rates of ground-water movement, and also will be decreased because the small rates of affected ground-water discharge (generally less than 0.3 ft^3/s) will be diluted by the relatively large rates of streamflow (generally 1 to 20 ft^3/s).

Minimal differences in model simulation results were obtained by changing the head configuration in a simulated underground mine to represent hydrologic conditions associated with open mine voids or collapsed mine voids.

Sensitivity analyses of model dispersivity and porosity indicated that simulation results are insensitive to dispersivity but more sensitive to porosity. Porosity variations of 33 percent produced a 13-percent change in the dissolved-solids concentrations of ground water discharging to a stream downgradient from a spoil aquifer.

REFERENCES CITED

Bachmat, Yehuda, Bredehoeft, J.D., Andrews, B., Holtz, D., and Sebastian, S.,1980, Groundwater management–The use of numerical models: Water Resources Monograph 5, Washington, D.C., American Geophysical Union, 127 p.

Bass, N.W., Eby, J.B., and Campbell, M.R., 1955, Geology and mineral fuels of parts of Routt and Moffat Counties, Colorado: U.S. Geological Survey Bulletin 1027-D, p. 143-240.

Beattie, D.A., 1958, Geology of part of southeast Moffat County, Colorado: Golden, Colorado School of Mines, unpublished Master's thesis, 176 p.

Berman, A.E., Poleschook, Daniel, Jr., and Dimelow, T.E., 1980, Jurassic and Cretaceous systems of Colorado, in Kent, H.C., and Porter, K.W., eds., Colorado geology: Denver, Rocky Mountain Association of Geologists, p. 111-128.

Blackmer, Joanne, 1939, Geology of the Steamboat Springs area with special emphasis on thermal springs: Boulder, University of Colorado, unpublished Master's thesis, 61 p.

Bouwer, Herman, and Rice, R.C., 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells: Water Resources Research, v. 12, no. 3, p 423-428.

Bradley, W.H., 1945, Geology of the Washakie Basin, Sweetwater and Carbon Counties, Wyoming, and Moffat County, Colorado: U.S. Geological Survey Oil Investigation Map no. 32, scale 1:190,080.

Brogden, R.E., and Giles, T.F., 1977, Reconnaissance of ground-water resources in a part of the Yampa River basin between Craig and Steamboat Springs, Moffat and Routt Counties, Colorado: U.S. Geological Survey Water-Resources Investigations 77-4 map, scale 1:120,000.

Bronson, R.J., 1979, Reconnaissance drill hole in the Yampa coal field, Routt County, Colorado: U.S. Geological Survey Open-File Report 79-1593, 3 p.

Brownfield, M.E., 1978a, Reconnaissance drilling during 1976 in th Rattlesnake Butte quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File Report 78-364, 11 p.

____1978b, Reconnaissance drilling during 1977 in the Yampa coal field, Moffat and Routt Counties, Colorado: U.S. Geological Survey Open-File Report 78-365, 135 p.

Buffler, R.T., 1967, The Browns Park Formation and its relationship to the late Tertiary history of the Elkhead region, northwestern Colorado, south central Wyoming: Berkeley, University of California, Ph.D. dissertation, 215 p.

Campbell, M.R., 1923, The Twentymile Park district of the Yampa coal field, Routt County, Colorado: U.S. Geological Survey Bulletin 748, 82 p. Chisholm, F.F, 1886, The Elk Head anticline coal field of Routt County: Denver, Colorado Scientific Society proceedings, v. 2, p. 147-149.

Collins, M.J., 1921, Some anticlines of Moffat County, Colorado: Boulder, University of Colorado, unpublished Master's thesis, 36 p.

Cooper, H.H., Jr., Bredehoeft, J.D., and Papadopulous, I.S., 1967, Response of a finite diameter well to an instantaneous charge of water: Water Resources Research, v. 3, no. 1, p. 263-269.

Crawford, R.D., Willson, Kenneth, and Perini, V.C., Jr., 1920, Some anticlines of Routt County: U.S. Geological Survey Bulletin 23, 61 p.

Dames and Moore, 1979, Coal resource occurrence and coal development potential maps of the Dunckley quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File Report, 79-813, 23 p.

____1980a, Coal resource occurrence and coal development potential maps of the Milner quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File Report 79-815, 33 p.

____1980b, Coal resource occurrence and coal development potential maps of the Oak Creek quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File Report 79-818, 44 p.

_____1980c, Coal resource occurrence and coal development potential maps of the Mount Harris quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File Report 79-821 30 p.

_____1980d, Coal resource occurrence and coal development potential maps of the Hayden quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File Report 79-825, 27 p.

_____1980e, Coal resource occurrence and coal development potential maps of the Breeze Mountain quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File 79-1393, 42 p.

____1980f, Coal resource occurrence and coal development potential maps of the Pagoda quadrangle, Routt and Moffatt Counties, Colorado: U.S. Geological Survey Open-File Report 79-1394, 34 p.

____1980g, Coal resource occurrence and coal development potential maps of the Hayden Gulch quadrangle, Routt County, Colorado: U.S. Geological Survey Open-File Report 79-1395, 35 p.

____1980h, Coal resource occurrence and coal development potential maps of the Rattlesnake Butte quadrangle, Routt County, Colorado: U.S Geological Survey Open-File Report 79-1396, 39 p.

Donaldson, J.C., and Macmillan, L.T. , 1980, Oil and Gas—History, development and principal fields in Colorado, in Kent, H.C., and Porter, K.W., eds., Colorado Geology: Denver, Rocky Mountain Association of Geologists, p. 175-189.

Dyni, J.R., 1966, Geologic map of the Thornburg oil and gas field and vicinity, Moffatt and Rio Blanco Counties, Colorado: U.S. Geological Survey Oil and Gas Investigation Map OM-216, scale 1:24,000.

Emmons, S.F., 1887, Valleys of the upper Yampa and Little Snake Rivers, in Hague, Arnold, and Emmons, S.F., Descriptive geology, v. 2 of Report of the geological exploration of the fortieth parallel [King survey]: Washington, D.C., U.S. Army Department of Engineers Professional Papers no. 18, p. 184-187.

Fatt, Irving, 1958, Compressibility of sandstones at low to moderate pressures: American Association of Petroleum Geologists Bulletin, v. 42, no. 8, p. 1924-1957.

Fenneman, N.H., and Gale, H.S., 1906, The Yampa coal field, Routt County, Colorado: U.S. Geological Survey Bulletin 297, 81 p.

Garrels, R.M., and Christ, C.L., 1965, Solution, minerals, and equilibria: San Francisco, Freeman, Cooper, and Co., 450 p.

Green, J.W., Dalsted, N.L., Moffet, M.H., and Winters, D.K., 1980, Colorado coal resources, production, and distribution: U.S. Environmental Protection Agency Energy Policy Coordination Report, 45 p.

Hancock, E.T., 1925, Geology and coal resources of the Axial and Monument Butte quadrangles, Moffat County, Colorado: U.S. Geological Survey Bulletin 757, 134 p.

Hem, J.D., 1970, Study and interpretation of chemical characteristics of natural water (2nd ed.): U.S. Geological Survey Water-Supply Paper 1473, 363 p.

Hewett, G.C., 1889, The northwestern Colorado coal region: American Institute of Mining Engineering Transactions, v. 17, p. 375-380.

Hills, R.C., 1893, Coal fields of Colorado: U.S. Geological Survey Mineral Resources 1892, p. 319-365.

Horn, G.H., 1959, Geologic and structure map of the Williams Fork Mountains coal field, Moffat County, Colorado: U.S. Geological Survey open-file map, scale 1:24,000.

Hounslow, Arthur, and Fitzpatrick, Joan, 1978, Overburden mineralogy as related to groundwater chemical changes in coal strip mining: U.S. Environmental Protection Agency Report 600/7-78-156, 299 p.

Hunt, C.B., 1969, Geologic history of the Colorado River: U.S. Geologic Survey Professional Paper 669-C, 71 p. Kerr, E.G., 1958, Geology of the Pagoda area, Routt and Moffat Counties, northwestern Colorado: Golden, Colorado School of Mines, unpublished Master's thesis, 124 p.

Kincaid, C.T., Morrey, J.R., and Rogers, J.E., 1982-1986, Geohydrochemical models for solute migration: Palo Alto, Calif., Electric Power Research Institute report EA-3417, 3 v.

Kiteley, L.W., 1980, Facies analysis of the lower cycles of the Mesaverde Group (upper Cretaceous) in northwestern Colorado: Boulder, Colo., University of Colorado, Master's thesis, 153 p.

Klinkenberg, L.J., 1941, The permeability of porous media to liquids and gases: American Petroleum Institute, Drill Production Practice, 200 p.

Kohler, M.A., Nordenson, T.J., and Baker, D.R., 1959, Evaporation map for the United States: U.S. Weather Bureau, Technical Paper 37, 13 p.

Konikow, L.F., and Bredehoeft, J.D., 1978, Computer model of two-dimensional solute transport and dispersion in ground water: U.S. Geological Survey Techniques of Water-Resources Investigations, chap. C2, bk. 7, 90 p.

Konishi, Kenji, 1959, Upper Cretaceous surface stratigraphy, Axial basin and Williams Fork area, Moffat and Routt Counties, Colorado, in Haun, J.D. and Weimer, R.J., eds., Cretaceous rocks of Colorado and adjacent areas (Wyoming): Denver, llth Field Conference, Washakie Sand Wash and Piceance basins—Guidebook, Rocky Mountain Association of Geologists, p. 67-73.

Kucera, R.E., 1959, Cretaceous strata of the Yampa district, northwestern Colorado, in Haun, J.D., and Weimer, R.J., eds., Cretaceous rocks of Colorado and adjacent areas (Wyoming): Denver, llth Field Conference, Washakie Sand Wash and Piceance basins—Guidebook, Rocky Mountain Association of Geologists, p. 37-45.

____1962, Geology of the Yampa district, northwest Colorado: Boulder, University of Colorado, unpublished Ph.D. dissertation, 575 p.

Lauman, G.W., 1965, Geology of the Iles Mountain area, Moffat County, northwestern Colorado: Golden, Colorado School of Mines, unpublished Master's thesis, 129 p.

Lohman, S.W., 1972, Definition of selected ground-water terms--Revisions and conceptual refinements: U.S. Geological Survey Water-Supply Paper 1988, 21 p.

Martin, J.E., 1980, Colorado energy production for the 80's: Aspen Colorado Energy Research Institute, 44 p.

Masters, C.D., 1967, Sedimentology of the Mesaverde Group and upper portion of the Mancos Formation, northwestern Colorado: New Haven, Conn., Yale University Master's thesis, 2 v.

Maura, W.S., 1982, Water-quality data for streams in the southern Yampa River Basin, northwestern Colorado: U.S. Geological Survey Open-File Report 82-1017, 112 p.

____1985, Selected trace-element data for streams in the southern Yampa River Basin, northwestern Colorado: U.S. Geological Survey, Open-File Report 85-192, 154 p.

McDonald, M.G., and Harbough, A.W., 1984, A modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 83-875, 528 p.

McWhorter, D.B., Rowe, J.W., Van Liew, M.W., Chandler, R.L., Skogerbee, R.K., Sunada, O.K., Skogerbee, G.V., 1979, Surface and subsurface water quality in surface mined watersheds: Cincinnatti, Ohio, Industrial Environmental Research Laboratory, EPA report 600/7-79-1932, 1 v.

Miller, A.E., 1975, Geology energy and mineral resources of Routt County, Colorado: Denver, Colo., U.S. Geological Survey Map Series 1, 2 sheets, scale not given.

National Oceanic and Atmospheric Administration, 1890-1987, Climatological data, Colorado: Asheville, N.C., National Climate Data Center, 92 p.

Parsons, H.F., and Liddell, C.A., 1903, Coal and mineral resources of Routt and Moffat Counties, Colorado: U.S. Geological Survey Bulletin no. 24, p. 7-46.

Parker, R.S., and Norris, J.M., 1989, Simulation of streamflow in small drainage basins in the southern Yampa River Basin, Colorado: U.S. Geological Survey Water-Resources Investigations Report 88-4071, 47 p.

Robson, S.G., 1974, Feasibility of digital water-quality modeling illustrated by application at Barstow, California: U.S. Geological Survey Water-Resources Investigations 73-46, 66 p.

Ryer, T.A., 1977, Geology and coal resources of the Foidel Creek EMRIA site and surrounding area, Routt County, Colorado: U.S. Geological Open-File Report 77-303, 31 p.

Science Applications, Inc., 1981, Tabulation of waste isolation computer models: Columbus, Ohio, Battelle Memorial Institute, ONWI-78, 1 v.

Sears, J.D., 1924, Geology and oil and gas prospects of part of Moffat County, Colorado, and southern Sweetwater County, Wyoming: U.S. Geological Survey Bulletin 751-G, p. 269-319.

Stewart, M.H., 1983, Hydrogeology of the upper part of the Mesaverde Group, Williams Fork Mountains, Routt and Moffat Counties, Colorado: Golden, Colorado School of Mines, thesis ER-2546, 210 p.

Storrs, L.S., 1902, The Rocky Mountain coal fields: U.S. Geological Survey twenty-second Annual Report, pt. 3, p. 415-471.

Thomas, S.D., Ross, Benjamin, and Mercer, J.W., 1982, A summary of repository siting models: Washington, B.C., U.S. Nuclear Regulatory Commission, NUREG/CR-2782, 237 p.

Turk, J.T., and Parker, R.S. 1982, Water-quality characteristics of six small semiarid watersheds in the Green River coal region of Colorado: U.S. Geological Survey Water-Resources Investigations 81-19, 96 p.

Tweto, Ogden, 1976, Geologic map of the Craig 1˚X2˚ quadrangle, northwestern Colorado: U.S. Geological Survey Miscellaneous Investigations Series Map 1-972, scale 1:1,000,000, 1 sheet.

___1980, Summary of Laramide orogeny in Colorado, in Kent, H.C., and Porter, K.W. , eds., Colorado Geology: Denver, Rocky Mountain Association of Geologists, p. 129-134.

U.S. Bureau of the Census, 1981, Final population and housing unit counts, Colorado (1980): Report PHC 80-V-7, 15 p.

U.S. Department of the Interior, 1976, Final environmental statement, northwest Colorado coal, regional analysis: 4 v.

Warner, J.W., and Dale, R.D., 1981, Digital-transport model study of the probable effects of coal-resource development on the ground-water system in the Yampa River basin, Moffat and Routt Counties, Colorado: U.S. Geological Survey Water-Resources Investigations 81-15, 70 p.

Weeks, J.B., Leavesley, G.H., Welder, F.A., and Saulnier, G.T., Jr., 1974, Simulated effects of oil-shale development on the hydrology of Piceance Basin, Colorado: U.S. Geological Survey Professional Paper 908, 84 p.

Weimer, R.J., 1976, Stratigraphy and tectonics of western coals, in Murray, O.K., ed., Geology of Rocky Mountain coal, 1976 symposium: Colorado Geological Survey Resource Series 1, p. 9-27.

Weston, W., 1904, The hydrocarbon field of western Colorado and eastern Utah of the projected line of the Denver, Northwestern and Pacific Railroad: Denver, Northwestern and Pacific Railroad report.

____1909, The Yampa coalfield of Routt County, Colorado, on the projected line of the Denver, Northwestern and Pacific Railroad (Moffat Road): Publisher unknown, 58 p.

____1914, The Yampa coalfield of Routt County, Colorado, of the line and the extension as projected of the Denver and Salt Lake Railroad (Moffat Road): Denver, Denver and Salt Lake Railroad report, 62 p.

White, C.A., 1878, Report on the geology of a portion of northwestern Colorado: U.S. Geological Survey and Geographic Survey of theTerritories, 10th Annual Report, p. 1-60.

___1889, The geology and physiography of a portion of northwestern Colorado and adjacent parts of Utah and Wyoming: U.S. Geological Survey 9th Annual Report, p. 677-712.

Willson, Kenneth, 1920, Northern part of the Tow Creek anticline, Routt County, Colorado: Boulder, University of Colorado, unpublished Master's thesis, 50 p.

Zapp, A.D., and Cobban, W.A., 1960, Some late Cretaceous strand lines in northwestern Colorado and northeastern Utah, in Geologic research, 1960--short papers in the geological sciences: U.S. Geological Survey Professional Paper 400-B, p. 246-249.