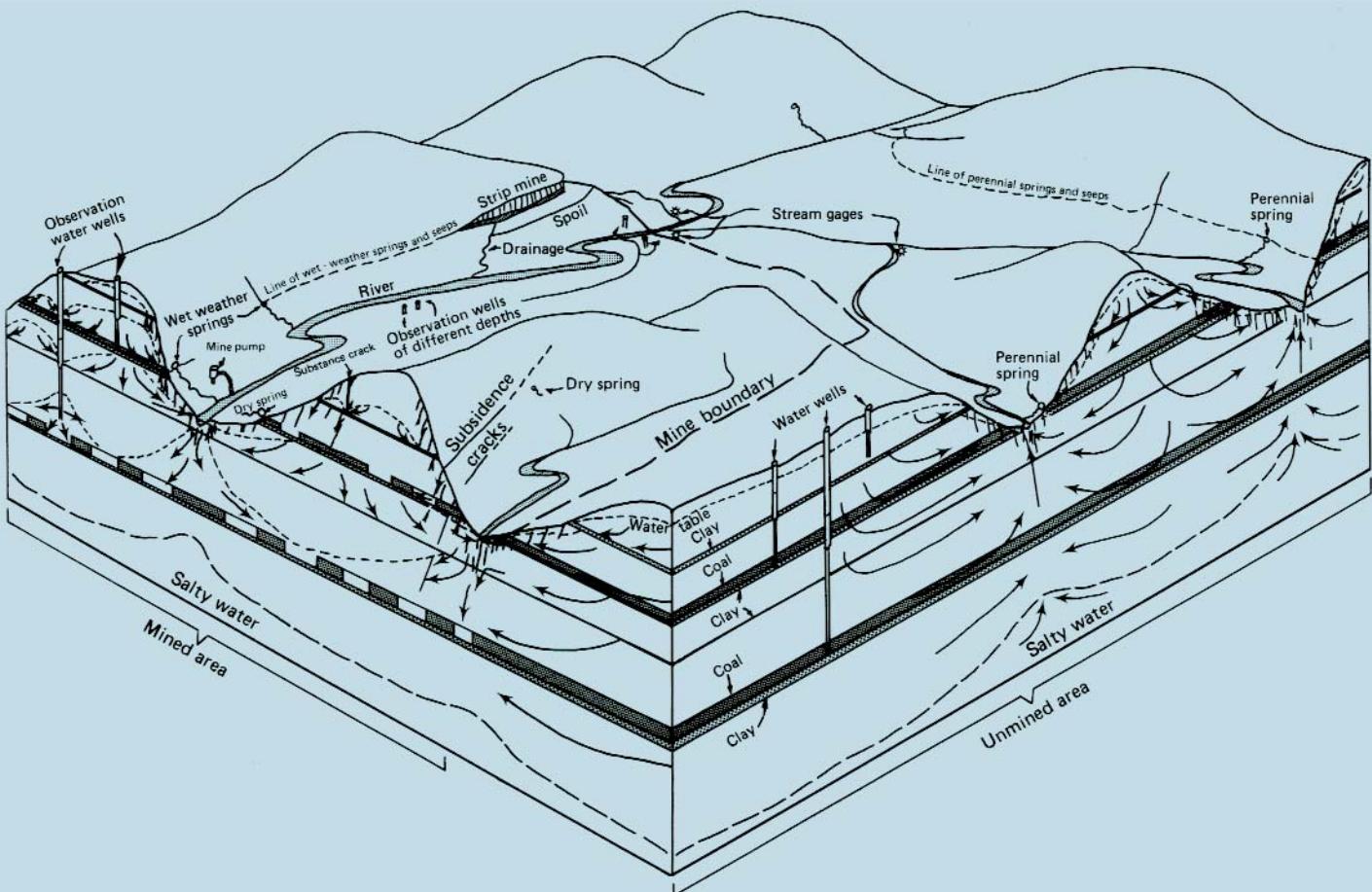


**GROUND-WATER INFORMATION MANUAL:
COAL MINE PERMIT APPLICATIONS — VOLUME II**



Prepared in cooperation with
U.S. Geological Survey

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VOLUME II**

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U. S. DEPARTMENT OF THE INTERIOR
Office of Surface Mining Reclamation and Enforcement

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CONVERSION FACTORS AND ABBREVIATIONS

For use of readers who prefer to use metric (SI) units,
conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
Length		
inch (in.)	25.4	millimeters (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
Area		
acre	4,047.	square meter (m^2)
square inch (in^2)	6.452	square centimeter (cm^2)
square foot (ft^2)	929.0	square centimeter (cm^2)
square foot (ft^2)	0.09294	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
Volume		
gallon (gal)	0.003785	cubic meter (m^3)
million gallons (Mgal)	3,785.	cubic meter (m^3)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
Flow		
Velocity		
foot per second (ft/s)	0.3048	meter per second (m/s)
foot per day (ft/d)	0.048	meter per day (m/d)
mile per hour (mi/h)	1.609	kilometer per hour (km/h)
Discharge		
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)
Mass		
ounce, avoirdupois (oz)	28.35	gram (g)
pound, avoirdupois (oz)	453.6	gram (g)
ton, short	0.9072	megagram (Mg)
Temperature		
degree Fahrenheit ($^{\circ}F$)	$^{\circ}C =$	degree Celsius ($^{\circ}C$)

Use of brand names throughout this manual is for identification purposes only and does not imply endorsement by U.S. Geological Survey.

PREFACE

The Surface Mining Control and Reclamation Act of 1977 requires that hydrologic information on the aquifers above and below the coal beds (or seams) to be mined be submitted with the permit application. With this information, the regulatory authority can evaluate the potential impact of the proposed mine on the aquifer system(s), as well as assess the cumulative hydrologic impacts of the proposed mine, or mines, on the adjoining properties.

The purpose of this manual, consisting of volumes I and II, is to assist applicants for coal mining permits in (1) describing the ground-water conditions in the vicinity of a permit area, and (2) assessing the potential impacts of mining on the ground-water resources in the area adjacent to the proposed site. The manual is directed at a moderately technical audience. The applicant, or the consultant for the applicant, is assumed to have a bachelor's degree in hydrology, engineering, or geology, or its equivalent, with a basic background in science, including mathematics, chemistry, and physics.

This manual describes four principal subjects: (1) the geologic setting of the bedrock units containing the coal to be mined, (2) the hydrologic setting (primarily ground water), including low flow in streams and its relationship with ground water (or lack of); (3) the potential impacts of mining on the ground-water resources; and, (4) the data requirements or monitoring plan for an impact analysis. Detailed discussions of these subjects are presented in volume I.

In volume II, the results of 11 ground-water studies are compiled. Each study is self-contained and is the result of a geohydrologic investigation conducted in cooperation with other State and Federal agencies, in one of the various coal provinces in the conterminous United States (see figure 1). These studies include the geologic and hydrologic settings and other hydrologic information. Their interrelation with volume I is shown in table 1.

In preparing the permit application, the applicant can use the studies in this manual as examples for presentation of ground-water information. However, these studies are not comprehensive in presenting the ground-water situations for all geologic and hydrologic settings. Also, the content of each of these studies is not directed at satisfying the requirements of the State regulatory authority. Thus, some studies may not contain sufficient hydrologic information to satisfy all the requirements of all regulatory agencies.

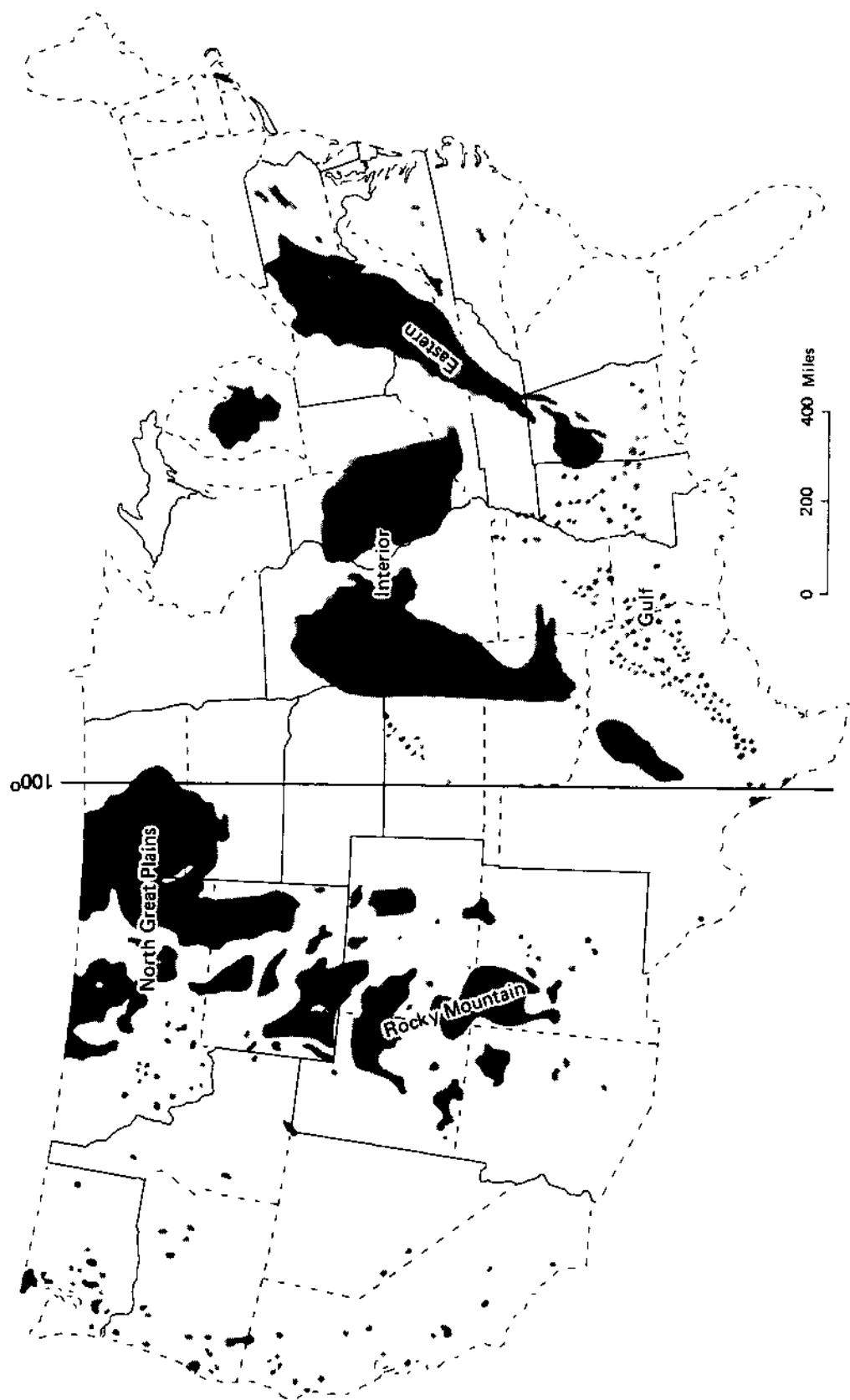


Figure 1.—Location of coal provinces in conterminous United States.
(Modified from Trumbull, 1960, sheet 1.)

Table 1.

Selected ground-water studies.
[X, indicates the occurrence of analysis for respective ground-water study.]

Ground-water study number	Geologic setting ^{1/}	Mining method ^{2/}	Availability of hydrologic data ^{3/}	Pre-mining mining data	Post-mining mining data	Stream-aquifer interaction	Aquifer properties	Soils-profile hydrogeology	Model analyses	Statistical analyses	Remarks (significant features of the study)
1	1	D,E	S	G,Q	X	X	X				Slug-test analysis; impacts on hydrologic system.
2	3,8	D,E	S,U	S,G,Q	X	X	X		X		Fracture-trace analysis; hydrologic-budget analysis; detailed water-quality analysis.
3	1	E	S	S,G,Q	X	X	X		X		Hydrologic-budget modeling; detailed water-quality analyses.
4	1	G	U	S,G,Q	X	X	X		X		Secondary permeability; aquifer test analyses; cross-sectional aquifer modeling.
5	1,7,8	D	U	S,G,Q	X	X	X		X		Fracture-trace analyses; subsidence; base-flow modification; detailed aquifer analyses.
Interior Province											
6	6	C,D	S	G	X	X	X	X	X		Alluvial aquifer(glacial); slug-test analysis; analytical dewatering models.
7	1	G	S,U	S,G,Q	X	X	X		X		Flow duration; water-quality regionalization.
Northern Great Plains Province											
8	1	E,G	S	S,G,Q	X	X	X		X		Geochemical analyses; detailed aquifer analyses and modeling.
9	1	C,D	S	G,Q	X	X	X		X		Geochemical & aquifer modeling; potentiometric and permeability maps; lignite.
Rocky Mountain Province											
10	1	D,E	S	S,G,Q	X	X			X		Transmissivity map; lignitic coal; detailed water-quality analyses; potentiometric map.
11	1,4	E,G	S,U	G,Q	X	X	X		X		Secondary permeability; potentiometric maps; detailed aquifer analysis; aquifer modeling.
^{1/} Geologic Setting: 1, Flat lying coal bed; 3, Synclinal geologic structure; 4, Low-angle dipping coal bed; 6, Coal bed 'under' stream valley; 7, Coal beds and fault structures; 8, Fractured bedrock caused by mine subsidence.											
^{2/} Hydrologic Setting: C, Coal bed in contact with saturated unconsolidated deposits; D, Coal bed in contact with confined bedrock aquifer; E, Coal bed in contact with unconfined aquifer; G, Coal bed within multi-layered aquifer system.											
^{3/} Mining Method: S, Surface; U, Underground.											
^{4/} Availability of Hydrologic Data: S, Streamflow data; G, Ground-water data; Q, Quality of water data.											