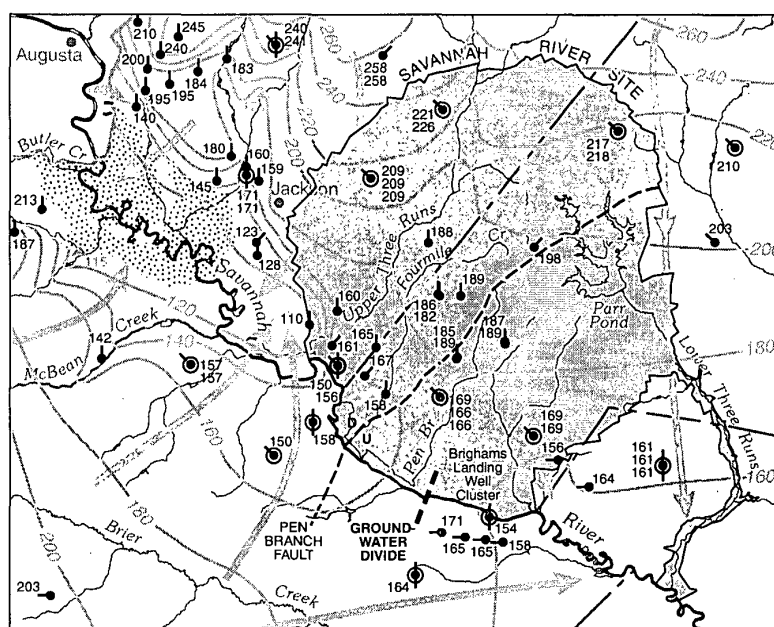


GROUND-WATER LEVELS, PREDEVELOPMENT GROUND-WATER FLOW, AND STREAM-AQUIFER RELATIONS IN THE VICINITY OF THE SAVANNAH RIVER SITE, GEORGIA AND SOUTH CAROLINA

U.S GEOLOGICAL SURVEY



Prepared in cooperation with the
U.S. DEPARTMENT OF ENERGY

**GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY**

Water-Resources Investigations Report 97-4197

GROUND-WATER LEVELS, PREDEVELOPMENT GROUND-WATER FLOW, AND STREAM-AQUIFER RELATIONS IN THE VICINITY OF THE SAVANNAH RIVER SITE, GEORGIA AND SOUTH CAROLINA

By John S. Clarke and Christopher T. West

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 97-4197

Prepared in cooperation with the

U.S. DEPARTMENT OF ENERGY and the

GEORGIA DEPARTMENT OF NATURAL RESOURCES

ENVIRONMENTAL PROTECTION DIVISION

GEORGIA GEOLOGIC SURVEY



U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Thomas J. Casadevall, Acting Director

For additional information write to:

District Chief
U.S. Geological Survey
3039 Amwiler Road
Peachtree Business Center, Suite 130
Atlanta, GA 30360

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
Denver Federal Center
Box 25286
Denver, CO 80225-0286

CONTENTS

Abstract	1
Introduction	2
Purpose and scope	3
Description of study area	3
Physiography	3
Climate	6
Drainage and runoff	6
Previous investigations	9
Methods of study	10
Well-numbering system	11
Acknowledgments	11
Hydrogeology	12
Geologic setting	12
Hydrogeologic units	14
Geologic characteristics of the Savannah River alluvial valley	15
Ground-water levels	17
Factors influencing ground-water levels	19
Ground-water withdrawal	19
Precipitation	23
Seasonal water-level fluctuations and long-term trends by aquifer	26
Floridan aquifer system	30
Upper Three Runs aquifer	30
Gordon aquifer	37
Dublin aquifer system	42
Millers Pond aquifer	42
Upper Dublin aquifer	49
Lower Dublin aquifer	49
Midville aquifer system	60
Upper Midville aquifer	61
Lower Midville aquifer	61
Vertical head differentiation within aquifers and aquifer systems	75
Predevelopment ground-water flow	76
Conceptualization of ground-water flow	77
Potentiometric surfaces	77
Previous studies of potentiometric surfaces	80
Upper Three Runs aquifer	80
Gordon aquifer	81
Dublin aquifer system	83
Midville aquifer system	84
Recharge-discharge relations	85
Stream-aquifer relations	91
Savannah River	92
Other streams	94
Influence of river incision	94
Trans-river flow	99
Summary and conclusions	100
Selected references	104
Appendix—Data for selected wells in the vicinity of the Savannah River Site, Georgia and South Carolina	113

ILLUSTRATIONS

Plates

[in pocket in back of report]

Plate	1	Maps showing estimated predevelopment potentiometric surface of the:
		1a. Upper Three Runs aquifer
		1b. Gordon aquifer
		1c. Upper and lower Dublin aquifers
		1d. Upper and lower Midville aquifers
Figures	1-3.	Maps showing:
		1a. Location of study area, Savannah River Site, well-cluster sites, and physiographic districts in Georgia and South Carolina 4
		1b. Areal and local ground-water contamination at the Savannah River Site, South Carolina 5
	2.	Mean-annual rainfall in the study area, 1941-70, and locations of precipitation-monitoring sites 7
	3.	Mean annual runoff in Georgia part of study area, 1941-70, and locations of selected streamflow-gaging stations 8
Figure	4.	Chart showing comparison of hydrogeologic units and names applied to the P-21/P5R testhole at the Savannah River Site, South Carolina 13
Figures	5-6.	Maps showing:
		5. Subsurface extent of hydrogeologic units beneath the Savannah River alluvial valley 16
		6. Ground-water-pumping centers that withdrew more than 1 million gallons per day during 1987-92 20
Figure	7.	Bar graphs showing ground-water withdrawal near the Savannah River, 1953-92 22
	8.	Pie chart showing estimated ground-water withdrawal by county in the vicinity of the Savannah River Site, Georgia and South Carolina 24
	9.	Pie chart showing estimated ground-water withdrawal by aquifer or aquifer system in the vicinity of the Savannah River Site, Georgia and South Carolina, 1953-92 25
Figure	10.	Graphs showing cumulative departure from normal precipitation for selected sites, July 1948 through December 1992 26
	11.	Boxplot showing seasonal water-level change in aquifers, May–October, 1992 28
	12.	Hydrograph showing daily mean water levels in wells 28X001 and 31Z033, Burke County, Georgia; and well 32X040, Screven County, Georgia, 1992 28
	13.	Boxplot showing maximum observed water-level change in aquifers prior to 1993 30
	14.	Map showing observed water-level change during May–October 1992 in wells completed in the Upper Three Runs aquifer 31
Figures	15-16.	Graphs showing daily mean water levels in selected wells completed in the Upper Three Runs aquifer in:
		15. Northern Screven County, Georgia, and precipitation at Midville, Georgia, December 1993–December 1995 33
		16. Burke County, Georgia, and Barnwell County, South Carolina, and precipitation at Augusta, Georgia, December 1993–December 1995 34
Figure	17.	Map showing maximum observed water-level change during the period of record in selected wells completed in the Upper Three Runs aquifer 35

ILLUSTRATIONS—Continued

- Figures 18-19. Graphs showing:
18. Daily mean and periodic water levels in selected wells completed in the Upper Three Runs aquifer; cumulative departure from normal (1948-92) precipitation; and estimated pumpage from the Upper Three Runs aquifer in the South Carolina part of study area, 1948-92 **36**
 19. Daily mean and periodic water levels in selected wells completed in the Upper Three Runs aquifer; cumulative departure from normal (1948-82) precipitation; and estimated pumpage from the Upper Three Runs aquifer in the Georgia part of study area, 1948-92 **38**
- Figure 20. Map showing observed water-level change during May-October 1992 in wells completed in the Gordon aquifer **39**
21. Graphs showing daily mean water levels in selected wells completed in the Gordon aquifer in South Carolina and Georgia; daily mean stream stage at the Savannah River; and daily precipitation at Augusta, Georgia, December 1993–December 1995 **40**
 22. Map showing maximum observed water-level change during the period of record in wells completed in the Gordon aquifer **41**
- Figures 23-24. Graphs showing:
23. Daily mean and periodic water levels in selected wells completed in the Gordon aquifer; cumulative departure from normal (1948-92) precipitation; and estimated pumpage from the Gordon aquifer in the South Carolina part of study area, 1952-92 **43**
 24. Periodic water levels in selected wells completed in the Gordon aquifer; cumulative departure from normal (1948-92) precipitation; and estimated pumpage from the Gordon aquifer in the Georgia part of study area, 1946-92 **44**
- Figure 25. Map showing observed water-level change during May-October 1992 in wells completed in Millers Pond aquifer **45**
26. Graphs showing daily mean water levels in well 30Z028 completed in the Millers Pond aquifer in Burke County, Georgia; daily mean stream stage at the Savannah River; and daily precipitation at Augusta, Georgia, December 1993–December 1995 **46**
 27. Map showing location of long-term monitoring wells completed in the Millers Pond aquifer **47**
 28. Graphs showing periodic water levels in selected wells completed in the Millers Pond aquifer; cumulative departure from normal (1948–92) precipitation; and estimated pumpage from the Millers Pond aquifer in the South Carolina part of study area, 1985-92 **48**
 29. Map showing observed water-level change during May-October 1992 in wells completed in upper Dublin aquifer **50**
 30. Graphs showing daily mean water levels in well AK-825, completed in the upper Dublin aquifer in Aiken County, South Carolina; and daily precipitation at Augusta, Georgia, December 1993–December 1995 **51**
 31. Map showing maximum observed water-level change during the period of record in wells completed in the upper Dublin aquifer **52**
 32. Graphs showing daily mean and periodic water levels in selected wells completed in the upper Dublin aquifer; cumulative departure from normal (1948-92) precipitation; and estimated pumpage from the upper Dublin aquifer in the South Carolina part of study area, 1952-92 **53**
 33. Map showing observed water-level change during May–October 1992 in wells completed in the lower Dublin aquifer **54**

ILLUSTRATIONS—Continued

- Figures 34-35. Graphs showing daily mean water levels in:
34. The upper and lower Dublin aquifers at the C-2 well-cluster site, Aiken County, South Carolina, and daily precipitation at Augusta, Georgia, December 1993–December 1995 **55**
 35. Selected wells completed in the lower Dublin aquifer in Burke and Screven Counties, Georgia; daily mean stream stage at the Savannah River; and daily precipitation at Augusta, Georgia, December 1993–December 1995 **56**
- Figure 36. Map showing maximum observed water-level change during the period of record for wells completed in the lower Dublin aquifer **58**
- Figures 37-38. Graphs showing:
37. Daily mean and periodic water levels in selected wells completed in the lower Dublin aquifer; cumulative departure from normal (1948-92) precipitation; and estimated pumpage from the lower Dublin aquifer in the South Carolina part of study area, 1951-92 **59**
 38. Periodic water levels in selected wells completed in the lower Dublin aquifer; cumulative departure from normal (1948-92) precipitation at Augusta, Georgia; and estimated pumpage from the lower Dublin aquifer in the Georgia part of the study area, 1967-92 **60**
- Figure 39. Map showing observed water-level change during May-October 1992 in wells completed in the upper Midville aquifer **62**
40. Graphs showing daily mean water levels in the upper Midville aquifer in Burke County, Georgia, and Aiken County, South Carolina; daily mean stream stage at the Savannah River; and daily precipitation at Augusta, Georgia, December 1993–December 1995 **63**
 41. Map showing maximum observed water-level change during the period of record in wells completed in upper Midville aquifer **64**
- Figures 42-43. Graphs showing:
42. Periodic water levels in selected wells completed in the upper Midville aquifer; cumulative departure from normal (1948-92) precipitation; and estimated pumpage from the upper Midville aquifer in the South Carolina part of study area, 1952-92 **65**
 43. Periodic water levels in well 26Z006, completed in the upper Midville aquifer in Jefferson County, Georgia; cumulative departure from normal (1948–92) precipitation at Augusta, Georgia; and estimated pumpage from the upper Midville aquifer in the Georgia part of study area, 1975–92 **66**
- Figure 44. Map showing observed water-level change during May-October 1992 in wells completed in the lower Midville aquifer **67**
- Figures 45-47. Graphs showing daily mean water levels in:
45. The lower Midville aquifer at the C-6 well-cluster site, Barnwell County, South Carolina, and in the upper and lower Midville aquifers at the C-2 well-cluster site, Aiken County, South Carolina; and daily precipitation at Augusta, Georgia, December 1993–December 1995 **68**
 46. Selected wells completed in the lower Midville aquifer at well-cluster sites, Burke and Screven Counties, Georgia; daily mean stream stage at the Savannah River; and daily precipitation at Augusta, Georgia, December 1993–December 1995 **70**
 47. Well 28X001, completed in the upper and lower Midville aquifers, Burke County, Georgia, and daily precipitation at Augusta, Georgia, December 1993–December 1995 **71**
- Figure 48. Map showing maximum observed water-level change during the period of record in wells completed in lower Midville aquifer **72**

ILLUSTRATIONS—Continued

- Figures 49-50. Graphs showing daily mean and periodic water levels in selected wells completed in the lower Midville aquifer in:
- 49. South Carolina; cumulative departure from normal (1948-92) precipitation; and estimated pumpage from the lower Midville aquifer in the South Carolina part of study area, 1952-92 73
 - 50. Georgia; cumulative departure from normal (1948-92) precipitation at Augusta, Georgia; and estimated pumpage from the lower Midville aquifer in the Georgia part of study area, 1966-92 74
- Figure 51. Schematic diagram of the hydrologic flow system in the vicinity of the Savannah River Site, South Carolina and Georgia 78
- Figures 52-54. Maps showing generalized vertical head difference between the:
- 52. Upper Three Runs and Gordon aquifers 86
 - 53. Gordon and upper/lower Dublin aquifers 87
 - 54. Upper/lower Dublin and upper/lower Midville aquifers 88
55. Map showing vertical head relations at selected well-cluster sites 90
56. Schematic diagram of artesian water gap and related pattern of ground-water flow 98

TABLES

Table	1. Water-level altitudes at selected well-cluster sites in the vicinity of the Savannah River Site, Georgia and South Carolina 17
	2. Industrial and municipal ground-water pumping centers in the vicinity of the Savannah River Site, Georgia and South Carolina, and average annual ground-water withdrawal, 1987-92 19
	3. Annual water-level fluctuations in selected wells in the vicinity of the Savannah River Site, Georgia and South Carolina, 1994 and 1995, based on continuous measurements 29
	4. Water-level altitudes in water-bearing zones of the Upper Three Runs aquifer at selected well-cluster sites 75
	5. Water-level altitudes in water-bearing zones of the Gordon aquifer at selected well-cluster sites 76
	6. Number of wells, by period, used to construct predevelopment potentiometric-surface maps 79
	7. Summary of estimated ground-water discharge to the Savannah River in the vicinity of the Savannah River Site, Georgia and South Carolina 93
	8. Mean-annual ground-water discharge to selected streams in the vicinity of the Savannah River Site, Georgia and South Carolina, based on hydrograph separation 95
	9. Estimated ground-water discharge to selected streams in the vicinity of the Savannah River Site, Georgia and South Carolina, during the 1954 and 1986 droughts 96

