;[180] however, the Committee Report made it clear that this provision would "nullify" EPA's 1989 radionuclide standards for such facilities.[181]

This provision was defeated on the Senate floor, but was soon replaced by a weaker measure that was successfully amended into the final Clean Air Act Amendments which became law in November 1990.[182] This successful amendment states that no standards for radionuclide emissions from NRC-licensed facilities need be promulgated under section 112 of the Clean Air Act "if the Administrator determines, by rule . . . that the regulatory program established by the Nuclear Regulatory Commission . . . for such category . . . provides an ample margin of safety to protect the public health."[183]

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177. *See, e.g.*, AMC Petition, *supra* note 175; Petition for Reconsideration and Stay of Effective Date, Environmental Protection Agency, from Pathfinder Mines Corporation (Feb. 12, 1990) (EPA Docket A-79-11, No. XIV-D-105, Wash., D.C.). The NRC also argued strongly in support of a petition for reconsideration. (Letter from Kenneth M. Carr, Chairman NRC, to William K. Reily, Administrator EPA (Feb. 12, 1990) (EPA Docket A-79-11, No. XIV-D-141, Wash., D.C.).)

As of March 1991, EPA had not agreed to reconsider the NESHAPS for sites regulated under 40 C.F.R. part 61, subpart T (reclaimed mill tailings), or for sites regulated under 40 C.F.R. part 61, subpart W (operating or existing mill tailings).

EPA did agree to reconsider, and did issue a stay for, the NESHAP for radionuclides for NRC licensees subject to 40 C.F.R. part 61, subpart I. This stay, which has been extended several times, affected certain research, industrial and medical facilities licensed by the NRC, as well as nuclear power reactors and uranium fuel fabrication facilities which are subject to subpart I rules. 55 Fed. Reg. 10,455-56 (1990); 55 Fed. Reg. 29,205 (1990); 55 Fed. Reg. 38,057 (1990); 56 Fed. Reg. 6339 (1991); 56 Fed. Reg. 10,514, 10,523 (1991). *See also infra* note 183.

178. The petitions for review were consolidated by the court, *sua sponte*, under the heading *American Mining Congress v. EPA*, No. 90-1058 (D.C. Cir.). (Notice of Stay, 55 Fed. Reg. 10,455-56 (1990)).

179. S. 1630, 101st Cong., 1st Sess., § 303 (1989). *See also* Melnykovych, *Simpson Backs Nuclear Industry On Clean Air Regs*, Casper Star-Tribune, Feb. 11, 1990, at A-1, A-14.

180. *See supra* notes 132, 158.

181. S. REP. No. 228, 101st Cong., 2d Sess. 205 *reprinted in* 1990 U.S. CODE CONG. & ADMIN. NEWS 3387, 3590.

182. Clean Air Act Amendments of 1990, Pub. L. No. 101-549, 104 Stat. 2399 [hereinafter CAA 1990]. On the passage of the Simpson Amendment, see 136 CONG. REC. S3797-99 (daily ed. April 3, 1990).

183. CAA 1990, Pub. L. No. 101-549, section 112(d)(9), 104 Stat. 2399, 2542 (to be codified at 42 U.S.C. § 7412).

In March 1991, citing CAA 1990, sec. 112(d)(9), EPA gave advance notice of a

This "ample margin of safety" requirement will most obviously pose a problem for those wanting to eliminate the new EPA standard for unreclaimed tailings. In December 1989, EPA argued that a 20 pCi/m2-s radon emission standard for unreclaimed ("existing" or "operating") tailings was necessary to provide an ample margin of safety to protect the public health.[184] NRC regulations provided an emission limit for tailings piles only after they were reclaimed, not for operating, unreclaimed, tailings piles.[185] EPA did admit that many unreclaimed tailings piles already met this new standard because they were temporarily covered with either water or clay.[186] However, EPA insisted that a new emission standard was necessary to prevent these piles from being allowed to become uncovered in the future, which could produce a dangerous rate of radon emissions.[187] While EPA did not change the NRC emission standard for tailings piles after they had been finally reclaimed, the EPA did, in December 1989, institute new requirements for measuring emissions, and a new deadline for reclaiming tailings piles that were full.[188]

EPA standards under the Clean Air Act, thus, are not a mere duplication of existing NRC regulations under UMTRCA. EPA made changes in the regulations governing mill tailings in December 1989, and supported these changes with arguments that existing regulations administered by the NRC did not provide an ample margin of safety to protect the public health. These arguments would have to be refuted if the Administrator of EPA were to exempt uranium mill tailings from regulation under the Clean Air Act. Any such attempt would also be sure to lead to a new series of legal challenges, thus continuing a history of court battles which began in the early 1980's.

If the EPA Administrator does not exempt uranium mill tailings from regulation under the Clean Air Act, then mill tailings could face new rules as a result of the 1990 Clean Air Act Amendments (CAA 1990). CAA 1990 will in any case apply to radon emissions from uranium mines. These mines are not regulated by the NRC, and thus the possibility of an exemption because of dual regulation does not arise. Exactly what new regulations might result from CAA 1990 is not yet clear. No standards have been produced. It is clear that new CAA 1990 standards initially will be based on maximum achievable control technology (MACT), rather than the previous "ample margin of safety

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proposed rule to exempt nuclear power reactors from radionuclide emission standards issued under the Clean Air Act. 56 Fed. Reg. 10,523 (1991).

184. 1989 NESHAPS, *supra* note 16, at 51,680.

185. NRC's general standards for protection against radiation do contain dose limits for individuals. *See supra* note 124. Those who argue that NRC regulation does provide an ample margin of safety to protect the public health point to the December 1990 change in NRC radon exposure limits to the public from 3 pCi/l to 0.1 pCi/l. *See, e.g.*, letter from Senator Alan K. Simpson, *supra* note 158, at 3.

186. 1989 NESHAPS, *supra* note 16, at 51,679, 51,680.

187. *Id.* at 51,680.

188. *Id.* at 51,702, 51,709-11. *See also supra* note 158, and *supra* text accompanying notes 171-174.

to protect [the public] health."[189] However, CAA 1990 does state that if after the initial application of MACT standards, a significant risk to public health remains, more stringent standards could be applied.[190] Specific reference is made to a one in one million maximum individual risk criterion as a guide to determine if further EPA action is needed.[191] This is a very rigorous standard, and it is doubtful if the excess cancer risks to the individual most exposed to emissions from existing uranium mill tailings could ever be reduced to one in one million.[192]

Supporters of the uranium industry and other industries already regulated under the Clean Air Act obviously hoped to avoid a new round of rule-making and the possibility of more stringent standards. However, efforts to grandfather or "save" these industries from the effect of the new law were only partially successful. A "savings" provision in CAA 1990 provides that "[a]ny standard under this section in effect before the date of enactment of the Clean Air Act Amendments of 1990 shall remain in force and effect after such date. . . ."[193] However, this provision is limited. For example, the new law also requires that "within 10 years" of the date of enactment of CAA 1990, "[e]ach such standard shall be reviewed and, if appropriate, revised" to comply with the requirements of CAA 1990.[194]

Another "savings" provision specifically deals with uranium mines and other facilities not licensed by the Nuclear Regulatory Commission, and provides that prior standards should remain in effect for these sources.[195] This would appear to be an important ex-

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189. CAA 1990, Pub. L. No. 101-549, § 112(d), 104 Stat. 2399, 2539-42. MACT standards for existing sources would be the average emissions limitation of the best-performing twelve percent of sources of similar category, excluding new sources on line before regulations are promulgated or proposed. Reductions could be achieved by any means, including technological pollution controls, process changes, or substitution of materials. *See Huge Clean Air Bill's Toxics Title Sets New Tone For Government Regulation*, [Current Developments] 21 ENVT. REP. (BNA) 1357-58 (Nov. 16, 1990); *Clean Air Act Amendments*, Pytte, 48 CONG. Q. 3934, 3942 (Nov. 24, 1990).

190. CAA 1990, Pub. L. No. 101-549, § 112(f)(1)(2), 104 Stat. 2399, 2543-44. *See also Huge Clean Air Bill's Toxics Title Sets New Tone For Government Regulation*, *supra* note 189, at 1358.

191. CAA 1990, Pub. L. No. 101-549, § 112(f)(2), 104 Stat. 2399, 2544. *See also Huge Clean Air Bill's Toxics Title Sets New Tone For Government Regulation*, *supra* note 189, at 1358.

192. In earlier rulemaking EPA indicated that a one in one million maximum individual risk criterion would require an emission limit for reclaimed tailings of 0.02 pCi/m2-s, rather than the current limit of 20 pCi/m2-s. (Proposed NESHAPS, *supra* note 109, at 9648.) At the time, an industry representative responded that such a standard would require 28 feet of cover over a tailings pile. Even this might be inadequate, he noted, as an emission rate of 0.02 pCi/m2-s is often less than the natural rate for radon emission found in topsoil near uranium mines. (Remarks by Robert Poyser, *supra* note 154, at 10).

193. CAA 1990, Pub. L. No. 101-549, § 112(q)(1), 104 Stat. 2399, 2562-63.

194. *Id.* However, the elemental phosphorus and phosphogypsum industries are permanently grandfathered, and are not subject to new standards under CAA 1990. *Id.* § 112(q)(2), 104 Stat. 2399, 2563.

195. *Id.* § 112(q)(3), 104 Stat. 2399, 2563. This section mentions "underground

emption for the uranium mining industry. Uranium mines cannot hope to escape EPA regulation because of dual regulation as they are not also regulated by the NRC. Furthermore, for open-pit uranium mines, existing Clean Air Act regulation is hardly onerous, since in December 1989, EPA decided that no emission standard was necessary for open-pit mines.[196] But, here too, the protection offered the uranium mining industry is largely illusory. CAA 1990 provides only that prior standards will remain in effect "unless the Administrator, in the Administrator's discretion, applies the requirements" of CAA 1990.[197]

The convoluted language of this "savings" provision and the lack of any explanation of this provision in the conference report[198] make interpretation difficult. But it would appear that, as with the provision dealing with dual regulation, the uranium industry has gained little or no protection against more stringent regulation in the future.

GROUNDWATER CONTAMINATION

Groundwater contamination is another major problem associated with uranium mill tailings. In a uranium mill, water and chemicals from the leaching process carry tailings to the ponds. This slurry contains about 40% solids and 60% water.[199] Often some of the slurry water is recycled for use in the mill.[200] The remaining liquid is the major source of groundwater contamination.[201]

As with radon emissions, there is disagreement over just how serious the problem is. One theoretical analysis performed for the NRC showed that without seepage control at a tailings pond, "the contamination of groundwater by selenium, sulfate, manganese, and iron might exceed current drinking water standards over an area 2 kilometers wide and 8 to 20 kilometers long."[202] However, a National Research Council study, often cited by industry, concluded from an examination of three mills in Wyoming that the "extent of groundwater

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uranium mines, surface uranium mines, and disposal of uranium mill tailings piles," as among facilities not licensed by the NRC. However, the NRC does regulate uranium mill tailings piles. Apparently, the mention of "uranium mill tailings" here was intended to refer to tailings sites that were either abandoned or inactive as of 1978 and which are being reclaimed by the Department of Energy. Interview with staff member of the U.S. Senate, Committee on Environment and Public Works, in Washington, D.C., Jan. 31, 1991.

196. 1989 NESHAPS, *supra* note 16, at 51,678. *See also supra* text accompanying note 159.

197. CAA 1990, Pub. L. No. 101-549, § 112(q)(3), 104 Stat. 2399, 2563.

198. H.R. CONF. REP. No. 952, 101st Cong., 2d Sess. 338-42, *reprinted in* 1990 U.S. CODE CONG & ADMIN. NEWS 3867, 3870-74.

199. NATIONAL RESEARCH COUNCIL, *supra* note 107, at 29.

200. *Id.*

201. Standards Licensed Sites, *supra* note 106, at 45,930.

202. *Id. See also* NUCLEAR REGULATORY COMM'N, FINAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON URANIUM MILLING at 6-7 to 6-12, app. E (NUREG-0706, Sept. 1980).

contamination from uranium mill tailings is likely to be limited to dimensions of between several hundred and several thousand meters."[203]

Interestingly, even those regulators responsible for preventing groundwater contamination acknowledge that most tailings ponds leak.[204] Yet, in Wyoming, where most uranium mills are located in unpopulated remote areas, the issue has caused little public concern. Several tailings dam failures and spills at tailings impoundments in Wyoming have aroused only slightly more interest.[205]

Most tailings ponds in Wyoming were built before liners were required. However, all tailings ponds must establish monitoring wells to check for seeping contaminants.[206] If leakage is detected, then collection wells and pumping systems must be installed to catch the seepage before it enters groundwater, and to pump it back into the pond.[207] These groundwater protection procedures were formalized in rules issued by the EPA in 1983 under UMTRCA.[208]

In operation, such monitoring systems have had problems. For example, Pathfinder's Lucky Mc mine had an elaborate network of wells and test holes. But, as a 1984 NRC report noted:

> The collection wells have had many operational problems. Pump failures, line breaks and power outages have dramatically decreased the amount of water which could have been removed from the aquifer. A review of the operational logs from November 1980 to November 1983 indicate that one or all of these wells

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203. NATIONAL RESEARCH COUNCIL, *supra* note 107, at 75. *See also id.* at 54-68.

204. *E.g.*, Standards Licensed Sites, *supra* note 106, at 45,930-31, 45,941.

205. For reports of such incidents see: NUCLEAR REGULATORY COMM'N, *supra* note 202, at T-10, T-11; Ambler, *NRC Tailings Control Too Lax, Wyoming Charges*, High Country News, Dec. 14, 1979, at 10; FINAL RULE RADON-222, *supra* note 85, at 4-30.

In New Mexico groundwater contamination from tailings ponds, and the 1979 tailings spill into the Rio Puerco, endangered a nearby rural population, and disrupted water supplies. Both situations attracted considerable attention and controversy. (*See Mill Tailings Dam Break at Church Rock, New Mexico: Oversight Hearing Before the Subcomm. on Energy and the Env't of the House Comm. on Interior and Insular Affairs*, 96th Cong., 1st Sess. (1979); Hinchman, *In New Mexico's Uranium Belt: Rebottling the Nuclear Genie*, High Country News, Jan. 19, 1987, at 1.) Because of tailings pond leakage and resultant groundwater pollution two licensed uranium mills in New Mexico have been added to the Superfund National Priority list. (Staats, *Land Swap Slows Cleanup*, Albuquerque Journal, May 11, 1986, at A1, A3).

206. Standards Licensed Sites, *supra* note 106, at 45,931, 45,940-42.

207. *Id.* at 45,931. *See also* ENVIRONMENTAL PROTECTION AGENCY, REPORT TO CONGRESS: WASTES FROM THE EXTRACTION AND BENEFICIATION OF METALLIC ORES, PHOSPHATE ROCK, ASBESTOS, OVERBURDEN FROM URANIUM MINING AND OIL SHALE 3-48 to 3-50 (1985).

208. 40 C.F.R. § 192, subpart D (1990). These standards incorporated groundwater protection regulations previously developed by EPA under authority of the Solid Waste Disposal Act. (*See* Standards Licensed Sites, *supra* note 106, at 45,940-42).

The standards in 40 C.F.R. § 192, subpart D have, in turn, been incorporated into NRC regulations, 10 C.F.R. part 40, app. A. NRC is the enforcing agency for UMTRCA.

> were inoperative for about half of this time. . . . Water quality data indicate that the pumping of the various components of the seepage collection system has not improved water quality.[209]

A similar problem was reported by DEQ in a 1988 visit to American Nuclear Corporation's Gas Hills Uranium Mill. "The seepage recovery pumpback system below pond No. 1 was operating at the time of this inspection, however, only well No. 6A was pumping . . . . The pump in well No. 4 apparently had just quit."[210] That same year in a report on Bear Creek Uranium Co. (Union Pacific), DEQ complained that:

> As it stands not enough water quality data is available to evaluate the status of the contaminant plume that was identified to the west of the tailings pond . . . . A second major concern is the lack of any information on the pumpback/seepage control system in the Annual Report. No status report is given so I am unable to determine if the system is working effectively or even if it is working at all.[211]

Lined tailings ponds can also have problems. In December 1980, a 130-foot seam separation was discovered in the synthetic liner at Minerals Exploration Company's (MEC) newly opened Sweetwater Uranium Project.[212] DEQ immediately inspected and recommended daily monitoring of the leak detection system. MEC was warned that "this could prevent a lot of possible problems which could result if radioactive water got into the groundwater."[213] The liner was quickly repaired. By 1985, however, DEQ was considerably more nonchalant when a similar problem arose with the same liner.

> [W]ave action and floating debris caused several small holes to develop on the east side of the cell. Continued wind and water erosion of the cell bank had caused these holes to grow. MEC is now utilizing a misting system to enhance evaporation of the tailings liquid. When the liquid level drops below the holes, repairs will be made to the liner.[214]

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209. Status Report on the Pumpback System at Pathfinder Mines Corporation, Lucky Mc Mine, from Gary Konwinski, Uranium Recovery Field Office, Region IV, NRC, at 10, 11 (June 8, 1984) (DEQ/LQD files).

210. Annual Inspection Report, American Nuclear, by Mark Moxley, DEQ (prepared June 22, 1988) (DEQ/LQD files).

211. Review of 1986-1987 Annual Report, Bear Creek Uranium, by Karen Spray, Hydrologist, DEQ (May 19, 1988) (DEQ/LQD files).

212. The pond contained fresh water, slurry water, mill tailings, and acidified leachate solution. (Letter from Minerals Exploration Company to Francis LaBarge, Water Quality Engineer, DEQ (Jan. 13, 1981) (DEQ/LQD files).)

Minerals Exploration Company is a Unocal 76 company, formerly Union 76.

213. Memorandum on Liner Break in Tailings Pond at Minerals Exploration Company, from Frank LaBarge, DEQ (Jan. 2, 1981) (DEQ/LQD files).

214. Annual Inspection Report, Minerals Exploration Company, by Steve Garland, DEQ (April 15, 1985) (DEQ/LQD files).

RECLAIMING TAILINGS

From the perspective of groundwater protection, tailings reclamation involves both cleaning up groundwater that has been contaminated, and ensuring that there is no future contamination.[215] The cleanup is done with injection wells which pump clean water into the aquifer to dilute and dispense contaminants.[216]

Prevention of groundwater contamination after mill shutdown requires that the tailings be dried out. This eliminates process water that could leach contaminants from the tailings pile. Dry tailings must then be protected from future infiltration of water, be it from floods, rain, or snow-melt.[217]

The primary permanent protection for tailings after they are dry is a six to twelve foot earthen cover.[218] This cover serves a dual purpose: radon-222 emissions are limited to at most 20 pCi/m2-s, and the tailings are protected from water.[219] Tailings covers are designed on a site by site basis, and must "be effective for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years."[220] Reclaimed piles must be sloped to allow for water runoff, but gradual enough to protect against erosion. Slopes must be covered with stone riprap, and the earthen cap covered with gravel or vegetation to protect the surface. Lined diversion channels may also be required as further erosion protection.[221]

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215. *See* 10 C.F.R. part 40, app. A, criteria 5B-5D, 5F, 7A (1991). *See also* Standards Licensed Sites, *supra* note 106, at 45,930.

216. *See* Standards Licensed Sites, *supra* note 106, at 45,931, 45,941, 45,943; L. CANTER & R. KNOX, GROUND WATER POLLUTION CONTROL (1985).

Ordinarily, "[h]azardous constituents in the ground water should be reduced to approved standards," as the NRC informed Western Nuclear, Inc. (Phelps Dodge). However, "[i]f that proves impossible or impracticable, as demonstrated by actual results from your corrective action program, alternate concentration limits may be considered." (Letter from Ramon E. Hall, Director, Uranium Recovery Field Office, Region IV, NRC, to Terrance A. Kippen, Western Nuclear, Inc. (Sept. 13, 1989) (DEQ/LQD files). *See also* 10 C.F.R. part 40, app. A, criteria 5B(3)-5B(6) (1991) (on Alternate Concentration Limits); 53 Fed. Reg. 24,820 (1988) (request for comments on Alternate Concentration Limits draft)).

217. *See* Standards Licensed Sites, *supra* note 106, at 45,930-31. *See also* NATIONAL RESEARCH COUNCIL, *supra* note 107, at 116-33.

218. *See* 10 C.F.R. part 40, app. A, criterion 6 (1991).

219. *Id.*

220. *Id.*

221. *Id. See also* Memorandum on Reclamation Plan Amendment to Source Material License SUA-1139 (Exxon), from Gary R. Konwinski, Uranium Recovery Field Office, Region IV, NRC (Oct. 27, 1988) (DEQ/LQD files); Memorandum on Amendment No. 29 to Source Material License SUA-551 for Reclamation and Closure of Petrotomics Uranium Mill in Shirley Basin, Wyoming, from Dawn L. Jacoby, Uranium Recovery Field Office, Region IV, NRC (Oct. 23, 1989) (DEQ/LQD files); FINAL RULE RADON-222, *supra* note 85, at 7-2 to 7-7, 7-16; 54 Fed. Reg. 33,101 (1989) (request for Public Comment on Erosion Protection Covers draft position); 54 Fed. Reg. 35,266 (1989) (on decommissioning plans).

Tailings Reclamation: Problems

Some basic problems remain in uranium mill tailings reclamation. One is the continued political battle, and uncertainty, over the federal standards to control radionuclide emissions.[222] Other problems are more of a technical nature. When tailings are covered with process water, radon emissions are diminished. However, as the tailings are dried out, in preparation for final reclamation, they lose the protection provided by the process water. This drying out process can take five years or more,[223] and radon emissions will increase considerably during this period.[224]

Another problem is with the pump-back systems used to recover seepage that leaks from tailings ponds. If these pumps operate during the drying out process, then the tailings are continually re-wetted. If the pump-back system is discontinued, then groundwater contamination may increase.[225] One solution is to require special evaporation ponds to receive this recovered water.[226] Most companies also have been required to install sprinkling systems, which they run in the summer to speed evaporation.

Recent research has even raised some doubts about the effectiveness of pumping as a technique for restoring contaminated aquifers. Despite years of groundwater pumping at Superfund cleanup projects, there has been little success in reducing contaminant concentrations to target levels.[227] Furthermore, in some cases when the pumps were turned off, contaminant levels began to rise again.[228]

A final problem with tailings reclamation might be mentioned—the environmental problem for future generations posed by the enduring nature of this radioactive residue. Junge and Dezman

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222. See *supra* text accompanying notes 177-98.

223. FINAL RULE RADON-222, *supra* note 85, at 7-38. Weber says stabilization and dewatering may last 15 years or more. (Weber, *Estimating Contaminant Discharge Rates From Stabilized Uranium Tailings Embankments*, GEOTECHNICAL & GEOHYDROLOGICAL ASPECTS OF WASTE MANAGEMENT 205-06 (1986) (8th Annual Symposium, Geotechnical Engin. Prog., Colo. State Univ., Fort Collins).

224. FINAL RULE RADON-222, *supra* note 85, at 3-1, and 7-19 to 7-22. *See also* 1989 NESHAPS, *supra* note 16, at 51,680.

225. *See, e.g.*, Annual Inspection Report, American Nuclear Corp., by Mark Moxley, DEQ (July 18, 1986) (DEQ/LQD files); letter from Edward F. Hawkins, Uranium Recovery Field Office, Region IV, NRC, to Western Nuclear, Inc. (June 15, 1989) (DEQ/LQD files).

226. *See, e.g.*, letter from Niles J. Andrus, American Nuclear Corp., to Mark Moxley, DEQ (April 2, 1987) (DEQ/LQD files); letter from Ramon E. Hall, Uranium Recovery Field Office, Region IV, NRC, to Western Nuclear Inc. (Sept. 29, 1989) (DEQ/LQD files).

227. Travis & Doty, *Can Contaminated Aquifers at Superfund Sites be Remediated?*, 24 ENVTL. SCI. & TECH. 1464-65 (1990). *See also* Mackay & Cherry, *Groundwater Contamination: Pump-and-Treat Remediation*, 23 ENVTL. SCI. & TECH. 630 (1989); 1 ENVIRONMENTAL PROTECTION AGENCY, EVALUATION OF GROUNDWATER EXTRACTION REMEDIES: SUMMARY REPORT (1989).

228. Travis & Doty, *supra* note 227 at 1465.

have shown that over a 1000-year time period there is a very high probability (63.2%) that at least one 1,000-year flood, earthquake, massive storm or other natural disaster will occur.[229] "This means that in about two of three chances a tailings disposal facility designed for a 1,000 year event will be damaged or destroyed in a 1,000 year time period."[230]

Another example of the future danger this tailings legacy represents is cited by Weber. Previously, it was assumed that after drying and final covering the discharge of contaminants from tailings ponds would be negligible.[231] Weber questions this assumption when very long periods of time are involved. He points out that "a fraction of the precipitation that falls on stabilized tailings infiltrates the surface and percolates downward until it recharges the saturated zone . . . . Even at arid sites where potential evaporation greatly exceeds annual precipitation, net recharge through tailings embankments to the saturated zone may be expected."[232] Water flux through reclaimed tailings may leach high concentrations of uranium, arsenic, molybdenum, selenium, thorium-230, radium-226, iron, chloride, sulfate, and other constituents, which could contaminate groundwater resources.[233] Practical methods do not yet exist for estimating discharge rates, but "[l]ong-term contaminant discharge rates increase in significance . . . when the duration of their occurrence is considered."[234]

RESTORING THE LAND

The rules governing mill tailings reclamation are still evolving, amid much controversy. These rules, however, at least incorporate current research and the latest reclamation techniques. In contrast, efforts to revegetate uranium mined lands sometimes appear to be a case of 1970's reclamation practices being used in the 1990's. The problem is not with the seed being used, or how it is applied. Rather, it is with reconstructing the soil to provide a medium that will support plant growth over time. In handling topsoil and dealing with potentially toxic material uncovered during mining, there are cases where reclamation practices in the uranium industry lag behind current procedures used to reclaim the West's surface coal mines.

New regulations would not likely resolve the problem. State regulations introduced in the early 1980's required that before mining be-

229. Junge and Dezman, *An Analysis of Control Standards for the Long-Term Containment of Uranium Mill Tailings*, MANAGEMENT OF URANIUM MILL TAILINGS, LOW-LEVEL WASTE AND HAZARDOUS WASTE 485-87 (1984) (Sixth Symposium on Uranium Mill Tailings Management, Geotechnical Engineering Program, Colo. State Univ., Fort Collins).
230. *Id.* at 487.
231. Weber, *supra* note 223, at 206.
232. *Id.*
233. *Id.* at 206, 213.
234. *Id.* at 206.

gins operators must develop "a plan for . . . handling and disposal of all toxic, acid-forming, or otherwise hazardous materials[.]"[235] But, by the time this regulation was issued, the damage had already been done. Mining had taken place without the benefit of such a plan. Only the task of reclamation remained. This gap poses the major problem for introducing modern techniques into uranium mine reclamation. The link between mining and reclamation has been severed. Whereas in western surface coal mining, successful restoration of the land often depends on decisions taken before mining begins.

Handling and Storage of Topsoil

A major advancement in reclamation in the early 1970's was stockpiling topsoil for future reclamation use.[236] A major innovation in the 1980's was the direct haul, or live soil-handling, technique.[237] In direct haul, topsoil is stripped from the area to be mined and is transported directly to a previously mined area that has been filled in and regraded. Topsoil is not stored, and is only in the scraper a matter of minutes before it is placed in its new permanent location. According to the authoritative *Western Surface Mine Permitting and Reclamation* study, immediate topsoil replacement "preserves the biologically active component of the soil and tends to encourage faster reestablishment of nutrient cycles."[238] Comparisons between direct haul and stockpiled topsoil "indicate that storing soil for more than about two years at many sites significantly decreases the viability of seeds and microbiota."[239] Another advantage of direct haul is that the spontaneous natural growth of native species is likely.[240] Improved soil properties achieved when storage is avoided also add to the success of planted species.[241]

Direct haul of topsoil is the ultimate in continuous reclamation. However, this technique would be difficult to incorporate in a reclamation plan for a uranium mine. The long and uncertain period a single pit might be considered worth mining makes it hard to coordinate one pit's reclamation with the opening of another pit. In any case, the direct haul of topsoil requires that mining and reclamation proceed simultaneously. As there has been little open-pit uranium mining in Wyoming since the early 1980's, the primary source of topsoil for ura-

235. WYO. DEP'T OF ENVTL. QUALITY, LAND QUALITY DIV., RULES AND REGS., *supra* note 47, at ch. II, § 2b(3)(a).

236. Interview with an official of the Land Quality Division, Wyo. Dept. of Envtl. Quality, Cheyenne (Aug. 9, 1988). *See also* LAND QUALITY DIV., RULES AND REGS., *supra* note 59, at ch. II, § 4.

237. OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 18, at 13, 240-43.

238. *Id.* at 240.

239. *Id.*

240. Schafer, *Cover-Soil Management in Western Surface-Mine Reclamation*, SYMPOSIUM ON SURFACE MINING HYDROLOGY, SEDIMENTOLOGY AND RECLAMATION 305, 307 (Univ. of Kentucky, Lexington, Dec. 4-7, 1979).

241. *Id.*

nium mine reclamation is limited to that which was stored when the pits were dug in the 1970's.

The Problem of Unsuitable Overburden

The material between the surface layer of soil and ore is called overburden, or spoil, when moved.[242] Overburden, together with topsoil, forms the basic material for the reclamation process. If deleterious overburden is placed in plant rooting zones, it can affect long-term plant growth and contaminate topsoil.[243] Acid and acid-forming soil, seleniferous soil, clayey soil and saline soil are just some types of unsuitable overburden uncovered during surface mining in Wyoming.[244] Radiation in soil also can be a criterion for unsuitable overburden as it can concentrate in plants and threaten animal life.[245] In the Gas Hills uranium producing area of central Wyoming, for example, acid and acid-forming soils are widespread.[246] A 1985 DEQ inspection report noted that as a result, "[s]ignificant portions of reclaimed pits and spoil dumps in the East Gas Hills are presently experiencing poor and failing revegetation."[247]

At coal mines in Wyoming today, the overburden handling plan generally involves a premining drilling program.[248] If premining drilling identifies unsuitable material comprising more that 20% of the overburden being removed, the material will be placed in an area of the trench, or pit, which contains heavy clay or silty shale to prevent further contact with air, surface water, aquifers, topsoil or vegetation.[249] After mining, the recontoured surface is filled "to within four feet of the final level with run-of-mine spoil[.]"[250] This is then "covered with the final four feet of near-surface, coarse-textured, oxidized, suitable spoil."[251] This surface material is sampled to assure suitability before topsoil is applied.[252]

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242. M. CARLSTROM, F. AMENDOLA, D. SHAY & D. DOLLHOPF, RECLAIMING MINE SOILS AND OVERBURDEN IN THE WESTERN UNITED STATES: ANALYTIC PARAMETERS AND PROCEDURES 107 (R. Williams & G. Schuman eds. 1987).

243. OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 18, at 13, 167.

244. A.V.I., REPORT OF INVESTIGATION: AML PROJECT 13, at 1-45 to 1-52 (Sept. 9, 1986) (prepared for Abandoned Mine Land Program, Wyo. Dept. of Envt. Quality, Land Quality Div.).

245. M. EISENBUD, *supra* note 96, at 179.

246. Silver King Mines, Inc. (TVA), Reclamation of Potential Acidic Overburden at the Gas Hills Project, Wyoming *passim* (July 1986) (DEQ/LQD files) [hereinafter Silver King Mines, Inc.].

247. Inspection Report, Umetco Minerals, by John Erickson, DEQ (May 20, 1985) (DEQ/LQD files).

248. OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 18, at 234.

There has been considerable debate over the utility of premining drilling because of the extreme geological variation over short distances in many western coal regions. (*See id.* at 126, 136-38, 220.)

249. *Id.* at 234.

250. *Id.*

251. *Id.*

252. *Id.* On current reclamation practices in western surface coal mines, *see also*

In contrast, uranium mining in the 1970's usually involved stacking overburden as it came out of the pit. Material near the surface, which is more likely suitable because it is partially weathered, ended up on the bottom of the spoil pile. More problematic overburden from deep in the pit was placed on top of the pile as it was last to be removed.[253] Soluble and suspended particles are less likely to have been leached out of this material from deeper in the pit. Its exposure to the near-surface environment can result in geochemical reactions, such as oxidation, not common in surface soil.[254] These geochemical reactions cause many of the later problems with plant growth.[255]

If spoil from uranium mining were returned to the pit, as required by federal surface coal mine legislation,[256] then the problem of unsuitable overburden would be less serious. The stacking process could be reversed, and the worst overburden returned to the bottom of the pit. However, Wyoming law does not require that all uranium pits be filled. Pits mined before the 1973 Wyoming Environmental Quality Act do not have to be reclaimed at all.[257] Even after 1973, most uranium mines were allowed to leave one or more pits as a permanent water impoundment, or small lake, for use by cattle and wildlife.[258] Spoil piles not used to fill a pit or cover tailings are regraded and reclaimed in place, often with a built-in problem of unsuitable

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Hearing on Bonding, *supra* note 78, at 348, 350-51.

253. The problem posed by stacking overburden was explained in a report from American Nuclear Corporation.

> You will note that most of the material in the first foot at the surface is unsuitable root zone material. This can be explained by the fact that in the stripping and mining process, especially when stripping is done with scrapers, the material coming out of the pit is deposited in the spoil pile in layers and the last material stripped, which becomes the surface layer, is generally from the ore zone.

Letter from Niles J. Andrus, American Nuclear Corp., to Mark Moxley, DEQ (Nov. 25, 1985) (DEQ/LQD files).

254. *See* Schafer, *supra* note 240, at 309; S. FISHER, F. MUNSHOWER & F. PARADY, RECLAIMING MINE SOILS AND OVERBURDEN IN THE WESTERN UNITED STATES: ANALYTIC PARAMETERS AND PROCEDURES 109, 116 (R. Williams & G. Schuman eds. 1987).

255. Another report on acidic overburden in the Gas Hills notes:

> Several alternative methods exist for handling overburden that has the potential to become acidic. The most effective way is identification of this material before mining so that it can be specially handled during progression of mining. This is usually done by selective burial so that the pyrites cannot be oxidized. For the Gas Hills project, this option, for the most part, is unavailable since overburden containing pyritic material near the ore zone was the last to be placed on top of stockpiles.

Silver King Mines, Inc. (TVA), *supra* note 246, at 2.

256. Surface Mining Control and Reclamation Act (SMCRA) § 515(b)(3), 30 U.S.C. § 1265(b)(3) (1988). *See also infra* notes 273, 274 and accompanying text.

Exceptions can be made for excess spoil resulting from volumetric expansion. SMCRA § 515(b)(3), 30 U.S.C. § 1265(b)(3) (1988). On exceptions and exemptions *see also infra* notes 265, 273.

257. For example, four out of the five pits mined since Western Nuclear, Inc. (Phelps Dodge) began operations in 1957 were not subject to state reclamation requirements. (Annual Report 1988, prepared by Western Nuclear, Inc. (Aug. 16, 1987 to May 31, 1988)) ("Tabulation of Out-of-Pit Spoil and Underground Spoil Dumps") (DEQ/LQD files).

258. *See infra* notes 270-272 and accompanying text.

soil near the surface. These spoil piles are large. A single pile might cover 100 to near 1,000 acres of ground, to depths varying from a few meters to over 100 meters.[259]

DEQ has adopted a flexible approach to deleterious overburden. Where seeding was done in the 1970's and early 1980's, and vegetation is today established, DEQ can be conciliatory. Thus, in 1988, during an assessment of revegetated land for bond release at the Exxon Highland mine, the DEQ plant ecologist asked: "Has any soil/spoil testing been done on the revegetated area? . . . My basic concern is about selenium levels on this area."[260] Tests were required, but, it was noted, the company would not be held responsible if unsuitable overburden were discovered. "If toxicities are detected, the operator cannot be required to ameliorate these since their reclamation program did not require special handling of unsuitable overburden. However, it is important that we identify any potential problems on this area and see that it is managed accordingly."[261]

More recently, DEQ has insisted that overburden be sampled early in reclamation, before placement of topsoil. When this is not done and unsuitable overburden is later discovered, notices of violation have been issued.[262] Special attention is given to areas with well-known problems of unsuitable overburden, such as in the Gas Hills. Where problems are found, treatment may vary, and is similar to that at coal operations. Unsuitable material may be buried and isolated. Acidic overburden is often neutralized with lime.[263] Problem areas may also be covered with a layer of suitable overburden, and then topsoil and possibly fertilizer.[264]

LEAVING PITS AND HIGHWALLS AFTER MINING

A major difference between uranium and coal reclamation in Wyoming is that uranium mine operators are often allowed to turn their final pit into a permanent water impoundment. Some pit walls also may be left in place if stable. With very few exceptions, coal mines cannot do this.[265] Some argue that in this case, the uranium mining industry is practicing better reclamation than the coal industry. They

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259. 2 ENVTL. PROTECTION AGENCY, *supra* note 14, at 3-45.

260. Memorandum re. Review of Exxon Highland's Bond Release Vegetation Study, from Paige Smith, Plant Ecologist, DEQ (April 27, 1988) (DEQ/LQD files).

261. Memorandum on Exxon Highland Uranium Mine, from Paige Smith, Plant Ecologist, DEQ (June 16, 1988) (DEQ/LQD files).

262. *See, e.g.*, Annual Inspection Report, Umetco Minerals, Inc., by John Erickson, DEQ (Aug. 13, 1985) (DEQ/LQD files); Annual Inspection Report, Pathfinder Mines Corp., Lucky Mc Mine, by John Erickson, DEQ (Sept. 7, 1988) (referring to an earlier Notice of Violation) (DEQ/LQD files).

263. Silver King Mines, Inc., *supra* note 246, at 17-18.

264. *Id.* at 2.

265. *See infra* notes 267-279 and accompanying text.

A major exception would be the special case of deep, open-pit bituminous coal mines operating near Kemmerer, Wyo. SMCRA § 527, 30 U.S.C. § 1277 (1988).

claim that in the barren Wyoming landscape, wildlife is better served by creating a more varied landscape.[266] However, the question is controversial. Recently, there was an extensive debate on the subject between the federal government and environmental groups on one side, and the coal mine industry and the State of Wyoming on the other. The issues raised in this debate should help illustrate the positive and negative aspects of allowing this practice in uranium mine reclamation.

Rules on Pits and Highwalls

Wyoming reclamation regulations contain general rules applicable to all mines.[267] These often are superseded by additional rules for coal[268] mandated by the federal Surface Mining Control and Reclamation Act of 1977 (SMCRA).[269] The State's general rules require that land be restored "to a condition equal to or greater than the 'highest previous use.' "[270] This goal can include turning a pit into a small human-made lake suitable "for recreational, irrigation, livestock or wildlife," if the Department of Environmental Quality judges this to be an equal or higher use of the land.[271] State rules also allow non-coal mines to leave part of the pit wall that is created when a mine is dug:

> If the reclamation plan provides for a permanent water impoundment . . . [and] it can be demonstrated to the Administrator's satisfaction that the pitwall can be stabilized by terracing or other techniques it may be permissible to leave not more than one-half (½) of a proposed shoreline composed of the stabilized pitwall. The remaining portion of the shoreline must be graded and contoured so as to provide access and blend in with the topography of the surrounding terrain.[272]

The Debate Over Highwalls and Pits

In December 1989, the federal Office of Surface Mining Reclamation and Enforcement (OSM) reaffirmed its strong opposition to leaving stabilized walls in coal mine reclamation. OSM emphasized that restoration of "the approximate original contour [AOC] of the land with all highwalls, spoil piles, and depressions eliminated" was a fun-

266. *E.g.*, Wyo. Regulatory Program, 54 Fed. Reg. 52,958 (1989); OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 18, at 254-60. *See also infra* notes 275-278 and accompanying text.

267. LAND QUALITY DIV., WYO. DEPT. OF ENVTL. QUALITY, RULES AND REGS. 1989, *passim*.

268. *See, e.g.*, *id.* at ch. IV, § 3.

269. SMCRA, 30 U.S.C. §§ 1201-1328 (1988).

270. LAND QUALITY DIV., *supra* note 267, at ch. IV, § 2(a)(i).

271. *Id.* at ch. II, § 2(b)(iii)(E).

272. *Id.* at ch. IV, § 2(b)(ii)(C).

damental principle of the federal surface mining act for coal.[273] This part of the federal coal mine law had its origin in the mountainous coal fields of Appalachia. Here, after mining, coal companies often left unstable piles of overburden and steep rock walls, called "highwalls," when the coal and cover material were removed. These remnants of mining created pollution and landslide threats, and greatly limited post-mining use of the land.[274]

OSM's firm restatement of the federal policy against leaving highwalls was in response to a request from Wyoming to amend its rules on coal mine reclamation. The proposed amendment would have allowed coal mines to retain highwalls as a final reclamation feature where this would benefit wildlife and livestock.[275] Wyoming argued that "in the Northern Great Plains, lack of topographical diversity is a critical factor limiting many wildlife populations, especially raptors."[276] Substitute features such as rock piles and artificial raptor nesting platforms had proved to be of limited value, the State said.[277] Because highwalls could provide windbreaks, it was argued that livestock also would benefit. "Most reclaimed areas offer little protection from severe weather."[278]

In the end, the request was rejected by OSM as having insufficient legal basis to override such a fundamental part of the federal law on coal mine reclamation. Nevertheless, OSM did concede that "under certain conditions, highwall remnants could restore or enhance premining wildlife habitat and related environmental values."[279] Several national environmental groups strongly opposed the Wyoming request, primarily because of the precedent it would set. " 'Environmental compliance always settles down to the lowest common denominator'," a representative of the Environmental Policy Institute stated. " 'We knew if Wyoming was granted an exemption, we'd be fighting it in every state in the East.' "[280] The Western Organization of Resource Councils argued the proposal would allow " 'too many

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273. Wyo. Regulatory Program, *supra* note 266, at 52,958.
OSM noted that "although the Act authorizes several exemptions from the AOC restoration requirement, the language of each exemption also specifies that all highwalls must be eliminated . . . ." *Id.*

274. *See* McDaniel, *supra* note 2, at 292. *See also* R. AUSTIN, SPOIL: A MORAL STUDY OF STRIP MINING FOR COAL 34-37 (1976).

275. Wyo. Regulatory Program, *supra* note 266, at 52,958.
Wyoming's request was supported by the Wyoming Mining Association. It was also supported by the U.S. Soil Conservation Service, the Bureau of Land Management, the U.S. Fish and Wildlife Service and the U.S. Forest Service, and even had initial support from environmental groups in the state. *Id.* at 52,959. *See also* Melnykovych, *Coal Miners, Enviros Step Off Same Cliff*, Casper Star-Tribune, Feb. 7, 1990, at A10.

276. Wyo. Regulatory Program, *supra* note 266, at 52,958.

277. *Id.*

278. Melnykovych, *Feds Reject Wildlife Habitat Proposal*, Casper Star-Tribune, Jan. 24, 1990, at A12. (Statement by Lyle Randen of Thunder Basin Coal Co.)

279. Wyo. Regulatory Program, *supra* note 266, at 52,958.

280. Melnykovych, *supra* note 278, at A1.

highwalls to be left with too little regulatory control and too little justification.' "[281]

Coal industry officials were quoted as saying that "the highwall proposal was not simply a ploy to cut reclamation costs. Stabilizing and contouring the highwalls would not be significantly cheaper than filling the mine pit[.]"[282] Also, in the State's proposal only part of the highwall would be left to form the reconstructed bluff. Some backfilling would still be necessary.[283] Nevertheless, moving earth is the most expensive part of reclamation work. In reclaiming a uranium mine it saves money if a pit is not backfilled, or a highwall not regraded. Typically, if a reclamation plan called for backfilling a pit, far more than half of the total reclamation costs would be for backfilling. The cost of backfilling a large pit can run into millions of dollars. For example, Petrotomics Company (Getty) estimated that it would cost $17.8 million in 1985 to fill its pit No. 4.[284] Pathfinder Mines (Cogema) estimated total backfilling costs of almost $44 million in 1989 for three pits at its Shirley Basin Mine.[285] Minerals Exploration Company (UNOCAL 76) estimated costs of $16.5 million in 1987 for filling its major pit and a small test pit.[286]

Wyoming's Experience With Pits and Highwalls

In the debate with Wyoming coal operators over leaving pits and highwalls, OSM conceded the theoretical point that such features could enhance wildlife habitat. Yet, before we can conclude that here, at least, the uranium industry has taken the lead in reclamation, we must examine Wyoming's experience with this practice. This is only fair, for it is on the basis of past experience and realism, not theory, that OSM and environmentalists base their opposition. They point to real abuses in the past in Appalachia, which led to the passage of SMCRA, and they also point to the real pressures any company faces to cut costs.

Soon after the Environmental Quality Act was passed in the early 1970's, the State had to deal with the fact that companies would prefer not to pay to refill pits if they did not have to. According to the

281. Wyo. Regulatory Program, *supra* note 266, at 52,960.

282. Melnykovych, *supra* note 278, at A1.

283. Discussions and correspondence with Fred Parady III, Manager, Environmental & Engineering, Bridger Coal Co., Rock Springs, Wyo. (Sept., 1990).

284. 22.5 million cubic yards times $0.792 per bank cubic yard (bcy). (1984-1985 Annual Report - Mining Permit #342, prepared by Petrotomics Co. (Getty) (June 26, 1985) (DEQ/LQD files)).

285. 73 million cubic yards times $0.60 per cubic yard. (Annual Report to the Dept. of Envtl. Quality, Pathfinder Mines Corp., Shirley Basin Mine, app. A (June 1989) (DEQ/LQD files)).

286. 22 million cubic yards times $0.75 per cubic yard. (Annual Mining and Reclamation Report for Report Period Nov. 1, 1986 to Oct. 31, 1987, Sweetwater Uranium Mine, Minerals Exploration Co., at § F (Dec. 1987) [hereinafter Annual Report 1987] (DEQ/LQD files).

first administrator of DEQ's Land Quality Division: "[I]f you didn't have to fill the hole, this would go into profit. So, it was worth it to come in and propose a mine permit application to propose that impoundment. All right. A mine did this, the next mine, so forth. Now, I had impoundments all along that strike. Well, the question is, how far does a Hereford cow have to walk for a drink of water."[287] This problem was resolved by allowing mines to leave only their final pit as a permanent water impoundment.

In the early 1980's, DEQ seemed most concerned with ensuring that if highwalls and water impoundments were left, they would actually contribute to an equal or better use of the land. Regulations were strictly interpreted, and it would be hard to argue that the exemptions granted endangered the environment or successful reclamation. For example, if companies planned to leave an impoundment, state rules mandated that they provide "[a]n alternative plan to be followed in the event monitoring indicates there is insufficient water of suitable quality to accomplish the proposed water impoundment plan."[288] DEQ insisted that the only acceptable alternate plan was to fill in the pit.[289] This alternate plan greatly increased costs to the companies, as they would have to bond for the possibility of filling in the pit.[290] The State, however, was protected against the creation of a dry lake or a radioactive lake. If the impoundment did not have sufficient water of suitable quality, then it would be filled in.

In 1982, Western Nuclear, Inc. (Phelps Dodge) challenged the requirement that the alternate plan must be to fill in the pit. DEQ had denied Western Nuclear a permit because its backup plan did not provide for filling in the pit.[291] Instead the alternate plan proposed to fill the pit to just above the water table, and to plant water loving trees, such as willow or cottonwoods, whose root systems would create a "phreatophytic pumping system" to keep contaminated water from

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287. In The Matter of the Denial of a Permit Application of Western Nuclear, Incorp., Transcript of Hearing Proceedings at 419, No. 951-81 (Wyo. Envt. Quality Council Mar. 23, 1982) [hereinafter Western Nuclear Hearing] (DEQ/LQD files).

288. LAND QUALITY DIV., WYO. DEPT. OF ENVTL. QUALITY, RULES AND REGS. 1982 ch. II, § 2b(3)(e)(v) (Aug. 1982).

289. *See, e.g., infra* text accompanying notes 292-294.

290. Companies complained. For example, in a plea to be allowed a less expensive backup plan, Mineral Exploration Co. (Unocal 76) said: "Our present bonding costs are exorbitant and the largest portion of this bond (over 75%) is to cover the costs associated with the alternate reclamation plan." (Annual Report 1987, *supra* note 286, § H.)

291. Western Nuclear Hearing, *supra* note 287, at 410-16; Purdy, *Uranium Company Challenging State Decision*, Casper Star-Tribune, Mar. 28, 1982, at A3.

Western Nuclear took its complaint to the Environmental Quality Council, whose seven members are appointed by the Governor with the advice and consent of the Senate. The Council acts as the hearing examiner for the Department of Environmental Quality, and hears and determines all cases or issues arising under the laws and regulations administered by DEQ. (WYO. STAT. §§ 35-11-111(a), 35-11-112(a) (1988 & Cum. Supp. 1990)).

rising to the surface.[292] The stated reason for this particular alternative was to save on the annual cost of reclamation bonds.[293]

DEQ argued that "the backup plan was even more speculative than the primary proposal and could not guarantee the land would be restored to as good or better condition than before it was mined[.]"[294] DEQ prevailed at the hearing, but eventually lost the larger battle. As part of the effort to ease the financial burden on the economically troubled uranium industry, the state Environmental Quality Council removed the requirements for a mandatory backup reclamation plan for water impoundments.[295] Since 1986, the alternate reclamation plan, and the considerable additional cost in bonding, can be waived if the applicant can "reasonably satisfy" DEQ that the water quality and quantity will be suitable for post-mining land use.[296] Obviously, the previous priority of assuring an environmentally acceptable outcome had been downgraded.

Where it appears that water quality in a permanent impoundment might not meet livestock drinking water standards, and a backup plan is necessary, the State also has been more willing to accept less costly alternatives that probably would have been rejected in the past. For example, when water quality problems arose in a proposed permanent impoundment, Mineral Exploration Company (MEC) was allowed to revise its backup plan. If water quality problems persisted,[297] the company would be allowed to partially fill the pit to at least five feet above pre-mine groundwater levels.[298] The impoundment would then be converted "from a lake to a reclaimed vegetated area consistent with the land uses of grazing and wildlife habitat . . . . MEC will attempt to establish willow and cottonwood shrub-trees on portions of this bottom area."[299] Estimates show that, compared to filling the pit, this new alternative would save Mineral Exploration Co. $7.5 million.[300]

Petrotomics (Texaco)[301] and Exxon's Highland Mine[302] provide

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292. Western Nuclear Hearing, *supra* note 287, at 412, 414-15; Purdy, *supra* note 291, at A3.

293. Western Nuclear Hearing, *supra* note 287, at 412.

294. Purdy, *supra* note 291, at A3.

295. Interview with an official of the Land Quality Division, Wyo. Dept. of Envtl. Quality, Cheyenne (Aug. 10, 1988).

296. LAND QUALITY DIV. RULES AND REGS., *supra* note 267, ch. II, § 2(b)(iii)(E)(III).

297. It is possible that over time sedimentation and sorption processes are likely to improve the quality of surface water and the water that recharges the groundwater system. 2 ENVTL. PROTECTION AGENCY, *supra* note 14, at 3-22.

298. Letter from Roger Shaffer, Administrator, Land Quality Division, DEQ, to Christopher Hill, Minerals Exploration Co. (June 20, 1988) (DEQ/LQD files).

299. Annual Report 1987, *supra* note 286, § H (revised Jan. 15, 1988).

300. *Id.*, table F-1 and revised table H-1.

301. Annual Inspection Report, Petrotomics Company, by Cindy Bosco, DEQ (July 9, 1986) (DEQ/LQD files); interview with an official of the Land Quality Division, Wyo. Dep't of Envtl. Quality, Cheyenne (Aug. 10, 1988).

302. 1987 Annual Report Review, Exxon Highland Uranium Mine, by Steve Ingle,

two additional examples of less costly backup plans accepted by DEQ. Both mines have had water quality problems in impoundments that are to be permanent. For each the alternative, if problems persist, is a barium chloride treatment of pit water.[303] The estimated cost for this treatment ($24,000) in the Petrotomics case is 1/10 of 1% of what it would cost to fill in the pit.[304]

CONCLUSION

How well did reclamation laws, regulators, and mining companies meet the unexpected test posed when the bottom fell out of the uranium market in the early 1980's? When the industry collapsed, some doubted that there would be any reclamation. Viewed from the perspective of that period, reclamation is progressing quite well. Most open-pit uranium mines in Wyoming will be reclaimed in the 1990's. However, results are less impressive when judged against current practices in the coal industry, or even when judged against expectations which existed when the State's reclamation law was passed—expectations of a speedy reclamation which would return the land to a condition equal to or greater than the highest previous use.

Are there any lessons in the State's experience with the uranium industry that might be applicable elsewhere, or in the future? Presently, Nevada is dealing with a gold mining boom and is considering new reclamation laws.[305] State officials have studied reclamation and bonding laws for non-coal mines in neighboring western states.[306] Perhaps they should also examine the application of these laws, especially in a post-boom situation.

In Wyoming today, the most land being disturbed by mining is for coal.[307] Would all this land be reclaimed if the demand for western coal dropped as it did in the 1950's, when coal mines throughout the region closed?[308] One study focusing on the West in the early twenty-first century answers this question in the negative.[309] This study de-

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Hydrologist, DEQ (April 25, 1988) (DEQ/LQD files).

303. Annual Inspection Report, *supra* note 301; Exxon Coal and Minerals Co., Highland Reclamation Project, Surety Requirements for Period Ending July 31, 1987, by DMR, at 1, 3 (Aug. 18, 1987) (DEQ/LQD files).

Barium chloride is used to coprecipate radium and is often used with a flocculent to remove other contaminants. 2 ENVTL. PROTECTION AGENCY, *supra* note 14, at 1-15.

304. Annual Report, Petrotomics Company, by Miles Bennett, Environmental Coordinator (June 24, 1987) (DEQ/LQD files). *See also supra* note 284 and accompanying text.

305. *Hearing on Bonding*, *supra* note 78, at 94.

306. *See, e.g.*, W. J. Gallaher & S. Lynn, Three State Bond Pool Programs: References and a Comparison of Western States Bonding and Reclamation Requirements (March 1989) (Public Resource Associates), *reprinted in Hearing on Bonding*, *supra* note 78, at 247-343.

307. 28 WYO. GEO-NOTES 2, 17-28 (1990).

308. A. GARDNER & V. FLORES, FORGOTTEN FRONTIER: A HISTORY OF WYOMING COAL MINING, ch. 6 (1989).

309. McKean and Diemer, *supra* note 7, at 9.

picts coal facing stiff competition from cleaner alternative energy sources in the future.[310] In the year 2020, or 2030, eastern Wyoming is described as "dotted with abandoned coal fired power plants and dusty remnants of mined-out strip mines."[311]

When the market disappeared for uranium, the State applied reclamation requirements with flexibility. This approach helped bring the industry through the crisis. If the State were administering a federally mandated reclamation law, as is the case with the federal coal surface mining act (SMCRA), the same flexibility would not have been possible. If the law for uranium mines had been enforced more strictly—reclamation within two years, rigorous soil testing, refilling pits—there would have been more defaults. Defaults would have put reclamation bonds to a hard test. Even without an economic crisis the safety and worth of these financial guarantees have been questioned.[312]

One might argue that the scenario of such a massive default for coal is unlikely, that taxpayers are protected because the federal law requires that coal mine reclamation take place "as contemporaneously as possible with the surface coal mining operations[.]"[313] Land can, in fact, be reclaimed as mining progresses. Overburden removed from one part of the trench or pit can be used to fill in another part that has been previously mined. As discussed, some coal mines haul topsoil for placement directly on a previously mined area that has been graded and prepared for final reclamation.[314] Yet, in the most important coal mining region of the most important coal mining state—the Powder River Basin of Wyoming—the situation is more complex, and reclamation is not being completed "contemporaneously" with mining.

The Powder River Basin contains many large surface mines. In the mid-1980's, there were sixteen mines in Wyoming, which had already disturbed over 18,000 acres.[315] Across the border in Montana, there were another seven mines, and ten more mines were planned for the area.[316] The overburden in this region is very thin relative to the thick coal beds. Generally, there is not sufficient overburden available to replace the large coal seams which have been removed. This results

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310. *Id.* at 4-6. *See also supra* note 7.

311. McKean and Diemer, *supra* note 7, at 9.

312. *See, e.g.*, Galloway & FitzGerald, *The Bonding Program under the 1977 Surface Mining Control and Reclamation Act: Chaos in the Coalfields*, 89 W. VA. L. REV. 675 (1987). *See generally supra* note 79.

313. Surface Mining Control and Reclamation Act, § 102(e), 30 U.S.C. § 1202(e) (1988).

314. *See supra* notes 237-241 and accompanying text.

315. L. MARTIN, D. NAFTZ, H. LOWHAM & J. RANKL, CUMULATIVE POTENTIAL HYDROLOGIC IMPACTS OF SURFACE COAL MINING IN THE EASTERN POWDER RIVER STRUCTURAL BASIN, NORTHEASTERN WYOMING 14 (U.S. Geological Survey, Water-Resources Investigations Report 88-4046, 1988) [hereinafter L. MARTIN].

316. OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 18, at 53.

in a lowering and flattening of the landscape after mining.[317] For final reclamation, entire new drainage systems will have to be designed and constructed.[318] This will require a coordinated operation among companies. New aquifers will emerge in the backfilled overburden as groundwater resaturates the spoil, but there is no certainty how long this process will take or what the final quality of water will be.[319] Obviously, if mining were to suddenly stop this year, what remained would not be an area that is mostly reclaimed.

Thus, in the Powder River Basin, at least, the particular experience that DEQ had of shepherding the uranium industry through to final reclamation could prove relevant. Even more relevant, however, may be the general lesson to emerge from the uranium crash and subsequent efforts to reclaim. Clearly that lesson is that the legal requirement to reclaim does not in itself guarantee successful reclamation.

This may seem a simple and obvious lesson today. But in the 1970's, many saw the battle to assure reclamation as one that would be fought in the legislature. How naive this now appears. The collapse of the uranium market and the Reagan "revolution" within federal enforcement agencies caught all unaware. These changes in the economic and political climate, in turn, greatly affected the possibility of achieving reclamation. At the federal level a battle began over the rules on limiting radiation from tailings that continues today. At the state level operators could not afford to mine, and the State was not going to force them to reclaim. After more than ten years of a depressed market, many of these companies finally have decided to reclaim. But their efforts will fall short of the expectations of the 1970's. Passing a law did not guarantee successful reclamation. One must also have the political will to enforce reclamation and the financial ability to fund it. These factors cannot be assumed, nor can they be dispensed with. This is the lesson from uranium mine reclamation in Wyoming.

317. L. MARTIN, *supra* note 315, at 12.

318. OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 18, at 70, 177; L. MARTIN, *supra* note 315, at 163-64.

319. OFFICE OF TECHNOLOGY ASSESSMENT, *supra* note 18, at 207, 218-19; L. MARTIN, *supra* note 315, at 156.